CEEC	Central and east European countries
CHP	Combined heat and power
CIS	Commonwealth of Independent States
DG	Directorate-General
EU	European Union
EU-15	European Union before the enlargement of May 2004
EU-25	Enlarged European Union
GDP	Gross domestic product
GIC	Gross inland consumption
Gpkm	Gigapassenger-kilometre
Gtkm	or 10^9 passenger-kilometre Gigatonne-kilometre or 10^9 tonne-kilometre
GW	Gigawatt, or 10^9 watt
IEA	International Energy Agency
km	Kilometre
ktoe	Thousand toe
kWh	Kilowatt-hour
MEuro	Million euro
Mt	Million metric tonnes
Mtoe	Million toe
NMS	New Member States
OECD	Organisation for Economic Cooperation and Development
pkm	Passenger-kilometre (one passenger transported a distance of one kilometre)
Eurostat	Statistical Office of the European Communities
t	Metric tonne, or 1 000 kilogrammes
tkm	Tonne-kilometre (one tonne transported a distance of one kilometre)
toe	Tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
TWh	Terawatt-hour, or 10^{12} watt-hour
UN	United Nations

Price (excluding VAT) in Luxembourg: EUR 45

Publications Office
Publications.eu.int

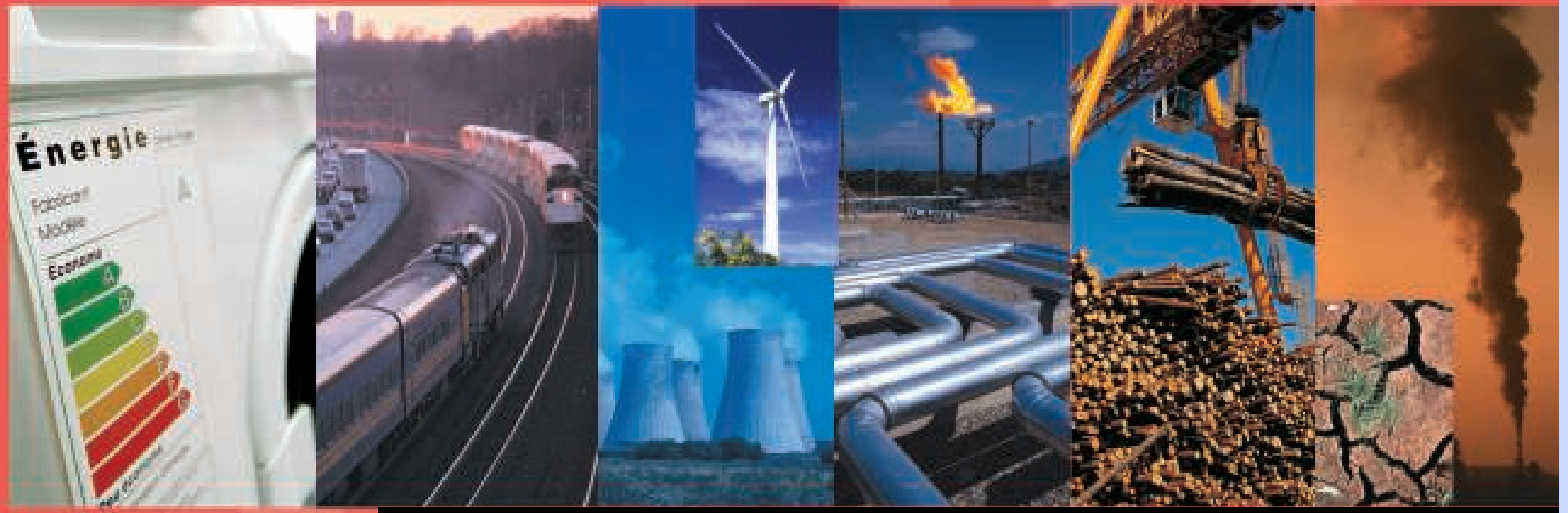
ISBN 92-894-6684-7
9 789289 466844

7 12 17
KO-AC-03-001-EN-C

EUROPEAN ENERGY AND TRANSPORT — SCENARIOS ON KEY DRIVERS

SEPTEMBER 2004

EUROPEAN ENERGY AND TRANSPORT



Scenarios on key drivers

Directorate-General for Energy and Transport
EUROPEAN COMMISSION

SALES AND SUBSCRIPTIONS

Publications for sale produced by the Office for Official Publications of the European Communities are available from our sales agents throughout the world.

How do I set about obtaining a publication?

Once you have obtained the list of sales agents, contact the sales agent of your choice and place your order.

How do I obtain the list of sales agents?

- Go to the Publications Office website http://publications.eu.int/
- Or apply for a paper copy by fax (352) 2929 42758

European Commission
Directorate-General for Energy and Transport

EUROPEAN ENERGY AND TRANSPORT SCENARIOS ON KEY DRIVERS

SEPTEMBER 2004

Includes a CD-ROM with detailed results and supporting documents

This publication was prepared by National Technical University of Athens, E3M-Lab, Greece

Dr. L. Mantzos (main author), Prof. P. Capros and M. Zeka–Paschou

In cooperation with:

Prof. J. Chesshire (Volume editor)

J.F. Guilmot (ESAP SA, Belgium)

The manuscript was completed on 30 July 2004.

Any comments and questions on this publication may be sent to: tren-projections@cec.eu.int

Cataloguing data can be found at the end of this publication.

Luxembourg: Office for Official Publications of the European Communities, 2004

ISBN 92-894-6684-7

Printed in Belgium

PRINTED ON WHITE CHLORINE-FREE BLEACHED PAPER

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

CD CONTENTS

The attached CD includes in pdf format:

- The present publication in electronic format (Scenarios on key drivers.pdf),
- The recent publication of the European Commission "European Energy and Transport – Trends to 2030" (Trends to 2030.pdf),
- A background study on global energy developments (World Energy Scenarios.pdf) prepared by IEPE (Institut d'Economie et de Politique de l'Energie/CNRS-UPMF Grenoble)

Under the **PRIMES model results and assumptions** directory a sub-directory is defined for each Chapter of the "Scenarios on key drivers" publication. In each **Chapter** sub-directory different sub-directories are defined that provide background material for the cases examined in the context of the study.

In each sub-directory the user can find **detailed tables** for the corresponding scenario on energy, transport and environment developments by group of countries (EU-25, EU-15, New Member States (NMS) and Europe-30) both as regards the developments over time within the respective scenarios and in comparison to the Baseline scenario. In addition **aggregate results** by Member State and by group of countries (again including both level projections and comparisons to the Baseline scenario) for the corresponding scenario are provided. The different **macro-economic assumptions** of the analysis (where applicable) are also available from the CD by Member State and group of countries.

Finally, there is a summary description of the PRIMES model under the directory **Model Description**. .

DEFINITIONS & UNITS

CEEC	Central and east European countries
CHP	Combined heat and power
CIS	Commonwealth of Independent States
DG	Directorate-General
EU	European Union
EU-15	European Union before the enlargement of May 2004
EU-25	Enlarged European Union
GDP	Gross domestic product
GIC	Gross inland consumption
Gpkm	Gigapassenger-kilometre or 10^9 passenger-kilometre
Gtkm	Gigatonne-kilometre or 10^9 tonne-kilometre
GW	Gigawatt, or 10^9 watt
IEA	International Energy Agency
km	Kilometre
ktoe	Thousand toe
kWh	Kilowatt-hour
MEuro	Million euro
Mt	Million metric tonnes
Mtoe	Million toe
NMS	New Member States
OECD	Organisation for Economic Cooperation and Development
pkm	Passenger-kilometre (one passenger transported a distance of one kilometre)
Eurostat	Statistical Office of the European Communities
t	Metric tonne, or 1 000 kilogrammes
tkm	Tonne-kilometre (one tonne transported a distance of one kilometre)
toe	Tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
TWh	Terawatt-hour, or 10^{12} watt-hour
UN	United Nations

INTRODUCTION

The "Scenarios on key drivers" investigate alternative energy futures as distinct from the baseline development that shows the effects of current trends and policies.[1] The key drivers concern either different framework conditions for energy and transport policies, such as higher world energy prices, higher or lower economic growth, or they are about different policy approaches on e.g. energy efficiency, renewables, nuclear, modal split in transport and climate change. This publication deals in 9 chapters with these different framework conditions and policy approaches. The analysis covers the European Union of 25 Member states and extends to the year 2030, although in the case of renewable energy, energy efficiency and transport modal shift the analysis focuses on the impact of alternative policies that could be implemented up to 2010. The scenario results were derived with the PRIMES model that was operated for all 25 Member states of the EU by the National Technical University of Athens.

In addition to a concise summary of the baseline developments in chapter 1, this publication deals with the following issues that are at the same time key drivers:

- Oil and gas energy import prices that are higher than in the baseline (chapter 2);
- Lower or higher GDP growth compared with the baseline (chapter 3);
- Considerably faster penetration of energy efficiency and renewables, which for renewables occurs overwhelmingly during the period 2000-2010 (chapter 4);
- Nuclear that could develop in two quite divergent directions, i.e. either a higher nuclear contribution following the introduction of improved technology that would find acceptance in the Member States or a phase-out of nuclear technology in the EU (chapter 5);
- Promoting railways and improved load factors along the lines of the option C scenario in the White Paper on Common Transport Policy (chapter 6);
- Various combinations of the above policies, with a view to reducing CO_2 emissions and import dependency (chapter 7);
- Energy implications of greenhouse gas targets that may be decided for the period post 2010 (chapter 8).

A summary of the main findings is provided in chapter 9.

THE BASELINE

The Baseline scenario provides a reference development for the other scenarios. The Baseline reflects a continuation of current trends and policies into the future.

- The Baseline depicts an EU energy future of increasing energy demand due to ongoing economic growth but allowing for significant energy intensity improvements.
- The growing EU energy economy will become increasingly reliant on energy imports - reaching 67% in 2030; energy partnership with producing countries is therefore a key issue.
- There are changes in the structure of energy consumption in the next three decades towards more natural gas and to some extent renewables to the detriment of solid fuels, oil and nuclear; however, following the nuclear phase-out decisions of certain Member States nuclear would be replaced largely with solid fuels in the absence of strong climate change policies.
- The share of renewables would increase only modestly from 5.8% in 2000 to 7.4% in 2010 and 8.6% in 2030 as the implementation of the renewables Directive of September 2001 is not included. The share of nuclear, which is the other CO_2 free and indigenous fuel, would decline.
- CO_2 emissions in EU-25 would stabilise at the 1990 level in 2010 but increase thereafter exceeding the 1990 level by 14% in 2030.

Key Assumptions

The baseline scenario takes into account existing policies and those in the process of being implemented at the end of 2001 (for tax rates in mid 2002, for renewable energy the implementation of the renewables electricity Directive of September 2001 is not included). The Baseline assumptions include, for example, the modernisation of the EU economy and the completion of the internal electricity and gas markets, certain policies to support renewables and energy efficiency (e.g. the fuel efficiency agreement with the car industry) as well as the nuclear phase-out decisions in certain Member States. It thus does not take into account the impact of the Directive 2001/77 on renewable energy in the electricity sector, and Directive 2003/30 on renewable energy in transport. No additional follow-up directives in these areas are assumed. For analytical purposes, the Baseline does not include additional policies to reduce greenhouse gas emissions. This is to assist in identifying any remaining policy gaps in the energy and transport sectors with respect to the EU's Kyoto commitments.

Energy import prices follow a rather moderate development. The oil price in 2010 is assumed to be considerably lower in comparison with the high level of 2000, but the price would rise in the long term as a result form the increased dependence upon the Gulf region and the higher production costs for unconventional oil. In 2030 the oil price would be back, in real terms, to the level already seen in 2000.

1 The baseline was presented in great detail in the publication "European Energy and Transport – Trends to 2030". The results in this publication represent the application of the PRIMES model for all Member States as distinct from the "Trends to 2030", where the new Member States were modelled with the ACE model due to the limited availability of data at that time. The ACE model is less sophisticated than PRIMES. The modelling results for the new Member States in this publication are therefore slightly different from those published in 2003 in the "Trends to 2030".

Gas prices broadly follow oil prices as these fuels compete for many end uses. Gas prices are influenced by two contrasting trends: the cleanliness and high use efficiency cause gas prices to rise faster than oil; but factors such as more intensive gas-to-gas competition and greater integration of regional gas markets (with more LNG) exert downward pressure on gas prices. Gas import prices in Europe stay below the oil price. Coal prices remain flat and well below those of oil and gas especially in the long run.

GDP is projected to grow 2.4% pa, slightly more than doubling between 2000 and 2030. Economic activity grows fastest in the service sector and expands more rapidly in the less energy intensive branches of industry. Baseline GDP growth rates are modest compared with the ambitions of the Lisbon strategy but rather high compared with the current weak state of the EU economy.

Primary energy demand

EU-25 primary energy demand is projected to be 19% higher in 2030 than in 2000 (+0.6% pa), with GDP twice that in 2000. The Baseline shows a continuation of the decoupling of energy demand from GDP. Energy intensity[2] develops favourably, improving by 1.7% pa over the period, some of which is due to structural changes as described below.

Some 80% of incremental energy consumption to 2030 will be met by natural gas; the demand for gas grows by two thirds in 2000-2030. In 2030, natural gas is the second largest fuel, with a 32% share of total EU-25 primary energy demand.

Oil remains the largest fuel, although consumption grows by only 6% between 2000 and 2030. In 2030, oil meets 34% of primary energy demand (down from 38% in 2000).

Renewables are the fastest growing energy source, expanding by three quarters over the next 30 years. But their share in primary energy demand rises from 5.8% in 2000 to 7.4% in 2010 and 8.6% in 2030 under Baseline conditions (not assuming the implementation of the legislation adopted at Community level at the end of 2001 and after, and in spite of the slow growth in energy demand.).

The nuclear contribution increases marginally (+3% in total) to 2010 given higher utilisation of existing capacity and some limited capacity additions, which together offset closure of certain reactors with safety concerns in the new Member States. However, in 2030, nuclear output is 22% lower than in 2000; and its share drops from 14.4% to 9.5% in 2000-2030. This results from the nuclear phase-out in certain Member States.

Solid fuels consumption declines steeply in the medium term but regains its 2000 level by 2030 as a replacement for nuclear and given coal's enhanced competitiveness against higher gas prices in the long term.

Final energy demand

The tertiary sector is the fastest growing final energy market in EU-25, followed by transport - both sectors growing more rapidly than overall final energy demand.

Transport energy demand growth derives from rising transport activity to 2030, and by modal shifts towards road and air transport under Baseline conditions. Passenger transport in EU-25 grows more slowly than GDP (1.5% pa compared with 2.4% pa) implying a considerable decoupling of passenger transport from GDP, but freight transport activity grows almost as fast as GDP leading only to a slight improvement of freight transport intensity. The rail share of both passenger and freight transport falls considerably. Road gains market shares accordingly, and with increasing per capita incomes there is a strongly increasing demand for air travel. However, transport energy demand growth is constrained by the agreement with the car industry on limiting CO_2 emissions from new cars through significant fuel efficiency improvements.

Industrial energy demand is projected to grow by 0.8% pa to 2030, having fallen in the 1990s because of the restructuring in the new Member States and the former GDR. Moreover, further structural change away from heavy industries towards less energy-intensive activities leads to significant energy intensity improvements, limiting industrial energy demand growth.

Household energy demand increases by 0.6% pa by 2030, reflecting higher living standards and more widespread use of electric appliances in the new Member states, but also some saturation effects especially in EU-15 space heating. But demand growth derives from rising household numbers due to demographic changes and lifestyles.

Total final energy demand is projected to grow by 0.9% pa to 2030. This is faster than growth of primary energy demand (0.6% pa), and reflects the significant efficiency gains in the energy transformation sector – especially in power generation.

Electricity is the fastest growing fuel in final use, growing by 1.5% pa to 2030. Heat from CHP and district heating plants comes next, rising 1.4% pa. Gas also grows above average (by 1.1% pa) but oil use increases more slowly. Despite increasing transport demand, the low oil growth reflects fuel switching away from oil in other final demand sectors. Final demand for solid fuels falls by 1.9% pa by 2030 as heavy industries lose their importance and households in the new Member States shift to more convenient means of space heating. The role of renewables in final demand increases quite slowly over the period, by 0.3% pa.

2 Energy intensity is the ratio of energy consumption to GDP

Power generation

Electricity production increases 52% in 2000-2030. Gas-based electricity grows particularly quickly - by almost 150% in this period - and in 2030 gas is the most important fuel input for electricity (accounting for 37% of power generation, from 16% in 2000). The power station sector gradually shifts away from solid fuels and nuclear, which each had a 32% share in 2000: i.e. nearly two thirds of electricity production is presently based on nuclear and solid fuels, both with favourable characteristics as regards security of supply. But, by 2030, the nuclear share falls to 17%, and that of solid fuels to 27%. Electricity from renewables rises nearly 80% by 2030. However, the renewables share (including waste) in electricity generation is projected to rise from 15% in 2000 to 18% in 2010, from where it increases only marginally through 2030 under Baseline conditions (i.e., not assuming the implementation of the Directive on electricity from renewables of September 2001).

The net effect of the change in the power generation mix, i.e. with greater use of renewables, but lower nuclear output, is that the share of carbon free sources for EU-25 electricity generation falls from 46% in 2000 to 36% in 2030. Given these trends, CO_2 emissions from power generation increase in the Baseline case.

Indigenous energy production and import dependency

Indigenous energy production in 2030 is 26% lower than in 2000. All fuels decrease except for renewables. Production of renewables increases 76% between 2000 and 2030. The widening gap between growing energy demand and declining indigenous production is closed with imports, which increase by 70% in 2000 to 2030.

With strong growth in gas demand, declining indigenous production of fossil fuels, the closure of existing nuclear power plants in certain Member States and the limited increase of the renewables share from 5.8% in 2000 to only 8.6% in 2030 under Baseline conditions, the EU dependency on energy imports is set to increase. By 2030 import dependency would amount to 67% compared to 47% in 2000

By fuel the highest import dependency will continue to be for oil, rising from 76% in 2000 to 88% in 2030. For natural gas this dependency grows from 50% in 2000 to 81% in 2030. Import dependency for solid fuels more than doubles, from 30% in 2000 to 66% in 2030.

CO_2 emissions

CO_2 emissions for the enlarged Union are expected to stabilise at the 1990 level in 2010; however in EU-15 emissions are projected to increase by 4% over the same period. This more favourable situation concerning CO_2 in EU-25 derives from trends in the central and eastern European Member States. CO_2 emissions in the new Member States fall 20% in 2010 compared with 1990 levels.

In the longer term, EU-25 CO_2 emissions rise. By 2030 CO_2 emissions in EU-25 exceed the 1990 level by 14%. This overall increase stems from the projected 19% rise in these emissions in EU-15 between 1990 and 2030, but an 8% fall in the new Member States, where CO_2 emissions are expected to remain well below their 1990 level even in 2030.

The carbon intensity[3] of the EU-25 energy system falls slightly to 2015 given greater use of renewables and especially natural gas. In the Baseline case this intensity trend is reversed after 2015 given the nuclear phase-out in several Member States, insufficient renewables growth to compensate for this lost nuclear output, and thus replacement of much nuclear generation by fossil fuels.

Policy challenges

Energy developments in EU-25 are challenging in many respects, especially concerning energy security, the penetration of renewables, increasing CO_2 emissions and the ongoing growth of road transport and aviation, which are particularly energy intensive. Nuclear will play an important role in this respect given its carbon free nature and status as indigenous energy source. More extensive policy measures will be needed to meet the above challenges, as set out in the Green Paper on energy security and the White Paper on common transport policy.

The scenarios in the following chapters show how key indicators, such as import dependency, the shares of renewables and nuclear, the rail share and CO_2 emissions develop under different policy approaches and framework conditions, including more or less successful economic policies and the geopolitical environment that impacts on the level of world energy prices. The next chapter addresses the latter issue by depicting scenarios on the impacts of world energy markets on the EU including the drivers for different world energy price developments.

WORLD ENERGY PRICES

Chapter 2 sets out the impacts of higher energy import prices on the EU energy system and addresses the conditions under which such higher world energy prices could materialise. The driving forces that could lead to higher world prices include stronger world GDP growth, especially in Asia, and a somewhat less favourable energy reserve situation than that assumed for the Baseline. The amount of oil and gas discoveries that will be added to the reserve base as commercially exploitable over the next 30 years is uncertain, but an important driver for the development of world energy prices. Moreover, heightened geopolitical tensions and/or a failure to develop stable and mutually beneficial trade relations including energy partnerships with energy producers could result in a prolonged period of high oil and gas prices.

- In addition to geopolitical influences, higher energy import prices could be brought about by particularly strong growth of

3 Carbon intensity is an indicator for the fuel mix calculated as CO_2 emissions divided by energy consumption

world GDP and energy consumption and a less favourable development of new oil and gas discoveries.

- Higher oil and gas prices would limit the level of EU energy consumption only somewhat, but would exert a stronger influence on its structure depending on how gas prices develop in relation to oil prices.

- In any case, higher oil and gas prices would encourage more renewables deployment, but would have only a small impact on nuclear, which is very capital intensive.

- Reductions of import dependency would be limited and would not exceed 5 percentage points in 2030 even with import prices 80% higher than Baseline throughout the projection period.

- Impacts on CO_2 emissions would be rather marginal given that high oil and gas prices encourage more solid fuel consumption and only some additional deployment of CO_2 free fuels.

In the "high oil and gas price" scenario (modelled with the world energy model POLES), the oil price would exceed its 2030 level by 20% and the gas price by 33% while the gas price remains still below the oil price in Europe. This case is discussed in chapter 2 as regards the world energy scene and the repercussions of these higher world prices on the EU energy economy.

Additional price cases were developed and are also briefly presented in chapter 2 addressing:

- Gas prices for Europe growing much faster than oil prices and slightly exceeding the oil price in 2030;
- A decoupling of the gas price from the oil price, where the gas price does not follow the oil price in the long term to higher levels than in the baseline, widening the gap between oil and gas prices;
- Soaring oil and gas prices that are 80% higher than in the baseline.

The world energy background leading to the first two additional price cases was modelled in detail with POLES. Another price case concerns a sharp medium term oil price increase to levels of 40$/bbl, which represents a doubling from baseline levels. Clearly, such a price hike would impact on GDP and therefore this case is discussed in chapter 3 dealing with economic development.

The ***high oil and gas price scenario*** is based on higher world GDP especially in developing world regions and a less favourable reserve situation. World GDP would exceed the baseline level by 5.7% in 2030, while world energy consumption would be 1.8% higher leading to a further improvement of world energy intensity. Nevertheless, with higher oil and gas prices in this scenario, the bulk of this energy growth would come from solid fuels, which results in CO_2 emissions that exceed the baseline level by 3.1% in 2030.

In the EU, high oil and gas prices decrease energy demand considerably in particular in the tertiary and households sectors. Transport is less affected due to the relatively small price increase for transport fuels given the existing high tax levels for oil used for transport purposes. EU-25 primary energy demand would be down 0.4% from baseline levels in 2030, with a 13.6% decline for natural gas and more moderate 1.5% decrease for oil. Solid fuel demand would increase by 16.9% in 2030 from Baseline, nuclear would be up 3.1% and renewables would show the highest growth rising by 18.6% above Baseline.

The shares of CO_2 free and indigenous fuels would increase. The renewables share would reach 7.7% in 2010 (+0.2 percentage points from Baseline) and 10.3% in 2030 (+ 1.6 percentage points). The nuclear share would be up 0.3 percentage points in 2030.

These changes in the EU fuel mix and the reduction of energy demand due to higher prices have only a small influence on CO_2, which would grow by 13.5% between 1990 and 2030, compared with +14.2% in the Baseline. The impacts on import dependency are somewhat more pronounced. Import dependency would be down 3.1 percentage points from Baseline level in 2030 to reach 64%. Import dependency for gas and oil would decrease, while dependency of coal imports would increase.

As regards the ***other price cases***, import dependency would be significantly reduced by 5 percentage points below Baseline in 2020 and 2030 in the "soaring oil and gas price" case. This case would also result in a decrease in CO_2 emissions by 2.5% in 2010, while in the long run emissions are almost at the Baseline level due to strongly increasing solid fuel consumption. The renewables share would develop more favourably in this case, reaching 11.2% in 2030 (compared with 8.6% in the Baseline). The impacts of the other two price cases are more limited. It is, however, notable that CO_2 emissions would be down 1.5% from Baseline in 2030 in case of a decoupling of gas from oil prices, which narrows the price gap between gas and coal. On the other hand, these fairly low gas prices lead to the smallest increase of the renewables share in all price cases by just 0.6 percentage points above Baseline in 2030; and import dependency would furthermore exhibit the smallest decrease by only 1.1 percentage points below Baseline in 2030. In total, the CO_2 effects from the price scenarios are rather marginal as emissions exceed the 1990 level in 2030 considerably varying from 12.5% to 14.4%.

ECONOMIC DEVELOPMENTS

Chapter 3 deals with economic drivers by examining the implications that different economic development pathways would have for the future evolution of the EU-25 energy system. A "low growth" case and a "high growth" case are presented, and in addition there is a brief analysis of the economic and energy effects of a sharp medium term increase in oil and gas prices.

- Economic growth is a key driver for energy demand and has a significant influence on the level of CO_2 emissions. With low economic growth, similar to that seen over recent years, EU-25 CO_2 emissions could remain well below the 1990 level by 2010, whereas high economic growth exerts strong upward pressure on CO_2 emissions and needs to be accompanied by energy policy with a view to reducing CO_2 emissions.

- Variations in GDP growth (of plus minus 11% in 2030) have only a marginal influence on the shares of renewables and nuclear.
- High economic growth makes the economy less energy intensive due to e.g. quicker capital turnover, whereas in case of low economic growth energy intensity improvements are smaller.
- The impacts of variations in economic growth on import dependency are rather limited with a slight increase of dependency in case of higher GDP levels and a small decrease with lower GDP.

The ***low growth case*** reflects a continuation of recent economic trends leading to an average annual GDP growth of only 2.0% pa in 2000 to 2030 instead of 2.4 % in the Baseline. Energy requirements in the EU-25 energy system decline by 7.5% from Baseline levels in 2030 compared to a decline of GDP by 10.7%, implying somewhat higher levels of energy intensity compared to Baseline. This less favourable development of energy intensity is due to a slower adoption of more efficient equipment by consumers but it is also a result of a less marked dematerialisation of the EU-25 economy with lower economic growth.

The share of renewable energy forms in the low economic growth case is projected to reach 8.9% in 2030 compared to 8.6% under Baseline assumptions. The use of nuclear energy falls only a little from Baseline levels, giving rise to a slightly higher nuclear share than in the Baseline. Moreover, demand for fossil fuels falls faster over the projection period. The decline in liquid fuel use relates to the projected evolution of transport activity, which is strongly affected by lower economic growth. On the other hand, the lower use of solid fuels and natural gas is mainly caused by trends in the power generation sector due to lower electricity demand.

The slower growth of fossil fuels demand is also reflected in overall import dependency, which is projected to reach 65.7% in 2030 (-1.6 percentage points lower than the Baseline). CO_2 emissions are projected to decrease 8.6% from Baseline levels in 2030. Thus, with low economic growth, the carbon intensity of the EU-25 energy system is lower than in the Baseline scenario. CO_2 emissions decline faster than energy consumption, as lower growth of total energy demand allows for a higher share of zero carbon fuels (renewables and nuclear) while there is less additional use of fossil fuels. Compared with the 1990 base-year, CO_2 emissions would increase less than in the Baseline and would remain 4% below the 1990 level in 2010. Even in 2030, low economic growth would limit CO_2 emissions to just 4% above its 1990 level (instead of +14% in the Baseline).

The high growth case simulates the energy, transport and emission consequences of achieving GDP growth rates that are near to the Lisbon economic growth target to 2010 and also represent a particularly successful enlargement in economic terms. GDP increases by 2.7% pa between 2000 and 2030, up 0.3 percentage points from Baseline.

With EU-25 GDP 10.7% above the Baseline level in 2030, energy demand exceeds the Baseline by 7.4%. Therefore the high growth case results in an additional improvement of energy intensity over and above the significant rates in the Baseline.

However, in the high growth case, CO_2 emissions rise faster than energy consumption exceeding the Baseline level in 2030 by 8.3%. This deterioration of carbon intensity compared with Baseline is due to strong growth of electricity demand, while the potential for nuclear is limited (e.g. phase-out decisions in certain Member states) leading only to a below average growth of nuclear and consequently to a slight decrease of nuclear share. Moreover, this high growth would not itself encourage much additional renewables deployment. The renewables share in total energy consumption would increase to 7.5% in 2010 and 8.8% in 2030 (up only 0.1 percentage point from Baseline in both years). The bulk of the additional electricity would be produced from natural gas and solid fuels.

Transport energy demand would also rise somewhat faster than overall energy demand with oil demand rising 8.3% above the Baseline level in 2030. The increasing demand for energy would be met predominantly by oil and gas (overwhelmingly from third countries). The combined share of oil and gas would reach 67% in 2030, slightly up from Baseline levels. Import dependency would therefore be even higher than in the Baseline – reaching as much as 68.5% in 2030.

Chapter 3 includes the analysis of a ***sharp increase in oil and gas prices***, where the oil price soars to twice its baseline level in the short term (in the modelling to 40 (2000) $/bbl in 2005). Thereafter, the oil price remains at high levels for several years decreasing gradually to the Baseline price trajectory by 2015 and remaining slightly below Baseline between 2015 and 2030. Oil price levels below Baseline reflect the reaction of the world energy system to very high oil and gas prices. A sharp increase in oil and gas prices affects the energy system in two different ways: it reduces economic activity, which in turn drives energy demand below Baseline levels, and higher energy prices exert also downward pressure on energy consumption and oil and gas demand in particular.

At the EU-25 level in 2010, when the oil price still exceeds its baseline level by 75%, energy consumption would be down 3.4% below Baseline. Natural gas would be affected particularly strongly, with demand down 12.3% from Baseline, while renewables deployment would be up 16.6% from Baseline. The renewables share would reach 9.0% in 2010 (up 1.5 percentage points from Baseline). The shares of nuclear and solid fuels would also increase due to lower energy demand and a substitution of solids for gas. Even in the long term, when the oil and gas prices are back to baseline levels, there would be a decline in the demand for all fossil fuels ranging from -2.3% below Baseline for gas to -3.2% for oil in 2030 with solid fuels in between. Nuclear deployment would remain at the Baseline level, while renewables demand would be 10.5% higher than Baseline in 2030. With lower fossil fuel demand, the renewables share in 2030 exceeds Baseline levels by 1.0 percentage points to reach 9.7% and the nuclear share increases slightly to 9.6% in 2030 (+0.1 percentage point compared with Baseline).

The medium term oil and gas price hike would reduce CO_2 emissions significantly in 2010; emissions fall to 5% below their 1990 level by that date. However, in the long run, CO_2 emissions grow to 111 % of their 1990 level in 2030, but remain 3% below their Baseline level in 2030. Import dependency would remain close to present levels by 2010, down 5 percentage points from Baseline in 2010. In the long term, however, the increase of import dependency would be almost as pronounced as in the Baseline with EU dependency on imports reaching 66% in 2030.

MAINSTREAM POLICY LINES: ENERGY EFFICIENCY AND RENEWABLES

Chapter 4 explores the effects up to 2030 of combined policies to promote energy efficiency and renewables implemented in the period up to 2010. The scenarios "freeze" policy at 2010 and do not address the possibility of introducing new Community policies and measures in these areas after that date. For analytical purposes the effects of isolated policies on energy efficiency, on the one hand, and renewables, on the other, are briefly addressed. In the pure renewables case, energy efficiency follows Baseline developments; while in the pure high energy efficiency case the assumptions related to renewables remain unchanged from Baseline.

- The 12% renewables objective for 2010 can be achieved with strong policies; the 12% renewables share is more easily obtained in combining strong renewables policies with ambitious energy efficiency policies; there are synergies between both approaches e.g. in terms of cogeneration from biomass.

- In the high efficiency and renewables scenario focussing on medium term action to 2010 in this chapter, total energy consumption increases at a reduced rate to 2010 and remains thereafter at the same consumption level (+0.3% total increase in 2010-2030, in which period renewables consumption increases by 19.1%).

- For maintaining momentum in renewables penetration, additional policies are required addressing the period post 2010 as, in the scenarios with policy "frozen" at 2010, markets and technology development alone entail only a minor increase of the renewables share beyond 12% reaching 14.4% in 2030.

- Nevertheless, the higher levels of renewables deployment and energy efficiency even in this limited scenario bring considerable benefits in terms of external dependency and CO_2 emissions. Import dependency would be 4 percentage points lower than Baseline in 2010 (- 6 percentage points in 2030). CO_2 emissions would fall to 12% below their 1990 level and remain at this low level through 2030. Additional policies on e.g. renewables, such as follow-up directives, with a view to 2020/2030 would bring about even better results.

- Strong energy efficiency policies lead to a further decrease of energy intensity, with annual improvements of over 2%; energy efficiency is a cornerstone of policies on energy security, climate change and competitiveness.

Strong renewables promotion that ensures the achievement of the 12% renewables objective for total energy consumption in 2010 was simulated in the following way. It was assumed for the modelling that additional incentives are provided to energy consumers and energy producers. Further penetration of renewable energy is achieved by policies in the demand side promoting the use of biomass and waste in industry and the use of solar thermal panels for water heating purposes in services and households, as well as through the implementation of the biofuels Directive that sets indicative shares for biofuels in petrol and diesel demand for transportation purposes. The targets for electricity from renewables by Member state, as defined in the renewables electricity Directive, are achieved in the modelling through support schemes that provide subsidies for electricity generation from renewables. However, these payments on account of the higher costs due to greater renewables deployment are passed on to the consumers through increased electricity prices. Therefore, the levels of renewables deployment in the energy system and hence the share of renewables in total energy consumptions are modelling results on the basis of these assumptions and the overall assumptions on e.g. GDP and energy import prices.

The "High efficiency" case investigates the effects of measures along the lines of the "Action Plan for Energy Efficiency" in the EU energy system, focusing on key actions that could be modelled. This approach includes better energy performance following the buildings Directive as well as action on CHP and energy services. Useful energy (energy services such as heat, light, cooling, motion, and communication) is supplied in a more efficient way by means of consumer choices based on perceived costs that take fuller account of the advantages of higher energy efficiency. The efficiency case assumes that consumers obtain a better appreciation of the benefits of adopting more efficient technologies, which in turn leads to faster deployment of improved and advanced technologies in the "High efficiency" case compared to the Baseline. Moreover, the efficiency case has somewhat better efficiency characteristics for established technology (compared with Baseline) brought about by e.g. efficiency standards that keep the least efficient energy consuming equipment out of the market. Consumers with a better appreciation of technology costs will consequently alter their choices compared to Baseline. Improvements in building construction lead to significant gains in thermal integrity and a reduction in energy requirements. In addition to such improvement on the demand side, the efficiency case also incorporates improvements on the supply side. The use of cogenerated steam and electricity is encouraged, resulting in higher shares of CHP in electricity and steam generation following the Directive on the promotion of cogeneration. Besides more cogeneration, the supply side shifts towards more efficient technologies in the long run driven by faster technological progress, which leads to improvements in terms of new equipment efficiency. Equipment costs also decline compared with the Baseline.

In the ***high energy efficiency and renewables case***, primary energy decreases considerably from baseline (more than -14% compared to the baseline in 2030). Total energy consumption stabilises after 2010 with a total increase over 20 years of only 0.3%. This stabilisation of energy consumption is accompanied by significant changes in the fuel mix with a strong increase in the use of renewable energy forms (both in absolute values and in terms of market shares). Consequently the demand for all other energy forms declines. The decline is most pronounced for solid fuels (-37.5% in 2030 compared to baseline). The share of renewable energy forms is projected to rise to 12.1% in 2010 and 14.4% in 2030 (+4.7 and +5.8 percentage points respectively from baseline levels). That this share is not higher after 2010 is explained by the assumptions made regarding the impacts of policies implemented up to and including 2010.

This result shows that promoting policies for renewable energy forms are not affected significantly by the similar pursuit of policies leading to further improvements of energy intensity for the EU-25 energy system. Synergies can indeed be developed through e.g. cogeneration on the basis of biomass, which in this scenario plays an important role. Energy intensity improves by 0.5 percentage points more per year than in the Baseline to reach 2.2 % pa up to 2030. As distinct from the energy intensity improvements in the Baseline that incorporate important impacts from the shift of economic activity towards e.g. services, these effects relate to better energy efficiency as the structure of economic activity remains unchanged form the Baseline. In addition, the promotion of renewables contributes to better energy intensity to some extent, because energy sources such as wind and hydro have a much higher efficiency than fossil fuels for electricity generation (due to EUROSTAT energy balance conventions).

The impacts on import dependency and CO_2 emissions are very significant. Import dependency in 2010 is limited to 48.7%, which is close to today's level (compared to 53.1% in the baseline). In 2030 import dependency reaches 61.5% (-5.9 percentage points from baseline levels). Energy efficiency and renewables policies lead to a CO_2 emission level well below those implied in the Kyoto targets for 2010 (-12.2% from 1990 levels). Moreover, under this scenario where renewable energy and energy efficiency policies are "frozen" in 2010, there would still be a stabilisation of CO_2 emissions at 12% below the 1990 level between 2010 and 2030. While deeper CO_2 cuts may be required in 2030, this scenario shows that energy efficiency is a cornerstone of all policies to curb CO_2 emissions and manage external dependency. It highlights also the importance of strong action on renewables. Additional policies on renewables and energy efficiency, going for example beyond those necessary for achieving the 12% renewables objective for 2010, should bring even better results.

A comparison between the pure high efficiency case and the combined high efficiency and renewables case illustrates the strong synergies that exist in implementing policies for energy efficiency combined with policies for promoting renewables. The decline of primary energy needs in the high efficiency and renewables case is slightly more pronounced than in the pure efficiency case, as the high efficiency of intermittent renewable energy forms further supports improvements in terms of energy intensity.

Similarly, a comparison between the isolated high renewables and the combined high efficiency and renewables case shows the existence of synergies between policies towards energy efficiency and promoting renewable energy forms. The share of renewables in primary energy consumptions reaches higher levels in the combined efficiency and renewables case compared to the pure renewables case with equivalent renewables policy intensity in both cases. For example, the EU-25 renewables share in 2010 increases to 12.1% in the combined high efficiency renewables case versus 11.6% in the isolated high renewables case (with 12.1% in EU-15). Finally, import dependency and CO_2 emissions reach much lower levels in the combined efficiency and renewables case compared to both the pure high renewables case and the pure high efficiency case.

NUCLEAR

The future development of nuclear is one of the key uncertainties and drivers for the EU energy outlook. Chapter 5 presents two contrasted developments on nuclear and addresses the overall energy and climate change repercussion that such contrasted developments would entail. Model based scenario analysis is a powerful tool to investigate the repercussions in energy and CO_2 terms of developments, without necessarily attaching a degree of probability to such development. Therefore, this chapter considers the closure of all existing nuclear power plants in the EU as one development and has also the acceptance of a new generation of nuclear power plants as a contrasted alternative.

This scenario analysis was undertaken against the background that many existing nuclear power plants will be retired over the 30 years projection horizon because of age, market conditions or political decisions. Even under Baseline conditions that include the nuclear phase-out decisions of certain Member States, there would be considerable nuclear investment, which would be much more pronounced if an improved nuclear technology finds acceptance. The latter case, in which a new generation of nuclear technology (such as the European Pressurised Reactor or the Westinghouse AP600 with highly improved passive safety features) would be accepted in all the Member States that have used nuclear so far, is presented in some detail as it involves the nuclear investment issue.

- The acceptance of an improved nuclear technology would lead to lower import dependency and lower CO_2 emissions in the long term given the long lead times for nuclear. Import dependency would be limited to 62% in 2030 and CO_2 emissions could be reduced by 6 percentage points or 240 mill.t CO_2 below their Baseline level in 2030.

- On the contrary, a nuclear phase-out in the entire EU would increase import dependency to 75% in 2030 and would raise CO_2 emissions in 2030 to 23% above their 1990 level adding 9 percentage points over and above the Baseline CO_2 growth from 1990 levels. Maintaining Baseline levels of nuclear avoids therefore some 320 mill.t additional CO_2 emissions.

- Strong policies for renewables that ensure the 12% objective under Baseline conditions would result in a renewables share of 14% in case of a nuclear phase-out; they could alleviate some of the effects of the nuclear phase-out, but would not suffice to prevent a significant increase from Baseline of both import dependency and CO_2 emissions.

• Nuclear and renewables are complementary in ensuring a high share of carbon free and indigenous fuels in total energy supply reaching 28% in 2030 in the combined new nuclear - high renewables case (up 10 percentage points from Baseline); this leads also to a rather low import dependency (59% in 2030) and lower CO_2 emissions.

There are two nuclear phase-out cases presented. One case concerns the closure of all nuclear plants in 2010 in the entire EU, which allows among other things to give an estimate of the present contribution of nuclear to limiting import dependency and CO_2 emissions. In the second nuclear phase-out case, there would be a slower closure of nuclear plants after a lifetime of 30 years for each plant. This chapter addresses also briefly the option of extending the lifetime of existing nuclear power stations beyond the assumed lifetime of 40 years in the Baseline for each plant. It highlights the energy and emission consequences of such a ten year's postponement of nuclear re-investment decisions.

Finally, the interactions between nuclear and a strong promotion of renewables (as depicted in chapter 4) are investigated, given that these energy forms are carbon free and indigenously produced. There are two combined cases:

- nuclear phase-out in 2010 plus strong promotion of renewables;
- new nuclear being accepted plus strong promotion of renewables.

The first combined case examines whether strong promotion of renewables could result in a situation where the consequences of a nuclear phase out could be offset by strong renewables penetration. The second combined case looks into the issue of a simultaneous pursuit of these indigenous and carbon free options.

The ***new nuclear technology accepted case*** examines a higher nuclear contribution than in the baseline arising from the acceptance of new nuclear technology with improved safety and techno-economic features and the re-evaluation of nuclear phase-out policies in certain Member States. In this scenario, changes are mainly concentrated in the power generation sector, while the evolution of the demand side remains similar to Baseline developments. The projected increase in the use of nuclear energy (+78.2% from Baseline levels in 2030) entails mainly a replacement of solid fuels and to a minor extent natural gas. This scenario leads to an increase of total gross inland consumption (+3.6% in 2030) because nuclear power plants have a lower efficiency than natural gas or new coal fired power stations.

The share of nuclear energy is projected to reach 16.3% of primary energy consumption in 2030 (the highest nuclear share ever) compared to 9.5% in the baseline scenario. The share of renewables declines somewhat in 2030 from 8.6% in the baseline to 8.3% in the high nuclear case. Nevertheless, carbon intensity of the EU energy system exhibits a significant improvement from baseline levels with CO_2 emissions in 2030 decreasing by 5.6% from Baseline. Furthermore, the lower dependence of the EU-25 energy system on fossil fuels (accounting for 75.5% of primary energy needs in 2030 compared to 81.8% in the Baseline scenario) allows for a significant improvement of import dependency which reaches 62.1% in 2030 (-5.2 percentage point from Baseline levels).

A ***nuclear phase-out*** in 2010 would have important impacts on both CO_2 emissions and import dependency. CO_2 emissions in 2010 would be 320 mill.t higher than in the Baseline, i.e. adding another 9% of the 1990 CO_2 emissions to the projected Baseline level in 2010, which is already too high for meeting the EU's international commitments. Long-term CO_2 emissions would also be affected by this nuclear phase-out in a similar way (also + 320 mill.t CO_2 in 2030), so that in 2030 the 1990 CO_2 emission level would be overshot by 23% (instead of 14% in the Baseline). Import dependency would also rise considerably to reach 75% in 2030 due to the nuclear phase-out (compared with 67% in the Baseline). A nuclear phase-out after 30 years of lifetime for each plant would give broadly the same results in 2030, allowing for somewhat different dynamics in earlier years and their repercussions on the capital stock in 2030 especially as regards the investments in power plants.

Extending the lifetime of nuclear plants for 10 more years to 50 years for all plants that are not affected by the nuclear phase-out decisions in certain Member States would increase the nuclear contribution in 2030 by almost a quarter above Baseline levels. The nuclear share would be 2.2 percentage points higher than Baseline in 2030, whereas the renewables share would stay almost at the Baseline level. CO_2 emissions would be down 1.6% from Baseline levels in 2030 and import dependency would drop nearly 3 percentage points from Baseline in the same year.

In the ***combined nuclear phase-out and renewables promotion case***, where renewables would benefit from the same promotion policies as in the renewables promoting case of chapter 4, there would be an important role for renewables in filling the gap in electricity generation caused by nuclear closure (rising over time to 51% of this gap in 2030). The renewables share would increase to reach almost 14% in 2010 and would stay at that level through 2030. However, assessed on the basis of other policy relevant indicators such as import dependency and CO_2 emissions, renewables (with the intensity of promotion that ensures the achievement of 12% target in 2010) would not be able to compensate for the nuclear contribution that were no longer available. Import dependency would increase almost 4 percentage points over Baseline in 2030 to reach 71%. CO_2 emissions would be up 3% above Baseline in 2010 and 2% in 2030. In addition, there is a considerable increase in electricity prices, which is even somewhat higher than in the pure nuclear phase out case.

The combination of the acceptance of new nuclear with promotion of renewables leads to a significantly different situation in terms of import dependency and CO_2 emissions. Import dependency would fall to only 59% in 2030 (compared with 67% in the Baseline). The share of nuclear and renewables would amount to 13.0% and 11.6% respectively in 2010 increasing to 15.7% and 12.4% in 2030. As a result, CO_2 emissions would stay below the 1990 level up to 2020 and would nearly stabilise at the 1990 level in 2030 (exceeding the 1990 CO_2 figure by only 1.9%). Moreover, the effects of a simultaneous acceptance of new nuclear and renewables promotion on electricity prices would be limited, leading only to a slight increase above baseline levels in the long run. These results show that investment in new nuclear and renewables promotion can act in a complementary manner in restructuring the EU energy system.

TRANSPORT

Chapter 6 looks at transport as one of the main drivers for energy demand. It explores in particular the energy consequences of the Option C scenario of the White Paper on Common Transport Policy, which illustrates the successful implementation of the policies proposed in the White Paper. Option C consists of two main elements: stabilisation of the rail share in 2010 on the basis of the situation in 1998 and a considerable improvement in load factors of all modes in the EU.

- Promotion of rail transport and higher load factors entails energy and transport policy benefits at the same time. In addition to the benefits through less congestion and accidents, there would be a significant reduction in CO_2 emissions in 2010 to 4% below the 1990 level.

- As regards renewables and import dependency there would be only a marginal improvement and the CO_2 benefits become smaller over time unless the time horizon post 2010 is addressed with additional transport policy.

In the ***White Paper Option C scenario***, there would be considerably higher transport activity by rail, public road and inland navigation than in the Baseline balanced by lower increases in private road transport and aviation. Moreover, all modes would exhibit higher energy efficiency for both passenger and freight transport brought about by higher load factors.

Option C results in a significant reduction of oil consumption (by e.g. 52 mtoe or 8% in 2010) - mainly in road transport. This leads to a reduction of total energy demand in 2010 by 3% below the Baseline. This reduction in energy demand, nearly exclusively oil, restrains the increase of import dependency, keeping dependency 1.3 percentage points below Baseline in 2010. However, as a purely demand side action, Option C has lower impacts on energy import dependency than policies on promoting indigenous energy sources such as renewables and nuclear.

The decline in the demand for liquid fuels in transport (from Baseline) leads to a somewhat lower contribution of renewable energy forms because mixed biofuels would be reduced with lower deliveries of petrol and diesel; this renewables effect is however rather small. Moreover, with more railway transport there is also slightly more electricity consumption; total electricity generation would be up by 5 TWh or 0.1% compared with the Baseline in 2010. Higher electricity generation entails some additional use of renewables for power generation.

The renewables share in the option C scenario would be 0.2 percentage points higher than Baseline in 2010 to reach 7.6% owing to the 3% decline in total energy demand, which exceeds the 1% decrease of renewables deployment (biofuels). Lower total energy demand would also increase the nuclear share by 0.4 percentage points in 2010 so that carbon free energy sources would increase their contribution by slightly more than half a percentage points in 2010 following policies to promote rail transport and better load factors.

Under this development, CO_2 emissions from transport in the EU are 13.4% lower in 2010 than in the Baseline. Achieving Option C would enable the EU to keep total energy related CO_2 emissions 4.4% below the 1990 level in 2010.

The long term effects are less pronounced, because the stabilisation effort for rail is geared to 2010 and the rail share decreases post 2010. Yet, import dependency in 2030 would stay 0.6 percentage points below Baseline, however reaching a level of almost 67%. The renewables and nuclear shares would be up 0.1 and 0.2 percentage points respectively from Baseline in 2030, and CO_2 emissions would increase by 11% between 1990 and 2030 instead of 14% in the Baseline.

While the stabilisation of the shares of rail, public road and inland navigation in the medium term is important, the greater part of the favourable energy effects of Option C stem from the improvements in load factors and the better energy intensity of transport that these improvements entail.

In addition to energy benefits of Option C developments (e.g. lower external dependency and CO_2 emissions), there are substantial benefits in terms of e.g. less congestion and better air quality. In fact, transport policy, while pursuing its objectives can contribute significantly to restraining energy demand and achieving energy policy objectives.

COMBINING VARIOUS OPTIONS

Chapter 7 investigates the effects of various combinations of the above policies that were analysed individually in chapters 4 to 6. In addition to the key policy drivers on energy efficiency, renewables, nuclear, transport, which are combined in different configurations, two of the following three cases include also additional policies on economic instruments and additional action on alternative fuels. The economic instruments concern the effects of higher energy taxation as well as the repercussions of emission trading permit costs on energy and CO_2 emissions. The alternative fuels considered are biofuels, natural gas and hydrogen as alternatives to oil in transport.

The "energy policy options" case examines the combined effect of promoting new policies for renewables and energy efficiency (up to 2010) and the acceptance of new nuclear technology. It draws on the results examined in chapters 4 and 5.

The "extended policy options" case combines the above strong action on energy efficiency and renewables (up to 2010) with transport policy options and economic instruments such as higher energy taxation and emission trading. It includes the assumptions used for the White paper option C scenario of chapter 6 and it incorporates, furthermore, a strong penetration of natural gas, biofuels and hydrogen in the transport sector.

The third case examined - called "full policy options" case – constitutes a combination of all policy measures examined under the previous two cases, i.e. the assumptions regarding the acceptance of new nuclear technology are also included in the "full policy options" case.

- The combination of various policies "in the pipeline" or under discussion can make a real difference to the development of the energy economy including CO_2 emissions.

- Import dependency can be limited to less than 60% in 2030 especially when a new generation of nuclear is accepted; import dependency would amount to only 55% in the "full policy options" case in 2030 (compared to 67% in the Baseline).

- The renewables share would increase considerably to up to 16% in the "extended policy options" case (and could grow even further with reinforced renewables policies addressing post 2010, not modelled in this study). In any case, indigenous and CO_2 free energy sources gain importance in these combined cases reaching a share of almost a third (31.8%) in the "full policy options" case in 2030 (up from 18.1% in the Baseline).

- CO_2 emissions can be substantially reduced falling by 12-19% below the 1990 level in 2010 in the combined cases; the greater reductions would be achieved in the case of adding policies along the lines of the Transport White paper including strong action on alternative fuels to oil as well as economic instruments.

- CO_2 reduction in the long term could be even more pronounced to reach minus 27% below the 1990 level in the "full policy option case"; still greater reductions are possible with carbon sequestration.

- With the availability of all policy options including nuclear, carbon sequestration did not turn out to be a cost-effective solution in this modelling exercise; more research and technology learning on carbon sequestration is required if fossil fuels, and abundant solids in particular, are to be maintained in the energy balance in a severely carbon constrained world.

- Costs are important in assessing policy packages. While cost indicators in the model show similar levels in the policy option cases and in the Baseline, it needs to be stressed that the model deployed due to its partial equilibrium character does not capture all the economic costs likely to be incurred.

- The transition to a lower carbon energy economy can be costly, especially if the change is implemented rapidly. The cost effects depend on the way deep cuts in CO_2 emissions materialise and can be restrained by providing active energy policy that widens the range of low-carbon options available to economic agents.

The ***energy policy options case*** shows energy consumption levels that are well below those of the baseline (-6% in 2010 and -11% in 2030) giving rise to further energy intensity improvements. The use of fossil fuels diminishes considerably ranging from -43% below Baseline in 2030 for solid fuels to -21% for oil and -13% for gas. Therefore, there is a considerable increase in the shares of the carbon free and indigenous energies. Even with policy "frozen" at 2010, the renewables share increases to 13.8% in 2030 (plus 5.2 percentage points compared with Baseline). The nuclear contribution rises to 14.3% in 2030 (share increasing by 4.8 percentage points above Baseline). CO_2 emissions are reduced 12% below their 1990 level in 2010 and continue falling slightly by 2030 to 15% below the 1990 level. Import dependency would remain close to the current level up to 2010 and rises to only 57% in 2030, which is 10 percentage points lower than in the Baseline scenario. This analysis illustrates that there are no significant trade-offs involved in combining strong policies for energy efficiency and renewables with the penetration of accepted new nuclear technology. The energy policy options examined allow for a significant improvement of the future evolution of the EU-25 energy system, compared with the baseline scenario, both in terms of issues related to the security of supply and in terms of CO_2 emissions.

In the ***extended policy options case***, energy consumption falls significantly more below Baseline levels than in the above energy policy case. Total energy needs are down 18% below Baseline in 2030. This means a break with the trend for rising energy demand, which we have seen for many decades, as total energy consumption stabilises at a level that is even slightly below today's energy demand. Moreover, the structure of energy consumption changes significantly as solid fuels consumption sinks substantially by 68% below Baseline in 2030 and oil consumption in 2030 diminishes 27% (compared with Baseline) mainly due to policies in the transport sector. The penetration of natural gas as alternative transport fuel in this scenario limits the decrease of total natural gas consumption to 4% below Baseline in 2030. On the other hand renewables deployment increases substantially above Baseline (+60% in 2010 and +54% in 2030).

The renewables share increases therefore to 13.1% in 2010 (+5.7 percentage points higher than Baseline) and, with policies "frozen" in their 2010 position, to 16.2% in 2030 (+7.5 percentage points), but still below the targets set forth as feasible in recent EU institutional documents[4] . This means a considerable increase in the contribution of carbon free fuels to over a quarter in 2030 (26.2% in 2030), as the nuclear share rises also above Baseline levels following a strong decline in overall energy consumption. Consequently, import dependency would be limited below 60% up to 2030. Import dependency in 2030 would be down 7.6 percentage points from Baseline to reach 59.7%.

The structural changes in energy consumption and the stabilisation of energy demand below present levels in this scenario give rise to important CO_2 emission reductions compared with the 1990 reference. CO_2 emissions decrease 19% below the 1990 level in 2010 and by even 23% in 2030. The additional policies in the transport sector exert a marked effect on CO_2 emissions from transport. Transport CO_2 emissions would be more than 10% lower than they were in 2000 during the entire projection period,

4 European Parliament resolution on the International Conference for Renewable Energies (Bonn, June 2004)

which, however, does not suffice to prevent an increase from the 1990 level given the high emission growth in the 1990s.

Again, as in the case of the "Energy policy options" scenario, the combination of options examined in the "Extended policy options" case leads to a significantly more favourable evolution of the EU-25 energy system, while trade-offs among the different policies examined are rather insignificant, i.e. the implementation of one option does not impede the effectiveness of another one; all options can therefore be pursued simultaneously.

The ***full policy options case*** combines all the above options and considers in an additional analysis the issue of carbon sequestration. The combination of all options leads to a stabilisation of total energy consumption at present levels up to 2020 and a slight increase thereafter; the 2030 energy consumption level is nevertheless 14% below Baseline. The more pronounced contribution of nuclear leads to somewhat higher energy consumption levels given that nuclear power plants have a lower efficiency than natural gas and new coal plants.

There are considerable changes in the structure of energy consumption in this scenario. Due to solid fuel consumption falling 73% below Baseline in 2030 the share of solid fuels would be down to 5% in 2030 (compared to 18% in 2000). The oil share would also decrease to reach only 29% in 2030 (38% in 2000) following a decline in oil consumption by 27% below Baseline in 2030. Although natural gas consumption would be somewhat below Baseline levels, too, there would be a higher gas share in 2030 compared with the Baseline share. Natural gas would be the largest fuel in 2030 with a share of 34%. Renewables and nuclear would be up some 50% each in 2030 compared with Baseline. The renewables share would reach 13.2% in 2010 and 15.4% in 2030 compared with 5.8% in 2000. The nuclear share would also increase significantly from 14.4% in 2000 to 16.4% in 2030 so that the share of carbon free, indigenous energies would reach almost one third in 2030 (31.8%).

These changes bring about a substantial reduction in import dependency and CO_2 emissions. Import dependency would remain stable at the 2000 level up to 2010 and would be limited to 55% by 2030, which is 12 percentage points less than in the Baseline. CO_2 emissions would decrease considerably by 19% between 1990 and 2010 further decreasing to 27% below the 1990 level in 2030.

As it was the case for the previous two scenarios, there are no significant trade-offs between the various policy options examined in the "Full policy options" case. This result indicates that there is a large variety of policy measures available to policy makers to manage external dependency and to reduce energy related CO_2 emissions.

Adding ***CO_2 sequestration*** to this "full policy options" case could further reduce CO_2 emissions. Moreover, this option would keep a larger part of fossil fuel supply (especially solid fuels) in the energy system even under severe carbon constraints. CO_2 emissions, in the full policy option case plus sequestration, could be reduced 30% below the 1990 in 2030. However, it emerges from the present study that carbon sequestration is a costly option, where substantial additional costs would need to be recovered.

In the modelling, the carbon sequestration option did not turn out to be a cost-effective solution when combined with the other options, such as energy efficiency, renewables, nuclear, modal shift towards railways and better load factors, hydrogen and other non-oil alternatives in transport. Carbon sequestration might more easily penetrate if one or more of the above policy options failed; or, probably more importantly, as a result of much greater research activity and technological 'learning' in this area - that so far has occurred only on a limited scale. These results on carbon sequestration suggest that it is worthwhile to intensify research and development activities for CO_2 separation and disposal. This is in order to reduce costs and to ensure the availability of a very low CO_2 emitting technology, if fossil fuels - and abundant solid fuels in particular - are to be remain part of the energy balance in a possible severely carbon-constrained world.

Adopting these specific policies has the potential to achieve deep cuts in CO_2 emissions at relatively low costs. While ***cost indicators*** in the model show similar levels in the policy option cases and in the Baseline, it needs to be stressed that the model deployed – due to its partial equilibrium character – does not capture all the economic costs likely to be incurred. For example, substantial CO_2 reductions can be achieved with better insulation of buildings, for which the CO_2 (and energy) effects have been modelled as part of the policies for energy efficiency. However, the total costs involved have not been captured entirely given that the investment (and amortisation) of expenditure for better insulation is not represented in the PRIMES model. Similarly, hydrogen has the potential to contribute significantly to CO_2 reduction depending on the sources from which it is produced. A hydrogen economy will require substantial infrastructure investment for transmission and distribution, which is not entirely captured in the PRIMES model.

Moreover, the strong policies required incur political costs and benefits. This is because there are winners (such as society at large benefiting from reduced climate change impacts) but also losers. The losers face stranded costs for previous investments that are no longer economic in a strongly CO_2 constrained environment and have to alter business practices as a result of a substantially changed energy framework. In any case, the cost implications are largely sector specific depending on the energy and carbon intensities of the individual sectors, their flexibility to undertake changes in response, as well as the form of the particular policy instruments which are chosen.

The transition to a lower carbon energy economy can be costly, especially if the change is implemented rapidly. However, the cost effects in the long run would be more limited. As an example, the "Full policy options" case, including various energy and transport policy options and the acceptance of new nuclear in particular, gives rise to electricity prices that are just 1% higher in 2030 than in the Baseline. In this scenario, CO_2 emissions from the power generation sector in 2030 fall 63% below the Baseline level. The limited long-term impacts on electricity prices of any assumed deep cuts in CO_2 emissions stem from the comparably high degree of flexibility in this sector, given that there are various options for low or zero carbon energy inputs and more efficient ways of generating electricity. In the first phase of the above policies, i.e. to 2010, there are more important cost effects due to the need for higher investment (for e.g. renewables) and higher operating costs (as a result of emission trading). Electricity prices in 2010 would be 9% higher than in the Baseline. In later years the assumed availability of new nuclear technology, and the efficiency gains stemming from the investments in the early phases of transition, explain the lower impacts on costs.

A complete representation of the economic effects of deep CO_2 emission cuts would go beyond the scope of this energy scenario analysis and the capabilities of the model deployed. In particular such an analysis would require fully capturing cost elements that are presently outside the scope of the PRIMES model, e.g. the costs involved in better building insulation. Furthermore, macroeconomic feedbacks, taking due account of international competitiveness, need to be modelled. Such competitiveness effects, in turn, depend on the assumptions regarding the climate change policies likely to be pursued by the EU's main trading partners.

In any case, the magnitude of the cost effects is contingent on the way deep cuts in CO_2 emissions materialise. Substantially higher compliance costs would be incurred if the approach consisted simply in charging for CO_2 emissions without providing active energy policy that widens the range of low-carbon options available to economic agents. Such low carbon options include renewables and nuclear as well as better energy efficiency. The following chapter, starting from imposed CO_2 targets, explores cost issues for CO_2 reduction more fully.

CLIMATE CHANGE: REPERCUSSIONS OF IMPLICIT CO2 TARGETS ON ENERGY

Chapter 8 examines the impacts of climate change policies and implicit CO_2 "targets" in particular on the development of the EU energy system. Targets have been agreed internationally for a basket of several greenhouse gases, of which CO_2 is the most important one. Moreover CO_2 stems nearly exclusively from energy activities including those in the transport sector. Therefore this analysis is confined to CO_2 alone, given that dealing with all greenhouse gases would go far beyond the scope of this analysis. In any case, the CO_2 constraints examined in this chapter are compatible with the Kyoto protocol. The scenarios in this chapter provide insights, from an energy point of view, in the consequences of CO_2 constraints that would be implied in greenhouse gas targets that may be decided for future years. Chapter 8 describes in detail how the implicit CO_2 constraints or targets were derived from the Kyoto protocol provisions and the approach for the years after 2012 set out in the Commission's communication in the run-up to the Gothenburg summit. The main cases deal with:

- the continuation of the implicit CO_2 "target" for 2010 through 2030 on the basis of the Kyoto targets for EU-15 and the 8 new Member States having Kyoto targets, i.e. there is no "increase" in the target ("Kyoto forever" case); and
- the progressive strengthening of the CO_2 constraint (target) over time along the lines of the "Gothenburg" approach, whereby it is assumed that the target is achieved only with domestic policies ("Gothenburg-domestic" case).

There are many provisions in the Kyoto protocol that influence the level of the implicit CO_2 abatement and therefore the energy consequences of greenhouse gas targets, such as the possibility to act on other gases than CO_2 (e.g. methane) or to enhance sinks or to have recourse to the Kyoto flexible mechanisms (emission trading, joint implementation, Clean Development Mechanism). Larger use of such approaches or instruments would lead to more lenient CO_2 restrictions or in this modelling context "CO_2 targets". For the sake of this analysis, it was assumed that the CO_2 "targets" in the "Kyoto forever" case amounts to minus 5.5% below the 1990 level for EU-25 up to 2030 drawing on all the technicalities involved in the above mentioned international agreements, but respecting the EU-15 target of minus 8%. The "Gothenburg-domestic" case involves furthermore the approach set out in the Commission's communication for the Gothenburg summit and leads to a progressive strengthening of the target from minus 5.5% in 2010 to minus 21% in 2030. The other cases contained in chapter 8 show the energy effects of a higher recourse to flexible mechanisms or action on other gases.

- Maintaining Kyoto type targets at the same level through 2030 involves rising marginal costs, as higher amounts of CO_2 have to be abated due to increasing emissions in the Baseline.
- Deeper cuts in CO_2 emissions, such as minus 21% below the 1990 level in 2030 examined in this chapter ("Gothenburg-domestic" case), lead to strongly increasing marginal costs and important consequences for the EU-25 energy balance.
- Pursuing targets at the EU-25 level offers the opportunity of achieving emission reductions at much lower marginal costs than would be incurred in achieving similar targets at the EU-15 level.
- The energy consequences of climate change policies are considerable in the long term even in the case of just keeping the target level through time; they are substantial when deep cuts in CO_2 are aimed at.
- Energy intensity improvements reduce CO_2 emissions, but the greater part of the CO_2 reduction in the scenarios of this chapter would be achieved through changes in the fuel mix.
- Fossil fuel consumption would decline and CO_2 free fuels would account for up to 28% of total energy consumption with the above deep cuts in CO_2 emissions (minus 21%), in which case the renewables share would rise to 15.5%.
- Solid fuels would loose up to 83% of their demand in 2030 shrinking their market share to 3% in the "Gothenburg-domestic" case, while gas increases its market share to some extent. Despite the fall in solid fuels consumption import dependency would decrease by up to 7 percentage points from Baseline in 2030; cost-effective and accepted carbon sequestration at a large scale could change this picture.

The energy consequences of the above "targets" were derived from treating the EU-25 energy system as one entity. The "targets" or emission constraints were achieved in modelling the energy economy in such a way as to obtain equal marginal costs across Member States and sectors, which ensures the lowest possible cost level in a given policy context. These hypothetical solutions allow determining the energy consequences implied in a given target irrespective of the instrument chosen for achieving the target. This approach is quite different from the one in chapter 7 as it does not simulate policies (e.g. on energy efficiency, renewables or nuclear). On the contrary, this approach starts from targets and there is no widening of the low carbon options of economic actors through specific policies beyond those available in the Baseline. CO_2 emission reductions are achieved only through price/cost mechanisms, which leads to rather high illustrative CO_2 abatement costs that are indicative of the relative difficulty involved in maintaining target levels over time or in achieving progressively more ambitious targets.

Maintaining the "target" of minus 5.5% up to 2030 involves increasing marginal costs over time as increasing amounts of CO_2, stemming from emission growth in the Baseline, have to be avoided. While technical progress and the adaptation of economic actors to the CO_2 constraints contributes to reducing costs, there is upward pressure on abatement costs on account of rising CO_2 emissions in the Baseline (increasing to 14.2 above 1990 in 2030). This widens the gap between the Baseline and the target (increasing from 196 mill.t CO_2 in 2010 to 740 mill.t in 2030). The corresponding carbon values or marginal costs involved rise from 15.3 €/t CO_2 in 2010 to 40.9 €/t CO_2 in 2030 (in prices of 2000). It is notable that the carbon values increase at a slower pace (+167%) from 2010 to 2030 than the CO_2 reductions triggered by these carbon values (+278%).

Higher targets, such as those of the ***"Gothenburg-domestic" case*** (e.g. minus 21% below the 1990 level in 2030) involve substantially higher carbon values. The carbon values at the EU-25 level rise to 136.6 €/ t CO_2. This carbon value leads to a CO_2 reduction below Baseline in 2030 of 1324 mill. t CO_2 (avoiding the 14% Baseline CO_2 increase to 2030 and bringing emissions down by a further 21% below the 1990 level in 2030). The marginal costs for achieving a targeted level of CO_2 emission reductions rise steeply when deep cuts in CO_2 emissions are aimed at.

Pursuing targets at the ***EU-25 rather than the EU-15*** level offers the opportunity to reduce compliance costs substantially. On the basis of the technicalities involved in the Kyoto protocol, the carbon value in 2010 that is necessary at the EU-15 level would amount to 34.9 €/t CO_2, which is much higher than the 15.3 €/t CO_2 required at the EU-25 in the "Kyoto forever" case (which is identical with the Gothenburg cases for 2010). There are also substantial cost differences in 2030 between targets at the EU-15 and EU-25 level, albeit the cost ratio is less striking in 2030 (e.g. in the Gothenburg-domestic case: 226.4 €/t CO_2 in EU-15 versus 136.6 €/t CO_2 in EU-25). Again in should be borne in mind that these carbon values are indicative only of the relative cost levels involved.

In any case, the ***energy consequences*** of both the Kyoto and the Gothenburg scenario are quite important. Both scenarios are identical for 2010 but differ considerably in 2030.

In the Kyoto and Gothenburg cases in ***2010***, EU-25 CO_2 emissions are down 5.5% below their 1990 level or 5.2% below Baseline. Primary energy demand sinks by 2.5% below Baseline. This decrease corresponds to energy intensity improvements over and above those in the Baseline as GDP is assumed to remain unchanged between the Baseline and the carbon constrained cases. Energy intensity improvements deliver therefore slightly less than 50% of the CO_2 reduction in 2010 (2.5% / 5.2%) the remainder being ensured by carbon intensity improvements, i.e. changes in the fuel mix. Only renewables increase compared with Baseline (+7.7% in 2010). Lower overall energy consumption and fuel switching away from high carbon fuels diminish solid fuel consumption by 14.0% below Baseline, while oil decreases 2.2% and natural gas is 1.1% lower.

In the longer term the changes in the energy balance are more substantial. In ***2030*** in the "Kyoto forever" case at the EU-25 level, total energy consumption is 5.7% lower than Baseline while CO_2 emissions stay 17.2% below Baseline. Energy intensity improvements over and above Baseline play therefore a much smaller role in the long term than changes in the fuel mix (carbon intensity). Total solid fuel consumption in 2030 is 60% lower than in the Baseline, reflecting the high carbon content of solid fuels. Oil falls 4.9% below Baseline, whereas natural gas consumption increases 5.0% as it is a low carbon fuel. Nevertheless, there is higher growth for the CO_2 free sources, nuclear and renewables. Nuclear rises 8.9% above Baseline and renewables benefit again from the highest growth (+30.6% from Baseline).

These effects are even more pronounced in the "Gothenburg-domestic" scenario in 2030. CO_2 emissions fall 30.8% from Baseline, while total energy consumption is down only 12.4% leaving the bulk of CO_2 abatement for changes in the fuel mix and only 40% for energy intensity improvements. In this case, all fossil fuels are faced with lower demand. Solid fuels loose 83% of their 2030 Baseline demand, which reduces their market share in 2030 to just 3% (compared with 18% in 2000). Oil consumption decreases by 11%. Natural gas decreases 7% below Baseline, but as this decrease is somewhat lower than the decline in total energy consumption there is a slight increase (over Baseline) in the gas share to reach 34% in 2030. Nuclear grows by 15.6% and renewables increase by 57.5% from Baseline. The share of carbon free energy sources rises to 28% in 2030 (from 20% in 2000). The renewables share in 2030 amounts to 15.5% compared with 8.6% in the Baseline in 2030 and 5.8% in 2000.

The high share of nuclear and renewables, which are also indigenous energy sources, ensures a reduction in import dependency in these scenarios despite the substantial decline in the consumption of solid fuels that are produced to a large extent domestically. In 2030, import dependency declines 3.1 percentage points from Baseline in the "Kyoto forever" case and by 7.2 percentage points in the "Gothenburg-domestic" scenario, in which case import dependency in 2030 amounts to 60%. Cost-effective carbon sequestration that is accepted at the high level of CO_2 to be treated in such an approach could change this picture significantly, keeping larger amounts of solid fuels in the energy balance with positive effects on energy security.

COMPARISON AND CONCLUSION

The following comparison among scenarios addresses the policy relevant indicators: import dependency, share of renewables and carbon free fuels as well as CO_2 emissions. This highlights some of the challenges ahead and shows how different framework conditions and policy approaches impact on these policy relevant indicators and the energy situation that surrounds them. Chapter 9 provides also some conclusions on this extensive modelling exercise.

The Baseline depicts an energy development that is challenging in terms of both energy security and CO_2 emissions. Import dependency in EU-25 would increase to 67% in 2030 on the basis of current trends and policies, up from less than 50% today. The share of the indigenous and CO_2 free energy sources renewables and nuclear would decrease from 20.2% in 2000 to only 18.1% in 2030 reflecting the nuclear phase-out decisions in certain Member States and the closure of nuclear reactors with safety concerns in some new Member States The renewables share would rise from 5.8% in 2000 to 8.6% in 2030, which is, however, much lower than the 12% renewables objective for 2010 reflecting the fact that the baseline scenario does not assume the implementation of the substantial legislative and policy measures adopted on renewables at EU level since the Autumn of 2001, but only the measures that were implemented in the Member States up to the end of 2001. Consequently, CO_2 emissions grow in the long term, exceeding the 1990 level by 14% in 2030, after a period of stabilisation at the 1990 level by 2010 thanks to developments in the new Member states.

These energy developments take place against the background of sustained economic growth that is assumed in the baseline in order to evaluate the energy, transport and environment consequences of fairly successful economic policies. GDP would double between 2000 and 2030, while total energy consumption would rise by 19% giving rise to considerable energy intensity improvements of 1.7% pa. Carbon intensity would decrease until 2015 and rises thereafter following the nuclear phase-out in certain Member States.

Import dependency, which increases already substantially in the Baseline, could be even higher in 2030 if the EU would benefit from higher economic growth or if there were a nuclear phase-out in the entire EU. In the high growth case (GDP growth of 2.7% pa instead of 2.4% pa in the Baseline), import dependency would rise to 68.5 in 2030 (+1 percentage point from Baseline). The increase of import dependency would be even more pronounced in the case of a nuclear phase-out (75% import dependency in 2030), which would be moderated only somewhat (71% import dependency in 2030) if there were renewables promotion at the same time that ensures the achievement of the 12% target.

On the other hand, lower economic growth or higher energy import prices would limit the growth of import dependency to some extent. With only 2.0% pa GDP growth, import dependency would rise to "only" 65.7%. The high import price scenarios result in a range of 62-66% for import dependency (compared with 67% in the Baseline).

Only in the policy cases that involve energy efficiency, renewables, nuclear or CO_2 restrictions is there a marked reduction of import dependency. Transport related action, such as railway promotion or better fuel efficiency through improved load factors, reduces import dependency only slightly.

With strong energy efficiency and renewables policies that ensure the achievement of the 12% renewables target in 2010, and are then "frozen" at their 2010 level, import dependency in 2030 would be limited to 61.5% (- 6 percentage points from Baseline). Similarly, the acceptance of new nuclear technology in all Member States that have used nuclear so far and the strong energy efficiency and renewables policies up to 2010 (i.e. the "energy policy options" case in chapter 7) would make import dependency drop to 57% in 2030. With additional renewables policies addressing the period beyond 2010 even better results can be expected. The growth of import dependency up to 2030 would be curtailed significantly if several of the energy and transport policy option would be combined. In the "full policy option" case of chapter 7 that includes strong action on transport (e.g. more than 20% alternative fuels in land transport in 2020 and railway promotion) in addition to energy efficiency and renewables (up to 2010) and nuclear, import dependency would increase only somewhat above current levels to reach 55% in 2030.

With import dependency increasing in all scenarios up to 2030 – albeit to a quite different degree according to the scenario – it is important to strengthen consumer– producer relations and energy partnerships. This should help ensuring secure and stable world energy market conditions. Moreover, mutually beneficial energy trade relations can exert a positive influence on geopolitical stability, which in turn exerts a positive influence on the security of energy supply.

Measures reducing ***CO_2 emissions*** would also reduce import dependency, as energy intensity improvements and fuel switching to CO_2 free fuels contribute towards both CO_2 reduction and lower import dependency. If the current Kyoto target were maintained up to 2030 (in this analysis at minus 5.5% for CO_2 only), import dependency in 2030 would be reduced to 64% and it would fall to 60% in the scenario with deep cuts in CO_2 by 21% below the 1990 level. This decline of import dependency materialises in spite of the associated strong decline in the consumption of solid fuels, which are largely produced domestically. Cost-effective and accepted carbon sequestration at a large scale could change this picture, which reinforces the point for additional research and progress on the learning curve for carbon sequestration.

In addition to the two cases above for CO_2 reduction, various energy and transport policy measures lead to lower CO_2 emission levels. In the medium term to 2010, energy efficiency and renewables offer the greatest potential. In the high energy efficiency and renewables scenario, CO_2 emissions decrease to 12% below their 1990 level in 2010. Action along the lines of the Transport White Paper Option C (i.e. railway promotion and better load factors as described in chapter 6) would bring CO_2 emissions below the 1990 level by over 4%. Combining all policy options discussed in this modelling analysis gives rise to a CO_2 emission decline of 19% below the 1990 level in 2010. Given the long lead times for nuclear investments, these numbers for 2010 do not include any additional nuclear contribution compared with Baseline.

Nuclear can play an important role in the long term. Combining the assumed acceptance of new nuclear with strong policies on energy efficiency and renewables up to 2010 (leading to 12% renewables in 2010) brings about CO_2 emission cuts to 15% below the 1990 level despite strong upward pressure on CO_2 from economic growth. Again, reinforced renewables policies addressing the post 2010 period would give rise to even better results. Particularly deep cuts in CO_2 emissions can be achieved when all options (including strong transport related policies) can be combined leading to CO_2 emissions in 2030 that are 27% lower than in 1990. With cost-effective and accepted carbon sequestration even deeper cuts are possible.

The development of GDP growth is also important for CO_2 emissions, whereas the impact of high oil and gas prices is more limited. In the low economic growth case (chapter 3), CO_2 emissions remain 4% below their 1990 level in 2010 and increase to 4% above 1990 in 2030 (instead of plus 14% in the Baseline). Higher economic growth, on the other hand, puts additional upward pressure on CO_2 emissions so that they would exceed the 1990 level by 3% in 2010 and 24% in 2030. Higher oil and gas prices compared with Baseline would keep CO_2 emissions close to their Baseline level as these high prices encourage at the same time greater use of solid fuels in addition to some more renewables deployment and lower oil and gas consumption.

The ***renewables share*** is an important indicator not only with a view to import dependency and climate change but also as renewables contribute to employment and cohesion objectives. The renewables share reaches the 12% target only with strong specific policies, it remains below this target in all other cases. The 12% renewables share is more easily obtained in combining strong renewables policies with ambitious energy efficiency policies; there are synergies between both approaches, e.g. in terms of cogeneration from biomass. For maintaining momentum in renewables penetration, additional policies are required addressing the period post 2010 as markets and technology development alone entail only a small increase of the renewables share beyond 12% reaching e.g. 14.4% in 2030 in the high efficiency and renewables scenario. Adding strong transport action and economic instruments, such as somewhat higher energy taxation and emission trading ("extended policy options" case of chapter 7) would increase the renewables share to 16% in 2030. This rather moderate renewables share in the long-term, achieved with renewables policies addressing 2010, reinforces the case for strengthening renewables policies for the post 2010 period.

Nuclear is the energy source that is surrounded by the greatest uncertainty. In this scenario exercise the nuclear share in 2030 spans a wide range from an extreme 0% (nuclear phase-out in the entire EU) to 16.4% in the scenario that combines all policy options including the acceptance of new nuclear technology. This would be the highest nuclear share ever given that the highest nuclear share so far was 14.8% in 2002 (the latest statistical year available). Under Baseline developments the nuclear share would fall to 9.5% in 2030.

There is indeed a large amount of uncertainty about our energy future, which relates also to the economic and geopolitical influences on energy and transport developments. The world in which policy makers have to act to achieve sustainable development is uncertain in many respects. Scenario analysis that considers both the demand and supply side of providing energy in an integrated fashion, including its economic and environmental dimensions, is a powerful tool to support policy making.

The Green paper on the Security of Energy Supplies and the White paper on the Common Transport Policy have shown clearly that there are many challenges ahead to ensure better security of supply, better services for the users of energy and transport, and lower impacts on the environment. Today's policy makers and citizens have it within their grasp to transform Europe's energy outlook to ensure sustainable development, including its economic, social and environmental dimensions. This publication examined a wide range of energy policy options over the next three decades showing that the energy futures can be quite different. Transport policy can furthermore contribute significantly towards restraining energy demand and making our energy system more efficient. Clearly, there are synergies to be developed between energy and transport policies. This analysis of scenarios on key drivers should contribute to an informed debate among stakeholders and provide valuable pointers to future policies.

INTRODUCTION

Secure energy supplies are vital for the functioning of our economy and the well-being of citizens. Energy plays an important role for the competitiveness of the European economy and it is also a main source for environmental pollution. Energy policy in Europe is confronted with important decisions, which have long term consequences given the long lead times for energy investments and the long lifespan covering several decades. In preparing such decisions, it is important to have a comprehensive and consistent view on the various aspects of the economy that will be affected. Model based scenario analysis as presented in this publication provides a comprehensive and consistent view on future energy supply and demand including its driving forces.

The European Energy and Transport Scenarios in this publication follow last year's publication on "Trends to 2030" and provide alternative projections to 2030 of the EU-25 energy system depending on the development of key drivers. Readers will find in this publication a variety of alternative energy futures based on a wide range of contrasted developments concerning the economy, the world energy context as well as energy and transport policies. These alternative outlooks or scenarios for the enlarged Union of 25 illustrate the broad directions in which our energy system could evolve following different framework conditions or policy decisions.

The Baseline scenario, a summary description of which is provided in Chapter 1, reveals the challenges ahead for the EU-25 energy system. Energy developments in EU-25 are challenging, especially concerning energy security, the penetration of renewables, increasing CO_2 emissions and the ongoing growth of road transport and aviation, which are particularly energy intensive. Nuclear will play an important role in this respect given its carbon free nature and status as indigenous energy source. More extensive policy measures will be needed to meet the challenges, as set out in the Green Paper on Energy Security and the White Paper on Common Transport Policy.

The scenario analysis shows the high degree of uncertainty that surrounds our energy future. The world in which policy makers have to act to achieve sustainable development is uncertain in many respects. Alternative framework conditions for energy policy making stem from the overall economic situation and the influences from world energy markets that are themselves dependent on geopolitical developments. The particularly high oil prices that we have seen this year are an example for this. If high economic growth is to be achieved to enable the EU to meet the challenges of unemployment and an ageing population, the consequences for the energy and transport sectors will be important.

Chapter 2 of this publication informs the reader about the energy, transport and environment consequences of higher oil and gas import prices than foreseen in the baseline and provides an analysis of the global energy situation in which such higher prices would materialise.

The analysis also deals, in Chapter 3, with the impacts of different economic growth developments on the EU-25 energy system, including a high economic growth case (where the Lisbon economic growth target would be realised) and a low growth case reflecting the weak state of the economy similar to recent years.

The policy cases analysed address a wide range of issues. It is demonstrated in Chapter 4 that more vigorous implementation of EU key policies on energy efficiency and renewables will bring benefits in terms of better energy security and a reduction in CO_2 emissions. These scenarios highlight also that energy policies in the Member States and the EU have to address the longer time horizon extending to 2020/30. Current measures alone – even if implemented vigorously and reaching for example the 12% renewables target for the EU – will not suffice to meet the long term energy policy challenges. Additional energy efficiency and renewables measures will have to be proposed and adopted addressing a longer time horizon.

As the Green paper on Energy Security sets out, keeping the nuclear option open will be important for the EU given the challenges ahead, especially in terms of managing growing energy import dependency and upward pressure on CO_2 emissions stemming from economic growth. Chapter 5 of this publication highlights both the current contribution of nuclear energy by simulating a hypothetical phase-out of this energy source in the entire EU and the energy and emission consequences of an alternative development, in which a new generation of improved nuclear technology would be implemented. This analysis confirms the conclusions of the Green paper that meeting Kyoto targets will be more difficult without nuclear, as a nuclear phase-out would add more than 300 mill t CO_2 to our CO_2 emissions that are already too high. In terms of the 1990 emission level, a nuclear phase-out would mean adding another 9 percentage points to the EU-25 CO_2 emissions of 1990, whereas the Community committed itself to reduce total greenhouse gas emissions by 8% below the 1990 level in EU-15. On the other hand, acceptance of new nuclear technology would make a difference only in the long run, given the long lead times for nuclear power plants and the retirement of existing plants due to ageing, market conditions or political decisions.

Transport is a major driver for energy demand. This publication investigates, in Chapter 6, the energy and emission consequences of realising the objectives of the White paper on the Common Transport Policy. Rising transport demand, concentrated increasingly on road and air modes, is one of the main reasons for increasing energy demand. Transport policy can contribute significantly towards restraining energy demand and making our energy system more efficient. Clearly, there are synergies to be developed between energy and transport policies.

In fact, energy and transport policies are not pursued in isolation but reinforce each other. This is analysed in cases that combine policy approaches on energy and transport and take into account other Community policies on the environment and on taxation (discussed in Chapter 7 of this publication). The combined cases, covering issues like renewables, energy efficiency, nuclear, transport, and emission trading / taxation, show that with better use of available policy approaches at the disposal of the EU more sustainable energy futures are possible. Energy import dependency can be limited and CO_2 emissions can be substantially reduced in the medium to long term provided that existing policies and measures are pursued vigorously and certain new measures introduced. The considerable changes of our energy balances that would be involved in such alternative developments have been analysed in detail. Better energy efficiency is a cornerstone of any such development and higher renewables shares will be instrumental in achieving this goal. It is notable that a large reduction in the share of fossil energies can be achieved under such scenarios favourably impacting upon CO_2 emissions.

Energy policy needs to anticipate issues in order to be prepared to act. Energy scenarios help to achieve this goal. Examining a wide range of possible key drivers, energy policy may be faced with the challenge of achieving major reductions in greenhouse gas emissions that may be debated in the context of the Kyoto protocol. Bearing in mind the requirement to integrate the environment in energy policy and in order to better understand the energy consequences of deep cuts in CO_2 emissions, the analysis has been extended to test the consequences of vigorous climate change policies on the energy system. The results, illustrated in Chapter 8, show that such deep cuts come at a cost and that they involve substantial changes in the EU energy system.

Some conclusions for the different policy options examined for the future evolution of the EU-25 energy system are presented in Chapter 9. The analysis clearly reveals the large uncertainties that prevail in the period to 2030. The analysis highlights, furthermore, the existence of alternative policies and measures that if pursued and implemented properly could lead to a significantly more favourable development compared to current trends both in terms of security of supply and as regards environmental concerns, especially those related to the evolution of CO_2 emissions in the EU.

The design of the scenarios, the analysis to determine the assumption and the actual modelling was undertaken in the period 2001 to early 2004 – that is in parallel to the process of enlargement. It was not clear during most part of this period, which countries were to join the EU at what time. The endeavour to present projections and scenarios on key drivers to 2030 for the EU representing all Member States meant however that considerably more time was needed to accomplish the work. Nevertheless, the Baseline modelling was finalised as soon as the Commission recommended concluding the accession negotiations with 10 candidate countries in October 2002. The publication "European Energy and Transport - Trends to 2030", which presented the Baseline, was still based on the ACE model for the new Member States, whereas this publication is based on the more sophisticated PRIMES model for all Member states. This meant that, the data concerning the new Member States had to be improved during this process to enable the use of the PRIMES model for all 25 Member States – which took additional time. The results of this lengthy process are presented in this book.

The particularly lengthy period for the preparation of this scenario analysis under the conditions of the biggest enlargement ever of the EU saw also some highly energy relevant events that were impossible to foresee. The terrorists' attacks on 11.9.2001, the Afghanistan and Iraq wars and the ongoing tensions in the Middle East are examples of political developments that have a strong short and medium term influence on oil prices and economic development in general - both of which are key drivers of energy demand.

In particular, the current very high oil price of around 40$/bbl had not been foreseen for the Baseline – but such an event was only considered as a scenario with a rather small likelihood – incidentally for 2004 (i.e. just a year before the first modelled year 2005).[5] Instead, the world energy modelling leading to the baseline price assumptions was undertaken in 2001, which was a period of declining oil prices. The Baseline price assumptions reflected the consensus view of a moderate future oil price development, which was, for example, similarly expressed in the IEA's 2002 World Energy Outlook. In any case, the economic fundamentals in the oil markets still justify the trend for long term moderate oil prices of close to 30$/bbl in 2030 in money of 2000.

The assumptions on GDP and sectoral economic developments were derived in 2001 and 2002 reflecting the European Commission Spring 2002 economic forecast for the short term. These economic growth projections appear somewhat optimistic from a 2004 perspective but fall considerably short of the ambitions expressed and repeatedly confirmed by the heads of state and governments of the EU in the framework of the Lisbon strategy. The economic growth assumptions used for the Baseline and most of the scenarios have been chosen in order to evaluate the energy, transport and environmental consequences of an economic development that accommodates policies to reduce unemployment and to cope with an ageing population. In any case, this scenario analysis on key drivers includes also a low economic growth case, in which the modest economic growth since 1990 continues throughout the projection period.

The analysis has been performed with the use of PRIMES model, a partial equilibrium model for the European Union energy system developed by, and maintained at the National Technical University of Athens, E3M-Laboratory led by Prof. Capros. The most recent version of the model used in this study covers all 25 EU Member States, the remaining EU candidate countries, Norway and Switzerland. The model uses EUROSTAT conventions and statistical methodology and its database is constructed using the official data sources of EUROSTAT, IEA and UN with the year 2000 being the base year. The PRIMES model is the result of collaborative research under a series of projects supported by the Joule Programme of the Directorate General for Research of the European Commission.

The CD enclosed in this publication gives background material. These files include detailed tables for each scenario on energy, transport and environment developments by group of countries (EU-25, EU-15, New Member States (NMS), and Europe-30) both as regards the developments over time within the respective scenarios and in comparison to the Baseline scenario, as well as aggregate results by Member State and by group of countries (again including both level projections and comparisons to the

5 The PRIMES model works on the basis of 5 year steps, i.e. provides projections for 2005, 2010, 2015, etc

Baseline scenario). In addition, the different macro-economic assumptions of the analysis are available from the CD by Member State and group of countries. Furthermore, the European Energy and Transport: Trends to 2030 publication of the European Commission is also available on the enclosed CD, as well as a background study on global energy developments and a short description of the PRIMES model.

This volume has been prepared within the "Long Range Energy Modelling" framework contract, which was financed by the Directorate-General for Energy and Transport and co-ordinated by Hugh Rees, Pirjo-Liisa Koskimaki (successively Heads of the economic analysis Unit TREN/B/1), Manfred Decker and other officials of the unit. Manfred Decker in particular provided valuable support and guidance throughout the scenario analysis process. The contributions of DG TREN officials, including Kurt Gläser of the information unit, were of major importance for the identification of the different cases to be examined and the preparation of this publication. A special acknowledgement is due to EUROSTAT, the main source for energy and economic data that has been used in this volume. The study benefited from the support related to data and information by P. Tavoularidis, N. Roubanis and other officials of EUROSTAT and by Marcel Lecloux and Walter Selders of the Directorate General for Energy and Transport. Member States' energy experts and European Commission officials have contributed through a process of comments and feedback towards the finalisation of this work.

Prof. Pantelis Capros, Dr. Leonidas Mantzos and Maria Zeka-Paschou of the National Technical University of Athens (NTUA) are responsible for the projections of the "European Energy and Transport – Scenarios on key drivers". They are also responsible for the construction and maintenance of the PRIMES model, on which the quantitative work reported here, is based. Jean-François Guilmot (ESAP) contributed to the maintenance of the PRIMES model database and in the analysis of key EU policies examined in this publication. Dr. Leonidas Mantzos is the main author of this report with contributions from Prof. Capros, M. Zeka-Paschou and other members of the NTUA, while Prof. John Chesshire has edited it. The views expressed in this report, although discussed with European Commission officials, do not engage the Commission and are not necessarily shared by the Energy and Transport DG. The responsibility rests solely with the authors.

An electronic letterbox (tren-projections@cec.eu.int) is at the reader's service and the Energy and Transport Directorate General's internet site (http://europa.eu.int/comm/dgs/energy_transport/index_en.html) provides detailed information on energy and transport policies and market developments.

CHAPTER 1: EU-25 energy and transport reference case to 2030 (baseline)

1.1. Introduction

This chapter reviews the key issues arising from a continuation of current trends and policies in terms of economic, energy, transport and CO_2 trends over the period to 2030 for the enlarged EU of 25 Member States (called hereafter EU-25). EU-25 refers to the enlarged European Union of 25 Member States including the ten new Member States (NMS)[6] that acceded to the EU on 1 May 2004. This baseline also serves as the reference case for the scenarios in the following parts of this publication. The results of these scenarios, representing alternative framework conditions and policies, are compared with these Baseline projections.

The results presented here are slightly different compared to those of the recent publication by the European Commission "European Energy and Transport – Trends to 2030".[7] In the Trends to 2030, the analysis of the energy system of candidate and neighbouring countries was performed with the use of the ACE[8] model, which has been developed and used in the context of the Long Range Energy Modelling (LREM) framework contract for the Energy and Transport DG. The need for the construction and use of the ACE model stemmed from the limited availability of detailed data, which initially did not fulfil the requirements of the PRIMES model,[9] for candidate and neighbouring countries, and also from the need to produce the "European Energy and Transport: Trends to 2030" publication of the European Commission within specific time limits. However, as data availability improved and as candidate countries became increasingly important (with ten of them entering the European Union in 2004), the PRIMES model was also developed in parallel and a new Baseline scenario was constructed. Efforts have been made for this new Baseline scenario, which is presented in the following chapters, to be as close as possible to that produced with the ACE model and presented in the "European Energy and Transport: Trends to 2030" publication. The analysis for the EU-15 Member States has already been performed with the PRIMES model for the Trends to 2030 so that the results of this Baseline and those in the Trends to 2030 are identical for EU-15.

All major trends of the candidate and neighbouring countries' energy systems remain similar between the two scenarios. However, it is obvious that some differences will exist given the extensive revisions of the energy data. Energy balances of EUROSTAT were used in PRIMES instead of OECD energy balances in the ACE model. Moreover, there is a much more analytical representation of the energy system in the PRIMES model compared to ACE.

1.2. Main assumptions of the Baseline Scenario

The definition of the Baseline scenario is important because it constitutes the basis for further policy analysis in addition to its function as a projection on the basis of current trends and policies. For this purpose, this scenario is conceived as the most likely development of the energy system in the future in the context of current knowledge, policy objectives and measures.

The Baseline scenario includes existing trends and the effects of policies in place and/or in the process of being implemented by the end of 2001. However, for renewable energy the implementation of the renewables electricity Directive of September 2001 is not included, whereas tax rates reflect the situation of July 2002 in the EU-15 Member States. As regards new Member States a gradual convergence of energy taxes towards those in EU-15 has been assumed. For analytical reasons the Baseline scenario excludes all additional policies and measures that aim at further reductions of CO_2 emissions so as to comply with the Kyoto emission commitments.

The Baseline scenario is used as the reference for additional policy-relevant scenario analyses addressing issues such as renewables, nuclear, energy efficiency, energy import prices, alternative GDP growth, and Kyoto targets presented in the following chapters.

The main assumptions underlying the Baseline scenario are presented below.[10]

---

6 Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

7 Mantzos, L., Capros, P., Kouvaritakis, N., Zeka-Paschou M. (2003): European Energy and Transport: Trends to 2030. European Commission – Directorate General for Energy and Transport, ISBN 92-894-4444-4, Office for Official Publications of the European Communities, Luxembourg.

8 The Accession Countries Energy (ACE) Model is a large-scale energy demand and supply model developed and maintained at the National Technical University of Athens, E3M-Laboratory led by Prof. Capros. It was developed and used in order to study the potential future energy-related developments in EU candidate and neighbouring countries. It covers all EU candidate and neighbouring countries and uses OECD and EUROSTAT as the main data sources with 2000 being the base year.

9 PRIMES is a partial equilibrium model for the European Union energy system developed by, and maintained at the National Technical University of Athens, E3M-Laboratory led by Prof. Capros. The most recent version of the model used in this study covers all EU Member States, EU candidate countries, Norway and Switzerland, uses EUROSTAT as the main data source and is updated with 2000 being the base year. The PRIMES model is the result of collaborative research under a series of projects supported by the Joule Programme of the Directorate General for Research of the European Commission.

Table 1-1: Population trends in the EU-25, 1990 to 2030

	Million inhabitants					Annual Growth Rate (%)				
	1990	2000	2010	2020	2030	90/00	00/10	10/20	20/30	00/30
EU15	366.01	378.69	387.83	390.45	389.02	0.34	0.24	0.07	-0.04	0.09
NMS	75.12	74.73	73.40	71.67	69.14	-0.05	-0.18	-0.24	-0.36	-0.26
EU-25	441.13	453.41	461.23	462.11	458.16	0.28	0.17	0.02	-0.09	0.03

Source: EUROSTAT, Global Urban Observatory and Statistics Unit of UN-HABITAT, PRIMES.

Table 1-2: Number of households in EU-25, 1990 to 2030

	Million households					Annual Growth Rate (%)				
	1990	2000	2010	2020	2030	90/00	00/10	10/20	20/30	00/30
EU15	141.25	157.67	174.21	187.33	197.12	1.11	1.00	0.73	0.51	0.75
NMS	25.72	28.11	30.03	30.53	30.46	0.89	0.66	0.17	-0.02	0.27
EU-25	166.97	185.78	204.24	217.86	227.58	1.07	0.95	0.65	0.44	0.68

Source: EUROSTAT, Global Urban Observatory and Statistics Unit of UN-HABITAT, PRIMES.

1.2.1. Demographic and weather assumptions

Population is an important determinant both of overall economic performance and of energy trends, especially in the transportation, household and services sectors. EUROSTAT figures have been used in the PRIMES Baseline scenario both as regards historical data and projections for the evolution of population in the EU-15 Member States.[11] As regards new Member States population data and short-term projections were taken from the EUROSTAT database, whereas population growth rates beyond 2003 and over the horizon to 2030 were derived from the UN Centre for Human Settlements.[12]

EU-25 population is projected to remain rather stable, peaking in 2020 at some 462 million but declining thereafter to reach 458 million by 2030 (see Table 1-1). The population in NMS is projected by 2030 to decline by some 5.6 million people or 7.5% of that in 2000. The NMS accounts by 2030 for 15.1% of the EU-25 population, compared to 16.5% in 2000.

Another key demographic factor that plays an important role as regards the growth of energy demand in households is the household size (i.e. number of persons per household). Rising life expectancy, combined with declining birth rates and changes in societal and economic conditions, are the main drivers for a significant decline in average household size, both in the EU-15 and in NMS. Following UN projections,[13] average household size in the EU-15 is expected to decline from 2.4 persons in 2000 to 1.97 persons in 2030 (-0.65% pa in 2000-2030). The corresponding decline in NMS is less pronounced (-0.52% pa, from 2.66 persons per household in 2000 to 2.27 persons in 2030). This trend gives rise to significant growth in the number of households, which increase by 42 million between 2000 and 2030 (+0.7% pa in 2000-2030) despite the rather stable evolution of population (see Table 1-2). Growth in the number of households is one of the key drivers of energy demand in the residential sector.

Weather conditions, which are important in determining both the intensity and the overall pattern of energy use (mainly as regards heating requirements), are assumed to remain unchanged over the projection period, i.e. the degree-days parameter is taken as constant at 2000 levels.

10 For a more detailed discussion of Baseline scenario assumptions please refer to the European Energy and Transport: Trends to 2030 publication of the European Commission (also available in the enclosed CD).

11 More specifically the growth rates of the base case projections of EUROSTAT for the EU Member States have been applied to historical data for the population in 2000 to construct the population growth projection used in the PRIMES baseline. This approach was adopted in order to cope with inconsistencies between EUROSTAT data for the year 2000 and the corresponding figures in EUROSTAT projections which were first produced in 1995 and revised in 1999. The numbers for France do not include the overseas territories.

12 United Nations (2002) Global Urban Observatory and Statistics Unit of UN-HABITAT (UN Centre for Human Settlements): Human Settlement Statistical Database version 4 (http://www.unhabitat.org/programmes/guo/guo_hsdb4.asp). The growth rates of the base case projections of the Global Urban Observatory and Statistics Unit of UN-HABITAT for the candidate and neighbouring countries have been applied to historical data in order to cope with inconsistencies between EUROSTAT data and the corresponding figures in UN-HABITAT projections.

13 United Nations (2002) Global Urban Observatory and Statistics Unit of UN-HABITAT (UN Centre for Human Settlements): Human Settlement Statistical Database version 4: Data and forecasts of population, number of households and household size (http://www.unchs.org/habrdd/CONTENTS.html) for EU-15 Member States; Human Settlement Statistical Database version 4 (http://www.unhabitat.org/programmes/guo/guo_hsdb4.asp) for new Member States.

1.2.2. Macroeconomic assumptions

The economic outlook presented below is based on a number of underlying assumptions. For example, the recent economic slowdown - including the impacts of the terrorist attack of 11 September 2001 - is assumed to be transitory, and the longer-term global economic climate is assumed to remain generally positive. In addition, the EU-25 is projected to benefit from economic and monetary unification as well as from a continued increase in world trade, as barriers continue to fall. Increases in commodity prices and inflation are assumed to remain modest.

The economic growth assumptions have been chosen in order to evaluate the energy, transport and environmental consequences of an economic development that accommodates policy efforts to reduce unemployment and to cope with an ageing population. Still higher economic growth might materialise if the Lisbon economic reform agenda is successfully implemented. On the other hand, with the weak state of the economy seen in the last few years, lower growth rates than those shown in the Baseline are also possible. The energy, transport and environmental consequences of these two alternative cases are analysed in Chapter 3 of this publication.

The Baseline economic outlook of EU-25 is dominated by the evolution of the EU-15 economy. This is because the contribution of new Member States, despite their much faster growth over the projection period (+3.5% pa in 2000-2030 compared to +2.3% pa in EU-15), remains rather limited in terms of overall EU-25 GDP (see Table 1-3). By 2030, NMS GDP reaches 6.1% of EU-25 economic activity compared to 4.4% in 2000[14] and, consequently, overall economic growth of EU-25 (+2.4% pa) follows closely that of the EU-15.

The slowdown in economic growth for NMS between 1990 and 2000 (+1.7% pa compared to +2.0% for the EU-15) largely reflects the major reforms of political and economic structures that Central and Eastern European countries (CEEC) have experienced since the early 1990s. These included: industrial restructuring and privatisation; establishment of viable legal structures and regulatory systems; reform of capital markets and trade policies, etc., which in turn induced a deep recession between 1990 and 1993 in all countries except Poland.

The GDP projections for EU-25 Member States are based on Economic and Financial Affairs DG forecasts of April 2002 for the short term (2001-2003);[16] and on macroeconomic forecasts from WEFA,[17] adjusted to reflect recent developments, for the horizon to 2030. Furthermore, for the EU-15 additional inputs were taken into account from Member States' stability programmes and long-term projections, stakeholders' consultation,[18] and the results of the GEM-E3 model.[19] Economic growth is not uniformly distributed across countries, but the convergence of Member States' economies (including NMS) is assumed to continue over the projection period. Furthermore, the integration of new Member States into the European Union is assumed to generate accelerated growth for their economies.

However, the convergence of NMS economies towards EU-15 levels remains far from complete even by 2030 (see Table 1-4). Despite much faster growth of per capita income projected in NMS than in EU-15 (+3.7% pa in 2000-2030 compared to +2.2% pa), per capita GDP in NMS (expressed in purchasing power standards) amounts to 69.3% of the corresponding EU-15 figure in 2030 (compared, however, to only 44.5% in 2000).

Table 1-3: Evolution of gross domestic product in EU-25, 1990 to 2030

	000 M Euro'00					*Annual Growth Rate (%)*				
	1990	2000	2010	2020	2030	90/00	00/10	10/20	20/30	00/30
EU15	6982	8545	10859	13641	16920	2.04	2.43	2.31	2.18	2.30
NMS	333	394	574	821	1100	1.70	3.82	3.64	2.97	3.48
EU-25	7315	8939	11433	14462	18020	2.03	2.49	2.38	2.22	2.36

Source: EUROSTAT, Economic and Financial Affairs DG, PRIMES.[10]

15 Incorporating results obtained from the WEFA study and GEM-E3 model runs (this applies to all the macroeconomic assumptions).

16 European Commission Economic Forecasts, Spring 2002 (EUROPEAN ECONOMY. No. 2. 2002. Office for Official Publications of the EC. ISBN92-894-3357-4; ISSN0379-0991). Also available at: http://europa.eu.int/comm/economy_finance/publications/europeaneconomy_en.htm.

17 WEFA (now integrated into DRI-WEFA) is an economic consultancy company which, in the context of the Long Run Energy Modelling framework contract, was subcontracted by NTUA to deliver a consistent macro-economic and sectoral forecast over the horizon to 2020 for the EU Member States and, at a more aggregate level, for candidate countries and EU neighbouring countries (Norway and Switzerland). This projection was delivered in March 2001 and has been used as a benchmark in the context of this study.

18 Workshop on "Business-as-usual in energy intensive sectors beyond 2010", organised by Commission services (DG-ENV and DG-TREN), March 2001.

19 The GEM-E3 model has been constructed under the co-ordination of NTUA within collaborative projects supported by DG-RESEARCH involving CES-KULeuven and ZEW.

Table 1-4: Per capita GDP in EU-25[20]

	Euro'00 per capita					Annual Growth Rate (%)				
	1990	2000	2010	2020	2030	90/00	00/10	10/20	20/30	00/30
EU15	19076	22565	28000	34937	43494	1.69	2.18	2.24	2.21	2.21
NMS	8663	10048	14912	21787	30144	1.49	4.03	3.86	3.30	3.73
EU-25	17303	20502	25917	32898	41479	1.71	2.37	2.41	2.34	2.38

Source: EUROSTAT, ENERDATA, Economic and Financial Affairs DG, PRIMES.

Table 1-5: Evolution of sectoral value added in EU-25

	000 MEuro'00					Annual Growth Rate (%)				
	1990	2000	2010	2020	2030	90/00	00/10	10/20	20/30	00/30
Gross Value added	**6833**	**8351**	**10793**	**13730**	**17165**	**2.03**	**2.60**	**2.44**	**2.26**	**2.43**
Industry	1486	1698	2168	2758	3436	1.34	2.47	2.44	2.22	2.38
Energy intensive	430	495	620	771	931	1.40	2.28	2.21	1.90	2.13
Non Energy intensive	1055	1203	1548	1987	2505	1.32	2.55	2.53	2.34	2.47
Construction	431	439	532	653	783	0.18	1.93	2.08	1.83	1.94
Services	4482	5709	7525	9667	12210	2.45	2.80	2.54	2.36	2.57
Agriculture	198	222	247	275	298	1.12	1.09	1.06	0.84	1.00
Energy branch	236	283	322	377	437	1.84	1.29	1.62	1.47	1.46

Source: EUROSTAT, Economic and Financial Affairs DG, PRIMES.

The projected evolution of sectoral value added in EU-25 is given in Table 1-5. The Baseline assumptions for economic growth of the EU-25 Member States reflect the long established trend of structural changes in developed economies, away from the primary and secondary sectors and towards services and high value-added products (less material and energy-intensive products). However the pace of change is expected to decelerate in the long run.

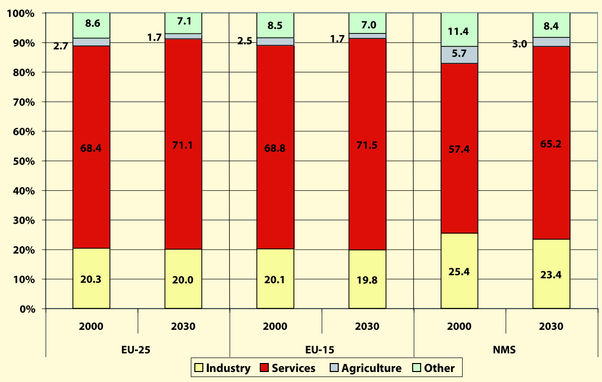
Services value added increases over the projection period at rates above average, implying a continuous increase of its share in total economic activity (71.1% in 2030 compared to 68.4% in 2000). This increase in market share of services occurs to the detriment of all other sectors of the economy. The market share of industrial activity, which grows at rates slightly below average, declines by 0.3 percentage points over the projection period (from 20.3% in 2000 to 20% in 2030). The lowest economic growth is projected for agriculture (+1.0% pa in 2000-2030), while the energy branch and construction sectors are also projected to exhibit a significant decline in terms of market shares, growing by 1.5% pa and 1.9% pa, respectively, to 2030.

As illustrated in Figure 1-1, despite the significantly faster growth of services, the new Member States' economies are projected to remain more reliant on industry and agriculture than the EU-15 to 2030. This clearly reflects the existing structural differences of their economies in 2000, differences that are not projected to be fully eliminated by 2030. The key features of the macroeconomic and demographic outlook of EU-25, EU-15 and NMS (but also Europe-30 including in addition Bulgaria, Romania, Turkey, Norway and Switzerland) as well as sectoral forecasts are presented in Appendix 1A.[21]

1.2.3. International fuel prices

The Baseline projections presented here, as regards the evolution of international fuel prices, are based on the important assumption that global energy markets will remain well supplied at a relative modest cost throughout the projection period. These projections derive from the output of the POLES model.[22] Thus, in comparison to the "ups and downs" of the past 30 years, the primary energy prices assumed here reflect the current consensus view that no

Figure 1-1: Structure of the EU-25 economy, shares in gross value added 2000, 2030



Source: PRIMES.

20 Expressed in purchasing power standards for NMS countries.

21 The detailed macroeconomic outlook and demographic assumptions for individual countries can be found in the enclosed CD.

Table 1-6: International price assumptions

	Average border prices in the EU ($00/boe)					*Annual Growth Rate (%)*			
	1990	**2000**	**2010**	**2020**	**2030**	**1990-2000**	**2000-2010**	**2010-2020**	**2020-2030**
Crude oil	27.9	28.0	20.1	23.8	27.9	0.03	-3.27	1.74	1.59
Natural gas	15.6	15.5	16.8	20.6	23.3	-0.06	0.80	2.06	1.25
Hard coal	13.1	7.4	7.2	7.0	7.0	-5.60	-0.25	-0.22	-0.01

Source: POLES.

major supply constraints are likely to be felt in the period to 2030. These assumptions on primary energy prices follow from an optimistic view of future discoveries of new oil and gas fields and on further advances in extraction technologies.

The evolution of primary fuel prices is illustrated in Table 1-6. Oil prices are assumed to decrease over the next few years from their high 2000 level. The 2010 oil price is projected at 20.1 US$(2000), from where it grows smoothly to reach by 2030 27.9 US$(2000). Natural gas prices are assumed to reach 16.8 US$(2000) per barrel of oil equivalent in 2010, which is higher than their 2000 level. This means a medium term decrease in the oil–gas price gap. With increasing gas-to-gas competition gas prices are decoupled from oil prices in the second part of the projection period. Coal prices remain essentially stable in real terms. Further justification for these price trajectories is provided in the related report by IEPE-CNRS.[23] This report also contains alternative price trajectories under different assumptions of GDP growth by region, energy resources, and availability of gas from certain regions. The energy consequences for Europe of these alternative price trajectories are discussed in Chapter 2.

1.2.4. Policy assumptions

The Baseline scenario assumes that agreed policies addressing economic actors in the EU-25 Member States, as known by the end of 2001, will continue. It presumes that all current policies and those in the process of being implemented at the end of 2001 will continue in the future. However, the implementation of the renewables electricity Directive 2001/77 of September 2001 is not included. This applies also to Directive 2003/30 on renewable energy in transport and any additional follow-up Directives.

No additional policies to reduce greenhouse gases in view of e.g. the Kyoto targets are included in the Baseline. In particular, no attempt has been made to forecast how Member States might endeavour to fulfil their Kyoto commitments. It is also assumed that EU-15 policies currently in place and in the pipeline will be gradually adopted and implemented by new Member States, according to each country's rate of attainment of the acquis communautaire and its overall path of convergence towards EU standards.

This approach allows the Baseline scenario to be considered as the benchmark against which a number of alternative policies can be judged, assisting policy analysts in the evaluation of alternative measures. Hence, the Baseline scenario takes into account:

- Technological progress, induced both by economic growth and by modernisation of installations in all sectors of the economy, thereby improving the efficiency of the energy system.
- The restructuring of the sectoral pattern of economic growth, which gradually shifts away from traditional energy-intensive sectors and concentrates on high value added activities, thereby reducing energy intensity.
- The effects from restructuring of markets through the liberalisation of electricity and gas in the EU, which proceeds in line with EC directives; liberalisation is assumed to be fully implemented in the period to 2010.[24] Completion of the internal electricity and gas markets is also assumed to take place in the new Member States.
- The restructuring in power and steam generation, which is enabled by mature gas-based power generation technologies that are efficient, involve low capital costs and are flexible regarding plant size, co-generation and independent power production.
- Changes in primary energy production patterns (especially in many new Member States), characterised by the closure of unprofitable coalmines that took place in the 1990s and which is expected to continue to some extent over the next few decades.
- Energy policies that aim at promoting renewable energy (wind, small hydro, solar energy, biomass and waste) and co-generation

22 The POLES model is a global sectoral model of the world energy system. The development of the POLES model has been partially funded under the Joule II and Joule III programmes of DG XII of the European Commission. Since 1997 the model has been fully operational and can produce detailed long-term (2030) world energy and CO2 emission outlooks with demand, supply and price projections by main region. The model splits the world into 26 regions. For the model design see the model reference manual: POLES 2.2. European Commission, DG XII, December 1996.

23 IEPE-CNRS (2002) World Energy Scenarios and International Energy Prices. Final Report to NTUA for the Long-Range Energy Modelling Project, March 2002. (Included in the enclosed CD.)

24 This country-by-country modelling has focused on the dynamics of the energy system within a country, while considering trade in fuels between countries. An in-depth study of trade developments in electricity and gas would necessitate further work on the PRIMES model, which goes beyond the scope of this study.

are assumed to continue, involving subsidies on capital costs and preferential electricity selling prices. Rather than imposing the indicative targets of the EC renewables electricity Directive [25] for each Member State, the Baseline includes policy measures in view of higher renewables deployment in individual countries.

- Ongoing infrastructure projects involving the introduction of natural gas. These are assumed to be completed in the next few years.
- Differences in current policies of EU-25 Member States as regards nuclear capacity, taking into account policy decisions as regards nuclear phase out in Belgium, Germany and Sweden; and plans concerning nuclear plant refurbishment/closure, as already agreed or under negotiation with the European Commission for new Member States.[26]
- The effects arising from the voluntary agreement reached between the European Commission and the European automobile industry on specific CO_2 emissions from new cars (followed in 1999 by similar agreements with Korean and Japanese car manufacturers).[27]
- Concerning the use of biofuels in transportation, it was assumed that all countries would follow EU rules[28] sooner or later. The impact of blending gasoline and diesel with biofuels on final consumer prices was assumed to be negligible, since higher fuel production costs will probably be offset by tax reductions scheduled to be implemented on these fuel blends.

In line with the Baseline philosophy, policy initiatives related to climate change are included only to the extent that they are agreed policy measures. For the purposes of the study it is assumed that no specific new policies and measures aimed at meeting Kyoto targets in 2008-2012, and possible more severe ones in the future, are implemented over the next 25 years. This assumption may be judged somewhat unrealistic; but it does help maintain the benchmark character of the reference case, allowing it to serve as a Baseline for comparisons with alternative CO_2 abatement policy scenarios.

However, it is assumed that stringent regulation for acid rain pollutants continues, especially for large combustion plants. Similarly, other clean air policies are assumed to continue.

1.2.5. Committed investment and decommissioning in power generation

The Baseline scenario assumes that all capacity expansion and decommissioning plans in power generation, already decided, would take place as indicated in the EURPROG report of EURELECTRIC and other statistical sources (e.g. EPIC)[29] . Beyond 2010 plant decommissioning occurs on the basis of technical lifetimes and agreed policies on nuclear phase-out.

1.2.6. Other Assumptions

The discount rate plays an important role within the PRIMES model. It is a crucial element in the determination of investment decisions by economic agents regarding energy using equipment. Three (real) rates are currently used within the model. The first, used mostly for large utilities, is set at 8%; the second, used for large industrial and commercial entities, is set at 12%; the third, used for households in determining their spending on transportation and household equipment, is set at 17.5%.

1.3. Baseline scenario results[30]

1.3.1. Main Findings

The results of the Baseline scenario show that, despite the evidence of some saturation for some energy uses in the EU-25, energy demand is expected to continue to grow, albeit at rates significantly lower than those experienced in the recent past. Primary energy demand in the EU-25 is projected to increase at an annual rate of 0.6% in 2000 to 2030 compared to an annual growth rate of 2.4% for GDP, implying that the energy intensity of the EU-25 energy system (expressed as primary energy demand per unit of GDP) will improve at a rate of 1.7% pa in 2000-2030.

The evolution of the EU-25 energy system to 2030 under Baseline assumptions reflects a continuation of the decoupling between energy demand and economic growth. In 2030, one unit of GDP in EU-25 is expected to be produced with only approximately half the energy input that was needed in 1990. The main reasons that justify this significant gain in energy intensity under the Baseline scenario include improvements in energy efficiency (both on the demand and the supply sides), changes in the structure of EU industry, satu-

25 European Commission Directive 2001/77/EC of the European Parliament and of the Council on The Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market. Brussels, 27 September 2001.

26 Nuclear policy assumptions of Central and Eastern European countries were drawn from the information contained in the 2001 Regular Reports from the Commission on Progress towards Accession, 13 November 2001 (http://europa.eu.int/comm/enlargement/report2001/index.htm).

27 European Commission (2000) Commission recommendations on the reduction of CO2 emissions from passenger cars, Official Journal of the European Communities, No L 40/49-13.2.99, L 100/57-20.4.2000 and L 100/55-20.4.2000. Also available at: http://europa.eu.int/comm/environment/co2/co2_agreements.htm

28 European Commission Communication COM(2001) 547 of the European Commission of 07/11/01 on an action plan and two proposals for Directives to foster the use of alternative fuels for transport, starting with the regulatory and fiscal promotion of biofuels. Also at: http://europa.eu.int/comm/energy/library/comm2001-547-en.pdf.

29 EURPROG report of 2002. The Epic database, developed by ESAP SA, gives a technical description, unit by unit, of power generation capacity. For EU-25 it contains more than 26,500 units above 100 kW. More information is available at www.esap.be.

30 Aggregate results by group of countries (EU-25, EU-15, NMS and Europe-30) can be found in Appendix 1B. Detailed results by group of countries and aggregate results by group of countries and by country are also available in the enclosed CD.

ration in demand for some important energy needs, and the policies already in place under Baseline assumptions.

Between 1990 and 2000 CO_2 emissions in the EU-25[31] decreased by -2.8% whereas the corresponding primary energy needs grew by 6.2%, implying a significant improvement in the carbon intensity (-0.9% pa in 1990-2000) of the EU-25 energy system. The changes in the fuel mix during this decade were the key driver for this improvement.

In the Baseline scenario CO_2 emissions are foreseen to grow throughout the projection period, but at lower rates than those for primary energy demand. In 2010, CO_2 emissions are projected to remain slightly below the 1990 level (whereas the corresponding growth for primary energy needs reaches +14.8%). In 2030 CO_2 emissions exceed the 1990 level by 14.2% (+26.1% for primary energy demand). Nevertheless, the strong decoupling between EU-25 energy demand and CO_2 emissions, which occurred between 1990 and 2000, is not projected to continue in the long run with a worsening of carbon intensity from 2015 onwards. Figure 1-2 illustrates the links between GDP, energy use and CO_2 emissions growth from 1990 to 2030 (with energy and carbon intensity plotted against the secondary axis).

Carbon intensity for the EU-25 energy system is projected to improve at a rate of -0.4% pa between 2000 and 2015. However, beyond 2015 the EU energy system is projected to become rather more carbon intensive (carbon intensity worsens at a rate of 0.3% pa). There are two main reasons for this result:

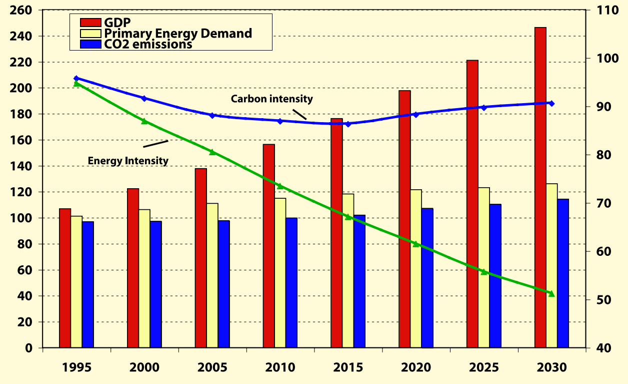
(i) The opportunities for CO_2 emissions reductions through fossil fuel switching (mainly on the demand but also on the supply side) become progressively more exhausted due to technological constraints on the extent that each sector is able to switch further to lower carbon content fuels; and

(ii) Nuclear decommissioning in the EU energy system beyond 2015, combined with declared nuclear phase-out policies in certain EU Member States (namely Belgium, Germany and Sweden), generates a gap in power generation that cannot be satisfied fully by other carbon free fuels.

Convergence between old and new Member States

These trends in energy consumption and economic growth materialise both in the new Member States and in EU-15 as there will be convergence between the old and new Member States. The NMS energy system is characterised by modernisation and economic

Figure 1-2: EU-25 primary energy indicators (index 1990=100), 1995-2030



Source: PRIMES.

restructuring away from energy-intensive activities, energy efficiency improvements and more rational use of energy, and progressive implementation of EU policies.

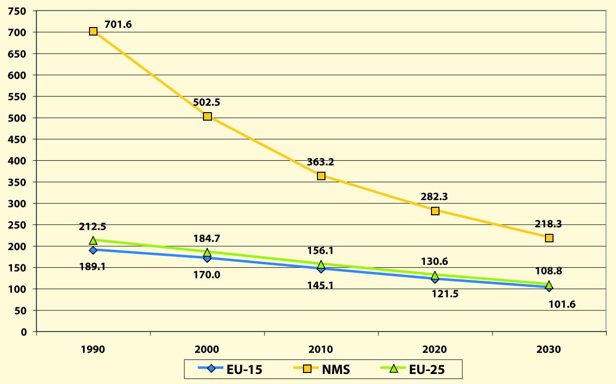
The energy intensity (primary energy demand per unit of GDP at market exchange rates) of the EU-25 energy system improves at a rate of 1.7% pa in 2000-2030 compared to 1.4% pa in 1990-2000). Energy intensity reaches 109 toe per million € in 2030 from 212 in 1990. However, as illustrated in Figure 1-3, the pace of improvement is significantly different between the EU-15 and the NMS. Following a substantial improvement in energy intensity of 2.5% pa during the last decade, driven by the economic restructuring of CEEC, energy intensity in NMS is projected to further improve at rates well above the EU-25 average over the projection period (-2.7% pa in 2000-2030) reaching 218 toe per million in 2030 compared to 702 toe per million € in 1990. The energy intensity improvement in EU-15 is less pronounced with a decrease from 189 toe per million € in 1990 to 102 in 2030 (-1.7% pa in 2000-2030). Nevertheless, energy intensity for NMS remains, even by 2030, more than twice that of the EU-15 (compared to 3.7 times higher in 1990 and 3.0 times higher in 2000).[32]

The restructuring in CEEC resulted in a decline of CO_2 emissions by an astonishing -20.4% for the NMS region in 1990-2000, while the fall in primary energy needs was -15.2% in the same period. Furthermore, the changes in the fuel mix that occurred during this decade in the EU-15 limited the increase of emissions to 1.2% in 1990-2000 compared with a 10% growth of primary energy needs. Both developments contributed to the decline of CO_2 emissions at the EU-25 level by -2.8% between 1990 and 2000 compared with a rise of primary energy needs of 6.2%. Beyond 2000, CO_2 emissions at the EU-25 level

31 It should be noted here that, within the PRIMES model, aviation includes both national and international flights from the EU, without distinguishing between the two (data on the split between domestic and international aviation are not currently available) following the corresponding EUROSTAT convention as regards energy consumption in aviation. Consequently total CO2 emissions from aviation are accounted for at the level of each Member State. However, consumption of international maritime bunkers is excluded from the analysis according to EUROSTAT conventions; consequently it is not accounted for in national CO2 emissions. According to the Guidelines for National Greenhouse Gas Inventories of the Intergovernmental Panel on Climate Change (IPCC), both emissions based upon fuel sold to aircraft engaged in international transport and to international maritime fleets should not be included in national totals, but reported separately.

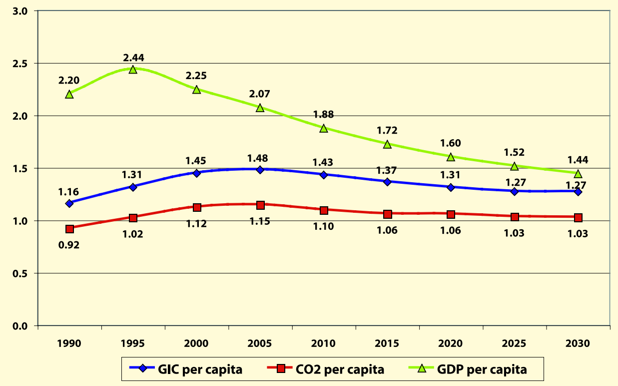
32 If GDP expressed in purchasing power standards is used energy intensity for NMS countries is some 1.55 times higher compared to the EU-15 average in 2000, declining to 1.17 times higher by 2030.

Figure 1-3: Evolution of energy intensity in EU-25 (in toe per MEuro'00)



Source: PRIMES.

Figure 1-4: Convergence in EU-25 (ratios: EU-15 to NMS)



Source: PRIMES.

are projected to grow in the Baseline case, reaching +14.2% from 1990 levels by 2030. But the emissions growth (+0.5% pa in 2000-2030) remains slower than the growth in primary energy needs (+0.6% pa), implying a further improvement of carbon intensity to 2030.

The trend is rather similar both for the EU-15 and the NMS. While opportunities for CO_2 emissions reductions through fossil fuel switching are largely exploited by 2015, there are several factors that contribute to a deterioration of carbon intensity beyond 2015. These include: replacement of nuclear with fossil fuels and coal in particular in the course of nuclear decommissioning largely brought about by the nuclear phase-out in certain Member States; the relatively slow penetration of renewables; and the significant growth of transport demand in NMS (with very limited possibilities for fuel switching).

Differences between the EU-15 energy system and that of the new Member States remain significant, as can be seen by comparing per capita levels of key indicators of the energy system, namely GDP, gross inland consumption (GIC) and CO_2 emissions (see Figure 1-4). By 2030, GDP per capita in EU-15 remains some 44.3% higher than in new Member States[33] compared to 125% higher in 2000. This indicates that, despite the significant improvements in new Member States' economies, full convergence with the EU-15 might not be completed by 2030.

On the other hand, convergence in terms of energy consumed per capita is more pronounced, with EU-15 citizens consuming by 2030 some 27% more energy than those in NMS (compared to 45% more in 2000). The more carbon intensive character of the NMS energy systems compared to the EU-15 is reflected in CO_2 emissions per capita. By 2030 CO_2 emissions per capita in the EU-15 are projected to be 3% higher than in the NMS, although EU-15 has much higher energy consumption per capita. In 2000, per capita CO_2 emissions in the EU-15 were still 12% higher than those in the NMS.

1.3.2. Primary Energy Needs

Total indigenous production of primary energy in EU-25 is expected to decline continuously over the projection period (-1% pa in 2000-2030). As illustrated in Table 1-7 the decline is more pronounced in fossil fuels production while, in contrast, renewable energy forms are expected to grow over the projection period. Indigenous production of solid fuels declines by some 50% in the 2000-2030 period (-57% for coal, -35% for lignite) driven by the increasing competitiveness of imported coal and natural gas. Crude oil and natural gas production also experiences a significant decline (-47% and -40% respectively from 2000 levels by 2030) due to the exhaustion of currently exploited reserves and the limited scope for the exploitation of new, more costly ones in a world of relatively modest energy prices.

Nuclear production is projected to experience limited growth to 2010. Thereafter it is likely to decline steeply (-22% in 2030 from 2000 levels), as a result of the closure of nuclear plants with safety concerns in some new Member States and the nuclear phase- out policies decided in certain EU-15 Member States. In other countries the decommissioning of nuclear plants at the end of their lifetime is not always compensated by new nuclear investment. As regards the use of renewable energy forms in the EU-25 energy system, policy measures and technological progress are the key drivers for the significant boost projected (+76% in 2000-2030). Beyond 2020, renewable energy forms become the second most important indigenous energy source (after nuclear) in the EU-25 energy system.

It is interesting to note that indigenous production declines much faster in NMS (-1.4% pa in 2000-2030) compared to the EU-15 (-0.9% pa), a result strongly related to the dominance of solid fuels as an indigenous energy form in the new Member States' energy systems in the past. By 2030 NMS account for some 13.3% of indigenous production of primary energy in EU-25, compared to 15.2% in 2000.

Primary energy demand in EU-25 rose some 6% between 1990 and 2000 with very different trends in EU-15 (+10%) and NMS (-15.2%). In new Member States, the slowdown of economic activity in CEEC, the massive closure of old energy-inefficient factories and

33 GDP per capita for new Member States is expressed in terms of purchasing power standards.

Table 1-7: Primary production of fuels in EU-25

	Mtoe					*Annual Growth Rate (%)*				
	1990	**2000**	**2010**	**2020**	**2030**	**90/00**	**00/10**	**10/20**	**20/30**	**00/30**
Solid Fuels	350.8	203.4	153.8	126.4	102.5	-5.3	-2.8	-1.9	-2.1	-2.3
Hard coal	236.2	135.7	90.2	72.3	58.9	-5.4	-4.0	-2.2	-2.0	-2.7
Lignite	114.5	67.6	63.7	54.1	43.7	-5.1	-0.6	-1.6	-2.1	-1.4
Liquid Fuels	120.3	163.5	131.7	102.1	86.5	3.1	-2.1	-2.5	-1.6	-2.1
Natural Gas	139.6	196.6	196.9	147.6	117.1	3.5	0.0	-2.8	-2.3	-1.7
Nuclear	196.9	237.7	245.3	213.5	185.3	1.9	0.3	-1.4	-1.4	-0.8
Renewable En. Sources	69.2	96.1	132.7	151.3	169.5	3.3	3.3	1.3	1.1	1.9
Total	**877**	**897**	**860**	**741**	**661**	**0.2**	**-0.4**	**-1.5**	**-1.1**	**-1.0**
EU-15	708	761	743	635	573	0.7	-0.2	-1.6	-1.0	-0.9
NMS	169	136	117	105	88	-2.1	-1.5	-1.1	-1.8	-1.4

Source: PRIMES.

Table 1-8: Primary energy demand in EU-25

	Mtoe					*Annual Growth Rate (%)*				
	1990	**2000**	**2010**	**2020**	**2030**	**90/00**	**00/10**	**10/20**	**20/30**	**00/30**
Solid Fuels	431	303	244	253	300	-3.4	-2.2	0.4	1.7	0.0
Liquid Fuels	596	636	654	672	674	0.6	0.3	0.3	0.0	0.2
Natural Gas	259	376	507	598	628	3.8	3.0	1.7	0.5	1.7
Nuclear	197	238	245	214	185	1.9	0.3	-1.4	-1.4	-0.8
Renewable En. Sources	69	96	133	151	169	3.3	3.3	1.3	1.1	1.9
Total	**1554**	**1651**	**1784**	**1889**	**1960**	**0.6**	**0.8**	**0.6**	**0.4**	**0.6**
EU-15	1321	1453	1576	1657	1719	1.0	0.8	0.5	0.4	0.6
NMS	234	198	208	232	240	-1.6	0.5	1.1	0.4	0.6

Source: PRIMES.

increasing energy prices progressively aligned to world energy market levels, led to a rapid decline of primary energy needs in the nineties. It is important to note that, before 1990, the CEEC were characterised by the world's highest energy intensity after the Former Soviet Union. This situation resulted from an industrial structure based on energy-intensive industries (steel, cement, chemicals) using energy inefficiently; and very low energy prices, as energy consumption was largely supplied from the Former Soviet Union at prices usually well below world market levels.

New Member States accounted in 2000 for some 12% of primary energy needs in EU-25 (from 15% in 1990) compared to 16.5% of the population and 4.4% of GDP, clearly reflecting the great inefficiencies that still prevailed in the NMS energy system. In the Baseline scenario primary energy demand is projected to grow by 18.7% in EU-25 between 2000 and 2030 (see Table 1-8), with energy needs growing slightly faster in NMS (+21.3%) compared to the EU-15 (+18.4%). By 2030 primary energy demand in NMS is projected to reach 12.3% of overall energy needs in EU-25. Thus, the evolution of EU-25 primary energy needs is still dominated by prevailing trends in the EU-15 energy system over the projection period.

Natural gas and renewable energy forms are projected to remain the fastest growing fuels in the EU-25 energy system (as was the case during the last decade), growing at rates 3 times faster than overall energy needs over the projection period (+1.7% pa in 2000-2030 for natural gas; and +1.9% pa for renewable energy forms). Primary energy demand for liquid fuels exhibits moderate growth over the projection period (+0.2% pa) though at a rate well below average. Solid fuels, after a strong decline to 2010, are projected to regain some market share in the EU-25 energy system beyond 2015 as a result of the increasing competitiveness of imported coal and also nuclear plant decommissioning. By 2030, primary energy demand for solid fuels is projected to come close to that observed in 2000. Novel energy forms, such as hydrogen and methanol, are not projected to make significant inroads in the EU-25 energy system in the period to 2030 under Baseline conditions.

In the Baseline, the EU-25 energy system is projected to become increasingly dependent on fossil fuels, though with significant changes occurring in the fuel mix (see Figure 1-5). Following a substantial decline during the last decade (from 27.7% of primary energy needs in 1990, down to 18.4% in 2000), the share of solid fuels is projected to decline further to 2015 (accounting then for 12.3% of primary energy needs), regaining some market share thereafter (15.3% in 2030). Liquid fuels are also projected to exhibit a modest decline, with their market share reaching 34.4% in 2030 compared to 38.5% in 2000. In contrast natural gas, spurred by its rapid penetration both on the demand and the supply sides, accounts by 2030 for 32.1% of primary energy needs (+9.3 percentage points compared to 2000 levels). Overall, in the Baseline case, the share of fossil fuels is projected to reach 81.8% of primary energy demand in the EU-25 energy system by 2030 compare to 79.6% in 2000.

As regards non fossil fuels, nuclear energy accounts for 9.5% of primary energy demand in 2030 (compared to 14.4% in 2000). The share of renewable energy forms increases only moderately from 5.8% of primary energy demand in 2000 to reach 8.6% in 2030 despite the considerable growth of renewable energy sources (including waste) in percentage terms (+76% in 2000-2030). It should be recalled that the Baseline does not assume the implementation of the legislation adopted at Community level at the end of 2001 and after (e.g. renewables electricity Directive).

The combined effect of increasing primary energy demand for fossil fuels and declining primary production results in a significant growth of **import dependency** for the EU-25 energy system from 47.2% in 2000 up to 67.3% in 2030 (see Table 1-9), an increase of more than 20 percentage points. By 2030 some 88.3% of EU-25 oil demand will be satisfied by imports compared to 76.6% in 2000. Oil imports are projected to continue consisting mainly of crude oil, as net imports of oil products will remain marginal. The EU-25 external dependence in terms of natural gas is projected to increase sharply, reaching 81.4% by 2030 compared to 49.5% in 2000. As regards solid fuels, though import dependency under Baseline assumptions is also projected to grow significantly, it remains at lower levels compared to oil and gas, reaching by 2030 65.8% -- up from 30.1% in 2000.

Both EU-15 and NMS energy systems are projected to reach similar levels of import dependency in the long run (67.8% and 63.6% respectively in 2030). This is despite the much better current position of new Member States, with an import dependency of 30.8% in 2000 compared to 49.4% in the EU-15. Faster growing energy needs in NMS, combined with a steep decline of indigenous solid fuels production, are the main reasons for this trend.

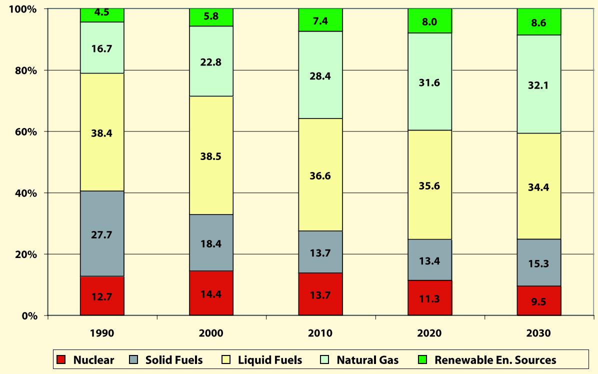
The increasing dependence of the EU-25 energy system on energy imports (more than two thirds of primary energy needs in 2030) raises significant concerns as regards the security of supply in the long run. This is especially the case for natural gas given the increasing dependence upon gas imports from a limited number of suppliers and the need for long distance transport infrastructures, as well as the increasing natural gas demand in other world regions such as Asia. In the oil market, supply is increasingly concentrated in the Middle East while North Sea production declines. On the other hand, the world coal market remains well diversified with abundant supplies.

Table 1-9: Import dependency in EU-25

	%				
	1990	**2000**	**2010**	**2020**	**2030**
Solid fuels	17.5	30.1	36.9	50.0	65.8
Liquid fuels	80.9	76.6	81.3	86.0	88.3
Natural gas	47.6	49.5	61.2	75.3	81.4
Total	**44.8**	**47.2**	**53.1**	**61.9**	**67.3**
EU-15	47.6	49.4	54.3	62.9	67.8
NMS	28.3	30.8	44.0	54.8	63.6

Source: PRIMES.

Figure 1-5: Structure of primary energy demand in EU-25.



Source: PRIMES.

1.3.3. Final Energy Demand projections

Final demand sectors have undergone significant changes both in the EU-15 and the NMS during the last decade. In EU-15, changes in the 1990s related mainly to shifts towards less energy-intensive manufacturing industries and services, higher standards of living, associated with widespread ownership of private cars and domestic appliances, increasing comfort levels in space heating and cooling, and changes in the fuel mix away from solid and liquid fuels towards gas and electricity uses. As regards new Member States, the restructuring of Central and Eastern European countries' economies between 1990 and 2000, including the massive closure of old energy-inefficient factories and increasing energy prices progressively aligned to world energy market levels, explain the changes on the demand side.

Between 1990 and 2000 final energy demand in EU-25 increased by 6% with the EU-15 exhibiting growth of 11%, whilst energy demand in NMS declined by -21%. Under Baseline assumptions, the factors that prevailed during the last decade in EU-15 are assumed to continue to do so in the future, while they are also likely to become important for NMS as the restructuring in CEEC progresses and economic conditions improve, further stimulated by the process of convergence.

Final energy demand in EU-25 is projected to increase by 29.8% between 2000 and 2030, well above that projected for primary energy needs (+18.7%). This difference reflects the significant efficiency gains in power generation expected under Baseline assumptions. Overall final energy demand growth is rather similar in the EU-15 and NMS regions (+28.7% and +38.4% respectively in 2000-2030), though exhibiting significant differences in terms of growth patterns (see Table 1-10). Thus, while demand growth in EU-15 is projected to peak in the next decade and to decelerate afterwards, energy demand in NMS is projected to exhibit even stronger growth between 2010 and 2020 and then to slow down in the long run. The main drivers for these different growth patterns include: issues related to the different economic evolution between EU-15 and NMS; the further reduction of inefficiencies in CEEC; and the likely faster development of saturation effects for a number of energy uses beyond 2010 in the EU-15.

1.3.3.1. Final energy demand by sector

The evolution of energy demand by sector for the EU-25 energy system is illustrated in Table 1-10. Between 1990 and 2000, structural changes in the EU-15 industrial sectors, combined with the impacts of industrial restructuring in CEEC, led to a decline of energy demand in **industry** by -6%. In the same period industrial value added increased by 14% with implied intensity gains in the sector reaching 1.9% pa. In the period 2000-2030, energy demand in EU-25 industry is projected to grow by 25.7% driven by higher economic growth (sectoral value added more than doubles between 2000 and 2030). However, energy intensity gains remain significant over the projection period (+1.5% pa) driven by structural changes towards less energy-intensive manufacturing processes but also by the exploitation of energy saving options; changes in the fuel mix towards fuels allowing for higher efficiency in use also contribute to this development.

Energy demand in the **tertiary** sector exhibited a limited increase in the last decade (+0.9% pa). However, energy demand in the sector grew much slower than economic activity, which increased by 2.4% pa in 1990-2000, driven mainly by structural shifts in the EU-15 and to a lesser extent by economic restructuring in NMS. In the Baseline scenario energy demand in the tertiary sector is likely to continue growing at a rather uniform pace over the projection period (+1.2% pa in 2000-2030) while the expected continuation of the restructuring of the EU-25 economy towards services leads to an economic growth of 2.5% pa. The improvement of energy intensity in this sector (energy consumption per unit of value added) is projected to reach +1.3% pa in 2000-2030 (compared to +1.4% pa in 1990-2000) but with a decelerating pace over the projection period.

The EU-25 **residential** sector also exhibited limited growth in terms of energy demand (+0.4% pa) between 1990 and 2000. The restructuring of CEEC economies (involving a more rational use of energy in the context of increasing energy prices), technological improvements (both in buildings and equipment), changes in the fuel mix, and saturation effects in many end uses for the EU-15 are some of the reasons for the limited growth of household energy needs. In the period to 2010, energy demand in households is projected to grow by 1.0% pa, but to decelerate afterwards to 0.6% pa in 2010-2020 and 0.3% pa in 2020-2030. The implied energy intensity improvement[34] in the residential sector reaches +1.6% pa in 2000-2030 compared to +1.5% pa observed in the last decade.

The **transport sector** exhibited the highest demand growth between 1990 and 2000 (+1.9% pa), accounting for some 90% of the total increase of EU-25 final energy demand. Following the strong decline of energy needs in industry in the same decade, the transport sector (excluding marine bunkers) became by 2000 the largest demand side sector - accounting for 31% of final energy demand compared to 27% in 1990. The predominant role of the transport sector in final energy demand growth is projected to continue under Baseline assumptions. It is only in the long run that the combined effect of decoupling of transport activity from economic growth (especially in passenger transport in EU-15) and technological progress lead to a deceleration of transport demand growth. However, the transport sector remains the second fastest growing demand sector over the projection period (+35% in 2000-2030 compared to +25.7% in industry, +41.5% in the tertiary and +21.4% in the residential sector). Transport in EU-25 is expected to account for close to one third of final energy demand in 2030.

1.3.3.2. Final energy demand by fuel

The demand side of the EU-25 energy system has undergone significant changes in terms of the fuel mix during the last decade as a result of shifts towards the use of more efficient energy forms. Demand for solid fuels declined by more than 50% between 1990 and 2000 while demand growth for liquid fuels (+0.9% pa) was significantly lower than that in the transport sector (+1.9% pa), implying a decline in oil consumption in all other demand sectors. Natural

Table 1-10: Final energy demand in EU-25 by sector

	Mtoe					Annual Growth Rate (%)				
	1990	**2000**	**2010**	**2020**	**2030**	**90/00**	**00/10**	**10/20**	**20/30**	**00/30**
Industry	327.2	309.1	338.9	367.4	388.5	-0.6	0.9	0.8	0.6	0.8
Domestic	408.8	433.3	482.9	523.5	556.9	0.6	1.1	0.8	0.6	0.8
Tertiary	140.7	154.2	174.3	194.3	218.1	0.9	1.2	1.1	1.2	1.2
Households	268.1	279.1	308.6	329.1	338.8	0.4	1.0	0.6	0.3	0.6
Transport	273.7	332.0	387.2	427.0	448.7	1.9	1.5	1.0	0.5	1.0
Total	**1010**	**1074**	**1209**	**1318**	**1394**	**0.6**	**1.2**	**0.9**	**0.6**	**0.9**
EU-15	859	955	1077	1165	1229	1.1	1.2	0.8	0.5	0.8
NMS	150	119	132	153	165	-2.3	1.0	1.5	0.8	1.1

Source: PRIMES.

34 Energy intensity in households is computed using per capita income as the denominator.

Table 1-11: Final energy demand in EU-25 by fuel

	Mtoe					Annual Growth Rate (%)				
	1990	2000	2010	2020	2030	90/00	00/10	10/20	20/30	00/30
Solid Fuels	117.7	57.4	42.3	36.2	32.1	-6.9	-3.0	-1.5	-1.2	-1.9
Liquid Fuels	424.2	464.2	503.4	537.6	554.7	0.9	0.8	0.7	0.3	0.6
Gas fuels	196.2	245.7	299.9	324.9	343.4	2.3	2.0	0.8	0.6	1.1
Steam	62.9	55.6	65.0	75.7	83.6	-1.2	1.6	1.5	1.0	1.4
Electricity	176.5	211.3	253.4	297.1	334.3	1.8	1.8	1.6	1.2	1.5
New fuels (hydrogen etc.)	0.0	0.0	0.3	1.0	1.4	-	-	12.6	3.6	-
Biomass	25.9	32.1	33.9	32.7	30.4	2.2	0.6	-0.4	-0.7	-0.2
Waste	5.8	7.5	8.7	9.5	10.1	2.6	1.6	0.8	0.6	1.0
Other renewables	0.5	0.8	2.0	3.2	4.0	4.6	10.4	4.8	2.2	5.7
Total	**1010**	**1074**	**1209**	**1318**	**1394**	**0.6**	**1.2**	**0.9**	**0.6**	**0.9**

Source: PRIMES.

gas (growing by 2.3% pa - a rate close to four times higher than average) and electricity (+1.8% pa) made some significant inroads on the demand side during the last decade, substituting for solids and liquid fuels. Demand for biomass and waste also increased at rates above average, although still representing a rather small proportion of final energy needs in 2000; while demand for distributed steam exhibited a significant decline in the last decade, strongly affected by the restructuring of CEEC.

Under Baseline assumptions these trends are also projected to prevail in the future evolution of final energy demand in EU-25 (see Table 1-11). Liquid fuels are expected to remain the main energy carrier in the EU-25 energy demand sectors over the projection period, but growing at rates well below average, constantly losing market share. By 2030 some 80% of liquid fuels demand is projected to arise from the transport sector, compared to 70% in 2000. Solid fuels demand declines over the projection period and, by 2030, they become an obsolete energy form in final use except for some heavy industries. Demand for biomass, though rising to 2010, declines thereafter mainly because of the fall in the number of rural households. In contrast, demand for waste grows over the projection period through its increasing use in industry.

Electricity demand is projected to exhibit the highest growth over the period (+1.5% pa in 2000-2030). Demand growth for natural gas (+1.1% pa in 2000-2030) decelerates in the long run due to limitations in infrastructure but also technological factors. The exploitation of cogeneration opportunities leads to significant growth of demand for distributed steam (+1.4% pa) over the outlook period. Novel final energy forms, such as hydrogen and ethanol, do not progress under Baseline assumptions primarily because of cost considerations. Finally, other renewable energy forms, such as solar energy used in water heaters, grow quite rapidly (+5.7% pa in 2000-2030) but they remain insignificant as a proportion of overall final consumption.

The changes of the fuel mix in final demand sectors in the Baseline are illustrated in Figure 1-6. By 2030 solid fuels account for 2.3% of energy needs on the demand side, compared to 5.3% in 2000 and 11.7% in 1990. Oil is also projected to lose market share dropping just below 40% in 2030 from 43.2% in 2000. The share of gas rises to 24.6% by 2030, while that of distributed steam, following a strong decline in the last decade, reaches 6% by 2030 because of increasing use of steam from co-generation plants. The most notable change is the increase by 4.3 percentage points in the share of electricity though, even by 2030, it accounts for less than a quarter of final energy demand. The projected electricity demand growth (+1.5% pa) can be considered as modest given that, historically, electricity use grew at rates above GDP. Saturation effects, technological progress and the exploitation of energy savings options are the main reasons limiting electricity demand growth in the Baseline scenario.

1.3.4. Electricity and steam generation

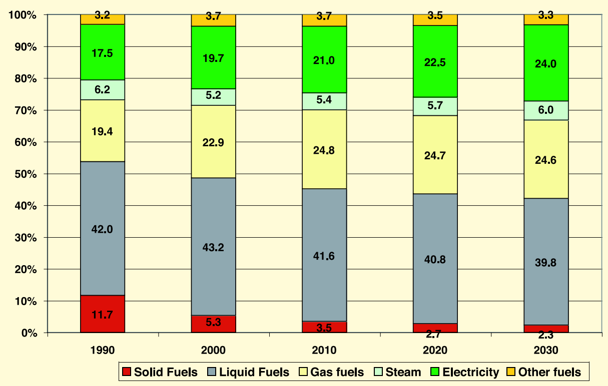
1.3.4.1. Electricity and steam demand

As discussed in the preceding section, demand for electricity will exhibit growth at rates well above average over the projection period. The increasing number of processes, appliances and applications that can use energy only in the form of electricity, but also issues related to the favourable characteristics of electricity (easy controllability, cleanliness at the point of use, etc.), lead to the increasing use of electricity in the EU-25 energy system. This projection is in line with the well-established long-term trend towards increased electrification in most sectors of developed economies.

Electricity requirements in EU-25 have shown an average increase of 1.7% pa since 1990. Demand growth in the current EU-15 reached close to 1.9% pa while in NMS electricity requirements exhibited limited growth from 1990 levels (+0.2% pa). The restructuring of CEEC economies led to a decline of electricity demand in NMS by -1.0% pa in 1990-1995, which was strongly related to the progressive ending of subsidy policies for electricity prices. However, this downward trend was reversed in the second part of the last decade with electricity demand rising by 1.5% pa.

Under Baseline assumptions total electricity generation is projected to expand by 1.4% pa in 2000-2030 (see Table 1-12). Demand growth will be especially rapid in the tertiary sector, while electricity demand in the residential sector also grows at rates above average. The different levels of electrification achieved in the EU-15 and in the NMS by 2000 are also reflected in the evolution of electricity demand to 2030. Thus, while electricity demand increases by 1.3%

Figure 1-6: Structure of Final Energy Demand by fuel in EU-25.



Source: PRIMES.

pa in the EU-15 between 2000 and 2030, with a decelerating pace over time, much more pronounced growth is projected for new Member States (+1.8% pa in 2000-2030) with an accelerating pace in the period to 2020.

The massive closure of inefficient district heating units in the nineties in CEEC, because of the restructuring of their energy system, which was characterised in the past by high levels of district heating utilisation, resulted in a decline of distributed steam demand in EU-25 by -1.3% pa in 1990-2000. The decrease in NMS reached an astonishing -6.3% pa, clearly reflecting the great inefficiencies that prevailed mainly at the level of steam distribution in CEEC in the past. In contrast, the use of distributed steam grew by +1.7% pa in the EU-15, driven by the further exploitation of cogeneration potential.

The shift towards the decentralisation of electricity and steam production, projected to occur over the outlook period, as well as technological progress allowing for smaller-scale distribution networks, are the key drivers for the further growth of distributed steam demand in the EU-15 (+1.5% pa in 2000-2030) and the reversal of past trends (beyond 2010) in NMS (+0.4% pa in 2000-2030). Overall distributed steam demand (i.e. excluding industrial and refinery boilers) is projected to grow in the EU-25 by 1.2% pa between 2000 and 2030 (see Table 1-13). Industry is projected to remain the dominant user of steam over the outlook period, with the tertiary sector, a potentially large user of steam, also exhibiting significant growth.

1.3.4.2. Capacities

Increasing energy requirements for electricity and steam lead to a large expansion of installed capacity in the EU-25 energy system, which is projected to almost double by 2030 from 2000 levels (see Table 1-14). Technological advances and the progressive deregulation of electricity markets - with smaller companies entering the market preferring plants with shorter lead times, lower capital costs and higher efficiency leading to lower fuel costs - are projected to cause significant growth in the use of gas for electricity generation. This is mainly through the extensive use of gas turbine combined cycle units. Thus installed capacity of gas turbine combined cycle plants is projected to increase dramatically, especially in the period to 2020, reaching by 2030 close to 385 GW from 47 GW in 2000. Installed capacity of small gas turbines is also projected to grow by a factor of 3 over the outlook period. As a result, gas fuelled power plants account for more than 40% of total EU-25 generating capacity in 2030 compared to 10.7% in 2000.

The overwhelming growth of gas-fired power plants occurs mainly at the expense of conventional fossil fuel and nuclear power plants. Installed capacity of conventional thermal power plants (open cycle monovalent and polyvalent units) is projected to decline very rapidly both in absolute terms and as a share of total installed capacity. By 2030, they are projected to represent some 17.8% of total installed capacity compared to more than 51% in 2000. The nuclear sector faces four major issues: the closure of unsafe nuclear plants in NMS; substantial decommissioning of existing nuclear plants beyond 2015; the nuclear phase-out policies in certain EU-15 Member States; and the likely decisions of economic actors not to replace all

Table 1-12: Electricity requirements by sector in EU-25[35]

	TWh					*Annual Growth Rate (%)*				
	1990	**2000**	**2010**	**2020**	**2030**	**90/00**	**00/10**	**10/20**	**20/30**	**00/30**
Industry	922	1042	1209	1376	1489	1.2	1.5	1.3	0.8	1.2
Tertiary	504	651	826	1023	1208	2.6	2.4	2.2	1.7	2.1
Households	568	695	837	981	1114	2.0	1.9	1.6	1.3	1.6
Transports	58	69	75	75	76	1.7	0.8	0.0	0.1	0.3
Energy sector	268	266	287	314	344	-0.1	0.8	0.9	0.9	0.9
Trans. and distr. Losses	160	201	210	204	193	2.3	0.5	-0.3	-0.6	-0.1
(Net imports)	25	25	24	24	27	-0.1	-0.3	-0.2	1.4	0.3
Total	**2456**	**2898**	**3419**	**3949**	**4397**	**1.7**	**1.7**	**1.5**	**1.1**	**1.4**
EU-15	2139	2574	3027	3450	3846	1.9	1.6	1.3	1.1	1.3
NMS	317	324	392	498	551	0.2	1.9	2.4	1.0	1.8

Source: PRIMES.

35 Electricity consumption in refineries as well as on-site auto-consumption of electricity in the power generation sector are included in the energy sector.

Table 1-13: Distributed steam requirements by sector in EU-25[36]

	TWh					Annual Growth Rate (%)				
	1990	2000	2010	2020	2030	90/00	00/10	10/20	20/30	00/30
Industry	423	357	422	510	554	-1.7	1.7	1.9	0.8	1.5
Tertiary	111	101	113	134	159	-0.9	1.1	1.7	1.7	1.5
Households	197	202	221	236	260	0.2	0.9	0.7	1.0	0.8
Energy sector	42	26	25	21	16	-4.7	-0.6	-1.7	-2.8	-1.7
Trans. and distr. Losses	32	34	32	32	30	0.7	-0.6	-0.2	-0.4	-0.4
Total	**805**	**721**	**813**	**933**	**1018**	**-1.1**	**1.2**	**1.4**	**0.9**	**1.2**
EU-15	438	529	633	734	802	1.9	1.8	1.5	0.9	1.4
NMS	367	192	180	198	217	6.3	-0.6	1.0	0.9	0.4

Source: PRIMES.

Table 1-14: Power generation capacity by type of plant in EU-25, 1995-2030.

	GW_e					% share				
	1995	2000	2010	2020	2030	1995	200	2010	2020	2030
Nuclear	134.7	140.3	129.8	108.0	107.8	21.8	21.4	16.6	11.4	9.6
Large Hydro (pumping excl.)	91.2	94.1	95.8	95.9	96.3	14.8	14.3	12.2	10.1	8.6
Small hydro	2.0	2.1	8.9	13.4	15.9	0.3	0.3	1.1	1.4	1.4
Wind	2.5	12.8	72.7	103.5	134.9	0.4	1.9	9.3	10.9	12.1
Other renewables	0.0	0.2	0.5	0.6	14.2	O0.0	0.0	0.1	0.1	1.3
Thermal plants	386.9	406.7	476.3	625.3	749.0	62.7	62.0	60.8	66.1	67.0
of which cogeneration plants	*87.3*	*103.4*	*129.7*	*168.1*	*198.7*	*14.1*	*15.8*	*16.5*	*17.8*	*17.8*
Open cycle - Fossil fuel	343.8	335.6	270.6	175.3	147.4	55.7	51.1	34.5	18.5	13.2
Clean Coal and Lignite	0.0	0.0	0.5	1.9	6.5	0.0	0.0	0.1	0.2	0.6
Supercritical Polyvalent	0.0	0.0	0.5	64.7	143.4	0.0	0.0	0.1	6.8	12.8
Gas Turbines Combined Cycle	20.4	47.4	169.6	318.8	384.6	3.3	7.2	21.6	33.7	34.4
Small Gas Turbines	22.0	22.8	33.9	63.3	65.8	3.6	3.5	4.3	6.7	5.9
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.7	1.0	1.2	1.3	1.4	0.1	0.2	0.2	0.1	0.1
Total	**617**	**656**	**784**	**947**	**1118**	**100**	**100**	**100**	**100**	**100**
EU-15	539	579	689	813	951	87.3	88.2	87.9	85.8	85.0
NMS	79	78	95	134	167	12.7	11.8	12.1	14.2	15.0

Source: PRIMES.

decommissioned nuclear with new nuclear plants on economic grounds. These factors result in a continuous decline of nuclear capacity, which by 2030 accounts for no more than 9.6% of total installed capacity in EU-25 (from 21.4% in 2000).

Under Baseline assumptions, a predominant role in the replacement of retired nuclear plants will be played by supercritical polyvalent units (with scope for burning coal, lignite, biomass and waste). But other clean coal technologies (e.g. IGCC and PFBC) are not projected to become a cost-effective option under Baseline conditions, on the basis of the currently prevailing technology forecasts for power generation, even in the long run. By 2030 installed capacity of supercritical polyvalent plants is projected to reach 143 GW (or 12.8% of total installed capacity).

Renewable energy forms are also expected to have an important role in power generation in future. However, capacity expansion in hydropower plants is projected to be rather limited over the outlook period as a result of the already high exploitation of suitable sites in the EU-25 energy system. This results in a decreasing share for hydro plants (from 14.6% in 2000 to 10% in 2030). In contrast, given supportive policies for renewable energy forms in the EU-15 - also likely to develop in new Member States - wind turbine capacity increases substantially, reaching by 2030 up to 135 GW (more than 12% of total installed capacity) compared to less than 13 GW in 2000. Solar photovoltaic energy starts emerging beyond 2020 (accounting for 1.3% of total installed capacity by 2030). However, the implementation of the renewables electricity Directive 2001/77 of September 2001 was not assumed in the Baseline.

The strong shift towards a gas based power generation system combined with electricity market liberalisation is also projected to encourage the more widespread exploitation of cogeneration options, especially at the level of independent autoproducers. CHP

36 Including on-site consumption of non-marketed steam from industrial co-generation units.

plant capacity is projected to increase from 103.4 GW in 2000 to 198.7 GW in 2030. By 2030, more than 16% of total EU-25 electricity generation will come from cogeneration units compared to 12.6% in 2000. In heat/steam generation, district heating plants (producing only heat) are projected to continuously lose market share under Baseline assumptions (accounting for less than 9% of steam supplies in 2030, down from 18.4% of total distributed steam in 2000).

1.3.4.3. Electricity and steam generation by fuel type

As a result of nuclear phase-out policies and decommissioning of existing nuclear capacity, nuclear electricity generation declines quite dramatically in the long run accounting for 17.4% of electricity production in 2030 compared to 31.8% in 2000 (see Figure 1-7).

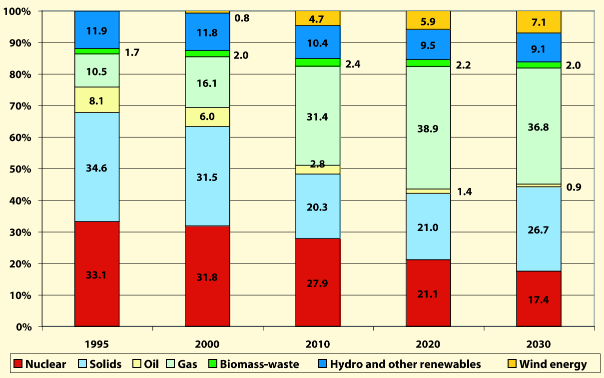
Electricity production from solid fuels exhibits a continuous decline in the short/medium term, but it later recovers as a replacement fuel for nuclear both in absolute terms and as a share of total electricity generated (26.7% in 2030 compared to 31.5% in 2000). The emerging gap is largely covered by greater use of natural gas, which beyond 2010 is projected to become the main energy input for electricity generation. It is interesting to note, however, that in the long run, though gas use continues to increase in absolute terms, its share in electricity generation falls, a trend largely related to the increasing cost-effectiveness of coal fired technologies expected in that period.

The contribution of renewable energy forms in power generation is projected to grow over time, reaching some 18.2% of total electricity production in 2030 from 14.6% in 2000. However, the limited potential for further exploitation and, consequently, the declining share of electricity generation from hydropower largely offsets the increasing contribution of wind energy in electricity generation, taking into account the rapidly growing electricity demand. Moreover, the implementation of Directive 2001/77 of September 2001 was not assumed for the Baseline.

1.3.4.4. Fuel input and efficiency in power generation

Fuel input in power generation is projected to experience lower growth (0.5% pa in 2000-2030) than the increases in electricity generation (1.4% pa) and in steam cogeneration (1.6% pa). As illustrated in Table 1-15, gas accounts for more than one third of power generation

Figure 1-7: Electricity generation by fuel in EU-25



Source: PRIMES.

fuel consumption by 2030 compared to 18% in 2000. Beyond 2010, and especially in the long run, coal is projected to make a strong come back. This, however, is not the case for lignite because the emergence of supercritical polyvalent units in the EU-25 power generation system is projected to be accompanied by a strong shift towards use of imported coal. Imported coal prices are lower than those for much domestically-produced coal and lignite; and state aids for coal and in some cases also lignite are assumed to be substantially reduced by 2030. Consumption of biomass and waste also grows at rates above average over the projection period but they are expected to account for less than 4% of total fuel input in 2030.

The significantly lower growth of fuel inputs in power generation compared to the corresponding electricity and steam produced largely reflects the investment choices of electricity generators towards technologies with high conversion efficiencies, such as gas turbine combined cycle plants, and certain renewable energy forms. The replacement of nuclear power plants (with efficiency typically between 33-35%) by other forms of generation (with efficiencies of some 55% for gas combined cycles or 100% as attributed by statistical conventions for e.g. hydro and wind) further contributes to this development. Efficiency of EU-25 thermal electricity production increases by 12 percentage points between 2000 and 2030 to reach 49%.

Table 1-15: Fuel use for electricity generation in EU-25

	Mtoe					*Annual Growth Rate (%)*				
	1995	**2000**	**2010**	**2020**	**2030**	**95/00**	**00/10**	**10/20**	**20/30**	**00/30**
Hard coal	153.6	144.5	112.9	138.9	200.9	-1.2	-2.4	2.1	3.8	1.1
Lignite	67.5	65.6	62.3	53.4	43.3	-0.6	-0.5	-1.5	-2.1	-1.4
Oil products	53.9	41.5	23.8	13.5	9.5	-5.1	-5.4	-5.5	-3.5	-4.8
Gas	70.0	112.6	185.1	245.7	255.2	10.0	5.1	2.9	0.4	2.8
Biomass	6.2	8.0	11.8	12.7	14.6	5.4	3.9	0.8	1.4	2.0
Waste	7.4	9.5	14.0	15.0	13.6	5.0	4.0	0.6	-1.0	1.2
Nuclear energy	215.3	237.7	245.3	213.5	185.3	2.0	0.3	-1.4	-1.4	-0.8
Geothermal Heat	2.1	3.0	3.4	3.6	3.9	6.6	1.4	0.7	0.8	1.0
Total	**576**	**622**	**659**	**696**	**726**	**1.6**	**0.6**	**0.6**	**0.4**	**0.5**
EU-15	496	541	568	596	625	1.7	0.5	0.5	0.5	0.5
NMS	80	81	90	101	101	0.3	1.1	1.1	0.1	0.7

Source: PRIMES.

1.3.5. The outlook for energy-related CO2 emissions

The evolution of the EU-25 energy system in the last decade has been characterised by a strong decoupling of energy demand from economic growth and, in addition, by a decoupling between energy demand and CO_2 emissions growth. While primary energy needs increased by 6.2% in 1990-2000, CO_2 emissions declined in the same period by -2.8%. The restructuring of CEEC economies was the main driver for this trend (CO_2 emissions in NMS in 2000 were 20.4% lower than in 1990). In EU-15 structural shifts towards less energy-intensive uses, technological progress and changes in the fuel mix all limited the CO_2 emissions growth to 1.2% between 1990 and 2000. As a result in 2000 new Member States accounted for 14.9% of overall CO_2 emissions at the EU-25 level compared to 18.2% in 1990.

CO_2 emissions, under Baseline assumptions, are projected to grow over the outlook period (+0.5% pa in 2000-2030; see Table 1-16). However, even in 2030, CO_2 emissions in NMS remain at levels significantly below those observed in 1990 (-7.6% lower) while emissions in the EU-15 are projected to rise by +19% from 1990 levels.

In the period 2000-2010, CO_2 emissions for EU-25 are projected to grow by 2.5%, but they remain 0.3% below the level observed in 1990. The further changes in the fuel mix towards less carbon intensive fuels, on both the demand and supply sides, are the main reason for this limited growth, with emission reductions in industry and in district heating largely offsetting the emissions growth projected from the transport sector. Beyond 2010, CO_2 emissions are projected to rise much faster, with the power generation sector becoming the main driver for this increase. Massive decommissioning of nuclear power plants and increasing competitiveness of coal in the power sector cause these higher emissions. In contrast, the growth of CO_2 emissions in the transport sector decelerates in the long run both because of technological progress and as a result of the projected decoupling of transport activity from economic growth. This slowdown in transport emissions growth takes place in spite of modal shifts towards less energy efficient modes. By 2030 electricity and steam generation account for 37.3% of total CO_2 emissions (from 32.6% in 2000) while the share of the transport sector reaches 29.2% (compared to 26.4% in 2000) - clearly reflecting the predominant role of these sectors in the EU-25 energy system.

It is important to note that the demand for transport, as well as for electricity and steam, derives from various social and economic activities related to different economic sectors (industry, services, agriculture, and households). Furthermore, to the extent that final demand sectors, such as industry, services and households, switch to more electricity or steam, they "export" considerable CO_2 emissions caused by their activities to the power and steam generation sector. [37]

In the Baseline case the carbon intensity (CO_2 emissions per unit of primary energy needs) of the EU-25 energy system improves by no more than 1% between 2000 and 2030 (see Table 1-17). Beyond 2015 carbon intensity worsens and CO_2 emissions rise accordingly to exceed in 2030 the 1990 level by 14%.

This growth in CO_2 emissions takes place against the background of substantial economic growth over the same period. Total GDP growth from 1990 to 2030 reaches 146%. The corresponding increase in primary energy demand is limited to 26%, reflecting a considerable improvement in energy intensity (energy demand per unit of GDP). The role of energy intensity gains becomes of increasing importance in the long run leading to strong decoupling between CO_2 emissions growth and GDP growth. Energy intensity gains in 1990-2010 reach 27% and improve a further 30% in 2010-2030.

CO_2 emissions grow more slowly than energy demand and, given the above energy intensity gains, the carbon intensity of the economy (i.e. CO_2 emissions per unit of GDP) evolves favourably with one unit of GDP in 2030 being produced with only 46% of the CO_2 emissions emitted in 1990. However, the challenge of climate change and the Kyoto process might require deep cuts in emissions up to

Table 1-16: CO_2 emissions by sector in EU-25

	Mt CO_2					Annual Growth Rate (%)				
	1990	**2000**	**2010**	**2020**	**2030**	**90/00**	**00/10**	**10/20**	**20/30**	**00/30**
Industry	713.2	605.7	544.4	545.8	551.9	-1.6	-1.1	0.0	0.1	-0.3
Tertiary	256.8	236.7	239.5	240.9	254.8	-0.8	0.1	0.1	0.6	0.2
Households	519.7	462.6	481.7	495.2	487.2	-1.2	0.4	0.3	-0.2	0.2
Transports	794.6	967.5	1110.5	1212.7	1257.6	2.0	1.4	0.9	0.4	0.9
Electricity-steam production	1240.0	1193.3	1218.7	1393.6	1605.0	-0.4	0.2	1.3	1.4	1.0
District heating	101.0	35.1	16.6	9.5	8.0	-10.0	-7.2	-5.5	-1.6	-4.8
New fuels (hydrogen etc.) prod.	0.0	0.0	0.2	1.2	1.9	-	-	19.6	4.3	-
Energy branch	144.2	164.0	145.6	141.8	137.2	1.3	-1.2	-0.3	-0.3	-0.6
Total	**3769**	**3665**	**3757**	**4041**	**4304**	**-0.3**	**0.2**	**0.7**	**0.6**	**0.5**
EU-15	3082	3118	3205	3444	3669	0.2	0.3	0.7	0.6	0.5
NMS	687	547	552	597	635	-4.5	0.1	0.8	0.6	0.5

Source: PRIMES.

37 The breakdown of CO2 emissions by sector is based on the statistical conventions of EUROSTAT and others, with power and steam generation being one sector. Therefore, future emissions are calculated to reflect this convention, and the projected CO2 emissions are reported in line with these statistical practices.

Table 1-17: Key indicators for the EU-25 energy system

	Index (1990 = 100)				
	1990	2000	2010	2020	2030
Gross Domestic Product	100	122	156	198	246
Gross Inland Consumption	100	106	115	122	126
CO_2 emissions	100	97	100	107	114
Energy intensity	100	87	73	61	51
Carbon intensity	100	92	87	88	91
CO_2 emissions / unit of GDP	100	80	64	54	46

Source: PRIMES.

2030; and therefore much better results than projected in the Baseline case might well be needed. CO_2 reduction scenarios are presented in Chapters 7 and 8.

1.4. Concluding remarks

The EU-25 energy system will need to deal with a number of major challenges over the next 30 years, including issues related to security of supply, tightening environmental pressures, competitive energy prices and critical investment decisions. The integration of the new Member States in the EU is not projected to cause radical changes in the projected evolution of the EU-25 energy system in the period to 2030. This is because of the relatively small size of the new Member States, both in economic and in energy terms, compared to the current EU-15. However the urgency with which these issues will become increasingly important for the energy system is certainly affected by the enlargement of the EU.

The GDP in EU-25 is projected to more than double between 2000 and 2030 (+102% or +2.4% pa) while the growth of primary energy demand is projected to be only 18.7% (or 0.6% pa) in the same period. This is a rate significantly lower than that observed historically, but demonstrates that there is still no complete decoupling between energy demand and economic growth. Energy intensity gains of over 1.7% pa are driven by structural changes on the demand side, better efficiency and technology in the individual sectors, and investment decisions in power generation.

The further dematerialization of EU-25 industry, combined with structural changes within sectors, strong saturation effects for a number of energy uses, improvements in thermal characteristics of buildings in the tertiary and household sectors, the slowdown in transport activity growth and the impacts arising from the EU agreement with car manufacturers, all contribute towards the decoupling of energy demand from economic growth. Improvements in energy technology, and changes in the fuel mix towards more efficient energy forms, also have a positive impact on energy intensity. In particular, the changes projected to occur in power generation towards the use of renewable energy forms and more efficient technologies and fuels further contribute to this tendency. The huge inefficiencies that prevailed in new Member States, and especially in CEEC, in the past and consequently the larger scope for efficiency gains compared to the EU-15, also act in favour of the decoupling between energy demand and economic growth in the EU-25.

The EU-25 energy system will remain dominated by fossil fuels over the next 30 years. Their share is projected to increase by more than 2 percentage points over the projection period, reaching 81.8% of overall energy needs by 2030. A more favourable trend is projected to occur in the horizon to 2015 with the share of fossil fuels declining by close to 0.5 percentage points from 2000 levels. The adverse trend observed thereafter is closely related to the substantial decline in nuclear power plant capacity due to occur after that date, following the nuclear phase-out policies in certain Member States, the closure of nuclear plants with safety concerns in new Member States, or the decisions of economic actors who do not always replace decommissioned nuclear plants with new nuclear units.

The use of fuels in the EU-25 energy system will become increasingly specialised. Solid fuel consumption declines over the period to 2015 but strongly increases thereafter as a highly competitive option in power generation in replacement of nuclear but also of natural gas. Higher natural gas import prices and maturity of advanced coal technologies are the key drivers for this result. By 2030 the bulk of solid fuels consumption occurs in power generation and in process-specific industrial uses (iron and steel, and cement). Oil becomes a fuel overwhelmingly used in the transport sector and as a petrochemical feedstock, growing at rates significantly lower than average. By 2030 its share in gross inland consumption declines to about 34%, more than 4 percentage points below 2000 levels. Gas demand is projected to continue growing strongly over the period to 2015 (+2.7% pa in 2000-2015) but to slow down thereafter, due to reduced competitiveness against coal in power generation but also limited potential for further changes in the fuel mix towards the use of gas on the demand side. Renewable energy forms are projected to remain the fastest growing energy carrier in the EU-25 energy system over the projection period (+1.9% pa in 2000-2030). The exploitation of renewable options in power generation is the key driver for this result. However, even in 2030, their share amounts to only 8.6% of primary energy needs, well below indicative targets set within the EU-25 even over the horizon to 2010. Novel energy forms (hydrogen, methanol etc.) do not make significant inroads under Baseline assumptions primarily due to cost considerations.

The projected increase in the use of fossil fuels has a twofold impact upon the EU-25 energy system. First, fossil fuels are mainly imported and - with their continuing dominance - more than two thirds of EU-25 primary energy requirements will need to be imported by 2030, compared to slightly less than half in 2000. The most significant change regarding EU-25 energy security relates to the increasing dependence upon gas imports from a limited number of suppliers and significantly more distant locations. Secondly, fossil fuels give rise to CO_2 emissions which is partly counterbalanced by the restructuring of CEEC economies in the nineties and the resulting substantial decline of CO_2 emissions between 1990 and 2000 in new Member States. CO_2 emissions for EU-25 are projected to remain below 1990 levels in 2010 (-0.3%). However, they increase thereafter to reach +14.2% in 2030. The corresponding figures for CO_2 emissions in the EU-15 are +4% in 2010 and +19% in 2030.

Developments in transport and power generation will have a dominant role in the future evolution of the EU-25 energy system. The transport sector is characterised by increasing energy needs over the projection period, though a decoupling of transport activity from economic growth is projected in the long run; and it also suffers from the lack of alternatives as regards any changes in the fuel mix towards less carbon intensive fuels. In the EU-25 power generation sector some 90% of the installed capacity by 2030 will need to be commissioned over the next three decades. This key sector will, therefore, face strategic technology and fuel choice dilemmas over that period. In turn, the solutions to these will have a major effect upon the overall EU-25 energy system in the long run. Therefore, energy and transport policies will face considerable challenges in dealing with those energy security and climate change issues that will become increasingly critical in the period to 2030 for the EU-25 energy system.

CHAPTER 2:
World energy prices (recalling the world context)

2.1. Definition of alternative scenarios

Energy import prices are one key driver for the development of EU-25 energy demand and supply. In the context of this study, different world market trends that could result in different international fuel price trajectories were examined with the POLES model, which is a global model for the world energy system. The work using the POLES model has been undertaken by IEPE (Institut d'Economie et de Politique de l'Energie/CNRS-UPMF Grenoble). The analysis examined different assumptions about economic growth for the different world regions as well as on the availability of fossil fuel resources. Higher economic growth exerts upward pressure on prices, while the magnitude and geographical distribution of oil and gas resources also have important influences on prices. The assumptions on solid fuel resources were kept unchanged given that these resources do not pose any restriction on availability for many decades to come. Besides the Baseline scenario, three additional scenarios were defined. The set of hypotheses developed to simulate these four world energy scenarios is described in Table 2-1. This table shows combinations of assumptions on economic growth and oil and gas resources for the different scenarios. Moreover, this table highlights key features of the scenarios in which the following issues have been addressed:

- stronger demand for CIS gas from Asian countries leaving less gas for Europe; and
- more pronounced uncoupling between oil and gas prices.[38]

Compared to the Baseline scenario (REF) which describes a world of abundant oil and gas resources and relatively moderate international fuel price increases in the period to 2030 (as a benchmark the price of oil increases to 23.8 $00/bl in 2020 and then to 27.9 $00/bl in 2030), the alternative scenarios examined provide three consistent international energy scenarios with contrasting oil and gas price profiles:

- High oil and gas price scenario (PS1) corresponds to a world with higher economic growth and lower oil and gas resources.
- Low gas availability for Europe scenario (PS2) is a high gas price scenario and shows a world with tighter conditions for gas coming to Europe, due to higher economic growth and demand in Asia and more expensive supplies from Russia and the other parts of CIS. In this case, the European gas price reaches levels similar to the price of oil between 2015 and 2020. Thereafter the gas price in Europe exceeds the oil price level for the rest of the projection period.
- The de-linking of oil and gas price scenario (PS3) is to some extent a symmetric scenario to PS2, as it illustrates the consequences of a higher relative availability of gas compared to oil; this case shows a decrease in the relative price of gas to oil in every region. This is, however, not sufficient to prevent the moderate rise of gas prices in Europe and thus also has a significant effect on the gas to coal relative price, albeit to a significantly smaller degree than in the low gas availability scenario for Europe (PS2).

Table 2-1: Key hypotheses for the four world energy and international price scenarios

		REF	PS1	PS2	PS3
Oil Resources	High Resources				
	Intermediate Resources	WEUR	WEUR	WEUR	WEUR
	Median Resources				
Gas Resources	High Resources				
	Intermediate Resources	WEUR	WEUR	WEUR	WEUR
	Median Resources				
Economic Growth	REFERENCE (2.9% /yr, 2000-2030)	WEUR	WEUR	WEUR	WEUR
	High Growth (3.1% /yr, 2000-2030)				
	High Growth, accelerated in Asia				
Low gas availability from CIS to Europe					
Oil and gas price disconnection					

Note: WEUR – Resources and economic growth in Western European Countries are kept constant in all scenarios for comparison reasons, as these scenarios examine the effects of different developments in the other parts of the world.

38 The detailed IEPE report on World Energy Scenarios and International Energy Prices can be found in the enclosed CD.

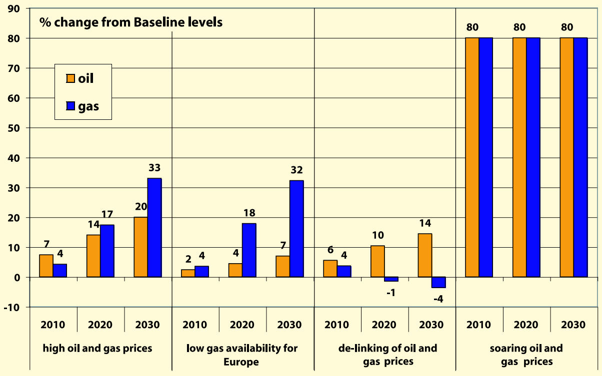
In addition to the above, a fourth scenario was examined assuming a very sharp and prolonged oil and gas price increase (Soaring oil/gas prices case - PS4). Major impacts of interest include the implications for security of supply within the EU and for its commitments regarding CO_2 emissions.[39] Under this "soaring prices" scenario, oil and gas prices from 2010 onwards are 80% higher than their Baseline level. Solid fuel prices remain the same as in the Baseline. The rationale behind such a scenario is the possibility of geopolitical tensions that give suppliers a strong position, which may keep oil and gas prices at very high levels for a prolonged period of time.

In all four scenarios examined it is assumed that economic agents successfully anticipate the changes in prices so that the energy using capital stock over the projection period is the one that agents planned in advance; and they do not find themselves in a situation where they have to scrap or retrofit equipment that would prove uneconomic in the price environment assumed under each scenario. It is also important to note that coal prices are not altered in the different world energy market projections. This is because the determinants of coal prices are rather different; and there is a strong current consensus that developed coal resources are sufficient to meet any likely global coal demand over the outlook period without necessitating an increase in real coal prices.

The motivation behind the use of these alternative scenarios is twofold. Firstly, long-term projections or assumptions on oil and gas prices are surrounded by much uncertainty. This uncertainty arises for many reasons. For example, one of the key determinants of long-term energy prices is the amount of new oil and gas that will be discovered over the next 30 years and the cost levels at which these newly discovered resources will be commercially exploitable. This is not only uncertain but literally unknown since it depends on the finding of new deposits for whose existence and cost there may only, at present, be theoretical geological indications. Also traditionally, oil prices have not been freely determined by market forces but have been strongly influenced by groups of producers with significant market power. Finally, technological developments and policy initiatives can have dramatic impacts on the use of fuels in the long run, which can also alter producer prices. Secondly, the importance of the relative price of coal and gas for the outlook of emissions beyond 2010 is a long-standing issue reflected both in the current Baseline scenario as well as in previous studies for the European Commission ("European Union Energy Outlook to 2020").[40] In view of the very rapid increase in EU gas imports over the projection period, it is important to examine the implications of different world market conditions, including the possibility of severe supply disruptions that could last for a prolonged period of time.

Figure 2-1 illustrates the changes from Baseline levels for oil and gas prices over the projection period for the four price scenarios examined. It is interesting to note that the gas price, in both the "High oil and gas prices" and the "Low gas availability for Europe" cases, exhibits a much stronger relative growth from Baseline levels compared to that of oil. However, it is only under the "Low gas availability for Europe" case that the price of oil becomes lower in absolute terms than that of natural gas in the long run (see Table 2-2)

Figure 2-1: International fuel prices assumptions under World Energy prices scenario assumptions (% change from baseline levels)



Source: POLES Model except "Soaring oil and gas prices" case.

Table 2-2: Evolution of international fuel prices under World Energy prices scenario assumptions

Oil Price	$00 per barrel				change from baseline (in $00 per barrel)		
	2000	2010	2020	2030	2010	2020	2030
"high oil and gas prices"	28.0	21.6	27.2	33.5	1.5	3.3	5.6
"low gas availability for Europe"	28.0	20.6	24.9	29.9	0.5	1.1	2.0
"de-linking of oil and gas prices"	28.0	21.2	26.3	32.0	1.1	2.5	4.0
"soaring oil and gas prices"	28.0	36.1	42.9	50.3	16.1	19.1	22.3
Gas Price	**$00 per barrel**				**change from baseline (in $00 per barrel)**		
	2000	2010	2020	2030	2010	2020	2030
"high oil and gas prices"	15.5	17.5	24.2	31.0	0.7	3.6	7.7
"low gas availability for Europe"	15.5	17.4	24.3	30.8	0.6	3.7	7.5
"de-linking of oil and gas prices"	15.5	17.4	20.3	22.5	0.6	-0.3	-0.8
"soaring oil and gas prices"	15.5	30.2	37.1	42.0	13.4	16.5	18.7

Source: POLES Model except "Soaring oil and gas prices" case.

39 This scenario consists of a repetition of the price *scenario examined in the context of the Scenarios Related to the Security of Supply of the European Union* study performed in the context of the LREM project in November 2000.

40 See Capros, P., Mantzos, L., Petrellis, D., Panos, V. and Delkis, K. (1999): 'European Union Energy Outlook to 2020'. European Commission – Directorate General for Energy (DG-XVII), Special issue of Energy in Europe, catalogue number CS-24-99-130-EN-C, ISBN 92-828-7533-4, Office for Official Publications of the European Communities, Luxembourg, November 1999.

In the following analysis, the impacts of the "High oil and gas prices" scenario (PS1 case) on the future evolution of the energy system, both at the world and the EU-25 levels, are discussed in detail. A brief discussion on the impacts of the "Low gas availability in Europe" (PS2), the "De-linking of oil and gas prices" (PS3) cases (both for the world and the EU-25 energy outlook) and the "Soaring oil/gas prices" (PS4) case (for the EU-25 energy outlook) is also provided.

2.2. World energy outlook under "High oil and gas prices" scenario assumptions

The assumption of abundant resources in the Baseline (reference) case results in global energy markets that remain well supplied at a relatively modest cost throughout the projection period. This is a plausible setting but, of course, it is not the only one possible. Substantial uncertainties surround both world economic growth and global energy resources.

The "High oil and gas prices scenario" focuses on the impacts that faster world economic growth in combination with relatively less abundant resources could have on the evolution of international fuel prices, which in turn affects the world energy outlook.

In the "high oil and gas prices" case world GDP grows at a rate of 3.1% pa in 2000-2030 (0.2 percentage points above reference levels per annum), leading to a GDP level that exceeds the Baseline case by 2.3%, 4.1% and 5.7% in 2010, 2020 and 2030 respectively. The bulk of this additional growth occurs in developing world regions, whereas for reasons of comparability concerning the effects of different import prices as distinct from economic growth, GDP in the EU remains unchanged from Baseline levels.

Conventional world oil reserves are assumed to be some 7200 Mtoe less than in the Reference case in 2010, reaching -23000 Mtoe in 2030 (-4.4% and -16.6% respectively) with changes in oil reserves for the Gulf region accounting for more than 70% of this decline in 2030 (see Table 2-3). However, increasing non-conventional oil reserves (+39% from reference levels in 2030) partly counterbalance this decrease. Total world oil reserves in this alternative case are some -6500 Mtoe lower than in the Baseline in 2010 and -11300 Mtoe lower in 2030 (-3.6% and -6.7% respectively). As far as natural gas is concerned, the overall reserves are 16.7% lower than in the Reference case in 2030 (-8.5% in 2010).

The combined effect of higher economic growth and lower reserves for oil and natural gas results in significant increases in international fuel prices above the reference levels (see Table 2-4). The crude oil price is projected to reach up to 33.5$00 per barrel in 2030 (compared to 27.9$ in the reference case or +20%). However, the most pronounced increase occurs for the price of gas in the American market (up +41.3% from Baseline levels in 2030). The increase in the European market comes next (+33% in 2030). On the other hand, natural gas prices in the Asian market exhibit less pronounced growth from reference levels (14.1% in 2030), remaining however at the highest absolute price level over the projection period.

The "High oil and gas prices" scenario results in world total energy consumption that is only slightly higher than in the Reference case (+1.5% in 2010, +1.8% in 2030) and well below the corresponding growth of GDP (see Table 2-5). However the consequences in terms of primary fuel mix are important as coal obtains a more important role, replacing natural gas to some extent. This increases CO_2 emissions above the Baseline levels by +2.2% in 2010 and +3.1% in 2030. Thus, the world energy system in the "High oil and gas prices" case is characterised by additional energy intensity gains (higher growth in GDP than in energy consumption) but also a worsening of carbon intensity in comparison to the Reference case.

As clearly illustrated in Table 2-6 changes in the evolution of gross inland consumption by region (compared to the Reference case) do not follow a uniform pattern. Thus, Europe (including Europe-OECD and CEEC) exhibits a decline of primary energy needs by up to -1.6% in 2030 as a result of high oil and gas prices and in the absence of additional economic growth. In North America the impact of higher oil and gas prices more than counterbalances the additional economic growth (+4.2% in 2030) assumed to occur in the "high oil and gas prices" case, with primary energy needs in 2030 declining by -0.6% from Reference levels in 2030.

Table 2-3: Oil and gas reserves under "high oil and gas prices" scenario assumptions

	000 Mtoe				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Oil Reserves							
World conventional	147.3	155.4	140.3	116.0	-4.4	-9.7	-16.6
Gulf	93.6	104.2	94.2	74.6	-3.8	-10.2	-18.3
OECD	8.5	6.5	5.4	5.1	-2.9	-1.8	-6.3
Other	45.3	44.6	40.7	36.2	-6.0	-9.6	-14.2
Non conventional	17.6	18.0	26.0	41.9	4.1	20.2	38.9
Total	**164.9**	**173.4**	**166.3**	**157.9**	**-3.6**	**-6.1**	**-6.7**
Gas Reserves							
OECD	22.6	27.1	25.3	20.4	-14.8	-17.4	-18.8
of which N.America	*8.5*	*9.0*	*7.1*	*3.7*	*-27.6*	*-35.3*	*-46.7*
Economies in transition	62.7	61.3	64.7	63.5	-10.9	-11.4	-13.4
Latin America	11.4	16.3	15.9	14.1	6.6	-6.8	-25.0
Asia	14.9	14.9	12.6	9.9	-21.2	-27.5	-31.0
Other	73.6	99.3	101.8	98.6	-5.0	-12.4	-15.2
Total	**185.2**	**218.9**	**220.3**	**206.5**	**-8.5**	**-13.4**	**-16.7**

Source: POLES.

Table 2-4: Evolution of oil and gas prices under "high oil and gas prices" scenario assumptions

	$00/boe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Crude oil	28.0	21.6	27.2	33.5	7.4	14.0	20.0
Natural gas							
Europe	15.5	17.5	24.2	31.0	4.3	17.4	33.0
America	21.1	15.7	20.3	27.7	7.3	20.2	41.3
Asia	29.2	26.7	30.5	33.2	13.9	9.9	14.1

Source: POLES.

Table 2-5: Key indicators for the World energy system under "high oil and gas prices" scenario assumptions

					% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Population (Million)	6102	6855	7558	8164	0.0	0.0	0.0
GDP (000 M$95-pps)	41211	58375	79500	103045	2.3	4.1	5.7
Gross Inland Consumption (Mtoe)	9954	12234	14771	17341	1.5	1.5	1.8
Gross Inl Cons / GDP (toe/M$95)	242	210	186	168	-0.8	-2.5	-3.7
CO_2 Emissions (Mtn CO_2)	23549	29943	37534	45409	2.2	2.4	3.1

Source: POLES.

Table 2-6: Gross inland consumption by region in the "high oil and gas prices" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
North America	2522	2794	2978	3122	0.8	0.0	-0.8
Europe OECD+CEEC	1887	2036	2196	2310	0.2	-0.8	-1.6
OECD Pacific	638	698	760	822	0.3	0.4	0.6
CIS	888	1016	1286	1484	1.9	1.6	1.1
Latin America	613	803	1046	1277	2.0	2.4	2.4
Middle East	497	623	828	1077	1.9	1.7	2.2
Africa	343	429	560	722	1.5	1.7	3.1
Asia	2565	3836	5117	6528	2.6	3.4	4.2
World	**9954**	**12234**	**14771**	**17341**	**1.5**	**1.5**	**1.8**

Source: POLES.

Gross inland energy consumption at the world level increases at the rate of 1.9% pa on average between 2000 and 2030 (1.8% under Baseline scenario assumptions). The increase of total energy consumption in the European Union is projected at only 0.6% pa between 2000 and 2030 (similar to the Baseline case). Developing countries (with energy consumption growing at rates above 2% pa in 2000-2030), and to a lesser extent economies in transition, are the main drivers as regards world primary energy demand growth in the period to 2030. In contrast, some saturation effects clearly become apparent in developed world regions, with primary energy needs growing at rates below 1% pa in 2000-2030. All other world regions exhibit an increase of primary energy needs higher than Reference levels over the projection period which, however, is accompanied by additional energy intensity gains above those achieved in the Reference case. In Asia, for which primary energy needs increase by +4.2% in 2030 (the highest growth among all regions), additional energy intensity improvements reach +4.8% in the same year.

In terms of changes in the fuel mix (see Table 2-7) demand for solid fuels exhibits a strong increase above Reference case levels (+11.9% in 2030), followed by other renewables (+10.8% in 2030) and nuclear energy (+7.1% in 2030). The growth of these three energy forms occurs to the detriment of natural gas (-6.0% in 2030), the market share of which is limited in 2030 to 24.8% of overall energy consumption (-2 percentage points lower than the Reference case). In contrast, high oil and gas prices have only a limited impact on liquid fuels consumption (-0.5% in 2030 compared to the Reference case) as the increase in the price of natural gas is significantly higher than that of liquids and, thus, the latter gain in terms of competitiveness against natural gas. In absolute terms, the increase in the use of solid fuels (+505 Mtoe in 2030) corresponds not only to the growth of primary energy demand because of higher economic growth (+300 Mtoe in 2030) but also accounts for a significant part of the gap generated by lower use of natural gas (-272 Mtoe in 2030).

Table 2-7: Gross inland consumption by fuel in the "high oil and gas prices" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solids	2286	2940	3732	4758	4.9	7.2	11.9
Liquids	3556	4444	5393	6232	0.7	0.0	-0.5
Gas	2221	2837	3642	4263	0.1	-1.7	-6.0
Nuclear	663	799	780	839	0.1	2.0	7.1
Hydro+Geothermal	238	290	341	392	0.1	0.3	0.6
Biomass	820	682	569	477	0.0	0.0	0.0
Other Renewables	170	243	312	380	2.4	6.3	10.8
Total	**9954**	**12234**	**14771**	**17341**	**1.5**	**1.5**	**1.8**

Source: POLES.

Table 2-8: Oil consumption and production by region in the "high oil and gas prices" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Consumption							
North America	973	1036	1057	1064	-0.5	-2.3	-3.7
Europe OECD+CEEC	730	787	828	836	-1.0	-2.1	-3.0
OECD Pacific	296	284	298	307	0.5	-0.7	-2.0
CIS	197	254	316	337	-0.2	-1.2	-1.7
Latin America	332	412	525	634	1.9	2.1	3.0
Middle East	269	338	423	545	0.9	3.1	7.1
Africa	54	110	174	213	0.9	-1.9	-10.3
Asia	705	1222	1772	2295	2.6	1.5	0.9
Total	**3556**	**4444**	**5393**	**6232**	**0.7**	**0.0**	**-0.5**
Production							
World conventional	3486	4310	5198	5814	0.5	-1.0	-2.6
Gulf	932	1559	2225	2581	15.8	9.1	9.1
OECD	830	827	807	874	-3.2	-1.3	-5.8
Other	1724	1924	2167	2360	-7.9	-9.5	-11.9
Non conventional	33	134	195	418	8.6	34.5	43.8
Total	**3519**	**4444**	**5393**	**6232**	**0.7**	**0.0**	**-0.5**
World R/P ratio	**46.9**	**39.0**	**30.8**	**25.3**	**-4.3**	**-6.1**	**-6.2**

Source: POLES.

Oil consumption in the OECD countries, CIS and Africa is projected to grow at rates below those observed in the Reference case, whereas in the other non-OECD regions additional economic growth and the increasing price competitiveness of oil versus natural gas leads to further growth above the Reference case levels (see Table 2-8). Oil production is also projected to undergo some significant changes under the "High oil and gas prices" case assumptions. The decrease in oil reserves is counterbalanced by an increase in the production of the Gulf region (+9.1%) and of non-conventional reserves (+43.8% in 2030). However, as overall production remains rather unchanged from reference levels, while oil reserves are significantly lower compared to those assumed in the Reference case, the reserves to production ratio exhibits a worsening in this "High oil and gas prices" case falling in 2030 to 25.3 years (some 1.7 years less than in the Reference case).

As far as natural gas is concerned, consumption in all world regions is projected to reach levels below those of the Reference case (see Table 2-9) as a result of higher price increases than in the case of oil, due to a larger reduction in resources. The decline in gas consumption is more pronounced in the OECD region (75% of the overall decline projected in 2030), as the highest price increases occur in the North American and European markets.

Natural gas production in the OECD region (and especially in North America) declines at rates above those for gas consumption given lower resources. In 2030 the OECD region is projected to account for 25.6% of natural gas production (the corresponding figure in the Reference case being 27%) and thus the gas import dependence of industrialised countries will further increase. In contrast, gas production in CIS is projected to exhibit only a limited decline in the long run, at rates well below average, with the share of CIS in total gas supply reaching 33.6% in 2030 (1.5 percentage points above reference levels). The decline in gas consumption is not enough to counterbalance the decrease in natural gas resources and the reserves/production ratio exhibits a dete-

Table 2-9: World gas consumption and production by region under "high oil and gas prices" scenario assumptions

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Consumption							
North America	700	783	861	820	0.6	-3.2	-12.3
Europe OECD+CEEC	441	546	603	618	1.2	-3.7	-10.6
OECD Pacific	91	135	168	193	-4.8	-3.5	-4.6
CIS	464	543	724	882	3.1	1.9	-0.2
Latin America	102	167	262	327	2.6	2.1	-3.9
Middle East	209	263	381	505	3.3	-0.1	-3.1
Africa	3	5	7	6	5.0	-16.2	-49.5
Asia	211	396	637	912	-7.2	-3.5	-3.9
Total	**2221**	**2837**	**3642**	**4263**	**0.1**	**-1.7**	**-6.0**
Production							
OECD	1001	1075	1172	1097	3.1	-2.4	-10.5
of which North America	*705*	*727*	*828*	*765*	*1.5*	*-3.1*	*-14.0*
CIS	583	704	1056	1438	0.1	1.6	-1.6
Middle East	165	226	527	759	-8.6	3.9	-10.2
Asia	258	439	383	328	-0.5	-20.9	-22.0
Other	227	379	488	636	-5.6	1.6	6.1
Total	**2232**	**2838**	**3647**	**4281**	**0.1**	**-1.8**	**-6.0**
World R/P ratio	**83.0**	**77.1**	**60.4**	**48.2**	**-8.6**	**-11.8**	**-11.4**

Source: POLES.

Table 2-10: Solids consumption by region in the "high oil and gas prices" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
North America	512	628	710	850	3.7	7.4	14.4
Europe OECD+CEEC	368	335	396	466	1.3	4.8	10.7
OECD Pacific	136	132	137	152	5.1	7.1	11.2
CIS	119	86	124	146	3.9	7.8	15.9
Latin America	33	35	45	71	5.1	14.2	32.4
Middle East	11	9	10	13	2.4	9.0	23.2
Africa	71	128	216	352	3.9	5.9	15.3
Asia	1035	1586	2095	2709	6.4	7.6	10.2
World	**2286**	**2940**	**3732**	**4758**	**4.9**	**7.2**	**11.9**

Source: POLES.

rioration to 48.2 years in 2030 compared to 54.4 years in the Reference case.

Solid fuels grow well above Baseline levels in the world energy system in the high oil and gas price case (+11.9% from Baseline levels in 2030; see Table 2-10). It is interesting to note that the Asian market, though exhibiting the smallest growth compared to the Reference case (+10.2% in 2030) among world regions, accounts for some 50% of total global incremental demand for solid fuels in 2030. In developed countries, demand for solids is projected to grow at rates below average with the exception of North America, in which solid fuels make some significant inroads above reference levels. This results from the strong impact of high price assumptions on natural gas consumption for this region. As in the Baseline, coal consumption in developed countries remains concentrated upon large users (mainly in the power sector).

The combined effect of higher economic growth and higher oil and gas prices, entailing increased solid fuel demand, leads to further growth of CO_2 emissions (+2.2% pa in 2000-2030 compared to +2.1% pa in the Reference case).

As clearly illustrated in Table 2-11, emissions grow above reference levels mainly in developing countries, both because of the increase in energy requirements but also as a result of the predominant role of solid fuels in satisfying the energy needs in these regions. In contrast, Europe is the only region in which CO_2 emissions are projected to decline in the "High oil and gas prices" case, reflecting higher prices in the European market and the assumed absence of additional economic growth in this region.

Table 2-11: CO_2 emissions by region in the "high oil and gas prices" case

	Mt CO_2				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
North America	6170	6971	7537	8042	1.3	1.0	0.9
Europe OECD+CEEC	4384	4626	5109	5458	0.3	-0.4	-0.7
OECD Pacific	1516	1563	1689	1826	1.0	1.1	1.4
CIS	2077	2267	2994	3496	2.2	2.0	1.8
Latin America	1298	1680	2252	2818	2.3	3.0	3.5
Middle East	1264	1578	2087	2723	1.8	1.9	3.0
Africa	439	838	1381	2037	2.7	2.6	5.3
Asia	6401	10420	14485	19010	3.9	4.3	5.3
World	**23549**	**29943**	**37534**	**45409**	**2.2**	**2.4**	**3.1**

Source: POLES.

2.2.1. World energy outlook under the "low gas availability for Europe" and the "de-linking of oil and gas prices" cases

The "Low gas availability for Europe" scenario describes a situation of higher economic growth and gas demand in Asia, combined with tighter supplies from the Former Soviet Union to Europe. Gas reserves are also assumed to be lower than in the Reference case (-17.4% in 2030).

In the "low gas availability for Europe" case, the European gas price follows similar trends to those observed in the Reference case until 2006. Beyond 2006, the European gas price rises more rapidly than the oil price; it reaches a level similar to the oil price between 2015 and 2020 and then exceeds it. Gas prices in other markets also converge closer to the oil price (which is also projected to be slightly higher than in the Reference case). Gas prices in 2030 rise by: +41.7% for the American market, +32.0% for Europe, +11.9% for Asia. Thus, with stronger growth of gas prices in the American and European markets, prices on these three regional markets undergo a marked process of convergence, with a final range of 27.8 (Americas) to 32.5 $00/boe (Asia). In the Baseline case this range is much larger (19.6–29.1 $00/boe).

The higher level of world GDP in the "Low gas availability for Europe" case results in an increase of total world energy consumption (+5.1% above reference levels in 2030), which remains significantly lower than that of GDP (+8.4%). Consequently there is a noticeable improvement in world energy intensity in this scenario (-3% in 2030 from reference levels). The increase in energy demand is more marked in the Asian region (+11% in 2030) where the accelerated economic growth takes place. This energy demand growth is largely covered by coal (+13.2% in 2030), which gains additional market shares to the detriment of gas (for which consumption in 2030 is down -4.7% below the Baseline) and to a lesser extent oil (+6.6% in 2030). Nuclear energy and renewables also benefit in the "low gas availability for Europe" case. These changes in the fuel mix lead to higher CO_2 emissions, which in 2030 are projected to exceed the Baseline level by +6.7%.

The "**De-linking of oil and gas prices" scenario** is developed in order to test the consequences of higher gas availability in the long term. Therefore it combines the hypothesis of smaller oil resources and high gas resources (oil reserves are assumed to be 7.5% lower than reference levels in 2030 whereas gas reserves are some 14.5% higher); a zero long-term gas-to-oil price elasticity is also introduced in this case. This scenario also supposes that gas supplies to Europe from the Former Soviet Union are relatively more abundant than in the other cases. To some extent this scenario is thus symmetrical to the "Low gas availability in Europe" case where overall oil availability was higher than that of gas but where the European gas supply from the East was much tighter.

In the "de-linking of oil and gas prices" case the price of oil exhibits growth above Reference case levels (+14.4% in 2030) whereas that for natural gas grows at a slower pace (-3.5% from reference levels in 2030 for the European market, -17.0% for the American market and -6.4% for the Asian market).

In these circumstances world gas consumption in 2030 is 6% higher than in the Reference case. The increase in the use of natural gas occurs to the detriment of oil and solid fuels (-6.0% and -1.8% respectively in 2030), while nuclear energy is also somewhat affected (-1.3% in 2030). Finally, consumption of renewable energy forms is projected to remain rather unchanged from reference levels under "de-linking of oil and gas prices" case assumptions. It is interesting to note that the full disconnection of oil and gas prices entails changes in the "gas to oil" relative price. However this change has rather small impacts because of the limited gas to oil competition. Moreover, the "gas to coal" price relationship - which could have strong impacts, particularly in the power generation sector - is not sufficiently improved by the high gas resource hypothesis to lead to more pronounced growth in gas demand.

The higher penetration of natural gas in the world energy system has a positive impact on energy intensity, improving by 1.1% above reference levels in 2030 (e.g. due to higher efficiency of gas fired power plants compared with coal). In addition, the more marked penetration of natural gas leads to lower CO_2 emissions (-1.6% below reference levels in 2030).

2.3. Higher oil /gas prices scenario results for EU-25[41]

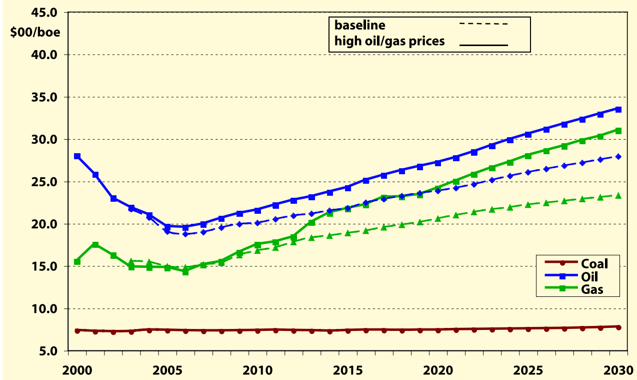
The evolution of international oil and gas prices in the context of the "High oil and gas prices" case in comparison to the Baseline scenario is illustrated in Figure 2-2. The energy system reacts to such changes, leading to higher energy costs both on the demand and the supply sides, through changes in the fuel mix as well as in terms of improving energy intensity.

Table 2-12 illustrates the projected evolution of EU-25 primary energy needs under the "High oil and gas prices" case assumptions. A slowdown of primary energy growth in the EU-25 energy system compared to the Baseline scenario is projected to occur, but this is rather limited over the projection period (below -0.5% even in the long run). The most important changes in the primary energy balance occur in the fuel mix. The impact of higher oil and gas prices is significantly more pronounced for natural gas demand (-13.6% from Baseline levels in 2030) while it remains rather limited over the projection period for liquid fuels (-1.5% in 2030).

There are two reasons for this result. First, the gas price increases more than the oil price (the gas price rises +8.0% from Baseline levels in 2030 compared to +5.5% for oil). Moreover, even under the Baseline scenario, liquids become almost exclusively a fuel for transportation and the petrochemical industry, where they are difficult to replace. Given the very limited flexibility of the transport sector in terms of changing its fuel mix, it is obvious that the evolution of liquid fuel demand is heavily influenced by trends in the transport sector.

The decline in the demand for liquid fuels and, mainly, natural gas is counterbalanced by a strong increase in the use of renewable energy forms over the projection period (+18.6% from Baseline levels in 2030) and of solid fuels especially in the long run (+16.9% in 2030).

Figure 2-2: International oil and gas prices for the EU-25 energy system under "high oil and gas prices" case assumptions (comparison to baseline)



Source: PRIMES.

The use of nuclear energy in the EU energy system is projected to exhibit limited growth above Baseline levels (+3.1% in 2030).

Under "high oil and gas prices" case assumptions the market share of renewable energy forms is projected to reach 7.65% in 2010 (some 0.25 percentage points above Baseline levels). Beyond 2010, renewable energy sources further gain market share in the EU-25 energy system. By 2030, they have a 10.3% share of total primary energy demand (compared with 8.6% in the Baseline).

Energy intensity gains, combined with the stronger penetration of renewable energy forms and higher utilisation of nuclear energy, more than offset the increased share of solid fuels in the EU-25 energy system leading to a small reduction of CO_2 emissions over the projection period (-0.6% in 2030 from Baseline levels). More details on CO_2 emissions can be found below under section 1.3.3.

Table 2-12: Primary Energy Demand in EU-25 in the "high oil and gas prices" case

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	245.0	272.1	350.8	0.6	7.7	16.9
Liquid Fuels	635.6	647.9	665.0	664.4	-0.9	-1.0	-1.5
Natural Gas	376.0	504.9	564.6	542.9	-0.4	-5.6	-13.6
Nuclear	237.7	245.3	216.1	191.1	0.0	1.2	3.1
Renewable energy forms	96.1	136.6	165.6	200.9	3.0	9.4	18.6
Total	**1650.7**	**1781.7**	**1885.4**	**1952.4**	**-0.1**	**-0.2**	**-0.4**
EU-15	**1453**	**1574**	**1653**	**1713**	**-0.1**	**-0.2**	**-0.4**
NMS	**198**	**208**	**232**	**239**	**-0.1**	**0.2**	**-0.5**
Mt CO_2 emitted	**3665**	**3741**	**4022**	**4278**	**-0.4**	**-0.5**	**-0.6**
EU-15	**3118**	**3189**	**3413**	**3629**	**-0.5**	**-0.9**	**-1.1**
NMS	**547**	**552**	**610**	**649**	**-0.1**	**2.2**	**2.3**

Source: PRIMES.

41 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to the Baseline can be found in APPENDIX 2. Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to the Baseline) are available in the enclosed CD.

Table 2-13: Import dependency in EU-25 in the "high oil and gas prices" case

	%				percentage points difference from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid fuels	30.1	37.1	52.4	68.7	0.2	2.4	2.9
Liquid fuels	76.6	80.7	84.7	86.8	-0.6	-1.3	-1.5
Natural gas	49.5	55.9	71.0	77.4	-5.3	-4.3	-4.0
Total	**47.2**	**51.2**	**59.5**	**64.2**	**-1.9**	**-2.4**	**-3.1**
EU-15	**49.4**	**52.4**	**60.6**	**64.9**	**-1.9**	**-2.3**	**-3.0**
NMS	**30.8**	**42.5**	**52.0**	**59.6**	**-1.5**	**-2.8**	**-4.0**

Source: PRIMES.

Table 2-14: Final Energy Demand and CO_2 emission by Sector in EU-25 in the high oil and gas prices" case

	Mtoe				*% change from baseline*		
	2000	2010	2020	2030	2010	2020	2030
Industry	309.1	338.5	366.0	385.8	-0.1	-0.4	-0.7
Tertiary	154.2	173.6	191.6	212.4	-0.4	-1.4	-2.6
Households	279.1	307.9	325.4	331.6	-0.3	-1.1	-2.1
Transports	332.0	386.8	426.0	446.7	-0.1	-0.2	-0.4
Total	**1074**	**1207**	**1309**	**1376**	**-0.2**	**-0.7**	**-1.3**
EU-15	**955**	**1075**	**1157**	**1214**	**-0.2**	**-0.7**	**-1.2**
NMS	**119**	**132**	**152**	**163**	**-0.2**	**-0.8**	**-1.6**
	Mt CO_2 emissions				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	605.7	542.2	539.3	538.3	-0.4	-1.2	-2.5
Tertiary	236.7	237.4	232.2	236.6	-0.9	-3.6	-7.1
Households	462.6	478.3	482.2	463.3	-0.7	-2.6	-4.9
Transports	967.5	1102.6	1193.7	1221.2	-0.7	-1.6	-2.9
Total	**2272**	**2361**	**2447**	**2459**	**-0.7**	**-1.9**	**-3.6**
EU-15	**2024**	**2103**	**2170**	**2179**	**-0.7**	**-1.9**	**-3.6**
NMS	**249**	**257**	**277**	**280**	**-0.4**	**-1.7**	**-3.7**

Source: PRIMES.

The projected shifts in primary energy needs of the EU-25 energy system, towards the greater use of solid fuels, renewable energy forms and nuclear and away from natural gas and oil, result in significant improvements as regards import dependency in comparison to the Baseline scenario. As can be seen in Table 2-13, import dependency of EU-25 improves by 3.1 percentage points in 2030 (3% in EU-15 and 4% in New Member States).

2.3.1. Impacts on the demand side

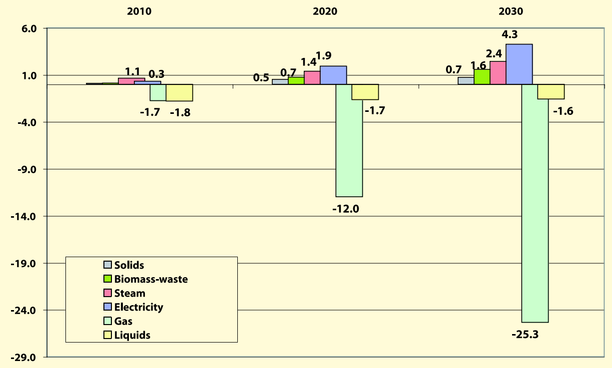
Energy requirements in the EU-25 demand side are projected to decline from Baseline levels over the projection period in the "High oil and gas prices" case (see Table 2-14). The projected decline in total final energy demand, ranging from -0.2% from Baseline levels in 2010 up to -1.3% in 2030, is significantly higher than the corresponding decline in primary energy needs because of the significant energy intensity gains above Baseline levels occurring on the demand side. This development is due to structural and behavioural changes but also to changes in the fuel mix and the adoption of more efficient equipment.

The tertiary and household sectors are the most responsive sectors to price changes whereas both industry and the transport sector exhibit only a limited reaction to price increases.

Because of the relatively low taxation of energy products for industrial uses, one would expect that this sector would be the most responsive to the price shock as it experiences the sharpest increase in energy prices. However, this sector is also characterised by limited flexibility regarding both short-term structural change and further substitution among fuels above that assumed in the Baseline projections. As a result energy use in industry exhibits only a limited decline from Baseline levels over the projection period. However, the sector undergoes some additional changes in the fuel mix towards the use of electricity and co-generated steam in the long run, which result in a CO_2 emissions reduction of -2.5% from Baseline levels in 2030.

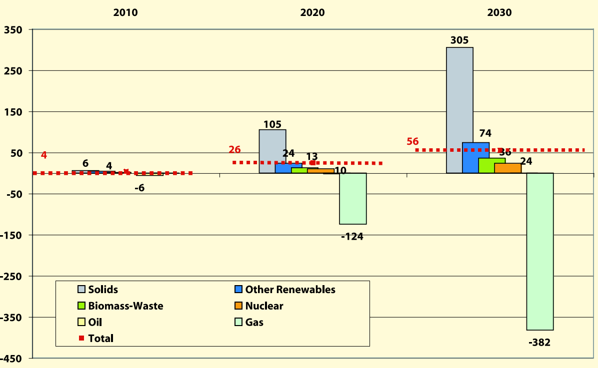
The tertiary and household sectors are projected to be the most responsive to higher oil and gas prices. Besides energy intensity

Figure 2-3: Changes in final energy demand by fuel in EU-25 in the "high oil and gas prices" case (diff. from baseline in Mtoe)



Source: PRIMES.

Figure 2-4: Changes in electricity generation by energy form in EU-25 in the "high oil and gas prices" case (diff. from baseline in TWh)



Source: PRIMES.

gains achieved through the adoption of more efficient technologies, higher fuel prices lead to a slowdown in the pace to which energy consumers shift towards higher comfort standards. As a result energy demand in the tertiary sector falls by 2.6% from Baseline levels in 2030 with the corresponding decrease in household energy demand reaching 2.1%. Furthermore, both sectors undergo significant changes in the fuel mix which in turn result in even more pronounced CO_2 emission reductions in 2030 (-7.1% from Baseline levels in the tertiary sector, -4.9% in households).

The transport sector is the least responsive sector on the demand side with energy requirements declining by only -0.1% from Baseline levels in 2010 (-0.4% in 2030) as the high taxes on transport fuels greatly dampen the impact of further changes in international fuel prices. Therefore, the reaction of energy consumers in satisfying their transport needs is rather limited. However, higher oil prices lead to some acceleration in the use of biofuels as a blended ingredient of gasoline and diesel oil. The share of biofuels in gasoline is projected to reach 2.8% in 2010 (compared to 2.1% under Baseline assumptions), 5.0% in 2020 (3.4% in Baseline) and 7.9% in 2030 (5.1% in Baseline). The corresponding shares for diesel oil are 3.1% in 2010, 5.2% in 2020; and 8.3% in 2030 (from 2.4%, 3.7% and 5.3% respectively under Baseline assumptions). The accelerated penetration of biofuels in transport impacts on the evolution of CO_2 emissions in the sector, which are projected to decrease at rates well above those of energy demand over the projection period (reaching -2.9% from Baseline levels in 2030).

In terms of fuel use, the most pronounced growth above Baseline levels on the demand side occurs for biomass and waste (+3.9% in 2030). However, in absolute terms it is mainly electricity and co-generated steam that are projected to exhibit a strong increase above Baseline levels (see Figure 2-3). This shift towards the use of electricity (+1.3% from Baseline levels in 2030) and steam (+2.9% in 2030) occurs because of the structural changes in power generation leading to absorption of additional costs imposed on the energy system as a result of higher fuel prices. Consequently, the increase in the price of electricity is much less than that for oil and gas - making the use of electricity and steam at the final demand level a more cost-effective solution compared to the Baseline scenario.

2.3.2. Impacts on electricity and steam generation

The electricity and steam generation sector undergoes significant changes due to the variation of international fuel prices in the "High oil and gas prices" case. Besides the increased demand for electricity and steam discussed above, the different international oil and gas price profiles lead to substantial changes in producers' investment decisions as regards the expansion and/or replacement of existing power generation capacity.

As can be seen in Figure 2-4, only limited changes are projected to occur in electricity generation in 2010. The gap generated due to additional electricity generation (+4 TWh or +0.1% from Baseline levels) and the decline in generation using liquid fuels (-6 TWh or -6.3%) is met by solid fuels (+6 TWh or +0.8%) and intermittent renewable energy forms (+4 TWh or +0.8%).

The impact of high oil and gas prices on the structure of electricity and steam generation becomes more pronounced in the long run, as solid fuels and to a lesser extent renewable energy forms gain in terms of competitiveness and replace natural gas in power generation. As a result of changes in the fuel mix on the demand side, electricity production in 2030 is projected to increase +56 TWh (or +1.3%) from Baseline levels. Furthermore, electricity production from natural gas declines by -382 TWh (or -23.6%) from Baseline levels. The gap generated is largely covered by the comeback of solid fuels in the power generation sector (+305 TWh or +26%), which is even more pronounced compared to the Baseline scenario. The role of hydro and intermittent renewable energy forms (+74 TWh or +10.4%) and biomass/waste (+36 TWh or +41.2%) is less pronounced. The nuclear contribution to electricity generation is also projected to exhibit limited growth above Baseline levels (+24 TWh or +3.1%). It should be noted that, as regards hydro and intermittent renewable energy forms, the bulk of the increase comes from wind energy (+59 TWh or +18.9% from Baseline levels in 2030). The changes in the sector lead to an increased share of renewable energy forms (including waste) in electricity generation, especially in the long run. The renewables share reaches 17.7% in 2010 (+0.15 percentage points above Baseline levels) and rises further to 20.4% in 2030 (compared to 18.2% in the Baseline scenario).

Table 2-15: Installed capacity by plant type in EU-25 under the "high oil and gas prices" scenario assumptions

	GW installed				change from baseline (in GW)		
	2000	2010	2020	2030	2010	2020	2030
Nuclear	140.3	129.8	108.5	109.6	0.0	0.5	1.8
Hydro	96.2	104.6	110.5	113.4	0.0	1.2	1.3
Wind	12.8	74.3	108.8	150.9	1.6	5.3	16.0
Other renewables	0.2	0.5	0.6	17.9	0.0	0.0	3.6
Conventional thermal	335.6	270.5	177.1	153.4	-0.1	1.8	6.0
Advanced coal	0.0	0.6	2.4	9.3	0.1	0.4	2.8
Supercritical polyvalent	0.0	0.9	86.1	210.5	0.4	21.4	67.1
Gas turbines CC	47.4	171.8	298.5	309.5	2.2	-20.3	-75.1
Small gas turbines	22.8	33.2	63.4	68.3	-0.7	0.0	2.5
Geothermal	1.0	1.2	1.3	1.5	0.0	0.0	0.1
Total	**656**	**787**	**957**	**1144**	**3.6**	**10.3**	**26.1**
EU-15	**579**	**692**	**822**	**975**	**3.1**	**9.1**	**24.2**
NMS	**78**	**96**	**135**	**169**	**0.5**	**1.2**	**1.8**
of which CHP	***103***	***132***	***169***	***201***	***2.5***	***1.0***	***2.4***
EU-15	***77***	***105***	***130***	***148***	***2.3***	***0.2***	***1.5***
NMS	***26***	***28***	***39***	***53***	***0.2***	***0.8***	***0.9***

Source: PRIMES.

Table 2-16: Fuel input in electricity and steam generation in EU-25 under "high oil and gas prices" case assumptions

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solids	217.4	178.2	212.0	295.0	0.7	10.1	20.8
Oil products	52.4	32.9	22.6	19.6	-4.2	-3.3	-0.7
Gas	131.7	203.8	244.3	215.3	-0.3	-7.5	-21.2
Biomass	12.7	19.0	24.8	32.9	1.4	16.8	37.2
Waste	19.3	25.5	27.7	27.5	0.2	1.9	3.8
Nuclear energy	237.7	245.3	216.1	191.1	0.0	1.2	3.1
Geothermal heat	3.0	3.5	3.7	4.1	2.1	2.3	4.1
Total	**674**	**708**	**751**	**785**	**0.0**	**0.7**	**1.1**
EU15	**581**	**609**	**641**	**674**	**-0.1**	**0.5**	**0.9**
NMS	**93**	**99**	**111**	**111**	**0.1**	**2.2**	**2.3**
Mt CO_2 emitted	***1355***	***1300***	***1494***	***1741***	***-0.1***	***1.9***	***3.9***
EU-15	***1068***	***1010***	***1167***	***1377***	***-0.1***	***0.9***	***3.0***
NMS	***287***	***291***	***327***	***364***	***0.2***	***5.7***	***7.3***

Source: PRIMES.

The above changes are also reflected in the investment decisions of power generators, which are clearly altered by these different fuel prices. More specifically, given higher gas prices, gas turbine combined cycle plants lose much of their cost effectiveness, and are mainly replaced by supercritical coal plants (using coal and biomass-waste as input fuel) and to a lesser extent by renewable technologies.

Total installed capacity is projected to be some 3.5 GW higher than Baseline levels in 2010, reaching +26 GW in 2030. Changes in terms of installed capacity by plant type are illustrated in Table 2-15. As can be seen in the table, the EU-25 power generation system reacts to higher gas prices by increasing investment in wind turbines (from 135 GW under Baseline conditions in 2030 to 151 GW) and supercritical polyvalent units (+67 GW from Baseline levels in 2030). On the other hand, the expansion of gas turbine combined cycle plants experiences a significant slowdown in the same period (-75 GW installed in 2030 from Baseline levels).

These changes are also reflected in the fuel inputs in electricity and steam generation (see Table 2-16). Transformation input of solids is higher than in the Baseline throughout the projection period. On the other hand, the growth in gas fuels for power generation exhibits a significant slowdown in the period to 2020 compared to Baseline levels and even becomes negative in 2020-2030. Finally biomass is projected to be exploited at fairly high rates to 2030 (with considerable increases over the corresponding Baseline levels).

In the short term, the shift towards carbon free energy forms for power generation more than counterbalances the increase in electricity and steam demand and the higher utilisation of solid fuels resulting in lower CO_2 emissions from Baseline levels. However, in the long run and as the changes in the fuel mix towards greater use of solid fuels and less natural gas become increasingly important, CO_2 emissions are projected to reach levels well above those in the Baseline (+3.9% in 2030 in EU-25), with an even higher increase in New Member States (+7.3%).

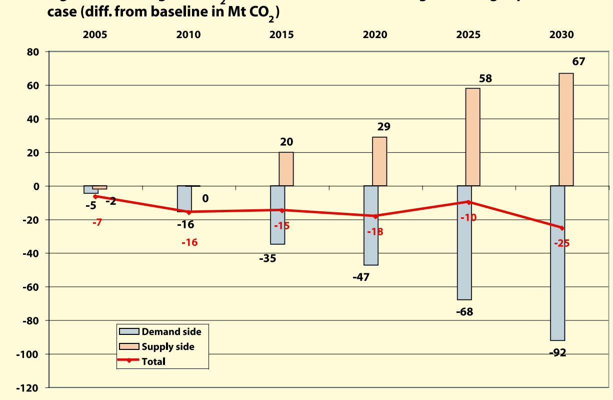
2.3.3. Impacts on CO2 emissions

In the "High oil and gas prices" case, the growth of CO_2 emissions is projected to exhibit a slowdown over the projection period compared to the Baseline. It is the demand side (both because of changes in the fuel mix and efficiency gains) that is the main driver for this reduction; whereas the supply side, especially in the long run, is characterised by a strong increase in CO_2 emissions, which driven by the higher exploitation of solid fuels in the power generation sector (see Figure 2-5). As a result the demand side accounts in 2030 for 60.0% of total CO_2 emissions emitted in the EU-25 energy system (-1.6 percentage points below Baseline levels).

2.3.4. Concluding remarks

The **high oil and gas prices case** shows the impacts on the EU-25 energy outlook that faster world economic growth and relatively less abundant resources, in comparison to the Baseline scenario, could generate. The increase, above Baseline levels, in oil and gas prices exerts only a small downward pressure on energy demand. The tertiary and household sectors are more responsive than transport due to the relatively small price increase for transport fuels given the existing high tax levels for oil used for transport. The power sector undergoes some significant changes in the fuel mix with solid fuels and, to a less extent, renewable energy forms gaining additional market shares to the detriment of natural gas. The share of renewables in primary energy needs increases especially in the long term (in 2010 less than 0.5 percentage point above Baseline levels but around 2 percentage points in 2030). CO_2 emissions are also projected to be lower than in the Baseline (-0.5% in 2010 and -1.1% in 2030). Finally, import dependency decreases significantly below Baseline (3 percentage points in 2030) as a result of the higher exploitation of indigenous energy sources.

Figure 2-5: Changes in CO_2 emissions in EU-25 in the "high oil and gas prices" case (diff. from baseline in Mt CO_2)



Source: PRIMES.

2.4. Scenario results for EU-25 in the other price cases: "low gas availability for Europe", "de-linking of oil and gas prices" and "soaring oil and gas prices" cases[42]

As in the "High oil and gas prices" case, the different international oil and gas price profiles examined in the "Low gas availability for Europe" and the "De-linking oil and gas prices" cases generate a rather limited impact on overall energy requirements for the EU-25 energy system but result in significant changes in the fuel mix in comparison to the Baseline scenario (see Table 2-17). However, in the "Soaring oil/gas prices" case, in which oil and gas prices are assumed to increase by 80% from Baseline levels in 2010 and continue to have this same increase above Baseline levels over the whole projection period, the response of the EU-25 energy system in terms of energy intensity gains becomes more pronounced (-1.5% from Baseline levels in 2010 and -1.4% in 2030). For these cases, too, as in the "high oil and gas prices" case, it has been assumed that changes in international fuel prices do not affect the evolution of the EU-25 economy. The projected reductions in terms of total primary energy requirements lead therefore to corresponding energy intensity gains compared with the Baseline case.

The higher gas price under the "Low availability of gas for Europe" case leads to a strong shift away from natural gas and towards the use of solid fuels. Primary energy demand for natural gas is projected to decline even in absolute terms in the long run - in 2030 falling 13.8% from Baseline levels. This generates an important gap, as the impact on overall primary energy needs is limited to -0.3% from Baseline levels in 2030. This gas is largely replaced by solid fuels (+16.6% in 2030) while renewable energy forms also contribute more to energy supplies. Renewables are projected to gain some additional market share, accounting in 2030 for 9.8% of overall primary energy needs (+1.2 percentage points in comparison to the Baseline).

In the "De-linking of oil and gas prices" case, the slower pace of growth of natural gas prices does not generate very strong impacts on the fuel mix of the EU-25 energy system, a result that reflects the high penetration of natural gas in the EU-25 energy system already achieved under Baseline assumptions. Thus, in the "De-linking of oil and gas prices" case, demand for solid fuels is projected to grow at a slower pace compared to the Baseline scenario (-3.9% in 2030), whereas the increase in natural gas is rather limited (+2% in 2030 from the Baseline level). This result indicates that the more competitive position of gas in the "de-linking of oil and gas prices" case entails only some delay in the comeback of coal in the EU-25 power generation sector. As in the "Low availability of gas for Europe" case renewable energy forms are pro-

42 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to the Baseline) for the three cases examined are available in the enclosed CD.

Table 2-17: Evolution of primary energy needs in the EU-25 in the "low gas availability for Europe", "de-linking of oil and gas prices" and "soaring oil and gas prices" cases

low gas availability for Europe	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303.2	244.4	270.8	349.7	0.3	7.2	16.6
Liquid Fuels	635.6	651.7	673.6	678.0	-0.3	0.3	0.5
Natural Gas	376.0	504.4	562.9	541.7	-0.5	-5.8	-13.8
Nuclear	237.7	245.3	216.1	190.8	0.0	1.2	3.0
Renewable energy forms	96.1	134.5	160.5	190.9	1.4	6.1	12.6
Total	**1650.7**	**1782.3**	**1886.0**	**1953.5**	**-0.1**	**-0.2**	**-0.3**
EU-15	**1453**	**1574**	**1654**	**1714**	**-0.1**	**-0.2**	**-0.3**
NMS	**198**	**208**	**232**	**239**	**-0.1**	**0.2**	**-0.4**
de-linking of oil and gas prices	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	245.3	252.2	288.3	0.7	-0.2	-3.9
Liquid Fuels	635.6	649.1	661.4	658.0	-0.7	-1.5	-2.4
Natural Gas	376.0	505.8	600.4	640.9	-0.2	0.4	2.0
Nuclear	237.7	245.3	213.2	185.9	0.0	-0.1	0.3
Renewable energy forms	96.1	135.4	158.6	181.5	2.1	4.8	7.1
Total	**1650.7**	**1783.0**	**1887.9**	**1957.0**	**-0.1**	**-0.1**	**-0.1**
EU-15	**1453**	**1575**	**1656**	**1717**	**-0.1**	**0.0**	**-0.1**
NMS	**198**	**208**	**231**	**240**	**-0.1**	**-0.1**	**-0.2**
soaring oil and gas prices	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	272.2	330.9	419.7	11.7	31.0	39.9
Liquid Fuels	635.6	634.2	652.5	650.0	-3.0	-2.8	-3.6
Natural Gas	376.0	442.3	469.5	451.1	-12.7	-21.5	-28.2
Nuclear	237.7	245.2	216.7	193.5	0.0	1.5	4.4
Renewable energy forms	96.1	161.3	187.9	216.4	21.6	24.2	27.7
Total	**1650.7**	**1757.3**	**1859.6**	**1933.0**	**-1.5**	**-1.6**	**-1.4**
EU-15	**1453**	**1553**	**1631**	**1697**	**-1.5**	**-1.6**	**-1.3**
NMS	**198**	**205**	**229**	**236**	**-1.8**	**-1.3**	**-1.9**

Source: PRIMES.

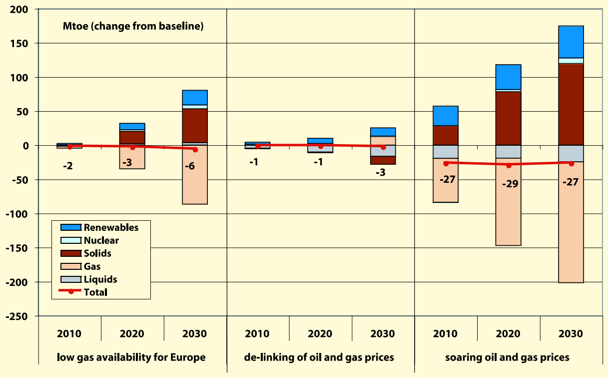
jected to gain some additional market share, accounting in 2030 for 9.3% of primary energy needs.

Under the "Soaring oil/gas prices" case, the changes in the EU energy system fuel mix are significantly more pronounced with demand for gas declining by 28.2% from Baseline levels in 2030. In contrast, demand for solid fuels increases by nearly 40% from Baseline levels. Under this "Soaring oil and gas price" case the impact on primary energy needs of liquid fuels becomes somewhat more significant (-3.6% in 2030) but still much less important than the changes in solid fuels and gas demand. This is due to the specific uses of liquid fuels in the EU-25 energy system (for transportation and in the petrochemical industry) projected to occur even in the Baseline scenario. In all cases examined the use of nuclear energy in the EU-25 energy system is projected to exhibit limited increases in comparison to the Baseline scenario, ranging from +0.3% in 2030 in the "de-linking of oil and gas prices" case up to +4.4% in the "Soaring oil/gas prices" case. This result strongly relates to the prevailing assumptions reflecting the political decisions vis-à-vis nuclear energy in the Baseline scenario, which are not assumed to change under the different fuel import price cases examined.

As can be seen in Figure 2-6 the changes that occur in the fuel mix in the different cases examined mainly relate to an increase in the demand for solid fuels and a similar decline in the use of natural gas or vice-versa. This result clearly indicates that different assumptions on the future evolution of oil and gas import prices for EU-25 alter the decisions of electricity producers as regards the expansion and/or replacement of the existing power generation capacity given that solid fuels are an energy form almost exclusively used in the EU-25 power sector.

It is also interesting to note that all cases are characterised by an increasing contribution of renewable energy forms to the EU-25 energy system. The most pronounced increase occurs under "Soaring oil/gas prices" case (+29.5% from Baseline levels in 2030). The smallest increase for renewables occurs in the "De-linking of oil and gas prices" case, where renewables grow by only +7.3% on top

Figure 2-6: Changes in primary energy needs by fuel in the EU-25 under the "low gas availability for Europe","de-linking of oil and gas prices" and "soaring oil and gas prices" cases assumptions



Source: PRIMES.

of Baseline levels in 2030. As already discussed, this increase, combined with the projected decline of overall primary energy needs under the cases examined, leads to a significant growth of the share of renewable energy forms in the EU-25 energy system (see Table 2-18).

However, the key drivers as regards this additional growth of renewable energy forms above Baseline levels are not uniform across the different cases examined. In the "Low gas availability for Europe" case the increase mainly takes place in the power generation sector as the growth of gas prices above Baseline levels makes the use of both biomass/waste and intermittent renewable energy forms a more cost-effective option.

On the other hand, under the "De-linking of oil and gas prices" case assumptions renewable energy forms lose out in terms of competitiveness against natural gas in the power generation sector and their share in electricity generation exhibits a small decline from Baseline levels (18.8% or -0.1 percentage points in 2030). However, higher oil prices lead to a more pronounced penetration of biofuels as a blended ingredient of gasoline and diesel oil, a trend that leads to the projected increase in the use of renewables in the EU-25 energy system. Finally, in the "Soaring oil and gas prices" case, where oil and gas prices rise substantially above Baseline levels, the increase in the use of renewable energy forms occurs both on the demand and supply sides.

CO_2 emissions are generally lower in the alternative price cases than in the Baseline. However, the deviations from Baseline levels are rather small (see Table 2-19) in comparison to the considerable changes in the composition of energy consumption. In addition to energy intensity gains, the stronger penetration of renewable energy forms under all cases examined, the higher utilisation of nuclear energy and the lower use of natural gas in most cases and years, counterbalance the increased share of solid fuels in the EU-25 energy system. This leads to similar levels of CO_2 emissions in the long run for both the "Low gas availability for Europe" and the "Soaring oil and gas price" cases compared to the Baseline CO_2 levels. In the "De-linking of oil and gas prices" case, the increase in the share of natur-

Table 2-18: Share of renewable energy forms in the EU-25 energy system under "low gas availability for Europe","de-linking of oil and gas prices" and "soaring oil and gas prices" cases assumptions

	% of primary energy needs				*percentage points change from baseline*		
	2000	2010	2020	2030	2010	2020	2030
low gas availability for Europe	5.8	7.5	8.5	9.8	0.11	0.50	1.12
de-linking of oil and gas prices	5.8	7.6	8.4	9.3	0.16	0.39	0.63
soaring oil and gas prices	5.8	9.2	10.1	11.2	1.74	2.09	2.55

Source: PRIMES.

Table 2-19: Evolution of CO_2 emissions in the EU-25 energy system under "low gas availability for Europe", "de-linking of oil and gas prices" and "soaring oil and gas prices" cases assumptions

	Mt of CO2				*% change from baseline*		
	2000	2010	2020	2030	2010	2020	2030
low gas availability for Europe	3665	3749	4038	4311	-0.2	-0.1	0.2
de-linking of oil and gas prices	3665	3748	4015	4239	-0.2	-0.6	-1.5
soaring oil and gas prices	3665	3664	4001	4301	-2.5	-1.0	-0.1
	Index (1990=100)						
	2000	2010	2020	2030			
low gas availability for Europe	97.2	99.5	107.1	114.4			
de-linking of oil and gas prices	97.2	99.4	106.5	112.5			
soaring oil and gas prices	97.2	97.2	106.2	114.1			

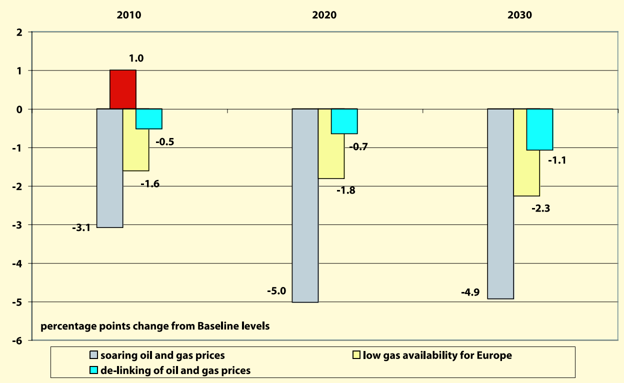
Source: PRIMES.

al gas occurs to the detriment of solid fuels. This leads to a further improvement of carbon intensity in the EU-25 energy system with CO_2 emissions decreasing in 2030 by -1.5% from Baseline levels.

Finally, the higher exploitation of indigenous energy resources, including solids, nuclear and renewable energy forms, leads to a significant reduction of import dependency for the EU-25 energy system (see Figure 2-7).

It is the "Soaring oil/gas prices" case that leads to the strongest decline in terms of import dependency for the EU-25 energy system (minus 5 percentage points from Baseline levels in both 2020 and 2030), followed by the "Low gas availability for Europe" case. Higher imports of gas in the "De-linking of oil and gas prices" case due to lower prices limit the decline of overall import dependency to -1.1 percentage points from Baseline levels in 2030.

Figure 2-7: Changes in import dependency in the EU-25 under "Low availability of gas for Europe", "de-linking of oil and gas prices" and "Soaring oil/gas prices" cases assumptions



Source: PRIMES.

CHAPTER 3: Economic developments

3.1. Description of the scenarios examined

In view of the large uncertainties regarding the future economic evolution of the EU-25 two alternative cases were examined. These cases show the impacts of a more, and a less, pronounced economic growth for the EU-25 energy system in the period to 2030 in comparison to the Baseline scenario. Under Baseline scenario assumptions GDP in EU-25 is projected to grow at a rate of 2.5% pa in 2000-2010, 2.4% in 2010-2020 and 2.3% in 2020-2030.

The "low growth" case assumes a continuation of recent trends as regards the observed economic slowdown in the European Union, incorporating also the DG-ECFIN projections of autumn 2003 for the short-term horizon to 2005. Under the "low growth" case assumptions GDP growth in the EU-25 is limited to 2.0% pa in 2000-2010, 2.1% pa in 2010-2020 and 1.9% pa in 2020-2030 (compared to 2.0% pa in 1990-2000).

On the other hand, the "high growth" case reflects the ambitions for high economic growth following the Lisbon and subsequent summits, i.e. 3% p.a. economic growth for the EU up to 2010. Furthermore, the variant assumes that a successful implementation of the Lisbon strategy in the EU would allow for an even better integration of new Member States in the enlarged EU, in turn resulting in higher economic growth for current EU-15 Member States in the long run. Under the "high growth" case assumptions EU-25 GDP growth rates are projected to reach 3.0% pa in 2000-2010, 2.7% pa in 2010-2020 and 2.5% pa in 2020-2030.

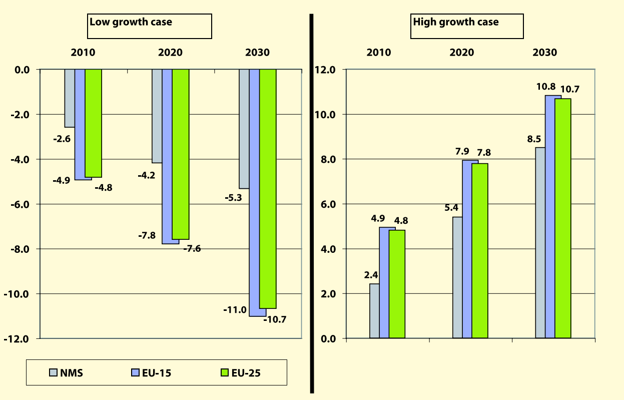
These cases were constructed on the basis of macroeconomic studies and the use of the GEM-E3 model, ensuring consistency of assumptions across the individual sectors and Member States.

As illustrated in Figure 3-1 the impact of different economic growth assumptions is not uniform across the enlarged EU. In the "low growth" case the slowdown in economic growth is more pronounced for the EU-15, with GDP decreasing -4.9% from Baseline levels in 2010, -7.8% in 2020 and -11.0% in 2030. However, in the new Member States (NMS), the decline is less pronounced (-2.6% from Baseline levels in 2010, -4.2% in 2020 and -5.3% in 2030) - reflecting the prevailing strong dynamics of their economies due to their integration in the European Union.

The higher responsiveness of EU-15 to economic growth assumptions is also observed in the "high growth" case, in which EU-15 GDP is projected to reach +10.8% from Baseline levels in 2030 (+4.9% in 2010 and +7.9% in 2020). GDP growth levels for NMS amounts to +8.5% above Baseline levels in 2030 (+2.4% in 2010, +5.4% in 2020). The slower pace of growth above Baseline levels for NMS economies under "high growth" assumptions reflects the assumed higher economic growth of new Member States under Baseline assumptions, which is significantly greater than that of EU-15.

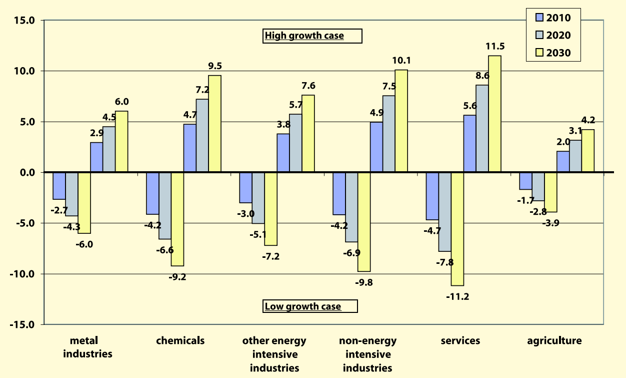
Changes in economic growth do not affect the different sectors of the EU-25 economy in a uniform manner[43] (see Figure 3-2). In the "low growth" case the service sector is most affected, as sectoral value added declines from Baseline levels at rates above those of GDP. The slowdown in the pace of growth for non-energy intensive

Figure 3-1: Change in GDP under different economic development assumptions (% difference from Baseline levels)



Source: PRIMES, GEM-E3

Figure 3-2: Change in value added by sector in EU-25 under different economic development assumptions (% difference from Baseline levels)



Source: PRIMES, GEM-E3

43 The GEM-E3 model has been used for this purpose and results obtained were appropriately adjusted to PRIMES Baseline macroeconomic assumptions.

industries and the chemical sector (driven mainly by slower economic growth in pharmaceuticals and cosmetics production) is also projected to be quite significant; whereas the impact on other industrial sectors, as well as agriculture, is less pronounced.

Similar (but reversed) developments materialise in the "high growth" case with the service sector exhibiting growth above Baseline levels and higher than that for GDP. Non-energy intensive industries, other industries and the chemical sector (with pharmaceuticals and cosmetics production again playing a predominant role) are projected to exhibit additional gains close to those of overall GDP, whereas growth only a little above Baseline is projected for other industrial sectors and agriculture.[44]

In the "low growth" case the services sector accounts for 70.6% of total value added in 2030 (some 0.5 percentage points below Baseline levels), with all other sectors having higher market shares than in the Baseline case. In contrast, in the "high growth" case, the share of services reaches 71.5% with other sectors' shares falling from Baseline levels. It is thus clear from the above that a slowdown in economic growth will lead to a delay in the dematerialisation of the EU economy compared to Baseline levels whereas higher economic growth accelerates the pace of such dematerialisation.

3.2. Scenario results for EU-25[45]

Changes in the evolution of the EU-25 economy are also reflected in the EU-25 energy system outlook over the horizon to 2030. Figure 3-3 illustrates the links between changes from Baseline levels for GDP, energy use and CO2 emissions over the projection period for the low and high growth cases.

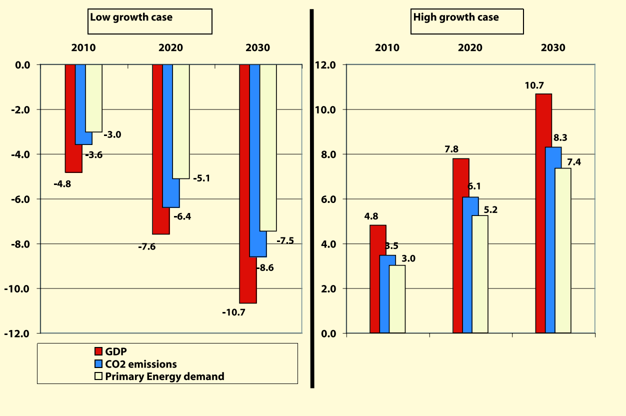
In the "low growth" case, energy demand is projected to decline at rates below that of GDP and, consequently, the projected energy intensity improvement of the EU-25 energy system is less pronounced compared to the Baseline. This development is due to the slower dematerialisation of the EU-25 economy but it is also results from the slower adoption of more efficient equipment by consumers in the different sectors. CO_2 emissions also decline compared to Baseline levels. The decline in such emissions is more pronounced than that of primary energy needs, implying an improvement of carbon intensity above Baseline levels. This result is explained by the fact that, as primary energy needs are projected to grow at a slower pace, there remains a higher exploitable potential for changes in the fuel mix towards the use of less carbon-intensive energy forms.

The trends are reversed in the "high growth" case. Energy demand is projected to grow at rates below that of GDP, implying additional energy intensity gains on top of the Baseline as a result of the further dematerialisation of the EU-25 economy; but also from the faster adoption of more efficient equipment technologies with accelerated capital stock turnover. Moreover, energy demand grows considerably slower than rapidly increasing income as some energy uses in the EU-25 are approaching saturation. In contrast, CO_2 emissions grow faster than energy demand growth over the projection period, reflecting the already high exploitation of changes in the fuel mix towards less carbon-intensive fuels under Baseline assumptions.

Thus, in the "high growth" case the evolution of the EU-25 energy system is characterized by additional energy intensity gains and a worsening of carbon intensity compared to the Baseline scenario. The opposite trends occur with lower economic growth, i.e. energy intensity gains become less pronounced compared to the Baseline scenario but carbon intensity develops more favourably than in the Baseline (see Figure 3-4).

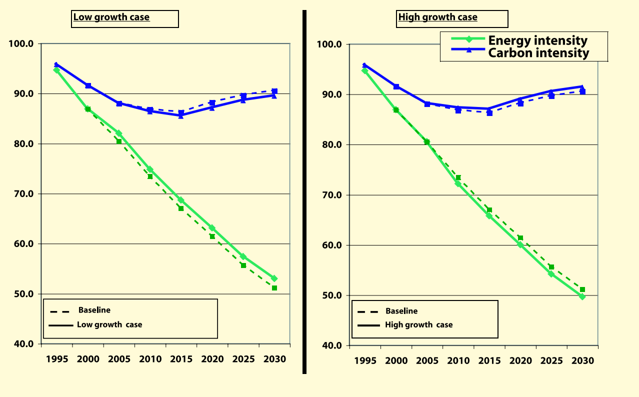
The evolution of primary energy needs by energy form in the two alternative growth cases is illustrated in Table 3-1. In the "low growth" case demand for natural gas and liquid fuels declines at

Figure 3-3: EU-25 primary energy indicators under different economic development assumptions (% change from Baseline levels)



Source: PRIMES.

Figure 3-4: Energy and carbon intensity improvement under different economic development assumptions (index, 1990=100; comparison to Baseline)



Source: PRIMES.

44 The demographic and macroeconomic assumptions of the low and high growth cases for EU-25, EU-15, NMS and Europe-30 can be found in APPENDIX 3A. The detailed macroeconomic outlook and demographic assumptions of individual countries can be found in the enclosed CD.

45 Aggregate results by group of countries (EU-25, EU-15, NMS and Europe-30) in comparison to baseline for the two cases examined can be found in APPENDIX 3B. Detailed results by group of countries and aggregate results by group of countries and by country (in comparison to the Baseline) are also available in the enclosed CD.

Table 3-1: Primary Energy Demand in EU-25 under different economic development assumptions (comparison to Baseline)

Low growth case	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	237.9	229.6	272.2	-2.4	-9.1	-9.3
Liquid Fuels	635.6	629.3	635.3	622.2	-3.7	-5.4	-7.7
Natural Gas	376.0	486.3	566.8	575.2	-4.1	-5.2	-8.4
Nuclear	237.7	245.2	211.6	180.0	0.0	-0.9	-2.9
Renewable energy forms	96.1	129.4	146.9	161.7	-2.5	-2.9	-4.6
Total	**1651**	**1730**	**1792**	**1814**	**-3.0**	**-5.1**	**-7.5**
EU-15	**1453**	**1525**	**1566**	**1582**	**-3.2**	**-5.5**	**-8.0**
NMS	**198**	**205**	**227**	**232**	**-1.6**	**-2.2**	**-3.4**
High growth case	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	246.1	267.6	321.8	1.0	5.9	7.3
Liquid Fuels	635.6	678.4	710.6	730.1	3.8	5.8	8.3
Natural Gas	376.0	528.8	631.3	677.2	4.3	5.6	7.8
Nuclear	237.7	245.3	215.3	187.5	0.0	0.8	1.2
Renewable energy forms	96.1	137.2	161.1	184.9	3.4	6.5	9.1
Total	**1651**	**1838**	**1988**	**2104**	**3.0**	**5.2**	**7.4**
EU-15	**1453**	**1627**	**1747**	**1850**	**3.2**	**5.4**	**7.6**
NMS	**198**	**211**	**241**	**254**	**1.4**	**3.8**	**5.8**

Source: PRIMES.

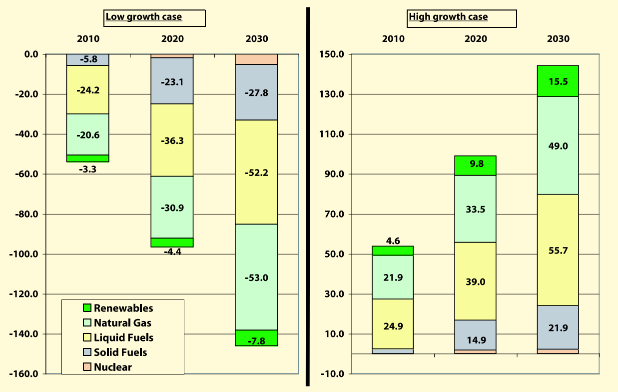
rates well above average (-4.1% and -3.7% from Baseline levels in 2010 respectively) in the short term. In the long run the strongest decline from Baseline levels occurs for solid fuels (-9.3% in 2030), while liquids and natural gas (-7.7% and -8.4% respectively in 2030) are also projected to decline at rates above average. On the other hand, primary energy needs for renewable energy forms experience a limited decline over the projection period (-2.5% in 2010, -4.6% in 2030). Their market share in the EU-25 energy system increases slightly compared to Baseline levels (7.5% in 2010 compared to 7.4% under Baseline assumptions, 8.2% with low economic growth in 2020 compared to 8.0% in Baseline and 8.9% in 2030 compared to 8.6%). Finally, the use of nuclear energy is projected to decline a little from Baseline levels only in the long run.

In absolute terms it is mainly demand for natural gas and liquid fuels that exhibit a strong decline from Baseline levels in the "low growth" case (see Figure 3-5). In 2030 these two energy forms account for more than 72% of the decline in primary energy needs (83% in 2010). In the long run, driven by a slowdown in penetration in electricity generation, the reduction in solid fuel use is also quite large (-28 Mtoe in 2030); whereas the decline in primary energy from renewable energy forms amounts to -7.8 Mtoe by 2030.

In the "high growth" case the highest demand growth from Baseline levels among fossil fuels in the long run is projected for liquid fuels (+8.3% in 2030), followed closely by natural gas (+7.8% in 2030). It is interesting to note that in the short term it is the demand for natural gas that exhibits the most pronounced growth above Baseline levels (+4.3% from Baseline levels in 2010 compared to +3.8% for liquid fuels). In contrast the role of solid fuels in satisfying additional energy requirements becomes increasingly important in the long run (reaching +7.3% above Baseline levels in 2030 compared to just +1% in 2010).

Higher economic growth allows for a more pronounced penetration of renewable energy forms in the EU-25 energy system, with primary energy needs for renewables rising at rates above average over the projection period (+3.4% in 2010 from Baseline levels, +9.1% in 2030). Thus, the market share of renewables in primary energy needs of the EU-25 energy system reaches 7.5% in 2010 and 8.8% in 2030 (+0.1 and +0.2 percentage points respectively from Baseline levels). Finally, in view of the prevailing policies for the use of nuclear energy (discussed in detail in Chapter 1), growth in use of

Figure 3-5: Changes in primary energy demand by fuel in the EU-25 under different economic development assumptions (diff. from Baseline in Mtoe)



Source: PRIMES.

Table 3-2: Import dependency in EU-25 under different economic development assumptions (comparison to Baseline)

Low growth case	%				percentage points difference from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid fuels	30.1	35.9	48.5	63.7	-1.0	-1.4	-2.1
Liquid fuels	76.6	80.7	85.3	87.4	-0.6	-0.7	-0.8
Natural gas	49.5	60.0	74.1	79.9	-1.2	-1.2	-1.4
Total	**47.2**	**52.0**	**60.7**	**65.7**	**-1.1**	**-1.2**	**-1.6**
EU-15	**49**	**53**	**62**	**66**	**-1.1**	**-1.2**	**-1.6**
NMS	**31**	**43**	**54**	**62**	**-0.7**	**-0.6**	**-1.2**
High growth case	**%**				**percentage points difference from baseline**		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid fuels	30.1	37.6	52.7	67.1	0.7	2.8	1.3
Liquid fuels	76.6	81.8	86.6	89.0	0.5	0.6	0.7
Natural gas	49.5	62.4	76.4	82.5	1.2	1.1	1.1
Total	**47.2**	**54.1**	**63.1**	**68.5**	**1.0**	**1.2**	**1.2**
EU-15	**49**	**55**	**64**	**69**	**1.0**	**1.2**	**1.1**
NMS	**31**	**45**	**56**	**65**	**0.7**	**1.5**	**1.3**

Source: PRIMES.

nuclear energy remains rather limited over the projection period, up only +1.2% from Baseline levels in 2030.

Natural gas and liquid fuels play a predominant role in satisfying the incremental energy requirements arising from higher economic growth assumptions. In 2010 they account for 87% of incremental demand in the EU-25 energy system, declining to some 70% in 2030, as solid fuels further penetrate (in comparison to Baseline) in the power generation sector (+21.9 Mtoe in 2030). Moreover, additional primary energy demand encourages an increase in the contribution from renewable energy sources (+15.5 Mtoe in 2030).

Oil and gas demand are heavily affected by changes in economic growth, with an important additional call on these sources with high economic growth (rather symmetrically to the "low growth" case). Renewables, on the other hand, fare somewhat differently. While low economic growth does not inhibit their expansion as much as it slows down the rise of overall energy demand, high economic growth allows for a fast increase of renewables - higher than that of all other energy sources in the longer term (2020 and 2030). Nuclear, by nature of the heavy investments involved and because of government policies, reacts only to a limited extent to different economic growth assumptions and experiences the smallest change compared with the Baseline in both the low and high economic growth cases.

The changes in primary energy requirements in the two cases examined also affect the evolution of import dependency for the EU-25 energy system. Overall import dependency in the "low growth" case is projected to rise at a slower pace compared to Baseline (-1.1 percentage points in 2010 compared to Baseline, -1.2 in 2020, -1.6 in 2030 – see Table 3-2). In contrast import dependency of the EU-25 energy system under high economic growth assumptions is projected to exceed Baseline levels (+1.0 percentage point in 2010, and +1.2 in both 2020 and 2030).

3.2.1. Impacts on the demand side

Lower economic growth is projected to lead to a decline of final energy demand by -3.2% from Baseline levels in 2010, by -5.3% in 2020 and -7.5% in 2030 (see Table 3-3). The greatest fall is projected in the transport sector (-8.7% from Baseline levels in 2030), as a result of slower growth in transport activity both for passenger and freight transport.

Freight transport activity declines by -10.1% in 2030 from Baseline levels, whereas the corresponding decline of GDP reaches -10.7%. One result of the low economic growth case is a small delay in the pace of de-coupling of freight transport activity from GDP compared to the Baseline scenario. Energy requirements for freight transport are projected to decline in 2030 by -10.9% from Baseline levels, as the deceleration in road freight transport activity growth (which is a particularly energy-intensive mode of freight transport) is significantly higher than that for rail and inland navigation. Passenger transport activity is also projected to decline because of lower income per capita, but at a significantly lower pace (-4.0% in 2030 from Baseline levels compared to a decline of -11.2% for private income). However, in aviation (in which activity growth occurs both for leisure and business purposes) the impact is significantly higher with the decline in activity reaching -17.5% from Baseline levels in 2030. This result leads to a decline of energy requirements for passenger transport (-6.9% in 2030 from Baseline levels), at a rate significantly higher than that of transport activity. The relatively higher decline of activity for transport modes that involve the use of more carbon-intensive fuels (such as diesel oil in freight transport

Table 3-3: Final Energy Demand and CO_2 emissions by Sector in the EU-25 under "low growth" case assumptions

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Industry	309.1	329.2	350.9	363.8	-2.8	-4.5	-6.4
Tertiary	154.2	168.3	184.1	202.1	-3.4	-5.3	-7.3
Households	279.1	299.1	312.0	313.7	-3.1	-5.2	-7.4
Transports	332.0	373.4	401.4	409.5	-3.6	-6.0	-8.7
Total	**1074**	**1170**	**1248**	**1289**	**-3.2**	**-5.3**	**-7.5**
EU-15	**955**	**1040**	**1099**	**1129**	**-3.4**	**-5.7**	**-8.1**
NMS	**119**	**130**	**150**	**160**	**-1.6**	**-2.3**	**-3.3**
	Mt CO_2 emissions				***% change from baseline***		
	2000	2010	2020	2030	2010	2020	2030
Industry	605.7	529.6	520.7	515.8	-2.7	-4.6	-6.6
Tertiary	236.7	233.4	230.2	239.4	-2.6	-4.5	-6.0
Households	462.6	468.7	472.7	458.4	-2.7	-4.5	-5.9
Transports	967.5	1069.8	1138.1	1145.0	-3.7	-6.2	-9.0
Total	**2272**	**2302**	**2362**	**2359**	**-3.1**	**-5.3**	**-7.6**
EU-15	**2024**	**2047**	**2086**	**2077**	**-3.3**	**-5.7**	**-8.1**
NMS	**249**	**255**	**276**	**282**	**-1.4**	**-2.3**	**-3.1**

Source: PRIMES.

and kerosene in passenger transport) compared to Baseline is reflected in the projected trend of CO_2 emissions in the sector which decline at rates slightly above those of energy demand.

The projected decline of energy requirements in the tertiary and household sectors follows a similar pattern over the projection period reaching -7.3% and -7.4% respectively from Baseline levels by 2030. The slower adoption of high comfort standards by consumers and the lower growth of floor space in the services sector are the key drivers for this result. Lower economic growth impacts significantly on the different energy uses. Energy requirements for air conditioning decrease by -8.7% from Baseline levels in 2030 in the tertiary sector, and by -7.5% in households. Energy use by electric appliances and lighting (-8.3% in the tertiary sector, -14.5% in households) exhibits even stronger decline. The more pronounced fall in electricity related energy uses is also reflected in the projected evolution of CO_2 emissions in these sectors, which decline by -6.0% and -5.9% respectively from Baseline levels, implying some deterioration of carbon intensity compared to Baseline.

Finally, energy demand in industry is projected to fall by -6.4% from Baseline levels in 2030, as the decline of economic activity in energy-intensive industrial sectors is less pronounced compared to non-energy intensive ones, but also because of the slower pace of renewal of existing equipment and adoption of improved technologies. As a result, overall intensity gains in industry are limited to 34.7% in 2000-2030 compared to 37.1% under Baseline assumptions. On the other hand, changes in the fuel mix towards the use of less carbon-intensive energy forms are slightly higher compared to the Baseline. Consequently the projected reduction in CO_2 emissions for the industrial sector is slightly higher than that of energy requirements.

In the **high growth** case final energy demand in the EU is projected to grow at rates slightly above those of primary energy needs (see Table 3-4). As in the "low growth" case, the transport sector is the most responsive (in the opposite direction however) to the introduction of high economic growth assumptions.

Higher economic growth leads to a significant increase of freight transport activity, which exhibits, nevertheless, a slightly more pronounced de-coupling from GDP compared to the Baseline scenario (freight transport activity increases by 9.7% in 2030 from Baseline levels with the corresponding increase of GDP reaching 10.7%, i.e. freight transport intensity is slightly lower than in the Baseline). Passenger transport activity increases because of higher income per capita, but at a significantly lower pace (+3.5% in 2030 from Baseline levels compared to an increase of +9.7% for private income) exhibiting a continuation of saturation trends already observed in the Baseline scenario. However, as the bulk of the increase in passenger transport activity is projected to occur in aviation (both for leisure and business purposes) energy demand in passenger transport grows much faster (+6.4% in 2030 from Baseline levels) than passenger transport activity.

The shift towards more carbon-intensive fuels (such as diesel oil in freight transport and kerosene in passenger transport) and the absence of additional incentives, on top of Baseline, for the further penetration of biofuels as a blended ingredient of gasoline and diesel oil lead to an increase of CO_2 emissions in transport at rates slightly above those of energy requirements.

Energy demand in the industrial, tertiary and household sectors responds in a rather similar way to higher economic growth – but the impact is lower than for transport. In industry, the high exploita-

Table 3-4: Final Energy Demand and CO_2 emissions by Sector in the EU-25 under "high growth" case assumptions

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	309.1	350.4	387.0	416.2	3.4	5.3	7.1
Tertiary	154.2	180.1	204.6	233.1	3.3	5.3	6.9
Households	279.1	318.0	346.4	363.1	3.0	5.2	7.2
Transports	332.0	400.7	451.8	485.7	3.5	5.8	8.2
Total	**1074**	**1249**	**1390**	**1498**	**3.3**	**5.5**	**7.5**
EU-15	**955**	**1115**	**1230**	**1323**	**3.5**	**5.6**	**7.7**
NMS	**119**	**135**	**159**	**175**	**1.7**	**4.1**	**5.9**
	Mt CO_2 emissions				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	605.7	561.5	572.9	588.7	3.1	5.0	6.7
Tertiary	236.7	245.9	250.4	266.4	2.7	4.0	4.5
Households	462.6	494.5	515.6	513.4	2.7	4.1	5.4
Transports	967.5	1150.3	1285.1	1364.3	3.6	6.0	8.5
Total	**2272**	**2452**	**2624**	**2733**	**3.2**	**5.2**	**7.1**
EU-15	**2024**	**2190**	**2332**	**2427**	**3.4**	**5.4**	**7.4**
NMS	**249**	**262**	**292**	**306**	**1.4**	**3.6**	**5.0**

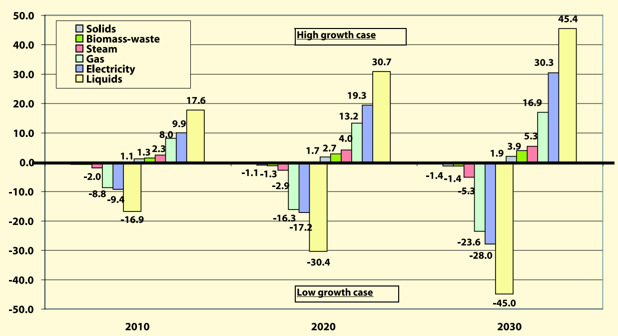
Source: PRIMES.

tion of potential structural changes within each industrial sector, as well as changes in the fuel mix, under Baseline assumptions, do not allow for significant additional gains in terms of energy intensity in the high economic growth scenario. Demand growth in the household sector (+7.2% above the Baseline in 2030) is rather pronounced due to rapid growth of demand for air conditioning (+7.0 % in 2030) and electric appliances (+16.3%). This gives rise to an overall growth of electricity demand in the sector by +12.1% above Baseline levels in 2030. The further electrification anticipated for both the household and tertiary sectors under high economic growth assumptions is the main reason for the less pronounced growth of CO_2 emissions over the projection period.

The changes in the fuel mix occurring in the low and high growth cases are illustrated in Figure 3-6. In the "low growth" case the decline in the use of liquid fuels (-8.1% from Baseline levels in 2030) is driven by reduced energy requirements in the transport sector (-39.1 Mtoe in 2030 compared to Baseline). Electricity demand declines by -8.4% from Baseline by 2030 as a result of the slower pace of electrification in households and services. Finally natural gas demand declines by some 24 Mtoe (or -6.9%) from Baseline levels in 2030, but still increases its market share on the demand side. Solids, co-generated steam and biomass/waste, as well as other renewable energy forms and new fuels (hydrogen etc.), also have higher market shares in final demand in the "low growth" case than in the Baseline.

In the "high growth" case additional energy requirements on the demand side are mainly satisfied by three energy forms, namely, liquid fuels, electricity and natural gas, whereas the contribution of other fuels is rather limited. The growth of liquid fuels demand (+8.2% in 2030 from Baseline levels) is driven by increasing transport energy requirements (+37 Mtoe in 2030 compared to Baseline). Electricity demand increases by 9.1% above the Baseline by 2030 as a result of the accelerated penetration of appliances and air conditioning in households and services. Finally demand for gas, though increasing by some 17 Mtoe from Baseline levels in 2030, increases at rates well below that of final demand (+4.9% from Baseline levels in 2030 compared to +7.5% for total final energy demand). Thus, while the market shares of liquid fuels and electricity on the demand side are projected to increase under high economic growth assumptions, that of natural gas declines, a result that reflects the increasing difficulties that this energy form will face in further penetrating the EU-25 demand side. This stems from the significant changes that already occur in the fuel mix towards the use of natural gas under Baseline assumptions, and the prevailing limitations both in terms of infrastructure and as regards the potential for even higher use of natural gas.

Figure 3-6: Changes in final energy demand by fuel in the EU-25 under different economic development assumptions (diff. from Baseline in Mtoe)



Source: PRIMES.

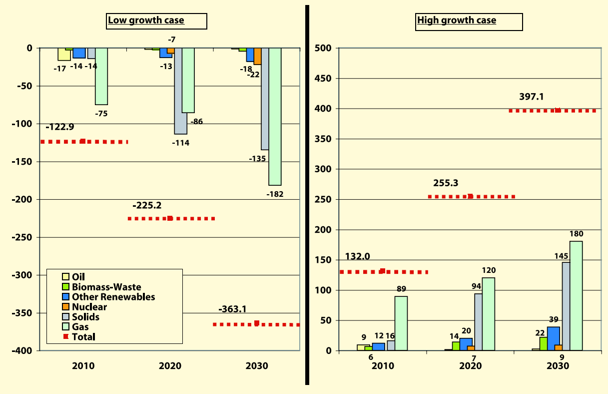
3.2.2. Impacts on electricity and steam generation

The trends for electricity demand follow contrasting directions in the low and high growth cases. This is because the different assumptions for the future evolution of the EU-25 economy largely affect the pace of electrification of the demand side, especially in the tertiary and household sectors.

In the low economic growth case electricity demand exhibits a strong decline from Baseline levels, which in turn is projected to lead to significant changes in the evolution of the power generation sector. Electricity generation declines by some 123 TWh (-3.6%) compared to Baseline levels in 2010, 225 TWh (-5.7%) in 2020 and 363 TWh (-8.3%) in 2030 (see Figure 3-7). In the short run the reduction in electricity generation mainly occurs at the expense of natural gas (accounting for 61% of the corresponding reduction of electricity generation). From 2020 onwards, the impact on electricity generation from solid fuels, which under Baseline assumptions exhibit a strong comeback in the long run, becomes equally important. In 2030, the reduction in electricity generation from solid fuels accounts for some 37% of the overall reduction; while the corresponding contribution of the decline in use of natural gas reaches 50%. The impact of low economic growth on the contribution of other energy forms in electricity generation remains rather limited over the projection period with nuclear and renewable energy forms gaining some additional market share compared to Baseline levels. The share of renewable energy forms (including waste) in total electricity generation in 2010 increases by only 0.15 percentage points from Baseline levels in 2010 to reach 17.7%. The increase becomes more pronounced in the long run with the renewable share in 2030 reaching 19.3% compared to 18.2% in the Baseline scenario. Furthermore, in the "low growth" case the share of cogeneration in electricity production is higher than in the Baseline. In 2030 some 16.9% (14.6% in 2010) of total electricity is generated in cogeneration power plants (compared to 16.3% and 14.4% respectively in the Baseline).

On the other hand, higher economic growth is projected to lead to an increase of electricity demand in the EU-25 energy system. Consequently electricity generation is projected to increase by some 132 TWh (+3.9%) compared to Baseline levels in 2010, 255 TWh (+6.5%) in 2020, and by 397 TWh (+9.0%) in 2030. In the short run some 68% of additional electricity generation is satisfied by natural gas, the rest being met mainly by renewable energy forms and solid fuels. However, in the long run while natural gas remains the main energy form through which additional electricity production is satisfied (accounting for 45% of incremental electricity generation in 2030), the contribution of solid fuels also increases (a 37% share in 2030 of incremental electricity generation). Electricity generation from both these energy forms grows at rates above average in the long run (+11.1% in 2030 from Baseline levels for natural gas, +12.4% for solid fuels) thus increasing the market shares of natural gas and solid fuels in total electricity generation. In contrast, the market share of renewable energy sources (including waste) becomes smaller compared with the Baseline. Renewable energy forms witness significant growth (+61 TWh in 2030 compared to the Baseline scenario) mainly driven by the further exploitation of biomass and waste (+24.8% from Baseline levels in 2030). The incremental use of biomass and waste mainly occurs in electricity cogeneration power plants (supercritical polyvalent units); this leads to a near stabilisation of the market share of co-generated electricity at Baseline levels. However, in 2030 the share of renewables amounts to 17.9%, some 0.3% percentage points below Baseline levels (17.4% and -0.1 percentage point from Baseline levels in 2010) due to rather limited further growth of hydro and intermittent renewables (+5.4% from Baseline levels in 2030).

Figure 3-7: Changes in electricity generation by energy form in EU-25 under different economic development assumptions (diff. from Baseline in TWh)



Source: PRIMES.

Total installed generating capacity in the low economic growth case is projected to be some 25 GW lower than Baseline levels in 2010, 50 GW in 2020 and 83 GW in 2030 (see Table 3-5). Gas turbine combined cycle plants and, to a lesser extent, supercritical polyvalent units are the capacity types most strongly affected by low economic growth, as incremental capacity requirements of the EU-25 energy system decline compared to Baseline levels. Thus, slower economic growth reduces the rate of penetration of gas turbine combined cycle units in the power generation sector and, to some extent, delays the come-back of coal fired power plants in the long run. It should be recalled here that the significant inroads that supercritical polyvalent units make in the long run under Baseline assumptions strongly relates to their cost effectiveness in filling the gap caused by nuclear decommissioning, a gap which is much smaller in the "low growth" case. Wind turbine capacity exhibits only a limited decline from Baseline levels throughout the projection period (-2.5 GW of installed capacity in 2030).

As in the case of low economic growth, gas turbine combined cycle plants and supercritical polyvalent units are the plant types most affected by higher economic growth assumptions as they are found to be cost-effective options in satisfying additional capacity requirements of the EU-25 energy system. Driven by the higher electricity and steam requirements on the demand side in the "high growth" case, total installed capacity is projected to be 28 GW higher than Baseline levels in 2010, 59 GW in 2020 and 97 GW in 2030. Additional investment above Baseline capacity expansion in gas turbine combined cycle units and supercritical polyvalent units account for 45% and 28% respectively of incremental generating capacity in 2030. However, in 2010 it is mainly natural gas combined cycle power plants that meet the additional capacity requirements and they account for more than 70% of such additional installed capacity. Wind capacity is also projected to increase above Baseline levels

Table 3-5: Installed capacity by plant type in the EU-25 under different economic growth assumptions

Low growth case	**GW installed**				***change from baseline (in GW)***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	108.2	105.8	0.0	0.2	-2.0
Hydro	96.2	104.3	108.8	110.7	-0.3	-0.5	-1.4
Wind	12.8	68.2	99.9	132.4	-4.5	-3.6	-2.5
Other renewables	0.2	0.5	0.6	12.6	0.0	0.0	-1.6
Conventional thermal	335.6	266.2	168.2	139.1	-4.4	-7.1	-8.3
Advanced coal	0.0	0.6	1.5	7.0	0.0	-0.5	0.5
Supercritical polyvalent	0.0	0.0	49.2	120.3	-0.4	-15.5	-23.1
Gas turbines CC	47.4	156.3	299.1	341.1	-13.2	-19.7	-43.5
Small gas turbines	22.8	31.8	59.5	64.5	-2.2	-3.8	-1.2
Geothermal	1.0	1.2	1.2	1.2	0.0	-0.1	-0.2
Total	**656**	**759**	**896**	**1035**	**-25.0**	**-50.5**	**-83.4**
EU-15	**579**	**665**	**766**	**874**	**-23.5**	**-46.6**	**-77.0**
NMS	**78**	**94**	**130**	**161**	**-1.5**	**-3.9**	**-6.3**
of which CHP	***103***	***128***	***162***	***188***	***-1.2***	***-6.4***	***-10.9***
EU-15	***77***	***102***	***124***	***137***	***-0.7***	***-5.9***	***-9.7***
NMS	***26***	***27***	***38***	***51***	***-0.5***	***-0.5***	***-1.2***
High growth case	**GW installed**				***change from baseline (in GW)***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	108.0	108.0	0.0	0.0	0.2
Hydro	96.2	105.3	110.5	113.2	0.7	1.3	1.0
Wind	12.8	76.5	108.2	143.8	3.8	4.7	8.8
Other renewables	0.2	0.5	0.6	15.0	0.0	0.0	0.7
Conventional thermal	335.6	271.0	179.0	156.0	0.4	3.7	8.6
Advanced coal	0.0	0.5	2.3	7.9	0.0	0.3	1.3
Supercritical polyvalent	0.0	2.6	82.5	170.2	2.1	17.8	26.8
Gas turbines CC	47.4	189.5	346.6	427.9	19.9	27.8	43.3
Small gas turbines	22.8	35.0	66.3	70.4	1.1	3.0	4.7
Geothermal	1.0	1.2	1.3	1.4	0.0	0.0	0.0
Total	**656**	**812**	**1005**	**1215**	**28.0**	**58.7**	**97.1**
EU-15	**579**	**715**	**865**	**1036**	**26.0**	**52.1**	**85.2**
NMS	**78**	**97**	**141**	**179**	**1.9**	**6.6**	**11.9**
of which CHP	***103***	***134***	***177***	***218***	***4.1***	***9.1***	***19.5***
EU-15	***77***	***106***	***137***	***163***	***3.8***	***7.5***	***16.8***
NMS	***26***	***28***	***40***	***55***	***0.3***	***1.5***	***2.7***

Source: PRIMES.

over the projection period (from +3.8 GW in 2010, and up to +8.8 GW in 2030). However, capacity expansion for wind turbines is somewhat restrained because of the high exploitation of cost-effective options already assumed under Baseline conditions.

Fuel input trends in electricity and steam generation for the two cases examined are illustrated in Table 3-6. In the "low growth" case, natural gas and solid fuels consumption experience a pronounced decline from Baseline levels. CO_2 emissions from electricity and steam generation are -4.4% below Baseline levels in 2010, -8.3% in 2020 and -10.2% in 2030. This decrease is significantly higher than that of electricity and steam demand because carbon-intensive energy forms are projected to lose market share under low economic growth assumptions. Consequently the carbon intensity of the power and steam generation sectors improves compared to the Baseline.

The opposite trend is projected in the "high growth" case, reflecting the increasing share of fossil fuels in power generation. In percentage terms the most pronounced growth as regards fuel input in the power generation sector occur in oil products (+26.3% from Baseline levels in 2030) followed by biomass and waste (+21.8% and +13.7% respectively in 2030). However, these energy forms account for only a rather small fraction of total fuel use in this sector. In absolute terms, it is mainly solid fuels and natural gas which satisfy the additional fuel input requirements (39% and 36% respectively in 2030). The role of natural gas is even more pronounced in the short term (in 2010 it accounts for more than 50% of incremental fuel input in the sector). This shift towards carbon-intensive energy forms, and higher electricity and steam demand, leads to an increase of CO2 emissions by 3.9% from Baseline levels in 2010. The corresponding increase in 2020 is 7.4% whereas that in 2030 reaches 9.8%.

Table 3-6: Fuel input in electricity and steam generation in the EU-25 under different economic growth assumptions

Low growth case	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solids	217.4	172.3	171.2	218.6	-2.6	-11.1	-10.5
Oil products	52.4	30.6	22.7	19.4	-11.0	-2.8	-1.5
Gas	131.7	192.9	249.5	243.6	-5.6	-5.6	-10.8
Biomass	12.7	18.3	20.8	22.6	-2.3	-2.1	-5.5
Waste	19.3	25.0	27.0	25.9	-1.7	-0.8	-2.3
Nuclear energy	237.7	245.2	211.6	180.0	0.0	-0.9	-2.9
Geothermal heat	3.0	3.4	3.4	3.4	0.0	-5.6	-12.5
Total	**674**	**688**	**706**	**714**	**-2.9**	**-5.3**	**-8.1**
EU15	**581**	**591**	**600**	**609**	**-3.2**	**-5.9**	**-8.9**
NMS	**93**	**97**	**106**	**105**	**-1.6**	**-1.8**	**-3.5**
Mt CO_2 emitted	***1355***	***1244***	***1344***	***1504***	***-4.4***	***-8.3***	***-10.2***
EU-15	***1068***	***959***	***1039***	***1178***	***-5.2***	***-10.1***	***-11.9***
NMS	***287***	***285***	***304***	***327***	***-1.6***	***-1.7***	***-3.6***
High growth case	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solids	217.4	180.5	209.2	268.9	2.0	8.6	10.1
Oil products	52.4	38.2	26.8	24.9	11.4	14.5	26.3
Gas	131.7	215.1	279.0	296.2	5.2	5.6	8.5
Biomass	12.7	20.2	25.5	29.2	8.1	19.8	21.8
Waste	19.3	26.5	29.0	30.1	3.9	6.5	13.7
Nuclear energy	237.7	245.3	215.3	187.5	0.0	0.8	1.2
Geothermal heat	3.0	3.5	3.7	4.0	2.5	2.4	2.4
Total	**674**	**729**	**788**	**841**	**2.9**	**5.7**	**8.2**
EU-15	**581**	**629**	**676**	**725**	**3.2**	**6.0**	**8.5**
NMS	**93**	**100**	**113**	**116**	**1.3**	**4.0**	**6.6**
Mt CO2 emitted	***1355***	***1351***	***1574***	***1840***	***3.9***	***7.4***	***9.8***
EU-15	***1068***	***1058***	***1253***	***1483***	***4.7***	***8.3***	***10.9***
NMS	***287***	***293***	***321***	***357***	***1.0***	***3.8***	***5.4***

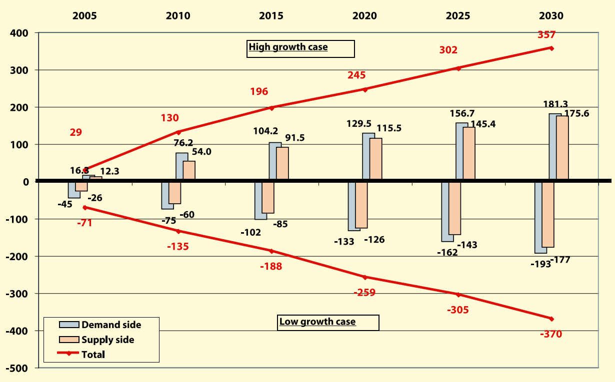
Source: PRIMES.

3.2.3. Impacts on CO_2 emissions

The impact of lower and higher economic growth assumptions on the projected evolution of CO_2 emissions for the EU-25 energy system is illustrated in Figure 3-8. Slower growth of energy requirements in the first case, both on the demand and supply sides, leads to lower CO_2 emissions compared to the Baseline. The demand side exhibits a stronger decline of CO_2 emissions over the projection period, whereas the contribution of the supply side becomes increasingly important in the long run. In 2010, under low economic growth conditions, CO_2 emissions in the EU-25 energy system are projected to decrease by -3.9% from 1990 levels (compared to a near stabilisation under Baseline assumptions). The impact of "low growth" assumptions is even greater in the long run with CO_2 emissions increasing in 2030 by only +4.4% from 1990 levels, compared to +14.2% in the Baseline scenario.

In contrast, the "high growth" case, driven by higher energy requirements both on the demand and supply sides and the worsening of carbon intensity of the EU-25 energy system, leads to significant growth of CO_2 emissions compared to Baseline levels. CO_2 emissions are projected to rise by +3.1% from 1990 levels in 2010 and +23.2% in 2030. As in the "low growth" case, the demand side accounts for the bulk of the change in CO_2 emissions over the projection period, while the contribution of the supply side becomes increasingly important in the long run.

Figure 3-8: Changes in CO_2 emissions in EU-25 under different economic growth assumptions (diff. from Baseline in Mt CO_2)



Source: PRIMES.

3.2.4. Concluding remarks

The two cases examined reflect the significant implications that different economic development pathways could have for the future evolution of the EU-25 energy system.

The **low growth case** reflects a continuation of recent trends as regards the observed economic slowdown in the European Union, incorporating the DG-ECFIN projections of autumn 2003 for the short-term horizon to 2005. Energy requirements in the EU-25 energy system decline by -7.5% from Baseline levels in 2030 compared to a decline of GDP of -10.7%, implying more gradual improvement in energy intensity - both because of slower adoption of more efficient equipment by consumers but also as a result of a less marked dematerialisation of the EU-25 economy. On the other hand CO_2 emissions are projected to decrease -8.6% from Baseline levels in 2030. Thus, with lower economic growth, the carbon intensity of the EU-25 energy system is lower than in the Baseline scenario.

This is because lower growth of total energy demand allows for a higher share of zero carbon fuels (renewables and nuclear) while there is less additional use of fossil fuels. The share of renewable energy forms in the low economic growth case is projected to reach 8.9% in 2030 compared to 8.6% under Baseline assumptions. The use of nuclear energy falls only a little from Baseline levels, giving rise to a somewhat higher nuclear share than in the Baseline. On the other hand, demand for fossil fuels falls faster over the projection period. The decline in liquid fuel use relates to the projected evolution of transport activity, which is strongly affected by lower economic growth. On the other hand, the lower use of solid fuels and natural gas is mainly caused by trends in the power generation sector - a combined effect of the lower electricity demand growth and the limited decline in the use of renewable energy forms and nuclear energy. The slower growth of fossil fuels demand is also reflected in overall import dependency, which is projected to reach 65.7% in 2030 (-1.6 percentage points lower than in the Baseline).

The high growth case simulates the energy, transport and emission consequences of achieving GDP growth rates that are in line with the Lisbon target and also represent a particularly successful enlargement in economic terms. With EU-25 GDP 10.7% above the Baseline level in 2030, energy demand exceeds the Baseline by 7.4%. Therefore the high growth case results in an additional improvement of energy intensity over and above the significant rates in the Baseline. However, in the high growth case CO_2 emissions rise faster than energy consumption exceeding the Baseline level in 2030 by 8.3%. This deterioration of carbon intensity compared with Baseline is due to strong growth of electricity demand, while the potential for nuclear is limited (e.g. phase-out decisions in certain Member states) and this high growth would not itself encourage much additional renewables deployment. The bulk of the additional electricity is produced with natural gas and solid fuels. Transport energy demand would also rise somewhat faster than overall energy demand with only small scope for replacing carbon-intensive oil by other less carbon-intensive fuels. The share of renewables would be slightly higher than in the Baseline. The increasing demand for energy would be met predominantly by oil and gas (overwhelmingly from third countries). Import dependency would therefore be even higher than in the Baseline – reaching as much as 68.5% in 2030.

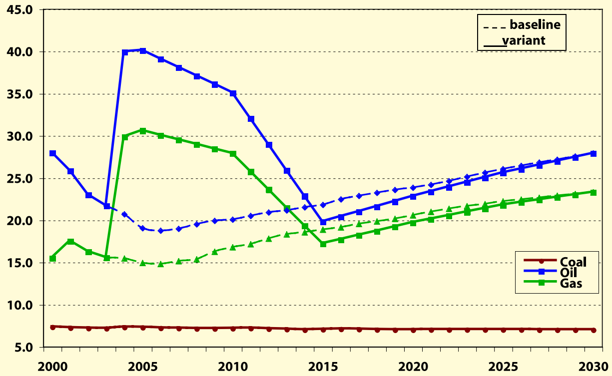
3.3. Scenario on high oil and gas prices in the medium term

3.3.1. Description of the scenario

This scenario examines the impact of a sharp increase of oil and gas prices in the short and medium term on the EU-25 energy system ("Sharp price increase" case). In order to simulate the economic, energy and emission consequences, it was assumed that oil prices increase sharply in 2004/05 to reach levels of 40$ per boe. The natural gas price is assumed to follow closely that for oil, whilst the hard coal price is unchanged from Baseline levels. Furthermore, this increase in oil and gas prices is assumed to be rather prolonged so that oil and gas prices return to levels close to those of the Baseline scenario only in 2014/15 (see Figure 3-9).

This analysis also addresses the impact of such an international fuel price development on the EU-25 economy,[46] and on the EU-25 energy system. The higher international fuel prices affect production costs both directly (i.e. producers facing increased input fuel prices) and indirectly (i.e. other inputs becoming more expensive as they, in turn, are also affected by higher prices). The higher prices also make consumers spend more on energy, given that at least in the short term energy demand is rather price insensitive, and consequently demand for other commodities is expected to fall. As a result EU-25

Figure 3-9: International fuel prices assumptions in the "Sharp price increase" case (comparison to Baseline)

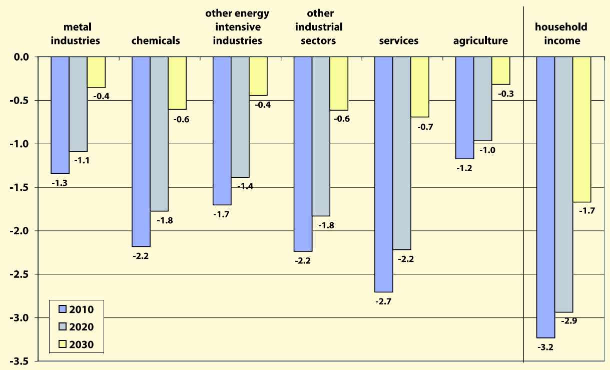


Source: PRIMES.

GDP is projected to be lower than Baseline levels. The impact is more pronounced in the short to medium term, with an almost 3% loss of GDP from Baseline levels in 2010 for the EU-25 on account of oil prices that exceed the Baseline levels by close to 100% in large parts of this decade. Average GDP growth in the current decade would amount to 2.2% pa, which is closer to the "low growth" case (2.0%

46 The GEM-E3 model has been used for this purpose.

Figure 3-10: Change of value added by sector in EU-25 in the "Sharp price increase" case (% difference from Baseline levels)



Source: PRIMES. GEM-E3.

pa) than to the Baseline (+2.5% pa). As oil and gas prices fall below Baseline levels in 2015 and beyond (because of adjustments in oil and gas demand), the EU-25 economy is expected to grow at an accelerated pace for some years, which limits the loss of GDP induced by the high medium-term energy import prices to just -0.8% below Baseline levels in 2030.

Despite the fact that energy-intensive industries face much higher fuel costs than the rest of the economy the projected impact on value added is less pronounced compared to other sectors of the EU-25 economy (see Figure 3-10). This is mainly due to the fact that other production factors in these sectors are not heavily affected. Furthermore, under Baseline scenario assumptions, these sectors are projected to grow at a much lower pace compared to non-energy intensive industries and services. In that sense there is limited scope for further shrinking of these sectors in the EU-25 economy, taking into account the rather inelastic demand for their products. The strongest economic impact is projected to be on service sector's value added.[47] Moreover, the real income of households is strongly affected (directly and indirectly) given inflationary pressure from oil price hikes.

3.3.2. Scenario results for EU-25[48]

Slower economic growth, changes in the fuel mix and energy intensity gains are the key drivers for the decrease of primary energy needs over the projection period, despite the fact that by 2015 international oil and gas prices drop to levels below those in the Baseline scenario. More specifically primary energy demand is projected to be 3.4% lower (or -60 Mtoe) compared to Baseline levels in 2010, 2.3% lower (or -44 Mtoe) in 2020 and 1.3% lower (or -26 Mtoe) in 2030 (see Table 3-7).

The most important changes in the primary energy balance in the short term are the increase in the use of solids (rising by around 8.5% in 2010) and renewable energy forms (+16.6% in 2010); and the decline in gas and liquid fuels (-12.3% and -6.3% respectively). In 2010 the share of renewables increases by 1.6 percentage points from Baseline levels to reach 9.0% of primary energy needs, driven by the higher use of biomass and, to a lesser extent, of wind energy. Beyond 2010, renewable energy sources are projected further to gain market share in the EU-25 energy system. By 2030, they are the only energy forms for which primary energy demand remains at levels well above those of Baseline (+10.5%) with a share of 9.7% in total primary energy demand (1.1 percentage points above Baseline levels). Renewables also exceed Baseline levels in the long term, when oil and gas import prices would be lower than in the Baseline, due to the previous heavy investment in renewables plant and equipment during the price hike period (e.g. around 2010). In contrast, and despite the fall in international oil and gas prices, demand

Table 3-7: Primary Energy Demand and CO_2 emissions in the EU-25 energy system under "Sharp price increase" case assumptions

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	264.4	235.1	291.7	8.5	-6.9	-2.8
Liquid Fuels	635.6	612.6	647.1	652.9	-6.3	-3.6	-3.2
Natural Gas	376.0	444.7	585.7	613.9	-12.3	-2.0	-2.3
Nuclear	237.7	245.2	212.6	185.2	0.0	-0.4	0.0
Renewable energy forms	96.1	154.7	162.6	187.3	16.6	7.5	10.5
Total	**1651**	**1724**	**1845**	**1933**	**-3.4**	**-2.3**	**-1.3**
EU-15	**1453**	**1524**	**1620**	**1698**	**-3.3**	**-2.2**	**-1.2**
NMS	**198**	**200**	**225**	**235**	**-4.0**	**-2.8**	**-2.1**
Mt CO_2 emitted	***3665***	***3577***	***3875***	***4175***	***-4.8***	***-4.1***	***-3.0***
EU-15	***3118***	***3041***	***3296***	***3556***	***-5.1***	***-4.3***	***-3.1***
NMS	***547***	***536***	***579***	***620***	***-3.0***	***-3.0***	***-2.4***

Source: PRIMES.

47 The detailed macroeconomic outlook and demographic assumptions of the scenario for high oil and gas prices in the medium term for EU-25, EU-15, NMS and Europe-30 and for individual countries can be found in the enclosed CD.

48 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to the Baseline) are available in the enclosed CD.

for solids, liquids and natural gas remains below Baseline in the horizon to 2030, as a result of both lower economic growth and additional energy intensity gains.

The lower primary energy requirements, combined with the higher contribution of renewable energy forms, more than counterbalance the higher use of solid fuels in the short term leading to a significant reduction of CO_2 emissions (-4.8% from Baseline levels in 2010). As international fuel prices fall below Baseline levels and economic growth in the EU-25 follows an accelerated pace compared to the Baseline scenario, the impact on CO_2 emissions becomes less pronounced. However, even in 2030 CO_2 emissions are projected to remain -3.0% below Baseline levels.

In addition to the above, the "Sharp price increase" case leads to a significantly lower import dependency for the EU-25 energy system in comparison to the Baseline scenario. In 2010 import dependency is projected at 48.2% (4.9 percentage points below Baseline levels). In 2030, import dependency reaches 65.9% (compared to 67.3% in the Baseline scenario) reflecting a higher contribution of indigenous energy sources (overwhelmingly renewables) against the background of some decrease of total energy consumption in comparison with Baseline developments.

CHAPTER 4: Mainstream policy lines: energy efficiency and renewables

4.1. Definition of alternative scenarios

The following alternative scenarios have been guided by the "Action Plan to Improve Energy Efficiency in the European Community",[49] presented by the European Commission in the year 2000, as far as the follow-up activities could be modelled. These alternative cases also include substantial policies on renewables with a view to achieving the 12% renewables target set for 2010. The modelling takes into account adopted and proposed legislation, such as the Directive on the promotion of renewables in the internal electricity market[50], the Directive on biofuels and the building Directive. It simulates the possible outcome of strengthened policies at both Community and Member State levels to achieve greater energy efficiency and a higher share of renewables. These scenarios do not address policies that might be pursued to achieve more ambitious renewables targets than 12% in the period beyond 2010. Most of the modelling was undertaken in 2002 and early 2003.

On the other hand, the scenarios do not aim at modelling the expected outcome of the already adopted or proposed measures, as this would require more in depth analysis including a thorough investigation of the degree of implementation in the Member States. The purpose of these alternative cases is to illustrate a possible EU energy development, where energy efficiency and renewables play a more important role (e.g. achievement of the 12% renewables objective in 2010) than under Baseline conditions. The Baseline only reflects current trends and the implementation of policies up to the end of 2001 (and, for tax rates, to mid 2002). In the case of renewables, the implementation of the renewables electricity Directive of September 2001 in the Member States is not included in the Baseline.

Energy efficiency and renewables have become mainstream policy lines over the last few years following the Green Paper on energy security. [51] The Green Paper recognised that - to enhance energy security and contribute to sustainable development in the EU - there exists wider scope for action on the demand side, i.e. energy efficiency, compared with supply side action. Enhanced penetration of renewables will contribute both to better energy security and reduced CO_2 emissions and therefore help to meet the EU's international obligations.

For this study, three different cases have been examined:

- The "Energy efficiency" case investigates the effects of actions along the lines of the EC Action Plan for Energy Efficiency in the EU-15 energy system, focusing on those key actions that can be modelled. This Action Plan outlines policies and measures for the removal of existing barriers to, and the realisation of the existing potential for, investment in energy efficiency. The approach includes the Building Directive[52] as well as action on cogeneration and energy services. Useful energy (energy services such as heat, light, cooling, motion, communication) is supplied in a more efficient way following consumer choices based on perceived costs that take into account more fully the advantages of higher energy efficiency. The "Energy efficiency" case assumes that consumers obtain a better understanding of the benefits of adopting more efficient technologies, which in turn leads to faster deployment of improved and advanced technologies compared to the Baseline. Moreover, energy related equipment has somewhat better efficiency characteristics (compared with Baseline) brought about by e.g. efficiency standards that force the least efficient energy consuming items out of the market. Consumers with a better understanding of technology costs will consequently alter their choices compared to the Baseline. Improvements in terms of building construction lead to significant gains in thermal integrity and reduced energy requirements. In addition to such improvements on the demand side, the "Energy efficiency" case also incorporates improvements on the supply side. The use of cogenerated steam and electricity is encouraged, resulting in higher shares of CHP in electricity and steam generation following the Directive on the promotion of cogeneration. Other than more cogeneration, the supply side also shifts towards more efficient equipment in the long run driven by faster technological progress. This leads to higher efficiency and lower equipment costs compared with the Baseline. The "Energy efficiency" case also assumes better energy intensity

49 European Commission, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee, and the committee of the regions: Action plan to improve energy efficiency in the European Community, COM (2000) 247 final. Brussels, 26 April 2000. Also at: http://europa.eu.int/eur-lex/en/com/cnc/2000/com2000_0247en01.pdf

50 Directive 2001/77/EC of 27 September 2001 on the Promotion of electricity produced from renewable energy source in the internal electricity market.

51 Green Paper of the European Commission "Towards a European strategy for the security of energy supply", COM (2000) 769 final of 29 November 2000.

52 European Commission Directive 2002/91/EC of the European Parliament and of the Council on the energy performance of buildings. Brussels, 16 September 2002. Also at: http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_001/l_00120030104en00650071.pdf

compared to Baseline for candidate countries and direct neighbours (Norway and Switzerland).

- The "12% renewables in 2010" case assumes that additional incentives are provided both to energy consumers and energy producers so that the global indicative target of a 12% contribution from renewable energy sources to gross national energy consumption by 2010, referred to in the renewables electricity Directive,[53] is reached. Further penetration of renewable energy forms on the demand side is achieved through promotional policies for the use of biomass and waste in industry and the use of solar thermal panels for water heating purposes in services and households. This case also assumes the implementation of the biofuels Directive, adopted in May 2003 that sets indicative shares for biofuels in petrol and diesel for transportation purposes of 2% in 2005 and almost 6% in 2010.[54] On the supply side, targets by Member State, as defined in the EC renewables electricity Directive, are achieved through support schemes that provide subsidies for electricity generation from renewable energy forms. However, these payments on account of higher costs due to more renewables deployment are passed on to the consumers through increased electricity prices (i.e. the electricity tariffs, paid by all electricity consumers, increase to reflect the higher costs of greater renewables deployment).
- The "Energy efficiency and 12% renewables in 2010" case, which combines the assumptions of the two cases discussed above, explores their aggregate effect on the evolution of the EU-25 energy system and allows for an in depth analysis of their possible synergies as well as any trade-offs.

In the remainder of this chapter the impacts of the "Energy efficiency and 12% renewables in 2010" case on the future evolution of the EU-25 energy system are discussed in detail. A briefer discussion of the impacts of the "Energy efficiency" and the "12% renewables share in 2010" cases is also provided.

4.1.1. EC policies towards energy efficiency

In 2000 the European Commission presented the Action Plan to Improve Energy Efficiency in the European Community.[55] This communication stressed the need for a renewed commitment to promote energy efficiency more actively. This was especially true when seen in the light of the Kyoto Protocol, as improved energy efficiency will play a key role in reducing CO_2 emissions and thus meeting the EU's Kyoto target economically. In addition to significant environmental benefits, greater energy efficiency will lead to a more sustainable energy policy and enhanced security of supply, as well as to many other benefits.

In 2000 the cost-effective potential for energy efficiency improvement was estimated to be more than 18% of EU energy consumption. Exploitation of this potential was constrained by market barriers which prevented the satisfactory diffusion of energy-efficient technology and the efficient use of energy. This potential was equivalent to over 160 Mtoe, or 1900 TWh, roughly the total final energy demand of Austria, Belgium, Denmark, Finland, Greece and the Netherlands combined.

Better energy efficiency is hampered by a large number of barriers to investment. These barriers include energy prices that still do not accurately reflect environmental externalities. There is lack of sufficient information on the use of cost-effective and energy-efficient technology. There are also numerous institutional and legal barriers. One example is the continued practice of selling energy in the form of kWh instead of as energy services (e.g. efficient heating and cooling, lighting and motive power) which is what the energy consumer ultimately wants. There are also many different technical barriers to energy efficiency, including the lack of harmonised and standardised components. Another important technical barrier is the lack of appropriate 'active' distribution and transmission infrastructures, to permit effective integration of greater volumes of small-scale, local generation. Financial barriers also exist including the short paybacks required for many demand-side investments compared with those for energy production.

The Commission's Action Plan outlined policies and measures for the removal of these barriers and the realisation of this significant energy efficiency potential. Three groups of mechanisms for improving energy efficiency were identified:

- Measures to enhance the integration of energy efficiency into other Community non-energy policy and programme areas, such as regional and urban policy, taxation and tariff policy, etc.
  - Transport policy is a priority area for energy efficiency as transport, especially road transport, absorbs over 30% of total final energy consumption. Policy priorities of a non-technological nature include incentives for optimal occupancy of vehicles, modal shifts and modal integration, completion of the internal market in rail transport, and changing behaviour regarding mobility.
  - As energy efficiency is a key factor for the competitiveness of many industrial sectors, it forms an important part of the overall action plan on sustainable development. The development of self-regulation arrangements (e.g. voluntary agreements) will play a key part in this process.
  - Regional and urban policy and programmes, such as the Regional Development and Cohesion Funds, give priority to the

53 European Commission Directive 2001/77/EC of the European Parliament and of the Council on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market. Brussels, 27 September 2001. Also at: http://europa.eu.int/eur-lex/pri/en/oj/dat/2001/l_283/l_28320011027en00330040.pdf

54 European Commission Directive 2003/30/EC of the European Parliament and of the Council on the promotion of the use of biofuels or other renewable fuels for transport. Brussels, 8 May 2003. Also at: http://europa.eu.int/comm/energy/res/legislation/doc/biofuels/en_final.pdf

55 Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, COM (2000) 247 final of 26 April 2000.

promotion of energy-efficient equipment in SMEs, households and public buildings as well as to investment by industry in energy-efficient and innovative technologies, such as Combined Heat and Power (CHP). These can therefore be more closely coupled with, for example, voluntary agreements, energy audits, labelling, and best practice initiatives in Member States.

- Taxation and tariff policies are important instruments for promoting energy efficiency. The recently adopted Directive concerning the broadening of the minimum tax base for energy products is an example. Carefully designed tariff structures for energy supply and distribution can also improve efficient end use and will therefore be promoted.
- International co-operation and pre-accession activities are critical elements in promoting energy efficiency in and outside the EU. Harmonised efficiency standards for internationally traded goods and services are a good example. Implementation of the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects would be a significant step forward.
- Member State policies and measures form the bedrock of energy efficiency in the EU. Member State objectives and targets in the area of energy efficiency and cogeneration need to be monitored and analysed. A Community framework on energy end use efficiency and energy services needs to be established.

• Further action to re-focus and reinforce existing Community energy efficiency measures.

- Transport efficiency: the EU has adopted a strategy on CO_2 and cars, which aims to reduce by one third the average CO_2 emissions of new cars by 2005/2010 compared to the 1995 baseline, using voluntary agreements. The present agreements with the European, Japanese and Korean car industries follow this route. Other measures include further action on vehicle fuel economy, more cost-reflective pricing, and increased competitiveness of alternative transport fuels.
- Energy efficiency labelling of appliances and negotiated agreements with manufacturers: the established effort to increase the flow of accurate and objective consumer information will be strengthened and extended to cover all major energy-using appliances and equipment. For office equipment the Commission has presented a Regulation to implement the Energy Star labelling scheme, following the conclusion of an agreement with the USA..
- Through the use of benchmarking, Long-term Agreements in industry have led to the increased use of more efficient motors, compressors, pumps, fans and other equipment, as well as to efficient processes. Agreements in industry will be strengthened and their use expanded to include the chemical, steel, pulp and paper, cement and textile industries, and the energy supply industry, following preparatory activities.
- The Community-wide target of raising the use of combined heat and power (CHP) to 18% of EU electricity production by 2010, as outlined in the Communication on CHP, has been supported through the recently adopted Cogeneration Directive. Measures will address the technical barriers and costs associated with connection to the grid.
- *Provision of energy services* (e.g. warm houses, lighting, transport, refrigeration) instead of purely energy quantities (such as kWh or litres of petrol) is instrumental for better energy efficiency, as professional energy service providers can exploit efficiency potentials better than individual household consumers. A Community framework on energy end use efficiency and energy services needs to be established. A proposed Directive[56] in this field has been put forward by the Commission. The proposal provides a framework to promote the market both for energy services and for energy efficiency measures in general in major energy end-use sectors. The proposal also includes a savings target at Member State level as a means of measuring energy efficiency improvements and stimulating greater market demand for energy services. The Commission will also continue to promote demand-side management through pilot projects and dissemination activities with a view to providing a comparison of demand-side and supply-side options on an equal economic basis.
- *Buildings* are particularly important for improving energy efficiency. The plans on strengthening the legal framework for energy efficiency in the building sector have now led to the adoption of the building Directive.[57] This Directive promotes energy efficiency in the building sector through measures on thermal insulation, energy certification of buildings and regular inspection of boilers and air conditioning systems. In addition, measures to achieve efficient installed systems include best practice information, labelling and its extension into local information schemes, and the incorporation of energy efficiency into public procurement. Encouraging building companies to use integrated environmental management systems such as EMAS supports this approach.
- A set of horizontal measures reinforces energy efficiency policies. This include: research and technology policy to develop new energy-efficient technologies on the demand side (domestic and tertiary, industry, transport), but also for utilities; establishment of energy management agencies at the local and regional levels; third-party financing; training and increased dissemination of information; and increased monitoring and evaluation.

• New common and co-ordinated policies and measures.

- The use of co-ordinated public procurement guidelines, regulations and agreements by public sector entities is an effective way to promote the diffusion and demonstration of energy efficient technology in close collaboration with the Community environmental management and audit scheme (EMAS), and the Community eco-label award scheme.

56 Proposal for a Directive of the European Parliament and of the Council on energy end-use efficiency and energy services, COM (2003) 739 final of 10 December 2003.

57 Directive 2002/91/EC of the European Parliament and the Council on the energy performance of buildings of 16 December 2002; Official Journal of the European Communities L1/65 of 4 January 2003.

- Technology procurement is an instrument used to specify and develop new energy-efficient technology. It is used to match producers' possibilities and consumers' needs (and aggregated demand), and to allow the market to function more efficiently with regard to the often-neglected dimension of energy efficiency.
- A European Energy Efficiency Best Practice Initiative is capable of providing a framework for decision-makers and end-users for a comprehensive source of independent and accessible energy efficiency advice, guidance and training on new technology and techniques. These will add substantially to the information necessary for more effective functioning of both the energy and energy technology markets.
- Energy audits in industry and the tertiary sector are an important means to identify companies' potential for improving energy efficiency and to help disseminate best practice by proposing concrete measures for improvement. Energy audits have been included in the proposed Directive on energy end-use efficiency and energy services.

4.1.2. EC policies promoting renewable energy forms

In November 1997 the European Commission adopted the Communication "Energy for the Future: Renewable Sources of Energy", a White Paper for a Community Strategy and Action Plan. The purpose of this White Paper is to contribute, by promoting renewable energy sources, to the achievement of overall energy policy objectives: security of supply, environment and competitiveness, and to improve and reinforce environment protection and sustainable development. To reach these goals the White Paper proposes to double the contribution of renewable energy sources (RES) to the European Union's gross inland energy consumption, establishing an indicative Community objective of 12% by 2010. The European Parliament in its Resolution on the White Paper welcomed the White Paper and Action Plan, considering the objective of 12 % by 2010 as a minimum. The Parliament also called on the Commission to introduce legislative proposals on electricity and also on the agriculture/biomass and building sectors.

The White Paper identified a number of priority actions in the regulatory sectors aimed at overcoming obstacles and redressing the balance in favour of renewable energy, to reach the indicative objective of 12% penetration by 2010. Key areas for promoting renewables include electricity from renewables, biofuels in transport, economic and fiscal measures, integration of renewables in buildings, and standardisation.

The Directive on the promotion of electricity from renewable energy sources in the internal electricity market[58] established in 2001 the Community framework for electricity from renewable energy sources. The objective is to support a significant medium-term increase of electricity from renewable energy, or "green electricity", in the EU and to facilitate its access to the internal electricity market. The Directive aims to create regulatory certainty for stakeholders, while at the same time respecting the principle of subsidiarity by providing for a wide degree of autonomy to each Member State to allow for their particular circumstances. Member States are obliged to establish national targets for the future consumption of green electricity. These national targets should lead to a 22% indicative share of electricity produced from renewable energy sources in total Community (EU-15) electricity consumption by 2010. A 22% share of electricity from renewables will contribute substantially towards the global indicative target of 12% renewables in gross national energy consumption by 2010. For the enlarged Union, the 22% target for electricity from renewables has been adjusted to 21%. The Directive establishes a basis for the promotion of renewables in the internal electricity market and tackles a number of technical issues, which are fundamental to the further development of green electricity. It thus obliges Member States:

- to introduce accurate and reliable certification of green electricity,
- to assure priority access for green electricity to the electricity grid,
- to check how administrative procedures applicable to the installation of generation plants for green electricity could be streamlined and simplified, and
- to ensure that the calculation of costs for connecting new producers of green electricity to the electricity grid is transparent and non-discriminatory.

Environmental taxes and charges can be an appropriate way of implementing the "polluter pays" principle by including environmental costs in the price of goods and services and, by this means, internalising external costs. The White Paper on renewables emphasised that the environmental benefits of renewable energy justify favourable financing conditions, e.g. through tax exemptions or reductions on products from RES. Many Member States have in recent times introduced environmentally motivated taxes on energy, or are seriously discussing the issue. These national tax schemes provide in most cases for a favourable treatment of renewable energy. The recently adopted Directive on minimum taxation rates for energy products allows support for renewables via favourable tax treatment, while extending the Community framework for excise taxes from mineral oils to all energy products. Production of liquid biofuels for transportation is being developed in the Member States. Efforts aimed at fostering biofuels include more stable production of biomass for energy purposes in the agricultural sector, greater use of liquid biofuels in fixed engines and the promotion of blended transportation fuels.

The production of heat and electricity from biogas by a controlled anaerobic digestion process, using biodegradable residues and wastes, is another route for biomass deployment. Overall, the increased use of waste for energy purposes helps to save fossil fuels. Similarly, growing more energy crops and strengthening other more traditional ways of biomass use contribute to increased utilisation of renewable energy sources.

Integrating renewables in improved building design fosters renewables deployment and energy efficiency at the same time, which is recognised in the building Directive. Heating, cooling and lighting

58 Directive 2001/77/EC of 27 September 2001 on the promotion of the electricity produced from renewable energy sources in the internal electricity market.

constitute the lion's share of energy demand in the building sector. Active and passive use of solar technologies can contribute significantly to satisfying these energy needs. Appropriate legislation is being introduced in Member States, e.g. through local regulations, both promoting the use of renewable energy sources and introducing energy efficiency measures.

There is a close link between energy efficiency and the use of renewable energy sources in buildings. In fact some advanced building projects have demonstrated commercial and residential buildings in cities that do not require any external conventional source of energy (e.g. electricity, gas or liquid fuels) if best available technologies in energy efficiency and RES are combined.

Community wide standardisation is important to facilitate the commercialisation and market penetration of RES. Therefore the Commission has taken initiatives on standards for solar thermal, solar PV, wind equipment and biomass.

Since the publication of the White Paper, important policy developments have underlined the key role of renewable energy in ensuring sustainable energy supplies for the Community, reinforcing social and economic cohesion, developing European industry and contributing to job creation. The ratification of the Kyoto Protocol and the process of integrating the environment into energy policy will both underpin a greater role of renewables and international co-operation in this field. A renewable energy contribution to sustainability is broadly endorsed at the international level.

Community policies on renewables have resulted in the adoption of the Directives on the promotion of electricity produced from renewable energy sources and on the promotion of biofuels. A higher renewables share is also supported by all those measures that reduce energy consumption through higher energy efficiency such as the Directive on the energy performance of buildings, the Directive on the promotion of cogeneration, and other measures on energy efficiency including product labelling. New proposals on energy efficiency have been made such as the proposed Directive on end use energy efficiency and energy services. The recently adopted "Intelligent Energy for Europe Programme" (2003-2006) provides assistance for the better deployment of renewables and energy efficiency in the Community including in the transport sector and extends to developing countries, too. This programme also covers renewables use outside of the electricity and transport sectors, for which no Directive so far exists.

Renewables market penetration is, on average, growing within the EU-15 but it is not yet sufficient. The available statistics show the undeniable take-off of wind energy. They also highlight that expansion rates, higher than the EU average, have been achieved in those Member States with proactive renewable energy policies. In addition, the deployment of RES in communities (regions, islands and cities) is directly related to the presence of proactive local policies. However, at this stage, it is far from certain that the White Paper's indicative target of a 12% RES contribution to EU gross inland energy consumption will be achieved by 2010. Though progress has been made, considerable further efforts will be necessary to achieve this objective.

The biomass sector represents the largest potential in RES. Therefore, specific attention needs to be given to biomass, and the framework conditions should be further improved. For instance, production of energy crops could be encouraged more vigorously, and energy taxation adapted to favour biofuels.

Solar energy also offers a big potential for further increasing renewables' deployment through solar thermal use, especially for water heating, in the short/medium term and solar photovoltaics in the longer term.

Therefore the "12% renewables in 2010" scenario analysed in this chapter includes not only the implementation of the electricity and the biofuels Directives, but it also assumes a significant biomass/waste contribution in industry and considerable penetration of solar water heating in the household and tertiary sectors. This scenario shows a successful medium-term renewables policy leading to the achievement of the 12% renewables share in 2010 without, however, addressing new and additional renewables policies to be adopted in later years.

4.2. "High levels of energy efficiency and renewables" scenario results for EU-25[59]

This scenario aims at simulating the energy and environment effects (in terms of CO_2 emissions) of successfully implementing strong policies for both energy efficiency and renewables as far as such measures can be modelled. The policies included relate to those recently adopted or currently under discussion. They do not include future initiatives that address a time horizon beyond 2010 as such policies have not yet been debated, and no concrete proposals have yet been put forward. Therefore, this scenario under no circumstances pre-empts the review of progress in the development of renewable energy sources, called for by the recently adopted Communication on the share of renewables,[60] the results of which are due in October 2005. Likewise, this scenario does not give any indication of the feasibility or appropriateness of further policy efforts to attain a 20% or so renewables share in 2020.

Nevertheless, combining policies along the lines of the Action Plan for Energy Efficiency and promotional policies for renewable energy forms with a view to achieving the 12% renewables share in 2010, leads to a significantly different evolution of the EU-25 energy system in comparison to the Baseline scenario. In 2010, primary energy needs

59 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to Baseline can be found in APPENDIX 4. Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD.

60 Communication from the Commission to the Council and the European Parliament on the share of renewables (COM (2004) 366 final) of 26 May 2004.

Table 4-1: Primary Energy Demand in EU-25 in the "Energy efficiency and 12% renewables share in 2010" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303.2	212.7	181.8	187.5	-12.7	-28.1	-37.5
Liquid Fuels	635.6	591.1	593.1	586.3	-9.6	-11.7	-13.1
Natural Gas	376.0	447.3	508.0	516.9	-11.8	-15.0	-17.7
Nuclear	237.7	222.3	185.1	148.4	-9.4	-13.3	-19.9
Renewable energy forms	96.1	204.0	227.5	242.9	53.8	50.4	43.3
Total	**1650.7**	**1679.5**	**1697.6**	**1684.3**	**-5.9**	**-10.1**	**-14.1**
EU-15	**1453**	**1487**	**1496**	**1490**	**-5.7**	**-9.7**	**-13.3**
NMS	**198**	**193**	**201**	**194**	**-7.4**	**-13.2**	**-19.3**
Mt CO2 emitted	***3665***	***3309***	***3319***	***3336***	***-11.9***	***-17.9***	***-22.5***
EU-15	***3118***	***2827***	***2837***	***2869***	***-11.8***	***-17.6***	***-21.8***
NMS	***547***	***482***	***483***	***467***	***-12.6***	***-19.1***	***-26.4***

Source: PRIMES.

in the "Energy efficiency and 12% renewables in 2010" case are projected to be 5.9% below Baseline levels. This decrease is even more pronounced in the long run (-14.1% in 2030). Total energy consumption remains broadly constant between 2010 and 2030 (only +0.3% total increase over 20 years) leaving more limited space for new energy investments and for a rapid penetration of renewables in particular.

Energy intensity decreases at the same rates given that no changes in GDP have been assumed. Moreover, given that the sectoral production patterns also remain unchanged in both the "Energy efficiency and 12% renewables in 2010" case and the Baseline, these energy intensity gains can be attributed to energy efficiency measures. Energy intensity improves by 0.5 percentage points more per year than in the Baseline to reach 2.2% pa up to 2030. In addition, the promotion of renewables contributes to better energy intensity to some extent, because energy sources such as wind and hydro have a much higher efficiency than fossil fuels for electricity generation (due to EUROSTAT's energy balance conventions).

In absolute terms, improved energy efficiency and further penetration of renewable energy forms lead to a near stabilisation of primary energy needs in the EU-25 energy system over the projection period (+0.06% pa in 2000-2030 compared to +0.6% pa in the Baseline scenario). This is accompanied by significant changes in the fuel mix (see Table 4-1).

Lower energy needs, combined with promotional policies for RES, significantly reduce future energy requirements for fossil fuels. The biggest decline occurs for solid fuels (-37.5% from Baseline levels in 2030), while demand for natural gas is also projected to decline at rates above average over the projection period (-17.7% in 2030). The impact on the use of liquid fuels is less marked (-13.1% from Baseline levels in 2030), so that these fuels are projected to gain some additional market share above Baseline levels. The slowdown in electricity demand growth due to greater energy efficiency and the further penetration of renewable energy forms in the power generation sector lead to a significant fall in the use of nuclear energy, which is projected to be 20% below Baseline levels in 2030.

Promotional policies for RES in the "Energy efficiency and 12% renewables in 2010" case bring about a large increase in renewables' deployment in the EU-25 energy system. This increase is well above Baseline levels over the projection period (+53.8% in 2010 compared to Baseline, +43.3% in 2030) despite the overall decline of primary energy needs. In 2010 the share of renewable energy forms is projected to reach 12.1% of primary energy needs in the EU-25 energy system (+4.7 percentage points above Baseline levels). The renewables share rises to 14.4% in 2030 (compared to 8.6% in the Baseline scenario).

This result for the renewables share shows that policies promoting RES are not significantly affected by the pursuit of policies leading to further improvements of energy efficiency in the EU-25 energy system. Synergies can indeed be developed through e.g. cogeneration on the basis of biomass, which in this scenario plays an important role. Nevertheless, most of the renewables penetration occurs by 2010, while the further penetration of RES is more modest in later years. No additional renewables policies are assumed in this scenario addressing the period post 2010. Renewables policies are in a sense "frozen" at 2010 in this scenario. But, to maintain momentum in renewables penetration, further policies are required for the post 2010 period. In the absence of such additional policies, underlying technology and market developments alone leads to the renewables share growing only from 12.1% in 2010 to 14.4% in 2030.

The further exploitation of biomass potential in this policy case is the key driver for the projected increase in the use of renewable energy forms; biomass increases +104% from Baseline levels in 2010 and +70% in 2030. In comparison with Baseline developments, biomass accounts for 84% of all incremental demand for renewable energy use in 2010 and for 70% in 2030. Wind energy is also projected to grow significantly increasing above Baseline by +46.8% in 2010, and by +40.6% in 2030. Wind accounts for 13% of the additional renewable consumption above Baseline in 2010 and for 20% in 2030.

The combined effect of slower energy demand growth and changes in the fuel mix away of carbon intensive fuels and towards the use

Table 4-2: Import dependency in EU-25 in the "Energy efficiency and 12% renewables share in 2010" case

	%				percentage points difference from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid fuels	30.1	34.5	40.1	58.4	-2.4	-9.9	-7.4
Liquid fuels	76.6	79.8	84.5	86.8	-1.5	-1.5	-1.5
Natural gas	49.5	57.1	70.8	77.0	-4.1	-4.5	-4.3
Total	**47.2**	**48.7**	**56.1**	**61.5**	**-4.4**	**-5.8**	**-5.9**
EU-15	**49.4**	**49.6**	**57.2**	**62.2**	**-4.7**	**-5.7**	**-5.6**
NMS	**30.8**	**41.6**	**47.3**	**55.3**	**-2.4**	**-7.5**	**-8.3**

Source: PRIMES.

of carbon-free ones is clearly reflected in the projected trend in CO_2 emissions. Such emissions decrease significantly between 2000 and 2010, so that in 2010 CO_2 emissions are 12% below those in 1990. Furthermore, CO_2 emissions are projected to stabilise at that level in the period to 2030, considerably lower than under Baseline developments (-11.9% from Baseline levels in 2010 and -22.5% in 2030). Thus, in addition to pronounced energy intensity gains, the "Energy efficiency and 12% renewables in 2010" case is further characterised by significant carbon intensity gains in comparison to the Baseline scenario. This is especially so in the long run, as carbon intensity improves by 6.4% from Baseline levels in 2010 reaching up to 9.8% in 2030.

This combination of policies towards energy efficiency and promoting renewable energy reduces import dependency in 2010 as it leads to lower energy consumption combined with a higher contribution from indigenous energy sources. The EU-25's energy import dependency in the "Energy efficiency and 12% renewables in 2010" case stays below 50% until 2010 and increases to only just over 60% by 2030 (see Table 4-2). Over the projection period, import dependency would be 4 to 6 percentage points lower than in the Baseline. The largest decline in import dependency occurs for solid fuels (-7.4 percentage points below Baseline levels in 2030) followed by that of natural gas (-4.3 percentage points in 2030). In contrast the impact on import dependency for liquids is rather limited at around 1.5 percentage points from Baseline levels over the projection period.

4.2.1. Impacts on the demand side

Energy requirements on the demand side of the EU-25 energy system grow at a significantly slower pace compared to the Baseline scenario under the "Energy efficiency and 12% renewables share in 2010" case assumptions (-5.1% in 2010, -8.8% in 2020 and -10.9% in 2030). The biggest decline occurs in the tertiary sector, where energy consumption is 17% lower than in the Baselines in 2030 (see Table 4-3). Energy needs in the household and transport sectors are also projected to decline significantly from Baseline levels (-12.6% and -13.4% in 2030 respectively) whereas the impact of the policies considered in this case is rather limited in industry (-2.8% in 2010, -3.2% in 2030). The projected decline in CO_2 emissions from the demand side is even higher than that of energy needs (-13.0% from Baseline levels in 2030 for CO_2 emissions compared with -10.9% for energy consumption), implying additional carbon intensity gains compared to the Baseline.

The limited energy intensity gains in industrial sectors are partly explained by the fact that macro-economic assumptions remain unchanged from Baseline levels, i.e. no further changes towards less energy intensive activities is included in the assumptions for this policy case. In addition, EU-25 industry already experiences significant energy intensity gains under Baseline assumptions (13% in 2000-2010, 37% in 2000-2030). These gains arise through industrial restructuring but also by adoption of more efficient production techniques. Thus there is only limited scope for further improvements. A significantly bigger decline is projected for CO_2 emissions from EU-25 industry (-6.9% in 2010, -7.9% in 2030) as promotional policies for RES result in changes in the fuel mix towards the use of biomass and waste and away from carbon intensive energy forms.

The focus of efficiency policies towards improvements in buildings' thermal integrity and demand side management, but also the labelling of electric appliances, is reflected in the projected changes in tertiary and household sector demand. The structure of energy demand in services and households is quite similar because the bulk of energy consumption takes place in buildings (like office blocks, hospitals, schools, dwellings etc) and for the same purposes, namely heating, cooling, cooking, lighting and appliances.

The technologies determining energy efficiency in services and households are also largely the same. However, differences in terms of energy related equipment size, especially for heating and cooling purposes, results in significant differences as regards consumers' behaviour. The average size of this equipment for a government building or an office block is significantly larger than that for a dwelling. Consequently, technologies that benefit from economies of scale in energy use are much more likely to be adopted in the services sector than by households. In addition, decisions to invest in energy efficiency are taken by firms in the tertiary sector but by individual people (or house builders) in the household sector. Their perceptions of capital costs and opportunity costs of capital naturally differ, in a way that investment in efficiency is often more easily adopted by firms than by individuals.

The above factors explain the much higher response of the tertiary sector in comparison to households to the introduction of the policies examined here. Energy needs for heating purposes in 2030 decline by -13% from Baseline levels in the tertiary sector and by -8.7% in households. The decline is significantly higher for consump-

Table 4-3: Final Energy Demand and CO_2 emission by Sector in EU-25 in the "Energy efficiency and 12% renewables share in 2010" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Industry	309.1	329.5	351.4	376.2	-2.8	-4.3	-3.2
Tertiary	154.2	154.5	168.6	181.0	-11.4	-13.3	-17.0
Households	279.1	293.8	298.7	296.1	-4.8	-9.2	-12.6
Transports	332.0	369.4	382.6	388.6	-4.6	-10.4	-13.4
Total	**1074**	**1147**	**1201**	**1242**	**-5.1**	**-8.8**	**-10.9**
EU-15	**955**	**1023**	**1067**	**1101**	**-5.0**	**-8.4**	**-10.4**
NMS	**119**	**124**	**135**	**141**	**-6.0**	**-12.1**	**-14.8**
	Mt CO_2 emissions				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Industry	605.7	506.7	494.7	508.4	-6.9	-9.4	-7.9
Tertiary	236.7	207.6	211.6	224.1	-13.4	-12.2	-12.0
Households	462.6	444.2	438.7	432.3	-7.8	-11.4	-11.3
Transports	967.5	1005.3	1039.2	1054.9	-9.5	-14.3	-16.1
Total	**2272**	**2164**	**2184**	**2220**	**-8.9**	**-12.4**	**-13.0**
EU-15	**2024**	**1925**	**1942**	**1974**	**-9.1**	**-12.2**	**-12.7**
NMS	**249**	**239**	**242**	**246**	**-7.4**	**-14.1**	**-15.6**

Source: PRIMES.

tion by electric appliances (-40.9% in 2030 for the tertiary sector; -31.1% in households) reflecting the existence of large scope for further action towards more rational use and the benefits of appliance labelling. As a result electricity demand in both sectors exhibits the largest decline among all energy forms over the projection period. But electricity's lower market share in total energy needs leads to a worsening of carbon intensity both in the tertiary and the households sectors. This is despite the significant growth above Baseline levels in the use of solar energy (6.6 times higher in the tertiary sector and 3.4 times higher in households in 2010, 5.4 and 1.2 times higher, respectively, in 2030). Thus, the projected decline in CO_2 emissions in 2030 is limited to -12.0% below Baseline levels in the tertiary sector and -11.3% in households.

The availability of more efficient new vehicle technologies, combined with greater incentives to consumers that encourage better understanding of technology costs, are the key drivers for the decline in transport sector energy requirements (-4.6% in 2010, -13.4% in 2030). The fall in CO_2 emissions is even more pronounced (-9.5% in 2010, -16.1% in 2030). This is because the share of biofuels in gasoline and diesel increases well above Baseline levels as a result of the assumed full implementation of the biofuels Directive and the accompanying tax provisions. In this modelling exercise, the target of the biofuels Directive is even over-achieved by 2010. The share of biofuels in gasoline is projected to reach 7.9% in 2010 (compared to 2.1% under Baseline assumptions), further rising to 8.4% in 2030 (+3.3 percentage points above Baseline levels). The corresponding shares for biofuels in diesel oil are 8.1% in 2010 and 8.6% in 2030 (from 2.4% and 5.3% respectively under Baseline assumptions).

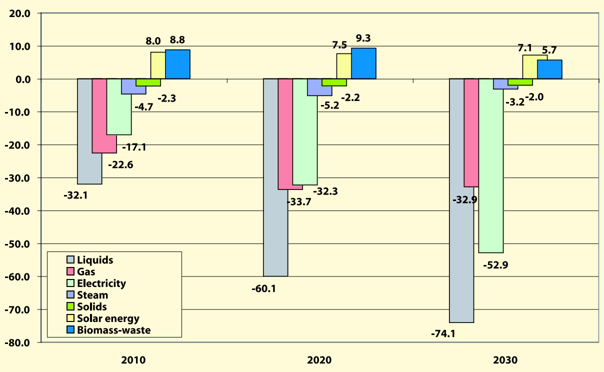
At the final energy demand level, oil decreases most in absolute terms. Changes in the transport sector are the key driver for this projected decline (see Figure 4-1), accounting for 56% of the overall reduction in final oil demand in 2010 and 81% in 2030. The fall in electricity use becomes increasingly important in the long run. Natural gas consumption is also significantly affected by strong policies on energy efficiency and renewables, but to a smaller extent than oil and electricity in the long run. The demand for co-generated steams remains close to Baseline levels. Thus its share in final energy demand side increases, consistent with the aim of promoting cogeneration.

Only renewables grow above Baseline levels in the combined "Energy efficiency and 12% renewables in 2010" case. Biomass and waste (mainly in industry) and solar energy (in tertiary and household sectors) increase both in absolute and percentage terms in comparison with Baseline (the contribution of wind, hydro and solar photovoltaics is included in electricity consumption and is dealt with below). However, this increase in biomass/waste and solar thermal use does not accelerate over time in this scenario given present knowledge of market potentials, some saturation effects (solar water heating) and, in particular, the focus of policy measures in this scenario on the time horizon to 2010 only.

4.2.2. Impacts on electricity and steam generation

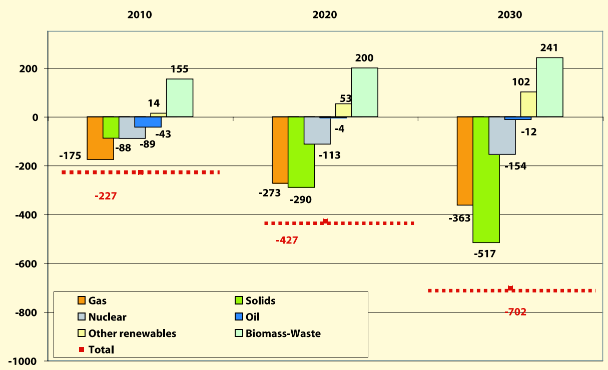
Policies towards energy efficiency and the promotion of RES cause significant changes for the electricity and steam generation sector. As a result of actions undertaken on the demand side, overall electricity production is projected to fall by 6.6% from Baseline levels in 2010 and 16% in 2030 (see Figure 4-2). Electricity generation from renewable energy forms grows significantly above Baseline levels. The overall share of renewables in power generation reaches 24.1% in 2010 and 30.9% in 2030 (+6.5 and +12.7 percentage points respectively above Baseline). It should be recalled here that this sce-

Figure 4-1: Changes in final energy demand by fuel in EU-25 (diff. from Baseline in Mtoe) in the "Energy efficiency and 12% renewables share in 2010" case



Source: PRIMES.

Figure 4-2: Changes in electricity generation by energy form in EU-25 (diff. from Baseline in TWh) in the "Energy efficiency and 12% renewables share in 2010" case



Source: PRIMES.

nario does not include additional legislation on renewables addressing the post-2010 period. Biomass and waste account for the bulk of the projected increase in electricity generation from renewable energy forms. They are largely used in cogeneration power plants with co-generated electricity increasing by +38% above Baseline levels in 2010 and +48.8% in 2030. Co-generated electricity accounts for 21.4% of total electricity generation in 2010 and 28.9% in 2030 (compared to 14.4% and 16.3% respectively in the Baseline scenario).

Declining electricity demand, combined with higher penetration of renewable energy forms in the EU-25 power generation, markedly reduce electricity generation from fossil fuels and nuclear. In the short term the decline, both in absolute and percentage terms, is more pronounced as regards electricity generation from natural gas (-16.3% from Baseline levels in 2010). Solid fuels and nuclear energy lose similar amounts of electricity generation in absolute terms (-12.6% and -9.3% from Baseline levels respectively). From 2020 onwards, electricity generation from solid fuels (which is projected to make a strong comeback in the power sector under Baseline assumptions) experiences the largest decline from Baseline levels (-34.9% in 2020, -43.9% in 2030). The decline in the use of natural gas is less pronounced (-17.8% in 2020, -22.4% in 2030). Nuclear energy is also affected (-10.8% in 2020, -16% in 2030) as investment in new nuclear power plants to replace those being decommissioned over this period becomes less pronounced compared to Baseline (see Table 4-4).

With overall installed capacity reaching levels well below those in the Baseline scenario (-3.4% in 2010, -12.1% in 2030), there is a considerable decline in fossil fuel and nuclear power generation capacity. The two power generation technologies most strongly affected are supercritical polyvalent units and gas turbine combined cycle plants. The installed capacity of supercritical polyvalent units falls to just 17.5 GW in 2030 with a share of 1.8% in total installed capacity, compared to 143.4 GW and 12.8% in the Baseline scenario. The fall in gas turbine combined cycle power plant capacity reaches -30.8% below Baseline levels in 2030. The decline in the use of gas in GTCC plants is partly counterbalanced by the emergence of fuel cell technology (using natural gas as input fuel and transforming it on site into hydrogen). Installed capacity of fuel cell electricity generation in the EU-25 is projected to reach 64.3 GW (or 6.5% of total installed capacity) in 2030. This is a result of the assumed faster technological progress, which leads to improvements in new equipment efficiency and lower costs compared with the Baseline. Such technological progress also drives the increase in the installed capacity of advanced coal power plants (+23.5 GW in 2030 above Baseline levels).

As regards installed capacity of renewable energy forms, the fastest growth above Baseline levels occurs for wind turbines with their capacity reaching 162.6 GW in 2030 or 16.5% of total installed capacity (from 134.9 GW and 12.1% respectively in the Baseline scenario). Another significant change in comparison to the Baseline scenario relates to the implementation of policies promoting cogeneration of electricity and steam in the EU-25 energy system under the "Energy efficiency and 12% renewables in 2010" case assumptions. Over the projection period, and despite the decline of overall installed capacity, cogeneration capacity increases (+25.7 GW in 2010 up to +71 GW in 2030) accounting for 20.5% of total capacity in 2010 and 27.4% in 2030 (16.5% and 17.8% respectively in the Baseline scenario).

The changes discussed above are also clearly reflected in the projected evolution of fuel inputs in the electricity and steam generation sector (see Table 4-5). The consumption of solid fuels in 2030 is just 55% of that in the Baseline scenario. The input of natural gas falls more than 30% below the Baseline level. On the other hand, the use of biomass is about three times higher than in the Baseline scenario (boosted by promotional policies for both renewables and cogeneration). The increase in the use of waste is less significant, ranging from +8.2% in 2010 to +20.2% in 2030 compared with Baseline. In addition to the reduction in fossil fuel use, strong policies on energy efficiency and renewables also lead to lower nuclear input to power generation mainly due to lower electricity demand.

The slower growth of electricity requirements, combined with the shift towards carbon free energy forms and the more efficient production of electricity and steam, leads to much lower CO_2 emissions from the power generation sector. CO_2 emissions from this sector decline over the projection period (-18.7% from Baseline levels in 2010 and -38.4% in 2030) with improvements in terms of carbon

Table 4-4: Installed capacity by plant type in EU-25 in the "Energy efficiency and 12% renewables share in 2010" case

	GW installed				change from baseline (in GW)		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	102.5	91.6	0.0	-5.5	-16.2
Hydro	96.2	108.3	114.7	118.1	3.7	5.4	6.0
Wind	12.8	74.5	120.9	162.6	1.8	17.4	27.7
Other renewables	0.2	0.5	1.9	16.6	0.0	1.3	2.4
Conventional thermal	335.6	276.9	177.7	158.3	6.3	2.3	11.0
Advanced coal	0.0	3.2	8.4	30.0	2.7	6.5	23.5
Supercritical polyvalent	0.0	0.0	9.7	17.5	-0.5	-55.0	-125.9
Gas turbines CC	47.4	136.6	277.5	266.0	-32.9	-41.3	-118.6
Small gas turbines	22.8	26.5	55.5	56.3	-7.5	-7.9	-9.5
Fuel cells	0.0	0.0	0.3	64.3	0.0	0.3	64.3
Geothermal	1.0	1.3	1.5	1.7	0.1	0.2	0.3
Total	**656**	**758**	**870**	**983**	**-26.3**	**-76.3**	**-135.0**
EU-15	**579**	**668**	**751**	**846**	**-20.7**	**-61.2**	**-104.8**
NMS	**78**	**90**	**119**	**137**	**-5.5**	**-15.1**	**-30.2**
of which CHP	***103***	***155***	***235***	***270***	***25.7***	***66.7***	***71.0***
EU-15	***77***	***123***	***190***	***217***	***20.6***	***60.4***	***71.1***
NMS	***26***	***32***	***44***	***52***	***5.1***	***6.3***	***-0.1***

Source: PRIMES.

Table 4-5: Fuel input in electricity and steam generation in EU-25 (including consumption in boilers) in the "Energy efficiency and 12% renewables share in 2010" case

	Mtoe				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solids	217.4	149.1	124.9	134.4	-15.7	-35.2	-44.9
Oil products	52.4	23.0	21.1	16.6	-33.0	-9.7	-16.1
Gas	131.7	162.5	200.2	187.4	-20.5	-24.2	-31.4
Biomass	12.7	55.1	64.6	66.7	194.6	204.0	178.2
Waste	19.3	27.6	30.7	31.8	8.2	12.7	20.2
Nuclear energy	237.7	222.3	185.1	148.4	-9.4	-13.3	-19.9
Geothermal heat	3.0	3.7	4.1	4.7	8.1	13.0	19.5
Total	**674**	**643**	**631**	**590**	**-9.2**	**-15.4**	**-24.0**
EU15	**581**	**555**	**541**	**513**	**-8.9**	**-15.2**	**-23.3**
NMS	**93**	**88**	**90**	**77**	**-10.9**	**-16.9**	**-28.9**
Mt CO_2 emitted	***1355***	***1058***	***1042***	***1032***	***-18.7***	***-28.9***	***-38.4***
EU-15	***1068***	***819***	***806***	***816***	***-19.0***	***-30.3***	***-39.0***
NMS	***287***	***240***	***236***	***216***	***-17.4***	***-23.8***	***-36.2***

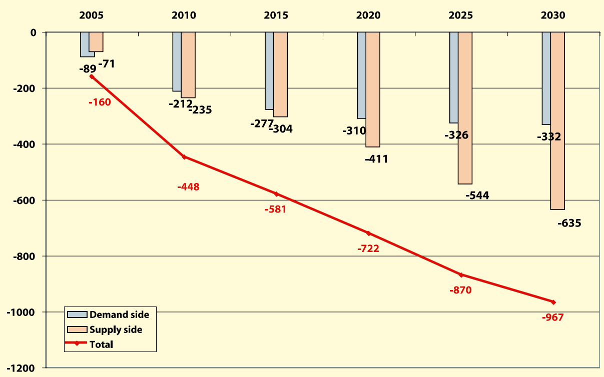
Source: PRIMES.

intensity (t of CO_2 emitted per MWh of electricity and steam) reaching 13.5% from Baseline levels in 2010 and 29.1% in 2030.

4.2.3. Impacts on CO_2 emissions

Supportive policies promoting energy efficiency and renewables (with a view to the 12% renewables target for 2010) have a very strong impact on the projected evolution of CO_2 emissions in the EU-25 energy system. In 2010, CO_2 emissions in EU-25 are projected to decline well below Baseline levels (-11.9%) but also those observed in 2000. Compared with the 1990 level, CO_2 emissions decline by 12.2%, which is well below the EU's target under its Kyoto commitment. Beyond 2010, CO_2 emissions are projected to grow only slightly from 2010 levels (+0.8% in 2010-2030) with the decline from Baseline levels becoming even more pronounced (-22.5% in 2030). Thus, even in 2030, CO_2 emissions in the EU-25 energy system are projected to remain well below 1990 levels (-11.5%) under the "Energy efficiency and 12% renewables in 2010" case assumptions. The distribution of CO_2 emissions reduction between the demand and the supply side (illustrated in Figure 4-3) is rather uniform in the short term, whereas in the long run the supply side becomes increasingly important accounting in 2030 for 66% of overall CO_2 emissions reductions. As already discussed, this result relates both to the further shift towards renewable energy forms in the power sector but also to the strong decline for electricity needs in the demand side arising from the improved efficiency characteristics and the more rational use of electric appliances under the "Energy efficiency and 12% renewables in 2010" case assumptions.

Figure 4-3: Changes in CO_2 emissions in EU-25 (diff. from Baseline in Mt CO_2) in the "Energy efficiency and 12% renewables share in 2010" case



Source: PRIMES.

4.2.4. Concluding remarks

The energy efficiency and 12% renewables share in 2010 case examines the effects of actions along the lines of the Action Plan for Energy Efficiency combined with policies to promote renewable energy forms in the EU-25 energy system with a view to achieve the 12% renewables target for 2010. In this case primary energy needs decline significantly from Baseline (more than -14% compared to the Baseline in 2030). This decline is also accompanied by significant changes in the fuel mix with a large increase in the use of the renewable energy forms (both in absolute and market share terms). Consequently the demand for all other energy forms declines (especially for solid fuels which falls -37.5% in 2030 compared to Baseline). The share of renewable energy forms rises to 12.1% in 2010 and 14.4% in 2030 (+4.7 and +5.8 percentage points respectively above Baseline levels). This result shows that policies promoting renewable energy forms are not affected by the simultaneous pursuit of policies to improve energy intensity in the EU-25 energy system. The responses to the policies examined are significant, both on the demand and supply sides, with changes in the latter becoming increasingly important over the projection period.

As regards CO_2 emissions, the impacts are very significant with such emissions from the EU-25 energy system falling well below those implied in the Kyoto targets for 2010 (-12.2% from 1990 levels). Even in 2030, CO_2 emissions are projected to decrease by -11.5% from 1990 levels (or -22.5% compared to Baseline). Import dependency is also reduced by supportive policies for energy efficiency and renewables. In 2010 import dependency is limited to 48.7% (compared to 53.1% in the Baseline), whereas in 2030 it is projected to be 61.5% (-5.9 percentage points below Baseline levels).

4.3. "Energy efficiency" scenario results for EU-25[61]

The "Energy efficiency" scenario examines the effects of policies along the lines of the Action Plan for Energy Efficiency. In this case, EU-25 primary energy needs decline by 5.6% in 2010, 10.0% in 2020 and 13.6% in 2030 from Baseline levels (see Table 4-6). Demand for all energy forms declines compared to Baseline. The biggest fall is projected for solid fuels, reaching -26.7% in 2030 compared to Baseline, followed by natural gas for which there is also an above average decline. As a result both these energy forms lose market share in primary energy needs. On the contrary, other energy forms gain market share (compared with Baseline) with the most significant increase in the long run occurring for renewable energy forms, the share of which reaches 9.1% in 2030.

The increasing market shares of renewables and nuclear energy lead to an improvement of carbon intensity in the EU-25 energy system above Baseline levels. CO_2 emissions decline at rates above those of primary energy needs (-16.4% from Baseline levels in 2030 compared with -13.6% for primary energy). Import dependency is projected to improve marginally compared to Baseline, ranging from -1.6 percentage points in 2010 to -2.1 percentage points in 2030.

Energy intensity gains from the demand side are quite significant though below those for primary energy needs with final energy demand declining by 5% in 2010 and 10.8% in 2030 from Baseline levels. As in the "Energy efficiency and 12% renewables in 2010" case the most pronounced decline is projected for the tertiary sector (-16.8% in 2030) followed by the household and transport sectors (-12.3% and -13.4% respectively from Baseline levels in 2030). Again industry exhibits only a limited response to the efficiency measures introduced with energy demand declining by -3% in 2030.

In terms of fuel consumption, liquid fuels experience the largest fall from Baseline levels in absolute terms (mainly caused by the decline of energy needs in the transport sector). In percentage terms the decline in electricity demand is the most pronounced (-14.9% from Baseline levels in 2030). However, in the absence of promotional policies for renewable energy forms, there is lower renewables use on the demand side. Combined with the lower market share of electricity this leads to a slight worsening of carbon intensity on the demand side in the long run in comparison to the Baseline scenario. Consequently the projected decline of CO_2 emissions from the demand side (-10.4% in 2030) is slightly below that of final energy demand.

In electricity and steam generation, the combination of lower electricity demand, higher exploitation of cogeneration options, and adoption of more efficient generation technologies in the long run, lead to significant changes compared to the Baseline scenario. Production from cogeneration units reaches 24.6% of electricity and 67.5% of steam generation by 2030 (16.4% and 64.5% respectively under Baseline scenario assumptions). Electricity generation from solid fuels falls greatest from Baseline levels (-26% in 2030) followed by that from natural gas (-13% in 2030).

On the other hand, generation from biomass and waste increases (+7.8% in 2030), as these fuels are used extensively in cogeneration power plants. On the contrary electricity generation from

61 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD.

Table 4-6: Evolution of primary energy needs and CO_2 emissions in the EU-25 under the "Energy efficiency" case assumptions

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	220.1	198.1	219.8	-9.7	-21.6	-26.7
Liquid Fuels	635.6	624.0	621.0	609.1	-4.5	-7.5	-9.7
Natural Gas	376.0	467.0	533.6	540.9	-7.9	-10.7	-13.9
Nuclear	237.7	245.1	205.3	165.9	-0.1	-3.8	-10.5
Renewable energy forms	96.1	126.0	140.6	155.5	-5.0	-7.1	-8.2
Total	**1650.7**	**1684.3**	**1700.8**	**1693.6**	**-5.6**	**-10.0**	**-13.6**
EU-15	**1453**	**1491**	**1500**	**1499**	**-5.4**	**-9.5**	**-12.8**
NMS	**198**	**193**	**201**	**194**	**-7.3**	**-13.3**	**-19.1**
Mt CO2 emitted	***3665***	***3487***	***3532***	***3598***	***-7.2***	***-12.6***	***-16.4***
EU-15	***3118***	***2982***	***3027***	***3106***	***-7.0***	***-12.1***	***-15.3***
NMS	***547***	***505***	***506***	***492***	***-8.5***	***-15.2***	***-22.5***

Source: PRIMES.

intermittent renewable energy sources declines from Baseline levels, but at rates well below those of total electricity production (-6.6% compared to -14.8% in 2030). This gives rise to an increase in the share of renewables in the power sector to 20.3% of total electricity generation in 2030 (from 18.2% in the Baseline).

In terms of installed capacity the most pronounced decline occurs for supercritical polyvalent units (-108.5 GW or -75.6% from Baseline levels in 2030) followed by gas turbine combined cycle power plants (-90.3 GW or -23.5% in 2030). These are largely replaced by fuel cells (using natural gas as input fuel and transforming it on site into hydrogen) that develop rapidly in the EU-25 power sector with a capacity of 56.1 GW in 2030.

The combined effect of lower electricity demand, the higher share for carbon free energy forms (including nuclear that declines by -10.6% from Baseline levels in 2030) and more efficient generation techniques lead to a big fall in CO_2 emissions from the EU-25 power sector (-26.1% in 2030). The electricity and steam generation sector is thus the key driver for the overall CO_2 emissions reduction (its share of total emissions reduction ranging from 55% in 2010 to 62% in 2030) achieved in the EU-25 energy system under the "Energy efficiency" case.

A comparison between the stand-alone "Energy efficiency" case and the combined "Energy efficiency and 12% renewables in 2010" case clearly illustrates the strong synergies that exist in policies which stimulate energy intensity gains and those promoting renewable energy forms. Thus the projected decline of primary energy needs in the "Energy efficiency and renewables" case is slightly greater than that in the pure "Energy efficiency" case. This is because the high efficiency of intermittent renewable energy forms (based upon EUROSTAT conventions) further assists improvements in energy intensity.

4.4. "12% renewables share in 2010" scenario results for EU-25[62]

The introduction of promotional policies aimed to achieve the 12% renewables share in 2010 leads to significant changes in the future evolution of the fuel mix in the EU-25 energy system. Yet overall primary energy demand is essentially unchanged from Baseline levels (see Table 4-7). In this scenario energy efficiency follows Baseline trends. This scenario addresses only those renewables policies relevant for the time horizon to 2010 (renewables policies are "frozen" in a sense at 2010). Nevertheless, demand for renewable energy forms exhibits a strong growth on top of baseline levels over the projection period (+56.2% in 2010, +49% in 2030) while a slowdown in the pace of growth of energy requirements for all other energy forms is projected.

In the medium term, the most pronounced changes occur in the use of nuclear energy and solid fuels (-5.3% and -5.0 % from Baseline levels in 2010 respectively). In the long term the use of solids is most affected (-9.2% in 2030) followed by natural gas (-4.7%). The bulk of the increase in renewable energy use is for biomass/waste (83% of incremental demand for renewables in 2010, 75% in 2030), whereas the contribution of other renewable energy sources, such as hydro, wind and solar energy, is less pronounced. The high exploitation of the large potential of biomass/waste in the EU-25 energy system, especially in power and steam generation, as well as in biofuels production, is the key driver for this result.

The share of renewable energy forms reaches 11.6% in 2010 and 12.9% in 2030 (compared with 7.4% and 8.6% respectively in the Baseline scenario). These changes also influence the projected evolution of CO_2 emissions from the EU-25 energy system. In 2010, CO_2 emissions in the "12% renewables in 2010" case are projected to be -4.8% below Baseline levels (-5.5% in 2030). Import dependency also improves somewhat, being limited to 50.1% in 2010 (-3 percentage points from Baseline levels) and 63.7% in 2030 (compared to 67.3% in the Baseline scenario).

62 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD.

Table 4-7: Evolution of primary energy needs in the EU-25 energy system in the "12% renewables in 2010" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303.2	231.5	223.1	272.4	-5.0	-11.7	-9.2
Liquid Fuels	635.6	623.1	646.0	654.5	-4.7	-3.8	-3.0
Natural Gas	376.0	488.6	579.7	598.9	-3.6	-3.0	-4.7
Nuclear	237.7	232.3	206.5	178.4	-5.3	-3.3	-3.8
Renewable energy forms	96.1	207.2	234.7	252.5	56.2	55.1	49.0
Total	**1650.7**	**1784.8**	**1892.1**	**1959.1**	**0.0**	**0.2**	**0.0**
EU-15	**1453**	**1576**	**1659**	**1718**	**0.0**	**0.1**	**-0.1**
NMS	**198**	**209**	**234**	**241**	**0.2**	**0.8**	**0.2**
Mt CO_2 emitted	***3665***	***3578***	***3807***	***4069***	***-4.8***	***-5.8***	***-5.5***
EU-15	***3118***	***3044***	***3223***	***3453***	***-5.0***	***-6.4***	***-5.9***
NMS	***547***	***534***	***583***	***615***	***-3.3***	***-2.3***	***-3.1***

Source: PRIMES.

As was true for primary energy needs, introduction of policies stimulating the use of renewable energy has only a limited impact on overall energy requirements on the demand side. However, higher use of biomass and waste in industry and of solar thermal panels for water heating in services and households leads to significant changes in the fuel mix. Both changes occur to the detriment of natural gas and liquid fuels. Natural gas loses market share in both industry (mainly through biomass/waste use in industrial boilers) and in services and households (where, for water heating, conventional fuels are replaced by solar thermal panels). On the other hand, the decline in liquid fuel use occurs mainly in industrial boilers. The share of biofuels increases significantly in this "12% renewables in 2010" scenario. Biofuels blended in gasoline reach shares of 7.9% in 2010 and 8.4% in 2030, while the biofuels share in diesel is projected to reach 8.1% in 2010 and 8.5% in 2030. The corresponding shares in the Baseline scenario are 2.1% in 2010 and 5.1% in 2030 for gasoline and 2.4% in 2010 and 5.3% in 2030 for diesel. Electricity demand remains similar to Baseline levels.

The projected changes in the fuel mix on the demand side towards the use of less carbon intensive energy forms lead to a reduction of CO_2 emissions by -4.1% from Baseline levels in 2010 and -3.2% in 2030. In the short term the biggest improvement in carbon intensity occurs in the transport sector. Transport related CO_2 emissions are projected to be -5% below Baseline levels in 2010, due to the higher exploitation of the biofuels potential. In the long term the industrial sectors experience the largest decline from Baseline levels in CO_2 emissions (-4.3% in 2030). It should be also noted that despite the substantial increase in the use of solar energy both in households and the tertiary sector in the "12% renewables in 2010" case (+145% in 2030 for households, +636% for the tertiary sector) the impact on CO_2 emissions is quite small over the projection period for both sectors (-2.8% in 2030 for tertiary and -3% for households). This result is explained by the fairly small share of solar energy in overall sectoral demand in both sectors even by 2030 but also because, to a significant extent, solar energy replaces electricity in water heating uses (which does not emit CO_2 at the point of use).

Significant changes also occur in the electricity and steam generation sector. Renewable energy forms increase their market share to the detriment of gas and solid fuels in the "12% renewables in 2010" case, while overall electricity requirements are similar to those in the Baseline scenario. The most pronounced growth above Baseline levels is projected for the use of biomass and waste in electricity generation (+139% in 2010, +167.5% in 2030), whereas expansion in the use of wind energy is limited to +17.2% in 2010 and +33.4% in 2030. In the short term the increased use of renewable energy forms for electricity generation purposes occurs to the detriment both of natural gas (-7.5% in 2010) and solid fuels (-6.9%). In the long term the picture is reversed with the decline in solid fuels use reaching -12% in 2030 compared to -9.1% for natural gas. The increasing share of renewable energy in electricity generation (22.3% in 2010 and 24.7% in 2030) is further accompanied by significant growth in the share of co-generated electricity (20.1% in 2030 or +3.7 percentage points from Baseline levels). This arises from the higher exploitation of biomass and waste in cogeneration power plants.

The projected changes in the fuel mix lead to CO_2 emissions reduction from the power generation sector of -7.3% from Baseline levels in 2010 and -10.4% in 2030. Overall CO_2 reduction compared with Baseline derives mostly from changes on the demand side in the short term to 2010 (54.7% of total CO_2 reduction in 2010), whereas the supply side contributes more in the long run (65.3% in 2030). CO_2 emissions in absolute terms stay below the 1990 level in the period to 2010 (-5.1%) rising thereafter to +1% above 1990 levels in 2020 and +7.9% in 2030.

As was the case in comparing the pure "Energy efficiency" case and the combined "Energy efficiency and 12% renewables in 2010" case, a comparison between the isolated renewables and the combined efficiency and renewables case reveals the existence of synergies between policies promoting energy efficiency and renewable energy forms. The overall share of renewable energy forms in EU-25 primary energy needs is higher in the combined "Energy efficiency and 12% renewables in 2010" case than in the "12% renewables share in 2010" case with equivalent renewables policy intensity in both cases. Finally, import dependency is lower in the combined "Energy efficiency and renewables" case than in the pure renewables case mainly because of the greater energy intensity gains achieved in the former.

CHAPTER 5: Nuclear

5.1. Definition of alternative scenarios

The future contribution of nuclear energy remains one of the great uncertainties for the EU-25 energy system given that the bulk of the existing nuclear capacity will have to be decommissioned in the period to 2030. Nuclear is used in only about half of the EU's Member States and some of them (Belgium, Germany and Sweden) have decided to phase out nuclear stations while others (among the new Member States) have agreed to close those nuclear power plants causing safety concerns. However, recently a decision was taken to build a new nuclear power plant in Finland before 2010. Given that the time horizon for this analysis is 2030, public opinion regarding nuclear energy may change in the EU during the projection period.

Scenario analysis is a powerful tool to investigate the impacts that alternative developments brought about by different levels of acceptance of nuclear technology have on the EU energy system. While the present public attitude towards nuclear remains critical in many Member States, it is difficult to have confidence that the key drivers of nuclear power will necessarily remain negative under a wide range of socio-economic and scientific developments. For example, strong confirmation of climate change or a finding that such change will lead to very severe economic disruptions could influence public opinion and the interest of private generators towards nuclear power. Similarly, the emergence of - and confidence in - an improved and inherently safer design of nuclear plants could enhance public acceptance and investors' interest in nuclear energy.

Thus, in the context of this study, an analysis was performed focusing on the examination of different conditions as regards the evolution of nuclear energy in the EU-25 energy system. For that purpose, four different scenarios were examined:

- The "Nuclear phase out" case assumes that nuclear production ceases in the EU-25 in 2010. This is obviously an extreme and unlikely scenario. However, the objective of this scenario is to provide insights into the potential magnitude of the impacts that abandoning use of nuclear power in the EU would have - including future carbon emissions, the cost of energy, technological choice and energy security. A fundamental assumption in the "Nuclear phase out" scenario is that the closure decisions occurring by 2010 would be fully established in 2005. Therefore, there is a five-year period to build the new power capacity required to replace that capacity to be phased out by 2010. Thus the scenario simulates an anticipated disruption in the continued availability of nuclear power after 2010.
- The "30 years nuclear lifetime" case assumes the decommissioning of existing nuclear plants after 30 years from start of operation (except in cases were stricter decommissioning policies apply in certain Member States), but there is no further investment in nuclear power for the purpose of this scenario. This can be considered as a smoother implementation of a hypothetical nuclear phase out policy across the entire EU-25 energy system.
- The "50 years nuclear lifetime" case is somewhat symmetrical to the previous case as it assumes that all Member States without declared nuclear phase out policies would extend the operating lifetime of their existing nuclear power plants to 50 years (compared to 40 years under Baseline assumptions). Moreover, the modelling in this scenario also provides for the possibility of investment in new nuclear power plants, based on economic criteria, in those Member States that have used nuclear to date and have not decided to phase it out.
- The "New nuclear technology accepted" case assumes that new nuclear designs (such as the European Pressurised Water Reactor (EPR) and the Westinghouse AP technology) become mature by 2010. These reactors possess passive safety features, which reduce core fusion probability from 10^{-5}/year for existing nuclear plants to less than 5.10^{-7}/year. It is assumed that this characteristic would ease public opinion concerns towards nuclear energy. In this case, those Member States with declared nuclear phase out policies, or where nuclear generation ceases in the period up to 2030 (Belgium, Germany, the Netherlands and Sweden), are assumed to re-evaluate their decisions and to permit new investment in these improved nuclear power plants.

It should be noted that in all cases examined, as in the Baseline scenario, it was assumed that the agreed closure of those existing nuclear plants causing safety concerns in Lithuania and Slovakia occurs according to the planned schedule.

Two additional cases were also examined that combine the effects of specific policy options for nuclear energy and promotional policies for renewable energy forms, as described in the case of "12% renewables share in 2010" case in Chapter 4:

- The "Nuclear phase out in 2010, with strong support for renewables" case assumes the simultaneous implementation of a nuclear phase out policy by 2010 (as defined in "Nuclear phase out" case) and the existence of additional incentives for renewable energy forms (as defined in the "12% renewables share in 2010" case).
- The "New nuclear technology, with strong support for renewables" case examines the evolution of the EU-25 energy system in an environment of favourable developments for both nuclear energy (using the assumptions of the "New nuclear technology accepted" case and the "12% renewables share in 2010" case).

In this chapter, the impacts of the "New nuclear technology accepted" case on the future evolution of the EU-25 energy system are discussed in detail. A briefer description is also provided of the results obtained under the other cases examined. The divergent character of these different policy cases permits a better understanding of their impacts for the EU-25 energy system.

5.1.1. Nuclear Safety in the European Union

The Green Paper entitled "Towards a European strategy for the security of energy supply", adopted by the Commission on 29 November 2000, raised the issue of the position of nuclear energy amongst the other energy sources in the European Union. On 26 June 2002, the Commission adopted the final report on the Green Paper, which concluded that "the range of choices available to the Member States has to be as wide as possible, without prejudice to their sovereignty in these matters. The nuclear option remains open to those EU Member States who would like it."

Independent of the energy policy choices made by the Member States, consistent action by the EU in the field of nuclear safety and waste management is necessary. In particular this reflects the recent EU enlargement which brought in countries with nuclear power stations which had earlier operated under different safety regimes, and also the EU's commitment to reduce greenhouse gas emissions.

Under the terms of the EURATOM Treaty, signed in 1957, the Union has adopted extensive legislation on radiation protection. But, although the Treaty provided for safeguards relating to the operation of nuclear installations and the use of nuclear materials, it set no standards on nuclear safety having the force of law. It is therefore appropriate to add safety standards for nuclear installations during and at the end of their working lives to the legislative corpus dealing with radiation protection. The Laeken European Council in December 2001 requested, in this respect, regular reports on nuclear safety. This would not be possible without the establishment of a Community reference framework on nuclear safety standards. The EU has undertaken concrete actions in the field of nuclear safety, largely for the benefit of new Member States and candidate countries.

As the Green Paper on security of energy supply emphasised, the nuclear option can only be pursued if a satisfactory and transparent solution can be found to the question of nuclear waste management. Opinion surveys recently undertaken by the Commission confirm this analysis and show that a clear policy for the management of nuclear waste would significantly enhance public attitudes towards the continued use of nuclear power. It is therefore important for the EU to ensure that Member States take decisions as regards safe disposal within a reasonable time and with future generations in mind. According to most experts, permanent deep disposal is the best-known solution for the long-term management of radioactive waste. Research into the technology of radioactive waste management has not yet resulted in a practicable alternative to geological disposal. However, research should be continued to give future generations access to new technologies for the treatment of radioactive waste - such as transmutation - in the hope that in due course waste can be significantly reduced.

In order to improve the Community framework for nuclear safety, the Commission has proposed a package of three measures covering nuclear safety and the decommissioning of obsolete installations, the management of radioactive waste, and trade in nuclear materials with Russia.

1. **A Directive on the safety of nuclear installations during operation and decommissioning.** A common approach to the safety of nuclear installations is now essential. Each Member State will be required to have an independent safety authority. Co-ordination of the national systems within a Community framework is a guarantee that high levels of safety will be maintained at nuclear installations. A Committee of Regulatory Authorities will be established. Each Member State will submit regular reports on the safety situation in its nuclear installation. Many nuclear installations in the Union are coming to the end of their service life, while in the new Member States a number of reactors will have to be shut down by 2009. The proposed Directive will require Member States to take the necessary measures for the decommissioning.

2. **A Directive on radioactive waste.** This Directive will help to produce a clear, transparent response in reasonable time to the issue of how to deal with radioactive waste. This proposal provides that Member States should adopt national programmes including a timetable for the storage of radioactive wastes in general studying the possibility to give priority to the solution of deep geological disposal. A Committee of Experts will be established. Each Member State will submit regular reports on its activities and programmes for the safe management of radioactive waste.

3. **A draft decision authorising the Commission to negotiate an Agreement between EURATOM and the Russian Federation on trade in nuclear materials.** Since 1992 the EURATOM Supply Agency has been pursuing a policy of diversification of sources of uranium supply in order to avoid over-dependence on the Russian Federation. This Agreement will have to protect the interests of European consumers and maintain the viability of the European industries, in particular the enrichment industry. The new Agreement will have to take account of the new conditions of the market in the enlarged Union. For the European Union it is also the opportune moment to make known to the Russian authorities that the opening of negotiations on the trade in nuclear materials should be accompanied by parallel detailed negotiations on the safety of those first-generation nuclear power stations still operating in Russia.

The acceptance of nuclear energy by the European population will be influenced by the implementation of these new legal provisions as well as by the development of new reactor designs incorporating improved levels of safety. In the context of the present study, two technologies have been considered for the analysis of the further development of nuclear energy with new types of nuclear power stations. These two new technologies are: the EPR reactor jointly developed by Areva and Siemens and selected for the planned new Finnish nuclear plant; and the AP600 reactor developed by

Westinghouse. Both reactor types are based on simplified and passive plant systems to enhance plant safety and operations.

- **The technical options of the EPR reactor**

The design of the EPR reactor is based on an "evolutionary" approach. This will allow maximum benefit to be drawn from the experience gained by France and Germany who initiated the project. In this way, most of the components and equipment of the EPR are the direct result of technologies already used in the most recent reactors built in France and Germany. Alongside this tried and tested technology, the EPR has several innovative features which were adopted by the partners after their benefits for safety, reliability and ease of operation had been demonstrated.

From the operational point of view, the new features adopted in the EPR to reduce costs principally concern fuel and maintenance. The core design will allow the reactor to operate with a fuel which is slightly less enriched than that used in current reactors. Refuelling operations will be less frequent, with cycles of between 18 and 24 months. Apart from conventional uranium fuel, the core will also take MOX mixtures (uranium oxide and plutonium) allowing the plutonium to be recycled. The operating lifetime of the reactor will be 60 years (as against a lifetime of around 40 years for current reactors) due to reinforced protection of the pressure vessel against neutron radiation.

From the safety point of view, one of EPR's innovations is that the possibility of a core meltdown is fully taken into account in the design stage. The probability of such an accident is even lower in EPR than with existing reactors. In addition the architecture of the facility and the planned back-up systems, such as emergency cooling or recovery of core materials which have fused (corium), should guarantee the almost complete elimination of all radioactive releases outside the double containment protecting the primary system. The systems allocated to safety operations (safety inspection, emergency steam generator supply, component cooling, and emergency electrical supply) are divided into four independent networks and geographically separated. In this way they can be individually powered by a diesel generating set allocated to each network. Finally, although the design of the primary and secondary systems follows that of existing reactors, the size of the main components (vessel, pressuriser, and steam generator) has been increased. This gives the whole system an increased inertia and provides the operator a longer time to intervene should any operating problem arise.

- **The technical options of the AP600 reactor**

The Westinghouse AP600 is a 600 MWe reactor utilising passive safety features that, once actuated, depend only on natural forces such as gravity and natural circulation to perform all required safety functions. These passive safety systems result in increased plant safety and can also significantly simplify plant systems, equipment, and operation.

Although the AP600 uses simplified and passive plant systems to an unprecedented extent to enhance plant safety and operations, the effectiveness of the technology has been demonstrated through years of operation and testing. The AP600's major components are also based on years of reliable operating experience. The canned motor reactor coolant pumps have been in use by the US Navy for decades. The steam generators and reactor vessel are based on field-proven technology with incremental improvements developed as a result of operating experience. The passive safety systems are an extension of the technology used previously, since Westinghouse-supplied PWRs have had accumulators for injection of core cooling water without the use of pumps for many years. The AP600 is the result of a logical progression in plant design.

In addition to being simpler, the passive safety systems do not require the large network of safety support systems needed in typical nuclear plants. The main features of the AP600 passive safety systems include passive safety injection, passive residual heat removal, and passive containment cooling. Simplification helps to reduce capital costs and provides a hedge against regulatory-driven increases in operating and maintenance costs by eliminating equipment which is subject to regulation. Economic performance driven by simplicity rather than scale allows generating companies to add capacity via AP600's in smaller increments that more closely match electricity demand growth.

5.2. "New nuclear technology accepted" scenario results for EU-25[63]

The availability of new nuclear technologies and the re-evaluation of declared nuclear phase out policies in EU-25 Member States lead to a potentially significant increase in the role of nuclear energy in power generation, especially in the long run (see Table 5-1). Under the "New nuclear technology accepted" case assumptions primary energy demand for nuclear exhibits a continuous growth over the projection period, reaching +78.2% higher than Baseline levels in 2030. The increased use of nuclear energy occurs to the detriment of solid fuel (-15.9% from Baseline levels in 2030) and to a lesser extent natural gas (-3.5%). But the availability of new nuclear technologies does not have a significant impact on the use of renewable energy forms in the EU-25 energy system. Primary energy requirements for liquid fuels remain rather stable at Baseline levels, clearly reflecting the insignificant role of this energy form in power generation, especially in the long run.

The higher use of nuclear power plants with an efficiency of some 33% in the EU-25 energy system involves an increase of overall primary energy requirements (+3.6% above Baseline levels in 2030), given that for example natural gas power plants have a much higher efficiency than nuclear plants. Thus energy intensity worsens for the EU-25 energy system in the "New nuclear technology accepted" case compared to the Baseline. But the increasing share of nuclear energy in primary energy requirements (16.2% in 2030 compared to 9.4% in the Baseline scenario), and the limited decline of renewable energy forms (with a market share of 8.3% in 2030 compared to

63 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to Baseline can be found in APPENDIX 5. Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD.

Table 5-1: Primary Energy Demand in EU-25 under the "New nuclear technology accepted" case assumptions

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303.2	243.4	230.3	252.3	-0.1	-8.8	-15.9
Liquid Fuels	635.6	653.3	670.5	674.2	0.0	-0.2	0.0
Natural Gas	376.0	506.8	589.2	606.5	0.0	-1.4	-3.5
Nuclear	237.7	245.0	276.5	330.2	-0.1	29.5	78.2
Renewable energy forms	96.1	132.7	149.8	167.5	0.0	-1.0	-1.1
Total	**1650.7**	**1783.2**	**1916.2**	**2030.4**	**-0.1**	**1.4**	**3.6**
EU-15	**1453**	**1575**	**1684**	**1786**	**0.0**	**1.6**	**3.9**
NMS	**198**	**208**	**232**	**245**	**-0.2**	**0.0**	**1.8**
Mt CO_2 emitted	***3665***	***3755***	***3927***	***4063***	***-0.1***	***-2.8***	***-5.6***
EU-15	***3118***	***3203***	***3332***	***3460***	***-0.1***	***-3.2***	***-5.7***
NMS	***547***	***552***	***594***	***603***	***0.0***	***-0.4***	***-5.0***

Source: PRIMES.

8.6% in the Baseline), lead to a significant improvement of the EU-25 energy system's carbon intensity (-8.9% from Baseline levels in 2030). This provides for a more favourable development in terms of CO_2 emissions. Thus, in 2030 CO_2 emissions are projected to increase by +7.8% from 1990 levels compared to +14.2% in the Baseline scenario.

Due to the higher exploitation of indigenous energy sources import dependency in the EU-25 energy system is projected to be lower in the long run in the "New nuclear technology accepted" case. In 2030, 62.1% of primary energy needs in the EU-25 energy system will have to be imported (compared to 67.4% in the Baseline scenario). As regards import dependency of individual fossil fuels, that for solid fuels is projected to reach 63.0% in 2030 (-2.8 percentage points from Baseline levels), with natural gas import dependency reaching 80.7% in 2030 (compared to 81.3% in the Baseline). Finally, import dependency for liquid fuels remains, as expected, unchanged from Baseline levels (88.3% in 2030) as energy requirements for liquid fuels are not affected by the assumptions introduced in the "New nuclear technology accepted" case.

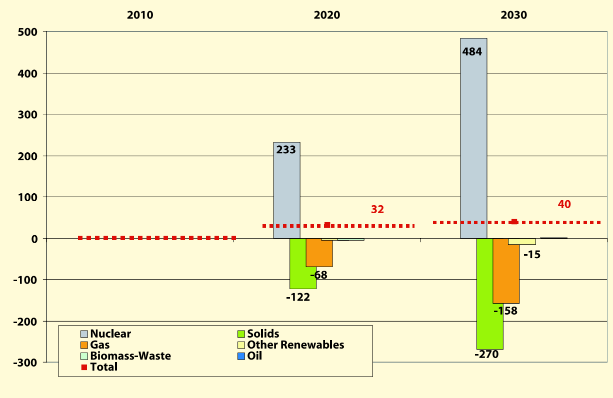
Another significant finding from the "New nuclear technology accepted" case concerns the evolution of final energy demand growth in the EU-25 energy system, which is projected to remain unchanged from Baseline levels over the projection period. The strong inertia of the demand side to the changes projected to occur on the supply side is largely explained by the fact that the adoption of new nuclear technology in the power sector does not lead to major changes in electricity production costs. Electricity generation costs are projected to be some -1% lower than Baseline levels both in 2020 and 2030. Thus, only limited changes in the fuel mix are projected to occur on the demand side, with electricity and also co-generated steam gaining some additional market share to the detriment of fossil fuels. The limited importance of these changes in the fuel mix is also reflected in the evolution of CO_2 emissions from the demand side which are projected to remain essentially unchanged from Baseline levels over the projection period.

5.2.1. Impacts on electricity and steam generation

As expected, the electricity and steam generation sector undergoes significant changes because of the assumptions introduced on the availability of new nuclear technologies and the re-evaluation of nuclear phase out policies in Member States (see Figure 5-1). While overall electricity generation exhibits only limited growth above Baseline levels (+0.8% in 2020, +0.9% in 2030), the use of nuclear energy for electricity generation rises significantly above Baseline levels (+27.9% in 2020, +63.2% in 2030).

The increase in nuclear electricity generation leads to strong downward pressure on generation from other energy forms. The most pronounced decline, both in absolute and percentage terms, in comparison to the Baseline scenario, is projected for solid fuels. Electricity generation from solids falls 28% below Baseline levels in 2030 (-17% in 2020). However, and despite this strong decline compared to the Baseline scenario, electricity generation from solid fuels is still projected to increase at rates above average in 2015-2030 (+2.6% pa compared to +1.2% pa). Thus, even in the "New nuclear technology accepted" case, the comeback of solid fuels in the power sector in the absence of strong policies on climate change is pro-

Figure 5-1: Changes in electricity generation by energy form in EU-25 (diff. from baseline in TWh) in the "New nuclear technology accepted" case



Source: PRIMES.

Table 5-2: Installed capacity by plant type in EU-25 in the "New nuclear technology accepted" case

	GW installed				*change from baseline (in GW)*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	146.8	199.5	0.1	38.8	91.7
Hydro	96.2	104.7	108.9	111.7	0.0	-0.4	-0.5
Wind	12.8	72.7	101.8	130.4	0.0	-1.7	-4.6
Other renewables	0.2	0.5	0.6	13.8	0.0	0.0	-0.4
Conventional thermal	335.6	271.3	176.3	145.3	0.7	1.0	-2.0
Advanced coal	0.0	0.5	2.4	6.5	0.0	0.5	0.0
Supercritical polyvalent	0.0	0.3	48.0	107.4	-0.2	-16.7	-36.0
Gas turbines CC	47.4	169.2	303.1	353.9	-0.4	-15.6	-30.7
Small gas turbines	22.8	33.8	64.4	67.5	-0.1	1.1	1.7
Fuel cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	1.0	1.2	1.3	1.4	0.0	0.0	0.0
Total	**656**	**784**	**954**	**1137**	**0.0**	**6.9**	**19.3**
EU-15	**579**	**689**	**820**	**970**	**0.0**	**7.0**	**18.9**
NMS	**78**	**95**	**134**	**168**	**0.0**	**0.0**	**0.4**
of which CHP	***103***	***129***	***171***	***205***	***-0.3***	***3.0***	***6.7***
EU-15	***77***	***102***	***133***	***154***	***-0.3***	***3.0***	***7.3***
NMS	***26***	***27***	***38***	***52***	***0.0***	***0.0***	***-0.6***

Source: PRIMES.

jected to occur in the EU-25 energy system though at a slower pace than in the Baseline case. Electricity generation from natural gas is projected to decline by -9.8% from Baseline levels in 2030 (-4.4% in 2020), whereas the decline in use of hydro and intermittent renewable energy forms is rather limited (-0.7% in 2020, -2.1% in 2030). The projected changes in the fuel mix of the EU-25 power generation sector lead to an increasing role for non-fossil fuels. These are projected to account for 45.8% of overall electricity generation in 2030 compared to 35.6% in the Baseline scenario (the corresponding figures for 2020 are 44.1% and 38.8% respectively).

The availability of new nuclear technology leads to important changes as regards the investment decisions of power generators. As illustrated in Table 5-2, nuclear plant capacity in the EU-25 power generation sector is projected to reach 146.8 GW in 2020 and 199.5 GW in 2030 (from 108.0 GW and 107.8 GW respectively in the Baseline scenario). This increase mainly occurs to the detriment of supercritical coal plants (-36 GW in 2030 from Baseline levels) that, under Baseline assumptions, enter the power sector in the long run to replace retired nuclear capacity. A significant impact is also projected for gas turbine combined cycle plants (-30.7 GW in 2030). This result strongly relates to one of the key features of the AP600 technology, that is its size (600 MW power plant units), which allows for more flexible operation in plant dispatching. The impact on all other power generation technologies is rather limited over the projection period. Despite the more favourable technological and economic characteristics of the new nuclear technology examined here and the 85% increase in nuclear capacity above the Baseline level in 2030, the nuclear share in total installed capacity is projected to reach only 17.5% in 2030 in the "New nuclear technology accepted" case compared to 21.4% in 2000.

The greater use of nuclear heat in power and steam generation (+78.2% in 2030 from Baseline levels) under the "New nuclear technology accepted" case leads to an increase of total transformation input for electricity and steam generation of up to +9.8% in 2030. This is despite the projected decline in the use of all other energy forms (see Table 5-3). This result stems from the lower efficiency of nuclear power plants compared with most alternatives. Among fossil fuels the most pronounced decline in fuel inputs is projected for solid fuels (-19.4% in 2030 from Baseline levels), whereas the reduction of natural gas inputs reaches -7.7% in 2030. The high decline in the use of solids relates to their role under Baseline assumptions, i.e. satisfying base load in replacement of nuclear energy that does not materialise in this scenario.

The increased use of nuclear energy, and the only very limited decline in the use of renewable energy forms, in the EU-25 energy system leads to a significant improvement of carbon intensity in electricity generation. This is clearly reflected in the projected evolution of CO_2 emissions in the power generation sector in the "New nuclear technology accepted" case. In 2020 CO_2 emissions are projected to reach levels equal to those observed in 2000 (or -7.6% below Baseline) whereas in 2030 they are -14.2% (or -238 Mt CO_2) below Baseline levels.

5.2.2. Impacts on CO_2 emissions

The "New nuclear technology accepted" case leads to lower CO_2 emissions compared to the Baseline scenario in the long run because of the changes in the power sector of the EU-25 energy system. The projected decline in CO_2 emissions is more pronounced in those Member States that under Baseline assumptions implement nuclear phase out policies. Significant reductions are also achieved in some New Member States. In those EU-15 Member States in which investors can freely decide on the use of nuclear energy under Baseline assumptions, a reduction of CO_2 emissions from Baseline levels is also projected, but at rates below average. Finally, reductions in CO_2 emissions are also projected for non-nuclear

Table 5-3: Fuel input in electricity and steam generation in EU-25 in the "New nuclear technology accepted" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solids	217.4	176.6	170.4	196.7	-0.2	-11.5	-19.4
Oil products	52.4	34.3	22.7	19.8	-0.1	-3.0	0.5
Gas	131.7	204.3	256.1	252.0	-0.1	-3.1	-7.7
Biomass	12.7	18.7	21.0	23.5	0.0	-1.0	-2.0
Waste	19.3	25.5	26.3	26.3	0.0	-3.2	-0.6
Nuclear energy	237.7	245.0	276.5	330.2	-0.1	29.5	78.2
Geothermal heat	3.0	3.4	3.6	3.9	0.0	0.0	0.0
Total	**674**	**708**	**777**	**853**	**-0.1**	**4.1**	**9.8**
EU15	**581**	**609**	**668**	**739**	**-0.1**	**4.9**	**10.6**
NMS	**93**	**98**	**108**	**114**	**-0.4**	**-0.1**	**4.4**
Mt CO_2 emitted	***1355***	***1300***	***1354***	***1438***	***-0.1***	***-7.6***	***-14.2***
EU-15	***1068***	***1009***	***1047***	***1131***	***-0.2***	***-9.4***	***-15.4***
NMS	***287***	***290***	***307***	***307***	***0.0***	***-0.8***	***-9.4***

Source: PRIMES.

Member States which, as in the Baseline scenario, are assumed to forego the use of nuclear energy. These reductions arise as a result of changes in imports and exports of electricity in the EU-25 energy system. Increasing imports of electricity from Member States that use nuclear energy is a cost-effective option both for the exporter and the importer of electricity (especially in satisfying base load needs).

5.2.3. Concluding remarks

The New nuclear technology accepted case examines a more favourable development for nuclear energy in the EU-25 energy system arising from the availability of new nuclear technology with improved safety and techno-economic features and the re-evaluation of nuclear phase-out policies in Member States. In this scenario, changes are mainly concentrated in the power generation sector, while the evolution of the demand side remains similar to that under Baseline assumptions. The projected increase in the use of nuclear energy (+78.2% from Baseline levels in 2030 at the level of primary energy needs) leads mainly to the replacement of solid fuels and to a lesser extent natural gas. This results in an increase of total gross inland consumption (+3.6% in 2030) because nuclear power plants have a lower efficiency than natural gas or solid fuel fired power stations. The share of nuclear energy is projected to reach 16.3% of primary energy needs in 2030 (the highest nuclear share ever) compared to 9.5% in the Baseline scenario. Moreover, there is only a limited decline in the market share of renewable energy sources, from 8.6% in the Baseline scenario in 2030 to 8.3% in the "New nuclear technology accepted" case. Therefore, the carbon intensity of the EU-25 energy system exhibits a significant improvement from Baseline levels with CO_2 emissions in 2030 decreasing by -5.6%. Furthermore, the lower dependence of the EU-25 energy system on fossil fuels (accounting for 75.5% of primary energy needs in 2030 compared to 81.8% in the Baseline scenario) allows for a significant reduction in import dependency, which reaches 62.1% in 2030 (-5.2 percentage points below Baseline levels).

5.3. Alternative nuclear policies for EU-25[64]

In view of the large uncertainties that prevail as regards the future evolution of nuclear energy in the EU-25 energy system, three additional alternative policy scenarios were examined for this study. Two of them contrast significantly from the "New nuclear technology accepted" case by assuming that nuclear energy would be abandoned in the EU-25. In the first case ("Nuclear phase out" case), the nuclear phase out occurs in 2010, whereas in the second ("30 years nuclear lifetime" case) it occurs via the decommissioning of existing power plants after 30 years of operating life (except in cases where stricter decommissioning policies apply). In marked contrast the third additional case ("50 years nuclear lifetime" case) assumes that all Member States without declared nuclear phase out policies extend the lifetime of their existing nuclear power plants to 50 years (compared to 40 years under Baseline assumptions), as well as continuing with nuclear expansion based on economic criteria.

The divergent character of the three additional nuclear scenarios examined is clearly reflected in the evolution of primary energy needs in the EU-25 energy system (see Table 5-4). In the "Nuclear phase out" and the "30 years lifetime" cases, which involve the massive closure of nuclear power plants in the EU-25 energy system, primary energy needs are projected to decrease compared to Baseline levels (-4.0% and -3.7% respectively in 2030). This is because nuclear power plants are replaced by more thermally efficient ones. On the contrary, under the "50 years lifetime" case, primary energy requirements experience limited growth above Baseline levels (+1.1% in 2030). The demand side remains rather unaffected by the introduction of different nuclear policy assumptions, leading to limited

64 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) for the scenarios examined are available in the enclosed CD.

Table 5-4: Evolution of primary energy needs in the EU-25 under the additional alternative nuclear cases examined

Phase-out case	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303.2	277.4	303.2	359.1	13.8	20.0	19.7
Liquid Fuels	635.6	663.9	676.2	675.3	1.6	0.7	0.1
Natural Gas	376.0	572.8	642.9	663.8	13.0	7.5	5.7
Nuclear	237.7	0.0	0.0	0.0	-100.0	-100.0	-100.0
Renewable energy forms	96.1	149.3	165.1	179.2	12.6	9.1	5.7
Total	**1650.7**	**1666.2**	**1790.3**	**1880.4**	**-6.6**	**-5.2**	**-4.0**
EU-15	**1453**	**1464**	**1565**	**1643**	**-7.1**	**-5.5**	**-4.5**
NMS	**198**	**202**	**225**	**238**	**-3.0**	**-2.9**	**-1.1**
30 years lifetime case	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	244.7	313.9	370.0	0.4	24.2	23.3
Liquid Fuels	635.6	653.5	674.1	673.8	0.0	0.4	-0.1
Natural Gas	376.0	513.7	625.5	655.7	1.3	4.6	4.4
Nuclear	237.7	224.9	36.1	3.7	-8.3	-83.1	-98.0
Renewable energy forms	96.1	134.7	162.6	180.9	1.5	7.5	6.7
Total	**1650.7**	**1773.7**	**1815.0**	**1886.7**	**-0.6**	**-3.9**	**-3.7**
EU-15	**1453**	**1565**	**1588**	**1647**	**-0.7**	**-4.2**	**-4.2**
NMS	**198**	**208**	**227**	**240**	**0.0**	**-1.9**	**-0.2**
50 years lifetime case	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	245.0	248.3	286.6	0.5	-1.7	-4.4
Liquid Fuels	635.6	653.4	670.9	674.0	0.0	-0.1	-0.1
Natural Gas	376.0	505.7	597.0	620.7	-0.2	-0.1	-1.2
Nuclear	237.7	245.4	224.7	230.1	0.0	5.2	24.2
Renewable energy forms	96.1	132.8	150.7	168.8	0.1	-0.4	-0.4
Total	**1650.7**	**1784.3**	**1893.4**	**1982.1**	**0.0**	**0.2**	**1.1**
EU-15	**1453**	**1576**	**1662**	**1738**	**0.0**	**0.3**	**1.1**
NMS	**198**	**208**	**232**	**244**	**0.0**	**0.0**	**1.6**

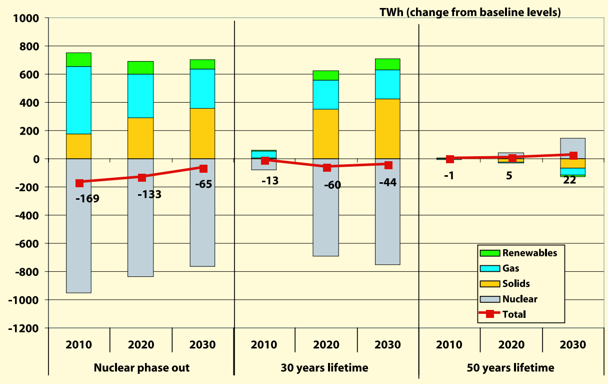
Source: PRIMES.

changes in the fuel mix following demand changes for electricity. Electricity demand declines below Baseline levels in those cases assuming the abandonment of nuclear, as electricity prices would be higher. On the contrary, there is higher electricity demand due to lower electricity prices in the "50 years lifetime" case. However, it should be recalled here that in both nuclear phase-out cases, it is assumed that the closure of nuclear power plants is fully anticipated by the producers of electricity and thus the impact on the demand side is not very pronounced. (The most significant change occurs in 2010 under the "Nuclear phase out in 2010" case, with electricity demand declining by some -4.2% from Baseline levels).

Different assumptions about the use of nuclear energy have a strong impact on the future evolution of the EU-25 power generation sector. In the "Nuclear phase out" case the capacity gap in power generation leads to greater deployment of fossil fuels and renewables. In 2010, electricity generation from solid fuels, natural gas and renewable energy forms grows at similar rates above Baseline levels. However, in absolute terms it is natural gas that plays a predominant role in covering that electricity production no longer met by nuclear energy (see Figure 5-2). Beyond 2010 the relatively higher cost effectiveness of coal in power generation is reflected in the results obtained, with solid fuels in 2030 covering close to 50% of the gap created by the nuclear phase out. In the "30 years lifetime" case, there are similar findings. The role of solid fuels becomes even more pronounced in the long run as the smoother pace of nuclear phase out delays the replacement of nuclear power plants compared to the "Nuclear phase out" case. The reverse trends are projected to occur in the "50 years lifetime" case that examines a more favourable environment for nuclear energy. In this case, nuclear energy gains some additional market share, especially in the long run, to the detriment of natural gas and solid fuels.

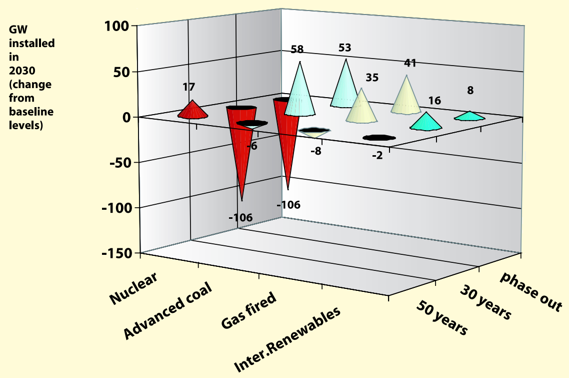
The role of renewable energy forms would be quite significant in the short run if a nuclear phase out policy occurred in the EU-25 energy system. However, beyond 2010 the increment in renewable energy forms is limited. This is due to the exhaustion of hydro potential in the EU-25 energy system and the high exploitation of low-cost wind energy potential already assumed in the Baseline, which means that higher costs are involved to achieve even further wind penetration. Thus in 2030 the share of renewable energy forms in electricity generation exhibits only a limited increase from Baseline levels, reaching

Figure 5-2: Changes in electricity generation by energy form in EU-25 (diff. from baseline in TWh) under different nuclear policy assumptions



Source: PRIMES.

Figure 5-3: Changes in installed electricity generation capacity in 2030 for the EU-25 under different nuclear policy assumptions



Source: PRIMES.

20.0% in the "Nuclear phase out" case and 20.2% in the "30 years lifetime" case (compared to 18.2% in the Baseline scenario).[65]

The different nuclear policy assumptions also have major effects on the investment decisions of power generators. More specifically, gas turbine combined cycle plants and supercritical coal plants (using coal and biomass as input fuels) are the most cost-effective options for power generators in the context of nuclear phase out policies (see Figure 5-3). In the "Nuclear phase out" case some 128.5 GW of nuclear power plants cease operating by 2010. The immense need for additional investment in 2010 leads to a substantial increase of gas turbines combined cycle plant capacity (+68.7 GW from Baseline levels) but also of supercritical coal plants (+21.5 GW). In the long run, and as supercritical coal technologies gain maturity and coal prices become more competitive compared to those of gas, additional capacity in this technology reaches +53 GW above Baseline levels. That of gas turbines combined cycle plants would increase by 41 GW above Baseline levels.

Under the "30 years lifetime" case, which allows for a smoother adjustment of power generators to the nuclear phase out, the increase of gas turbine combined cycle plant capacity is smaller (+35 GW above Baseline levels in 2030) while that of supercritical coal plants increases by some 58 GW. The increase of intermittent renewable energy forms capacity in the "30 years lifetime" case rises +16 GW from Baseline levels in 2030 compared to +8 GW in the abrupt "Nuclear phase out" case.

Expanding the lifetime of existing nuclear power plants to 50 years leads to an increase of nuclear capacity by some 17 GW in 2030, occurring mainly to the detriment of supercritical coal technology (-6 GW) and natural gas combined cycle plants (-8 GW).

The changes in the EU-25 power generation sector under the different nuclear policies examined here significantly affect the future evolution of CO_2 emissions in the EU-25 (see Table 5-5). Abandoning nuclear energy leads to a substantial worsening of the EU-25's CO_2 situation. CO_2 emissions would increase by +8.2% from 1990 levels in 2010 under the "Nuclear phase out" case, and by close to +23% above 1990 levels in 2030 for both the "Nuclear phase out" and "30 years lifetime" cases. For comparison, the projected growth of CO_2 emissions from 1990 levels under Baseline assumptions is -0.3% in 2010 and +14.2% in 2030. On the contrary, the "50 years lifetime" case

Table 5-5: Evolution of CO_2 emissions in the EU-25 energy system under different nuclear policy assumptions

	Mt of CO_2				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Nuclear phase out	3665	4078	4361	4623	8.5	7.9	7.4
30 years lifetime	3665	3777	4356	4642	0.5	7.8	7.9
50 years lifetime	3665	3759	4019	4233	0.0	-0.5	-1.6
	Index (1990=100)						
	2000	2010	2020	2030			
Nuclear phase out	97.2	108.2	115.7	122.7			
30 years lifetime	97.2	100.2	115.6	123.2			
50 years lifetime	97.2	99.7	106.6	112.3			

Source: PRIMES.

65 These results for renewables apply to the renewables environment of the Baseline. Alternative developments for renewables in the case of strong policy support (as shown in Chapter 4), in combination with either a phasing out of nuclear or with new nuclear technology being accepted, are analysed in the next box.

leads to a slower growth of projected CO_2 emissions in the long run (+12.2% from 1990 levels in 2030 instead of + 14.2% in the Baseline).

Besides the impact of the different nuclear cases examined on projected CO_2 emissions, import dependency is also strongly affected by different policies on nuclear. Under nuclear phase out conditions, a significant indigenous energy source is no longer available and is substituted, to a very large extent, by imported fuels. Consequently import dependency in 2030 for the EU-25 energy system increases to reach 74.7% in the "Nuclear phase out" and 74.6% in the "30 years lifetime" cases, compared to 67.3% in the Baseline scenario. In the "50 years lifetime" case import dependency of the EU-25 energy system is projected to improve slightly, decreasing to 65.5% in 2030 (-1.9 percentage points from Baseline levels).

The results obtained from this analysis illustrate that different nuclear policies can significantly influence the future evolution of the EU-25 energy system. Nuclear phase out policies, if anticipated by producers of electricity, would not have a large impact on the demand side or lead to a further improvement of energy intensity in the EU-25 energy system. This is because of the lower efficiency of nuclear power plants compared to fossil fuel fired and renewable power stations. But such policy developments would further exacerbate climate change and security of supply concerns. It is therefore worthwhile to examine the possible role of additional renewable policies under these different nuclear trajectories, focusing in particular on CO_2 emissions and import dependency which are both influenced favourably by greater renewables deployment.

5.4. Combining nuclear policies with policies promoting renewable energy forms in the EU-25

In the context of this nuclear analysis, two additional cases were examined focusing on the impact that promotional policies for renewable energy forms, as described in the "12% renewables share in 2010" case in Chapter 4, would have upon the future evolution of the EU-25 energy system. The nuclear cases examined comprise the "Nuclear phase out" case, where nuclear deployment ceases in 2010, and the "New nuclear technology accepted" case.

The scope of the "Nuclear phase out with strong support for renewables" case was to investigate the potential contribution of renewable energy forms in counterbalancing the environmental and security of supply pressures that become increasingly important in the EU-25 energy system if use of nuclear energy were to be abandoned. On the other hand, the "New nuclear with strong support for renewables" case investigates the potential synergies and/or trade-offs that exist for the EU-25 energy system if promotional policies for renewable energy forms are implemented in an environment of greater use of nuclear energy.

5.4.1. "Nuclear phase out in 2010 with strong support for renewables" case

A nuclear phase out policy combined with the increased promotion of renewable energy forms, as in the "12% renewables share in 2010" case of Chapter 4, would lead to significant changes in the future evolution of primary energy needs in the EU-25 energy system, both in absolute terms and in terms of the fuel mix (see Table 5-6). Overall primary energy needs decline from Baseline levels by -5.9% in 2010 and by -3.7% in 2030. The incentives for the use of renewable energy forms lead to an even more pronounced growth of renewables demand compared to both the "Nuclear phase out" and the "12% renewables share in 2010" cases. In 2010, primary energy needs for renewables increase +72.9% from Baseline levels (compared with +12.6% in the "Nuclear phase out" case and +56.2% in the "12% renewables share in 2010" case). This higher renewables deployment is, however, not sufficient to fill the gap generated by the termination of nuclear power production. The additional energy requirements to replace nuclear in 2010 involve more natural gas and to a smaller extent more solid fuels.

In the long run, the increase in the use of renewable energy forms becomes less pronounced (+53.8% in 2030 from Baseline levels) but still higher than in the "Nuclear phase out" and the "12% renewables share in 2010" cases (+5.7% and +49% respectively in 2030). As in the "Nuclear phase out" case demand for solid fuels is also projected to exhibit a significant (but less pronounced) growth from Baseline levels in the long run (+10.2% in 2030 compared to +19.7% in the "Nuclear phase out case"). The higher exploitation of renewable energy forms limits the additional demand for natural gas to just +1.6% above Baseline levels in 2030 (compared to +5.7% in the "Nuclear phase out case"). Primary energy needs for liquid fuels decline at rates similar to those projected in the "12% renewables share in 2010" case as this change results mainly from the higher use of biofuels in transport and not to changes in the power generation sector.

The renewables share in primary energy reaches 13.7% in 2010 and 13.8% in 2030 in the EU-25 energy system under the "Nuclear phase out in 2010 with strong support for renewables" case assumptions, compared with 8.6 % in the Baseline. The higher penetration of renewable energy forms partly counterbalances the impact of the nuclear phase out on CO_2 emissions in the EU-25 energy system. Thus, the growth of CO_2 emissions is limited to +3.2% above Baseline levels in 2010 and +2.0% in 2030 (compared to +8.5% and +7.4% respectively in the "Nuclear phase out" case). Furthermore, promotional policies for renewables in the event of a nuclear phase out lead to a lower import dependency compared to the pure "Nuclear phase out" case. Import dependency reaches 58.9% in 2010 and 71.1% in 2030 (-3.9 and -3.6 percentage points respectively lower than the "Nuclear phase out" case). However, it should be noted that import dependency in the combined "Nuclear phase out in 2010 with strong support for renewables" case would be +5.8 percentage points higher in 2010 than in the Baseline. In 2030 the increase in import dependency over and above Baseline levels would amount to +3.7 percentage points, reaching 71% instead of 67% in the Baseline.

The implementation of promotional policies for renewable energy forms is the key driver for the projected changes on the demand side (see Figure 5-4), whereas overall energy requirements exhibit only a limited decline from Baseline levels over the projection period (-0.7%

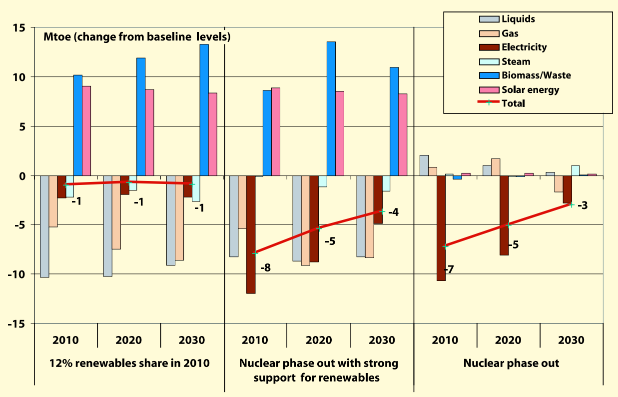
66 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) for the scenarios examined are available in the enclosed CD.

Table 5-6: Evolution of primary energy needs in the EU-25 in the "Nuclear phase out in 2010, with support for renewables" case

	Mtoe				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	262.9	279.2	330.4	7.9	10.5	10.2
Liquid Fuels	635.6	629.4	648.0	654.9	-3.7	-3.5	-2.9
Natural Gas	376.0	554.7	621.7	638.1	9.4	4.0	1.6
Nuclear	237.7	0.0	0.0	0.0	-100.0	-100.0	-100.0
Renewable energy forms	96.1	229.3	248.4	260.6	72.9	64.2	53.8
Total	**1650.7**	**1679.1**	**1800.2**	**1887.0**	**-5.9**	**-4.7**	**-3.7**
EU-15	**1453**	**1476**	**1573**	**1648**	**-6.3**	**-5.1**	**-4.2**
NMS	**198**	**203**	**227**	**239**	**-2.5**	**-1.9**	**-0.6**
Mt CO_2 emitted	***3665***	***3876***	***4133***	***4391***	***3.2***	***2.3***	***2.0***
EU-15	***3118***	***3317***	***3527***	***3766***	***3.5***	***2.4***	***2.6***
NMS	***547***	***559***	***606***	***625***	***1.3***	***1.6***	***-1.5***

Source: PRIMES.

Figure 5-4: Changes of final energy demand by fuel in the EU-25 in the "Nuclear phase out in 2010 with strong support for renewables" case (changes in Mtoe compared to Baseline for three different cases: 12% renewables share in 2010, nuclear phase out in 2010 with strong support for renewables, and pure nuclear phase out)



Source: PRIMES.

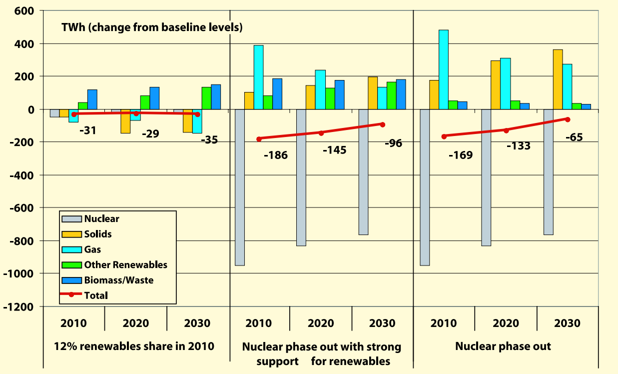
in 2010; -0.3% in 2030). Promotional policies for the use of biomass and waste in industry and of solar thermal panels for water heating purposes in services and households give rise to a significant increase in the use of renewable energy forms. This occurs to the detriment of natural gas and liquid fuels. However, as electricity demand also declines, due to the higher electricity prices facing consumers because of the nuclear phase out, the projected decline for liquids and natural gas is less pronounced than in the "12% renewables share in 2010" case.

The most pronounced changes in the "Nuclear phase out in 2010 with strong support for renewables" case occur in the power generation sector (see Figure 5-5). Electricity generation from renewable energy forms grows well above Baseline levels but also above the "12% renewables share in 2010" case levels especially in the short run (+44.9% in 2010 and +42.9% in 2030 compared to 25.5% in 2010 and +34.9% in 2030 in the "12% renewables share in 2010" case). Thus, a nuclear phase out further accelerates the penetration of renewable energy forms in the power generation sector. The bulk of additional electricity generation from renewables results from the further exploitation of biomass and waste potential over the projection period (some 69.4% in 2010 declining to 52.8% in 2030). The rest is mainly satisfied by wind turbines (capacity of which rises to 174.2 GW in 2030, +39.3 GW above Baseline levels) as the unexploited hydro potential is rather limited in the EU-25 energy system. The share of renewables in electricity generation reaches 26.9% in 2010 and 26.6% in 2030 (+9.4 and +8.4 percentage points from Baseline levels respectively) whereas the corresponding shares in the "12% renewables share in 2010" case were 22.3% and 24.7%.

However, despite this significant growth projected for renewable energy forms in the "Nuclear phase out in 2010, with strong support for renewables" case, the gap arising from the nuclear phase out in electricity generation cannot be filled entirely with renewables. This gives rise to a large increase in electricity generation from natural gas and solid fuels, especially in the short run. In 2010 some 51% of the gap generated in electricity production due to nuclear phase out is satisfied with natural gas (36% for renewables and 13% from solids). By 2030 renewable energy forms become the key means for replacing nuclear energy, accounting for 51% of the gap in electricity generation followed by solids (29%) and natural gas (20%). The results obtained in the "Nuclear phase out in 2010 with strong support for renewables" case are significantly different from those in the "Nuclear phase out" case. In the latter case electricity generation from renewable energy forms accounts for just 13% in 2010 and 9% in 2030 of the gap generated in the power sector due to closure of nuclear power plants in the EU-25. It is thus clear that promotional policies for renewable energy forms, in the context of nuclear phase out, lead to a much more favourable renewables development in the power generation sector.

These changes in the power sector are also reflected in the evolution of CO_2 emissions in the EU-25 energy system (see Figure 5-6). The projected decline of CO_2 emissions from the demand side, arising from promotional policies for renewables, are of a similar magnitude to those projected in the "12% renewables share in 2010" case. The growth of CO_2 emissions above Baseline levels from the supply side is also projected to be less pronounced than in the

Figure 5-5: Changes in electricity generation in the EU-25 in the "Nuclear phase out in 2010 with strong support for renewables" case (changes in TWh compared to Baseline for three different cases: 12% renewables share in 2010, nuclear phase out in 2010 with strong support for renewables, and pure nuclear phase out)



Source: PRIMES.

"Nuclear phase out" case. In 2010, additional CO_2 emissions from the supply side are +209 Mt CO_2 above Baseline levels (compared to +310 Mt CO_2 for the supply side in the "Nuclear phase out case), declining in 2030 to +165 Mt CO_2 (almost half the increase projected in the "Nuclear phase out" case). As a combined effect of the improvement of carbon intensity, compared to the Baseline scenario, on the demand side and the less pronounced worsening in the supply side, CO_2 emissions from the EU-25 energy system are +2.8% above 1990 levels in 2010 (compared with -0.3% in the Baseline and +8.2% in the "Nuclear phase out" case). In 2030, CO_2 emissions in the combined "Nuclear phase out in 2010 with strong support for renewables" case exceed the 1990 level by +16.5% (+2.3 percentage points higher than in the Baseline scenario but -6.2 percentage points less than in the pure "Nuclear phase out" case).

5.4.2. "New nuclear technology with strong support for renewables" case

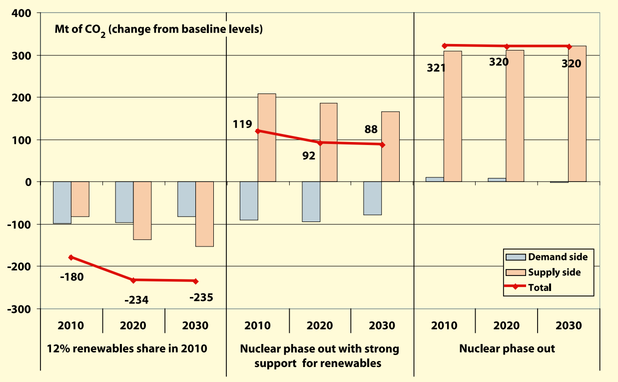
The "New nuclear technology, with strong support for renewables" case combines the acceptance of new nuclear technology with the promotion of renewables, as in the "12% renewables share in 2010" case of Chapter 4. This case shows an alternative trajectory, with a high contribution of non-fossil fuels in the EU-25 energy system and thus positive effects both on the evolution of CO_2 emissions and on import dependency. As illustrated in Table 5-7 primary energy needs for nuclear energy and renewable energy forms experience growth well above Baseline levels in the long run, while demand for fossil fuels declines.

In 2010, the results obtained in the "New nuclear with strong support for renewables" case are almost identical to those of the "12% renewables share in 2010" case. This is because the key driver for change compared to the Baseline scenario is the implementation of promotional policies for renewable energy forms, given that the time horizon is too short for significant new nuclear investment in 2010. Beyond that period, and as declared nuclear phase out policies of EU-25 Member States are revisited given the assumed acceptance of new nuclear technology, significant changes occur in terms of primary energy needs. Both nuclear energy and renewable energy forms gain additional market share in the EU-25 energy system to the detriment of solid fuels and, to a lesser extent, natural gas and liquid fuels. In 2030 nuclear energy accounts for 15.7% of primary energy needs while the share of renewables reaches 12.4%. This leads to lower fossil fuel dependence of the EU-25 energy system (fossil fuels accounting for 71.2% of primary energy needs in 2030 compared to 81.8% in the Baseline).

This change is also reflected in the import dependency for the EU-25 which in 2030 is limited to 58.7% (-8.7 percentage points below Baseline levels). CO_2 emissions would stay below the 1990 level up to 2020 and would nearly stabilise at this level in 2030 (exceeding the 1990 CO_2 figure by only 1.9% whereas this increase amounts to 14.2% in the Baseline). Thus the "New nuclear with strong support for renewables" case results illustrate that promoting renewables and the acceptance of a new nuclear technology can act in a complementary manner in the restructuring of the EU-25 energy system (see also Figure 5-7).

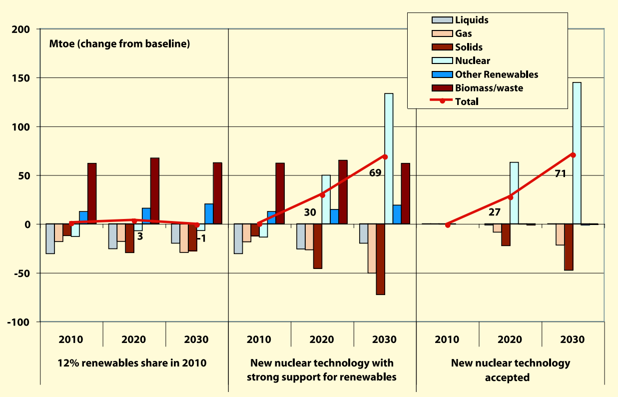
In line with the findings of the "New nuclear technology accepted" case, in which the higher exploitation of nuclear energy in power generation did not result in significant changes as regards the projected evolution of final energy demand, the changes on the demand side arise from implementation of promotional policies for

Figure 5-6: Changes in CO_2 emissions for the EU-25 in the "Nuclear phase out in 2010 with strong support for renewables" case (changes in Mt CO_2 compared to Baseline for three different cases: 12% renewables share in 2010, nuclear phase out in 2010 with strong support for renewables, and pure nuclear phase out)



Source: PRIMES.

Figure 5-7: Changes in primary energy needs by fuel in the EU-25 in the "New nuclear technology, with support for renewables" case (changes in Mtoe compared to Baseline for three different cases: 12% renewables share in 2010, new nuclear technology, with support for renewables, and new nuclear technology being accepted)



Source: PRIMES.

Table 5-7: Evolution of primary energy needs in the EU-25 in the "New nuclear technology, with support for renewables" case

	Mtoe				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	231.4	207.1	227.3	-5.0	-18.1	-24.2
Liquid Fuels	635.6	623.0	645.8	654.5	-4.7	-3.8	-2.9
Natural Gas	376.0	488.5	571.2	577.7	-3.6	-4.5	-8.1
Nuclear	237.7	231.6	263.4	318.7	-5.6	23.4	72.0
Renewable energy forms	96.1	207.5	231.2	250.7	56.4	52.8	47.9
Total	**1650.7**	**1784.2**	**1918.5**	**2028.6**	**0.0**	**1.6**	**3.5**
EU-15	**1453**	**1576**	**1685**	**1784**	**0.0**	**1.7**	**3.7**
NMS	**198**	**208**	**233**	**245**	**0.0**	**0.7**	**2.0**
Mt CO_2 emitted	***3665***	***3577***	***3721***	***3841***	***-4.8***	***-7.9***	***-10.8***
EU-15	***3118***	***3043***	***3142***	***3259***	***-5.0***	***-8.8***	***-11.2***
NMS	***547***	***534***	***580***	***582***	***-3.3***	***-2.8***	***-8.4***

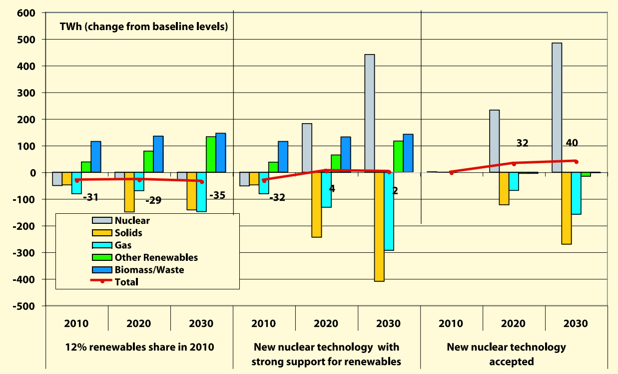
Source: PRIMES.

renewable energy forms. Overall energy requirements remain at similar levels to those observed under Baseline assumptions. But biomass and waste (the use of which increases well above Baseline levels in industrial sectors) and solar energy (in satisfying water heating requirements for households and services) gain additional market share to the detriment of all other energy forms. In addition the share of biofuels in transport rises above Baseline levels, following similar trends to those observed the "12% renewables share in 2010" case. This increase largely explains the projected decline of primary energy needs for oil, as its role in power generation is rather limited.

The combination of promotional policies for renewables and the acceptance of new nuclear technology lead to a significantly different development of the EU-25 power generation sector compared to the Baseline scenario. As illustrated in Figure 5-8, the use of renewables in electricity generation experiences similar growth above Baseline levels to that observed in the "12% renewables share in 2010" case. The evolution of electricity generation from nuclear power plants in this combined renewables and nuclear case is also similar to that in the "New nuclear technology accepted" case. Given that electricity production remains essentially unchanged from Baseline levels over the projection period, electricity generation from fossil fuels is projected to fall significantly.

In the "New nuclear technology with strong support for renewables" case electricity generation from renewable energy forms increases by some 260 TWh (or +32.5%) in 2030 compared to the Baseline scenario (45% of which is produced from hydro and intermittent renewable energy forms). This gives rise to an increase in their market share, which reaches 24.1% of total electricity generation in 2030 (+5.9 percentage points above Baseline levels). The market share of nuclear in electricity generation also increases well above Baseline levels, reaching 27.5% in 2030 (+10 percentage points higher than Baseline levels) following an increase of nuclear production by 441 TWh or +57.6%. Thus, in the "New nuclear technology with strong support for renewables" case fossil fuels account in 2030 for only 48.5% of electricity generation compared to 64.5% in the Baseline

Figure 5-8: Changes in electricity generation in the EU-25 in the "New nuclear technology with strong support for renewables" case (changes in TWh compared to Baseline for three different cases: 12% renewables share in 2010, new nuclear technology with strong support for renewables, and new nuclear technology being accepted)

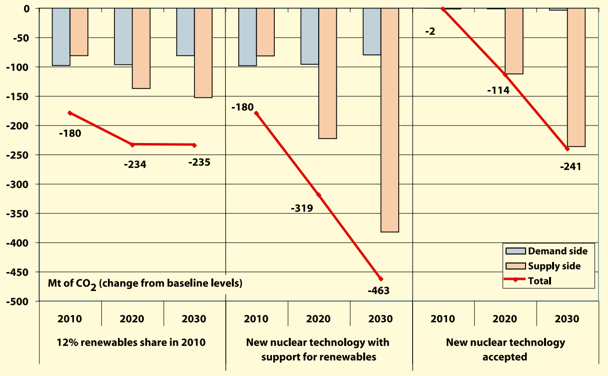


scenario. Electricity production from solid fuels declines in 2030 by -410 TWh (or -34.8%) compared to the Baseline scenario, while the corresponding decline in natural gas-based electricity is -293 TWh (or -18.1%). It is important to note that electricity generation from solid fuels in 2015-2030 still grows somewhat (+2.1% pa compared to +4.0% pa in the Baseline scenario) even in the "New nuclear with strong support for renewables" case. Thus, the projected comeback of hard coal in the power generation sector beyond 2015 still occurs though at a slower pace than in the Baseline scenario.

The increasing importance of non-fossil fuels in electricity generation results in a significant decline of CO_2 emissions from the supply side compared to the Baseline scenario (see Figure 5-9). In the "New nuclear technology with strong support for renewables" case CO_2 emissions from the supply side of the EU-25 energy system in 2030 are projected to fall by 21.8% compared with the Baseline scenario (-383 Mt CO_2). Furthermore, CO_2 emissions from the demand side are also projected to grow at a slower pace (-3.1% from Baseline levels in 2030).

In 2010, the total CO_2 emissions reduction is equivalent to that observed in the "12% renewables share in 2010" case while in the long run it is more than 2.5 times higher reaching -463 Mt CO_2 (or -10.8%) below Baseline levels in 2030. It is interesting to note that the reduction achieved in 2030 is almost equivalent to the sum of the projected reductions for the "12% renewables share in 2010" case (-235 Mt CO_2) and for the "New nuclear technology accepted" case (-241 Mt CO_2). This result clearly illustrates that promotional policies for renewable energy forms and the acceptance of new nuclear technology do not contradict one another. In comparison to 1990 levels CO_2 emissions reach -5.1% in 2010 and +1.9% in 2030 (from -0.3% and +14.2% respectively in the Baseline scenario).

Figure 5-9: Changes in CO_2 emissions for the EU-25 in the "New nucleartechnology with strong support for renewables" case (changes in Mt CO_2 compared to Baseline for three different cases: 12% renewables share in 2010, new nuclear technology with strong support for renewables, and new nuclear technology being accepted)



Source: PRIMES.

CHAPTER 6: Transport

6.1. Definition of alternative scenarios

Transport is a key driver for the EU-25 outlook in terms of both energy and emissions. In the Baseline scenario, energy demand in the transport sector is projected to remain a very important segment of energy needs in the EU-25 energy system (accounting for about one third of final energy demand over the projection period). Transport is also the fastest growing demand sector in new Member States (NMS), with its share in final energy demand in these states rising from 19.2% in 2000 to 25.4% in 2030. The transport projections in the Baseline are in line with those in the White Paper on Common Transport Policy: Anticipated trend scenario, allowing for different economic growth assumptions. Given the importance of transport for the economy and the daily lives of citizens, and because of its impacts on oil supply security and environmental emissions, this sector has been a priority policy area within the EU for many years. It is important to note that transport energy demand is rather insensitive to high fuel taxation, especially for private transportation. Thus, there has been increasing emphasis on influencing the efficiency of transportation fuel use through non-market instruments. Such a non-market instrument is the agreement of the Commission with ACEA/KAMA/JAMA that is already included in the Baseline scenario assumptions.

In addition to the policies included in the Baseline scenario, this chapter shows the energy, transport and emission consequences of realising the Option C scenario of the White Paper on Common Transport Policy up to 2010, which assumes the successful implementation of the policies proposed in the White Paper. These policies and measures impact on energy consumption by encouraging more efficient transport modes or through increasing the efficiency of transport within individual modes, including higher load factors (e.g. better utilisation of vehicle capacities). In order to obtain a better analytical insight into the results of this scenario, two alternative cases were defined:

- A scenario assuming that the share of rail (both passenger and freight) and public road transport activity will remain essentially stable at the 1998 level up to 2010, in contrast to the Baseline trend of continuously diminishing shares of these modes. In other words the scenario assumes that, with overall transport volume (expressed in passenger kilometres and tonne kilometres) remaining unchanged from Baseline levels, policies promoting rail transport and public road transport will lead to stronger growth for these modes compared to Baseline. This growth will occur to the detriment of other transport modes, thereby leading to a higher share of rail and public road transport. This scenario can be considered a partial implementation of the Option C scenario.
- A scenario involving the assumptions made above for rail and public road transport activity but assuming, additionally, that load factors of all transport modes will increase significantly by 2010 in comparison to Baseline trends. This means that all transport modes will be used in a much more efficient way than today. This scenario is in line with the Option C scenario in the Commission's White Paper on Transport. It can therefore be considered as the scenario involving virtually all measures that can be implemented up to 2010 to curb energy consumption and CO_2 emissions from transportation under Baseline economic developments.

The impacts of the development of the EU-25 transport sector following the trends of the Option C scenario of the White Paper on Common Transport Policy up to 2010 (both for the partial and the full implementation scenarios) are discussed below.

6.1.1. Policy Guidelines of the transport White paper

Transport is a key factor in modern economies. However, there is a permanent tension between society, which demands ever greater mobility, and public opinion, which is becoming increasingly intolerant of congestion, chronic delays, noise, environmental impacts and the poor quality of some transport services. As demand for transport keeps increasing, the Community's answer cannot be limited merely to building new infrastructure and opening up markets. The transport system needs to be optimised to meet the demands of enlargement and sustainable development, as set out in the conclusions of the Gothenburg European Council. A modern transport system must be sustainable from an economic and social, as well as an environmental, viewpoint.

Mixed performance of the common transport policy

The 1990s brought important advances in common transport policy through a significant drop in consumer prices (e.g. in aviation), combined with a higher quality of service and a wider range of choice. Developments in transport have materially changed the lifestyles and consumption habits of European citizens. Personal mobility, which increased from 17 km a day in 1970 to 35 km in 1998, is now more or less seen as a basic right.

The second advance of this policy, apart from the results of EU-funded research programmes, was to develop the most modern techniques within a European framework of interoperability. Projects launched at the end of the 1980s are now bearing fruit, as symbolised by the trans-European high-speed rail network and the Galileo satellite navigation programme. However, it is a matter for regret that modern techniques and infrastructure have not always been matched by modernisation of company management, particularly in some rail companies.

Despite the successful opening-up of the transport market over the last 10 years, the need to complete the internal market makes it difficult to accept distortions of competition resulting from lack of fiscal and social harmonisation. The fact that there has been no harmonious development of the common transport policy is the reason for current problems such as:

- unequal growth in the different modes of transport. While this reflects the fact that some modes have adapted better to the needs of a modern economy, it is also a sign that not all external costs have been included in the price of transport. Consequently, road transport accounted for 45% of the total EU-15 goods transport market in 2001 compared with 40% for short sea shipping, 8% for rail and 4% for inland waterways. The predominance of roads is even more marked in passenger transportation, roads accounting for 87% of the market, while air with 6% is about to overtake railways, which are now down to 7%;[67]
- congestion on the main road and rail routes, in towns, and at airports;
- harmful effects on the environment (road construction, land use for parking, emissions etc.) and on public health and, of course, the heavy toll from road accidents.

Growth in transport in the enlarged European Union

There are two key factors behind the continued growth in transport demand. For passenger transport, the determining factor is the spectacular expansion in car use. The number of cars has tripled in the last 30 years, increasing by some 3 million cars each year. By 2010, the enlarged Union will see its car fleet increase substantially. As far as goods transport is concerned, growth is mainly due to changes in the European economy and its system of production. In the last 20 years, we have moved from a 'stock' to a 'flow' economy. The abolition of frontiers within the Community has resulted in the establishment of a 'just-in-time' or 'revolving stock' production system. Specialisation, globalisation, the search for manufacturing scale economies, and rationalisation of production facilities have also increased freight movements.

Unless major new measures are taken by 2010 in the EU so that the Member States can use each mode of transport more rationally, heavy goods vehicle traffic alone will increase by nearly 50% over its 1998 level in EU-15. This means that those regions and main through routes which are already heavily congested will have to handle even more traffic. The strong economic growth expected in the new Member States, and better links with outlying regions, will also increase transport flows, in particular road haulage traffic.

The need for integration of transport in sustainable development

The Commission's November 2000 Green Paper on Security of Supply highlighted the important role of transport in the growth of energy demand and CO_2 emissions. Transport in the enlarged Union accounted for 26% of overall CO_2 emissions in 2000. According to the Baseline developments, shown in Chapter 1 of this publication, CO_2 emissions from transport are expected to increase by 40% between 1990 and 2010 in EU-25, whereas total CO_2 emissions will remain at their 1990 level. Road transport is the main source since it alone accounts for 84% of the total CO_2 emissions attributable to transport.

In this context, efforts already made, particularly in the road sector, to preserve air quality and combat noise, have to be continued. This is in order to meet the needs of the environment and public concerns without compromising the competitiveness of the transport system and of the economy. Enlargement will have a considerable impact on demand for mobility. This will involve greater efforts to break the link gradually between transport growth and economic growth and make for a modal shift, as called for by the European Council in Gothenburg.

The Transport White Paper is based on this approach. Its proposals comprise a series of measures ranging from pricing, to revitalising alternative modes of transport to road, and targeted investment in the trans-European network.

Principal measures proposed in the White Paper

The White Paper proposes some 60 specific measures on transport policy to be taken at Community level, which address the following issues:

- **Revitalising the railways.** Rail transport is, in some ways, the key to the success of efforts to shift the modal balance, particularly in the case of goods. The priority is to open up markets, not only for international services, as agreed in December 2000, but also for cabotage in Member States' national markets and for international passenger services. This opening-up of markets must be accompanied by further harmonisation in the fields of interoperability and safety.
- **Improving quality in the road transport sector.** The Commission will propose legislation allowing harmonisation of certain clauses in contracts to protect carriers from consignors, and enable them to revise their tariffs in the event of sharp rises in fuel prices.
- **Promoting transport by sea and inland waterway.** The way to revive short-sea shipping is to build virtual sea "motorways" within the framework of the master plan for the trans-European network. This will require better connections between ports and the rail and inland waterway networks, together with improvements in the quality of port services. To increase maritime safety the Commission will propose minimum social rules to be observed in ship inspections and develop a genuine European maritime traffic management system.
- **Striking a balance between growth in air transport and the environment.** It is imperative to implement a series of specific proposals establishing Community legislation on air traffic. Accompanying measures must also ensure that the inevitable expansion of airport capacity remains strictly subject to new regulations to reduce aircraft noise and pollution.

67 Source: "Energy and Transport in Figures – Statistical Pocketbook 2003", Energy and Transport DG. It should be noted that the shares in the goods and passenger transport markets on this page include short sea shipping, which is not represented in energy statistics. Energy statistics treat most sea-borne traffic of ships under the heading of bunkers. Therefore, the shares on this page do not correspond to those in the following energy analysis which do not include short-sea shipping, given that energy and transport statistics have been developed for different purposes in the past. Energy consumption for short sea shipping, i.e. bunkers, has not been considered as part of inland energy consumption in EUROSTAT energy balances, which form the basis for the following energy projections.

- **Turning inter-modality into reality.** Action must be taken to ensure fuller integration of those modes offering considerable potential transport capacity, as links in an efficiently managed transport chain which joins up all the individual services. The priorities must be technical harmonisation and interoperability between systems, particularly for containers.
- **Building the trans-European transport network.** To reduce the saturation of certain major arteries and the consequent pollution, the Commission proposes to concentrate the revision of Community guidelines on removing bottlenecks in the railway network; completing the routes identified as the priorities for absorbing the traffic flows generated by enlargement, particularly in frontier regions; and improving access to outlying areas.
- **Improving road safety.** Every day the total number of people killed on Europe's roads is practically the same as in a medium-haul plane crash. Road accident victims, the dead or injured, cost society tens of billions of euros - but the human costs are incalculable. For this reason, the EU will endeavour to halve the number of such victims by 2010.
- **Adopting a policy on effective charging for transport.** The White Paper develops the following guidelines: (i) harmonisation of fuel taxation for commercial users, particularly in road transport; and (ii) alignment of the principles for charging for infrastructure use. The integration of external costs must also encourage the use of those modes with lower environmental impacts.
- **Recognising the rights and obligations of users.** European citizens' rights to have access to high quality services providing integrated services at affordable prices will be reinforced.
- **Developing high-quality urban transport.** A better approach is needed from local public authorities to reconcile modernisation of the public transport services with more rational car use to achieve sustainable development.
- **Putting research and technology at the service of clean, efficient transport.** The research framework programme for 2002–06 provides an opportunity to put new applications such as inter-modality, clean vehicles and telematics into action; and to facilitate co-ordination and increased efficiency in the transport research system.
- **Developing medium- and long-term environmental objectives for a sustainable transport system.** A sustainable transport system needs to be defined in operational terms to provide policy-makers with more useful guidelines and information. Wherever possible, the proposed objectives need to be quantified.

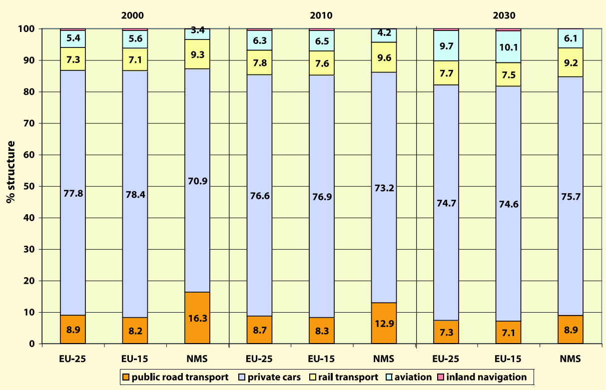
6.2. "Promoting rail and improved load factors" scenario results for EU-25[68]

The "Promoting rail and improved load factors" case reflects development of the EU-25 transport sector along the lines of the Option C scenario of the Transport White Paper. The Option C scenario deals with the future evolution of the EU-15 transport sector and comprises a series of measures (described in the White Paper). These range from pricing, to revitalising alternative modes of transport to road, and targeted investment in the trans-European network. Implementation of these measures is expected to lead to a stabilization of the market shares of rail transport and inland navigation to their levels in 1998, to the detriment of road transport, while overall transport activity remains at Baseline levels. In addition policy incentives are provided to encourage consumers towards more rational use of transport modes, especially through improved vehicle load factors. To obtain a better understanding of the impact of improving vehicle load factors an additional case was examined ("Promoting rail" case)[69], focusing only on re-balancing the structure of transport activity.

Figure 6-1 illustrates the projected development of passenger transport activity in the "Promoting rail and improved load factors" case for the EU-25, the EU-15 and the NMS. As regards the EU-15, the projected trends in for passenger transport activity are in line with those discussed in the Option C case of the White Paper for Transport. Similar trends have been assumed for new Member States.

Rail transport activity, at the EU-25 level, is projected to increase by some 21.3% from Baseline levels in 2010 (+88.3 Gpkm;[70] see also Figure 6-2). Its share in total passenger transport activity is 7.8% in 2010 (compared to 6.4% in the Baseline and 7.3% in 2000). Thereafter it follows Baseline growth rates with the rail share declining to 7.7% in 2030 (compared with 6.3% under Baseline assumptions). Public road transport activity is also assumed to increase significantly (+11.1% from Baseline levels in 2010 or +56.1 Gpkm, +12.3% in 2030). The share of all public transport reaches 8.7% in 2010 (from 8.9% in 2000), declining to 7.3% in 2030. Under Baseline

Figure 6-1: Structure of passenger transport activity by mode in EU-25, EU-15 and in the new Member States (NMS) in the "Promoting rail and improved load factors" case



Source: PRIMES.

68 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to the Baseline) for the three cases examined are available in the enclosed CD.

69 Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) for the "Promoting rail" case are available in the enclosed CD.

70 Passenger transport activity is expressed in passenger kilometres (1 Gpkm = 10^9 pkm); one pkm relates to one person travelling a distance of one km.

assumptions the share of public road transport activity declines to 7.8% in 2010, and 6.5% in 2030. The declining share of public road transport activity in the EU-25 strongly relates to the assumptions introduced in the "Promoting rail and improved load factors" case as regards passenger transport activity in new Member States.

There is a lack of detail on structural changes for new Member States (NMS), unlike that for EU-15 (as specified in Option-C of the White Paper on Transport). It was thus assumed that the projected higher contribution of rail transport in the "Promoting rail and improved load factors" case compared to Baseline would occur to the detriment of all other transport modes including public road transport. This is because of the already high share of collective road transport and strongly rising incomes in the new Member States. Public road transport plays a much bigger role in NMS (16.3% of total passenger transport activity in 2000, 13.2% in 2010 under Baseline conditions), compared to the EU-15 share of 8.2% in 2000 and 7.3% in 2010 under Baseline conditions. Moreover, economic and structural developments, in particular rising incomes, in NMS are projected to lead to a strong shift towards the use of private cars. Such an approach implies that the share of public road transport in total passenger transport activity for the NMS would also decline from Baseline levels (some -0.3% in 2010, -0.1% in 2030). This contrasts with an assumed stabilization in the period to 2010 of the share of public road transport activity for the EU-15 in Option C of the White Paper on Transport. It should also be noted that, even with this slight decrease in the "Promoting rail and improved load factors" case, the share of public road transport in NMS remains more than 50% higher than that for the EU-15.

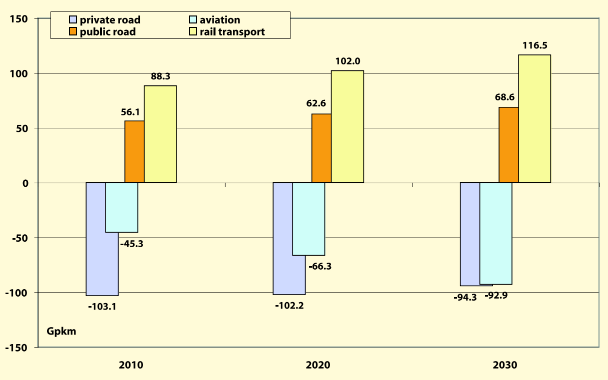
In 2010 the increase of rail and public road transport activity, in absolute terms, occurs mainly to the detriment of private road transport activity (-103.1 Gpkm in 2010 compared to -45.3 Gpkm for aviation). In the long run the decline in aviation activity (-92.9 Gpkm in 2030) is of equal importance to that of private road transport (-94.3 Gpkm). However, in relative terms it is mainly aviation (-10.1% both in 2010 and 2030 from Baseline levels) that faces the greater impact as a result of policies promoting higher rail use throughout the projection period. Private road transport activity declines by just -2.1% from Baseline levels in 2010 and by only -1.5% in 2030. Inland navigation is also assumed to decline (-2.7% from Baseline levels in 2010 and –1.6% in 2030) which is, however, insignificant in absolute terms.

As regards freight transport activity, the Option C scenario of the White Paper for Transport focuses on the implementation of promotional policies that will allow for a stabilization of the market shares of rail freight and inland navigation in 2010 at 1998 levels. This compares to the projected decline under Baseline scenario assumptions (see Figure 6-3). In 2010 the share of rail freight activity reaches 17.3% in 2010 (from 14.1% in the Baseline scenario and 17.1% in 2000) but declines thereafter to 14% in 2030 (compared to 11.2% in the Baseline scenario). Similarly the share of inland navigation in the "Promoting rail and improved load factors" case increases from 13.8% in 2000 to 13.9% in 2010 (12.8% in Baseline), dropping to 12.4% in 2030 (11.3% in Baseline).[71]

Again, as in the case of passenger transport activity, for the new Member States the Option C scenario was applied with some adjustments as regards the development of rail freight market shares. The share of railways in freight transport is considerably higher in NMS than in the EU-15: in 2000, the share of rail in total freight transport was over 43% in NMS, compared to 13.3% in EU-15. The trend towards lower railway shares in freight transport seems to be almost inevitable in the long term due to structural changes in the NMS' economies. These changes will encourage smaller, more specialised and decentralised industries and services, which in turn will increasingly require trucks for transport of goods and commodities. In that context it was assumed for NMS that the significant share of rail freight in 2000 will decline over the projection period, but at rates well below those observed under Baseline assumptions (with rail freight accounting for 41.6% in 2010 and 30.4% in 2030, compared to 33.8% in 2010 and 23.6% in 2030 under Baseline assumptions).

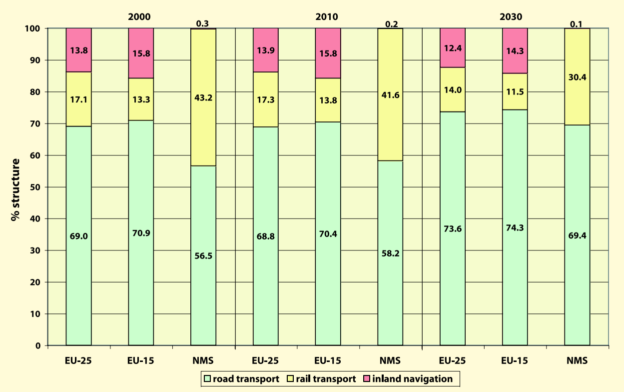
Changes in freight transport activity in comparison to the Baseline scenario are illustrated in Figure 6-4. In 2010 more than two thirds of the decline of road freight transport activity from Baseline levels

Figure 6-2: Passenger transport activity in EU-25 in the "Promoting rail and improved load factors" case (change from Baseline levels in Gpkm)



Source: PRIMES.

Figure 6-3: Structure of freight transport activity by mode in EU-25, EU-15 and in the new Member states (NMS) in the "Promoting rail and improved load factors" case



Source: PRIMES.

71 See footnote 67 earlier on the modal shares and the differences between energy and transport statistical concepts.

(-89.5 Gtkm)[72] are explained by corresponding growth above Baseline for rail freight activity (+60.8 Gtkm) and the rest by inland navigation. A similar trend is also projected for 2030, with rail freight activity some +76 Gtkm above Baseline levels and inland navigation at +42.7 Gtkm. The increase of rail freight is +23.1% in 2010 and +24.9% in 2030, compared to 8.1% and +9.3% respectively for inland navigation. However, given the predominant role of road freight activity in the EU-25 transport sector, the effects arising from implementation of promotional policies for rail and inland navigation on the evolution of road freight transport activity is quite limited, ranging from -5.9% from Baseline levels in 2010 to -5.1% in 2030.

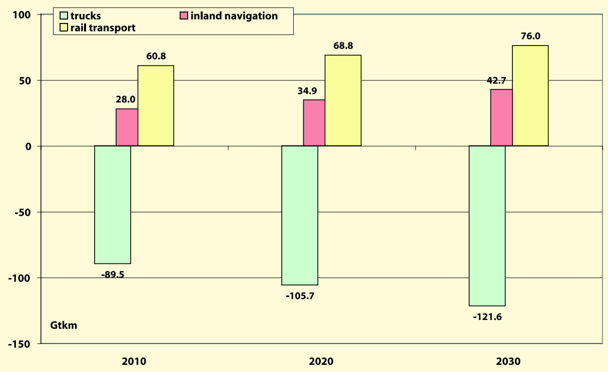
Changes in the structure of transport activity, combined with improved vehicle load factors in the "Promoting rail and improved load factors" case, lead to significant reductions in energy use by the transport sector (see Table 6-1). Energy requirements in the transport sector decline by -13.0% from Baseline levels in 2010 and by -8.7% in 2030. Furthermore, this shift towards rail transport leads to an even more pronounced slowdown in CO_2 emissions growth (-13.4% from Baseline levels in 2010, -9.0% in 2030) due to changes in the fuel mix in favour of electricity use in transport. In 2010 the most pronounced decline is projected for energy demand in aviation (-17.1% from Baseline levels), followed by road freight (-16.4%) and private cars (-4.8%). In the long run, these trends are reversed with the most pronounced decline from Baseline levels projected for private cars (-12.1% in 2030) followed by road freight and aviation (-7.2% and -10.7% respectively). This result stems from the assumed improvement of vehicle load factors (e.g. fuller and bigger airplanes). This has a much stronger impact on energy consumption in aviation, the most energy-intensive passenger transport mode, than for other transport modes.

The importance of improved vehicle load factors is clearly revealed when comparing the results of the "Promoting rail and improved load factors" case to those of the "Promoting rail" case (see Table 6-1). The "Promoting rail" case incorporates an almost identical evolution of transport activity by mode to that of the "Promoting rail and improved load factors" case, but it excludes improvements in vehicle load factors. In this case the decline in energy requirements from Baseline levels is limited to -3.5% in 2010 and -3.7% in 2030, with the corresponding decline in CO_2 emissions ranging from -4.0% in 2010 to -4.1% in 2030. Among passenger transport means the most pronounced change occurs for private car use, which declines by -2.1% in 2010 and -1.6% in 2030 compared to -11.0% and -12.1% respectively in the "Promoting rail and improved load factors" case. This result clearly illustrates the importance of policies promoting higher load factors in cars. The role of a more rational use of trucks is also highlighted by the results obtained. The decline in energy requirements for road freight in 2010 under the "Promoting rail" case is only one third of that achieved in the "Promoting rail and improved load factors" case from Baseline levels (-5.5% compared to -16.4% respectively).

The "Promoting rail and improved load factors" case leads to a reduction of transport energy requirements from Baseline levels by 50.3 Mtoe in 2010 and 38.8 Mtoe in 2030 (see Figure 6-5). The corresponding declines in the "Promoting rail" case are limited to 13.7 Mtoe and 16.5 Mtoe respectively, i.e. improved load factors alone account for a reduction of energy requirements in the transport sector by -36.6 Mtoe in 2010 and -22.3 Mtoe in 2030. Furthermore, the impact on the fuel mix also differs between the two cases. The decline in diesel oil and gasoline is significantly greater when improved vehicle load factors are assumed.

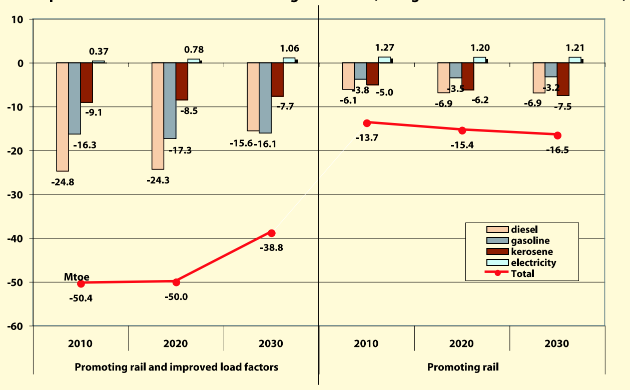
Fuel efficiency gains in overall passenger transport activity (see Figure 6-6) reach 11.4% in 2010 and 10.4% in 2030 above Baseline levels under the "Promoting rail and improved load factors" case. But the corresponding gains in the "Promoting rail" case are only 3.4% in 2030. Under the "Promoting rail and improved load factors" case efficiency gains occur for all passenger transport modes, with road and rail transport exhibiting the greatest gains. In the "Promoting rail" case only rail and road exhibit efficiency gains compared with Baseline throughout the projection period. In contrast, fuel efficiency in aviation and inland navigation worsens somewhat compared with Baseline, mainly due to slower vehicle stock replacement because of lower growth in transport activity. Another interesting finding in the long run is that in both cases overall efficiency gains are more pronounced compared to those of the individual trans-

Figure 6-4: Freight transport activity in EU-25 in the "Promoting rail and improved load factors" case (change from Baseline levels in Gtkm)



Source: PRIMES.

Figure 6-5: Transport sector energy demand by fuel in EU-25 in the "Promoting rail and improved load factors" and "Promoting rail" cases (change from Baseline levels in Mtoe)



Source: PRIMES.

72 Freight transport activity is expressed in tonne kilometres (1 Gtkm = 10 [9] tkm); one tkm = one tonne transported a distance of one km.

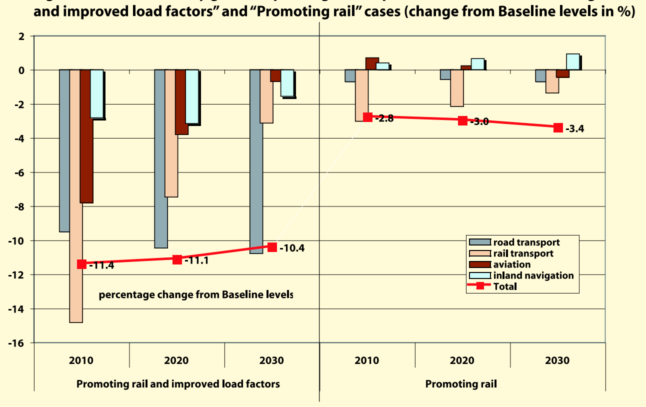
Table 6-1: Transport sector energy demand in EU-25 in the "Promoting rail and improved load factors" and "Promoting rail" cases

Promoting rail+load factors	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
road transport	273	278	308	331	-13.0	-12.1	-9.0
public road transport	7	7	7	7	3.6	5.8	9.5
motorcycles	2	2	3	2	-4.8	-4.5	-2.0
private cars	155	148	146	140	-11.0	-11.8	-12.1
trucks	109	120	151	181	-16.4	-13.3	-7.2
rail transport	9	8	7	7	5.1	12.7	18.0
aviation	45	44	55	64	-17.1	-13.5	-10.7
inland navigation	5	6	7	8	-0.6	1.8	5.4
Total transport	**332**	**337**	**377**	**410**	**-13.0**	**-11.7**	**-8.7**
EU15	**309**	**311**	**344**	**372**	**-13.0**	**-11.6**	**-8.5**
NMS	**23**	**26**	**33**	**38**	**-13.3**	**-12.7**	**-10.0**
Mt CO_2 emitted	***969***	***962***	***1066***	***1144***	***-13.4***	***-12.1***	***-9.0***
EU-15	***904***	***888***	***973***	***1039***	***-13.3***	***-12.0***	***-8.8***
NMS	***65***	***74***	***93***	***105***	***-13.9***	***-13.3***	***-10.6***
Promoting rail	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
road transport	273	309	339	353	-3.3	-3.2	-3.0
public road transport	7	8	8	7	11.0	11.1	11.4
motorcycles	2	2	3	3	-2.0	-1.6	-1.2
private cars	155	163	163	156	-2.1	-1.7	-1.6
trucks	109	136	166	186	-5.5	-5.1	-4.7
rail transport	9	9	8	8	18.7	19.5	20.6
aviation	45	48	57	64	-9.5	-9.8	-10.5
inland navigation	5	7	8	8	7.1	7.6	8.3
Total transport	**332**	**373**	**412**	**432**	**-3.5**	**-3.6**	**-3.7**
EU15	**309**	**345**	**376**	**392**	**-3.5**	**-3.5**	**-3.6**
NMS	**23**	**29**	**36**	**40**	**-4.6**	**-4.5**	**-4.2**
Mt CO_2 emitted	***969***	***1066***	***1164***	***1206***	***-4.0***	***-4.0***	***-4.1***
EU-15	***904***	***985***	***1062***	***1095***	***-3.8***	***-3.9***	***-4.0***
NMS	***65***	***81***	***102***	***112***	***-5.5***	***-5.2***	***-4.8***

Source: PRIMES.

port means due to the shift of transport activity towards less energy-intensive modes and especially rail transport.

Figure 6-6: Fuel efficiency gains for passenger transport in EU-25 in the "Promoting rail and improved load factors" and "Promoting rail" cases (change from Baseline levels in %)



Source: PRIMES.

The findings as regards efficiency gains in freight transport are similar (see Figure 6-7), with efficiency gains of 15.1% in 2010 and 6.1% in 2030 from Baseline levels in the "Promoting rail and improved load factors" case. The corresponding figures under the "Promoting rail" case are 4.1% in 2010 and 3.5% in 2030. Again in the "Promoting rail and improved load factors" case all transport means exhibit significant gains above Baseline levels. This clearly reflects the importance of policies promoting rail transport that lead to an increasing share of rail freight activity to the detriment of road freight.

The rather isolated character of the evolution of the transport sector in these particular transport scenarios compared to the rest of the EU-25 energy system is clearly illustrated when examining the changes that arise at the level of primary energy needs under the "Promoting rail and improved load factors" and "Promoting rail" cases from baseline levels (see Table 6-2).

Primary energy needs in the EU-25 are projected to be some -0.8% lower than Baseline levels over the projection period under the

Table 6-2: Evolution of primary energy needs in the EU-25 in the "Promoting rail and improved load factors" and "Promoting rail" cases

Promoting rail+load factors	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303.2	244.1	253.6	301.1	0.2	0.4	0.4
Liquid Fuels	635.6	601.1	619.9	634.7	-8.0	-7.7	-5.9
Natural Gas	376.0	507.0	598.1	628.3	0.0	0.1	0.0
Nuclear	237.7	245.3	213.5	185.4	0.0	0.0	0.0
Renewable energy forms	96.1	131.4	149.3	167.5	-1.0	-1.3	-1.1
Total	**1650.7**	**1730.9**	**1836.5**	**1919.4**	**-3.0**	**-2.8**	**-2.1**
EU-15	**1453**	**1527**	**1610**	**1683**	**-3.1**	**-2.9**	**-2.1**
NMS	**198**	**204**	**227**	**236**	**-2.0**	**-2.1**	**-1.8**
Mt CO_2 emitted	***3665***	***3603***	***3891***	***4190***	***-4.1***	***-3.7***	***-2.6***
EU-15	***3118***	***3063***	***3309***	***3567***	***-4.4***	***-3.9***	***-2.8***
NMS	***547***	***540***	***583***	***623***	***-2.2***	***-2.4***	***-1.9***
Promoting rail	**Mtoe**				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	244.5	253.8	301.2	0.3	0.4	0.4
Liquid Fuels	635.6	638.2	654.6	656.8	-2.3	-2.5	-2.6
Natural Gas	376.0	508.0	598.6	628.4	0.2	0.1	0.0
Nuclear	237.7	245.3	213.6	185.4	0.0	0.0	0.0
Renewable energy forms	96.1	132.6	151.1	169.3	0.0	-0.1	-0.1
Total	**1650.7**	**1770.7**	**1873.7**	**1943.4**	**-0.8**	**-0.8**	**-0.8**
EU-15	**1453**	**1564**	**1644**	**1705**	**-0.8**	**-0.8**	**-0.9**
NMS	**198**	**207**	**230**	**239**	**-0.7**	**-0.7**	**-0.7**
Mt CO_2 emitted	***3665***	***3717***	***3996***	***4256***	***-1.1***	***-1.1***	***-1.1***
EU-15	***3118***	***3169***	***3404***	***3626***	***-1.1***	***-1.2***	***-1.2***
NMS	***547***	***548***	***592***	***631***	***-0.7***	***-0.8***	***-0.7***

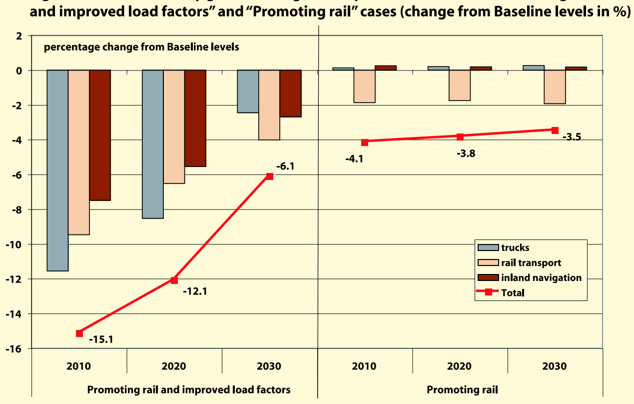
Source: PRIMES.

"Promoting rail" case. The effect of policies promoting rail and public road transport, combined with policies improving load factors, are even more pronounced. Primary energy needs are -3.0% lower in 2010 (-53.1 Mtoe from Baseline levels), -2.8% lower in 2020 (-52.4 Mtoe in 2020), and -2.1% lower in 2030 (-40.3 Mtoe). Besides a large fall in liquid fuel use, a reduction is also projected for renewable energy forms. This results from the lower need for biofuels as an ingredient in gasoline and diesel oil. On the other hand a limited increase above Baseline levels is projected for solid fuels (up to +1.2 Mtoe in 2030 in the "Promoting rail and improved load factors") and natural gas (up to +1.1 Mtoe in 2010 in the "Promoting rail" case). This is because the larger share of rail transport leads to greater electricity demand in the transport sector. This additional electricity is generated largely from coal and gas.

Given that this reduction of energy demand mainly concerns liquid fuels, the growth in EU-25 energy import dependency is also projected to be somewhat slower. In the "Promoting rail and improved load factors" case import dependency reaches 51.8% in 2010 and 66.7% in 2030 (compared to 53.1% and 67.3% respectively in the Baseline scenario). In the "Promoting rail" case the corresponding values are 52.7% in 2010 and 67.0% in 2030.

CO_2 emissions in the EU-25 also grow less than in the Baseline. In the "Promoting rail" case in 2010 they are 39.8 Mt CO_2 below the Baseline level (-1.1%). In the "Promoting rail and improved load factors" case, CO_2 emissions are 154 Mt CO_2 below Baseline in 2010 (-4.1%). Compared to 1990 levels CO_2 emissions in 2010 decrease by -1.4% in the "Promoting rail" and by -4.4% in the "Promoting rail and improved load factors" case, compared to the slight decrease of -0.3% in the Baseline. As was the case for primary energy needs, the impact on CO_2 emissions is less pronounced in the long run. The

Figure 6-7: Fuel efficiency gains for freight transport in EU-25 in the "Promoting rail and improved load factors" and "Promoting rail" cases (change from Baseline levels in %)



Source: PRIMES.

decline from Baseline levels in 2030 is limited to only -2.6% in the "Promoting rail and improved load factors" case while remaining close to the projected Baseline level in 2010 for the "Promoting rail" case (-1.1% in 2030).

6.2.1. Concluding remarks

The introduction of policies to promote railways (both in passenger and freight transport) and public road transport leads to more favourable development of the EU-25 transport sector. Improvements are even greater if policies towards the more rational use of transport modes (through improving vehicle load factors) are also implemented. In this case energy requirements in the transport sector fall -13.0% from Baseline levels in 2010 and remain quite significant even in the long run (-8.7% in 2030). The limited response of consumers to several policy instruments used in the past, including very high taxation on private road transport fuels, and the increasing importance of the transport sector in the future evolution of the EU-25 energy system were stressed earlier in this chapter. As a result it is evident that the implementation of the proposed policies under the Option C of the White Paper for Transport can play a significant role in easing the pressures caused by rapid growth of the transport sector. Furthermore it should be noted that Option C policy options also contribute to improvements in congestion, air quality etc, which are beyond the scope of the analysis performed in this study.

CHAPTER 7: Combining various options

7.1. Definition of alternative scenarios

The scope of the analysis performed in the cases that combine various policy options was twofold. First it explores the potential contribution of policy action to achieve energy policy objectives, such as managing external dependency and reductions of energy-related CO_2 emissions, and second it analyses possible trade-offs between the different policy actions. Three different cases were examined. The first focuses on energy policy options ("Energy policy options" case). The second ("Extended policy options") case addresses the combined effects of energy and transport policy options, as well as of the CO_2 emissions trading regime for the EU-25 energy system. Finally, the third case ("Full policy options") combines all policy options examined under the first two cases and further investigates the potential contribution of CO_2 sequestration from 2015 onwards in the EU-25 energy system. The key assumptions for the three cases examined are summarised below.

7.1.1. The "Energy policy options" case

The "Energy policy options" case examines the combined effects of promotional policies for renewable energy forms, better energy efficiency in all sectors and the availability and acceptance of new nuclear capacity. It draws on the approach and results obtained for the individual policy cases examined in the previous chapters.

The "New nuclear technology accepted" case, discussed earlier in Chapter 5, assumes that new nuclear designs (such as the EPR or the AP1000 and AP600) with passive safety features (which reduce core fusion probability from 10^{-5}/year of existing nuclear plants to less than 5.10^{-7}/year) become mature by 2010. It is assumed that this would reduce public opposition towards nuclear energy. For this case, the Member States with declared nuclear phase out policies, or where nuclear utilisation ceases in the period up to 2030 (Belgium, Germany, the Netherlands and Sweden), are assumed to re-consider their decisions and to allow new investment in these improved nuclear power plants.

The "High renewables" case (see Chapter 4) assumed that additional incentives are provided to energy consumers and producers in Member States so that the global indicative targets of a 12% contribution from renewable energy sources to gross national energy consumption by 2010, referred to in the EC renewables electricity Directive[73], are achieved. Further penetration of renewable energy forms on the demand side is achieved by policies promoting the use of biomass and waste in industry and the use of solar thermal panels for water heating purposes in services and households. It is also promoted through the implementation of the biofuels Directive, adopted in May 2003 that sets indicative shares for biofuels in petrol and diesel for transportation purposes of 2% in 2005 and almost 6% in 2010.[74] On the supply side targets by Member State, as defined in the EC renewables electricity Directive, are achieved through support schemes that provide subsidies for electricity generation from renewable energy forms. However, these payments on account of the higher costs due to greater renewables deployment are passed on to consumers via increased electricity prices (i.e. the electricity tariffs paid by all electricity consumers increase given the higher costs caused by larger deployment of renewables).

Finally, the "High efficiency" case (also discussed in Chapter 4) investigated the effects of measures along the lines of the Action Plan for Energy Efficiency (COM (2000) 247 final of 6.4.2000) in the EU energy system, focusing on key actions that could be modelled. This approach includes the energy performance of buildings Directive as well as action on CHP and energy services. Useful energy (energy services such as heat, light, cooling, motion, and communication) is supplied in a more efficient way by means of consumer choices based on perceived costs that take fuller account of the advantages of higher energy efficiency. The efficiency case assumes that consumers obtain a better appreciation of the benefits of adopting more efficient technologies, which in turn leads to faster deployment of improved and advanced technologies in the "High efficiency" case compared to the Baseline. Moreover, the efficiency case has somewhat better efficiency characteristics for established technology (compared with Baseline) brought about by e.g. efficiency standards that keep the least efficient energy consuming equipment out of the market. Consumers with a better appreciation of technology costs will consequently alter their choices compared to Baseline. Improvements in building construction lead to significant gains in thermal integrity and a reduction in energy requirements.

In addition to such improvement on the demand side, the efficiency case also incorporates improvements on the supply side. The use of co-generated steam and electricity is encouraged, resulting in higher shares of CHP in electricity and steam generation following the Directive on the promotion of cogeneration. Besides more cogeneration, the supply side shifts towards more efficient technologies in the long run driven by faster technological progress, which leads to improvements in terms of new equipment efficiency. Equipment costs also decline compared with the Baseline.

73 Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market, Official Journal of the European Union L283 of 27.9.2001, page 33.

74 Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the Promotion of the Use of Biofuels and Other Renewable Fuels for Transport, Official Journal of the European Union L123 of 17.5.2003, page 42.

In the "Energy Policy options" case a combination of the assumptions of the three above-mentioned cases was examined so as to explore their aggregate effect on the evolution of the EU-25 energy system and to analyse the possible trade-offs.

7.1.2. The "Extended policy options" case

The second case, called the "extended policy options" case, combines the above strong action on energy efficiency and renewables with transport policy options and economic instruments such as higher energy taxation and emission trading for the EU-25 energy system. Thus, the assumptions of the "Promoting rail and improved load factors" scenario (discussed in Chapter 6) are also introduced.

This transport scenario assumes that the share of rail (both passenger and freight) and public road transport activity will return to their 1998 levels by 2010, in contrast to the Baseline trend of continuously diminishing shares for these modes. Promotional policies for rail transport and public road transport in this scenario will lead to stronger growth for these modes compared to Baseline, while overall transport volumes remain unchanged from Baseline levels. Consequently, the other modes (mainly private road and air) grow more slowly than in the Baseline, thereby increasing the shares of rail and public road transport. In addition, it was assumed in this scenario that load factors of all transport modes increase significantly by 2010 in comparison to Baseline trends. This means that all transport modes will be used in a more efficient way than today. This scenario is in line with the 'Option C' scenario discussed in the Commission's White Paper on a Common Transport Policy. It can therefore be considered as the scenario involving virtually all measures that can be implemented by 2010 to curb energy consumption and CO_2 emissions from transportation under Baseline economic developments.

Furthermore, the "Extended policy options" case incorporates the following additional assumptions:

- A strong penetration of natural gas, biofuels and hydrogen in the transport sector occurs in the horizon to 2020/30 (with an orientation to simulate the achievement of a non-oil share in transport of 20% as put forward in the Green Paper on Energy Security).
- Incorporation of the Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.
- Incorporation of the Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emissions allowance trading within the Community and amending Council Directive 96/61/EC.

In the Baseline scenario, the transport sector remains heavily dependent upon the use of liquid fuels. Natural gas and novel energy forms, such as methanol, ethanol and hydrogen, grow quite rapidly in percentage terms but they remain insignificant in absolute terms even by 2030. This is because novel vehicle technologies, such as fuel cell cars, are not expected to gain significant market shares even by 2030 under Baseline assumptions. This is primarily because of cost considerations but also because of the lack of infrastructure for the supply and distribution of these novel energy forms. In the "Extended policy options" case it is assumed that stakeholders undertake strong efforts to develop the infrastructure required for new fuel cycles like hydrogen and methanol; and also that faster technological progress leads to improvements in new vehicle technologies like fuel cells and gas fired vehicles with equipment costs declining in comparison to the Baseline. Furthermore, it is assumed that strong promotional policies towards the use of non-oil vehicles are adopted. As a result consumers obtain a better understanding of technology costs and consequently alter their choices compared to Baseline in satisfying their transport needs.

The Council Directive 2003/96/EC of 27 October 2003 on restructuring the Community framework for the taxation of energy products and electricity incorporates many derogations and transitional periods before being fully implemented. Moreover, there is uncertainty as to how Member States will make use of the general provision to delay implementation until 2007, if found necessary. Thus, it was deemed preferable, for the purposes of this scenario analysis, to include the effects of the Directive from 2010 onwards. By no means does this reflect the Commission services' views on the appropriateness of any particular delay by Member States in implementing the Directive from 2004 onwards. But this adjustment has been necessary to keep the energy analysis manageable. A detailed analysis taking into account all the provisions and the use made of all the derogations and transitional periods has not been undertaken. It would require a separate, in-depth tax study to gather and then to evaluate the vast amount of information from the Member States on the choices they have made, and may make in future, concerning the various options contained in the Directive.

Furthermore, a number of simplifications were made for modelling purposes. Therefore, in this scenario, the minimum tax rates as set out in the Directive apply from 2010 onwards. However, wherever existing rates in individual Member States are already higher than the new minimum rates, these higher rates apply. Thus, it has been assumed that there will be no reduction of tax rates from Baseline levels. All tax rates remain constant in real terms over the projection period. The following exemptions contained in the Directive have been taken into account for this scenario, which is motivated to a large extent by efforts to reduce CO_2 emissions:

- all inputs for electricity production (however, electricity output is taxed);
- all renewables use (electricity and non-electricity related)[75] and biomass in particular (given that this scenario is designed to explore CO_2 reductions);
- electricity and fuels for rail transport and for inland waterways as well as aviation (for reasons of CO_2 reduction and international competitiveness);
- all industries that have fuel costs of at least 3% of their total production value, or which are subject to emission trading (this concerns all industries except for food, textiles, engineering and other miscellaneous industries). In non energy intensive industrial sectors, half the business tax rates have been applied.

75 As far as this could be modelled – see the further explanations below on this point.

A distinction has also been made between services and agriculture, for which full business energy tax rates have been applied, and also for households which pay different energy excise and tax rates.

It should be borne in mind that this scenario on energy and transport policy analysis has to make simplifying assumptions on the implementation of the energy tax Directive. As stated earlier, it does not aim at a comprehensive representation of all the provisions of this Directive.

In the transport sector it is assumed that commercial diesel rates apply from 2010 onwards (2015 for new Member States) except for those Member States (the U.K. in particular) that already charge higher rates. This approach is justified by taking into account the combined effect of fuel taxation and infrastructure charging. The higher charge implied in maintaining such above average diesel taxation can be considered to include at least notional charges on infrastructure use, i.e. road pricing, in case a Member State decides to reduce a high diesel tax to compensate for the economic effects of applying road pricing. Furthermore, the same minimum tax rate applies for non-commercial use of diesel and unleaded petrol from 2010 (2015 in new Member States) onwards on the basis of the proposed Directive on commercial diesel.

It should be noted here that no specific exemptions have been introduced for natural gas tax rates, even where possible. This is because this provision is limited in time and subject to conditions; and, moreover, such an approach would not necessarily comply with the purpose of a scenario with a particular emphasis on CO_2 reduction. In addition, it was not possible to introduce different taxation policy for electricity generated from renewable energy forms and/or CHP units (which, according to the Directive, should be exempted from taxation). In order to do so major changes would be required in the PRIMES model (i.e. introducing one additional level of competition among consumers purchasing electricity depending on the type of fuel used in generation). This would add much complexity to the model and is thus outside the scope of the current study. However, it should be remembered that in the "Extended policy options" case electricity generation from renewable energy forms and/or cogeneration units is promoted (as described in Chapter 4) and, thus the lack of a distinctive taxation policy for electricity is largely offset.

Finally, in the "Extended policy options" case it is assumed that, on the basis of the relevant Directive, an emission trading regime is established among companies in the participating sectors (power and steam generation, refineries, iron and steel, non metallic mineral, pulp and paper industries) in the EU-25. The permit price for CO_2 emissions trading has been defined exogenously, in line with the assumptions of the DG-Environment Clean Air for Europe programme of the European Commission – "With climate policy measures Baseline scenario". The assumed permit prices are 12 € per t of CO_2 in 2010, 16 € per t of CO_2 in 2015 and 20 € per t of CO_2 from 2020 onwards. Sectors participating in this emission trading regime react to the permit prices by undertaking measures to reduce CO_2 emissions.[76]

7.1.3. The "Full policy options" case

The third case examined - hereafter called the "Full policy options" case - constitutes a combination scenario of all policy measures examined under the "Energy policy options" and "Extended policy options" cases, i.e. the assumptions regarding the availability of new nuclear technology are also included in the "Full policy options" case.

Furthermore, the potential contribution of CO_2 sequestration techniques from 2015 onwards has been examined in the context of the "Full policy options" case. In this analysis it has been assumed that three power plant technologies used by utilities (namely integrated gasification combined cycle power plants, supercritical polyvalent units and advanced natural gas combined cycle power plants) are - by default - available with CO_2 capture equipment from 2015 onwards. The revised technical and economic characteristics for these technologies were derived from a study prepared for the Institute for Prospective Technological Studies (IPTS) of the European Commission.[77] The introduction of the revised techno-economic characteristics for these three power generation technologies in the model assumptions resulted in their abandonment by electricity generators in the model runs. This result reflects their lack of economic competitiveness in the absence of strong promotional policies and/or the need to impose deep cuts in CO_2 emissions to make this technology more cost-effective. It also highlights the need for further research and technology development work. The cost of generating one kWh of electricity in a power plant with CO_2 capture equipment (including costs for capture, transport and final storage) is nearly double that for the same power plant without such equipment. In that sense, it was found preferable to revert to the initial techno-economic characteristics of the three technologies; and then to estimate the additional costs to be met by stakeholders (through subsidies or other policy measures) if power plants with CO_2 sequestration remained in use on the power generating system.

Hence the modelling was applied to determine a cost-effective mix in power generation on the basis of all the above policy options for CO_2 reduction and of the techno-economic assumptions without sequestration. But, in a subsequent step, the additional CO_2 benefits and costs were calculated under the assumption that the above three power plant types were all equipped with CO_2 sequestration technology. This additional calculation identifies the CO_2 reduction benefits and the additional costs of including CO_2 sequestration. Under the assumption that the additional costs for sequestration are covered by subsidies, the other energy results on final energy demand in this scenario apply to the combination of all the above options both for the case without CO_2 sequestration and for that including CO_2 sequestration. However, CO_2 sequestration modifies the primary energy balance, as the fuel input to power generation

76 The way sectors react to permit prices is described in detail in the methodological review in Chapter 8 of this publication which examines the impacts of CO_2 emission reduction targets on the future evolution of the EU-25 energy system.

77 "Techno-Economic characterisation of CO_2 sequestration technologies: A technology status survey" synthesis report, prepared by J.C. Abanades, R. Moliner (IPTS, 2002). European Commission, Joint Research Centre, Report EUR 20391 EN.

and consequently gross inland energy consumption are somewhat higher given the efficiency losses due to separating CO_2 in power plants. The differences are, however, small in this scenario.

Clearly, with greater research and technology development in sequestration and with technology learning the costs of sequestration will decrease more rapidly; and sequestration might prove to be a more cost-effective solution for keeping fossil fuels in the energy system in a CO_2 constrained world. Similarly, the potential failure of one or more of the alternative options to sequestration (examined in this scenario) and/or the pursuit of deeper cuts in CO_2 emissions (that may become necessary in later years) would make sequestration a more viable and potentially cost-effective solution. It should be recalled in this respect that this case combines policy options but does not start from any particular emission reduction target that must be achieved.

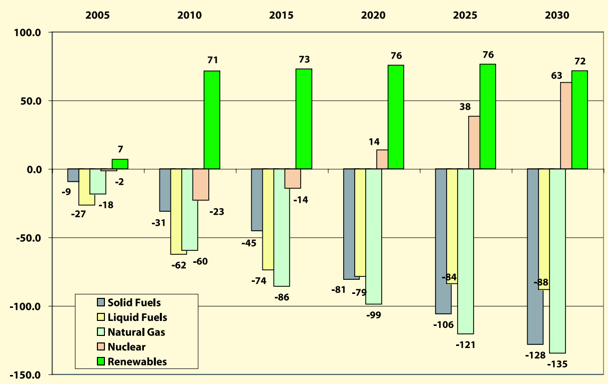
7.2. The Energy Policy Options case[78]

The combination of promotional policies for renewable energy forms, better energy efficiency in all sectors and the availability and acceptance of new nuclear technology leads to significant changes as regards the projected evolution of the EU-25 energy system in comparison to the Baseline scenario. Primary energy needs in the EU-25 fall markedly compared to Baseline, ranging from -5.9% in 2010 to -11.2% in 2030 (see Table 7-1). Furthermore a strong shift towards the use of nuclear energy (+34% in 2030 compared to Baseline) and renewable energy forms (+54% in 2010, +42% in 2030 over Baseline levels) occurs to the detriment of solids (-43% in 2030 compared to Baseline) and to a lesser extent gas and liquids (-21% and -13% respectively in 2030).

It is interesting to note that over the period to 2015, only renewable energy forms grow at rates above Baseline (both in absolute terms and in terms of market shares; see also Figure 7-1). The share of renewable energy forms is projected to reach 12.1% in 2010 (from 7.4% under Baseline assumptions), further increasing to 13.8% in 2030 (8.6% in the Baseline). The availability of new nuclear designs beyond 2010 leads to a significant boost in the use of nuclear energy in the long run, which occurs both to the detriment of solid fuels and natural gas, further augmenting the impact of better efficiency and promotional policies for renewable energy forms. The lower deployment of nuclear in the medium term (compared with the Baseline) is the result of these policies on energy efficiency and renewables, which reduce the demand for electricity and foster strong renewables penetration in power generation by 2010 in accordance with the renewables electricity Directive. Finally, the decline in primary energy needs for oil results mainly from improved efficiency and higher use of biofuels for transportation purposes.

The increase in the use of indigenous energy sources under the "Energy policy options" case is also reflected in the projected evolution of the import dependency of the EU-25 energy system (see Table 7-2). Import dependency grows more slowly compared to the Baseline case (-4.4 percentage points from Baseline levels in 2010, -7.5 in 2020, -10.0 in 2030) Thus the 20 percentage point rise in import dependency in the Baseline case is halved in the alternative scenario case which combines strong policies on energy efficiency and renewables with the acceptance of new nuclear plants. The decline in import dependency in 2030 reaches -9.8 percentage points from Baseline levels for solid fuels, -5.4 percentage points for natural gas and -1.5 percentage points for oil.

Figure 7-1: Changes in primary energy demand by fuel in EU-25 in the "Energy policy options" case (diff. from Baseline in Mtoe)



Source: PRIMES.

Table 7-1: Evolution of primary energy needs in the EU-25 energy system in the "Energy policy options" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303	213	172	172	-12.7	-32.0	-42.7
Liquid Fuels	636	591	593	586	-9.6	-11.7	-13.1
Natural Gas	376	447	499	494	-11.8	-16.5	-21.4
Nuclear	238	222	227	248	-9.4	6.5	34.0
Renewable energy forms	96	204	227	241	53.8	49.9	42.2
Total	**1651**	**1680**	**1718**	**1741**	**-5.9**	**-9.1**	**-11.2**
EU-15	**1453**	**1487**	**1517**	**1546**	**-5.7**	**-8.5**	**-10.1**
NMS	**198**	**193**	**201**	**195**	**-7.4**	**-13.1**	**-19.0**

Source: PRIMES.

78 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to Baseline can be found in APPENDIX 7. Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to the Baseline) are available in the enclosed CD.

Table 7-2: Import dependency in EU-25 in the "Energy policy options" case

	%				*percentage points difference from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid fuels	30.1	34.5	39.1	56.0	-2.4	-10.9	-9.8
Liquid fuels	76.6	79.8	84.5	86.8	-1.5	-1.5	-1.5
Natural gas	49.5	57.1	70.3	76.0	-4.1	-5.1	-5.4
Total	**47.2**	**48.7**	**54.5**	**57.4**	**-4.4**	**-7.5**	**-10.0**
EU-15	**49.4**	**49.6**	**55.4**	**57.7**	**-4.7**	**-7.5**	**-10.1**
NMS	**30.8**	**41.6**	**47.1**	**54.6**	**-2.4**	**-7.6**	**-9.0**

Source: PRIMES.

Table 7-3: Changes on the demand side of the EU-25 energy system in the "Energy policy options" case

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	309.1	329.5	351.5	376.7	-2.8	-4.3	-3.0
Tertiary	154.2	154.5	168.6	181.1	-11.4	-13.2	-17.0
Households	279.1	293.8	298.7	296.3	-4.8	-9.2	-12.5
Transports	332.0	369.4	382.6	388.5	-4.6	-10.4	-13.4
Total	**1074**	**1147**	**1201**	**1243**	**-5.1**	**-8.8**	**-10.9**
EU-15	**955**	**1023**	**1067**	**1102**	**-5.0**	**-8.4**	**-10.3**
NMS	**119**	**124**	**135**	**141**	**-6.0**	**-12.1**	**-14.8**
	Mt CO_2 emissions				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	605.7	506.7	494.4	506.6	-6.9	-9.4	-8.2
Tertiary	236.7	207.6	211.3	223.8	-13.4	-12.3	-12.2
Households	462.6	444.2	438.7	432.0	-7.8	-11.4	-11.3
Transports	967.5	1005.3	1039.1	1054.8	-9.5	-14.3	-16.1
Total	**2272**	**2164**	**2184**	**2217**	**-8.9**	**-12.5**	**-13.1**
EU-15	**2024**	**1925**	**1941**	**1972**	**-9.1**	**-12.3**	**-12.8**
NMS	**249**	**239**	**243**	**246**	**-7.4**	**-14.1**	**-15.6**

Source: PRIMES.

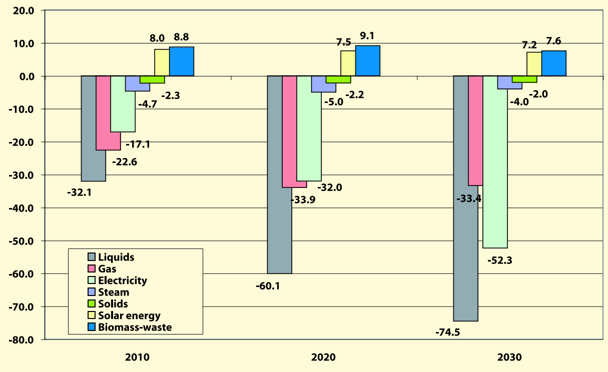
7.2.1. Final energy demand

Enhanced efficiency policies lead to a significant decline in energy requirements on the demand side of -10.9% from Baseline levels in 2030 (see Table 7-3). It should be noted that this decline in energy consumption is accounted for by the energy intensity gains achieved above the Baseline levels, as the macroeconomic assumptions remain unchanged between the "Energy policy options" case and the Baseline. The decline of energy needs is more pronounced in the tertiary, household and transport sectors while the response of industrial sectors is rather limited. Improvements in buildings' thermal integrity and demand side management, which constitute the main focus of efficiency policies, allow for significant energy intensity gains in the household and tertiary sectors but have limited impact in industry.

The better perception of technology costs, which also contributes to the reduction of energy requirements in the tertiary and household sectors, plays a major role in the lower energy needs in the transport sector (with car efficiency reaching rates well above those of the current agreement with the car industry, and significant gains above Baseline levels also occurring in other transport modes). On the other hand, in industry, consumers already have a good understanding of technology costs even under Baseline assumptions, which in turn leads to significant energy intensity improvements in the Baseline (both through industrial restructuring but also through adoption of more efficient production techniques). Thus there is limited scope for further improvements in the context of the "Energy policy options" case.

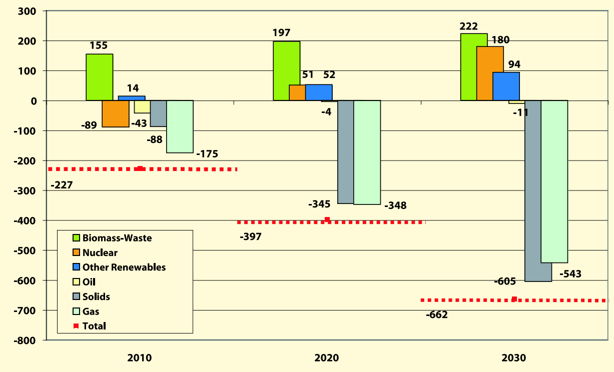
Changes in the fuel mix towards the use of less carbon-intensive energy forms, and especially biomass-waste, lead to a significant improvement of carbon intensity in industrial sectors compared to Baseline levels. In 2030, CO_2 emissions in industry fall -8.2% from Baseline levels, more than twice the reduction in energy needs. The transport sector also exhibits carbon intensity gains that are greater than those of energy demand (-16.1% from Baseline levels in 2030 for CO_2 compared to -13.4% for energy) as a result of the higher share of biofuels

Figure 7-2: Changes in final energy demand by fuel in the EU-25 energy system in the "Energy policy options" case (diff. from Baseline in Mtoe)



Source: PRIMES.

Figure 7-3: Changes in electricity generation in the EU-25 energy system in the "Energy policy options" case (diff. from Baseline in TWh)



Source: PRIMES.

blended in gasoline and diesel. In contrast, a worsening of carbon intensity is projected for the household and tertiary sectors compared to Baseline (CO_2 emissions decrease in 2030 by -11.3% and -12.2% respectively, while the corresponding reductions in energy requirement are -12.5% and -17%). This largely reflects the lower share of electricity in final demand in these sectors due to more rational energy use and the improved technological characteristics of electric appliances. In total the EU-25 demand side is projected to exhibit a further improvement of carbon intensity above Baseline levels over the projection period (CO_2 emissions from the demand side reach -13.1% in 2030 compared to a reduction of energy requirements by -10.9%).

Figure 7-2 illustrates the projected changes in the fuel mix under the "Energy policy options" case assumptions. Promotional policies for renewable energy forms lead to a significant growth of final energy demand, both in absolute and market share terms, for biomass-waste and solar energy over the projection period. Final energy demand for solid fuels exhibits a small decline from Baseline levels in the horizon to 2030, as its use is limited to specific industrial uses even under Baseline assumptions. A limited decline from Baseline levels in absolute terms is also projected for distributed steam, as efficiency policies also involve the further promotion of cogeneration. However, both solid fuels and distributed steam are projected to gain some additional market share on the demand side under the "Energy policy options" case assumptions.

The energy forms projected to exhibit a strong decline from Baseline levels, both in absolute and market share terms, are liquid fuels and to a lesser extent natural gas and electricity. These result from the combined effect of changes in the fuel mix towards renewable energy forms, better building thermal integrity, more rational use of energy and the adoption of more efficient energy-related equipment by consumers. It should also be noted that promotional policies for biofuels lead to an increase of their share in gasoline and diesel from 2.3% under Baseline assumptions in 2010 to 8.0% (+18 Mtoe) and from 5.3% in the Baseline in 2030 to 8.5% in this policy case (+8.2 Mtoe).

7.2.2. Power and steam generation

The electricity and steam generation sector undergoes significant changes resulting from the combination of promotional policies for renewable energy forms and co-generated electricity (following the Directive on cogeneration), the availability of new nuclear technology and the decline of electricity demand (see Figure 7-3). In the "Energy policy options" case, electricity generation is projected to decline by 227 TWh (or -6.6%) from Baseline levels in 2010, reaching -662 TWh (or -15.1%) in 2030. In the short run the reduction strongly affects the use of natural gas (but also solid fuels and nuclear energy), whereas in the same period strong growth occurs in the use of biomass and waste and to a lesser extent hydro and intermittent renewable energy forms. Biomass and waste play a major role in the increase of co-generated electricity production, the share of which reaches 21.4% of total electricity generation (some 6.9 percentage points higher than Baseline levels). The overall share of renewable energy forms (including waste) in electricity generation also experiences significant growth above Baseline levels - reaching 24.1% of total electricity generation in 2010 compared to 17.6% in the Baseline scenario.

In the long run, renewable energy forms are projected to experience further growth above Baseline levels (with an increasing role for intermittent renewable sources). Their share in electricity generation is projected to reach 29.9% in 2030 (+11.7 percentage points above Baseline). Biomass and waste remain the key drivers as regards the growth of co-generated electricity, which in 2030 accounts for 27.5% of total electricity generation compared to only 16.3% in the Baseline. Furthermore, the availability and acceptance of new nuclear technology leads to a significant resurgence of nuclear energy in the long run with electricity generation from nuclear in 2030 reaching levels above those observed in 2000 (+180 TWh or +23.5% from Baseline levels in 2030). The increase in the use of renewable energy forms and nuclear energy for electricity generation largely obviates the growing use of solid fuels projected in the Baseline scenario; and also leads to lower electricity generation from natural gas. In 2030, solid fuels account for some 15.3% of total electricity generation (compared to 26.7% in the Baseline) and natural gas for 28.8% (from 36.8% in the Baseline). The share of zero-carbon fuels rises to 55.2% in 2030 compared with 35.6% in the Baseline.

Changes in the fuel mix are also reflected in the investment decisions of power generators. Total installed capacity is projected to be some 26 GW lower than Baseline levels in 2010 and 120 GW lower in 2030 (see Table 7-4). Gas turbine combined cycle plants and supercritical

Table 7-4: Installed capacity by plant type in EU-25 in the "Energy policy options" case							
	GW installed				change from baseline (in GW)		
	2000	2010	2020	2030	2010	2020	2030
Nuclear	140.3	129.8	125.6	153.3	0.0	17.6	45.5
Hydro	96.2	108.3	114.6	117.7	3.7	5.3	5.5
Wind	12.8	74.5	120.5	159.8	1.8	17.0	24.9
Other renewables	0.2	0.5	1.9	16.4	0.0	1.3	2.1
Conventional thermal	335.6	276.9	176.9	153.3	6.3	1.6	6.0
Advanced coal	0.0	3.2	7.7	31.7	2.7	5.8	25.2
Supercritical polyvalent	0.0	0.0	5.6	8.3	-0.5	-59.1	-135.1
Gas turbines CC	47.4	136.6	263.9	237.4	-32.9	-54.8	-147.2
Small gas turbines	22.8	26.5	55.5	59.8	-7.5	-7.8	-5.9
Fuel cells	0.0	0.0	0.4	58.3	0.0	0.4	58.3
Geothermal	1.0	1.3	1.5	1.7	0.1	0.2	0.3
Total	**656**	**758**	**874**	**998**	**-26.3**	**-72.5**	**-120.3**
EU-15	**579**	**668**	**755**	**861**	**-20.7**	**-57.4**	**-90.3**
NMS	**78**	**90**	**119**	**137**	**-5.5**	**-15.2**	**-30.1**
of which CHP	***103***	***155***	***235***	***267***	***25.7***	***67.0***	***67.9***
EU-15	***77***	***123***	***190***	***214***	***20.6***	***60.6***	***67.8***
NMS	***26***	***32***	***45***	***52***	***5.1***	***6.4***	***0.1***

Source: PRIMES.

Table 7-5: Fuel input in electricity and steam generation in EU-25 (including consumption in boilers) in the "Energy policy options" case							
	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solids	217.4	149.1	115.0	118.9	-15.7	-40.3	-51.3
Oil products	52.4	23.0	21.1	16.7	-33.0	-9.8	-15.5
Gas	131.7	162.5	191.3	164.8	-20.5	-27.6	-39.7
Biomass	12.7	55.1	64.0	67.2	194.6	201.0	180.3
Waste	19.3	27.6	30.7	30.3	8.2	12.7	14.3
Nuclear energy	237.7	222.3	227.3	248.3	-9.4	6.5	34.0
Geothermal heat	3.0	3.7	4.1	4.6	8.1	13.0	17.0
Total	**674**	**643**	**654**	**651**	**-9.2**	**-12.4**	**-16.2**
EU15	**581**	**555**	**563**	**572**	**-8.9**	**-11.6**	**-14.3**
NMS	**93**	**88**	**90**	**78**	**-10.9**	**-16.9**	**-27.9**
Mt CO_2 emitted	***1355***	***1058***	***981***	***917***	***-18.7***	***-33.0***	***-45.3***
EU-15	***1068***	***819***	***747***	***704***	***-19.0***	***-35.4***	***-47.4***
NMS	***287***	***240***	***234***	***214***	***-17.4***	***-24.3***	***-36.9***

Source: PRIMES.

polyvalent units are strongly affected by the decline in additional capacity requirements; supercritical polyvalent units even fail to penetrate the system in this scenario. On the other hand, there is considerably higher investment in renewables and nuclear energy. In particular, wind capacity increases significantly in the long run. Nuclear capacity rises substantially to reach more than 150 GW in 2030 (an increase of some 42% above Baseline levels).

Advanced coal technologies, and more specifically integrated gasification combined cycle power plants, are also projected to make some significant inroads compared to Baseline as they are found to be cost effective options (compared with conventional thermal power plants). The somewhat higher investment in conventional thermal power plants in the long run is focused largely on cogeneration with the use of biomass and waste in a policy environment which promotes both renewables and cogeneration. Finally, fuel cell power generation capacity (using natural gas as input fuel to be reformed into hydrogen) reaches 58.3 GW in 2030 as a result of the faster technological progress in advanced power generation technologies assumed to occur in the "Energy policy options" case.

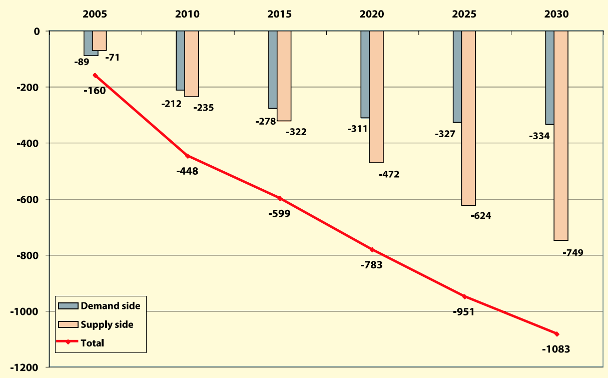
Fuel inputs for electricity and steam generation in the "Energy policy options" case are also projected to experience significant changes from Baseline levels (see Table 7-5). Consumption of solid fuels exhibits the most pronounced decline in the long run, being limited to just 49% of that observed in the Baseline scenario; while that of natural gas is limited to slightly above 60%. On the other hand, the acceptance of new nuclear technology leads to an increase in the use of nuclear energy by +34% in 2030 compare with Baseline levels. Biomass and waste are also projected to exhibit strong growth above Baseline levels because of policy encouragement for both renewable energy forms and cogeneration.

The shift towards carbon-free energy forms (both nuclear energy and renewable energy) and the more efficient production of electricity and steam leads to a significant improvement of carbon intensity in the power generation sector (expressed in t of CO_2 emitted per MWh of electricity and steam). Compared with the Baseline, the improvements reach 13.5% in 2010 and 37.5% in 2030. Given the decline of electricity requirements in comparison to the Baseline scenario, CO_2 emissions in the EU-25 power generation sector decline over the projection period from 2000 levels (compared to a strong increase beyond 2015 under Baseline assumptions). In 2010 CO_2 emissions fall -18.7% below Baseline levels, further declining by 2030 to account for only slightly more than 55% of the corresponding CO_2 emissions in the Baseline.

7.2.3. Impacts on CO_2 emissions

These changes in the electricity and steam generation sector are also very significant in explaining the CO_2 emissions reductions achieved on the demand and supply sides of the EU-25 energy system in the "Energy policy options" case (see Figure 7-4). The reduction of CO_2 emissions from the supply side in 2010 (-235 Mt CO_2 or -17.0%) is of equal importance to that achieved on the demand side over this period. However, the importance of the supply side in CO_2 emission reduction increases in the long run. Given the combined effect of the projected re-emergence of nuclear energy, further penetration of renewable energy forms and the decline in electricity requirements, CO_2 emissions reduction from the supply side reaches 749 Mt CO_2 (or -42.8% below Baseline levels in 2030). By then it accounts for some 70% of the overall CO_2 emissions reduction achieved in the EU-25 energy system.

Figure 7-4: Changes in CO_2 emissions in EU-25 in the "Energy policy options" case (diff. from Baseline in Mt CO_2)



Source: PRIMES.

In this case by 2030 total EU-25 CO_2 emissions are projected to be -25.2% below Baseline levels (-11.9% in 2010). CO_2 emissions remain well below their 1990 level throughout the projection period: in 2010 CO_2 emissions are only 87.8% of those observed in 1990; in 2020 they are 86.4% of their 1990 level and 85.4% in 2030.

7.2.4. Concluding remarks

This analysis illustrates that there are no significant trade-offs in combining the availability of new nuclear technology with promotional policies for energy efficiency and renewable energy forms. On the contrary, the energy policy options examined here allow for significant improvements in the future evolution of the EU-25 energy system, compared to the Baseline scenario, both in terms of security of supply and in reduced CO_2 emissions. In particular, with this policy combination the total CO_2 emissions reduction required by the Kyoto targets for the EU-25 Member States would be more than achieved in the period to 2010 - with emissions remaining at this lower level even in the long run. However, given construction lead times, the nuclear contribution by 2010 is clearly limited.

7.3. The Extended Policy Options case[79]

In the "Extended policy options" case, besides supportive policies for energy efficiency and renewable energy forms, it is also assumed that strong action is undertaken in the transport sector, both by means of changes in the structure of transport modes and through shifts

Table 7-6: Evolution of primary energy needs in the EU-25 energy system in the "Extended policy options" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303.2	190.9	118.3	97.1	-21.7	-53.2	-67.6
Liquid Fuels	635.6	534.5	494.6	490.6	-18.2	-26.4	-27.3
Natural Gas	376.0	452.2	567.4	602.1	-10.8	-5.1	-4.2
Nuclear	237.7	223.1	191.7	160.8	-9.0	-10.2	-13.2
Renewable energy forms	96.1	212.5	242.2	260.8	60.2	60.1	53.9
Total	**1650.7**	**1615.4**	**1616.2**	**1613.7**	**-9.5**	**-14.4**	**-17.7**
EU-15	**1453**	**1429**	**1429**	**1432**	**-9.3**	**-13.7**	**-16.7**
NMS	**198**	**186**	**187**	**182**	**-10.7**	**-19.4**	**-24.5**

Source: PRIMES.

79 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to Baseline can be found in APPENDIX 7. Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD.

Table 7-7: Import dependency in EU-25 in the "Extended policy options" case

	%				*percentage points difference from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid fuels	30.1	34.8	41.2	49.0	-2.1	-8.8	-16.8
Liquid fuels	76.6	79.2	81.9	84.6	-2.1	-4.1	-3.7
Natural gas	49.5	57.6	73.8	80.3	-3.5	-1.5	-1.1
Total	**47.2**	**47.6**	**55.0**	**59.7**	**-5.6**	**-6.9**	**-7.6**
EU-15	**49.4**	**48.3**	**55.0**	**59.5**	**-6.0**	**-7.9**	**-8.4**
NMS	**30.8**	**42.0**	**54.9**	**61.7**	**-2.0**	**0.1**	**-1.8**

Source: PRIMES.

Table 7-8: Changes on the demand side of the EU-25 energy system in the "Extended policy options" case

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	309.1	326.9	346.2	371.3	-3.5	-5.8	-4.4
Tertiary	154.2	153.6	167.4	180.0	-11.8	-13.9	-17.5
Households	279.1	292.2	296.7	294.4	-5.3	-9.8	-13.1
Transports	332.0	319.6	335.0	353.9	-17.5	-21.5	-21.1
Total	**1074**	**1092**	**1145**	**1200**	**-9.6**	**-13.1**	**-14.0**
EU-15	**955**	**972**	**1016**	**1064**	**-9.7**	**-12.8**	**-13.4**
NMS	**119**	**120**	**129**	**136**	**-9.4**	**-15.6**	**-17.9**
	Mt CO_2 emissions				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	605.7	494.9	475.4	491.1	-9.1	-12.9	-11.0
Tertiary	236.7	208.1	213.5	225.3	-13.1	-11.4	-11.6
Households	462.6	442.2	436.6	430.0	-8.2	-11.8	-11.7
Transports	967.5	860.9	840.4	871.8	-22.5	-30.7	-30.7
Total	**2272**	**2006**	**1966**	**2018**	**-15.6**	**-21.2**	**-20.9**
EU-15	**2024**	**1779**	**1740**	**1791**	**-16.0**	**-21.3**	**-20.8**
NMS	**249**	**227**	**226**	**228**	**-12.0**	**-20.1**	**-21.8**

Source: PRIMES.

towards non-oil fuels. Furthermore, in this case it is also assumed that the Directive on taxation of fuel and electricity is implemented and that an emission trading regime is established within the EU-25 energy system in line with the emission trading Directive. The changes in the primary energy needs of the EU-25 energy system - resulting from the combined effect of all the above-mentioned assumptions in comparison to the Baseline scenario - are illustrated in Table 7-6.

Renewable energy forms are projected to grow at rates well above those observed under Baseline assumptions. Their market share reaches 13.1% of primary energy needs in 2010 (some 5.7 percentage points higher than Baseline levels) and further increases to 16.2% in 2030 (7.5 percentage points higher than the Baseline). Demand for natural gas declines somewhat from Baseline levels in the long run, a result largely reflecting the increasing role natural gas will play in satisfying energy needs in the transport sector in the "Extended policy options" case. The market share of natural gas is lower than that under Baseline assumptions in the short run, but exhibits a strong increase thereafter. Primary energy needs for nuclear energy are also projected to decline at rates below average. In contrast, a strong decline is projected for solid and liquid fuels use in the EU-25 energy system (primary energy needs of which reach -67.6% and -27.3% respectively below Baseline levels in 2030). Under the "Extended policy options" case assumptions, solid fuels fail to re-emerge in the EU-25 power generation sector, while demand for liquid fuels is strongly affected by the substantial shift towards the use of non-oil fuels in the transport sector.

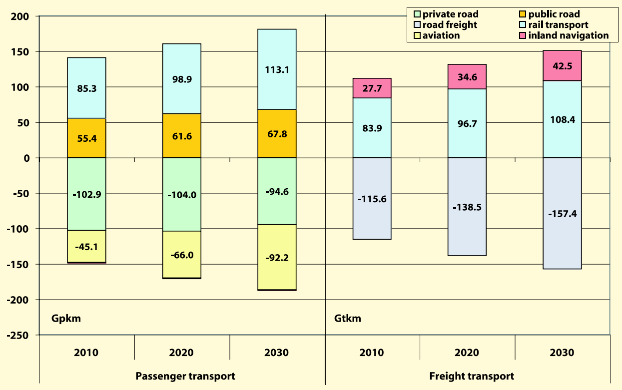
The projected slowdown in primary energy growth and the higher exploitation of renewable energy sources have a significant impact on projected trends in EU-25 import dependency (see Table 7-7). In 2010, overall import dependency is projected to reach 47.6% (some 0.4 percentage points higher than that observed in 2000, compared to an increase of 6 percentage points under Baseline assumptions). In 2030, import dependency reaches 59.7% (7.6 percentage points lower than the Baseline). As expected, changes are more pronounced in the import dependency for solids and liquid fuels, whereas the "Extended policy options" case assumptions have a limited impact on the import dependency of natural gas especially in the long run.

7.3.1. Final energy demand

Energy requirements on the demand side (i.e. final energy demand) decrease at rates slightly lower than those of primary energy needs over the projection period (see Table 7-8). Changes in industrial, tertiary and household sectors exhibit similar trends to those observed in the "Energy policy options" case for both energy needs and CO_2 emissions. Promotional policies for energy efficiency and renewable energy forms are the key drivers for these changes compared to the Baseline scenario. It should be noted, however, that changes in industry are more marked than in the "Energy policy options" case. This results from the assumed participation of the iron and steel, non-metallic mineral and pulp and paper industries in an emission trading regime. This leads to further improvements in these sectors for both energy intensity gains (through structural changes and the adoption of more efficient technologies) and carbon intensity gains (through changes in the fuel mix towards less carbon-intensive fuels).

In the "Extended policy options" case, it is the transport sector that exhibits the greatest falls in both energy requirements and CO_2 emissions compared to Baseline levels. These effects are significantly higher than those under the "Energy policy options" case as a result of the implementation of Option C of the White Paper on Transport (involving both structural shifts and improved load factors) and the assumption of much faster penetration of non-oil technologies in road transport.

Figure 7-5: Transport activity in EU-25 in the "Extended policy options" case (change from Baseline levels)



Source: PRIMES.

Figure 7-5 illustrates the changes that occur in passenger and freight transport activity in the "Extended policy options" case in comparison to the Baseline scenario. As regards passenger transport activity, rail and public road transport experience significant growth above Baseline levels (+20.5% and +11% respectively in 2010, +21% and +12.2% respectively in 2030). This occurs to the detriment of private road transport (-2.1% in 2010, -1.5% in 2030) and aviation (-10% in both 2010 and 2030). It is interesting to note that in absolute terms private road transport activity exhibits the strongest reduction from Baseline levels. However, in relative terms, it is mainly aviation that faces the strongest impact as a result of policies promoting rail and public road transport. Inland navigation activity is also projected to decline somewhat, both in absolute and relative terms. The market share of rail transport in passenger transport activity reaches 7.8% in 2010 and 7.6% in 2030 (from 6.4% and 6.3%, respectively, under Baseline assumptions). That of public road transport reaches 8.7% in 2010 (7.8% in the Baseline) and 7.3% in 2030 (6.5% in the Baseline).

In the freight transport sector, rail freight activity rises +23.9% above Baseline levels in 2030 (+22.2% in 2010), while a smaller increase occurs in inland navigation (reaching +8% in 2010 and +9.3% in 2030 above Baseline levels). However, road remains the main freight transport mode despite a decline of some 6% from Baseline levels in 2010 and 5% in 2030. In 2010 the share of rail in total freight transport reaches 17.2% and that of inland navigation 13.8% (from 14% and 12.8% respectively, under Baseline assumptions). Yet both these shares decline over the period to 2030, with rail freight accounting for 13.9% (from 11.2% in the Baseline) and inland navigation for 12.4% (11.3% in the Baseline).

Table 7-9: Transport sector energy demand in EU-25 in the "Extended policy options" case

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
road transport	273	273	282	292	-14.8	-19.5	-19.6
public road transport	7	7	7	6	0.2	-5.0	-3.1
motorcycles	2	2	2	2	-6.1	-9.0	-9.2
private cars	155	146	138	132	-12.6	-17.1	-17.2
trucks	109	118	135	152	-18.2	-22.5	-22.2
rail transport	9	8	6	7	-4.2	-0.8	5.8
aviation	45	33	40	47	-37.5	-37.4	-33.7
inland navigation	5	6	7	8	-1.2	-1.0	-0.2
Total transport	**332**	**320**	**335**	**354**	**-17.5**	**-21.5**	**-21.1**
EU15	**309**	**295**	**307**	**323**	**-17.4**	**-21.2**	**-20.6**
NMS	**23**	**25**	**28**	**31**	**-17.6**	**-25.2**	**-26.7**
Mt CO_2 emitted	***969***	***861***	***840***	***872***	***-22.5***	***-30.7***	***-30.7***
EU-15	***904***	***795***	***768***	***796***	***-22.4***	***-30.5***	***-30.2***
NMS	***65***	***66***	***72***	***76***	***-22.7***	***-32.5***	***-35.1***

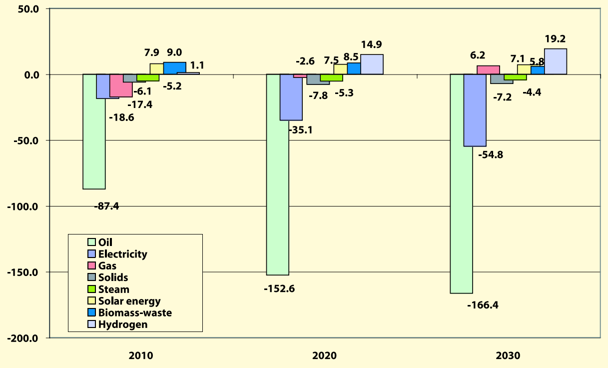
Source: PRIMES.

The changes in energy requirements by transport mode are illustrated in Table 7-9. Overall transport sector energy demand is projected to fall 17.5% from Baseline levels in 2010, 21.5% in 2020 and 21.1% in 2030. This substantial improvement compared to Baseline results from the combined effect of structural changes in transport activity, the implementation of policies to improve load factors, promotional policies for efficiency measures and the strong penetration of non-oil technologies in transport. Thus, energy requirements in all transport modes are projected to decline at rates significantly higher than the corresponding changes in transport activity. This implies significant efficiency gains above those achieved in the Baseline. It is only in rail transport that energy demand exhibits in 2030 an increase of 5.8% above Baseline levels, which is, however, significantly lower than the corresponding increase in transport activity (+21% in passenger rail and +23.9% in rail freight).

Furthermore, changes in the fuel mix towards the use of non-oil fuels in this scenario allow for a significant improvement of carbon intensity above Baseline levels in the transport sector (see Figure 7-6). Thus CO_2 emissions from transport activity are projected to be -30.7% below Baseline levels in 2030 (-22.5% in 2010), a decline well above that for energy needs. In the short run it is mainly promotional policies for renewable energy forms, through which the share of biofuels in gasoline and diesel oil reaches 8% in 2010 compared to 2.3% in the Baseline, that permit this improvement of carbon intensity in the transport sector. Some additional contribution also comes from the much faster penetration of natural gas vehicles. In the long run, natural gas is projected to make further inroads (accounting by 2030 for some 11% of total energy consumed in transport). The penetration of fuel cell vehicles (using hydrogen produced from natural gas through reformers) also becomes increasingly important. On the other hand, some saturation effects become visible as regards the further growth in the use of biofuels, the share of which reaches 10.9% of gasoline and diesel (or 7.3% of total energy requirements in the transport sector) by 2030. Electricity growth in transport is limited, as electricity remains an energy form almost entirely restricted to use in rail transport. By 2030 non-oil fuels (including biofuels and electricity) account for close to 26% of energy consumed in the transport sector (10.6% in 2010).

The importance of the changes in the transport sector is reflected in the projected evolution of final energy demand by fuel in the "Extended policy options" case (see Figure 7-7). Many changes are in line with those observed in the "Energy policy options" case, as promotional policies for energy efficiency and renewable energy forms remain the key drivers for the evolution of energy needs in other demand side sectors. But there is a much stronger decline in the demand for liquid fuels and more growth in the use of natural gas and hydrogen. By 2030 the strong penetration of natural gas in the transport sector more than counterbalances declining use of gas in other demand sectors and results in higher natural gas consumption in final energy demand (compared with Baseline levels). Furthermore, hydrogen is also projected to make significant inroads on the EU-25 demand side especially in the long run.

Figure 7-7: Changes in final energy demand by fuel in the EU-25 energy system in the "Extended policy options" case (diff. from Baseline in Mtoe)

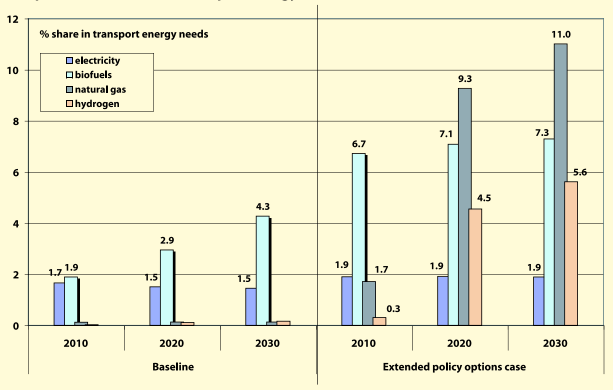


Source: PRIMES.

7.3.2. Power and steam generation

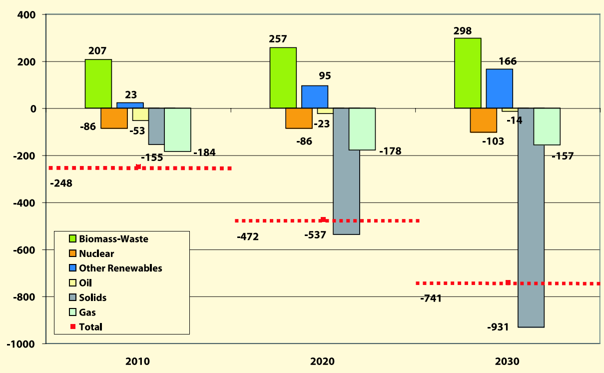
Promotional policies for renewable energy forms and co-generated electricity, as well as the changes that derive from the participation of the EU-25 power generation sector in the emission trading regime (both in terms of investment decisions and in terms of changes in the fuel mix) are the key drivers as regards the future evolution of the sector in the "Extended policy options" case (see Figure 7-8). As a result of demand side actions, electricity generation is projected to reach levels significantly below those observed in the Baseline. In 2010 electricity generation is projected to be 248 TWh lower than in the Baseline scenario (or -7.3%), reaching -741 TWh (or -16.8%) in 2030.

Figure 7-6: Non-oil fuels in the transport sector of EU-25 in the "Extended policy options" case (share in transport energy demand)



Source: PRIMES.

Figure 7-8: Changes in electricity generation in the EU-25 energy system in the "Extended policy options" case (diff. from Baseline in TWh)



Source: PRIMES.

Electricity generation from biomass-waste and other renewable energy forms is projected to grow at rates well above those observed in the Baseline as a result of renewables and energy efficiency policies in the "Extended policy options" case. Thus, in 2010 electricity generation from biomass-waste (mainly in co-generation power plants) is 3.5 times higher than in the Baseline, further increasing to 4.4 times the Baseline level in 2030. Growth in the use of other renewable energy sources is less pronounced (+4.4% from Baseline levels in 2010, +23.3% in 2030) but still notable in absolute terms, especially in the long run. The share of renewable energy forms (including waste) in total electricity generation reaches 26.2% in 2010 and 34.5% in 2030 (from 17.6% and 18.2% respectively in the Baseline scenario).

Co-generation of electricity and steam is also projected to make significant progress above Baseline levels in the "Extended policy options" case. The share of co-generated electricity is projected to reach 22.3% in 2010 and 25.8% in 2030 (from 14.4% and 16.3% respectively in the Baseline scenario). Electricity generation in nuclear power plants declines at rates above average to 2010, as a result of changes on the demand side. However, in the long run the decline becomes significantly lower than that of total electricity generation and, thus, nuclear energy is projected to gain some additional market share above Baseline levels. Solid fuels are affected most in the power generation sector given the policy assumptions of the "Extended policy options" case, especially in the long run. Compared with Baseline levels the share of electricity generation from solids from 2020 onwards declines significantly. In 2030, solid fuels are projected to account for just 6.7% of total electricity generation (from 36.8% in the Baseline).

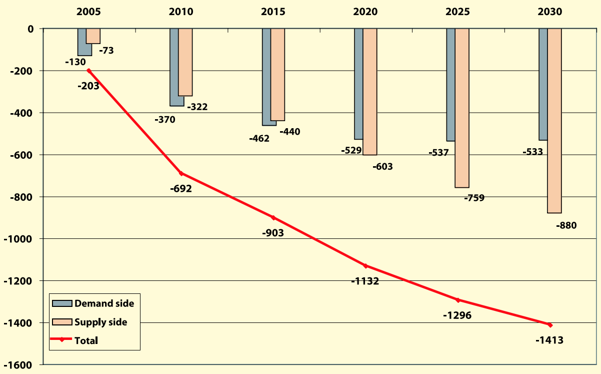
Electricity generation from natural gas experiences the largest decline in absolute terms in 2010 (-17.2% from Baseline levels), but this is more limited in the long run - reaching -9.7% below Baseline levels in 2030. Nevertheless, the gas share in electricity generation in 2030 is some 40% of total electricity generation (+3.2 percentage points above Baseline levels). In the "Extended policy options" case the key driver for this trend in the long run is the strong penetration of fuel cell technologies in power generation (using natural gas reformed to hydrogen as input fuel).

In 2030, fuel cells' installed capacity is projected to exceed 105 GW, accounting for more than 10% of total installed capacity in the EU-25 power generation sector (see Table 7-10). As in the "Energy policy options" case, supercritical polyvalent units fail to penetrate the EU-25 power generation sector. But advanced solid fuel technologies (e.g. pressurised fluidised bed combustion and integrated gasification combined cycle units) grow faster than Baseline levels, as they become cost-effective options (compared with conventional thermal power plants) for cogeneration with the use of biomass and waste. Wind energy capacity also grows significantly above Baseline levels to reach 180 GW by 2030 (more than 18% of total installed capacity).

7.3.3. Impacts on CO_2 emissions

The changes in the energy system under the "Extended policy options" case assumptions lead to a significant relaxation of envi-

Figure 7-9: Changes in CO_2 emissions in EU-25 in the "Extended policy options" case (diff. from Baseline in Mt CO_2)



Source: PRIMES.

Table 7-10: Installed capacity by plant type in the EU-25 in the "Extended policy options" case

	GW installed				*change from baseline (in GW)*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	106.1	99.0	0.0	-1.9	-8.8
Hydro	96.2	108.8	116.1	119.1	4.2	6.8	7.0
Wind	12.8	77.7	137.3	179.7	5.0	33.8	44.8
Other renewables	0.2	0.5	1.8	20.1	0.0	1.3	5.8
Conventional thermal	335.6	283.1	176.9	129.2	12.6	1.6	-18.1
Advanced coal	0.0	3.6	5.9	14.1	3.1	3.9	7.6
Supercritical polyvalent	0.0	0.0	7.3	17.0	-0.5	-57.4	-126.4
Gas turbines CC	47.4	133.2	263.8	260.5	-36.4	-55.0	-124.0
Small gas turbines	22.8	25.2	44.3	42.1	-8.7	-19.1	-23.7
Fuel cells	0.0	0.0	16.1	105.6	0.0	16.1	105.6
Geothermal	1.0	1.3	1.5	1.8	0.1	0.2	0.3
Total	**656**	**763**	**877**	**988**	**-20.6**	**-69.6**	**-129.9**
EU-15	**579**	**674**	**761**	**854**	**-14.6**	**-51.3**	**-97.1**
NMS	**78**	**89**	**116**	**134**	**-6.0**	**-18.3**	**-32.8**
of which CHP	***103***	***162***	***205***	***222***	***31.9***	***37.2***	***23.5***
EU-15	***77***	***129***	***165***	***175***	***26.5***	***34.6***	***29.1***
NMS	***26***	***33***	***41***	***47***	***5.4***	***2.6***	***-5.5***

Source: PRIMES.

ronmental concerns in EU-25 compared to the Baseline scenario (see Figure 7-9). In 2010, total CO_2 emissions are limited to just 81.3% of those observed in 1990 (-903 Mt of CO_2 or -18.4% from Baseline levels in 2010), implying an "over-achievement" of Kyoto emission reduction targets. Both the demand and the supply sides contribute to this CO_2 emissions reduction, but with actions on the demand side making the larger contribution by that date.

By 2030 CO_2 emissions are projected to have declined further to reach 76.7% of those in 1990 (-1413 Mt of CO_2 or -32.8% from Baseline levels). However, in the long run, the role of policy measures on the supply side is of increasing importance, with reductions achieved by the demand side accounting for only about 38% of total CO_2 emissions reduction.

7.3.4. Concluding remarks

Again, as in the case of the "Energy policy options" scenario, the combination of options examined in the "Extended policy options" case leads to a significantly more favourable evolution of the EU-25 energy system. Trade-offs among the different policy options examined are rather insignificant, i.e. the implementation of one option does not impede the effectiveness of any another one; and thus all options can be pursued simultaneously. The cost developments that can be measured by the modelling approach are rather favourable, but it should be noted that both cases involve certain cost elements that do not link directly to the energy system costs examined in the modelling for these scenarios. In particular, greater energy efficiency, a key policy in these combinations of options, has quite favourable impacts on overall costs and economic efficiency. For a fuller discussion of the cost issues involved see the concluding remarks later in Chapter 7, following the discussion of the "Full policy options" case.

7.4. The Full Policy Options case[80]

For the "Full policy options" case all policy options examined under the two cases presented above were combined, i.e. the hypothesis of the availability of new nuclear technology was also included in

Table 7-11: Techno-economic characteristics for power plants with CO_2 capture capability (index, Baseline technology characteristic = 1)

	2000	2010	2015	2020	2025	2030
Supercritical coal unit						
Capital cost (turn key on)	1.555	1.538	1.530	1.522	1.513	1.505
Fixed operating cost	1.555	1.536	1.526	1.517	1.507	1.498
Variable cost	1.411	1.418	1.407	1.396	1.385	1.375
Fuel Efficiency	0.734	0.783	0.808	0.834	0.862	0.889
CO_2 emission factor	0.135	0.124	0.119	0.115	0.110	0.106
Capture, transport and storage cost (in Euro'00 per t of CO_2 sequestrated)	55	48	44	41	38	36
Integrated gasification combined cycle						
Capital cost (turn key on)	1.362	1.291	1.257	1.223	1.191	1.159
Fixed operating cost	1.170	1.120	1.096	1.073	1.050	1.027
Variable cost	1.468	1.396	1.362	1.328	1.295	1.263
Fuel Efficiency	0.855	0.906	0.932	0.959	0.975	0.990
CO_2 emission factor	0.117	0.112	0.109	0.107	0.105	0.102
Capture, transport and storage cost (in Euro'00 per t of CO_2 sequestrated)	38	27	23	19	16	14
Natural gas combined cycle						
Capital cost (turn key on)	2.303	2.160	2.093	2.026	1.963	1.900
Fixed operating cost	2.357	2.500	2.483	2.466	2.449	2.432
Variable cost	1.314	1.273	1.253	1.233	1.214	1.195
Fuel Efficiency	0.802	0.833	0.850	0.866	0.883	0.900
CO_2 emission factor	0.120	0.109	0.104	0.099	0.094	0.090
Capture, transport and storage cost (in Euro'00 per t of CO_2 sequestrated)	65	44	36	29	24	20

Source: PRIMES.

80 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to Baseline can be found in APPENDIX 7. Detailed results by group of countries (EU-25, EU-15, NMS and Europe-30) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD.

the assumptions for this case. Furthermore, the potential contribution of carbon sequestration in power generation was examined by assuming that three advanced power plant technologies used by utilities (namely integrated gasification combined cycle power plants, supercritical polyvalent units and advanced natural gas combined cycle power plants) are - by default- equipped with CO_2 capture equipment from 2015 onwards.

Table 7-11 illustrates the technical and economic characteristics of these three power plant types with carbon sequestration as well as their projected CO_2 sequestration costs in terms of capture, transport and final storage. The data were derived from a study prepared for the Institute for Prospective Technological Studies - IPTS of the European Commission - and adjusted for the purposes of the PRIMES modelling.[81] The impact of carbon sequestration for these three power plant types leads to a significant reduction in their cost-effectiveness. As a result, in the model simulations performed, power generators abandon these technologies, unless there are strong supporting policies for their use and/or the need for deep CO_2 emissions cuts is imposed on power plants. It was decided therefore to keep the initial techno-economic characteristics for these technologies the same as in the "Extended policy options" case. In that case these technologies (without carbon sequestration) are projected to gain some market share in the EU-25 energy system. A further analysis was then performed to estimate the additional costs faced by the energy system if these three power plant types were equipped with CO_2 capture capability. This further analysis dealt with the impact on costs, fuel inputs, and the additional reductions in CO_2 emissions.

The combination of policies examined in the "Full policy options" case leads to a significant decline of primary energy needs from Baseline levels (see Table 7-12). Furthermore, large changes occur in the fuel mix with renewable energy forms and nuclear energy (in the long run) growing faster than observed in the Baseline case, to the detriment of solids, liquid fuels and natural gas. It should be noted, however, that the projected decline in natural gas consumption is lower than that of total energy demand and, thus, the market share of natural gas in total primary energy needs rises above Baseline levels. The availability and public acceptance of new nuclear technology are the key drivers for the strong re-emergence of nuclear energy in the long run. Furthermore, renewable energy forms are not affected by this nuclear resurgence. The increased contributions of renew-

Table 7-12: Evolution of primary energy needs in the EU-25 energy system in the "Full policy options" case

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	191.0	110.4	80.7	-21.6	-56.3	-73.1
Liquid Fuels	635.6	534.5	494.5	490.5	-18.2	-26.4	-27.3
Natural Gas	376.0	452.1	551.7	577.5	-10.8	-7.7	-8.1
Nuclear	237.7	222.3	248.9	276.8	-9.4	16.6	49.4
Renewable energy forms	96.1	212.7	239.7	259.0	60.3	58.4	52.8
Total	**1650.7**	**1614.7**	**1645.1**	**1684.2**	**-9.5**	**-12.9**	**-14.1**
EU-15	**1453**	**1429**	**1457**	**1497**	**-9.3**	**-12.1**	**-12.9**
NMS	**198**	**186**	**188**	**187**	**-10.9**	**-19.0**	**-22.1**
Mt CO_2 emitted	**3665**	**3065**	**2839**	**2767**	**-18.4**	**-29.7**	**-35.7**
EU-15	**3118**	**2621**	**2445**	**2393**	**-18.2**	**-29.0**	**-34.8**
NMS	**547**	**444**	**394**	**374**	**-19.6**	**-34.0**	**-41.1**

Source: PRIMES.

Table 7-13: Import dependency in EU-25 in the "Full policy options" case

	%				*percentage points difference from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid fuels	30.1	34.8	42.4	45.0	-2.0	-7.6	-20.8
Liquid fuels	76.6	79.2	81.9	84.6	-2.1	-4.1	-3.7
Natural gas	49.5	57.6	73.1	79.4	-3.5	-2.2	-1.9
Total	**47.2**	**47.6**	**52.9**	**55.1**	**-5.5**	**-9.0**	**-12.2**
EU-15	**49.4**	**48.3**	**52.8**	**54.8**	**-6.0**	**-10.1**	**-13.0**
NMS	**30.8**	**42.0**	**54.0**	**57.5**	**-2.0**	**-0.8**	**-6.1**

Source: PRIMES.

81 "Techno-Economic characterisation of CO_2 sequestration technologies: A technology status survey" synthesis report prepared by J.C. Abanades, R. Moliner (IPTS, 2002). European Commission, Joint Research Centre, Report EUR 20391 EN.

ables, on the one hand, and nuclear on the other, are projected to be of similar importance in 2030 in the "Full policy option" case in both absolute and percentage terms. In the medium term, renewables rise much faster above Baseline levels than does nuclear power, given the long lead times involved in nuclear investments. The share of renewable energy forms in total primary energy needs for the EU-25 energy system reaches 13.2% in 2010 and 15.4% in 2030, compared to 7.4% and 8.6% respectively in the Baseline scenario

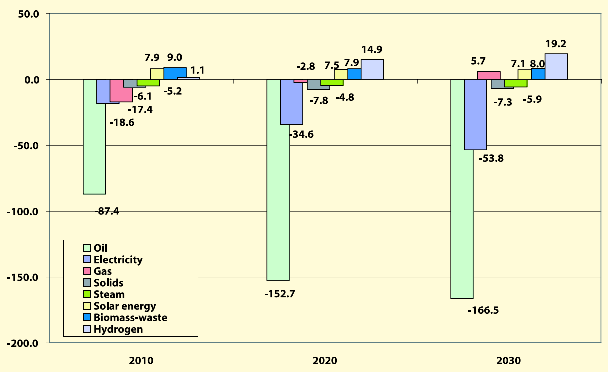
7.4.1. Final energy demand and power and steam generation

Changes on the demand side (i.e. final energy consumption) are in line with those observed in the "Extended policy options" case, as the key drivers remain the same in these two cases (see Table 7-14 and Figure 7-10).

On the other hand, electricity and steam generation is strongly affected by the availability of the new nuclear technology, which is projected to make strong inroads in the EU-25 power generation sector in the long run to the detriment of solid fuels and also natural gas (see Figure 7-11). In addition, electricity generation falls considerably below Baseline levels by 249 TWh or 7.3% in 2010 and by as much as 694 TWh or 15.8% in 2030.

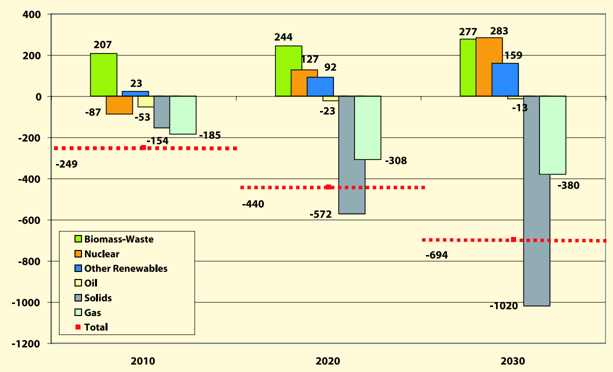
The decline in electricity generation from solid fuels is in this case 10% higher than in the "Extended policy options" scenario (-1020 TWh from Baseline levels in 2030 compared to -931 TWh in the "Extended policy options" case). Electricity generation using natural gas decreases by 380 TWh from Baseline levels in 2030 (compared to -157 TWh in the "Extended policy options" case). Thus the "Full policy option" case leads to a fall in natural gas use more than twice as high as in the "Extended policy option" case.

Figure 7-10: Changes in final energy demand by fuel in the EU-25 energy system in the "Full policy options" case (diff. from Baseline in Mtoe)



Source: PRIMES.

Figure 7-11: Changes in electricity generation in the EU-25 energy system in the "Full policy options" case (diff. from Baseline in TWh)



Source: PRIMES.

Table 7-14: Changes on the demand side of the EU-25 energy system in the "Full policy options" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Industry	309.1	326.9	346.2	372.0	-3.5	-5.8	-4.3
Tertiary	154.2	153.6	167.4	180.2	-11.8	-13.8	-17.4
Households	279.1	292.2	296.8	294.6	-5.3	-9.8	-13.1
Transports	332.0	319.6	335.0	353.9	-17.5	-21.5	-21.1
Total	**1074**	**1092**	**1145**	**1201**	**-9.6**	**-13.1**	**-13.9**
EU-15	**955**	**972**	**1016**	**1065**	**-9.7**	**-12.8**	**-13.3**
NMS	**119**	**120**	**129**	**136**	**-9.4**	**-15.6**	**-17.9**
	Mt CO_2 emissions				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Industry	605.7	494.9	475.1	490.0	-9.1	-13.0	-11.2
Tertiary	236.7	208.1	213.2	224.5	-13.1	-11.5	-11.9
Households	462.6	442.3	436.5	430.1	-8.2	-11.8	-11.7
Transports	967.5	860.9	840.4	871.7	-22.5	-30.7	-30.7
Total	**2272**	**2006**	**1965**	**2016**	**-15.6**	**-21.2**	**-21.0**
EU-15	**2024**	**1779**	**1739**	**1789**	**-16.0**	**-21.4**	**-20.9**
NMS	**249**	**227**	**226**	**228**	**-12.0**	**-20.0**	**-21.8**

Source: PRIMES.

Electricity generation from renewables remains almost unchanged between the two cases (+436 TWh from Baseline levels in 2030 in the "Full policy options" case; +464 TWh in the "Extended policy options" case). This result clearly indicates that there are no significant trade-offs between policies promoting renewables and penetration of new nuclear technology. The renewable energy share (including waste) of total electricity generation under the "Full policy options" case is projected to reach 26.2% in 2010 and 33.4% in 2030 (from 17.6% and 18.2% respectively in the Baseline scenario). Similarly the value of policies promoting cogeneration is also not anticipated to be affected significantly by the penetration of new nuclear technology. Thus the share of cogeneration in total electricity production reaches 22.3% in 2010 and 24.3% in 2030 (the corresponding shares being 14.4% and 16.3% in the Baseline scenario, and 22.3% and 25.8% in the "Extended policy options" case).

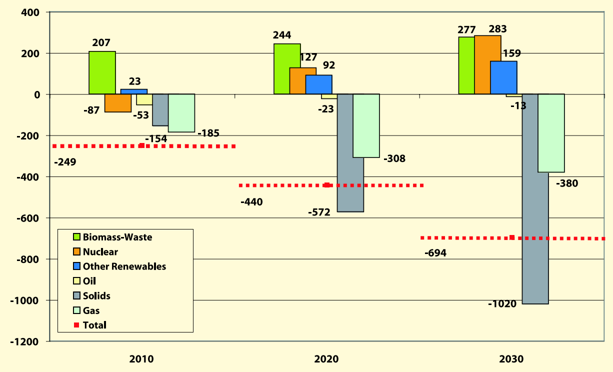
In 2030, 61.2% of total electricity generation comes from non-fossil energy forms (nuclear and renewables) compared to 35.6% in the Baseline scenario and 52.7% in the "Extended policy options" case.

Trends in installed capacity for the EU-25 power generation sector are summarised in Table 7-15. Nuclear and wind capacity grow at rates well above those observed in the Baseline scenario. Furthermore, fuel cells (using natural gas as input fuel for reforming into hydrogen) are also projected to make significant inroads in the power generation sector in the long run, driven by the assumed faster technological progress. In contrast, capacity expansions in gas turbine combined cycle power plants and supercritical coal units are much lower than in the Baseline case.

7.4.2. Impacts on CO_2 emissions

The policies included in the "Full policy options" case lead to a substantial improvement in the projected CO_2 emissions from the EU-25 energy system. In 2010, total CO_2 emissions are projected to be

Figure 7-12: Changes in CO_2 emissions in EU-25 in the "Full policy options" case (diff. from Baseline in Mt CO_2)



Source: PRIMES.

only 81.3% of those observed in 1990 (-903 Mt of CO_2 or -18.4% from Baseline levels in 2010). Policy measures for the demand side contribute slightly less to this result in 2010 than those for the supply side (see Figure 7-12).

The reduction in CO_2 emissions is even more pronounced in the long run as CO_2 emissions in 2030 fall to only 73.4% of their Baseline level in 2030 (-1537 Mt of CO_2 or -35.7% from Baseline levels). The supply side accounts for 65% of the total CO_2 emissions reduction, resulting from the faster penetration of renewable energy forms and the increased use of nuclear energy.

7.4.3. Meta-analysis on CO_2 sequestration

As already stated, a meta-analysis was also performed to explore the impacts that CO_2 sequestration might have in the EU-25 energy system if applied to three specific power generation technologies (supercritical coal units, integrated gasification combined cycle units

Table 7-15: Installed capacity by plant type in the EU-25 in the "Full policy options" case

	GW installed				*change from baseline (in GW)*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	140.6	174.1	0.0	32.5	66.3
Hydro	96.2	108.8	116.0	119.1	4.2	6.7	7.0
Wind	12.8	77.7	135.5	177.5	5.0	32.0	42.5
Other renewables	0.2	0.5	1.8	19.5	0.0	1.3	5.2
Conventional thermal	335.6	283.1	175.3	128.8	12.5	0.0	-18.5
Advanced coal	0.0	3.6	5.7	8.8	3.1	3.8	2.3
Supercritical polyvalent	0.0	0.0	7.1	10.2	-0.5	-57.6	-133.2
Gas turbines CC	47.4	133.3	239.6	234.3	-36.3	-79.2	-150.3
Small gas turbines	22.8	25.2	44.4	44.8	-8.7	-19.0	-21.0
Fuel cells	0.0	0.0	15.4	88.6	0.0	15.4	88.6
Geothermal	1.0	1.3	1.5	1.8	0.1	0.2	0.3
Total	**656**	**763**	**883**	**1007**	**-20.5**	**-63.8**	**-110.8**
EU-15	**579**	**674**	**767**	**872**	**-14.6**	**-45.6**	**-78.8**
NMS	**78**	**89**	**116**	**135**	**-5.9**	**-18.2**	**-32.0**
of which CHP	***103***	***162***	***206***	***221***	***32.1***	***38.3***	***22.0***
EU-15	***77***	***129***	***165***	***175***	***26.6***	***35.5***	***28.2***
NMS	***26***	***33***	***41***	***46***	***5.5***	***2.7***	***-6.2***

Source: PRIMES.

Table 7-16: Projections for supercritical coal and natural gas combined cycle units in the "Full policy options" case (without carbon sequestration)

	Supercritical coal unit				*Natural gas combined cycle*			
	2015	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**
Installed capacity (GW)	0.04	7.14	8.60	10.21	38.20	58.66	76.63	80.45
Fuel input (Mtoe)	0.04	6.33	8.25	10.13	30.88	44.38	52.65	47.12
Electricity generated (TWh)	0.25	38.87	52.18	65.08	224.29	329.73	397.15	360.67
Electricity generation cost (Euro00/kWh)	0.043	0.045	0.041	0.039	0.047	0.049	0.051	0.055
CO_2 emissions (Mt CO_2)	0.16	24.95	32.52	39.92	72.14	103.67	122.99	110.08
emitted	0.16	24.95	32.52	39.92	72.14	103.67	122.99	110.08
captured	-	-	-	-	-	-	-	-
Electricity generation cost including CO_2 emissions permits cost (mEuro00/kWh)	0.053	0.058	0.053	0.051	0.052	0.055	0.058	0.061

Source: PRIMES.

Table 7-17: Introducing CO_2 sequestration in supercritical coal and natural gas combined cycle units in the "Full policy options" case results [82]

Supercritical coal unit					change from without storage			
	2015	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**
Fuel input (Mtoe)	0.05	7.59	9.58	11.39	0.01	1.26	1.32	1.26
Electricity generation cost (Euro00/kWh)	0.061	0.064	0.057	0.054	0.019	0.019	0.017	0.015
CO_2 emissions (Mt CO_2)	0.20	29.91	37.74	44.90	0.04	4.96	5.22	4.98
emitted	0.02	3.43	4.15	4.74	-0.14	-21.53	-28.37	-35.18
captured	0.18	26.49	33.59	40.16	0.18	26.49	33.59	40.16
Electricity generation cost including CO_2 sequestration and emission permits costs (mEuro00/kWh)	0.095	0.094	0.084	0.077	0.042	0.036	0.031	0.026
Natural gas combined cycle					**change from without storage**			
	2015	**2020**	**2025**	**2030**	**2010**	**2020**	**2030**	**2030**
Fuel input (Mtoe)	36.34	51.23	59.60	52.33	5.46	6.85	6.95	5.21
Electricity generation cost (Euro00/kWh)	0.075	0.076	0.078	0.083	0.028	0.027	0.027	0.028
CO_2 emissions (Mt CO_2)	84.89	119.68	139.23	122.25	12.75	16.01	16.24	12.17
emitted	8.81	11.83	13.13	10.98	-63.33	-91.85	-109.86	-99.10
captured	76.08	107.85	126.09	111.27	76.08	107.85	126.09	111.27
Electricity generation cost including CO_2 sequestration and emission permits costs (mEuro00/kWh)	0.088	0.086	0.087	0.090	0.036	0.031	0.029	0.029

Source: PRIMES.

and advanced natural gas combined cycle units) from 2015 onwards. One result of the modelling was that in the "Full policy options" case the projected fuel input to integrated gasification combined cycle units was biomass. Given that biomass is considered CO_2 neutral, it would clearly not be meaningful to examine the additional cost impacts for CO2 capture equipment in such biomass plants. Thus the analysis of additional CO_2 benefits and of CO_2 sequestration costs was undertaken only for supercritical coal and advanced natural gas combined cycle units, as these use fossil fuels. Table 7-16 summarises the results obtained for these two technologies in the "Full policy options" case (in terms of installed capacity, energy requirements and electricity generated, CO_2 emissions and electricity generation costs per kWh - with and without the permit price from emission trading). It should be noted that electricity generation costs per kWh are not directly comparable between these two different power plant types as they serve different parts of the load curve.

Assuming (i) that the power plants under examination are equipped with CO_2 capture equipment (introduction of the revised techno-economic characteristics presented in Table 7-11) and (ii) operate as projected in the context of the "Full policy options" case then changes occur in fuel inputs, electricity generation costs and CO_2

82 Electricity generation costs presented in the table incorporate cost changes arising from the revision of technical and economic characteristics given the application of carbon sequestration to the power plants examined.

emissions (see Table 7-17). As clearly illustrated in these results, even in the long run the exploitation of CO_2 capture remains an expensive option for the EU-25 power generation sector. Costs per unit of electricity generated are some 51.5% higher in supercritical coal units and 47.2% higher in natural gas combined cycle units.

However, if these additional costs were subsidised, at an estimated total cost of 12.1 billion 00 in 2030, then this would result in a further reduction of CO_2 emissions of 134 Mt CO_2. Thus, in 2030 total CO_2 emissions in the EU-25 energy system would be limited to around 2632 Mt CO_2 (69.8% of CO_2 emissions observed in 1990 and -38.8% below Baseline levels in 2030). But carbon sequestration would entail a slight increase of primary energy needs (to power the sequestration process), with the reduction from Baseline levels in 2030 being limited to -13.7% compared to -14.1% in the "Full policy options" case (without sequestration). More specifically, primary energy needs for hard coal and natural gas are projected to increase by 1.26 Mtoe and 5.21 Mtoe respectively in 2030 compared to the "Full policy options" case, a result of the higher energy requirements in power plants with CO_2 sequestration. Thus, it is clear from the analysis for this scenario that the exploitation of CO_2 sequestration would be a costly option for the EU-25 energy system over the period to 2030. It could, however, contribute to a significant reduction of CO_2 emissions if strong supporting policies are introduced.

7.4.4. Concluding remarks and outlook on cost issues

When combining the available options in this modelling exercise - such as greater energy efficiency, renewables, nuclear, modal shifts towards railways and better load factors, hydrogen and other non-oil alternatives in transport, with CO_2 capture and disposal - the carbon sequestration option did not turn out to be a cost-effective solution. Carbon sequestration might more easily penetrate if one or more of the above policy options failed; or, probably more importantly, as a result of much greater research activity and technological 'learning' in this area - that so far has occurred only on a limited scale. These results on carbon sequestration suggest that it is worthwhile to intensify research and development activities for CO_2 separation and disposal. This is in order to reduce costs and to ensure the availability of a very low CO_2 emitting technology, if fossil fuels - and abundant solid fuels in particular- are to remain part of the energy balance in a possible severely carbon-constrained world.

As for the previous two scenarios, there are no significant trade-offs between the various policy options examined in the "Full policy options" case. This result indicates that there is a large range of policy measures available to policy makers to manage external dependency and to reduce energy-related CO_2 emissions. Combining all the available options leads to an import dependency that is only somewhat higher than today's level of nearly 50%. In the "Full policy options" case, import dependency would be 55% in 2030, or 12 percentage points below the 2030 level in the Baseline case. Moreover, combining all options would give rise to fairly deep cuts into CO_2 emissions, which in the "Full policy options" case amount to -26.6 % below the 1990 level in 2030 (-30.2% if carbon sequestration is added).

Adopting these specific policies has the potential to achieve deep cuts in CO_2 emissions at relatively low costs. While cost indicators in the model show similar levels in the policy option cases and in the Baseline, it needs to be stressed that the model deployed – due to its partial equilibrium character – does not capture all the economic costs likely to be incurred. For example, substantial CO_2 reductions can be achieved with better insulation of buildings, for which the CO_2 (and energy) effects have been modelled as part of the policies for energy efficiency. However, the total costs involved have not been captured entirely given that the investment (and amortisation) of expenditure for better insulation is not represented in the PRIMES model.[83]

Similarly, hydrogen has the potential to contribute significantly to CO_2 reduction depending on the sources from which it is produced. A hydrogen economy will require substantial infrastructure investment for transmission and distribution, which is not entirely captured in the PRIMES model. Decisions of economic agents as regards better insulation or hydrogen penetration are rational (cost-effective) in the modelling context of the respective scenarios, but not all of the associated macro-economic costs are completely represented in the model's outputs.

Moreover, the strong policies required incur political costs and benefits. This is because there are winners (such as society at large benefiting from reduced climate change impacts) but also losers. The losers face stranded costs for previous investments that are no longer economic in a strongly CO_2 constrained environment and have to alter business practices as a result of a substantially changed energy framework. In any case, the cost implications are largely sector specific depending on the energy and carbon intensities of the individual sectors, their flexibility to undertake changes in response, as well as the form of the particular policy instruments which are chosen.

The transition to a lower carbon energy economy can be costly, especially if this occurs abruptly. However, the cost effects in the long run would be more limited. As an example, the "Full policy options" case, including various energy and transport policy options and the acceptance of new nuclear in particular, gives rise to electricity prices that are just 1% higher in 2030 than in the Baseline. In this scenario, CO_2 emissions from the power generation sector in 2030 fall 63% below the Baseline level. The limited long-term impacts on electricity prices of any assumed deep cuts in CO_2 emissions stem from the comparably high degree of flexibility in this sector, given that there are various options for low or zero carbon energy inputs and more efficient ways of generating electricity. In the first phase of the above policies, i.e. to 2010, there are more important cost effects due to the need for higher investment (for e.g. renewables) and higher operating costs (as a result of emission trading). Electricity prices in 2010 would be 9% higher than in the Baseline. In later years the assumed availability of new nuclear technology, and the efficiency gains stemming from the investments in the early phases of transition, explain the lower impacts on costs.

83 The level of insulation is one of the factors that determine the level of energy services (useful energy demand) satisfied in the PRIMES modelling on the basis of simulating the investment in more or less efficient equipment (e.g. boilers) and the corresponding consumption of fuels.

A complete representation of the economic effects of deep CO_2 emission cuts would go beyond the scope of this energy scenario analysis and the capabilities of the model deployed. In particular such an analysis would require fully capturing cost elements that are presently outside the scope of the PRIMES model, i.e. the costs involved in better building insulation. (At present PRIMES captures only the substantial benefits of building insulation as a key element of energy efficiency policies). Furthermore, macro-economic feedbacks, taking due account of international competitiveness, need to be modelled. Such competitiveness effects, in turn, depend on the assumptions regarding the climate change policies likely to be pursued by the EU's main trading partners.

In any case, the magnitude of the cost effects is contingent on the way deep cuts in CO_2 emissions materialise. Substantially higher compliance costs would be incurred if the approach consisted simply in charging for CO_2 emissions without providing active energy (and energy technology) policies that widen the range of low-carbon options available to economic agents. Such low-carbon options include renewables and nuclear as well as better energy efficiency. The following chapter explores these factors more fully.

CHAPTER 8: Climate Change: Repercussions of CO_2 targets

8.1. Description of the scenarios examined

According to the Kyoto Protocol of December 1997, the European Community (EU-15) should reduce its greenhouse gas (GHGs) emissions in the 2008-12 period to 8% below their level of 1990. The integration of the New Member States into the EU (all of which, with the exemptions of Cyprus and Malta are among Annex B[84] countries) leads to a lower implicit "target" for the enlarged EU (EU-25). This takes into account the option available for former countries in transition to choose a base year other than 1990.

The GHGs covered by the Kyoto Protocol are CO_2 (energy and non-energy related emissions), methane, nitrous oxide, hydro-fluorocarbons, perfluorocarbons and sulphur hexafluoride. For the three fluorinated gases the Protocol gives countries the option of using 1995 as the base year. Furthermore, the Protocol allows the use of a number of different ways in the attainment of targets. These include carbon emissions savings generated from changes in land use, such as reforestation; and emissions reductions obtained from implementing projects among Annex B countries (i.e. joint implementation) or through emissions savings from financing allowable projects in developing (non Annex B) countries by using the "clean developing mechanism". Finally, the Protocol provides the opportunity to trade greenhouse gas emission permits across all Annex B countries.

Nevertheless, illustrative target values for energy related CO_2 emissions had to be fixed for this analysis in order to examine the energy consequences of CO_2 developments that reflect Kyoto type targets. These values should be understood as indicative of what may be required from the energy system following the logic of the Kyoto agreement. Given that there is particularly high uncertainty on the role of non-CO_2 GHG, sinks and the Kyoto flexible mechanisms (joint implementation, clean development mechanism, and emissions trading), various cases with different "target" values for energy related CO_2 emissions have been examined.

While there is no formal target for the EU-25, an implicit Kyoto "target" has been derived for this analysis on the basis of the Kyoto commitments for individual countries and the choices of some former countries in transition concerning a base year earlier than 1990 (with substantially higher GHG emissions). This analysis deals only with energy related CO_2 emissions and assumes a "target" value of minus 5.5% for energy related CO_2 emissions in EU-25 on the basis of the above considerations. GHG targets have been used as indicators for energy related CO_2 emissions, and statistics on CO_2 emission developments up to 1990 have been used for those former countries in transition that have opted for a base year other than 1990. All "targets" are expressed in relation to the CO_2 statistics of 1990. For comparison, the EU-15 target for the six Kyoto greenhouse gases amounts to a reduction of 8% in 2010 compared with the base year level, which is 1990 for most gases. The implicit CO_2 "target" of minus 5.5%, which is needed as a starting point for this energy analysis, is a result of technicalities as analysed in this study and does not imply any change in the EU-15 target of minus 8% for all Kyoto greenhouse gases.

The analysis performed with the use of the PRIMES model focused on the repercussions that the introduction of Kyoto type constraints (and possible post Kyoto targets) would generate for the EU-25 energy system. The constraints for EU-25 were treated as if they applied only to CO_2 emissions coming from the combustion of fossil fuels, given that the analysis of GHG emissions other than energy related CO_2 emissions (e.g. methane from agriculture) is outside the scope of the present analysis. The horizon of the analysis on CO_2 targets in EU-25 is 2010, the middle year of the period 2008-2012, which is the first Kyoto commitment period. For later years, either the same target value (stabilisation at lower levels than today) or further reductions in CO_2 emissions were assumed according to the case examined. Four cases for the EU-25 were examined:

- The first case examines the achievement of the Kyoto targets leading to an emissions decrease of -5.5% from 1990 levels for the EU-25 energy system and the stabilisation of emissions at that level in the period to 2030. Thus this case can be understood as a "Kyoto forever" scenario.

- The second case examines the achievement of a -5.5% reduction from 1990 levels in 2010 and the impact of the introduction of progressively higher emission reduction targets up to 2030, following the approach set out in the Commission's Communication in the run up to the Gothenburg Summit. The substantial CO_2 emission reduction in this case is assumed to take place without recourse to the flexible mechanisms (as in the previous "Kyoto forever" scenario), i.e. the "Gothenburg" emission reduction would be achieved entirely through domestic action. Thus this second case is denoted in what follows as the "Gothenburg-domestic" case ("Gothenburg type" targets with domestic action).

- The third case examined assumes that the targets to be satisfied by the EU-25 energy system drop to half of those assumed under the "Gothenburg-domestic" scenario. This approach reflects the possi-

84 Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, European Community, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom and United States of America

bilities of achieving Kyoto type targets by means other than reducing energy related CO_2 emissions, i.e. in particular by using flexible mechanisms and by acting on other (non-CO_2) gases. This scenario would, therefore, include a substantial contribution from flexible mechanisms in addition to action on other (non-CO_2) gases and sinks ("Gothenburg type" targets using flexible mechanisms or "Gothenburg-flexible" scenario). The "targets" in this scenario were fixed for purely analytical reasons; a higher contribution from other gases, sinks and flexible mechanisms is possible, which would in turn lead to a lower implicit "target" for CO_2 emissions.

- An additional scenario was examined serving to show the energy consequences of more domestic action over time and less reliance on flexible mechanisms, etc in the attainment of long-term CO_2 emission reductions post 2010. This scenario is an intermediate case compared with achieving "Gothenburg type targets" by relying solely on domestic action ("Gothenburg-domestic" case) and the "Gothenburg-flexible" case which has a large contribution from flexible mechanisms and action on other gases or sinks. This intermediate case on achieving "Gothenburg type" targets is therefore denoted as "Gothenburg-intermediate."

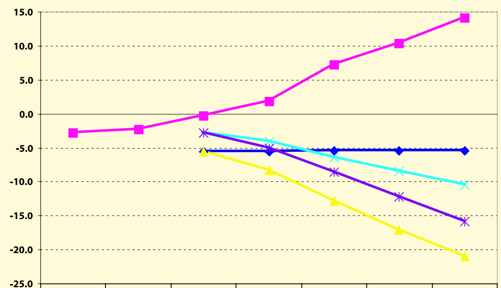
In all cases, it was assumed that energy consumers and producers would anticipate the emission reduction commitments and will therefore already undertake efforts before 2010. Furthermore, it has been assumed that the introduction of CO_2 emission reduction constraints does not affect the evolution of the EU-25 economy. Thus, the macro-economic assumptions remain unchanged compared to Baseline levels. The same is the case for international fuel prices, which are also assumed to remain unchanged from Baseline levels under the CO_2 emission reduction targets examined here. These assumptions are made in order to provide an in-depth analysis of the energy consequences of CO_2 action within this modelling framework.

The "targets" for energy related CO_2 emissions under the different cases examined for the EU-25 energy system in comparison to the 1990 CO_2 emission level are illustrated in Figure 8-1. Baseline emission developments (relative to 1990) are given for comparison.

Similar cases were also examined separately for the EU-15 energy system so as to obtain some insight of the - positive or negative - contribution of the New Member States' energy system in the achievement of Kyoto objectives. However, when excluding the New Member States and notably the former countries in transition, the EU-15 targets for all the cases examined are more ambitious than the EU-25 targets, as EU-15 countries do not have the option to choose a more favourable base year than 1990. Therefore, the EU-15 illustrative CO_2 target in the "Kyoto forever" case amounts to minus 8% from 1990 levels in 2010. The other cases for EU-15 are constructed according to the same logic as the cases for EU-25, starting from the minus 8% in 2010. They reflect in particular a strengthening of the Kyoto commitment over time ("Gothenburg-domestic" scenario); more use of flexible mechanisms and higher recourse to the reduction of other greenhouse gases/more use of sinks ("Gothenburg-flexible scenario); and finally an increasing share of domestic action over time ("Gothenburg-intermediate" scenario). These assumed "target" values for the EU-15 energy system in comparison to the 1990 CO_2 emissions level are illustrated in Figure 8-2 together with the Baseline emission developments.

The approach used in this analysis treats the EU-25 (or EU-15) energy system as one entity. In this case, emission reductions for each EU Member State are not those set according to the Burden Sharing Agreement.[85] Rather they are based on least-cost considerations within the EU-25 (EU-15) energy system and determined by opening up for EU-wide trading of emission allowances without any a priori allocation of emissions reductions to any sector or country. This represents a least-cost solution for achieving a given target as it

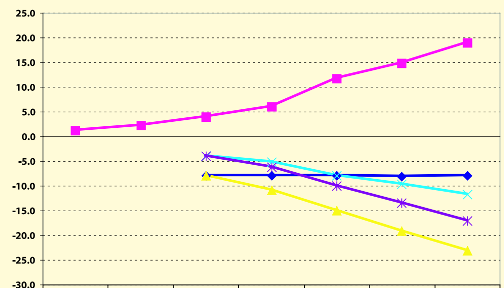
Figure 8-1: CO_2 emission reduction constraints for the EU-25 energy system (% difference from 1990 levels) for the different cases examined; Baseline emission developments for comparison



	2000	2005	2010	2015	2020	2025	2030
Baseline	-2.8	-2.3	-0.3	1.9	7.2	10.3	14.2
Kyoto forever			-5.5	-5.5	-5.5	-5.5	-5.5
Gothenburg-domestic			-5.5	-8.3	-12.8	-17.0	-20.9
Gothenburg-flexible			-2.8	-4.1	-6.4	-8.5	-10.5
Gothenburg-intermediate			-2.8	-5.1	-8.6	-12.2	-15.8

Source: PRIMES.

Figure 8-2: CO_2 emission reduction constraints for the EU-15 energy system (% difference from 1990 levels) for the different cases examined; Baseline emission developments for comparison



	2000	2005	2010	2015	2020	2025	2030
Baseline	1.2	2.2	4.0	6.0	11.7	14.8	19.0
Kyoto forever			-8.0	-8.0	-8.0	-8.0	-8.0
Gothenburg-domestic			-8.0	-10.9	-15.1	-19.1	-23.0
Gothenburg-flexible			-4.0	-5.1	-7.9	-9.7	-11.7
Gothenburg-intermediate			-4.0	-6.2	-10.0	-13.5	-17.1

Source: PRIMES.

85 In June 1999 the EU Member States agreed to meet the Kyoto Target of -8% in 2008-2012. The targets agree for each Member State were: Austria -13.0%; Belgium -7.5%; Denmark -21.0%; Finland 0.0%; France 0.0%; Germany -21.0%; Greece 25.0%; Ireland 13.0%; Italy -6.5%; Luxembourg -28.0%; Netherlands -6.0%; Portugal 27.0%; Spain 15.0%; Sweden 4.0% and the UK -12.5%. Furthermore according to the Kyoto Protocol the following targets apply for new Member States: Czech Republic -8,.% ; Estonia -8.0%; Hungary -6.0%; Latvia -8.0%; Lithuania -8.0%; Poland -6.0%; Slovakia -8.0% and Slovenia -8.0%.

leads to equal marginal abatement costs across countries and sectors, irrespective of any political or industrial realism or other considerations. The modelling solution could also represent any other instrument for emission reduction (other than emission trading based systems) that leads to equal marginal costs across countries and sectors. However, this modelling approach relies purely on price/cost mechanisms and does not include any new specific policies, such as those discussed in Chapter 7, which would widen the options of economic actors in achieving CO_2 emission reductions.

8.2. Methodology

The PRIMES model simulates a market equilibrium solution for energy supply and demand. The model determines the equilibrium by finding the prices of each energy form such that the quantity producers find best to supply matches the quantity consumers wish to use. The equilibrium is static (within each time period) but repeated in a time-forward path, under dynamic relationships. For example, the equilibrium in a given period depends among other things on the investment decisions (e.g. in power plants) in earlier periods. Given the technical features and design of the model, the imposition of global or sectoral emissions constraints is equivalent to the inclusion of a variable, which reflects the economic costs imposed by this constraint.[86] This shadow variable is the marginal abatement cost that is associated with the emission constraint and represents the economic cost of avoiding the last (marginal) unit of carbon that is required by the constraint. The marginal abatement cost is equivalent to the price of permits that a perfect market would establish for any given emission reduction target. Both the permit price and marginal abatement cost reflect the degree of ease or difficulty in reaching the target. These costs entail changes in the relative prices, reflecting the CO_2 emissions that each commodity or activity involves. This leads to adjustments in the behaviour of economic agents, i.e. producers and consumers of energy, inducing a general trend to shift away from activities that cause CO_2 emissions.

The analysis starts from a Baseline scenario, which takes into account current policies and trends without including specific (additional) efforts to reduce CO_2 emissions. Starting from this Baseline, the model is run for each scenario to determine the least- cost solution which is implied by the emission reduction constraints. These scenarios are defined to reflect and examine alternative emission reduction schemes. The model determines the allocation of effort by sector within each Member State that is necessary to meet the global constraint, implicitly assuming the existence of a full trading regime for emissions within each country or another 'perfect policy'.

The model distinguishes between energy demand and supply sectors. Emissions are accounted for in a sector only if directly emitted from fossil fuel combustion in the sector. Hence, the analysed trading schemes can be classified as "downstream". Emissions indirectly incorporated in electricity and steam use (including district heating) are considered in the power and heat generation sectors. Consequently, the emission reduction target for sectors may be interdependent, since for example a demand sector (e.g. a cement kiln) shifting the energy mix in favour of electricity might induce higher emissions in a supply sector (e.g. in power plants). A systems analysis model, such as PRIMES, ensures consistent representation of these interdependencies and a consistent calculation of emission reduction efforts and marginal costs.

The analysis draws conclusions by considering the differences between the results of emissions constrained cases and the Baseline scenario. These differences cover the whole energy system, showing changes that are necessary to reach the lower emission level. Such changes may concern consumer behaviour in using energy, structural changes in energy uses and processes, possible accelerated adoption of new technologies, changes in the fuel mix, etc.

The model provides simultaneous estimations of the marginal cost of avoided emissions, and of the energy system costs of these changes, by sector and Member State. Following a least-cost methodology, the marginal costs plotted against the varying levels of emission reduction (i.e. the model-based marginal abatement cost for CO_2 emissions) can be used as a basis for defining a distribution of the emission reduction effort by country and by sector.
The economic interpretation of the costs to the economy arising from these marginal costs is complex. The imposition of a CO2 constraint induces an external cost to CO_2 consuming agents compared to Baseline conditions. However, from the perspective of societal welfare, the constraint aims to internalise the external cost of emitting CO_2, so as to improve the allocative efficiency of the overall economy. Under such a constraint, the system bears a loss of welfare (compared to Baseline, ignoring the economic benefits of averted climate change), for each tonne of CO_2 avoided, equal to the marginal abatement cost corresponding to that tonne. Therefore, total abatement cost implied by an emission constraint is equal to the area (the integral) below the marginal abatement cost curve.[87]

This estimation comes from partial equilibrium analysis since PRIMES covers only the energy demand and supply system, the rest of the economy being considered unchanged under the imposition of emission reduction targets. Consequently the above estimation does not include any macro-economic indirect effects resulting from

86 The PRIMES energy system model formulates energy market equilibrium according to the mixed-complementary mathematical methodology, which roughly corresponds to the Kuhn-Tucker conditions that are dual to a mathematical programming problem. Consequently, the imposition of a global or sectoral constraint on emissions is mathematically strictly equivalent to the inclusion of a shadow variable, a shadow cost, which appropriately affects all economic costs, proportionally to their emissions.

87 Successive runs of the PRIMES model, using increasing emission reduction targets, were made so as to obtain a marginal abatement cost curve for the European energy system by Member State. The latter was obtained by mapping the resulting marginal abatement costs against the reduction target, in comparison to the Baseline scenario.

the allocation of larger investment in energy demand and supply to obtain higher efficiency and less carbon intensity. Furthermore, any deviation from a least-cost allocation, among the different demand and supply sectors, for example because of policy implementation failure, would entail higher compliance costs. In order to investigate these issues, a general equilibrium framework would be needed. However, such an approach would be very complex and would not deliver the energy sector details that are set out below.

8.3. "Kyoto forever" scenario results for EU-25[88]

At the aggregate level of analysis, the economic system has two means of responding to the imposition of the carbon constraint while maintaining the same level of GDP. Either it can reduce the level of energy used per unit of GDP (the energy intensity) or it can change the fuel mix in order to reduce the carbon intensity of its energy sub-system. The division of the system's response between these two effects is an important indication of where most of the flexibility in the system can be found. A reduction in the carbon intensity of the energy system indicates that, to a certain degree, substitution opportunities among fuels are more cost effective than substitution of energy by other goods (leading to energy intensity improvements).

These two effects for the EU-25 as a whole can be seen in Table 8-1. To reach a level 5.5% below 1990, CO_2 emissions in 2010 are 5.2% less than in the Baseline (which itself has CO_2 emissions 0.3% below the 1990 level). Although CO_2 emissions decrease by 5.2%, primary energy demand declines by only 2.5% from its Baseline level. This reduction of 2.5% in energy demand is equivalent to the improvement in energy intensity, because GDP in the "Kyoto forever" case does not change from Baseline. In 2010 energy intensity improvements contribute about 47% of the total emission reduction. This contribution diminishes to 33% of total emissions reduction in 2030 reflecting the increasing difficulty for the energy system in further reducing energy requirements. The balance of the emission reduction is achieved through improvements in carbon intensity; that is through fuel switching away from high carbon fuels such as coal and lignite to low carbon fuels, such as natural gas, and carbon free fuels, such as renewables and nuclear.

In terms of primary energy consumption, the imposition of the CO_2 emissions reduction constraints leads to significant changes in primary fuel demand reflecting the above effects due to a reduction in the overall level of energy needs (energy intensity reductions) and fuel switching (carbon intensity reductions). The demand for solid fuels, which are the most carbon intensive of all the primary fuels, declines not only because of the overall fall in energy consumption but also because their use is replaced by less carbon-intensive fuels. In 2010 demand for solid fuels declines by -14.0% from Baseline levels, a decline that becomes even more pronounced in the long run reaching close to -60.0% in 2030.

The modest negative effect on liquid fuels (-2.2% from Baseline levels in 2010; -4.9% in 2030) is due mostly to the reduction in overall demand rather than to substitution. This is because - even under Baseline assumptions - liquid fuels become an energy form used almost exclusively in the transport sector and the petrochemical industry. Given the very limited flexibility of the transport sector to change the fuel mix in the absence of specific policies, it is obvious that the evolution of liquids demand is constrained by the evolution of the transport sector itself. Demand for natural gas is projected to decline by -1.1% from Baseline levels in 2010, increasing thereafter to be +5.0% higher than the Baseline in 2030. Similar findings apply to nuclear energy, which in the long run exhibits strong growth above Baseline levels (+8.9% in 2030). The falls in natural gas and

Table 8-1: Primary energy demand in the EU-25 in the "Kyoto forever" case

	Mtoe				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303	210	139	121	-14.0	-45.0	-59.6
Liquid Fuels	636	639	649	641	-2.2	-3.3	-4.9
Natural Gas	376	501	617	659	-1.1	3.2	5.0
Nuclear	238	245	210	202	0.0	-1.9	8.9
Renewable energy forms	96	143	185	221	7.7	21.9	30.6
Total	**1651**	**1740**	**1801**	**1847**	**-2.5**	**-4.7**	**-5.7**
EU-15	**1453**	**1539**	**1585**	**1622**	**-2.4**	**-4.3**	**-5.7**
NMS	**198**	**202**	**216**	**226**	**-3.3**	**-6.9**	**-6.1**
Mt CO2 emitted	***3665***	***3561***	***3562***	***3563***	***-5.2***	***-11.8***	***-17.2***
EU-15	***3118***	***3047***	***3063***	***3071***	***-4.9***	***-11.0***	***-16.3***
NMS	***547***	***515***	***499***	***493***	***-6.8***	***-16.4***	***-22.4***

Source: PRIMES.

88 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to Baseline can be found in APPENDIX 8. Detailed results by group of countries (EU-25, EU-15 and NMS) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD..

Table 8-2: Final energy demand in the EU-25 in the "Kyoto forever" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Industry	309.1	332.0	354.2	373.4	-2.0	-3.6	-3.9
Tertiary	154.2	165.8	183.8	203.2	-4.8	-5.4	-6.8
Households	279.1	301.7	316.3	322.9	-2.2	-3.9	-4.7
Transports	332.0	380.3	411.7	425.1	-1.8	-3.6	-5.3
Total	**1074**	**1180**	**1266**	**1325**	**-2.4**	**-3.9**	**-5.0**
EU-15	**955**	**1050**	**1119**	**1168**	**-2.4**	**-3.9**	**-5.0**
NMS	**119**	**129**	**147**	**157**	**-2.2**	**-4.2**	**-5.1**
	Mt CO_2 emissions				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	605.7	514.6	500.1	492.6	-5.5	-8.4	-10.7
Tertiary	236.7	221.1	220.3	226.8	-7.7	-8.6	-11.0
Households	462.6	463.1	463.2	449.9	-3.8	-6.5	-7.6
Transports	967.5	1090.8	1168.8	1190.5	-1.8	-3.6	-5.3
Total	**2272**	**2290**	**2352**	**2360**	**-3.6**	**-5.7**	**-7.5**
EU-15	**2024**	**2041**	**2089**	**2093**	**-3.6**	**-5.6**	**-7.4**
NMS	**249**	**249**	**263**	**267**	**-3.6**	**-6.8**	**-8.4**

Source: PRIMES.

nuclear demand in the medium term stems from the overall reduction in primary energy demand.

In an environment of CO_2 emissions reduction constraints, renewable energy sources are projected to grow at rates above those observed in the Baseline scenario during the entire projection period (+7.7% in 2010; +30.6% in 2030). The major role that renewable energy forms are called upon to play for the EU-25 energy system in reducing CO_2 emissions is clearly illustrated in their market share in total primary energy needs which is projected to reach 12.0% in 2030 (+3.3 percentage points above Baseline levels).

The changes in primary energy needs described above for the "Kyoto forever" case lead to the stabilisation of CO_2 emissions in the EU-25 energy system at -5.5% from 1990 levels from 2010 onwards, with reductions in comparison to the Baseline scenario ranging from -5.2% in 2010 to -17.2% in 2030. Furthermore, the decline of primary energy needs, combined with the projected shifts towards the use of indigenous energy sources (such as renewable energy forms and nuclear energy), has a significant impact on the evolution of EU-25 import dependency, especially in the long run. Import dependency is projected to reach 52.6% in 2010 (-0.5 percentage points from Baseline levels) and 64.2% in 2030 (compared to 67.3% in the Baseline scenario).

8.3.1. Final energy demand

The response of the demand side to the introduction of emission reduction constraints differs somewhat from the overall reaction of the EU-25 energy system. Firstly, CO_2 emissions reduction on the demand side remains significantly lower than the overall energy system emissions reduction. For example, total CO_2 emissions decrease by 17.2% below Baseline in 2030, whereas CO2 emissions from the final demand sectors decline by only 7.5% (see Table 8-2 in comparison with Table 8-1). Furthermore, the difference between the reduction in final energy demand and the corresponding reduction in CO_2 emissions is much less than the difference between energy consumption and emission changes in the case of primary energy. CO_2 emissions related to final energy demand are projected to fall -7.5% in 2030 from Baseline, but with final energy demand declining by only -5.3%. Consequently, carbon intensity, that is fuel switching, can play a bigger role for CO_2 reduction at the primary energy level than in final demand, which explains the marked CO_2 reductions in comparison with Baseline developments in this scenario.

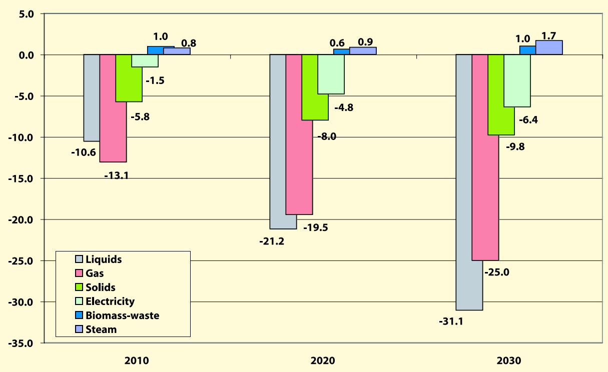
The tertiary sector is the most responsive to the introduction of the CO_2 emissions reduction constraint, both in terms of energy requirements (declining by -4.8% from Baseline levels in 2010 and -6.8% in 2030) and CO_2 emissions (-7.7% in 2010 and -11.0% in 2030). Changes in consumers' behaviour and the adoption of more efficient technologies are the key drivers for the projected energy intensity gains (accounting for 62% of projected CO_2 emissions reduction both in 2010 and in 2030). Shifts in the fuel mix towards less carbon intensive energy forms allow for the projected improvement in carbon intensity. The same drivers, but with a less pronounced effect, act for energy and carbon intensity gains achieved in households. In 2010 energy requirements in households in the "Kyoto forever" case are projected to be -2.2% below Baseline levels in 2010, with the reduction in CO_2 emissions reaching -3.8%. The corresponding changes in 2030 are -4.7% for energy requirements and -7.6% for CO_2 emissions.

In the transport sector the impact of the introduction of emission reduction constraints through higher fuel use costs (depending on the carbon content of fuels) is largely dampened by the pre-existence of high consumption taxes. The additional energy cost faced by consumers because of carbon values does not significantly alter the overall energy use costs in this sector. Even so consumers react to the introduction of emissions constraints by reducing overall transport activity, shifting towards less energy-intensive transport modes, and adopting more efficient vehicle technologies. Energy requirements in the transport sector are projected to decline by -1.8% from Baseline levels in 2010 and by -5.3% in 2030. However, as no new cost-effective fuels are expected to enter the transportation sector in any significant way in the near future without strong specific policies,[89] changes in the fuel mix are very limited. Thus the projected CO_2 emissions reduction in transport is equivalent to the corresponding decline in energy requirements.

Industry exhibit stronger inertia to the introduction of the emissions reduction constraints with energy use in industrial sectors declining less than that of other final sectors (-2.0% from Baseline levels in 2010, -3.9% in 2030). This result is largely due to the significant restructuring and energy intensity gains that already occur in industrial sectors under Baseline assumptions. But it is also explained by the assumption that the introduction of the emission reduction target in the EU-25 energy system does not affect the sectoral value added of industrial sectors in comparison to Baseline. On the other hand CO_2 emissions reduction in industry reach -5.5% in 2010 and -10.7% in 2030, with carbon intensity gains accounting for some 63% of the emissions reduction achieved in 2010 and 64% in 2030. The significant changes in the fuel mix towards the use of less carbon intensive fuels are largely explained by the fact that industry experiences the sharpest variations in terms of energy costs because of the relatively low pre-existing taxation of energy products in this sector.

Carbon intensity gains on the demand side of the EU-25 energy system in the "Kyoto forever" case arise from changes in the fuel mix towards the use of biomass/waste and co-generated steam. These

Figure 8-3: Changes in final energy demand by fuel in EU-25 (diff. from Baseline in Mtoe) in the "Kyoto forever" case



Source: PRIMES.

are projected to grow above Baseline levels over the projection period despite the overall decline of energy needs on the demand side (see Figure 8-3). Moreover, electricity demand decreases much less than total final energy demand (-0.6% for electricity versus -2.4% from Baseline levels for final energy demand in 2010 and -1.9% versus -5.0% respectively in 2030). The reason for this is the comparatively low impact of the imposition of carbon values on the price of electricity. This is due to the various other cost components included in the electricity price in addition to fossil fuel costs. The comparatively low impact on electricity prices of the carbon constraints also stems from the adaptation measures in power generation undertaken in response to the additional costs arising from carbon values on fossil fuels (see below).

On the contrary, demand for fossil fuels diminishes. Solid fuels decrease -13.6% from Baseline levels in 2010 and -30.4% in 2030. Liquids decline by -2.1% in 2010 and -5.6% in 2030, and natural gas demand is -4.4% lower than Baseline in 2010 (-7.3% in 2030). Given these rates of decline for fossil fuels are above average there is a reduction in the market share of these energy forms on the demand side. This leads to the projected improvement of carbon intensity in the "Kyoto forever" case. It should be recalled here that CO_2 emissions for the production of electricity and co-generated steam are accounted for on the supply side.

In 2010, CO_2 emissions reduction from the demand side accounts for 44.1% of total CO_2 emissions reduction under the "Kyoto forever" case. In the long run the contribution of the demand side falls. Thus, in 2020 CO_2 emissions reduction from the demand side accounts for 29.7% and in 2030 for 25.9% of the overall CO_2 emissions reduction achieved in the EU-25 energy system.

8.3.2. Impacts on electricity and steam generation

Clearly, larger reductions in CO_2 emissions originate from the process of transformation of primary energy into final energy. More specifically, the power and steam generation sector of the EU-25 energy system appears to be that which can adjust in the most cost-effective way to emission constraints. The contribution by the energy sector, which includes activities like refining,[90] is relatively modest. There are many reasons for the high flexibility within the power generation system. Firstly, since a part of electricity generation takes place using carbon free primary fuels, such as hydro, wind and nuclear, a given reduction in emissions in the system can take place merely by reducing electricity production from fossil fuels. Moreover these reductions can concentrate on particularly high carbon content fuels such as lignite or coal. Secondly, generation through carbon free fuels can be increased. Thirdly, the system can respond by increasing the overall efficiency of generation based on fossil fuels. This can be achieved by adopting improvements in the technology used for any given fuel, through alternative combinations of technologies and fuels (such as the use of gas-turbine combined cycle units as opposed to conventional thermal coal plant). This results in substantial efficiency gains in addition to using lower

89 The use of low or zero carbon fuels in transportation implies the massive development of infrastructure for new fuel cycles, like hydrogen and methanol originating from biomass, or fossil fuels with CO_2 sequestration.

90 The effects on the power and steam generation activities of refineries are accounted for in the power sector.

carbon content fuels. It can also be achieved through changes in the allocation of available plants in merit order dispatching.

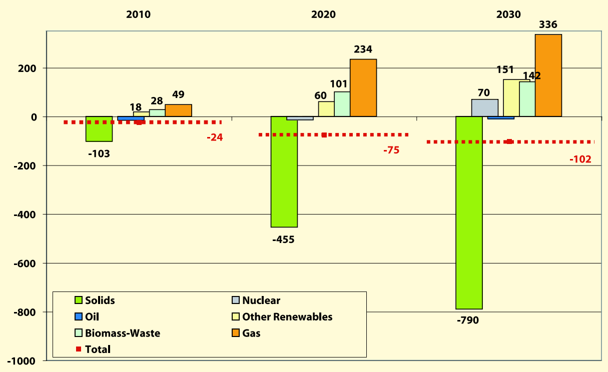
As can be seen from a comparison between Table 8-2 and Table 8-3, electricity production declines at rates well below those of total final energy demand. There are shifts in the fuel mix towards the increased use of electricity in the "Kyoto forever" case despite efficiency gains in electricity applications.

There exists a sharp difference between the decline in the power generation system's output and fossil fuel inputs. It should be recalled that fossil fuel inputs become more expensive in this scenario due to the carbon values imposed on fossil fuel consumption in relation to the carbon content of the individual fuel (and the global level of CO_2 reduction aimed at). It can be seen from the following that the imposition of carbon values has substantial effects on fuel choices in the power generation sector. In 2010 fossil fuels input in power generation declines by -4.0% from Baseline levels compared to a reduction of electricity production by just -0.7%. Thus, the decline in fossil fuel inputs is 5.8 times higher than the corresponding decline in electricity generation.

This effect becomes even more pronounced in the long run, with the reduction of fossil fuel inputs in 2030 being 6.1 times higher that that of electricity production (fossil fuels input declines by -14.2% from Baseline levels in 2030 versus -2.3% for electricity production). The large increase in the use of carbon free fuels (renewables and nuclear energy), electricity generation from which grows both in absolute and in market share terms above Baseline levels, together with adoption of more efficient power generation technologies are the key drivers for the much more pronounced decline of fossil fuels input compared to electricity production.

The flexibility of the power and steam generation sector to respond to carbon constraints is shown most dramatically by the changes achieved in CO_2 emissions. On average, for every one per cent reduction in generation output there is a multiple decline in CO_2 emissions. Thus, by reducing electricity and steam generation by just -0.7% in 2010, the generation system reduces its CO2 emissions by -9%. In turn this accounts for 56% of the overall energy system reduction in CO_2 emissions achieved in 2010 in the "Kyoto forever" case. The corresponding reductions in 2030 are 2.3% for electricity generation versus 34.1% for CO_2 emissions. These significant gains

Figure 8-4: Changes in electricity generation by energy form in EU-25 (diff. from Baseline in TWh) in the "Kyoto forever" case



Source: PRIMES.

in carbon intensity of the power generation sector are due to the already discussed increased market share of non-fossil fuels in electricity generation. They are also explained by the changes in the fuel mix as regards electricity generation from fossil fuels, with substantial replacement of solid fuels by gas (see Figure 8-4).

With overall electricity production declining by -24 TWh from Baseline levels, electricity generation from solid fuels declines by -103 TWh (or -14.8%). This trend is even more pronounced in the long run with the projected decline of electricity generation from solid fuels in 2030 (-790 TWh or -67.2% from Baseline levels) being more than 8.5 times higher than the projected decline for overall electricity production. Thus, the introduction of the CO_2 emissions reduction constraints largely affects the cost effectiveness of solid fuels and obviates their comeback in the power sector beyond 2015 which is projected under Baseline assumptions.

Solid fuels are largely replaced by natural gas. Gas-based electricity production increases by 49 TWh (+4.5%) from Baseline levels in 2010 and by 336 TWh (+20.8%) in 2030. Biomass and waste also grow well above Baseline levels with the increase of electricity generation from these energy forms rising as much as +162.6% in 2030 (+33.4% in 2010). This increase, combined with the significant growth in the use of hydro energy and intermittent energy sources (+3.5% in 2010; +21.3% in 2030) and the overall decline of electrici-

Table 8-3: Power generation in the EU-25 in the "Kyoto forever" case

					% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Fossil fuel input (Mtoe)	**384.6**	**396.5**	**441.6**	**464.0**	**-4.0**	**-8.6**	**-14.2**
Electricity generated (TWh)	**2897.9**	**3395.1**	**3873.9**	**4295.3**	**-0.7**	**-1.9**	**-2.3**
Nuclear	921.2	952.5	819.5	836.2	0.0	-1.7	9.1
Thermal (incl. biomass/waste)	1617.2	1912.1	2392.3	2603.6	-2.1	-4.8	-11.0
Hydro & Intermittent renewables	359.5	530.6	662.1	855.5	3.5	9.9	21.3
CO_2 emissions (Mt of CO_2)	**1193**	**1109**	**1058**	**1057**	**-9.0**	**-24.1**	**-34.1**

Source: PRIMES.

ty generation, allows for substantial growth of the market share of renewable energy forms (including waste) in electricity generation. In 2010 this share rises to 19.1% (from 17.3% in the Baseline) and in 2030 to 25.4% (+7.3 percentage points above Baseline levels).

Finally, nuclear electricity production remains unchanged in 2010, exhibiting only a limited growth above Baseline levels in 2030 (+9.1%). Even so this increase is still significant taking into account that it has been assumed that Member States with declared nuclear phase-out policies do not alter these policies, and also that Member States with no nuclear under Baseline assumptions remain as such under the "Kyoto forever" scenario assumptions. Thus, it is only for a limited number of Member States that nuclear energy is available as an option to reduce CO_2 emissions in the scenario examined.

The changes described above in electricity generation clearly indicate the strong impact that the introduction of CO_2 emissions reduction constraints has upon the investment decisions of power generators. In the short term power generators react to emissions reduction constraints through higher investment in wind turbines and gas turbine combined cycle power plants. This investment occurs mainly to the detriment of conventional thermal power plant technologies (see Table 8-4). It is also interesting to note that capacity of supercritical polyvalent units (with the potential of using solid fuels as well as biomass and waste) increases in the "Kyoto forever" case in comparison to the Baseline scenario. This is because such capacity is found to be a cost-effective option in further exploiting biomass and waste potential for electricity production. On the contrary, in the long run and as the comeback of solid fuels is largely cancelled by the emission reduction constraints, supercritical polyvalent units face major difficulties. Installed capacity of such units in 2030 is limited to about only 50% of the corresponding capacity under Baseline assumptions (72.9 GW installed in the "Kyoto forever" case compared to 143.4 GW in the Baseline).

Capacity expansions for advanced coal, conventional thermal power plants and small gas turbines are also projected to be less significant than in the Baseline scenario. As a result of increased cost effectiveness due to the introduction of CO_2 emissions reduction constraints (that is carbon values), power producers are projected to undertake additional investment in gas turbine combined cycle power plants (+54.1 GW or +14.0% above Baseline levels in 2030) and also in wind turbines (+49.7 GW in 2030 or +36.8%). Nuclear capacity is also projected to grow well above Baseline levels in the long run (+18.6 GW in 2030), while solar photovoltaic power plants also make some additional inroads compared to the Baseline. It should be noted that as regards nuclear energy a reversion of trends, observed in the Baseline scenario, occurs in the "Kyoto forever" case with nuclear capacity increasing in absolute terms between 2020 and 2030.

As a result of the above mentioned changes the share of gas turbine combined cycle power plants in total installed capacity reaches 38.4% in 2030 (from 34.4% in the Baseline scenario). Hydro and intermittent renewables (wind turbines and solar photovoltaic) account for 28.1% of total installed capacity (+4.7 percentage points above Baseline levels). It is partly because of this significant growth of intermittent renewables capacity, but also because of the under-utilisation of installed carbon-intensive power plants, that total installed capacity grows slightly above Baseline levels over the projection period (+2.2% in 2030) despite the fact that overall electricity production declines.

Fuel input for power and steam generation declines by -2.5% from Baseline levels in 2010 and -8.0% in 2030 (see Table 8-5). The consumption of solid and liquid fuels declines markedly from Baseline levels, whereas the use of other energy forms increases. In 2030, fuel input of solid fuels in power generation is limited to slightly above 30% of that projected under Baseline assumptions. Natural gas has

Table 8-4: Installed capacity by plant type in EU-25 in the "Kyoto forever" case

	GW installed				*change from baseline (in GW)*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	112.9	126.4	0.0	4.9	18.6
Hydro	96.2	105.4	112.4	116.0	0.8	3.2	3.8
Wind	12.8	79.8	129.4	184.7	7.1	25.8	49.7
Other renewables	0.2	0.5	0.8	21.1	0.0	0.2	6.8
Conventional thermal	335.6	265.1	163.9	126.7	-5.5	-11.4	-20.7
Advanced coal	0.0	0.3	0.6	2.7	-0.2	-1.3	-3.8
Supercritical polyvalent	0.0	2.9	31.5	72.9	2.4	-33.2	-70.5
Gas turbines CC	47.4	175.1	349.2	438.7	5.6	30.5	54.1
Small gas turbines	22.8	30.8	52.2	52.4	-3.2	-11.1	-13.4
Fuel cells	0.0	0.0	0.0	0.6	0.0	0.0	0.6
Geothermal	1.0	1.2	1.5	1.8	0.0	0.2	0.4
Total	**656**	**791**	**955**	**1144**	**7.0**	**7.8**	**25.7**
EU-15	**579**	**696**	**821**	**977**	**7.1**	**8.7**	**25.9**
NMS	**78**	**95**	**133**	**167**	**-0.1**	**-0.8**	**-0.2**
of which CHP	***103***	***133***	***166***	***214***	***3.0***	***-2.6***	***15.0***
EU-15	***77***	***106***	***130***	***166***	***3.6***	***0.0***	***19.7***
NMS	***26***	***27***	***36***	***48***	***-0.6***	***-2.6***	***-4.8***

Source: PRIMES.

Table 8-5: Fuel input in electricity and steam generation in EU-25 in the "Kyoto forever" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solids	217.4	148.6	87.2	76.0	-16.0	-54.7	-68.9
Oil products	52.4	31.0	22.8	17.5	-9.8	-2.8	-11.2
Gas	131.7	210.6	299.8	326.2	3.0	13.5	19.4
Biomass	12.7	23.3	43.1	55.8	24.7	102.5	132.8
Waste	19.3	28.6	32.7	32.4	12.2	20.2	22.2
Nuclear energy	237.7	245.3	209.5	201.9	0.0	-1.9	8.9
Geothermal heat	3.0	3.5	3.9	4.5	2.7	6.8	14.4
Total	**674**	**691**	**699**	**714**	**-2.5**	**-6.3**	**-8.0**
EU15	**581**	**596**	**602**	**614**	**-2.2**	**-5.6**	**-8.1**
NMS	**93**	**94**	**97**	**100**	**-4.4**	**-10.3**	**-7.7**
Mt CO_2 emitted	***1355***	***1190***	***1126***	***1124***	***-8.5***	***-23.2***	***-32.9***
EU-15	***1068***	***929***	***897***	***905***	***-8.1***	***-22.4***	***-32.3***
NMS	***287***	***262***	***229***	***218***	***-9.8***	***-26.1***	***-35.5***

Source: PRIMES.

the highest growth above Baseline levels in absolute terms (+53 Mtoe in 2030); whereas in percentage terms it is biomass that is most favoured by the introduction of emission reduction constraints, with its fuel input increasing by +132.8% from Baseline levels in 2030 (+31.8 Mtoe).

The clear shift towards the use of less carbon intensive and carbon free energy forms in the "Kyoto forever" case leads to a significant improvement of carbon intensity in electricity and steam generation. CO_2 emissions from electricity and steam generation (including emissions from industrial boilers and district heating) are limited to 91.5% of those projected under Baseline assumptions in 2010 and fall to 67.1% of the Baseline level in 2030. This results in a reversal of the trend that prevailed in the Baseline scenario, with CO_2 emissions declining continuously in absolute terms over the projection period compared to a projected growth in the Baseline from 2010 onwards.

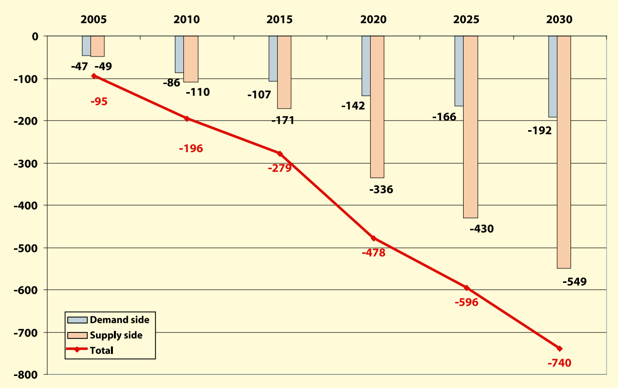
8.3.3. Impacts on CO_2 emissions and cost implications

Figure 8-5 illustrates the changes of CO_2 emission levels in the "Kyoto forever" case compared with the Baseline levels for the respective projection years. As already discussed, changes on the supply side are the key driver for the achieved CO_2 emissions reduction over the projection period. Such changes become increasingly important in the long run. Whereas in 2010 CO_2 emissions reduction from the supply side accounts for 56% of the overall emissions reduction, in 2030 this share reaches 74%. This result clearly reflects the large potential existing in the power generation sector to reduce CO_2 emissions due to the wide range of options for responding to the introduction of CO_2 emissions reduction constraints.

Given the growth in CO_2 emissions in the Baseline scenario, the stabilisation of CO_2 emissions in the EU-25 energy system at -5.5% compared to the 1990 levels from 2010 onwards requires additional effort to be undertaken by energy agents over the projection period. Thus the reduction from Baseline levels increases from -5.2% in 2010 to -17.2% in 2030. This is clearly reflected by the marginal abatement costs (carbon values) estimated through successive runs of the PRIMES model. Thus the stabilisation of emissions for the EU-25 energy system at -5.5% from 1990 levels requires a carbon value of 15.3 €00[91] per t of CO_2 in 2010, 28.1 €00 in 2020 and 40.9 €00 in 2030.

It is interesting to note that the carbon values required to stabilise CO_2 emissions at the examined level increase at a slower pace compared to the achieved reduction in CO_2 emissions between the different time periods. While in 2010 a marginal abatement cost of 15.3 €00 per t of CO_2 leads to a CO_2 emissions reduction of 196 Mt CO_2 from Baseline levels, in 2020 a reduction of 478 Mt CO_2 from Baseline levels (some 145% more compared to that in 2010) is achieved with an increase of marginal abatement cost by 12.8 €00

Figure 8-5: Changes in CO_2 emissions in EU-25 energy system in the "Kyoto forever" case



Source: PRIMES.

91 The carbon values are expressed in prices of the year 2000, which is denoted by "€00".

per t of CO_2 or +84% compared to the carbon value applied in 2010. Similarly in 2030 with a marginal abatement cost of 40.9 €00 per t of CO_2 (+45% compared to the marginal abatement cost in 2020) the reduction in CO_2 emissions from Baseline levels reaches 740 Mt CO_2 (+54% compared to the corresponding CO_2 reduction in 2020). This feature reflects the fact that, as a result of achieving a target in a specific time period, the energy system adjusts through improvements in energy and carbon intensity In turn this allows for an easier achievement of targets faced in the future. In addition to the above, as we move further into the future, then technological improvements make emission reductions relatively easier than is true with current technologies.

This is also illustrated by the increase in energy system costs arising from the imposition of marginal abatement costs. Total energy costs also take into account the reactions of the energy system in terms of energy consumption and fuel inputs to energy transformation. These energy costs are purely illustrative of the relative cost levels involved in different targets. They do not represent the full costs related to the implementation of CO_2 reduction policies given that the modelling approach is exclusively based on the imposition of carbon values. Although the carbon value approach does not simulate those CO_2 reduction policies that might be pursued in reality, it does provide insights into the relative difficulty of achieving more or less deep cuts in CO_2 emissions. Total energy system costs for the EU-25 increase by 24.3 billion €00 in 2010 in comparison to the Baseline scenario due to the indicative costs for CO_2 reduction that are reflected in the carbon values. The additional costs over and above Baseline amount to 31.7 billion €00 in 2020 and to 25.1 billion €00 in 2030. Between 2020 and 2030, a period in which the marginal abatement cost increases, additional system costs exhibit a declining trend which reflects largely the achieved improvement in the EU-25 energy system up to 2020 in reaction to the carbon constraints.

When interpreting these carbon values and cost indicators, including their possible impacts on costs of individual sectors, it needs to be borne in mind that they are only indicative of the relative difficulty of achieving targets. They do not represent costs of policy implementation. The imposition of carbon values, which lead to the CO_2 reductions aimed at, does not involve any policies that widen the options of economic actors to adapt to the necessary changes. On the contrary, in the carbon value approach, CO_2 reductions through changes in behaviour, production processes and technology deployment are triggered only by cost mechanisms. Given the inertia in the energy systems, the costs involved are high in the absence of specific policies, such as those analysed in Chapter 7.

8.3.4. Concluding remarks

The introduction of marginal abatement costs in the EU-25 energy system to achieve stabilisation of CO_2 emissions at -5.5% below 1990 levels from 2010 onwards, examined under **the Kyoto forever** case, leads to significant changes in comparison to the Baseline scenario both in terms of energy intensity gains and changes in the fuel mix. Primary energy needs decline by -2.5% from Baseline levels in 2010 and -5.7% in 2030. This decline is further accompanied by strong shifts towards the use of renewable energy forms (+30.6% above Baseline levels) and to a lesser extent nuclear energy and natural gas (+8.9% and +5.0% respectively in 2030). On the contrary demand for solid fuels faces strong downward pressure (-59.6% below Baseline levels in 2030).

The overall decline of primary energy needs, combined with the shift towards use of non-fossil energy forms, causes a decline in the share of fossil fuels in primary energy needs (77.6% in 2010 and 77.0% in 2030, compared to 78.7% and 81.8% respectively in the Baseline scenario). Moreover, the trend towards a rising share of fossil fuels in the Baseline is reversed as the fossil fuel share diminishes slightly leaving more room for CO_2 free energy sources. The renewables share rises to 8.2% in 2010 (+0.8 percentage points above Baseline levels) and to 12.0% in 2030 (+3.3 percentage points). In addition import dependency of the EU-25 energy system would be lower than in the Baseline (-0.5 and -3.1 percentage points in 2010 and 2030 respectively) to reach 52.6% in 2010 and 64.2% in 2030.

The power generation and other energy transformation sectors play a key role in achieving the CO_2 emissions reduction required from Baseline levels. In 2010, with overall CO_2 emissions in the EU-25 energy system falling by -5.2% from Baseline levels, the decline from the supply side reaches -7.9% compared to -3.6% for final energy demand. The role of the supply side is even more pronounced in the long run. Thus, in 2030, with overall CO_2 emissions in the EU-25 energy system reaching -17.2% below Baseline levels, the supply side reduces CO_2 emissions by -32.9% whereas changes on the demand side achieve a reduction of just -7.5% from Baseline levels.

8.3.5. Achieving "Kyoto forever" in the EU-15[92]

Besides the analysis performed at the level of the enlarged EU of 25 Member States, the "Kyoto forever" case was also examined for the EU of 15 Member States ("Kyoto forever in EU-15" case). The target examined for the EU-15 energy system is more ambitious than that for the EU-25 (-8.0% from 2010 onwards compared to -5.5%). Moreover, the difficulty in achieving the CO_2 emissions reduction target for the EU-15 is also augmented by the fact that the EU-15 energy system is more advanced both in terms of energy and carbon intensity compared to EU-25. In addition, the EU-15 energy system is projected to have a higher growth of CO_2 emissions compared to that of the EU-25 (especially in the short run). Under Baseline scenario assumptions CO_2 emissions increase +4.0% from 1990 levels in 2010 for the EU-15 compared to a decline of -0.3% for the EU-25; CO_2 emissions rise +19.0% by 2030 compared to +14.2% for the EU-25.

Thus stabilising CO_2 emissions at -8% from 1990 levels in the EU-15 energy system requires a reduction from Baseline levels of -11.5% in 2010 and -22.7% in 2030. The changes that occur in primary energy needs for the EU-15 energy system in the "Kyoto forever in EU-15" case are illustrated in Table 8-6. In 2010, energy intensity gains

92 Detailed results for the EU-15 and aggregate results for the EU-15 and by country (in comparison to Baseline) are available in the enclosed CD.

Table 8-6: Primary energy demand in the EU-15 in the "Kyoto forever in EU-15" case

	Mtoe				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	212	109	69	52	-35.0	-61.4	-76.6
Liquid Fuels	587	562	562	558	-5.8	-7.5	-7.7
Natural Gas	339	446	517	550	-2.2	-2.3	-1.0
Nuclear	223	230	194	192	0.0	-2.6	6.8
Renewable energy forms	88	147	189	216	20.2	35.8	40.5
Total	**1453**	**1497**	**1534**	**1571**	**-5.0**	**-7.5**	**-8.6**
Mt CO_2 emitted	**3118**	**2837**	**2835**	**2835**	**-11.5**	**-17.7**	**-22.7**

Source: PRIMES.

(equivalent to the decline of primary energy needs as macro-economic assumptions remain unchanged from Baseline levels) account for 43.4% of total CO_2 emissions reduction in the EU-15 energy system, the rest coming from changes in the fuel mix towards less carbon intensive fuels. In the long run the role of energy intensity improvements becomes somewhat smaller, with changes in the fuel mix accounting in 2030 for 62% of the overall CO2 emissions reduction achieved.

Demand for all fossil fuels declines from Baseline levels over the projection period in the "Kyoto forever in EU-15" case. The most pronounced impact arising from CO_2 emissions reduction constraints is projected for solid fuels with their consumption in the EU-15 energy system decreasing by -35% below Baseline in 2010 and falling further by -76.6% below Baseline in 2030. The decline in the use of liquids and natural gas is less pronounced. In the long term, oil and gas decline at rates below average, implying an increase of the market share of both energy forms in primary energy needs above Baseline levels. Renewable energy forms experience the highest growth above Baseline levels (+20.2% in 2010; +40.5% in 2030), while nuclear energy also sees an increase in the long run (+6.8% in 2030). The share of renewable energy forms in primary energy needs reaches 9.8% in 2010 and 13.7% in 2030 (from 7.8 and 8.9% respectively in the Baseline scenario); while the share of fossil fuels is limited to 74.6% in 2010 and 73.8% in 2030 (-2.8 and -6.6 percentage points, respectively, below Baseline levels).

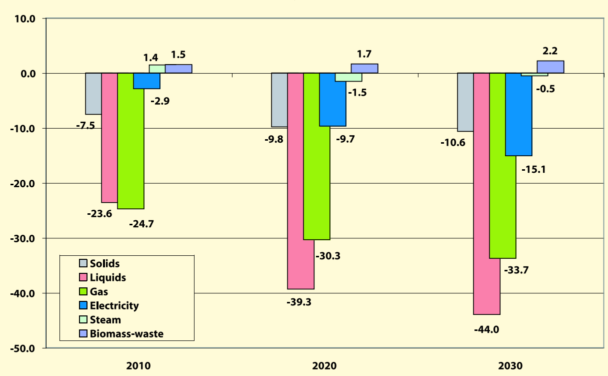
The higher deployment of indigenous energy sources is also reflected in the import dependency of the EU-15 energy system, which grows more slowly than in the Baseline scenario. In 2010 import dependency in the "Kyoto forever in EU-15" case reaches 52.6% (-1.7 percentage points below Baseline levels) further rising to 62.3% in 2030 (-5.5 percentage points below Baseline).

The response of the demand side to the introduction of CO_2 emissions reduction constraints in the "Kyoto forever in EU-15" case leads to a reduction of energy requirements at rates similar to those for primary energy needs (-5.2% from Baseline levels in 2010, -8.3% in 2030). In line with the findings of the "Kyoto forever" case at the EU-25 level the tertiary sector exhibits the highest energy intensity gains (with energy requirements in 2030 declining by -11.6% from Baseline levels). This is followed by households and the transport sector (-8.6% and -8.4%, respectively, below Baseline levels in 2030), while in industrial uses the decline of energy requirements is limited to -6.0% from Baseline levels in 2030.

As regards changes in the fuel mix (see Figure 8-6) the largest decline from Baseline levels in absolute terms occurs for liquid fuels and natural gas, both of which are projected to lose market share in final energy demand as they decline at rates above average (-5.1% in 2010 and -8.8% in 2030 for liquid fuels, -9.3% in 2010 and -11.2% in 2030 for natural gas). An even more pronounced decline, in percentage terms, is projected for solid fuels with energy requirements being limited to 73.5% of those under Baseline assumptions in 2010 and to just 54% in 2030. On the contrary, and despite their projected decline from Baseline levels, electricity (-1.3% in 2010, -5.1% in 2030) and co-generated steam (+2.8% in 2010, -0.8% in 2030) increase their market shares on the demand side. Biomass-waste and solar energy are the only energy forms that grow above Baseline levels over the projection period. Biomass-waste use increases above Baseline by 4.1% in 2010 and by +6.1% in 2030. Solar energy exhibits some growth ahead of Baseline levels in the long run (+4.8% in 2030).

Changes in the fuel mix are not uniform across the demand side sectors. Thus improvements in carbon intensity are quite significant in industry allowing for a reduction of CO_2 emissions by -15.1% from Baseline levels in 2030, slightly below the CO_2 emissions reduction

Figure 8-6: Changes in final energy demand by fuel in EU-15 (diff. from Baseline in Mtoe) in the "Kyoto forever in EU-15" case



Source: PRIMES.

achieved in the tertiary sector (-16.8% in 2030). Changes in the fuel mix for households are less pronounced leading to a decline of CO_2 emissions by -11.6% from Baseline levels in 2030, whereas in the transport sector the predominant role of liquid fuels leads to CO_2 emissions declining at rates that are only slightly above those of energy requirements (-8.5% versus -8.4% in 2030). Overall CO_2 emissions reduction from the demand side reaches -7.6% from Baseline levels in 2010 and -11.3% in 2030, i.e. well below the corresponding reductions achieved for the overall EU-15 energy system. This clearly reflects the key role of the supply side in achieving the CO_2 emission reduction targets set in this analysis.

The EU-15 power generation sector undergoes significant changes in an environment of CO_2 emissions reduction constraints. Adjustments on the demand side lead to a decline of electricity generation by -1.4% from Baseline levels in 2010 and -5.6% in 2030. Furthermore, solid fuels, which in the Baseline scenario are projected to make a strong comeback in power generation beyond 2015, are no longer a cost-effective option for power generators. This is due to the carbon values that increase the costs of fuel inputs depending on their carbon content. These developments encourage the further exploitation of renewable energy forms and natural gas and, in the long run, nuclear energy (see Figure 8-7).

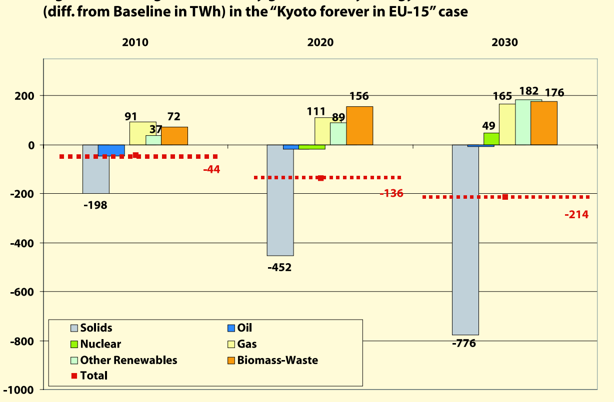
Electricity generation from solid fuels is only 58.7% of that in the Baseline scenario in 2010 and just 11.3% in 2030. The decline of solid fuel based electricity generation in absolute terms exceeds the reduction of overall electricity production several times (4.5 times higher in 2010, and 3.6 times higher in 2030). In the medium term, the gap is largely covered by natural gas (+9.1% from Baseline levels) and biomass-waste electricity production which almost doubles (+93.8%). Production from hydro and intermittent renewables also increases but at a slower pace (+7.4% in 2010). In the long run, and as CO_2 emission reduction requirements from Baseline levels rise, the role of hydro and intermittent renewables (+28.2% from Baseline in 2030) becomes increasingly important - driven by the further exploitation of wind energy but also solar photovoltaic. Moreover, electricity production from biomass-waste more than triples from Baseline levels in 2030 (252.3 TWh compared to 76.7 TWh). Electricity generation from natural gas also grows above Baseline levels in the long term (+11.2% in 2030).

The increase in the use of nuclear energy is less pronounced (+6.5% in 2030) as, in this scenario, nuclear remains an option for power generation in 2030 for only a limited number of EU-15 Member States reflecting political decisions on nuclear.. The shift towards the use of renewable energy forms (including waste) is also reflected on their market share, which reaches 22.6% in 2010 and 29.9% in 2030 (+3.9 and +11.0 percentage points respectively above the Baseline scenario). As a result, the share of electricity generated from non-fossil fuels (nuclear and renewables) increases to 52.6% in 2010 and 51.7% in 2030 (4.3 and 13.4 percentage points higher, respectively, above Baseline levels). Given this, and the lower contribution of solid fuels (with a share of 9.4% in 2010 and 2.7% in 2030 compared to 15.9% and 22.8% in the Baseline scenario), the power and steam generation sector sees significant improvements in its carbon intensity. As a result CO_2 emissions in the EU-15 power generation sector are limited to 78.5% of those projected under Baseline assumptions in 2010 and just 55.3% of Baseline emissions in 2030.

The supply side plays a key role in meeting CO_2 emissions reduction constraints for the EU-15 energy system (see Figure 8-8). In 2010 it accounts for 56% of overall CO_2 emissions reduction achieved from Baseline levels, further rising to 62% in 2020 and 69% in 2030. In comparison to the "Kyoto forever" case for the EU-25 energy system the percentage contribution of the supply side to overall CO_2 emissions reduction remains similar in 2010 but is smaller in the long run (a share of 74% was projected in the "Kyoto forever" case at the EU-25 level). This result stems from the higher CO_2 emissions reduction from Baseline levels that need to be achieved in the "Kyoto forever in EU-15" case and to the less carbon intensive character of the EU-15 energy system under Baseline assumptions compared with the New Member States' energy system.

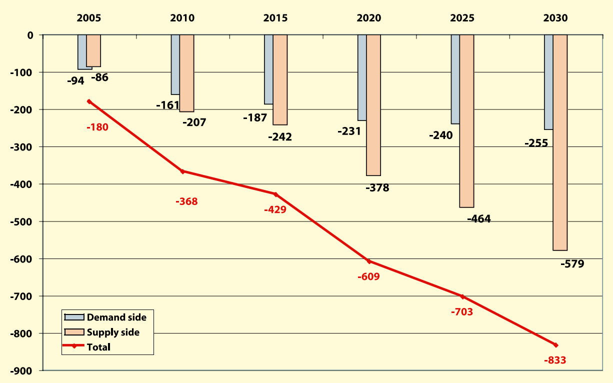
The higher contribution of energy intensity gains in achieving the CO_2 emissions reduction constraints implies the need for much higher effort in the EU-15 energy system. This is illustrated in the projected marginal abatement costs needed to meet the targets examined. In 2010, a carbon value of 34.9 €00 per t of CO_2 is required so that CO_2 emissions in the EU-15 energy system are limited to -8.0% from 1990 levels (2.3 times higher than the carbon value required in the EU-25 energy system to achieve the target of -5.5% from 1990 levels in the same period). The corresponding car-

Figure 8-7: Changes in electricity generation by energy form in EU-15 (diff. from Baseline in TWh) in the "Kyoto forever in EU-15" case



Source: PRIMES.

Figure 8-8: Changes in CO2 emissions in EU-15 energy system in the "Kyoto forever in EU-15" case



Source: PRIMES.

bon values for 2020 and 2030 are 55.1 €00 and 67.1 €00 per t of CO_2 (2 times and 1.6 times higher than those for the EU-25 energy system). The inclusion of the New Member States in achieving Kyoto type targets thus provides the opportunity to reduce compliance costs substantially.

8.4. "Gothenburg type targets with domestic action" scenario results for EU-25[93]

The "Gothenburg type targets with domestic action" case (denoted hereafter as the "Gothenburg-domestic" case for simplicity reasons) examines the achievement of a -5.5% emissions reduction from 1990 levels in 2010 and the impact of the introduction of progressively higher emission reduction targets up to 2030. This follows the approach set out in the Commission's Communication in the run up to the Gothenburg Summit. Thus in 2020 the EU-25 energy system reduces its CO_2 emissions by -12.8% below the 1990 level, reaching -20.9% in 2030. The introduction of much more stringent emissions reduction targets has a powerful impact on the EU-25 energy system's evolution with changes from Baseline levels much greater than those observed in the "Kyoto forever" case (see Table 8-7).

Changes from Baseline levels in 2010 are identical in the "Gothenburg-domestic" case to those projected in the "Kyoto forever" case as the same CO_2 emissions reduction targets for 2010 apply in the EU-25 energy system. The targets assumed for later years, for example -20.9% below 1990 levels in 2030, cause significant changes in both the level and structure of overall energy requirements.

Primary energy demand decreases by -12.4% from Baseline levels in 2030 (compared to -5.7% in the "Kyoto forever" case). This decrease in 2030 is equivalent to energy intensity improvements, as the macro-economic assumptions remain unchanged from Baseline levels. The energy intensity improvement accounts for 40.4% of the overall CO_2 emissions reduction achieved (compared to 33.3% in the "Kyoto forever" case). Thus, with higher CO_2 emissions reduction targets, the role of the reduction in overall energy demand (energy intensity reductions) becomes more pronounced.

There are also substantial changes in the fuel mix to achieve these deep cuts in CO_2 emissions. Solid fuels, the most carbon intensive primary energy form, become almost obsolete in the EU-25 energy system - accounting for just 2.9% of primary energy needs in 2030 (compared to 15.3% in the Baseline scenario and 6.6% in the "Kyoto forever" case). Demand for liquid fuels declines at rates slightly below average (-11.3% from Baseline levels in 2030) driven by energy intensity gains rather than changes in the fuel mix, as liquids are an energy form mainly used in the transport sector (with limited potential for fuel switching in the absence of strong policy and technological incentives) and in the petrochemical industry. Natural gas demand declines at rates well below average (-7.0% from Baseline levels in 2030) as it partly covers the capacity gap in the power generation sector due to the abandonment of solid fuels in response to the targeted CO_2 reduction in this scenario.

Nuclear energy and renewable energy sources exceed the Baseline levels in 2030 by +15.6% and +57.5% respectively (compared to +8.9% and +30.6% in the "Kyoto forever" case). The limited increase in the use of nuclear energy above that projected in the "Kyoto forever" case relates to the policy decisions of the Member States that are reflected in the assumptions on nuclear in the EU-25 energy system. Non-nuclear Member States in 2000 remain so, while those that have decided on nuclear phase out policies are not assumed to change their decision in this scenario because of the introduction of high CO_2 emissions reduction constraints. Combined with the energy intensity gains occurring in the EU-25 energy system in the

Table 8-7: Primary energy demand in the EU-25 in the "Gothenburg-domestic" case

	Mtoe				% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Solid Fuels	303	210	96	51	-14.0	-61.9	-83.1
Liquid Fuels	636	639	627	598	-2.2	-6.6	-11.3
Natural Gas	376	501	601	584	-1.1	0.5	-7.0
Nuclear	238	245	211	214	0.0	-1.4	15.6
Renewable energy forms	96	143	212	267	7.7	39.8	57.5
Total	**1651**	**1740**	**1748**	**1716**	**-2.5**	**-7.4**	**-12.4**
EU-15	**1453**	**1539**	**1540**	**1507**	**-2.4**	**-7.1**	**-12.4**
NMS	**198**	**202**	**208**	**209**	**-3.3**	**-10.3**	**-12.9**
Mt CO2 emitted	***3665***	***3561***	***3287***	***2980***	***-5.2***	***-18.7***	***-30.8***
EU-15	***3118***	***3047***	***2841***	***2583***	***-4.9***	***-17.5***	***-29.6***
NMS	***547***	***515***	***445***	***397***	***-6.8***	***-25.4***	***-37.5***

Source: PRIMES.

93 Aggregate results by group of countries (EU-25, EU-15 and NMS) in comparison to Baseline can be found in APPENDIX 8. Detailed results by group of countries (EU-25, EU-15 and NMS) and aggregate results by group of countries and by country (in comparison to Baseline) are available in the enclosed CD.

Table 8-8: Final energy demand in the EU-25 in the "Gothenburg-domestic" case

	Mtoe				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	309.1	332.0	344.9	354.7	-2.0	-6.1	-8.7
Tertiary	154.2	165.8	174.3	178.2	-4.8	-10.3	-18.3
Households	279.1	301.7	303.5	290.5	-2.2	-7.8	-14.3
Transports	332.0	380.3	400.1	394.6	-1.8	-6.3	-12.1
Total	**1074**	**1180**	**1223**	**1218**	**-2.4**	**-7.2**	**-12.6**
EU-15	**955**	**1050**	**1082**	**1074**	**-2.4**	**-7.1**	**-12.6**
NMS	**119**	**129**	**141**	**144**	**-2.2**	**-7.8**	**-12.9**
	Mt CO_2 emissions				***% change from baseline***		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Industry	605.7	514.6	469.0	429.3	-5.5	-14.1	-22.2
Tertiary	236.7	221.1	201.1	185.8	-7.7	-16.5	-27.1
Households	462.6	463.1	433.4	386.5	-3.8	-12.5	-20.7
Transports	967.5	1090.8	1134.9	1102.8	-1.8	-6.4	-12.3
Total	**2272**	**2290**	**2238**	**2104**	**-3.6**	**-10.3**	**-17.5**
EU-15	**2024**	**2041**	**1990**	**1872**	**-3.6**	**-10.0**	**-17.2**
NMS	**249**	**249**	**248**	**232**	**-3.6**	**-12.1**	**-20.2**

Source: PRIMES.

"Gothenburg-domestic" case, the increase in the use of nuclear and renewable energy leads to significant growth in the share of non-fossil fuels in primary energy needs. In 2030, 28.0% of primary energy needs in the EU-25 energy system are satisfied by non-fossil fuels (15.5% for renewables) compared to 18.1% (8.6% renewables) in the Baseline scenario and 22.9% (12.0% renewables) in the "Kyoto forever" case.

The higher exploitation of indigenous energy sources (only partly counterbalanced by the decline in the use of solid fuels), and the overall decline of primary energy needs, lead to lower import dependency in 2030 reaching 60.1% (compared to 67.3% in the Baseline scenario and 64.2% in the "Kyoto forever" case).

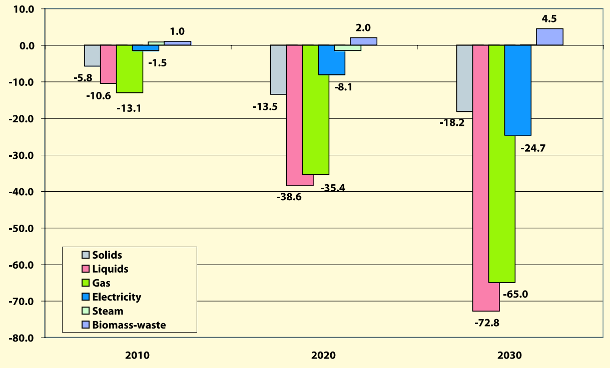
8.4.1. Final energy demand

As in the "Kyoto forever" case energy intensity gains at the final demand level play the key role in reducing CO_2 emissions whereas carbon intensity improvements arising from changes in the fuel mix are less pronounced (see Table 8-8). In 2030 final energy demand declines by -12.6% from Baseline levels (compared to -5.0% in the "Kyoto forever" case) accounting for 72.1% of overall CO_2 emissions reduction from the demand side. The most significant improvements in energy intensity occur in the tertiary sector followed by households and the transport sector, whereas energy intensity gains remain rather limited in industrial sectors. However, industry is significantly more flexible in terms of changes in the fuel mix compared to the other demand side sectors , reducing CO_2 emissions in 2030 by -22.2% from Baseline levels with 60.9% of this reduction arising from carbon intensity improvements. In services and households carbon intensity gains account for 32.4% and 30.9% respectively of the CO_2 emissions reduction achieved in comparison with Baseline. In the transport sector, the limited flexibility for changes in the fuel mix in the absence of specific policies limits the role of carbon intensity gains to just 1.9% of the overall CO_2 emissions reduction achieved.

The changes in the fuel mix on the EU-25 demand side under the "Gothenburg-domestic" case assumptions are illustrated in Figure 8-9. The most pronounced decline from Baseline levels in percentage terms in 2030 is projected for solid fuels (-56.7% in 2030), followed by natural gas (-18.9%) and liquid fuels (-13.1%). Demand for co-generated steam remains unchanged from Baseline levels in 2030 whereas the decline in the use of electricity is limited to -7.4%, well below the overall decline of energy requirements on the demand side. Electricity and steam (which lead to CO_2 emissions only at the stage of production and are therefore accounted for on the supply side) gain additional market share in final energy demand. In 2030, electricity accounts for 25.4% of total final energy demand (from 24.0% in the Baseline scenario and 24.8% in the "Kyoto forever" case). Co-generated steam reaches a share of 6.9% in 2030, which is +1.1 and +0.4 percentage point higher than in the Baseline and the "Kyoto forever" case respectively. The only energy forms that are projected to grow in absolute terms above Baseline levels in 2030 are biomass-waste (+11.0%) and solar energy (+9.2%). However, their shares in final energy demand remain quite small (3.7% for biomass-waste in 2030, 0.4% for solar energy).

The projected energy intensity gains, combined with changes in the fuel mix, lead to a decline of CO_2 emissions from the demand side of -3.6% in 2010, -10.3% in 2020 and -17.5% in 2030. These reductions correspond to 44.1% of total CO_2 emissions reduction in the "Gothenburg-domestic" case in 2010 (equivalent to that projected in the "Kyoto forever" case), 34.0% in 2020 (from 29.7% in the "Kyoto forever" case) and 33.8% in 2030 (from 25.9% in the "Kyoto forever"

Figure 8-9: Changes in final energy demand by fuel in EU-25 (diff. from Baseline in Mtoe) in the "Gothenburg-domestic" case



Source: PRIMES.

case). Thus, in the presence of stricter CO_2 emissions reduction constraints the reductions stemming from the demand side become increasingly important as available options on the supply side (the role of which remains predominant in reducing CO_2 emissions) are increasingly exploited.

8.4.2. Impacts on electricity and steam generation

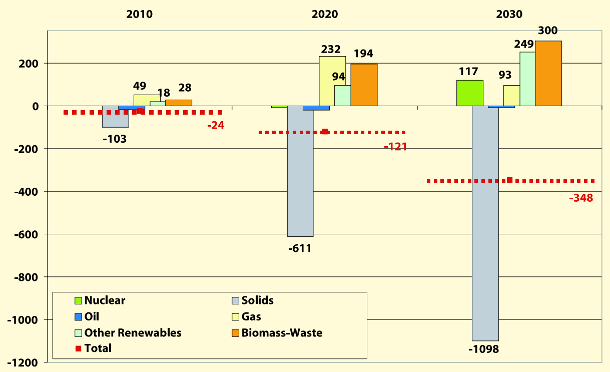
The changes that occur in the EU-25 power generation sector under the "Gothenburg-domestic" case assumptions in comparison to the Baseline scenario are summarised in Table 8-9. With electricity generation declining in 2030 by -7.9% from Baseline levels due to changes occurring on the demand side, the decline in fossil fuels input reaches -25.6% as higher costs for fossil fuel inputs due to high carbon values lead to strong shifts towards the use of nuclear and intermittent renewables. These shifts, combined with higher exploitation of the biomass-waste potential in thermal power plants, allow for a more pronounced decline of CO_2 emissions in the power generation sector. CO_2 emissions from power generation fall by -54.2% below Baseline in 2030.

Solid fuels are most affected by the introduction of stricter CO_2 emissions reduction targets in the long run. Electricity generation from solid fuels shrinks by -93.4% from Baseline levels in 2030. The decline in electricity production from solid fuels in 2030 (-1098 TWh) is more than three times higher in absolute terms than the corresponding decline of overall electricity production (-348 TWh) (see Figure 8-10). In 2030 electricity generation from solid fuels accounts for just 1.9% of total electricity production, compared to 26.7% under Baseline assumptions and 9.0% in the "Kyoto forever" case. As a result production of electricity from all other energy forms grows above Baseline levels. The highest growth both in absolute and percentage terms is projected for biomass-waste. Electricity generation from hydro and intermittent renewable energy sources increases by +35% above Baseline levels in 2030. Nuclear power production rises by +15.3% above the Baseline level in 2030. Electricity from natural gas is +9.0% higher than Baseline in 2030.

The share of renewable energy forms (including waste) in total electricity production reaches 33.3% in 2030 (+15.1 percentage points above Baseline levels, +7.8 percentage points above the "Kyoto forever" case levels). Together with the growth above Baseline levels for nuclear energy, the share of non-fossil fuels in electricity generation rises to 55.1% in 2030 compared to 44.9% in the "Kyoto forever" case and 35.6% in the Baseline scenario.

These changes are also reflected in total installed capacity (see Table 8-10) with the combined share of hydro, wind and solar photovoltaic reaching 32.0% of total installed capacity in 2030. The nuclear share amounts to 12.1% in 2030. Supercritical polyvalent technology is affected most by the severe CO_2 emission constraints whereas there is even a slight growth above Baseline levels for advanced coal power plants due to their potential for using biomass as an input

Figure 8-10: Changes in electricity generation by energy form in EU-25 (diff. from Baseline in TWh) in the "Gothenburg-domestic" case



Source: PRIMES.

Table 8-9: Power generation in the EU-25 in the "Gothenburg-domestic" case

					% change from baseline		
	2000	2010	2020	2030	2010	2020	2030
Fossil fuel input (Mtoe)	**384.6**	**396.5**	**424.0**	**402.3**	**-4.0**	**-12.2**	**-25.6**
Electricity generated (TWh)	**2897.9**	**3395.1**	**3827.8**	**4048.9**	**-0.7**	**-3.1**	**-7.9**
Nuclear	921.2	952.5	824.0	883.9	0.0	-1.1	15.3
Thermal (incl. biomass/waste)	1617.2	1912.1	2307.8	2212.4	-2.1	-8.2	-24.4
Hydro & Intermittent renewables	359.5	530.6	696.0	952.6	3.5	15.5	35.0
CO_2 emissions (Mt of CO_2)	**1193**	**1109**	**900**	**736**	**-9.0**	**-35.4**	**-54.2**

Source: PRIMES.

Table 8-10: Installed capacity by plant type in EU-25 in the "Gothenburg-domestic" case

	GW installed				*change from baseline (in GW)*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Nuclear	140.3	129.8	115.5	137.4	0.0	7.5	29.6
Hydro	96.2	105.4	114.4	118.9	0.8	5.1	6.7
Wind	12.8	79.8	144.8	213.5	7.1	41.3	78.5
Other renewables	0.2	0.5	1.9	31.5	0.0	1.3	17.3
Conventional thermal	335.6	265.1	174.8	137.2	-5.5	-0.5	-10.1
Advanced coal	0.0	0.3	3.3	12.3	-0.2	1.4	5.8
Supercritical polyvalent	0.0	2.9	15.2	19.6	2.4	-49.4	-123.8
Gas turbines CC	47.4	175.1	351.6	383.6	5.6	32.9	-1.0
Small gas turbines	22.8	30.8	48.8	47.0	-3.2	-14.5	-18.8
Fuel cells	0.0	0.0	0.0	34.3	0.0	0.0	34.3
Geothermal	1.0	1.2	1.6	2.1	0.0	0.3	0.7
Total	**656**	**791**	**972**	**1137**	**7.0**	**25.4**	**19.3**
EU-15	**579**	**696**	**839**	**975**	**7.1**	**26.7**	**24.0**
NMS	**78**	**95**	**133**	**162**	**-0.1**	**-1.3**	**-4.7**
of which CHP	***103***	***133***	***178***	***212***	***3.0***	***9.7***	***13.6***
EU-15	***77***	***106***	***143***	***166***	***3.6***	***13.2***	***19.9***
NMS	***26***	***27***	***35***	***46***	***-0.6***	***-3.5***	***-6.3***

Source: PRIMES.

Table 8-11: Fuel input in electricity and steam generation in EU-25 in the "Gothenburg-domestic" case

	Mtoe				*% change from baseline*		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solids	217.4	148.6	51.0	16.7	-16.0	-73.5	-93.2
Oil products	52.4	31.0	18.5	17.2	-9.8	-21.0	-12.8
Gas	131.7	210.6	300.3	289.4	3.0	13.7	5.9
Biomass	12.7	23.3	64.4	87.7	24.7	202.8	266.0
Waste	19.3	28.6	34.6	36.0	12.2	27.2	35.9
Nuclear energy	237.7	245.3	210.6	214.2	0.0	-1.4	15.6
Geothermal heat	3.0	3.5	4.1	5.1	2.7	12.9	28.8
Total	**674**	**691**	**683**	**666**	**-2.5**	**-8.4**	**-14.2**
EU15	**581**	**596**	**589**	**570**	**-2.2**	**-7.6**	**-14.6**
NMS	**93**	**94**	**95**	**96**	**-4.4**	**-12.7**	**-11.7**
Mt CO_2 emitted	***1355***	***1190***	***970***	***803***	***-8.5***	***-33.8***	***-52.1***
EU-15	***1068***	***929***	***780***	***645***	***-8.1***	***-32.6***	***-51.7***
NMS	***287***	***262***	***190***	***157***	***-9.8***	***-38.5***	***-53.5***

Source: PRIMES.

fuel. Gas turbine combined cycle power plant capacity remains almost unchanged from Baseline levels in 2030. The projected growth above Baseline levels for electricity generation from natural gas arises from the operation of fuel cells units that reform natural gas into hydrogen on site. Fuel cell capacity reaches 34.3 GW in 2030 (from zero in the Baseline scenario and 0.6 GW in the "Kyoto forever" case).

The higher share of hydro and intermittent renewable energy forms in electricity generation, combined with the adoption of more efficient technologies by power generators, lead to a reduction of fuel inputs in the sector by -14.2% below Baseline levels in 2030 (see Table 8-11). Consumption of solid fuels faces the greatest decline from Baseline levels with fuel input in 2030 being even lower than that of oil products, which play only a limited role in the EU-25 electricity and steam generation sector even under Baseline assumptions. On the contrary, the consumption of other energy forms increases above Baseline levels with biomass seeing the highest growth both in absolute and percentage terms (+63.7 Mtoe or +266.0% in 2030), followed by nuclear energy (+28.9 Mtoe or +15.6%) and natural gas (+16.2 Mtoe or +5.9%).

The changes in the EU-25 electricity and steam generation sector have a strong impact on the evolution of the related CO_2 emissions, which in 2030 are limited to less than half of those projected under Baseline assumptions, a much higher overall CO_2 emissions reduction than is achieved in the EU-25 energy system in the Gothenburg-domestic" case (-30.8% from Baseline levels in 2030).

8.4.3. Impacts on CO_2 emissions and cost implications

The critical role of CO2 emissions reduction from the supply side in achieving the targets set in the "Gothenburg-domestic" case for the EU-25 energy system is clearly illustrated in Figure 8-11.

The share of CO_2 emissions reduction achieved from the supply side in total CO_2 emissions reduction increases from 56% in 2010 to 66.2% in 2030. However, in comparison to the "Kyoto forever" case, in which the supply side accounted for 74.1% of overall emissions reduction, its contribution in the "Gothenburg-domestic" case is significantly lower. This clearly reflects the high exploitation of available options towards improving energy and carbon intensity in the power generation sector, and also the need for additional measures to be undertaken on the demand side given the more stringent emission reduction target examined in this scenario.

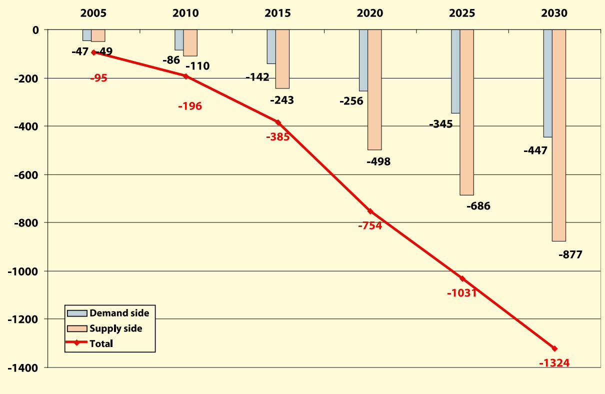
Marginal abatement costs (carbon values) also increase significantly in the long run reaching 60.3 €00 per t of CO_2 in 2020 and 136.6 €00 per t of CO_2 in 2030 (from 15.3 €00 per t of CO_2 in 2010). The carbon values (or marginal costs) to achieve deeper cuts in CO_2 emissions over time rise substantially in this scenario. This result reflects the increasing exploitation of technological options over time as well as the inherent limitations of the energy system as regards more profound changes in the fuel mix.

The increasing carbon values for achieving progressively deeper cuts in CO_2 emissions are also reflected in the additional costs that the EU-25 energy system faces in the "Gothenburg-domestic" case. These additional costs take into account the changes in energy consumption and transformation following the introduction of carbon values (or CO_2 constraints). These costs are purely illustrative of the relative cost levels involved in different targets and do not represent the costs related to the implementation of CO_2 reduction policies. In this "Gothenburg-domestic" case, these additional costs rise from 24.3 billion €00 in 2010 to 70.8 billion €00 in 2020. In 2030 the additional costs amount to 65.3 billion €00. As in the "Kyoto forever" case, the additional energy system costs between 2020 and 2030 reveal a declining trend, despite the significant increase in the carbon values involved This result reflects the improvements that, gradually over time, take place in both the level and structure of EU-25 energy consumption, which in turn limit the total additional costs of meeting CO_2 constraints.

8.4.4. Concluding remarks

The **Gothenburg type targets with domestic action case** examines how the EU-25 energy system might evolve so as to reduce CO_2 emissions by -5.5% from 1990 levels in 2010 (a reduction equivalent to that examined in the "Kyoto forever" case), with CO_2 reductions becoming increasingly severe over time to reach -20.9% below 1990 levels in 2030. These CO_2 reductions are achieved solely by relying on the carbon values. The carbon values needed for these reductions become very high in the long run, illustrating the increasing marginal costs of achieving deep cuts in CO_2 emissions.

Figure 8-11: Changes in CO_2 emissions in EU-25 energy system in the "Gothenburg-domestic" case



Source: PRIMES.

Moreover, these high carbon values lead to considerable changes in comparison to the Baseline scenario. Energy consumers and transformers shift towards more efficient use of energy. The energy intensity gains (which are equivalent to the corresponding decline in primary energy needs as macro-economic assumptions remain unchanged in comparison to the Baseline scenario) reach 12.4% from Baseline levels in 2030. Furthermore, large improvements also occur in terms of carbon intensity (-20.9% from Baseline levels) through changes in the fuel mix. Solid fuels become an obsolete energy form in the EU-25 energy system in the long run in a severely carbon constrained world. On the other hand, there is substantial growth in the use of renewable energy forms (accounting for 15.5% of primary energy needs in 2030 compared to 8.6% in the Baseline scenario). This leads to a decline in the share of fossil fuels in primary energy needs by some 10 percentage points in 2030 from 81.6% in the Baseline to 71.8% in this scenario given the required deep cuts in CO_2 emissions.

In addition to a decline of CO_2 emissions in 2030 by -30.8% below Baseline levels, there is also a reduction of import dependency by 7 percentage points below Baseline in 2030. This lower import dependency (60% in 2030) is mainly due to the growing role of carbon free, indigenous fuels in this scenario. In 2030, the combined share of renewables and nuclear rises 10 percentage points above the Baseline level to reach 28%.

8.4.5. Using flexible mechanisms in achieving CO_2 emission reduction targets in the EU-25 energy system[94]

Two additional cases were examined reflecting the possibilities of achieving Kyoto type targets by other means than reducing energy related CO_2 emissions, i.e. in particular by using flexible mechanisms and by acting on other (non-CO_2) gases and sinks. In both cases it is assumed that the CO_2 target to be met by the EU-25 energy system in 2010 is -2.8% from 1990 levels, i.e. it drops to half of that examined in the "Kyoto forever" and the "Gothenburg-domestic" case. The remaining 50% of the reduction would be achieved through the other means mentioned above. Beyond 2010 the two additional cases differ in terms of the assumed recourse to flexible mechanisms, other gases and sinks. The "Gothenburg-flexible" case assumes that the target for the EU-25 energy system drops to half of that in the "Gothenburg-domestic" case (CO_2 emissions reduction in 2030 reaching -10.5% from 1990 levels) leaving the rest to be secured by other means. The "Gothenburg-intermediate" case has a position in between the "Gothenburg-domestic" and the "Gothenburg-flexible" case, with CO_2 emissions reductions relying increasingly over time on domestic action in this case. The CO_2 reduction imposed on the EU-25 energy system rises to -15.8% below 1990 levels in 2030.

The changes that occur in the EU-25 energy system in the two cases examined (see Table 8-12) involve improvements both in terms of energy and carbon intensity. In 2010 energy requirements in the EU-25 energy system decline by -1.2% from Baseline levels (compared to -2.5% in the "Kyoto forever" case); whereas in 2030 the decline reaches -7.5% from Baseline levels in the "Gothenburg-flexible" case and -9.8% in the "Gothenburg-intermediate" case. This compares to -12.5% in the "Gothenburg-domestic" case. In the long term, CO_2 emissions decline significantly faster from Baseline than does primary energy demand in the "Gothenburg-flexible" and "Gothenburg-intermediate" cases. This result applies also for the other cases examined in this chapter. This leads to the conclusion that, in the short term and for relatively small CO_2 emissions reduction targets, energy intensity gains are almost equivalently important to carbon intensity ones. However, in the long term and with stricter emission reduction targets, carbon intensity improvements, i.e. changes in the fuel mix, deliver most of the CO_2 reduction required.

Table 8-12: Primary energy demand in the EU-25 in the "Gothenburg" cases with flexible mechanisms

"Gothenburg-flexible" case		**Mtoe**				***% change from baseline***	
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	227.9	130.9	92.0	-6.5	-48.2	-69.3
Liquid Fuels	635.6	646.6	648.6	630.0	-1.1	-3.4	-6.6
Natural Gas	376.0	503.6	616.3	641.7	-0.6	3.1	2.1
Nuclear	237.7	245.3	208.8	212.4	0.0	-2.2	14.6
Renewable energy forms	96.1	137.6	192.4	234.7	3.7	27.1	38.5
Total	**1650.7**	**1763.0**	**1799.1**	**1813.2**	**-1.2**	**-4.8**	**-7.5**
EU-15	**1453**	**1558**	**1584**	**1591**	**-1.1**	**-4.4**	**-7.5**
NMS	**198**	**205**	**215**	**222**	**-1.8**	**-7.4**	**-7.4**
Mt CO_2 emitted	**3665**	**3664**	**3527**	**3373**	**-2.5**	**-12.7**	**-21.6**
EU-15	**3118**	**3133**	**3041**	**2907**	**-2.3**	**-11.7**	**-20.8**
NMS	**547**	**531**	**486**	**466**	**-3.8**	**-18.5**	**-26.6**
"Gothenburg-intermediate" case		**Mtoe**				***% change from baseline***	
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Solid Fuels	303.2	227.9	118.1	62.6	-6.5	-53.2	-79.1
Liquid Fuels	635.6	646.6	640.4	615.6	-1.1	-4.6	-8.7
Natural Gas	376.0	503.6	613.4	624.6	-0.6	2.6	-0.6
Nuclear	237.7	245.3	208.0	213.4	0.0	-2.6	15.2
Renewable energy forms	96.1	137.6	198.4	250.0	3.7	31.2	47.5
Total	**1650.7**	**1763.0**	**1780.4**	**1768.6**	**-1.2**	**-5.7**	**-9.8**
EU-15	**1453**	**1558**	**1569**	**1552**	**-1.1**	**-5.3**	**-9.7**
NMS 198	**205**	**212**	**216**	**-1.8**	**-8.6**	**-9.9**	
Mt CO_2 emitted	**3665**	**3664**	**3445**	**3174**	**-2.5**	**-14.7**	**-26.3**
EU-15	**3118**	**3133**	**2978**	**2744**	**-2.3**	**-13.5**	**-25.2**
NMS	**547**	**531**	**467**	**429**	**-3.8**	**-21.8**	**-32.4**

Source: PRIMES.

94 Detailed results by group of countries (EU-25, EU-15 and NMS) and aggregate results by group of countries and by country (in comparison to Baseline) for the two scenarios examined are available in the enclosed CD.

Table 8-13: Power generation in the EU-25 in the "Gothenburg" cases with flexible mechanisms

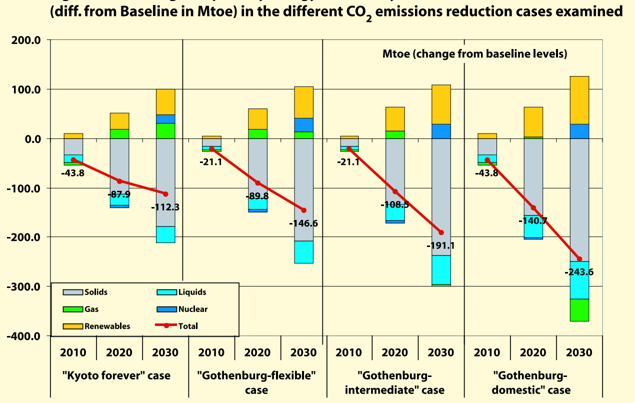
	"Gothenburg-flexible" case				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Fossil fuel input (Mtoe)	**384.6**	**405.4**	**442.5**	**439.1**	**-1.9**	**-8.4**	**-18.8**
Electricity generated (TWh)	**2897.9**	**3410.0**	**3881.6**	**4213.5**	**-0.3**	**-1.7**	**-4.2**
Nuclear	921.2	952.6	816.7	877.5	0.0	-2.0	14.5
Thermal (incl. biomass/waste)	1617.2	1935.2	2398.9	2452.7	-1.0	-4.5	-16.2
Hydro & Intermittent renewables	359.5	522.2	666.0	883.3	1.9	10.6	25.2
CO_2 emissions (Mt of CO_2)	**1193**	**1169**	**1031**	**933**	**-4.0**	**-26.0**	**-41.9**
	"Gothenburg-intermediate" case				% change from baseline		
	2000	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Fossil fuel input (Mtoe)	**384.6**	**405.4**	**436.2**	**421.7**	**-1.9**	**-9.7**	**-22.0**
Electricity generated (TWh)	**2897.9**	**3410.0**	**3869.7**	**4136.6**	**-0.3**	**-2.0**	**-5.9**
Nuclear	921.2	952.6	813.5	880.6	0.0	-2.4	14.9
Thermal (incl. biomass/waste)	1617.2	1935.2	2372.6	2352.5	-1.0	-5.6	-19.6
Hydro & Intermittent renewables	359.5	522.2	683.6	903.5	1.9	13.5	28.1
CO_2 emissions (Mt of CO_2)	**1193**	**1169**	**987**	**821**	**-4.0**	**-29.2**	**-48.9**

Source: PRIMES.

As regards changes in the fuel mix, the EU-25 energy system reacts through shifting away from carbon intensive energy forms towards the use of less carbon intensive and carbon free fuels. Such shifts become increasingly pronounced as higher CO_2 emissions reduction targets apply (see Figure 8-12). In the medium term, the EU-25 energy system reacts by higher exploitation of renewable energy forms compared with Baseline developments, whereas in the long run gas (but with a declining role as higher CO_2 emissions reduction targets apply) and nuclear energy become increasingly important.

In all cases examined renewable energy forms see the highest growth both in absolute and percentage terms above Baseline levels over the projection period. In the "Gothenburg-flexible" case the share of renewable energy forms in primary energy needs reaches 12.9% in 2030, further rising to 14.1% in the "Gothenburg-intermediate" case (compared to 8.6% in the Baseline scenario and 15.6% in the "Gothenburg-domestic case").

Figure 8-12: Changes in primary energy demand by fuel in EU-25 (diff. from Baseline in Mtoe) in the different CO_2 emissions reduction cases examined

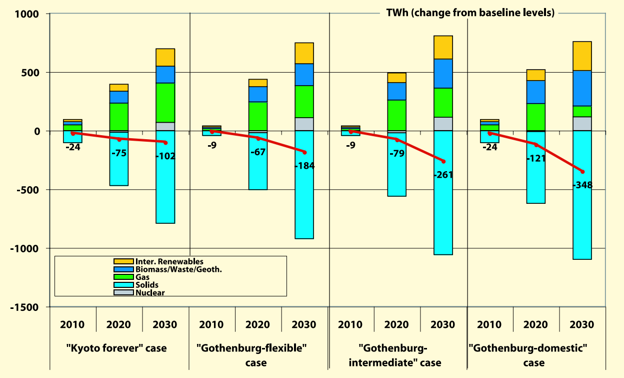


Source: PRIMES.

On the demand side, the introduction of CO_2 emissions reduction constraints leads to adjustments towards the more efficient use of energy. But the contribution of changes in the fuel mix towards reducing CO_2 emissions is less pronounced, as strong shifts towards less carbon intensive energy forms already take place under Baseline assumptions. In the "Gothenburg-flexible" and "Gothenburg-intermediate" cases energy requirements on the EU-25 demand side decline in 2010 by -1.2% from Baseline levels, with the corresponding decline in terms of CO_2 emissions reaching -1.8%. In 2030, the decline in final energy demand reaches -7.0% below Baseline levels in the "Gothenburg-flexible" case and -9.6% in the "Gothenburg-intermediate" case. The corresponding reductions in terms of CO_2 emissions are -10.0% and -13.3% from Baseline levels. Changes in the fuel mix involve higher market shares for biomass-waste, solar energy, electricity and co-generated steam - all occurring to the detriment of solid fuels, liquids and natural gas. In line with the findings of the cases discussed earlier the tertiary sector is the most responsive in terms of energy intensity gains to the introduction of CO_2 emissions reduction constraints, followed by households and the transport sector.

The bulk of the additional CO_2 emissions reduction required to cope with the targets examined here are achieved through changes in the power and steam generation sector. In the "Gothenburg-flexible" and "Gothenburg-intermediate" cases in 2010, overall electricity production declines by just -0.3% from Baseline levels. The corresponding reduction in CO_2 emissions reaches -4.0%, as a result of higher exploitation of renewable energy forms and natural gas to the detriment of solid fuels (see Table 8-13). These significant

Figure 8-13: Changes in electricity generation by energy form in EU-25 (diff. from Baseline in TWh) in the different CO_2 emissions reduction cases examined

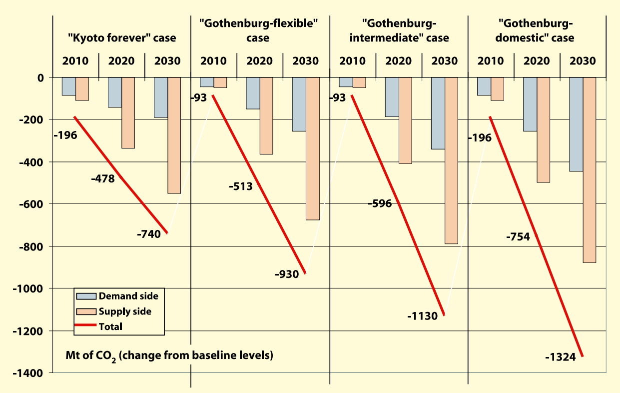


Source: PRIMES.

changes from Baseline for electricity generation and CO_2 emissions from electricity also apply in the long run. CO_2 emissions from power and steam generation decline in 2030 by -41.9% below Baseline compared to a fall in electricity production of only -4.2% in the "Gothenburg-flexible" case. Similarly, in the "Gothenburg-intermediate" case, CO_2 emissions are -48.9% lower than Baseline in 2030, whereas electricity generation decreases by only -5.9%. In 2030, non-fossil fuels account for 48.5% of total electricity generation (with the share of renewable energy at 27.6%) in the "Gothenburg-flexible" case and 51.4% (30.1% for renewables) in the "Gothenburg-intermediate" case.

With higher CO_2 emission reduction targets, solid fuels lose competitiveness due to the high carbon values (see Figure 8-13). Solids effectively become an obsolete energy form for power generation in 2030 in the event of any deep cuts required in CO_2 emissions. This result reinforces the point for strengthening research into carbon sequestration (see Chapter 7). Natural gas plays a key role in satisfying the resulting gap created in the power generation sector in

Figure 8-14: Changes in CO_2 emissions in EU-25 energy system in the different CO_2 emission reduction cases examined



Source: PRIMES.

those cases and years with medium CO_2 emissions reduction targets. However, with high emissions reduction targets, the role of natural gas becomes progressively less significant.

On the other hand, renewable energy forms (both hydro and intermittent ones and biomass-waste) play an important role in electricity generation in all carbon constrained cases. This role becomes increasingly important over time and with more ambitious targets. Nuclear energy also gains additional market share in electricity generation. It is, however, heavily constrained by the prevailing assumptions as regards nuclear energy use in the EU-25 Member States, especially given the phase out policies decided in several Member States.

The key role of the supply side in reducing CO_2 emissions is illustrated in Figure 8-14.

In the "Gothenburg-flexible" and "Gothenburg-intermediate" cases CO_2 emissions reduction from the demand side accounts for 46.7% of the total reduction achieved in 2010 (compared to 44.1% in the "Kyoto forever" case). This contribution declines in the long run, accounting in 2030 for 31.5% in the "Gothenburg-intermediate" and 27.5% in the "Gothenburg-flexible" case (compared to 33.8% in the "Gothenburg-domestic" case and 25.9% in the "Kyoto forever" case). These results illustrate that, in the short run, low-cost measures are available on the demand side. Thus the demand side contributes almost as much as the supply side to the emissions reduction achieved in 2010. However, in the long run, CO_2 emissions reductions over and above Baseline developments are easier to achieve through changes on the supply side. Yet, as higher targets need to be met, all the more easily available options on the supply side are increasingly exploited. The adoption of progressively higher cost measures on the supply side, leading to higher prices, then in turn encourages additional energy intensity gains on the demand side.

The above findings are clearly reflected by the marginal abatement costs needed to achieve the CO_2 emissions reduction targets in the EU-25 energy system. In 2010, a marginal abatement cost of 7.4 €00 per t of CO_2 is required so that CO_2 emissions in the EU-25 energy system are limited to -2.8% below 1990 levels (compared to 15.3 €00 per t of CO_2 in the "Kyoto forever" case which has a CO_2 reduction target of -5.5%). In 2030, a -10.5% reduction from 1990 levels ("Gothenburg-flexible" case) is achieved with a marginal abatement cost of 62.5 00 per t of CO_2; while in the "Gothenburg-intermediate" case, which requires an emissions reduction of -15.8% below 1990 levels, the marginal abatement cost increase to 94.4 €00 per t of CO_2.

The disproportional increases in marginal abatement costs as higher CO_2 emissions reduction targets apply is clearly illustrated when comparing their relative growth to that of the CO_2 emissions avoided. For example, in 2030 under the "Gothenburg-flexible" case, CO_2 emissions need to be reduced by -930 Mt CO_2 below Baseline levels

95 It should be borne in mind that the Kyoto Protocol stipulates emission reductions for a basket of six greenhouse gases mainly on the basis of emissions in 1990. The analysis in this chapter concerns only energy related CO_2 emissions. While the CO_2 "targets" used for analytical purposes in this chapter are compatible with the Kyoto Protocol, there are no specific CO_2 targets in the Kyoto Protocol but only targets for all six greenhouse gases combined.

Table 8-14: CO_2 emission reduction and required marginal abatement costs in the EU-25 and the EU-15 energy systems for the different cases examined[96]

	EU-25				EU-15			
	2000	2010	2020	2030	2000	2010	2020	2030
"Kyoto Forever" case								
CO_2 Emissions (Mt CO_2)	3664.9	3561.2	3562.2	3563.4	3117.5	2836.8	2835.2	2835.4
Reduction from Baseline (Mt CO_2)		-196.0	-478.4	-740.2		-368.1	-608.8	-833.3
% of 1990 level	97.2	94.5	94.5	94.5	101.2	92.0	92.0	92.0
Carbon value (Euro'00/t CO_2)		15.3	28.1	40.9		34.9	55.1	67.1
"Gothenburg type" targets using Flexible mechanisms								
CO_2 Emissions (Mt CO_2)	3664.9	3664.0	3527.4	3373.3	3117.5	2957.6	2838.1	2720.3
Reduction from Baseline (Mt CO_2)		-93.2	-513.3	-930.3		-247.4	-605.9	-948.3
% of 1990 level	97.2	97.2	93.6	89.5	101.2	96.0	92.1	88.3
Carbon value (Euro'00/t CO_2)		7.4	33.0	62.5		24.5	59.5	94.6
Intermediate case on achieving "Gothenburg type" targets								
CO_2 Emissions (Mt CO_2)	3664.9	3664.0	3445.0	3173.8	3117.5	2957.5	2772.9	2556.2
Reduction from Baseline (Mt CO_2)		-93.2	-595.7	-1129.9		-247.4	-671.1	-1112.5
% of 1990 level	97.2	97.2	91.4	84.2	101.2	96.0	90.0	82.9
Carbon value (Euro'00/t CO_2)		7.4	43.6	94.4		24.5	70.9	144.5
"Gothenburg type" targets with Domestic action case								
CO_2 Emissions (Mt CO_2)	3664.9	3561.2	3286.6	2980.0	3117.5	2836.8	2618.0	2372.5
Reduction from Baseline (Mt CO_2)		-196.0	-754.1	-1323.7		-368.1	-826.0	-1296.1
% of 1990 level	97.2	94.5	87.2	79.1	101.2	92.0	84.9	77.0
Carbon value (Euro'00/t CO_2)		15.3	60.3	136.6		34.9	92.2	226.4

Source: PRIMES.

whereas the corresponding decline in the "Gothenburg-intermediate" case is -1130 Mt CO_2 (21.4% more). The corresponding increase in marginal abatement costs is 51.1%. In the "Gothenburg-domestic" case - in which CO_2 emissions reduction from Baseline levels in 2030 amounts to -1328 Mt CO_2 (17.5% more than that required in the "Gothenburg-intermediate" case) - the disproportional growth of marginal abatement costs becomes even more evident as the marginal abatement costs rise to 136.7 €00 per t of CO_2 (+44.8% more than in the "Gothenburg-intermediate" case).

8.4.6. Comparison between achieving targets cost effectively at the EU-25 level instead of at the EU-15 level

In the foregoing analysis of the implementation of the "Kyoto forever" case in the EU-25 and the EU-15 energy systems, it was shown that achieving CO_2 emissions reduction "targets"[95] for the EU-15 energy system is much more difficult than for the EU-25 energy system for a number of reasons. Firstly, higher emissions reductions from 1990 levels need to be achieved in EU-15 compared to EU-25 following the terms of the Kyoto Protocol. In the first Kyoto commitment period (2008-2012) the EU-15 needs to reduce its emissions by -8% from 1990 levels whereas the corresponding decline for the EU-25 energy system is -5.5% (this is not a formal target but reflects the Kyoto commitments for individual countries and the choices of some former countries in transition concerning use of a base year earlier than 1990, with substantially higher GHG emissions).

Second, the present characteristics of the EU-15 energy system in terms of both energy and carbon intensity are more advanced than those of the New Member States' energy system. Thus there exists greater potential for low-cost improvements at the EU-25 level than for the EU-15. Third, the restructuring that took place in most of the New Member States during the 1990s led to a significant improve-

96 Detailed results for the EU-15 and aggregate results for the EU-15 and by country (in comparison to Baseline) for the "Gothenburg-domestic in EU-15", "Gothenburg-flexible in EU-15" and "Gothenburg-intermediate in EU-15" cases are available in the enclosed CD.

ment of their position in terms of CO_2 emissions. In the EU-15 energy system CO_2 emissions in 2000 were 1.2% above 1990 levels whereas in the NMS they were -20.4% below 1990 levels. This resulted in a reduction at the EU-25 level of -2.8% from Baseline levels, i.e. providing an easier starting position for achieving any given CO_2 reduction on the basis of 1990 CO_2 emissions.

The marginal abatement costs (carbon values) required to achieve the emission reduction targets for all the emission reduction cases examined in this chapter were estimated through successive runs of the PRIMES model both at the EU-25 and the EU-15 levels. At the EU-15 level these targets are more ambitious than at the EU-25 level for the reasons discussed above. The marginal abatement costs and the corresponding CO_2 emissions reduction achieved (compared to 1990 levels) are illustrated in Table 8-14. As can be seen in the table the achievement of CO_2 emissions reduction targets in the EU-15 energy system in 2010 and 2020 requires higher absolute reductions from Baseline levels than those for the EU-25 energy system. Only in the "Gothenburg-intermediate" and the "Gothenburg-domestic" cases in 2030, are CO_2 emissions reductions from Baseline levels in absolute terms somewhat lower for the EU-15 than for the EU-25 energy system.

In all cases and over the entire projection period the marginal abatement costs required for the EU-15 energy system to meet the emissions reduction targets are higher than those for the EU-25.

The carbon value needed in the EU-15 energy system to meet the Kyoto target without recourse to flexible mechanisms (and other gases/sinks) in 2010 (-5.5% from 1990 levels for EU-25, -8% for EU-15) is 2.3 times that required for the EU-25 energy system. The corresponding ratio if flexible mechanisms are used (the assumed target for the EU-25 energy system drops to -2.8% from Baseline levels and that of the EU-15 energy system to -4%) increases to as high as 3.3. This big cost difference reflects, among other things, the existence of a large low-cost potential for energy and carbon intensity improvements in the New Member States' energy system.

In the long run significant energy and carbon intensity gains take place in the New Member States energy systems under Baseline assumptions As a result the differences between the marginal abatement costs required at the EU-25 and the EU-15 levels become less pronounced - ranging from 1.6 times higher in the "Kyoto forever" case to 1.7 times higher in the "Gothenburg-domestic" case. However, in absolute terms, the differences become even more marked. For example, the marginal abatement cost of the EU-15 energy system in achieving a reduction of -23% below 1990 levels in 2030 (the "Gothenburg-domestic" case) amounts to 226.4 €00 per t of CO_2 This is 89.7 €00 per t of CO_2 higher than the carbon value required for the EU-25 energy system to reduce its CO_2 emissions by -21% from 1990 levels.[97]

97 It should be recalled that the different "targets" at the EU-15 and EU-25 level derive from different targets for individual Member States, i.e. Poland and Hungary having -6% instead of -8% in 2010, and the possibility for former countries in transition to choose a base year other than 1990.

CHAPTER 9: Comparison of scenarios and conclusions

9.1. Key findings for the scenarios examined

The scope of the analysis presented in the previous chapters of this volume was to exploit the possible evolution of the EU-25 energy system in the horizon to 2030 under different assumptions as regards economic growth, international fuel prices and the level of implementation of various policies. In that framework a number of scenarios and variants were defined and examined against the Baseline scenario which reflects the evolution of the EU-25 energy system under current trends and policies. The different aspects examined in that context were the following:

- Different views for the world economic and energy developments that give rise to alternative scenarios with contrasting oil and gas price profiles.
- Alternative economic growth cases for the future economic development of the EU-25 given the currently prevailing uncertainties.
- The role of a faster implementation of policies towards energy efficiency, guided by the "Action Plan to Improve Energy Efficiency in the European Community", further enhanced by substantial policies on renewables with a view to achieving the 12% renewables target set for 2010.
- Different developments as regards the use of nuclear energy in the EU examining two quite divergent directions: one in which improved technology that would find acceptance in the Member States leads to a higher contribution of nuclear energy in the long run, and a second in which a phase-out of nuclear in the entire EU occurs.
- The implementation of policies in the transport sector in line with the Option C scenario of the White paper on Common Transport Policy.
- Combinations of the above policies with a view to improving security of supply for the EU and reducing CO_2 emissions.
- Analysis of the repercussions that the introduction of Kyoto type constraints (and possible post Kyoto targets) would generate for the EU-25 energy system.

In the following the main findings of the key scenarios examined as well as the possible synergies and/or trade-offs of the various policies for the EU-25 energy system are discussed.

The **Baseline scenario** (presented in Chapter 1), which acts as the reference case against which all other cases examined are compared, reflects a continuation of existing trends and takes into account current policies and those in the process of being implemented at the end of 2001 (without including the implementation of the renewables electricity Directive of September 2001; tax rates reflect the situation in mid 2002).In the Baseline scenario energy demand continues to grow in the EU-25, but at a considerably lower pace than GDP (+0.6% pa in 2000-2030 compared to +2.4% pa respectively), thus leading to marked improvements of energy intensity (gross inland consumption / GDP) that reach 1.7% pa. Some of the key drivers towards the projected energy intensity improvements are the structural changes in the demand side (such as the further dematerialisation of the EU-25 industry), saturation effects for a number of energy uses (including the slowdown of transport activity growth), better efficiency and technology in the individual sectors, investment decisions in power generation, and changes in the fuel mix towards the use of more efficient energy forms both in the demand and the supply side. In addition to the above, new Member States are characterised by a larger scope for energy intensity gains (given the large inefficiencies that prevailed in the past in their energy systems, especially in CEEC) compared to the EU-15.

Fossil fuels will continue playing a predominant role in satisfying energy needs in the EU-25 over the projection period, exhibiting however reverse trends in the horizon to 2015 and in 2015 to 2030. Thus, demand for fossil fuels grows at rates below average in 2000-2015 with their share over primary energy needs declining by close to -0.5 percentage points in 2015 from their 79.6% in 2000. Beyond that date, and as a substantial decline occurs in nuclear power plants capacity following the nuclear phase-out policies for a number of EU Member States, the closure of nuclear plants with safety concerns in new Member States, or the decisions of economic actors not to replace nuclear plants at the end of their lifetime with new nuclear plants, demand for fossil fuels grows at rates well above average with their share reaching 81.8% of overall energy needs in 2030.

Renewable energy forms exhibit the highest growth among all energy forms under Baseline assumptions (+1.9% pa in 2000-2030; more than three times higher than the corresponding growth in overall primary energy needs) spurred by the further exploitation of renewable options in the supply side. Nevertheless, their share in 2030 amounts to only 8.6% of primary energy needs (from 5.8% in 2000 and 7.4% in 2010), well below the indicative targets set within the EU in the horizon to 2010.

The transport and power generation sectors play a predominant role as regards the projected evolution of the EU-25 energy system in the horizon to 2030. The transport sector, characterised by the lack of alternatives as regards changes in the fuel mix away from liquid fuels in the absence of strong policies in this direction, exhibits a continuous growth of energy needs over the projection period despite the projected decoupling of transport activity from economic growth in the long run. As a result the transport sector accounts in 2030 for 32.2% of energy requirements and 49.3% of CO_2 emissions in the demand side (from 30.9% and 42.6% respectively in 2000).

The power generation sector needs to meet increasing electricity and steam demand (growing at rates of +1.5% pa and +1.4% pa, respectively, in 2000-2030) both of which gain additional market share in the demand side in the Baseline scenario. Thus, the sector is faced with strategic technology and fuel choice dilemmas in replacing existing capacity (some 90% of which will be decommissioned by 2030) and further expanding it so as to satisfy additional demand. The strong decline in the use of nuclear energy beyond 2015 that leads to a significant comeback of solid fuels results in a significant growth of CO_2 emissions from the EU-25 power generation sector. Thus, in 2030 the power generation sector accounts for 64.5% of incremental CO_2 emissions from 2000 levels in the EU-25 energy system.

CO_2 emissions for EU-25 are projected to remain below 1990 levels in 2010 (-0.3%) under Baseline assumptions, a result strongly related to the accession of new Member States in the EU but also to the changes in the fuel mix towards the use of less energy intensive energy forms. The restructuring of CEEC economies in the nineties resulted in a substantial decline of CO_2 emissions by -20.4% between 1990 and 2000 in new Member States whereas in the same period CO_2 emissions grew by +1.2% in the EU-15. In 2010, CO_2 emissions in the EU-15 are projected to increase +4.0% from 1990 levels exhibiting a significantly less pronounced growth to that for primary energy needs in the same period (+19.3%) as a result of changes in the fuel mix towards the use of natural gas and renewable energy forms. The same trends are also observed in new Member States with CO_2 emissions decreasing -19.7% from 1990 levels in 2010 compared to a decline of primary energy needs by -10.8%. However, beyond 2010, and as available options for changes in the fuel mix of the demand side become highly exploited while coal re-emerges in the supply side in replacing nuclear energy, CO_2 emissions increase to reach +14.2% from 1990 levels in 2030 (+19.0% in the EU-15, -7.6% in the NMS).

The increasing role of fossil fuels in the EU-25 energy system under Baseline assumptions, combined to the declining trends as regard their indigenous production, gives rise to a further growth of import dependency which is projected to reach 67.3% in 2030 from 47.2% in 2000. Thus, under Baseline assumptions the EU-25 energy system will be faced with increasing CO_2 emissions and security of supply concerns, despite the significant improvements in terms of energy intensity and the higher exploitation of renewables.

A different evolution of world energy prices, examined in Chapter 2, generates some changes in the future evolution of the EU-25 energy system without however altering the main trends observed under Baseline assumptions. In the **high oil and gas prices** case world oil and gas prices are 20% and 33% higher respectively than in the Baseline in 2030. With these higher prices the EU-25 energy system achieves some additional energy intensity gains of 0.4% from Baseline levels in 2030, further accompanied by changes in the fuel mix occurring to the detriment of natural gas (-13.6% from Baseline levels in 2030). Demand for liquid fuels remains rather unchanged (-1.5% from Baseline levels in 2030) as the oil price increase does not lead to changes in the fuel mix in the transport sector, the main consumer of oil products in the EU. The gap generated is largely covered by solid fuels (+16.9% in 2030) and renewable energy forms (+18.6%) whereas nuclear energy exhibits a limited growth above Baseline levels (+3.1%). The share of renewables in primary energy needs reaches 10.3% in 2030 (+1.7 percentage points from Baseline levels) whereas import dependency is also projected to decrease compared to the Baseline scenario being limited to 64.2% in 2030 (from 67.3% in the Baseline) as a result of the higher exploitation of indigenous energy sources. CO_2 emissions in the EU-25 energy system increase +13.5% from 1990 levels in 2030 (compared to +14.2% in the Baseline scenario) as energy intensity gains in combination to the higher exploitation of renewables and nuclear energy more than counterbalance the further growth of solid fuels.

Besides the "high oil and gas prices" case, three additional cases on world energy prices were examined. It is interesting to note that even in the "Soaring oil and gas prices" case, in which an increase of international oil and gas prices by 80% from Baseline levels from 2010 onwards was assumed, the EU-25 energy system would follow similar trends to those under Baseline assumptions, though at a significantly slower pace, with primary energy needs increasing by 0.5% pa in 2000-2030 (from 0.6% pa in the Baseline). Renewable energy forms, which become considerably more competitive in that context, gain additional market share accounting by 2030 for 11.2% of primary energy needs in the EU (9.1% in 2010). However, CO_2 emissions reach similar levels to those observed in the Baseline scenario as solid fuels have a significantly greater role in satisfying energy needs, leading to a worsening of carbon intensity that counterbalances the projected energy intensity gains and the higher exploitation of renewables. Import dependency is projected to grow at a slower pace reaching 62.4% by 2030.

The key importance of the economic development on the evolution of the energy system is revealed in the **high** and **low economic growth** cases, discussed in Chapter 3. The "high economic growth case" assumes a GDP growth of 2.7% pa in 2000-2030 (from 2.4% pa in the Baseline) being more in line with the Lisbon economic growth targets. On the contrary, the "low economic growth" case assumes that the current economic slowdown will continue with GDP growth in the EU being limited to only 2.0% pa in 2000-2030. The "high economic growth" case leads to a significant increase of energy requirements and CO_2 emissions compared to the Baseline scenario, the inverse occurring in the "low economic growth" one. However, the analysis shows further changes in the evolution of the EU-25 energy system. The "high economic growth" case is characterised by additional energy intensity gains (primary energy needs increase by +7.4% from Baseline levels in 2030 whereas GDP is 10.7% higher in the same year). However, there is also a worsening of carbon intensity with CO_2 emissions growing by +8.3% from Baseline levels in 2030. On the contrary, in the "low economic growth" case energy needs in the EU-25 energy system decline by -7.5% from Baseline levels in 2030 compared to a decline of -10.7% for GDP, implying a less pronounced improvement of energy intensity. At the same time CO_2 emissions decrease by -8.6% from Baseline levels, i.e. more than energy demand giving rise to a slight improvement in carbon intensity.

The higher energy intensity gains in the "high economic growth" case stem from further dematerialisation of the EU economy, accompanied by a faster adoption of more efficient equipment by consumers. However, as energy needs further grow on top of Baseline levels the potential changes in the fuel mix towards the use of less carbon intensive or carbon free energy forms become increasingly exhausted, thus leading to a worsening of carbon intensity. The opposite trends are present in the "low economic growth" case, where there is e.g. less dematerialisation, while the less pronounced growth of energy needs allows for a higher market share of low carbon intensive and non-fossil fuels in the energy system. Nevertheless, in both cases renewable energy forms gain some additional market share from Baseline levels reaching 8.8% in 2030 for the "high economic growth" case (as economic growth above Baseline levels allows for a more pronounced penetration of renewables) and 8.9% in the "low economic growth" case (as demand for renewables declines at rates well below average). Import dependency reaches 68.5% in 2030 in the "high economic growth" case and 65.7% under "low economic growth" case assumptions (+1.2 and -1.6 percentage points respectively from Baseline levels).

The **Energy efficiency and 12% renewables share in 2010** case, discussed in Chapter 4, aims at simulating the energy and environment effects (in terms of CO_2 emissions) of successfully implementing strong policies for both energy efficiency and renewables as far as such measures can be modelled. The policies included relate to those recently adopted or currently under discussion. They do not include future initiatives that address a time horizon beyond 2010 as such policies have not yet been debated, and no concrete proposals have yet been put forward. Thus, renewables policies are in a sense "frozen" at 2010 in this scenario.

The results obtained from the "Energy efficiency and 12% renewables share in 2010" case clearly reveal the large scope existing as regards further improvements in terms of energy intensity in the EU-25 energy system with primary energy needs growing at a rate of 0.07% pa in 2000-2030 (compared to 0.6% pa in the Baseline scenario). This decline is also accompanied by significant changes in the fuel mix with a large increase in use of renewable energy forms (both in absolute and market share terms) while the demand for all other energy forms declines (especially for solid fuels which falls -37.5% in 2030 compared to Baseline). The share of renewable energy forms rises to 12.1% in 2010 and 14.4% in 2030 (+4.7 and +5.8 percentage points' respectively above Baseline levels). CO_2 emissions are also projected to be strongly affected by the implementation of policies towards energy efficiency and the promotion of renewable energy forms, remaining not only well below Baseline levels over the projection period (-11.9% in 2010, -22.5% in 2030) but also below those implied in the Kyoto targets for 2010 (-12.2% from 1990 levels). Even in 2030, CO_2 emissions are projected to remains -11.5% below 1990 levels. Import dependency is also reduced by supportive policies for energy efficiency and renewables. In 2010 import dependency is limited to 48.7% (compared to 47.2% in 2000 and 53.1% in the Baseline), whereas in 2030 it is projected to be 61.5% (-5.9 percentage points below Baseline levels).

Furthermore, two additional cases were examined focusing separately on the impact of the implementation of policies towards energy efficiency and that of promoting policies for renewables. The results obtained, in comparison to the "Energy efficiency and 12% renewables share in 2010" case, show that there are synergies in combining policies promoting renewable energy forms and energy efficiency.

Nuclear energy is one of the key uncertainties and drivers for the future evolution of the EU-25 energy system. Therefore, a number of quite different cases with contrasting characteristics were examined and discussed in Chapter 5.

The **New nuclear technology accepted** case assumes that new nuclear designs (such as the European Pressurised Water Reactor (EPR) and the Westinghouse AP technology) with improved passive safety characteristics become mature by 2010. It is furthermore assumed that this would ease public opinion concerns towards nuclear energy and lead to the re-evaluation of declared nuclear phase out policies in EU-25 Member States. Under these assumptions the EU-25 power generation sector undergoes significant changes compared to the Baseline scenario while the evolution of the demand side remains similar to that in the Baseline. Nuclear capacity exhibits a significant growth above Baseline levels, especially in the long run, reaching 199.5 GW in 2030 (from 140.3 GW in 2000 and 107.8 GW in 2030 under Baseline assumptions). The projected increase in electricity generation from nuclear energy (+63.2% from Baseline levels in 2030) occurs mainly to the detriment of solid fuels (-22.9% in 2030) and, to a smaller extent, natural gas (-9.8%). This results in an increase of total gross inland consumption (+3.6% in 2030) because nuclear power plants have a lower efficiency than natural gas or solid fuel fired power stations. Nuclear energy accounts for 16.3% of primary energy needs in 2030 (the highest nuclear share ever) compared to 9.5% in the Baseline scenario. Moreover, there is only a limited decline in the market share of renewable energy sources, from 8.6% in the Baseline scenario in 2030 to 8.3% in the "New nuclear technology accepted" case. Therefore, the carbon intensity of the EU-25 energy system exhibits a significant improvement from Baseline levels with CO_2 emissions in 2030 decreasing by -5.6%. Furthermore, the lower dependence of the EU-25 energy system on fossil fuels (accounting for 75.5% of primary energy needs in 2030 compared to 81.8% in the Baseline scenario) allows for a significant reduction in import dependency, which reaches 62.1% in 2030 (-5.2 percentage points below Baseline levels).

The above trends are reversed in the **nuclear phase-out** case that assumes that nuclear production ceases in the EU-25 in 2010, with nuclear closure being well anticipated by power generators already from 2005 leading to only limited changes in the demand side. In that case solid fuels and natural gas are the main drivers for covering the gap generated in the power sector with the role of solids becoming increasingly important in the long run, while renewable energy forms are also projected to make some additional inroads compared to the Baseline scenario. Primary energy needs decline from Baseline levels (-4.0% in 2030) as a result of the replacement of nuclear power plants with more efficient ones whereas the significant worsening of carbon intensity is clearly reflected in the projected evolution of CO_2 emissions that reach 7.4% above Baseline levels in 2030. A complete nuclear phase-out would increase CO_2 emissions by more than 300 mill t CO_2 in the projection period, which means, in terms of the 1990 emission level, to add another 9 percentage points to the EU-25 CO_2 emissions of 1990. Under nuclear phase out conditions, a significant indigenous energy source is no longer available and is substituted, to a very large extent, by imported fuels. Consequently import dependency in 2030 for the EU-25 energy system increases to 74.7% in the "Nuclear phase out" case, compared to 67.3% in the Baseline scenario.

Moreover, each of the above two nuclear cases were combined with the "12% renewables in 2010" case. In the "Nuclear phase out in 2010 with strong support for renewables" case renewables account in 2030 for 51% of the gap generated due to nuclear phase-out. The share of renewable energy forms in primary energy needs rises to 13.7% in 2010 and 13.8% in 2030. However, as the growth of renewable energy forms is not enough to fully compensate for the nuclear phase-out, CO_2 emissions grow on top of Baseline levels (+2.0% in 2030) as does import dependency that reaches 71.1% in 2030 (+3.7 percentage points compared to the Baseline).

The "New nuclear technology with strong support for renewables" case combines the acceptance of new nuclear technology with the promotion of renewables showing an alternative trajectory with a high contribution of non-fossil fuels in the EU-25 energy system and thus positive effects both on the evolution of CO_2 emissions and on import dependency. The results obtained demonstrate that promotional policies for renewable energy forms and the acceptance of new nuclear technology can be complementary. The share of renewables in primary energy needs reaches 12.4% in 2030 while the nuclear share reaches 15.7%. Both nuclear energy and renewable energy forms gain additional market share in the EU-25 energy system to the detriment of solid fuels and, to a lesser extent, natural gas and liquid fuels. This results in significantly slower growth of CO_2 emissions, which in 2030 increase by only +1.9% from 1990 levels, compared to +14.2% under Baseline assumptions. In 2010 CO_2 emissions remain -5.1% below the 1990 level (compared with -0.3% in the Baseline). Due to the higher exploitation of indigenous energy sources, import dependency also improves reaching 58.7% in 2030 (-8.7 percentage points from Baseline levels).

The transport sector is one of the main drivers for the growth of energy needs in the demand side. The **promoting rail and improved load factors** case (discussed in Chapter 6) addresses the impacts that the implementation of policies along the lines of the Option C scenario of the Transport White Paper would have on the evolution of the EU-25 energy system. Option C consists of two main elements: stabilisation of the rail share in 2010 on the basis of the situation in 1998 and a considerable improvement in load factors of all modes in the EU.

In this case energy requirements in the transport sector fall -13.0% from Baseline levels in 2010 (-8.7% in 2030) whereas changes in other demand side sectors and in the supply side are insignificant over the projection period. The corresponding reduction in terms of primary energy needs is -3.0% in 2010 and -2.1% in 2030 mainly occurring in the use of liquid fuels. This leads to lower import dependency for the EU-25 energy system, which nevertheless increases to 51.8% in 2010 and 66.7% in 2030 (-1.3 and -0.6 percentage points respectively from Baseline levels). CO_2 emissions are projected to decline by -4.1% from Baseline levels in 2010 and -2.6% in 2030. As a side effect of the lower growth of primary energy needs, renewable energy forms gain some additional market share from Baseline levels (+0.2 percentage points in 2010, +0.1 percentage point in 2030).

The effects of **combining various options**, discussed in Chapter 7, are quite substantial as regards the future evolution of the EU-25 energy system. Besides the key policy drivers on energy efficiency, renewables, nuclear and transport that were analysed individually in chapters 4-6, additional policies on economic instruments and additional actions towards the use of alternative fuels were also examined in the combined cases. These combined scenarios include the available policy options to different degrees.

The **"energy policy options"** case examines the combined effect of policies on energy efficiency, renewables and the acceptance of new nuclear technology drawing on the results of the cases examined in chapters 4 and 5. The results obtained illustrate the absence of significant trade-offs between such policies. On the contrary, they allow for a significant improvement of the future evolution of the EU-25 energy system both in terms of security of supply and environmental concerns. Primary energy needs are projected to grow less than under Baseline assumptions with implied energy intensity gains of 5.9% above Baseline levels in 2010 and 11.2% in 2030. This improvement occurs despite the much higher exploitation of nuclear power in the long run (+34% in 2030), an energy form that is less efficient in power generation than solid fuels and natural gas. Total solid fuel consumption falls 42.7% below Baseline levels in 2030, whereas natural gas declines by -21.4%. Demand for liquid fuels is strongly affected by the implementation of policies towards energy efficiency declining by -13.1% from Baseline levels in 2030. On the contrary, renewables grow considerably over the projection period (+53.8% from Baseline in 2010 and +42.2% in 2030). The share of renewable energy forms is projected to reach 12.1% in 2010 (from 7.4% under Baseline assumptions), further increasing to 13.8% in 2030 (8.6% in the Baseline) while nuclear energy accounts for 13.2% of primary energy needs in 2010 and 14.3% in 2030 (compared to 13.7% and 9.5% respectively under Baseline assumptions). The increase in the use of indigenous and carbon free energy sources under the "Energy policy options" case is also reflected in the projected evolution of the import dependency and CO_2 emissions for the EU-25 energy system. Import dependency grows more slowly reaching 48.7% in 2010 and 57.4% in 2030 (-4.4 percentage points from Baseline levels in 2010, -10 in 2030). The effects on CO_2 emissions are important as emissions are projected to decrease -12.2% below the 1990 level in 2010 (from -0.3% in the Baseline scenario) and to further decline in 2030 to -14.6% below 1990 levels (from +14.2% in the Baseline scenario).

An even more favourable development for the EU-25 energy system is projected in the **"extended policy options"** case, in which besides supportive policies for energy efficiency and renewables it is also assumed that strong action is undertaken in the transport sector, both by means of changes in transport modes and load factors (as described in Chapter 6) and through shifts towards non-oil fuels. Furthermore, this case includes the 2003 Directive on taxation of fuel and electricity and economic effects of an emission trading regime following the adoption of the emission trading Directive.

Primary energy needs decline by -9.5% from Baseline levels in 2010, a decline that becomes even more pronounced in the long run

(-17.7% in 2030) while marked changes in the fuel mix occur. Renewable energy forms account for 13.1% of primary energy needs in 2010 (5.7 percentage points higher than Baseline levels). The renewables share further increase to 16.2% in 2030 (7.5 percentage points higher than Baseline). All other energy forms are projected to decline from Baseline levels. The most pronounced decline occurs for solid fuels (-67.6% from Baseline levels in 2030) as their comeback in the power generation sector is largely cancelled in an environment of promoting policies for renewables and the participation of the power generation sector in the emission trading regime. A significant decline is also projected for total liquid fuels demand, which declines by -27.3% from Baseline levels in 2030 both because of energy efficiency improvements but also as a result of the higher penetration of non-oil fuels in the transport sector. It is because of these changes in the transport sector that the demand for natural gas exhibits only a small decline in the long run (-4.2% in 2030 from Baseline levels) as gas becomes an important energy carrier in the transport sector accounting in 2030 for 11% of transport demand. Hydrogen also makes significant inroads accounting for 5.6% of transport demand in 2030. CO_2 emissions are projected to decline over the projection period reaching -18.7% and -23.3% from 1990 levels in 2010 and 2030 respectively (the corresponding decline from Baseline levels ranging from -18.4% in 2010 to -32.8% in 2030). Import dependency reaches 47.6% in 2010 (exhibiting an increase of just 0.4 percentage points from 2000 levels compared to 6 percentage point in the Baseline) further rising to 59.7% in 2030 (compared with 67.3% in the Baseline scenario).

The "**full policy options**" case combines all the above options and considers in addition the issue of carbon sequestration, which was introduced as an option for selected power generation technologies. However, in the presence of all available options such as greater energy efficiency, renewables, nuclear, modal shifts towards railways and better load factors, hydrogen and other non-oil alternatives in transport, the carbon sequestration option did not turn out to be a cost-effective solution. In the "full policy option" case (without carbon sequestration), the EU-25 energy system undergoes significant changes compared to the Baseline scenario with primary energy needs remaining rather stable at the 2000 level in the horizon to 2020 and exhibiting only a limited growth in the long run with implied energy intensity gains from Baseline levels reaching 9.5% in 2010 and 14.1% in 2030. The projected slight growth of primary energy needs in the long run is largely the result of the much higher deployment of nuclear energy in the EU-25 energy system (+49.4% compared to the Baseline scenario in 2030) which account for 16.4% of primary energy needs in 2030 (from 9.5% under Baseline assumptions). Renewable energy forms are also strongly encouraged in the "full policy options" case increasing by +60.3% in 2010 and +52.8% in 2030 from Baseline levels. The share of renewables in primary energy needs reaches 13.2% in 2010 and 15.4% in 2030 (from 7.4% and 8.6% respectively in the Baseline scenario). The shifts towards the use of nuclear energy and renewable energy forms mainly occur to the detriment of solid fuels which under the "full policy options" case assumptions become a rather obsolete energy form in the EU-25 energy system accounting for just 4.8% of primary energy needs in 2030 compared to 15.3% in the Baseline scenario. Demand for liquid fuels and, to a less extend, natural gas also exhibits a decline compared to the Baseline scenario, in line with the "Extended policy options" case. In 2010, CO_2 emissions are projected to fall -18.7% below 1990 levels further declining to -26.6% from 1990 levels in 2030, while import dependency is limited to 47.6% in 2010 and 55.1% in 2030 (-12.2 percentage points in comparison to the Baseline scenario).

In the context of a meta-analysis it was assumed, that two selected technologies (namely supercritical coal units and advanced natural gas combined cycle units) are equipped with CO_2 capture equipment. In this hypothetical carbon sequestration case, CO_2 emissions in 2030 would further decline reaching -30.2% from 1990 levels. This, however, would entail considerable additional costs, estimated at about 12 billion €'00, in 2030. Thus, it is clear from this analysis that the exploitation of CO_2 sequestration would be a costly option for the EU-25 energy system over the period to 2030. It could, however, contribute to a significant reduction of CO_2 emissions while maintaining fossil fuels with energy security advantages in the energy balance if strong supporting policies are introduced. More research into carbon sequestration and technology learning should reduce these additional costs.

The repercussions of **targeted CO_2 emissions reductions** on the future evolution of the EU-25 energy system were examined in different scenarios (reflecting different CO_2 emissions reduction constraints over the projection period). The energy consequences of the above CO_2 constraints that are compatible with Kyoto and possible post Kyoto targets were derived from treating the EU-25 energy system as one entity. The "targets" or emission constraints were achieved in modelling the energy economy in such a way as to obtain equal marginal costs across Member States and sectors, which ensures the lowest possible cost level in a given policy context.

The "**Kyoto forever**" case (described in detail in chapter 8) examines the achievement of a CO_2 emissions reduction of -5.5% from 1990 levels for the EU-25 energy system and a stabilisation of CO_2 emissions at these levels in the period to 2030. Given that under Baseline assumptions CO_2 emissions follow a growing trend, the gap between the Baseline and CO_2 emissions reduction target increases over time (from 196 Mt CO_2 or -5.2% in 2010 to 740 Mt or -17.2% in 2030). The carbon values or marginal costs involved to reach the "target"[98] rise from 15.3 €/t CO_2 in 2010 to 40.9 €/t CO_2 in 2030 (in prices of 2000). The energy system reacts to the introduction of CO_2 emissions constraints by improving energy intensity, and by improving carbon intensity through changes in the fuel mix towards the use of less carbon intensive or carbon free energy forms. In the "Kyoto forever" case the response of the EU-25 energy system is dominated by improvements in terms of carbon intensity (account-

98 It should be borne in mind that the Kyoto Protocol stipulates emission reductions for a basket of six greenhouse gases mainly on the basis of emissions in 1990. The analysis in this chapter concerns only energy related CO_2 emissions. While the CO_2 "targets" used for analytical purposes in this chapter are compatible with the Kyoto Protocol, there are no specific CO_2 targets in the Kyoto Protocol but only targets for all six greenhouse gases combined

ing for 53% of overall CO_2 emissions reductions achieved in 2010, further rising to 67% in 2030). Primary energy needs decline by -2.5% from Baseline levels in 2010 and -5.7% in 2030. Changes in the fuel mix involve strong shifts away from the use of solid fuels, especially in the long run; in 2030 demand for solid fuels is limited to 40.4% of that under Baseline assumptions. Demand for liquid fuels declines somewhat (-4.9% in 2030) as a result of the higher exploitation of efficiency options in the transport sector. Natural gas exhibits a limited decline in 2010 (-1.1% from Baseline levels) but gains additional market share in the long run (growing by +5.0% above Baseline levels in 2030) as it acts in replacing solid fuels in the power generation sector. Nuclear energy grows above Baseline levels in the long run (+8.9% in 2030), a significant increase taking into account that it has been assumed that Member States without nuclear and those with declared nuclear phase-out policies do not alter their approach to nuclear in this scenario.

Renewable energy forms become increasingly competitive in an environment of CO_2 emissions reduction constraints growing at rates well above those under Baseline assumptions (+7.7% in 2010, +30.6% in 2030). The market share of renewables in primary energy needs reaches 8.2% in 2010 and 12.0% in 2030 (+3.3 percentage points above Baseline levels). The higher exploitation of indigenous energy sources in combination to the additional energy intensity gains occurring in the EU-25 energy system lead to a slower pace of growth of import dependency which reaches 52.6% in 2010 and 64.2% in 2030 (-0.5 and -3.1 percentage points from Baseline levels).

The "**Gothenburg type targets with domestic action**" case, examines the achievement of a -5.5% emissions reduction from 1990 levels in 2010 and the impact of the introduction of progressively higher emission reduction targets up to 2030. This follows the approach set out in the Commission's Communication in the run up to the Gothenburg Summit. Thus in 2020 the EU-25 energy system reduces its CO_2 emissions by -13% below the 1990 level, reaching -21% in 2030. The introduction of higher CO_2 emissions reduction constraints in the long run leads in a higher exploitation of carbon intensity improvement options in the EU-25 energy system and generates the need for additional action in terms of improving energy efficiency. Thus, in 2030 energy intensity improvements account for 40.4% of the overall CO_2 emissions reduction achieved (compared to 33.3% in the "Kyoto forever" case). The need for additional effort towards improving energy efficiency, especially in the demand side, is also reflected on the carbon values or marginal costs, which reach 136.6 € 00 per t of CO_2 in 2030 in this scenario.

The reduction of CO_2 emissions by -30.8% below Baseline levels in 2030 (-21% from 1990) involves substantial changes in the EU-25 energy system. The energy intensity gains (which are equivalent to the corresponding decline in primary energy needs as macro-economic assumptions remain unchanged in comparison to the Baseline scenario) reach 12.4% from Baseline levels in 2030. Solid fuels become an obsolete energy form in the EU-25 energy system in the long run in a severely carbon constrained world. On the other hand, there is substantial growth in the use of renewable energy forms (accounting for 15.5% of primary energy needs in 2030 compared to 8.6% in the Baseline scenario). This leads to a decline in the share of fossil fuels in primary energy needs by some 10 percentage points in 2030 from 81.6% in the Baseline to 71.8% in this scenario given the required deep cuts in CO_2 emissions, while import dependency also improves reaching 60.1% in 2030 (-7.2 percentage points below Baseline levels).

Two additional cases were also examined, the "Gothenburg-flexible" case and the "Gothenburg-intermediate" case, reflecting the possibilities of achieving Kyoto type targets by other means than reducing energy related CO_2 emissions, i.e. in particular by using flexible mechanisms and by acting on other (non-CO_2) gases and sinks. The results obtained from these two cases further confirm the findings discussed above with energy intensity improvements becoming increasingly important as higher targets need to be met.

Furthermore, the same analysis has been performed at the level of the EU-15 energy system. The results obtained clearly illustrate that it is much more difficult for the EU-15 energy system to meet CO_2 emissions reduction "targets"[99] than for the EU-25 for a number of reasons. First, higher emissions reductions from 1990 levels need to be achieved in EU-15 compared to EU-25 following the terms of the Kyoto Protocol. In addition the present characteristics of the EU-15 energy system in terms of both energy and carbon intensity are more advanced than those of the New Member States' energy system. Thus there exists greater potential for low-cost improvements at the EU-25 level than for the EU-15. Third, the restructuring that took place in most of the New Member States during the 1990s led to a significant improvement of their position in terms of CO_2 emissions. In the EU-15 CO_2 emissions in 2000 were 1.2% above 1990 levels whereas in the NMS they were -20.4% below 1990 levels.

9.2. Key indicators across scenarios and conclusions

The results obtained from the various scenarios illustrate the large uncertainties that prevail as regards the future evolution of the EU-25 energy system in the period to 2030 arising from different world energy market conditions, economic developments and levels of policy intensity. In all cases the energy needs in the EU-25 are projected to exhibit a further de-linking from economic growth. Under Baseline assumptions **energy intensity improvements** of 1.7% pa in 2000-2030 are projected to occur in the EU-25 energy system. Similar energy intensity gains are projected for most of the cases examined (with small upward on downward deviations stemming from changes in nuclear deployment, international fuel prices and economic growth deviations). However, the strong policies towards improving energy efficiency (described in chapter 4) give rise to energy intensity improvements of 0.5 percentage points per year above Baseline levels throughout the projection period. Energy intensity gains of a similar magnitude also occur in the presence of deep cuts for CO_2 emissions, such as in the "Gothenburg type targets with domestic action" case, in which case they reach 2.2% pa.

Despite the higher energy intensity gains achieved in comparison to the Baseline scenario, the "high economic growth" case exhibits the most pronounced growth in terms of energy requirements, which

99 see the previous footnote

reach +27.5% in 2030 from 2000 levels (compared to +18.7% in the Baseline scenario). On the contrary, the implementation of the policies assumed in the "extended policy options" case result in a decline of energy needs in the EU-25 by -2.2% from 2000 levels in 2030. It should be noted that this is the only case in which such an evolution is projected while in the "full policy options" case the higher exploitation of nuclear energy results in an increase of energy requirements in 2030 by +2.0% from 2000 levels. Similarly, the response of the EU-25 energy system through improvements in energy efficiency to the introduction of high CO_2 emissions reduction constraints leads to a near stabilisation of energy requirements (+4.0% in 2000-2030) under the "Gothenburg type targets with domestic action" case assumptions.

The evolution of the level and structure of primary energy needs is of key importance as regards two main challenges that the EU-25 energy system faces in the period to 2030, namely security of supply and environmental concerns. The challenges concerning energy security are illustrated by the increase of **import dependency** from 47.2% in 2000 to 67.3% in 2030 (i.e. by 20.1 percentage points in 2000-2030) under Baseline assumptions. A lower increase in import dependency occurs in the cases that involve more renewables and/or nuclear energy. In the "full policy options" case, import dependency increases by just 7.9 percentage points in 2000-2030, while a slightly higher growth of import dependency (+10.2 percentage points) is projected for the "energy policy option" case. In the "extended policy options" case, which does not involve the further penetration of new nuclear in the EU, import dependency reaches 59.7% in 2030 (+12.5 percentage points), a result similar to that of the "Gothenburg type targets with domestic action" case with import dependency of 60.1% in 2030. On the contrary, the abandonment of nuclear energy in the EU would entail larger security of supply concerns with import dependency in 2030 reaching 75% in the "nuclear phase-out" case. Promoting policies for renewables can only partly counterbalance this development as illustrated in the results of the "nuclear phase-out with strong support for renewables" case in which import dependency in 2030 reaches 71.1%.

With import dependency increasing in all scenarios up to 2030 – albeit to a quite different degree according to the scenario – it is important to strengthen consumer– producer relations and energy partnerships. This should help ensuring secure and stable world energy market conditions. Moreover, mutually beneficial energy trade relations can exert a positive influence on geopolitical stability, which in turn exerts a positive influence on the security of energy supply.

As regards environmental concerns, the most favourable development in terms of **CO_2 emissions** occurs in the "full policy options" case, where CO_2 emissions exhibit a continuous decline over the projection period reaching -26.6% from 1990 levels in 2030 (or -30.2% if CO_2 sequestration is also taken into account). This is a substantial reduction considering that CO_2 emissions grow by +14.2% from 1990 in the Baseline scenario. Similarly, there are also deep cuts in CO_2 emissions in the "extended policy options" case (-23.3% in 1990-2030) and the "Gothenburg type targets with domestic action" case (-20.9% in 1990-2030). It is interesting to note that compared to the high costs involved in the achievement of the -20.9% reduction in the "Gothenburg type targets with domestic action" case, resulting from the introduction of carbon values that reach 136.6 €00 per t of CO_2 in 2030, the impact on energy system costs in the "full policy options" and the "extended policy options" cases are rather limited. This results from the approach retained in the CO_2 emissions reduction cases on the basis of carbon values that do not simulate additional policies (e.g. on energy efficiency, renewables or nuclear) beyond those available in the Baseline scenario but on the contrary, start from targets. In these carbon value cases, instead of widening the choices of economic actors for low carbon options through policy, CO_2 emissions reductions are achieved only through price/cost mechanisms, which leads to rather high illustrative CO_2 emission reduction costs. The carbon values (or marginal CO_2 emissions reduction costs) are indicative of the relative difficulty involved in maintaining target levels over time or in achieving progressively more ambitious targets.

The most pronounced increase in CO_2 emissions occurs in the "high economic growth" case (+23.6% in 2030 from 1990 levels) as in the absence of specific policies encouraging CO_2 emissions reduction (such as policies on energy efficiency and renewables) there is a considerable increase in carbon intensity, which is not offset by the improvement of energy intensity brought about in the context of higher economic growth., In particular, there is more use of solid fuels in the power generation in satisfying additional energy requirements due to higher GDP. The same trends occur in the cases that involve the phase-out of nuclear energy in the EU with CO_2 emissions in 2030 rising by +23% from 1990 levels in the "nuclear phase-out" case. In the "nuclear phase-out with strong support for renewables" case, the increase in CO_2 emissions in 2030 is limited to 16.5% from 1990 levels.

The combination of policies towards higher energy efficiency with promoting policies for renewables that ensure a 12% renewables share in 2010 leads to a 12% decline of CO_2 emissions below the 1990 level in 2010. Even though renewables policies are "frozen" at 2010 in this scenario, CO_2 emissions would remain broadly at 12% below the 1990 level up to 2030. Clearly, with reinforced renewables policies post 2010 even better results can be obtained and CO_2 emissions could fall further below the EU Kyoto commitments in 2008-2012 for the 6 greenhouse gases.

As regards the effects of higher oil and gas import prices, the results obtained from the cases examined illustrate that energy intensity gains achieved on top of Baseline levels are largely counterbalanced by shifts in the fuel mix towards the use of solid fuels and, thus, CO_2 emissions in 2030 are only slightly below those of the Baseline scenario.

Renewable energy forms exhibit the highest growth among all energy forms in all cases examined. Thus, the market share of renewables is projected to increase over the projection period clearly reflecting the key role that renewables will play in satisfying future energy needs in the EU-25 energy system. In the Baseline scenario the renewables share increases from 5.8% in 2000 to 7.4% in 2010 and 8.6% in 2030. Although renewables exhibit a quite significant increase of +76.3% in 2000-2030, the renewables share remains well below the target set in the EU for 2010 (12% of primary energy needs). The renewables share is an important indicator not only with a view to import dependency and climate change but also as renewables contribute to employment and cohesion objectives. The renewables share reaches the 12% target only with strong specific policies; it remains below this target in all other cases. The 12% renewables share is more easily obtained in combining strong renewables policies with ambitious energy efficiency policies; there are synergies between both approaches, e.g. in terms of cogeneration from biomass. Thus renewables shares of 12% or above in 2010 are achieved in the "full policy options" and "extended policy options" cases (13.2% in each case), in the "energy policy options" case and the "energy efficiency and 12% renewables share in 2010" case (12.1% each). The highest renewables share in 2010 (13.6%) would be achieved in the hypothetical case of a complete nuclear phase-out in 2010 that is accompanied by the same supporting policies for renewables that ensure the 12% renewables share under Baseline conditions.

In the long run, and in the absence of additional policies on renewables addressing the period post 2010, market and technology developments alone entail only a limited increase of the renewables share beyond 12%. For maintaining momentum in renewables penetration, additional policies are required addressing the period post 2010. In 2030, the market share of renewables reaches up to 16.2% in the "extended policy options" case, 15.4% in the "full policy options" case and 14.4% in the "energy efficiency and 12% renewables share in 2010" case. The introduction of ambitious CO_2 emissions reduction targets also entails a greater exploitation of renewable energy forms in the long run; the share of renewables in the "Gothenburg type targets with domestic action" case reaches 15.5% in 2030.

Nuclear is the energy source that is surrounded by the greatest uncertainty. In this scenario exercise the nuclear share in 2030 spans a wide range from an extreme 0% (nuclear phase-out in the entire EU) to 16.4% in the scenario that combines all policy options including the acceptance of new nuclear technology. This would be the highest nuclear share ever given that the highest nuclear share so far was 14.8% in 2002 (the latest statistical year available). Under Baseline developments the nuclear share would fall to 9.5% in 2030.

There is indeed a large amount of uncertainty about our energy future, which relates also to the economic and geopolitical influences on energy and transport developments. The world in which policy makers have to act to achieve sustainable development is uncertain in many respects. Scenario analysis that considers both the demand and supply side of providing energy in an integrated fashion, including its economic and environmental dimensions, is a powerful tool to support policy making.

The Green paper on the Security of Energy Supplies and the White paper on the Common Transport Policy have shown clearly that there are many challenges ahead to ensure better security of supply, better services for the users of energy and transport, and lower impacts on the environment. Today's policy makers and citizens have it within their grasp to transform Europe's energy outlook to ensure sustainable development, including its economic, social and environmental dimensions. This publication examined a wide range of energy policy options over the next three decades showing that the energy futures can be quite different. Transport policy can furthermore contribute significantly towards restraining energy demand and making our energy system more efficient. Clearly, there are synergies to be developed between energy and transport policies. This analysis of scenarios on key drivers should contribute to an informed debate among stakeholders and provide valuable pointers to future policies.

Carbon intensity: The amount of CO_2 by weight emitted per unit of energy consumed or produced (t of CO_2/tonne of oil equivalent (toe) or MWh)

Clean coal units: A number of innovative, new technologies designed to use coal in a more efficient and cost-effective manner while enhancing environmental protection. Among the most promising technologies are fluidised-bed combustion (PFBC), integrated gasification combined cycle (IGCC), coal liquefaction and coal gasification.

CO_2 Emissions to GDP: The amount of CO_2 by weight emitted per unit of GDP (carbon intensity of GDP - t of CO_2/MEuro'00).

Cogeneration thermal plant: A system using a common energy source to produce both electricity and steam for other uses, resulting in increased fuel efficiency (see also: CHP).

Combined Cycle Gas Turbine plant (CCGT): A technology which combines gas turbines and steam turbines, connected to one or more electrical generators at the same plant. The gas turbine (usually fuelled by natural gas or oil) produces mechanical power, which drives the generator, and heat in the form of hot exhaust gases. These gases are fed to a boiler, where steam is raised at pressure to drive a conventional steam turbine, which is also connected to an electrical generator. This has the effect of producing additional electricity from the same fuel compared to an open cycle turbine.

Combined Heat and Power: This means cogeneration of useful heat and power (electricity) in a single process. In contrast to conventional power plants that convert only a limited part of the primary energy into electricity with the remainder of this energy being discharged as waste heat. CHP makes use of large parts of this energy for e.g. industrial processes, district heating, and space heating. CHP therefore improves energy efficiency (see also: cogeneration thermal plant).

Efficiency for thermal electricity production: A measure of the efficiency of converting a fuel to electricity and useful heat; heat and electricity output divided by the calorific value of input fuel times 100 (for expressing this ratio in percent).

Efficiency indicator in freight transport (activity related): Energy efficiency in freight transport is computed on the basis of energy use per tonne-km. Given the existence of inconsistencies between transport and energy statistics, absolute numbers (especially at the level of individual Member States) might be misleading in some cases. For that reason, the numbers given are only illustrative of the trends in certain cases.

Efficiency indicator in passenger transport (activity related): Energy efficiency in passenger transport is computed on the basis of energy use per passenger-km travelled. Issues related to consistency of transport and energy statistics also apply to passenger transport (see also: Efficiency indicator in freight transport).

Energy branch consumption: Energy consumed in refineries, electricity and steam generation and in other transformation processes; it does not include the energy input for transformation as such.

Energy intensity: energy consumption/GDP or another indicator for economic activity

Energy intensive industries: Iron and steel, non-ferrous, chemicals, non-metallic minerals, and paper and pulp industries.

Final energy demand: Energy finally consumed in the transport, industrial, household and tertiary sectors with tertiary comprising services and agriculture. It excludes deliveries to the energy transformation sector (e.g. power plants) and to the energy branch. It includes electricity consumption in the above final demand sectors.

Freight transport activity: Expressed in tonne kilometres (1 Gtkm = 10^9 tkm); one tkm = one tonne transported a distance of one km. It should be noted that inland navigation includes both waterborne inland transport activity and domestic sea shipping. However, international short sea shipping is not included in the above category as, according to EUROSTAT energy balances, energy needs for international shipping are allocated to bunkers.

Fuel cells: A fuel cell is an electrochemical energy conversion device converting hydrogen and oxygen into electricity and heat with the help of catalysts. The fuel cell provides a direct current voltage that can be used to power various electrical devices including motors and lights.

Fuel input to power generation: Fuel use in electricity, CHP plants and heat plants.

Gas: Includes natural gas, blast furnace gas, coke-oven gas and gas-works gas.

Generation capacity: The maximum rated output of a generator, prime mover, or other electric power production equipment under specific conditions designated by the manufacturer.

Geothermal plant: A plant in which the prime mover is a steam turbine. The turbine is driven either by steam produced from hot water or by natural steam that derives its energy from heat in rocks or fluids beneath the surface of the earth. The energy is extracted by drilling and/or pumping.

Gross Inland Consumption: Quantity of energy consumed within the borders of a country. It is calculated as primary production + recovered products + imports +/- stock changes – exports – bunkers (i.e. quantities supplied to sea-going ships).

Gross Inland Consumption/GDP: Energy intensity indicator calculated as the ratio of total energy consumption to GDP – (toe/MEuro'00).

Hydro power plant: A plant producing energy with the use of moving water. For the purposes of these energy balance projections, hydro excludes pumped storage plants that generate electricity during peak load periods by using water previously pumped into an elevated storage reservoir during off-peak periods when excess generating capacity is available.

Non fossil fuels: Nuclear and renewable energy sources.

Non-energy uses: Non-energy consumption of energy carriers in petrochemicals and other sectors, such as chemical feedstocks, lubricants and asphalt for road construction.

Nuclear power plant: A plant in which a nuclear fission chain reaction can be initiated, controlled, and sustained at a specific rate. They include new nuclear designs (such as the EPR as well as the AP1000 and AP600) with passive safety features (which reduce core fusion probability from 10-5/year of existing nuclear plants to less than 5.10-7/year).

Oil: Includes refinery gas, liquefied petroleum gas, kerosene, gasoline, diesel oil, fuel oil, crude oil, naphtha and feedstocks.

Open cycle units: A turbine connected to an electrical generator. Less efficient than a combined cycle gas turbine (CCGT) because it does not recover and use the heat of the exhaust gases. Open cycle units include polyvalent units, monovalent coal-lignite units, monovalent oil-gas units and monovalent biomass-waste units.

Passenger transport activity: Expressed in passenger kilometres (1 Gpkm = 10^9 pkm); one pkm relates to one person travelling a distance of one km. Passenger transport activity includes energy consuming passenger transport on roads (public and private), by rail, in airplanes and on ships as far as this takes place on rivers, canals, lakes and as domestic sea shipping; international short sea shipping is not included as, according to EUROSTAT energy balances, energy needs for international shipping are allocated to bunkers.

Primary production: Total indigenous production.

Renewable energy sources: Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include: biomass, hydro, wind, geothermal, solar, wave and tidal energy.

Solar power plant: A plant producing energy with the use of radiant energy from the sun; includes solar thermal and photovoltaic (direct conversion of solar energy into electricity) plants.

Solids: Include both primary products (hard coal and lignite) and derived fuels (patent fuels, coke, tar, pitch and benzol).

Supercritical polyvalent units: A power plant for which the evaporator part of the boiler operates at pressures above 22.1 MegaPascals (MPa). The cycle-medium in this case is a single phase fluid with homogenous properties and thus there is no need to separate steam from water in a drum, allowing for higher efficiency in power generation.

Thermal power plants: Type of electric generating station in which the source of energy for the prime mover is heat.

Wind power plant: Typically a group of wind turbines interconnected to a common utility system through a system of transformers, distribution lines, and (usually) one substation. Operation, control, and maintenance functions are often centralised through a network of computerised monitoring systems, supplemented by visual inspection.

APPENDIX 1A

Assumptions by group of countries
(EU-25, EU-15, new Member states (NMS) and Europe-30)

BASELINE SCENARIO
EU - 25: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	441.1	453.4	461.2	462.1	458.2	0.3	0.2	0.0	-0.1					
Average household size (persons)	2.6	2.4	2.3	2.1	2.0	-0.8	-0.8	-0.6	-0.5					
Number of households (Million)	167.0	185.8	204.2	217.9	227.6	1.1	1.0	0.6	0.4					
Gross Domestic product (in 000 MEuro'00)	**7315.2**	**8939.3**	**11433.0**	**14462.1**	**18020.3**	**2.0**	**2.5**	**2.4**	**2.2**					
Households expenditure (in 000 MEuro'00)	**4255.6**	**5161.0**	**6580.1**	**8277.7**	**10195.9**	**1.9**	**2.5**	**2.3**	**2.1**					
Gross Value Added (in 000 MEuro'00)	**6833.4**	**8350.5**	**10792.7**	**13730.4**	**17164.8**	**2.0**	**2.6**	**2.4**	**2.3**					
Industry	1485.6	1697.8	2167.7	2758.3	3436.2	1.3	2.5	2.4	2.2	21.7	20.3	20.1	20.1	20.0
iron and steel	58.7	52.5	53.6	55.2	56.0	-1.1	0.2	0.3	0.1	0.9	0.6	0.5	0.4	0.3
non ferrous metals	21.0	23.8	32.9	42.6	53.2	1.3	3.3	2.6	2.3	0.3	0.3	0.3	0.3	0.3
chemicals	158.2	195.2	256.1	329.4	410.8	2.1	2.8	2.5	2.2	2.3	2.3	2.4	2.4	2.4
petrochemicals, fertilisers and others	102.3	114.6	137.3	158.9	177.7	1.1	1.8	1.5	1.1	1.5	1.4	1.3	1.2	1.0
pharmaceuticals and cosmetics	55.9	80.6	118.8	170.5	233.1	3.7	4.0	3.7	3.2	0.8	1.0	1.1	1.2	1.4
non metallic minerals	70.9	75.5	90.1	109.0	127.5	0.6	1.8	1.9	1.6	1.0	0.9	0.8	0.8	0.7
paper, pulp, printing	121.5	147.5	187.1	235.0	283.4	2.0	2.4	2.3	1.9	1.8	1.8	1.7	1.7	1.7
paper and pulp production	22.4	27.2	32.3	38.2	43.5	1.9	1.7	1.7	1.3	0.3	0.3	0.3	0.3	0.3
printing and publishing	99.1	120.3	154.8	196.8	240.0	2.0	2.6	2.4	2.0	1.5	1.4	1.4	1.4	1.4
food, drink, tobacco	170.7	203.2	258.8	325.5	396.6	1.8	2.4	2.3	2.0	2.5	2.4	2.4	2.4	2.3
textiles and leather	103.2	86.1	88.5	93.5	97.3	-1.8	0.3	0.6	0.4	1.5	1.0	0.8	0.7	0.6
engineering	641.9	756.5	1001.5	1322.2	1716.3	1.7	2.8	2.8	2.6	9.4	9.1	9.3	9.6	10.0
other industries	139.4	157.5	199.1	246.0	295.1	1.2	2.4	2.1	1.8	2.0	1.9	1.8	1.8	1.7
Construction	431.3	439.3	531.7	653.2	782.9	0.2	1.9	2.1	1.8	6.3	5.3	4.9	4.8	4.6
Services	4482.3	5708.7	7524.5	9666.9	12210.5	2.4	2.8	2.5	2.4	65.6	68.4	69.7	70.4	71.1
market services	1603.1	2154.2	2992.2	3974.8	5164.8	3.0	3.3	2.9	2.7	23.5	25.8	27.7	28.9	30.1
non-market services	1450.5	1700.4	2019.2	2401.0	2825.5	1.6	1.7	1.7	1.6	21.2	20.4	18.7	17.5	16.5
trade	1428.7	1854.1	2513.1	3291.1	4220.2	2.6	3.1	2.7	2.5	20.9	22.2	23.3	24.0	24.6
Agriculture	198.5	221.8	247.2	274.6	298.5	1.1	1.1	1.1	0.8	2.9	2.7	2.3	2.0	1.7
Energy sector	235.8	282.9	321.6	377.4	436.8	1.8	1.3	1.6	1.5	3.5	3.4	3.0	2.7	2.5

Source: PRIMES

BASELINE SCENARIO
EU - 15: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	366.0	378.7	387.8	390.4	389.0	0.3	0.2	0.1	0.0					
Average household size (persons)	2.6	2.4	2.2	2.1	2.0	-0.8	-0.8	-0.7	-0.5					
Number of households (Million)	141.3	157.7	174.2	187.3	197.1	1.1	1.0	0.7	0.5					
Gross Domestic product (in 000 MEuro'00)	**6982.1**	**8545.0**	**10859.1**	**13641.2**	**16919.9**	**2.0**	**2.4**	**2.3**	**2.2**					
Households expenditure (in 000 MEuro'00)	**3998.7**	**4863.3**	**6147.2**	**7644.3**	**9345.6**	**2.0**	**2.4**	**2.2**	**2.0**					
Gross Value Added (in 000 MEuro'00)	**6537.9**	**8003.5**	**10283.4**	**12993.0**	**16174.3**	**2.0**	**2.5**	**2.4**	**2.2**					
Industry	1407.4	1609.6	2036.3	2573.5	3204.4	1.4	2.4	2.4	2.2	21.5	20.1	19.8	19.8	19.8
iron and steel	54.6	49.2	49.7	50.8	51.2	-1.0	0.1	0.2	0.1	0.8	0.6	0.5	0.4	0.3
non ferrous metals	20.5	23.2	32.1	41.5	52.0	1.2	3.3	2.6	2.3	0.3	0.3	0.3	0.3	0.3
chemicals	152.1	188.1	243.4	310.2	385.8	2.1	2.6	2.5	2.2	2.3	2.4	2.4	2.4	2.4
petrochemicals, fertilisers and others	98.0	110.5	131.1	150.3	166.9	1.2	1.7	1.4	1.1	1.5	1.4	1.3	1.2	1.0
pharmaceuticals and cosmetics	54.1	77.6	112.3	159.9	218.9	3.7	3.8	3.6	3.2	0.8	1.0	1.1	1.2	1.4
non metallic minerals	67.5	70.2	82.8	99.1	115.7	0.4	1.7	1.8	1.6	1.0	0.9	0.8	0.8	0.7
paper, pulp, printing	117.6	141.8	178.2	221.8	266.5	1.9	2.3	2.2	1.9	1.8	1.8	1.7	1.7	1.6
paper and pulp production	21.3	26.1	30.8	36.0	40.8	2.0	1.7	1.6	1.3	0.3	0.3	0.3	0.3	0.3
printing and publishing	96.3	115.7	147.4	185.7	225.7	1.9	2.5	2.3	2.0	1.5	1.4	1.4	1.4	1.4
food, drink, tobacco	158.5	185.9	233.1	291.6	355.8	1.6	2.3	2.3	2.0	2.4	2.3	2.3	2.2	2.2
textiles and leather	94.1	79.7	80.9	84.9	87.9	-1.7	0.1	0.5	0.3	1.4	1.0	0.8	0.7	0.5
engineering	615.4	726.0	955.5	1253.1	1626.4	1.7	2.8	2.7	2.6	9.4	9.1	9.3	9.6	10.1
other industries	127.2	145.5	180.7	220.5	263.3	1.4	2.2	2.0	1.8	1.9	1.8	1.8	1.7	1.6
Construction	407.7	418.0	500.9	607.9	722.8	0.3	1.8	2.0	1.7	6.2	5.2	4.9	4.7	4.5
Services	4330.7	5509.5	7219.9	9207.3	11564.7	2.4	2.7	2.5	2.3	66.2	68.8	70.2	70.9	71.5
market services	1568.5	2100.8	2900.0	3823.3	4939.3	3.0	3.3	2.8	2.6	24.0	26.2	28.2	29.4	30.5
non-market services	1396.3	1642.6	1937.5	2284.3	2667.5	1.6	1.7	1.7	1.6	21.4	20.5	18.8	17.6	16.5
trade	1365.9	1766.1	2382.3	3099.8	3957.8	2.6	3.0	2.7	2.5	20.9	22.1	23.2	23.9	24.5
Agriculture	179.4	201.9	224.5	248.3	268.7	1.2	1.1	1.0	0.8	2.7	2.5	2.2	1.9	1.7
Energy sector	212.7	264.6	301.9	356.0	413.7	2.2	1.3	1.7	1.5	3.3	3.3	2.9	2.7	2.6

Source: PRIMES

BASELINE SCENARIO
NEW MEMBER STATES: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				**% Structure of total value added**				
Main Demographic Assumptions														
Population (Million)	75.1	74.7	73.4	71.7	69.1	-0.1	-0.2	-0.2	-0.4					
Average household size (persons)	2.9	2.7	2.4	2.3	2.3	-0.9	-0.8	-0.4	-0.3					
Number of households (Million)	25.7	28.1	30.0	30.5	30.5	0.9	0.7	0.2	0.0					
Gross Domestic product (in 000 MEuro'00)	**333.1**	**394.3**	**573.9**	**820.9**	**1100.4**	**1.7**	**3.8**	**3.6**	**3.0**					
Households expenditure (in 000 MEuro'00)	**256.9**	**297.6**	**432.9**	**633.4**	**850.3**	**1.5**	**3.8**	**3.9**	**3.0**					
Gross Value Added (in 000 MEuro'00)	**295.5**	**347.0**	**509.3**	**737.4**	**990.6**	**1.6**	**3.9**	**3.8**	**3.0**					
Industry	78.1	88.2	131.4	184.8	231.8	1.2	4.1	3.5	2.3	26.4	25.4	25.8	25.1	23.4
iron and steel	4.1	3.3	3.9	4.4	4.8	-2.2	1.7	1.1	0.8	1.4	1.0	0.8	0.6	0.5
non ferrous metals	0.5	0.7	0.8	1.0	1.2	2.6	2.2	2.4	1.4	0.2	0.2	0.2	0.1	0.1
chemicals	6.1	7.1	12.7	19.2	25.0	1.5	6.1	4.2	2.7	2.1	2.0	2.5	2.6	2.5
petrochemicals, fertilisers and others	4.3	4.1	6.2	8.6	10.8	-0.5	4.2	3.4	2.3	1.5	1.2	1.2	1.2	1.1
pharmaceuticals and cosmetics	1.8	3.0	6.5	10.5	14.2	5.2	8.2	4.9	3.0	0.6	0.9	1.3	1.4	1.4
non metallic minerals	3.4	5.3	7.4	9.8	11.8	4.6	3.2	2.9	1.9	1.2	1.5	1.4	1.3	1.2
paper, pulp, printing	3.9	5.7	8.9	13.2	16.9	3.8	4.6	4.0	2.5	1.3	1.6	1.8	1.8	1.7
paper and pulp production	1.1	1.1	1.5	2.2	2.7	0.0	3.2	3.4	2.2	0.4	0.3	0.3	0.3	0.3
printing and publishing	2.8	4.6	7.4	11.0	14.2	5.0	4.9	4.1	2.6	1.0	1.3	1.4	1.5	1.4
food, drink, tobacco	12.2	17.3	25.6	34.0	40.9	3.6	4.0	2.9	1.9	4.1	5.0	5.0	4.6	4.1
textiles and leather	9.1	6.4	7.6	8.6	9.4	-3.4	1.8	1.2	0.8	3.1	1.8	1.5	1.2	0.9
engineering	26.6	30.4	46.0	69.1	90.0	1.4	4.2	4.1	2.7	9.0	8.8	9.0	9.4	9.1
other industries	12.2	12.0	18.4	25.5	31.8	-0.2	4.4	3.3	2.2	4.1	3.4	3.6	3.5	3.2
Construction	23.7	21.3	30.8	45.3	60.1	-1.0	3.7	3.9	2.9	8.0	6.1	6.0	6.1	6.1
Services	151.6	199.2	304.7	459.6	645.8	2.8	4.3	4.2	3.5	51.3	57.4	59.8	62.3	65.2
market services	34.6	53.4	92.1	151.5	225.5	4.4	5.6	5.1	4.1	11.7	15.4	18.1	20.5	22.8
non-market services	54.1	57.9	81.7	116.7	158.0	0.7	3.5	3.6	3.1	18.3	16.7	16.0	15.8	15.9
trade	62.8	88.0	130.8	191.3	262.3	3.4	4.1	3.9	3.2	21.3	25.3	25.7	25.9	26.5
Agriculture	19.0	19.9	22.7	26.3	29.8	0.5	1.3	1.5	1.3	6.4	5.7	4.5	3.6	3.0
Energy sector	23.1	18.3	19.7	21.5	23.1	-2.3	0.7	0.9	0.7	7.8	5.3	3.9	2.9	2.3

Source: PRIMES

BASELINE SCENARIO
EUROPE - 30: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				**% Structure of total value added**				
Main Demographic Assumptions														
Population (Million)	540.2	563.1	578.2	585.6	587.4	0.4	0.3	0.1	0.0					
Average household size (persons)	2.8	2.6	2.4	2.3	2.2	-0.7	-0.8	-0.6	-0.5					
Number of households (Million)	193.6	217.3	241.2	259.4	273.1	1.2	1.0	0.7	0.5					
Gross Domestic product (in 000 MEuro'00)	**7886.4**	**9631.1**	**12334.4**	**15748.3**	**19799.3**	**2.0**	**2.5**	**2.5**	**2.3**					
Households expenditure (in 000 MEuro'00)	**4689.1**	**5689.3**	**7261.4**	**9258.7**	**11576.3**	**2.0**	**2.5**	**2.5**	**2.3**					
Gross Value Added (in 000 MEuro'00)	**7365.3**	**8989.0**	**11630.1**	**14941.0**	**18853.0**	**2.0**	**2.6**	**2.5**	**2.4**					
Industry	1600.3	1855.4	2372.9	3054.7	3841.2	1.5	2.5	2.6	2.3	21.7	20.6	20.4	20.4	20.4
iron and steel	61.9	56.6	58.5	60.7	62.0	-0.9	0.3	0.4	0.2	0.8	0.6	0.5	0.4	0.3
non ferrous metals	23.2	27.2	37.2	47.9	59.4	1.6	3.2	2.6	2.2	0.3	0.3	0.3	0.3	0.3
chemicals	170.9	215.1	283.7	370.8	467.2	2.3	2.8	2.7	2.3	2.3	2.4	2.4	2.5	2.5
petrochemicals, fertilisers and others	109.5	124.7	149.8	176.2	200.8	1.3	1.8	1.6	1.3	1.5	1.4	1.3	1.2	1.1
pharmaceuticals and cosmetics	61.4	90.3	134.0	194.7	266.4	3.9	4.0	3.8	3.2	0.8	1.0	1.2	1.3	1.4
non metallic minerals	76.0	82.4	99.6	123.7	148.4	0.8	1.9	2.2	1.8	1.0	0.9	0.9	0.8	0.8
paper, pulp, printing	129.3	161.5	205.4	259.8	315.8	2.2	2.4	2.4	2.0	1.8	1.8	1.8	1.7	1.7
paper and pulp production	25.4	30.7	36.7	43.8	50.3	1.9	1.8	1.8	1.4	0.3	0.3	0.3	0.3	0.3
printing and publishing	103.9	130.8	168.7	216.0	265.5	2.3	2.6	2.5	2.1	1.4	1.5	1.5	1.4	1.4
food, drink, tobacco	182.3	226.3	289.4	368.0	453.8	2.2	2.5	2.4	2.1	2.5	2.5	2.5	2.5	2.4
textiles and leather	114.7	96.2	99.2	106.4	112.9	-1.7	0.3	0.7	0.6	1.6	1.1	0.9	0.7	0.6
engineering	687.2	811.0	1072.5	1427.7	1864.1	1.7	2.8	2.9	2.7	9.3	9.0	9.2	9.6	9.9
other industries	155.0	179.2	227.3	289.7	357.6	1.5	2.4	2.5	2.1	2.1	2.0	2.0	1.9	1.9
Construction	457.9	467.4	564.0	697.6	844.8	0.2	1.9	2.1	1.9	6.2	5.2	4.8	4.7	4.5
Services	4804.9	6092.3	8042.9	10420.6	13264.3	2.4	2.8	2.6	2.4	65.2	67.8	69.2	69.7	70.4
market services	1726.5	2298.4	3185.7	4255.6	5557.6	2.9	3.3	2.9	2.7	23.4	25.6	27.4	28.5	29.5
non-market services	1540.3	1800.1	2149.7	2584.2	3073.3	1.6	1.8	1.9	1.7	20.9	20.0	18.5	17.3	16.3
trade	1538.1	1993.7	2707.5	3580.8	4633.4	2.6	3.1	2.8	2.6	20.9	22.2	23.3	24.0	24.6
Agriculture	243.9	262.8	293.7	343.7	404.2	0.7	1.1	1.6	1.6	3.3	2.9	2.5	2.3	2.1
Energy sector	258.2	311.1	356.6	424.5	498.5	1.9	1.4	1.8	1.6	3.5	3.5	3.1	2.8	2.6

Source: PRIMES

APPENDIX 1A DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS FOR THE BASELINE SCENARIO

APPENDIX 1B

Summary energy balances and indicators by group of countries
(EU-25, EU-15, new Member states (NMS) and Europe-30)

EU - 25: BASELINE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Primary Production	**876.8**	**896.9**	**897.3**	**892.5**	**860.3**	**799.8**	**740.9**	**687.9**	**660.9**	**0.2**	**-0.4**	**-1.5**	**-1.1**
Solids	350.8	264.7	203.4	174.8	153.8	133.0	126.4	113.6	102.5	-5.3	-2.8	-1.9	-2.1
Oil	120.3	162.2	163.5	148.6	131.7	112.1	102.1	93.8	86.5	3.1	-2.1	-2.5	-1.6
Natural gas	139.6	174.0	196.6	203.8	196.9	173.2	147.6	126.6	117.1	3.5	0.0	-2.8	-2.3
Nuclear	196.9	215.3	237.7	253.5	245.3	239.4	213.5	193.8	185.3	1.9	0.3	-1.4	-1.4
Renewable energy sources	69.2	80.7	96.1	111.8	132.7	142.0	151.3	160.1	169.5	3.3	3.3	1.3	1.1
Hydro	23.4	26.3	29.0	28.9	30.1	31.0	31.7	32.1	32.2	2.2	0.4	0.5	0.2
Biomass	31.1	35.4	42.2	49.4	57.5	60.7	64.9	69.5	73.7	3.1	3.1	1.2	1.3
Waste	12.3	15.9	19.3	23.4	25.7	27.0	27.7	26.9	27.2	4.6	2.9	0.8	-0.2
Wind	0.1	0.4	1.9	5.3	13.9	17.2	20.1	23.9	26.8	40.0	21.8	3.7	2.9
Solar and others	0.1	0.3	0.4	1.0	1.7	2.3	3.0	3.6	5.3	10.6	16.0	5.8	6.0
Geothermal	2.2	2.5	3.3	3.7	3.8	3.8	4.0	4.1	4.2	4.2	1.2	0.5	0.7
Net Imports	**711.6**	**701.7**	**799.3**	**878.9**	**974.5**	**1089.9**	**1204.5**	**1284.4**	**1361.8**	**1.2**	**2.0**	**2.1**	**1.2**
Solids	75.2	73.8	91.4	87.0	89.9	94.6	126.3	154.3	197.4	2.0	-0.2	3.5	4.6
Oil	510.8	491.8	519.6	544.8	572.5	606.1	626.0	632.8	650.9	0.2	1.0	0.9	0.4
Crude oil and Feedstocks	480.2	471.5	496.8	517.8	549.8	586.4	611.0	622.8	645.0	0.3	1.0	1.1	0.5
Oil products	30.6	20.3	22.8	27.0	22.7	19.7	14.9	10.1	6.0	-2.9	-0.1	-4.1	-8.7
Natural gas	123.5	134.8	186.2	245.1	310.0	387.2	450.2	495.0	511.1	4.2	5.2	3.8	1.3
Electricity	2.2	1.4	2.1	2.0	2.1	2.1	2.1	2.3	2.4	-0.1	-0.3	-0.2	1.4
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1724.0**	**1784.1**	**1836.1**	**1888.9**	**1912.7**	**1959.7**	**0.6**	**0.8**	**0.6**	**0.4**
Solids	430.6	346.0	303.2	261.8	243.7	227.6	252.7	267.9	299.9	-3.4	-2.2	0.4	1.7
Oil	596.2	622.2	635.6	646.0	653.5	664.6	671.6	666.9	674.4	0.6	0.3	0.3	0.0
Natural gas	259.2	307.1	376.0	449.0	506.9	560.4	597.8	621.6	628.2	3.8	3.0	1.7	0.5
Nuclear	196.9	215.3	237.7	253.5	245.3	239.4	213.5	193.8	185.3	1.9	0.3	-1.4	-1.4
Electricity	2.2	1.4	2.1	2.0	2.1	2.1	2.1	2.3	2.4	-0.1	-0.3	-0.2	1.4
Renewable energy forms	69.2	80.7	96.1	111.8	132.7	142.0	151.3	160.1	169.5	3.3	3.3	1.3	1.1
as % in Gross Inland Consumption													
Solids	27.7	22.0	18.4	15.2	13.7	12.4	13.4	14.0	15.3				
Oil	38.4	39.6	38.5	37.5	36.6	36.2	35.6	34.9	34.4				
Natural gas	16.7	19.5	22.8	26.0	28.4	30.5	31.6	32.5	32.1				
Nuclear	12.7	13.7	14.4	14.7	13.7	13.0	11.3	10.1	9.5				
Renewable energy forms	4.5	5.1	5.8	6.5	7.4	7.7	8.0	8.4	8.6				
Electricity Generation in TWhe	**2455.6**	**2608.7**	**2897.9**	**3134.7**	**3419.1**	**3689.7**	**3948.7**	**4172.9**	**4397.2**	**1.7**	**1.7**	**1.5**	**1.1**
Nuclear	780.0	864.4	921.2	983.6	952.5	930.9	833.5	781.4	766.5	1.7	0.3	-1.3	-0.8
Hydro & wind	272.7	309.7	359.5	398.4	512.6	561.5	602.4	654.8	705.5	2.8	3.6	1.6	1.6
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1752.7	1954.0	2197.3	2512.7	2736.7	2925.1	1.4	1.9	2.5	1.5
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**395.6**	**413.3**	**438.4**	**482.9**	**512.2**	**540.9**	**0.5**	**0.7**	**1.6**	**1.1**
Solids	248.2	221.1	210.1	186.9	175.2	164.9	192.3	210.0	244.2	-1.7	-1.8	0.9	2.4
Oil (including refinery gas)	53.7	53.9	41.5	30.6	23.8	20.0	13.5	10.4	9.5	-2.5	-5.4	-5.5	-3.5
Gas	50.4	70.0	112.6	151.9	185.1	222.7	245.7	260.3	255.2	8.4	5.1	2.9	0.4
Biomass - Waste	10.3	13.6	17.5	22.8	25.8	27.2	27.7	27.7	28.1	5.5	4.0	0.7	0.2
Geothermal heat	1.9	2.1	3.0	3.3	3.4	3.5	3.6	3.8	3.9	4.7	1.4	0.7	0.8
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**789.4**	**807.1**	**821.4**	**843.1**	**851.8**	**871.7**	**-0.1**	**0.2**	**0.4**	**0.3**
Refineries	641.3	675.9	710.9	716.7	733.3	750.7	767.0	771.9	788.5	1.0	0.3	0.5	0.3
District heating	31.7	23.1	14.5	11.4	10.8	9.3	8.9	8.9	8.8	-7.6	-2.9	-1.9	-0.1
Biofuels and hydrogen production	0.0	0.2	0.6	4.6	10.2	12.2	18.1	23.0	27.5		32.2	5.9	4.2
Others	127.6	81.2	68.3	56.7	52.8	49.1	49.1	47.9	47.0	-6.1	-2.5	-0.7	-0.4
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**77.1**	**77.1**	**77.0**	**77.2**	**76.7**	**77.2**	**0.8**	**-0.7**	**0.0**	**0.0**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**108.7**	**114.3**	**118.9**	**121.4**	**123.3**	**124.9**	**1.2**	**0.8**	**0.6**	**0.3**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1140.3**	**1209.0**	**1262.8**	**1317.9**	**1356.3**	**1394.1**	**0.6**	**1.2**	**0.9**	**0.6**
by sector													
Industry (1)	327.2	303.3	309.1	318.9	338.9	355.0	367.4	377.4	388.5	-0.6	0.9	0.8	0.6
energy intensive industries	212.9	198.9	202.0	207.7	216.3	222.3	226.3	227.7	229.0	-0.5	0.7	0.5	0.1
other industrial sectors	114.3	104.4	107.0	111.2	122.5	132.7	141.1	149.6	159.5	-0.7	1.4	1.4	1.2
Residential	268.1	277.2	279.1	293.5	308.6	320.4	329.1	333.8	338.8	0.4	1.0	0.6	0.3
Tertiary	140.2	147.5	154.2	163.2	174.3	183.6	194.3	205.4	218.1	1.0	1.2	1.1	1.2
Transport	273.7	295.6	332.0	364.7	387.2	403.8	427.0	439.7	448.7	1.9	1.5	1.0	0.5
by fuel (1)													
Solids	117.7	80.8	57.4	46.3	42.3	38.5	36.2	34.1	32.1	-6.9	-3.0	-1.5	-1.2
Oil	424.2	443.7	464.2	483.3	503.4	518.1	537.6	547.4	554.7	0.9	0.8	0.7	0.3
Gas	196.2	219.5	245.7	280.0	299.9	313.7	324.9	332.6	343.4	2.3	2.0	0.8	0.6
Electricity	176.5	187.9	211.3	229.2	253.4	275.9	297.1	315.8	334.3	1.8	1.8	1.6	1.2
Heat (from CHP and District Heating)	62.9	56.7	55.6	58.4	65.0	69.8	75.7	80.3	83.6	-1.2	1.6	1.5	1.0
Other	32.1	35.3	40.3	43.2	44.9	46.7	46.4	46.2	45.9	2.3	1.1	0.3	-0.1
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.6**	**3664.9**	**3680.9**	**3757.2**	**3840.7**	**4040.6**	**4158.1**	**4303.6**	**-0.3**	**0.2**	**0.7**	**0.6**
Electricity and Steam production	1341.0	1242.7	1228.3	1234.3	1235.3	1264.0	1403.0	1495.0	1613.1	-0.9	0.1	1.3	1.4
Energy Branch	144.2	163.9	164.0	147.7	145.8	144.2	143.0	140.1	139.0	1.3	-1.2	-0.2	-0.3
Industry	713.2	644.8	605.7	543.9	544.4	546.6	545.8	545.7	551.9	-1.6	-1.1	0.0	0.1
Residential	519.7	490.4	462.6	463.4	481.7	491.2	495.2	490.2	487.2	-1.2	0.4	0.3	-0.2
Tertiary	256.8	251.0	236.7	236.1	239.5	238.6	240.9	247.0	254.8	-0.8	0.1	0.1	0.6
Transport	794.6	858.8	967.5	1055.6	1110.5	1156.1	1212.7	1240.0	1257.6	2.0	1.4	0.9	0.4
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**97.7**	**99.7**	**101.9**	**107.2**	**110.3**	**114.2**				

See explanations on the last page of the Appendix

Source: PRIMES

EU - 25:BASELINE SCENARIO										SUMMARY ENERGY BALANCE AND INDICATORS (B)			
	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Main Energy System Indicators													
Population (Million)	441.1	448.6	453.4	458.7	461.2	462.3	462.1	461.0	458.2	0.3	0.2	0.0	-0.1
GDP (in 000 MEuro'00)	7315	7817	8939	10080	11433	12887	14462	16169	18020	2.0	2.5	2.4	2.2
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	171.0	156.1	142.5	130.6	118.3	108.8	-1.4	-1.7	-1.8	-1.8
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.8	3.9	4.0	4.1	4.1	4.3	0.3	0.6	0.6	0.5
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	6834	7413	7981	8545	9052	9597	1.4	1.5	1.4	1.2
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.14	2.11	2.09	2.14	2.17	2.20	-0.9	-0.5	0.2	0.3
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	8.0	8.1	8.3	8.7	9.0	9.4	-0.6	0.1	0.7	0.7
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	365.2	328.6	298.0	279.4	257.2	238.8	-2.3	-2.2	-1.6	-1.6
Import Dependency %	44.8	43.6	47.2	49.6	53.1	57.7	61.9	65.1	67.3				
Energy intensity indicators (1990=100)													
Industry (Energy on Value added)	100.0	91.1	82.7	76.4	71.0	65.7	60.5	55.5	51.3	-1.9	-1.5	-1.6	-1.6
Residential (Energy on Private Income)	100.0	98.1	85.8	80.2	74.4	68.7	63.1	57.5	52.7	-1.5	-1.4	-1.6	-1.8
Tertiary (Energy on Value added)	100.0	96.7	86.8	80.2	74.9	69.6	65.3	61.4	58.2	-1.4	-1.5	-1.4	-1.1
Transport (Energy on GDP)	100.0	101.1	99.3	96.7	90.5	83.7	78.9	72.7	66.5	-0.1	-0.9	-1.4	-1.7
Carbon Intensity indicators													
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.32	0.29	0.28	0.29	0.29	0.30	-1.8	-2.3	-0.2	0.4
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	2.02	1.97	1.93	1.89	1.86	1.83	-0.7	-0.7	-0.4	-0.3
Industry	2.18	2.13	1.96	1.71	1.61	1.54	1.49	1.45	1.42	-1.1	-2.0	-0.8	-0.4
Residential	1.94	1.77	1.66	1.58	1.56	1.53	1.50	1.47	1.44	-1.6	-0.6	-0.4	-0.5
Tertiary	1.83	1.70	1.54	1.45	1.37	1.30	1.24	1.20	1.17	-1.7	-1.1	-1.0	-0.6
Transport	2.90	2.91	2.91	2.89	2.87	2.86	2.84	2.82	2.80	0.0	-0.2	-0.1	-0.1
Electricity and steam generation													
Generation Capacity in GW_e		**617.4**	**656.2**	**716.0**	**783.9**	**862.8**	**946.7**	**1034.3**	**1118.2**		**1.8**	**1.9**	**1.7**
Nuclear		134.7	140.3	138.9	129.8	123.7	108.0	106.6	107.8		-0.8	-1.8	0.0
Hydro (pumping excluded)		93.3	96.2	101.0	104.6	107.5	109.3	111.4	112.2		0.8	0.4	0.3
Wind and solar		2.5	13.0	28.0	73.2	91.7	104.1	125.2	149.2		18.9	3.6	3.7
Thermal		386.9	406.7	448.1	476.3	539.9	625.3	691.1	749.0		1.6	2.8	1.8
of which cogeneration units		*87.3*	*103.4*	*115.2*	*129.7*	*149.8*	*168.1*	*184.2*	*198.7*		*2.3*	*2.6*	*1.7*
Open cycle(incl. biomass-waste)		343.8	335.6	324.0	270.6	210.3	175.3	151.9	147.4		-2.1	-4.2	-1.7
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.0	1.0	13.1	66.6	104.5	149.9			52.7	8.4
Gas Turbines Combined Cycle		20.4	47.4	95.9	169.6	263.9	318.8	365.8	384.6		13.6	6.5	1.9
Small Gas Turbines		22.0	22.8	27.0	33.9	51.3	63.3	67.5	65.8		4.1	6.4	0.4
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Geothermal heat		0.7	1.0	1.2	1.2	1.2	1.3	1.3	1.4		1.6	0.7	0.8
Indicators													
Efficiency for thermal electricity production (%)		35.8	37.1	39.9	42.6	45.2	46.8	48.1	48.7				
Load factor for gross electric capacities (%)		48.2	50.4	50.0	49.8	48.8	47.6	46.1	44.9				
CHP indicator (% of electricity from CHP)		11.5	12.6	13.8	14.4	14.7	15.5	16.0	16.3				
Non fossil fuels in electricity generation (%)		46.8	46.4	46.6	45.5	43.0	38.7	36.6	35.6				
nuclear		33.1	31.8	31.4	27.9	25.2	21.1	18.7	17.4				
renewable energy forms		13.7	14.6	15.2	17.6	17.7	17.6	17.9	18.2				
of which waste		*0.9*	*1.1*	*1.3*	*1.3*	*1.3*	*1.2*	*1.0*	*1.0*				
Transport sector													
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**5944.2**	**6432.8**	**6963.4**	**7509.1**	**8031.4**	**8538.9**	1.7	1.5	1.6	1.3
public road transport	484.5	469.2	493.8	498.5	503.9	518.1	533.0	545.7	555.6	0.2	0.2	0.6	0.4
private cars and motorcycles	3593.6	3950.3	4291.6	4647.4	5025.6	5410.7	5788.4	6143.3	6474.5	1.8	1.6	1.4	1.1
rail transport	408.3	371.7	402.3	400.1	414.9	445.2	479.3	508.8	537.6	-0.1	0.3	1.5	1.2
aviation	168.5	215.5	298.3	360.8	448.1	546.1	661.6	783.2	917.0	5.9	4.2	4.0	3.3
inland navigation	28.9	31.9	33.6	37.3	40.4	43.3	46.8	50.4	54.1	1.5	1.8	1.5	1.5
travel per person (km per capita)	10618	11233	12174	12959	13947	15062	16249	17423	18637	1.4	1.4	1.5	1.4
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2397.9**	**2689.8**	**3003.5**	**3339.0**	**3684.5**	**4042.8**	2.0	2.3	2.2	1.9
trucks	1064.3	1233.6	1482.7	1711.4	1966.6	2232.5	2516.9	2818.8	3132.6	3.4	2.9	2.5	2.2
rail transport	440.2	358.0	368.0	367.3	378.3	397.3	419.9	435.5	453.2	-1.8	0.3	1.0	0.8
inland navigation	258.1	268.2	297.0	319.3	344.9	373.7	402.2	430.2	457.1	1.4	1.5	1.6	1.3
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	238	235	233	231	228	224	0.0	-0.2	-0.2	-0.3
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**364.7**	**387.2**	**403.8**	**427.0**	**439.7**	**448.7**	1.9	1.5	1.0	0.5
public road transport	7.7	6.9	7.0	7.1	7.1	7.1	7.0	6.7	6.4	-1.0	0.2	-0.3	-0.9
private cars and motorcycles	138.1	146.1	157.1	169.4	169.0	164.3	168.6	166.8	161.6	1.3	0.7	0.0	-0.4
trucks	82.9	93.2	108.5	125.1	143.8	161.1	174.5	186.8	195.5	2.7	2.9	2.0	1.1
rail transport	8.8	8.9	9.0	8.7	8.0	7.1	6.6	6.3	6.2	0.1	-1.1	-2.0	-0.5
aviation	29.1	33.8	45.1	48.5	53.0	57.4	63.3	65.7	71.2	4.5	1.6	1.8	1.2
inland navigation	7.0	6.7	5.4	5.8	6.3	6.7	7.1	7.4	7.8	-2.6	1.6	1.2	0.9
Efficiency indicator (activity related)													
passenger transport (toe/Mpkm)	39.0	38.6	39.2	39.1	36.6	33.7	32.6	30.5	28.7	0.1	-0.7	-1.2	-1.3
freight transport (toe/Mtkm)	51.7	54.4	53.8	55.3	56.3	56.3	54.7	52.9	50.5	0.4	0.5	-0.3	-0.8

Source: PRIMES

EU - 15: BASELINE SCENARIO — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Primary Production	**708.1**	**739.5**	**761.3**	**768.4**	**743.0**	**689.2**	**635.5**	**589.5**	**572.9**	**0.7**	**-0.2**	**-1.6**	**-1.0**
Solids	209.9	138.0	99.4	85.5	70.3	57.0	56.1	47.4	43.0	-7.2	-3.4	-2.2	-2.6
Oil	117.7	159.2	160.4	146.0	129.2	109.6	99.6	91.4	84.2	3.2	-2.1	-2.6	-1.7
Natural gas	132.9	166.6	190.6	197.9	191.0	167.5	142.1	121.4	112.2	3.7	0.0	-2.9	-2.3
Nuclear	181.4	201.2	222.8	236.7	230.3	224.5	198.7	183.1	180.0	2.1	0.3	-1.5	-1.0
Renewable energy sources	66.3	74.4	88.1	102.3	122.2	130.5	138.9	146.2	153.6	2.9	3.3	1.3	1.0
Hydro	22.3	24.9	27.6	27.0	28.1	28.9	29.5	29.9	30.1	2.2	0.2	0.5	0.2
Biomass	29.7	30.8	36.1	43.0	51.2	54.2	58.6	62.5	65.7	2.0	3.6	1.4	1.2
Waste	11.9	15.6	18.7	22.5	24.3	25.6	26.2	25.3	25.4	4.7	2.6	0.8	-0.3
Wind	0.1	0.4	1.9	5.1	13.3	16.0	18.2	21.4	23.6	40.0	21.3	3.2	2.6
Solar and others	0.1	0.2	0.3	0.9	1.4	2.0	2.4	2.9	4.5	9.5	15.1	5.6	6.3
Geothermal	2.2	2.5	3.3	3.7	3.8	3.8	4.0	4.1	4.2	4.2	1.2	0.5	0.7
Net Imports	**645.4**	**651.3**	**737.9**	**803.3**	**882.3**	**978.6**	**1077.0**	**1143.7**	**1208.2**	**1.3**	**1.8**	**2.0**	**1.2**
Solids	89.9	94.4	107.2	97.5	97.1	96.6	123.4	144.9	179.5	1.8	-1.0	2.4	3.8
Oil	460.9	446.7	472.4	493.4	516.9	546.2	562.7	566.3	582.2	0.2	0.9	0.9	0.3
Crude oil and Feedstocks	436.8	434.7	455.5	475.1	503.6	536.5	558.0	566.5	586.7	0.4	1.0	1.0	0.5
Oil products	24.1	12.0	16.9	18.3	13.3	9.7	4.8	-0.2	-4.5	-3.5	-2.3	-9.8	
Natural gas	92.3	108.6	154.7	209.0	265.0	332.5	387.5	429.3	443.4	5.3	5.5	3.9	1.4
Electricity	2.3	1.5	3.7	3.4	3.3	3.3	3.3	3.2	3.2	4.6	-1.0	-0.1	-0.2
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1525.5**	**1575.7**	**1615.4**	**1657.2**	**1674.7**	**1719.5**	**1.0**	**0.8**	**0.5**	**0.4**
Solids	302.8	237.7	212.4	183.1	167.4	153.7	179.5	192.2	222.5	-3.5	-2.4	0.7	2.2
Oil	545.8	575.6	586.9	593.1	596.5	603.4	607.1	599.3	604.7	0.7	0.2	0.2	0.0
Natural gas	222.1	273.4	338.7	406.9	456.0	500.0	529.6	550.7	555.6	4.3	3.0	1.5	0.5
Nuclear	181.4	201.2	222.8	236.7	230.3	224.5	198.7	183.1	180.0	2.1	0.3	-1.5	-1.0
Electricity	2.3	1.5	3.7	3.4	3.3	3.3	3.3	3.2	3.2	4.6	-1.0	-0.1	-0.2
Renewable energy forms	66.3	74.4	88.1	102.3	122.2	130.5	138.9	146.2	153.6	2.9	3.3	1.3	1.0
as % in Gross Inland Consumption													
Solids	22.9	17.4	14.6	12.0	10.6	9.5	10.8	11.5	12.9				
Oil	41.3	42.2	40.4	38.9	37.9	37.4	36.6	35.8	35.2				
Natural gas	16.8	20.0	23.3	26.7	28.9	31.0	32.0	32.9	32.3				
Nuclear	13.7	14.8	15.3	15.5	14.6	13.9	12.0	10.9	10.5				
Renewable energy forms	5.0	5.5	6.1	6.7	7.8	8.1	8.4	8.7	8.9				
Electricity Generation in TWhe	**2139.1**	**2308.3**	**2574.1**	**2783.6**	**3027.1**	**3240.7**	**3450.5**	**3646.3**	**3846.1**	**1.9**	**1.6**	**1.3**	**1.1**
Nuclear	720.1	810.1	863.7	918.3	894.0	872.7	775.4	739.4	745.1	1.8	0.3	-1.4	-0.4
Hydro & wind	259.8	294.2	343.8	374.0	482.5	523.4	555.9	600.7	642.6	2.8	3.4	1.4	1.5
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1491.2	1650.7	1844.6	2119.2	2306.2	2458.4	1.7	1.9	2.5	1.5
Fuel Inputs for Thermal Power Generation [(1)]	**291.8**	**295.1**	**318.3**	**326.5**	**337.8**	**357.1**	**397.0**	**420.3**	**444.8**	**0.9**	**0.6**	**1.6**	**1.1**
Solids	186.1	163.9	153.6	131.5	117.7	107.5	133.8	147.8	179.2	-1.9	-2.6	1.3	3.0
Oil (including refinery gas)	48.7	49.6	38.3	27.1	20.3	16.8	11.1	7.8	6.8	-2.4	-6.1	-5.8	-4.9
Gas	45.1	66.0	106.3	142.9	172.4	204.1	222.8	235.8	229.6	9.0	5.0	2.6	0.3
Biomass - Waste	10.0	13.5	17.1	21.6	24.0	25.3	25.6	25.2	25.3	5.5	3.4	0.7	-0.1
Geothermal heat	1.9	2.1	3.0	3.3	3.4	3.5	3.6	3.8	3.9	4.7	1.4	0.7	0.8
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**723.6**	**741.1**	**752.9**	**771.8**	**777.1**	**793.9**	**0.3**	**0.2**	**0.4**	**0.3**
Refineries	594.6	635.8	665.7	670.6	683.6	697.1	709.9	711.3	725.3	1.1	0.3	0.4	0.2
District heating	12.4	11.0	6.0	5.4	6.2	5.1	5.2	5.8	6.0	-7.1	0.4	-1.7	1.3
Biofuels and hydrogen production	0.0	0.2	0.6	4.6	10.1	12.1	17.7	22.1	25.8		32.1	5.8	3.8
Others	97.1	58.1	50.6	43.0	41.2	38.6	38.9	37.9	36.9	-6.3	-2.0	-0.6	-0.5
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**67.6**	**67.4**	**67.2**	**67.3**	**67.1**	**67.9**	**1.0**	**-0.3**	**0.0**	**0.1**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**98.4**	**103.3**	**106.8**	**108.5**	**109.6**	**110.5**	**1.2**	**0.8**	**0.5**	**0.2**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1016.8**	**1076.6**	**1119.9**	**1164.8**	**1196.7**	**1229.0**	**1.1**	**1.2**	**0.8**	**0.5**
by sector													
Industry [(1)]	262.2	255.6	268.7	280.2	299.4	314.3	325.3	334.3	344.6	0.2	1.1	0.8	0.6
energy intensive industries	180.4	170.9	175.8	182.3	190.7	196.3	199.7	201.0	202.1	-0.3	0.8	0.5	0.1
other industrial sectors	81.9	84.7	92.9	97.9	108.7	118.0	125.6	133.3	142.5	1.3	1.6	1.5	1.3
Residential	228.1	236.0	244.7	258.4	270.9	279.1	284.4	287.2	291.0	0.7	1.0	0.5	0.2
Tertiary	115.3	127.9	132.7	139.8	149.2	156.7	165.7	175.4	186.6	1.4	1.2	1.1	1.2
Transport	253.8	275.7	309.1	338.4	357.2	369.8	389.4	399.8	406.7	2.0	1.5	0.9	0.4
by fuel [(1)]													
Solids	76.8	47.0	36.0	30.4	28.4	26.2	25.2	24.2	23.1	-7.3	-2.3	-1.2	-0.9
Oil	391.5	414.1	430.6	445.8	462.2	473.1	489.0	496.5	501.9	1.0	0.7	0.6	0.3
Gas	169.7	194.9	220.3	250.9	266.6	277.3	285.0	291.1	300.8	2.6	1.9	0.7	0.5
Electricity	156.0	169.4	191.6	207.4	228.3	246.4	263.8	279.9	296.3	2.1	1.8	1.5	1.2
Heat (from CHP and District Heating)	35.2	39.3	42.1	44.9	51.9	55.9	60.7	64.5	66.6	1.8	2.1	1.6	0.9
Other	30.3	30.6	34.5	37.4	39.3	41.0	41.0	40.7	40.3	1.3	1.3	0.4	-0.2
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.7**	**3117.5**	**3150.9**	**3204.9**	**3266.0**	**3444.0**	**3538.1**	**3668.6**	**0.1**	**0.3**	**0.7**	**0.6**
Electricity and Steam production	997.6	947.7	948.3	960.6	951.9	970.2	1100.0	1174.5	1280.5	-0.5	0.0	1.5	1.5
Energy Branch	129.8	144.4	145.4	137.4	135.2	133.1	131.6	128.6	127.6	1.1	-0.7	-0.3	-0.3
Industry	576.2	526.5	509.3	457.1	458.4	461.3	460.0	459.4	466.4	-1.2	-1.0	0.0	0.1
Residential	436.4	417.4	412.9	416.9	432.4	439.4	440.6	435.9	434.2	-0.6	0.5	0.2	-0.1
Tertiary	203.5	212.7	199.6	198.3	202.6	203.1	206.4	212.5	219.8	-0.2	0.2	0.2	0.6
Transport	738.5	802.9	902.2	980.5	1024.5	1058.8	1105.3	1127.1	1140.2	2.0	1.3	0.8	0.3
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**102.2**	**104.0**	**106.0**	**111.7**	**114.8**	**119.0**				

See explanations on the last page of the Appendix

Source: PRIMES

EU - 15:BASELINE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (B)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Main Energy System Indicators													
Population (Million)	366.0	373.4	378.7	384.6	387.8	389.6	390.4	390.3	389.0	0.3	0.2	0.1	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	9612	10859	12194	13641	15212	16920	2.0	2.4	2.3	2.2
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	158.7	145.1	132.5	121.5	110.1	101.6	-1.1	-1.6	-1.8	-1.8
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	4.0	4.1	4.1	4.2	4.3	4.4	0.6	0.6	0.4	0.4
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7238	7805	8317	8837	9342	9887	1.5	1.4	1.2	1.1
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	2.07	2.03	2.02	2.08	2.11	2.13	-0.8	-0.5	0.2	0.3
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	8.2	8.3	8.4	8.8	9.1	9.4	-0.2	0.0	0.7	0.7
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	327.8	295.1	267.8	252.5	232.6	216.8	-1.9	-2.1	-1.5	-1.5
Import Dependency %	47.6	46.6	49.4	51.1	54.3	58.7	62.9	66.0	67.8				
Energy intensity indicators (1990=100)													
Industry (Energy on Value added)	100.0	95.0	89.6	84.2	78.9	73.5	67.8	62.4	57.7	-1.1	-1.3	-1.5	-1.6
Residential (Energy on Private Income)	100.0	97.6	88.2	83.0	77.3	71.2	65.2	59.5	54.6	-1.2	-1.3	-1.7	-1.8
Tertiary (Energy on Value added)	100.0	101.8	90.9	83.7	78.4	72.9	68.5	64.7	61.7	-1.0	-1.5	-1.3	-1.0
Transport (Energy on GDP)	100.0	101.2	99.5	96.8	90.5	83.4	78.5	72.3	66.1	-0.1	-0.9	-1.4	-1.7
Carbon Intensity indicators													
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.29	0.26	0.25	0.26	0.27	0.28	-2.3	-2.5	0.1	0.5
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	2.02	1.97	1.93	1.90	1.87	1.84	-0.7	-0.7	-0.3	-0.3
Industry	2.20	2.06	1.90	1.63	1.53	1.47	1.41	1.37	1.35	-1.5	-2.1	-0.8	-0.4
Residential	1.91	1.77	1.69	1.61	1.60	1.57	1.55	1.52	1.49	-1.3	-0.6	-0.3	-0.4
Tertiary	1.76	1.66	1.50	1.42	1.36	1.30	1.25	1.21	1.18	-1.6	-1.0	-0.9	-0.6
Transport	2.91	2.91	2.92	2.90	2.87	2.86	2.84	2.82	2.80	0.0	-0.2	-0.1	-0.1
Electricity and steam generation													
Generation Capacity in GW_e		**538.8**	**578.6**	**631.9**	**688.7**	**750.3**	**812.6**	**882.8**	**951.0**		**1.8**	**1.7**	**1.6**
Nuclear		126.2	131.0	128.8	121.9	115.8	100.1	101.1	105.0		-0.7	-1.9	0.5
Hydro (pumping excluded)		87.1	89.8	93.9	97.0	99.5	101.0	103.0	103.7		0.8	0.4	0.3
Wind and solar		2.5	12.9	27.0	70.4	86.2	95.4	113.7	134.2		18.5	3.1	3.5
Thermal		322.9	344.8	382.2	399.5	448.9	516.1	565.0	608.1		1.5	2.6	1.7
of which cogeneration units		*59.3*	*77.1*	*89.8*	*102.3*	*118.1*	*129.9*	*138.3*	*146.4*		*2.9*	*2.4*	*1.2*
Open cycle(incl. biomass-waste)		281.8	276.9	266.6	214.7	162.1	135.8	114.4	113.3		-2.5	-4.5	-1.8
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.0	0.5	7.1	51.6	83.3	119.0			60.5	8.7
Gas Turbines Combined Cycle		20.0	46.0	91.1	157.3	238.3	279.3	313.9	323.0		13.1	5.9	1.5
Small Gas Turbines		20.3	21.0	23.3	25.9	40.2	48.2	52.0	51.4		2.1	6.4	0.6
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Geothermal heat		0.7	1.0	1.2	1.2	1.2	1.3	1.3	1.4		1.6	0.7	0.8
Indicators													
Efficiency for thermal electricity production (%)		36.6	37.8	41.0	43.9	46.5	48.0	49.3	49.7				
Load factor for gross electric capacities (%)		48.9	50.8	50.3	50.2	49.3	48.5	47.1	46.2				
CHP indicator (% of electricity from CHP)		9.2	10.3	11.9	12.6	13.0	13.8	14.0	14.1				
Non fossil fuels in electricity generation (%)		49.9	49.3	49.1	48.2	45.7	41.1	39.0	38.3				
nuclear		35.1	33.6	33.0	29.5	26.9	22.5	20.3	19.4				
renewable energy forms		14.8	15.8	16.2	18.7	18.8	18.6	18.8	18.9				
of which waste		*1.0*	*1.2*	*1.4*	*1.4*	*1.4*	*1.3*	*1.1*	*1.1*				
Transport sector													
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5400.4**	**5817.1**	**6256.3**	**6700.4**	**7124.8**	**7540.2**	1.8	1.5	1.4	1.2
public road transport	368.8	382.2	412.6	417.7	422.7	435.6	448.4	458.4	465.2	1.1	0.2	0.6	0.4
private cars and motorcycles	3325.6	3634.5	3938.8	4252.1	4566.3	4873.5	5167.2	5444.5	5704.4	1.7	1.5	1.2	1.0
rail transport	316.4	320.9	356.0	353.8	366.7	393.0	421.1	442.6	462.8	1.2	0.3	1.4	0.9
aviation	157.3	201.5	281.5	340.1	421.7	511.6	617.7	729.7	854.5	6.0	4.1	3.9	3.3
inland navigation	28.3	31.4	33.0	36.7	39.7	42.6	46.0	49.6	53.3	1.5	1.9	1.5	1.5
travel per person (km per capita)	11465	12240	13261	14043	14999	16057	17161	18254	19383	1.5	1.2	1.4	1.2
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2095.1**	**2350.4**	**2614.9**	**2896.8**	**3190.2**	**3501.5**	2.7	2.3	2.1	1.9
trucks	946.0	1114.6	1327.2	1523.3	1742.7	1962.7	2197.3	2450.4	2720.1	3.4	2.8	2.3	2.2
rail transport	234.9	220.2	249.3	253.3	263.6	279.3	298.0	310.4	325.2	0.6	0.6	1.2	0.9
inland navigation	257.1	266.9	296.1	318.5	344.0	372.9	401.4	429.3	456.2	1.4	1.5	1.6	1.3
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	218	216	214	212	210	207	0.6	-0.1	-0.2	-0.3
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**338.4**	**357.2**	**369.8**	**389.4**	**399.8**	**406.7**	2.0	1.5	0.9	0.4
public road transport	6.3	5.9	5.8	6.0	6.0	6.0	5.8	5.6	5.3	-0.8	0.3	-0.3	-0.9
private cars and motorcycles	130.2	136.6	145.5	156.4	154.2	148.1	150.9	148.2	142.2	1.1	0.6	-0.2	-0.6
trucks	76.0	86.5	101.0	115.9	132.7	147.9	159.4	170.2	177.5	2.9	2.8	1.8	1.1
rail transport	6.9	7.5	7.7	7.4	6.9	6.1	5.6	5.3	5.3	1.1	-1.1	-2.1	-0.5
aviation	27.8	32.5	43.8	46.9	51.1	55.1	60.7	63.2	68.7	4.7	1.6	1.7	1.3
inland navigation	6.7	6.7	5.3	5.8	6.3	6.7	7.1	7.4	7.8	-2.2	1.6	1.2	0.9
Efficiency indicator (activity related)													
passenger transport (toe/Mpkm)	40.7	39.8	40.2	40.0	37.4	34.3	33.2	31.2	29.4	-0.1	-0.7	-1.2	-1.2
freight transport (toe/Mtkm)	57.8	58.5	57.3	58.5	59.5	59.4	57.6	55.7	52.9	-0.1	0.4	-0.3	-0.8

Source: PRIMES

NMS: BASELINE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Primary Production	**168.7**	**157.4**	**136.0**	**124.0**	**117.3**	**110.5**	**105.4**	**98.5**	**88.0**	**-2.1**	**-1.5**	**-1.1**	**-1.8**
Solids	140.9	126.7	104.0	89.3	83.5	76.0	70.3	66.3	59.5	-3.0	-2.2	-1.7	-1.7
Oil	2.6	3.0	3.1	2.5	2.5	2.5	2.4	2.4	2.3	1.7	-2.0	-0.3	-0.6
Natural gas	6.7	7.4	6.1	6.0	5.9	5.7	5.5	5.2	4.9	-1.0	-0.3	-0.8	-1.0
Nuclear	15.5	14.1	14.8	16.7	14.9	14.9	14.8	10.7	5.3	-0.5	0.1	-0.1	-9.7
Renewable energy sources	3.0	6.3	8.0	9.5	10.5	11.5	12.4	13.9	15.9	10.4	2.7	1.7	2.5
Hydro	1.1	1.3	1.4	1.9	2.0	2.1	2.1	2.2	2.2	2.0	4.0	0.6	0.3
Biomass	1.4	4.6	6.1	6.3	6.3	6.4	6.4	7.0	7.9	15.7	0.3	0.2	2.2
Waste	0.5	0.3	0.5	0.9	1.4	1.4	1.5	1.6	1.8	1.9	9.5	0.9	1.8
Wind	0.0	0.0	0.0	0.2	0.6	1.2	1.9	2.5	3.2			12.2	5.5
Solar and others	0.0	0.0	0.0	0.2	0.3	0.4	0.5	0.7	0.8		22.3	6.8	4.8
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		-2.0	-6.8	-7.1
Net Imports	**66.3**	**50.4**	**61.4**	**75.6**	**92.2**	**111.3**	**127.6**	**140.7**	**153.6**	**-0.8**	**4.1**	**3.3**	**1.9**
Solids	-14.6	-20.7	-15.9	-10.5	-7.2	-2.1	2.9	9.4	17.9				20.1
Oil	49.9	45.0	47.3	51.4	55.6	59.8	63.2	66.5	68.8	-0.5	1.6	1.3	0.8
Crude oil and Feedstocks	43.4	36.7	41.3	42.7	46.2	49.9	53.1	56.3	58.3	-0.5	1.1	1.4	0.9
Oil products	6.5	8.3	6.0	8.7	9.4	9.9	10.2	10.3	10.5	-0.8	4.6	0.8	0.3
Natural gas	31.2	26.2	31.5	36.1	45.0	54.7	62.7	65.7	67.7	0.1	3.6	3.4	0.8
Electricity	-0.2	-0.1	-1.5	-1.4	-1.2	-1.2	-1.2	-0.9	-0.8				
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**198.5**	**208.4**	**220.7**	**231.8**	**237.9**	**240.3**	**-1.6**	**0.5**	**1.1**	**0.4**
Solids	127.8	108.2	90.8	78.8	76.3	73.9	73.2	75.7	77.4	-3.4	-1.7	-0.4	0.6
Oil	50.4	46.6	48.7	52.8	57.0	61.2	64.5	67.6	69.8	-0.3	1.6	1.2	0.8
Natural gas	37.1	33.8	37.3	42.1	50.9	60.4	68.1	70.9	72.7	0.0	3.2	3.0	0.6
Nuclear	15.5	14.1	14.8	16.7	14.9	14.9	14.8	10.7	5.3	-0.5	0.1	-0.1	-9.7
Electricity	-0.2	-0.1	-1.5	-1.4	-1.2	-1.2	-1.2	-0.9	-0.8				
Renewable energy forms	3.0	6.3	8.0	9.5	10.5	11.5	12.4	13.9	15.9	10.4	2.7	1.7	2.5
as % in Gross Inland Consumption													
Solids	54.7	51.8	45.8	39.7	36.6	33.5	31.6	31.8	32.2				
Oil	21.6	22.3	24.6	26.6	27.4	27.7	27.8	28.4	29.0				
Natural gas	15.9	16.2	18.8	21.2	24.4	27.4	29.4	29.8	30.2				
Nuclear	6.6	6.7	7.5	8.4	7.2	6.7	6.4	4.5	2.2				
Renewable energy forms	1.3	3.0	4.1	4.8	5.0	5.2	5.3	5.9	6.6				
Electricity Generation in TWhe	**316.6**	**300.5**	**323.8**	**351.1**	**392.0**	**449.0**	**498.2**	**526.6**	**551.1**	**0.2**	**1.9**	**2.4**	**1.0**
Nuclear	60.0	54.3	57.4	65.3	58.5	58.2	58.2	42.1	21.5	-0.4	0.2	-0.1	-9.5
Hydro & wind	12.9	15.5	15.7	24.3	30.2	38.1	46.5	54.1	62.9	2.0	6.7	4.4	3.1
Thermal (incl. biomass)	243.7	230.7	250.6	261.5	303.4	352.7	393.5	430.4	466.7	0.3	1.9	2.6	1.7
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**69.1**	**75.5**	**81.2**	**85.9**	**91.9**	**96.1**	**-0.9**	**1.3**	**1.3**	**1.1**
Solids	62.2	57.2	56.5	55.4	57.5	57.5	58.5	62.2	65.0	-1.0	0.2	0.2	1.0
Oil	4.9	4.4	3.2	3.5	3.4	3.2	2.4	2.7	2.7	-4.4	0.8	-3.5	1.1
Gas	5.3	4.0	6.3	9.0	12.7	18.6	22.9	24.5	25.7	1.6	7.4	6.0	1.1
Biomass - Waste	0.3	0.1	0.4	1.2	1.8	2.0	2.1	2.5	2.8	4.6	16.6	1.3	3.2
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**65.8**	**66.0**	**68.5**	**71.3**	**74.7**	**77.8**	**-3.0**	**-0.8**	**0.8**	**0.9**
Refineries	46.7	40.1	45.2	46.1	49.7	53.6	57.0	60.6	63.2	-0.3	1.0	1.4	1.0
District heating	19.3	12.1	8.5	6.0	4.5	4.2	3.6	3.2	2.8	-7.9	-6.0	-2.2	-2.6
Biofuels and hydrogen production	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.9	1.7			20.5	14.8
Others	30.5	23.1	17.7	13.7	11.6	10.5	10.2	10.0	10.1	-5.3	-4.1	-1.3	-0.1
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.6**	**9.7**	**9.9**	**9.9**	**9.6**	**9.3**	**0.0**	**-2.8**	**0.2**	**-0.6**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**10.3**	**11.0**	**12.1**	**12.9**	**13.7**	**14.3**	**0.4**	**0.5**	**1.6**	**1.0**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**123.5**	**132.3**	**142.9**	**153.1**	**159.6**	**165.1**	**-2.3**	**1.0**	**1.5**	**0.8**
by sector													
Industry	65.0	47.7	40.4	38.7	39.5	40.7	42.1	43.1	43.9	-4.6	-0.2	0.7	0.4
energy intensive industries	32.5	27.9	26.2	25.4	25.6	26.0	26.5	26.8	26.9	-2.1	-0.2	0.3	0.1
other industrial sectors	32.4	19.7	14.2	13.3	13.8	14.7	15.6	16.3	17.0	-8.0	-0.2	1.2	0.9
Residential	40.0	41.2	34.4	35.1	37.8	41.3	44.8	46.6	47.8	-1.5	0.9	1.7	0.6
Tertiary	24.9	19.6	21.5	23.5	25.1	26.9	28.6	30.0	31.5	-1.5	1.6	1.3	1.0
Transport	19.9	19.8	22.9	26.3	30.0	34.0	37.6	39.8	42.0	1.4	2.7	2.3	1.1
by fuel													
Solids	40.9	33.8	21.4	15.9	13.9	12.3	10.9	9.9	9.0	-6.3	-4.2	-2.3	-1.9
Oil	32.7	29.6	33.6	37.5	41.3	45.0	48.6	51.0	52.9	0.3	2.1	1.6	0.9
Gas	26.5	24.6	25.4	29.1	33.3	36.4	39.9	41.5	42.6	-0.4	2.8	1.8	0.7
Electricity	20.5	18.5	19.6	21.7	25.1	29.5	33.3	35.9	38.0	-0.4	2.5	2.9	1.4
Heat (from CHP and District Heating)	27.7	17.4	13.5	13.5	13.2	14.0	15.0	15.8	17.0	-6.9	-0.3	1.3	1.3
Other	1.8	4.7	5.8	5.8	5.6	5.7	5.4	5.5	5.6	12.1	-0.2	-0.3	0.2
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**530.1**	**552.2**	**574.7**	**596.7**	**620.0**	**635.0**	**-2.3**	**0.1**	**0.8**	**0.6**
Electricity and Steam production	343.4	295.0	280.1	273.7	283.4	293.8	303.1	320.6	332.5	-2.0	0.1	0.7	0.9
Energy Branch	14.4	19.5	18.7	10.3	10.6	11.1	11.4	11.5	11.4	2.6	-5.5	0.7	0.1
Industry	137.0	118.2	96.4	86.8	86.0	85.3	85.8	86.3	85.5	-3.5	-1.1	0.0	0.0
Residential	83.2	72.9	49.7	46.6	49.3	51.8	54.5	54.3	53.0	-5.0	-0.1	1.0	-0.3
Tertiary	53.3	38.3	37.2	37.7	36.9	35.5	34.5	34.5	35.0	-3.5	-0.1	-0.7	0.1
Transport	56.1	55.9	65.3	75.1	86.0	97.3	107.4	112.9	117.4	1.5	2.8	2.2	0.9
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**77.1**	**80.3**	**83.6**	**86.8**	**90.2**	**92.4**				

See explanations on the last page of the Appendix

Source: PRIMES

NMS: BASELINE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (B)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Main Energy System Indicators													
Population (Million)	75.1	75.2	74.7	74.1	73.4	72.7	71.7	70.6	69.1	-0.1	-0.2	-0.2	-0.4
GDP (in 000 MEuro'00)	333	323	394	468	574	693	821	957	1100	1.7	3.8	3.6	3.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	424.1	363.2	318.5	282.3	248.5	218.3	-3.3	-3.2	-2.5	-2.5
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.7	2.8	3.0	3.2	3.4	3.5	-1.6	0.7	1.3	0.7
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	4738	5341	6177	6952	7454	7971	0.3	2.1	2.7	1.4
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.67	2.65	2.60	2.57	2.61	2.64	-0.6	-0.4	-0.3	0.3
CO2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.2	7.5	7.9	8.3	8.8	9.2	-2.2	0.3	1.0	1.0
CO2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	1132.3	962.3	829.5	726.8	647.7	577.0	-3.9	-3.6	-2.8	-2.3
Import Dependency %	28.3	24.1	30.8	37.9	44.0	50.2	54.8	58.8	63.6				
Energy intensity indicators (1990=100)													
Industry (Energy on Value added)	100.0	83.6	55.1	43.3	36.1	31.0	27.4	24.7	22.8	-5.8	-4.1	-2.7	-1.8
Residential (Energy on Private Income)	100.0	106.5	74.2	64.2	56.0	50.0	45.4	40.3	36.0	-2.9	-2.8	-2.1	-2.3
Tertiary (Energy on Value added)	100.0	74.8	67.2	61.0	52.5	45.7	40.4	35.7	32.0	-3.9	-2.4	-2.6	-2.3
Transport (Energy on GDP)	100.0	102.9	97.4	93.9	87.6	82.1	76.7	69.7	63.8	-0.3	-1.1	-1.3	-1.8
Carbon Intensity indicators													
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.51	0.50	0.46	0.44	0.44	0.43	0.8	-0.9	-1.3	0.0
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.99	1.95	1.89	1.84	1.80	1.76	-0.5	-0.7	-0.6	-0.4
Industry	2.11	2.48	2.38	2.24	2.18	2.09	2.04	2.00	1.95	1.2	-0.9	-0.7	-0.4
Residential	2.08	1.77	1.44	1.33	1.31	1.25	1.22	1.17	1.11	-3.6	-1.0	-0.7	-0.9
Tertiary	2.14	1.95	1.73	1.61	1.47	1.32	1.21	1.15	1.11	-2.1	-1.6	-2.0	-0.8
Transport	2.82	2.82	2.85	2.86	2.86	2.87	2.86	2.84	2.80	0.1	0.1	0.0	-0.2
Electricity and steam generation													
Generation Capacity in GW_e		**78.6**	**77.6**	**84.1**	**95.2**	**112.5**	**134.1**	**151.5**	**167.2**		**2.1**	**3.5**	**2.2**
Nuclear		8.4	9.3	10.0	7.9	7.9	7.9	5.5	2.8		-1.6	0.0	-9.7
Hydro (pumping excluded)		6.1	6.4	7.1	7.7	8.0	8.3	8.4	8.4		1.9	0.7	0.2
Wind and solar		0.0	0.0	1.0	2.8	5.6	8.7	11.5	15.0		67.5	12.0	5.5
Thermal		64.0	61.9	66.0	76.8	91.0	109.2	126.1	140.9		2.2	3.6	2.6
of which cogeneration units		*28.1*	*26.3*	*25.4*	*27.3*	*31.7*	*38.2*	*45.9*	*52.3*		*0.4*	*3.4*	*3.2*
Open cycle (incl. biomass-waste)		61.9	58.6	57.4	55.9	48.2	39.6	37.5	34.0		-0.5	-3.4	-1.5
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.0	0.5	6.1	15.0	21.1	30.9			40.1	7.5
Gas Turbines Combined Cycle		0.4	1.4	4.8	12.3	25.6	39.5	52.0	61.6		24.4	12.4	4.5
Small Gas Turbines		1.7	1.8	3.8	8.0	11.1	15.1	15.5	14.4		15.8	6.5	-0.5
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Indicators													
Efficiency for thermal electricity production (%)		32.0	34.3	34.5	36.4	39.3	41.4	42.4	44.0				
Load factor for gross electric capacities (%)		43.6	47.6	47.6	47.0	45.5	42.4	39.7	37.6				
CHP indicator (% of electricity from CHP)		29.4	30.4	29.0	28.3	27.2	27.3	30.2	31.6				
Non fossil fuels in electricity generation (%)		23.4	23.1	26.7	24.2	23.0	22.5	20.0	17.2				
nuclear		18.1	17.7	18.6	14.9	13.0	11.7	8.0	3.9				
renewable energy forms		5.3	5.4	8.1	9.3	10.0	10.8	12.0	13.3				
of which waste		*0.0*	*0.1*	*0.2*	*0.6*	*0.5*	*0.4*	*0.4*	*0.4*				
Transport sector													
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**543.8**	**615.7**	**707.1**	**808.7**	**906.5**	**998.7**	0.2	2.1	2.8	2.1
public road transport	115.7	87.0	81.2	80.8	81.2	82.5	84.6	87.3	90.5	-3.5	0.0	0.4	0.7
private cars and motorcycles	268.0	315.8	352.9	395.3	459.2	537.2	621.2	698.8	770.2	2.8	2.7	3.1	2.2
rail transport	91.9	50.8	46.3	46.3	48.2	52.3	58.2	66.2	74.8	-6.6	0.4	1.9	2.5
aviation	11.2	14.0	16.8	20.7	26.4	34.5	44.0	53.5	62.5	4.1	4.6	5.2	3.6
inland navigation	0.6	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	1.1	0.9	0.9	0.4
travel per person (km per capita)	6489	6227	6662	7337	8388	9728	11284	12833	14444	0.3	2.3	3.0	2.5
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**302.8**	**339.4**	**388.6**	**442.2**	**494.3**	**541.3**	-1.6	2.1	2.7	2.0
trucks	118.4	119.0	155.5	188.1	223.9	269.8	319.5	368.3	412.5	2.8	3.7	3.6	2.6
rail transport	205.2	137.8	118.7	113.9	114.7	118.0	121.9	125.1	128.0	-5.3	-0.3	0.6	0.5
inland navigation	1.0	1.3	0.8	0.8	0.8	0.8	0.8	0.9	0.9	-2.2	-0.2	0.3	0.6
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	647	591	561	539	516	492	-3.3	-1.6	-0.9	-0.9
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**26.3**	**30.0**	**34.0**	**37.6**	**39.8**	**42.0**	1.4	2.7	2.3	1.1
public road transport	1.4	1.0	1.2	1.2	1.1	1.1	1.1	1.1	1.1	-1.9	-0.2	-0.3	-0.5
private cars and motorcycles	7.9	9.5	11.6	13.0	14.8	16.3	17.7	18.6	19.3	3.9	2.4	1.8	0.9
trucks	7.0	6.7	7.5	9.2	11.1	13.2	15.1	16.6	18.1	0.8	3.9	3.2	1.8
rail transport	2.0	1.4	1.3	1.2	1.1	1.0	1.0	1.0	1.0	-4.0	-1.4	-1.3	-0.2
aviation	1.3	1.2	1.3	1.5	1.9	2.2	2.6	2.5	2.5	-0.4	3.8	3.4	-0.5
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-22.4	0.6	0.4	0.2
Efficiency indicator (activity related)													
passenger transport (toe/Mpkm)	24.4	26.5	29.5	30.1	29.8	28.4	27.1	25.0	23.4	1.9	0.1	-0.9	-1.5
freight transport (toe/Mtkm)	24.6	28.8	30.0	32.7	34.5	35.6	35.5	34.7	34.4	2.0	1.4	0.3	-0.3

Source: PRIMES

EUROPE-30: BASELINE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Primary Production	**1081.2**	**1155.4**	**1199.3**	**1204.9**	**1192.5**	**1127.9**	**1055.7**	**980.5**	**940.7**	**1.0**	**-0.1**	**-1.2**	**-1.1**
Solids	375.0	289.4	226.9	195.8	177.6	156.7	147.2	129.4	117.2	-4.9	-2.4	-1.9	-2.3
Oil	216.2	314.3	337.6	323.4	302.8	265.4	233.7	199.2	176.9	4.6	-1.1	-2.6	-2.7
Natural gas	186.9	215.6	254.0	274.0	287.1	274.2	256.0	243.3	238.8	3.1	1.2	-1.1	-0.7
Nuclear	206.9	226.3	250.7	265.5	256.3	251.8	226.0	203.8	191.7	1.9	0.2	-1.3	-1.6
Renewable energy sources	96.2	109.8	130.1	146.2	168.7	179.7	192.9	204.7	216.1	3.1	2.6	1.3	1.1
Hydro	40.0	44.4	48.5	48.4	51.4	54.1	56.3	57.7	58.1	1.9	0.6	0.9	0.3
Biomass	40.8	45.4	55.3	62.6	69.9	72.5	77.7	82.9	87.3	3.1	2.4	1.1	1.2
Waste	12.9	16.8	20.5	24.9	27.6	28.8	30.0	29.3	29.6	4.7	3.0	0.8	-0.1
Wind	0.1	0.4	1.9	5.3	14.0	17.8	21.6	26.5	30.7	40.0	21.9	4.4	3.6
Solar and others	0.1	0.3	0.4	1.1	1.8	2.5	3.2	4.0	5.9	11.3	16.0	6.0	6.3
Geothermal	2.3	2.6	3.5	3.8	4.0	4.1	4.2	4.3	4.5	4.5	1.2	0.5	0.6
Net Imports	**695.2**	**622.6**	**683.2**	**754.6**	**849.9**	**993.9**	**1151.8**	**1283.3**	**1410.9**	**-0.2**	**2.2**	**3.1**	**2.0**
Solids	85.6	84.0	105.7	101.3	104.6	109.4	143.1	177.6	225.9	2.1	-0.1	3.2	4.7
Oil	491.0	411.7	414.2	439.1	475.7	538.0	592.6	636.4	686.5	-1.7	1.4	2.2	1.5
Crude oil and Feedstocks	459.4	390.5	384.4	407.3	448.9	514.7	573.9	622.5	675.8	-1.8	1.6	2.5	1.6
Oil products	31.6	21.2	29.8	31.8	26.8	23.2	18.7	13.9	10.6	-0.6	-1.1	-3.5	-5.5
Natural gas	117.0	126.8	163.6	214.6	269.8	346.6	416.3	469.0	498.1	3.4	5.1	4.4	1.8
Electricity	1.7	0.1	-0.3	-0.4	-0.2	-0.2	-0.1	0.2	0.4				
Gross Inland Consumption	**1739.9**	**1749.6**	**1836.6**	**1910.7**	**1990.3**	**2066.5**	**2149.3**	**2202.2**	**2286.6**	**0.5**	**0.8**	**0.8**	**0.6**
Solids	465.5	380.9	341.8	297.0	282.2	266.1	290.2	306.9	343.1	-3.0	-1.9	0.3	1.7
Oil	669.7	691.7	703.2	713.7	726.3	748.1	768.1	774.1	798.4	0.5	0.3	0.6	0.4
Natural gas	299.9	340.7	411.0	488.6	556.8	620.8	672.3	712.4	736.9	3.2	3.1	1.9	0.9
Nuclear	206.9	226.3	250.7	265.5	256.3	251.8	226.0	203.8	191.7	1.9	0.2	-1.3	-1.6
Electricity	1.7	0.1	-0.3	-0.4	-0.2	-0.2	-0.1	0.2	0.4				
Renewable energy forms	96.2	109.8	130.1	146.2	168.7	179.7	192.9	204.7	216.1	3.1	2.6	1.3	1.1
as % in Gross Inland Consumption													
Solids	26.8	21.8	18.6	15.5	14.2	12.9	13.5	13.9	15.0				
Oil	38.5	39.5	38.3	37.4	36.5	36.2	35.7	35.2	34.9				
Natural gas	17.2	19.5	22.4	25.6	28.0	30.0	31.3	32.3	32.2				
Nuclear	11.9	12.9	13.6	13.9	12.9	12.2	10.5	9.3	8.4				
Renewable energy forms	5.5	6.3	7.1	7.7	8.5	8.7	9.0	9.3	9.5				
Electricity Generation in TWhe	**2794.8**	**2979.7**	**3323.5**	**3582.1**	**3929.4**	**4266.6**	**4620.3**	**4935.3**	**5271.5**	**1.7**	**1.7**	**1.6**	**1.3**
Nuclear	818.6	906.8	971.6	1030.3	995.5	979.5	882.0	820.6	791.6	1.7	0.2	-1.2	-1.1
Hydro & wind	465.9	520.1	586.3	624.8	761.6	835.6	906.0	982.0	1051.7	2.3	2.6	1.8	1.5
Thermal (incl. biomass)	1510.3	1552.7	1765.7	1927.0	2172.4	2451.4	2832.2	3132.7	3428.1	1.6	2.1	2.7	1.9
Fuel Inputs for Thermal Power Generation [1]	**403.9**	**398.4**	**424.8**	**437.1**	**462.0**	**492.5**	**546.3**	**586.2**	**630.0**	**0.5**	**0.8**	**1.7**	**1.4**
Solids	268.6	241.3	231.5	208.5	200.3	191.7	218.3	237.6	277.5	-1.5	-1.4	0.9	2.4
Oil (including refinery gas)	62.3	59.6	46.4	34.5	25.9	21.9	15.4	12.4	11.3	-2.9	-5.7	-5.1	-3.0
Gas	60.4	80.9	125.4	166.2	204.3	246.0	278.4	300.6	303.6	7.6	5.0	3.1	0.9
Biomass - Waste	10.8	14.5	18.5	24.6	28.0	29.4	30.5	31.7	33.5	5.5	4.2	0.8	1.0
Geothermal heat	1.9	2.1	3.0	3.4	3.5	3.6	3.8	3.9	4.1	4.9	1.6	0.7	0.8
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Fuel Input in other transformation proc.	**884.9**	**860.6**	**864.8**	**863.9**	**887.6**	**912.7**	**947.2**	**966.9**	**1003.3**	**-0.2**	**0.3**	**0.7**	**0.6**
Refineries	712.5	744.8	771.6	783.7	806.1	834.5	863.5	878.9	911.7	0.8	0.4	0.7	0.5
District heating	39.2	26.0	16.6	13.0	12.6	11.3	10.8	11.0	10.7	-8.2	-2.7	-1.5	-0.1
Biofuels and hydrogen production	0.0	0.2	0.6	4.8	10.5	12.6	18.8	24.1	29.1		32.6	6.0	4.5
Others	133.2	89.6	76.0	62.5	58.4	54.4	54.2	52.9	51.8	-5.5	-2.6	-0.7	-0.4
Energy Branch Consumption	**87.0**	**95.6**	**95.1**	**89.2**	**90.4**	**91.2**	**92.4**	**92.9**	**94.8**	**0.9**	**-0.5**	**0.2**	**0.3**
Non-Energy Uses	**103.3**	**112.1**	**114.0**	**117.2**	**123.1**	**128.6**	**132.3**	**135.5**	**138.6**	**1.0**	**0.8**	**0.7**	**0.5**
Final Energy Demand	**1131.4**	**1140.3**	**1198.9**	**1269.3**	**1352.7**	**1425.6**	**1504.4**	**1566.4**	**1633.8**	**0.6**	**1.2**	**1.1**	**0.8**
by sector													
Industry [1]	379.8	345.9	352.9	361.1	384.0	404.5	420.7	434.1	448.9	-0.7	0.8	0.9	0.7
Residential	297.4	310.5	316.9	333.4	352.1	368.0	381.7	392.1	403.6	0.6	1.1	0.8	0.6
Tertiary	153.9	160.7	168.2	177.9	190.7	201.7	215.3	229.8	245.3	0.9	1.3	1.2	1.3
Transport	300.4	323.3	360.9	396.8	425.9	451.5	486.8	510.5	536.0	1.9	1.7	1.3	1.0
by fuel [1]													
Solids	130.8	90.9	70.6	57.0	52.8	47.4	44.8	42.5	38.9	-6.0	-2.9	-1.6	-1.4
Oil	473.1	492.1	514.1	535.4	561.9	586.3	617.1	636.0	658.6	0.8	0.9	0.9	0.7
Gas	218.3	235.0	260.8	299.6	324.1	344.1	359.9	376.1	396.7	1.8	2.2	1.1	1.0
Electricity	200.1	212.2	238.4	257.8	286.2	313.1	340.8	365.3	390.9	1.8	1.8	1.8	1.4
Heat (from CHP and District Heating)	68.1	64.9	61.0	63.4	70.9	76.5	83.5	89.0	93.0	-1.1	1.5	1.7	1.1
Other	42.0	45.7	54.1	56.1	56.9	58.1	58.3	57.5	55.7	2.6	0.5	0.3	-0.5
CO_2 Emissions (Mt of CO_2)	**4201.2**	**4039.1**	**4069.4**	**4089.3**	**4217.1**	**4354.1**	**4616.0**	**4801.6**	**5048.1**	**-0.3**	**0.4**	**0.9**	**0.9**
Electricity and Steam production	1495.0	1377.6	1366.3	1373.5	1395.7	1440.1	1597.2	1713.4	1871.9	-0.9	0.2	1.4	1.6
Energy Branch	166.0	190.0	189.5	171.8	172.3	172.7	173.8	172.3	173.8	1.3	-0.9	0.1	0.0
Industry	821.6	728.6	702.3	632.2	635.2	641.6	643.6	646.0	654.7	-1.6	-1.0	0.1	0.2
Residential	564.3	532.3	503.9	508.6	533.2	548.1	555.9	557.3	562.8	-1.1	0.6	0.4	0.1
Tertiary	282.8	271.7	256.6	255.3	259.5	259.3	262.5	272.8	282.1	-1.0	0.1	0.1	0.7
Transport	871.5	939.0	1050.8	1148.0	1221.3	1292.4	1382.9	1440.0	1502.7	1.9	1.5	1.3	0.8
CO_2 Emissions Index (1990=100)	**100.0**	**96.1**	**96.9**	**97.3**	**100.4**	**103.6**	**109.9**	**114.3**	**120.2**				

See explanations on the last page of the Appendix

Source: PRIMES

EUROPE-30: BASELINE SCENARIO										SUMMARY ENERGY BALANCE AND INDICATORS (B)			
	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Main Energy System Indicators													
Population (Million)	540.2	552.7	563.1	572.4	578.2	582.6	585.6	587.6	587.4	0.4	0.3	0.1	0.0
GDP (in 000 MEuro'00)	7886	8428	9631	10844	12334	13964	15748	17689	19799	2.0	2.5	2.5	2.3
Gross Inl. Cons./GDP (toe/MEuro'00)	220.6	207.6	190.7	176.2	161.4	148.0	136.5	124.5	115.5	-1.4	-1.7	-1.7	-1.7
Gross Inl. Cons./Capita (toe/inhabitant)	3.2	3.2	3.3	3.3	3.4	3.5	3.7	3.7	3.9	0.1	0.5	0.6	0.6
Electricity Generated/Capita (kWh/inhabitant)	5174	5391	5902	6258	6796	7323	7890	8399	8974	1.3	1.4	1.5	1.3
Carbon intensity (t of CO_2/toe of GIC)	2.41	2.31	2.22	2.14	2.12	2.11	2.15	2.18	2.21	-0.9	-0.4	0.1	0.3
CO2 Emissions/Capita (t of CO_2/inhabitant)	7.8	7.3	7.2	7.1	7.3	7.5	7.9	8.2	8.6	-0.7	0.1	0.8	0.9
CO2 Emissions to GDP (t of CO_2/MEuro'00)	532.7	479.3	422.5	377.1	341.9	311.8	293.1	271.4	255.0	-2.3	-2.1	-1.5	-1.4
Import Dependency %	39.2	34.9	36.3	38.5	41.6	46.8	52.2	56.7	60.0				
Energy intensity indicators (1990=100)													
Industry (Energy on Value added)	100.0	88.2	80.1	73.6	68.2	63.1	58.0	53.3	49.3	-2.2	-1.6	-1.6	-1.6
Residential (Energy on Private Income)	100.0	98.9	87.8	82.3	76.5	70.6	65.0	59.6	55.0	-1.3	-1.4	-1.6	-1.7
Tertiary (Energy on Value added)	100.0	96.5	86.9	80.3	75.1	69.7	65.6	62.0	58.9	-1.4	-1.5	-1.3	-1.1
Transport (Energy on GDP)	100.0	100.7	98.4	96.1	90.7	84.9	81.2	75.8	71.1	-0.2	-0.8	-1.1	-1.3
Carbon Intensity indicators													
Electricity and Steam production (t of CO_2/MWh)	0.43	0.38	0.36	0.31	0.29	0.28	0.28	0.28	0.29	-2.0	-2.0	-0.2	0.3
Final energy demand (t of CO_2/toe)	2.25	2.17	2.10	2.00	1.96	1.92	1.89	1.86	1.84	-0.7	-0.7	-0.3	-0.3
Industry	2.16	2.11	1.99	1.75	1.65	1.59	1.53	1.49	1.46	-0.8	-1.8	-0.8	-0.5
Residential	1.90	1.71	1.59	1.53	1.51	1.49	1.46	1.42	1.39	-1.8	-0.5	-0.4	-0.4
Tertiary	1.84	1.69	1.53	1.43	1.36	1.29	1.22	1.19	1.15	-1.8	-1.1	-1.1	-0.6
Transport	2.90	2.90	2.91	2.89	2.87	2.86	2.84	2.82	2.80	0.0	-0.2	-0.1	-0.1
Electricity and steam generation													
Generation Capacity in GW_e		**716.9**	**762.7**	**838.8**	**925.4**	**1022.0**	**1138.2**	**1256.5**	**1377.0**		**2.0**	**2.1**	**1.9**
Nuclear		141.9	148.2	145.9	135.9	130.6	114.9	112.2	111.3		-0.9	-1.7	-0.3
Hydro (pumping excluded)		148.5	154.9	163.9	173.2	181.6	189.0	194.0	195.7		1.1	0.9	0.3
Wind and solar		2.5	13.1	28.4	74.2	94.9	113.1	139.7	171.7		19.0	4.3	4.3
Thermal		424.0	446.6	500.6	542.1	614.9	721.2	810.6	898.3		2.0	2.9	2.2
of which cogeneration units		*97.7*	*112.8*	*125.4*	*143.1*	*165.8*	*189.9*	*212.2*	*230.0*		*2.4*	*2.9*	*1.9*
Open cycle (incl. biomass-waste)		377.6	368.2	358.5	301.6	236.7	198.0	171.2	164.2		-2.0	-4.1	-1.9
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.0	1.0	13.2	67.2	110.6	166.7			52.8	9.5
Gas Turbines Combined Cycle		23.2	53.7	109.0	196.1	301.3	374.4	439.7	477.5		13.8	6.7	2.5
Small Gas Turbines		22.4	23.6	32.0	42.2	62.4	80.2	87.7	88.4		6.0	6.6	1.0
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Geothermal heat		0.7	1.0	1.2	1.2	1.3	1.3	1.4	1.4		1.8	0.7	0.8
Indicators													
Efficiency for thermal electricity production (%)		34.4	35.4	39.7	42.3	44.8	46.6	48.0	48.9				
Load factor for gross electric capacities (%)		47.4	49.7	48.8	48.5	47.7	46.3	44.8	43.7				
CHP indicator (% of electricity from CHP)		11.0	11.7	13.3	13.9	14.2	14.9	15.4	15.5				
Non fossil fuels in electricity generation (%)		49.6	48.9	48.6	47.2	44.9	40.9	38.7	37.1				
nuclear		30.4	29.2	28.8	25.3	23.0	19.1	16.6	15.0				
renewable energy forms		19.1	19.6	19.8	21.8	21.9	21.8	22.1	22.1				
of which waste		*0.8*	*1.0*	*1.2*	*1.3*	*1.2*	*1.1*	*1.0*	*1.0*				
Transport sector													
Passenger transport activity (Gpkm)	**5067.8**	**5411.6**	**5930.0**	**6404.8**	**6975.3**	**7632.7**	**8365.2**	**9140.7**	**10000.7**	1.6	1.6	1.8	1.8
public road transport	599.6	583.8	605.7	613.5	621.4	634.9	648.4	659.0	670.0	0.1	0.3	0.4	0.3
private cars and motorcycles	3785.2	4142.0	4529.7	4929.5	5379.9	5878.5	6423.0	7004.7	7648.5	1.8	1.7	1.8	1.8
rail transport	466.3	415.2	439.2	436.6	452.7	486.5	526.9	564.3	603.3	-0.6	0.3	1.5	1.4
aviation	182.5	233.3	315.7	381.6	474.4	582.3	712.1	853.4	1015.6	5.6	4.2	4.1	3.6
inland navigation	34.2	37.2	39.7	43.6	47.0	50.5	54.9	59.2	63.3	1.5	1.7	1.6	1.4
travel per person (km per capita)	9381	9791	10530	11189	12063	13101	14286	15556	17026	1.2	1.4	1.7	1.8
Freight transport activity (Gtkm)	**2074.5**	**2142.5**	**2458.3**	**2738.7**	**3101.3**	**3499.7**	**3927.5**	**4366.8**	**4820.6**	1.7	2.4	2.4	2.1
trucks	1248.5	1420.5	1699.0	1955.1	2276.7	2621.9	2993.2	3383.8	3787.7	3.1	3.0	2.8	2.4
rail transport	522.4	410.7	409.2	407.4	419.1	440.3	466.0	485.0	506.5	-2.4	0.2	1.1	0.8
inland navigation	303.5	311.3	350.0	376.2	405.4	437.6	468.2	498.0	526.4	1.4	1.5	1.5	1.2
freight activity per unit of GDP (tkm/000 Euro'00)	263	254	255	253	251	251	249	247	243	-0.3	-0.2	-0.1	-0.2
Energy demand in transport (Mtoe)	**300.4**	**323.3**	**360.9**	**396.8**	**425.9**	**451.5**	**486.8**	**510.5**	**536.0**	1.9	1.7	1.3	1.0
public road transport	9.3	8.4	8.6	8.8	8.8	8.7	8.5	8.1	7.7	-0.8	0.3	-0.3	-1.0
private cars and motorcycles	145.9	153.7	167.3	181.6	184.1	183.9	195.6	201.7	207.9	1.4	1.0	0.6	0.6
trucks	95.1	106.0	119.6	137.6	159.6	180.7	197.4	211.5	223.1	2.3	2.9	2.1	1.2
rail transport	9.9	10.2	10.2	9.8	9.0	8.0	7.4	7.1	7.1	0.3	-1.3	-1.9	-0.4
aviation	31.8	37.3	48.9	52.1	57.1	62.3	69.6	73.5	81.2	4.4	1.5	2.0	1.6
inland navigation	8.5	7.7	6.3	6.9	7.4	7.9	8.3	8.6	9.0	-2.9	1.5	1.2	0.8
Efficiency indicator (activity related)													
passenger transport (toe/Mpkm)	38.6	38.5	39.3	39.1	36.9	34.3	33.5	31.7	30.3	0.2	-0.6	-1.0	-1.0
freight transport (toe/Mtkm)	50.5	53.7	52.0	53.4	54.4	54.3	52.6	50.6	48.3	0.3	0.5	-0.3	-0.9

Source: PRIMES

(1) EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

APPENDIX 2

Summary energy balances and indicators by group of countries (EU-25, EU-15, new Member states (NMS)) – comparison to baseline

EU25: HIGH OIL AND GAS PRICE SCENARIO — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**893.3**	**785.5**	**720.3**	**33.0**	**44.6**	**59.4**	**3.8**	**6.0**	**9.0**
Solids	350.8	264.7	203.4	154.1	129.6	109.6	0.3	3.3	7.1	0.2	2.6	6.9
Oil	120.3	162.2	163.5	134.5	110.2	95.9	2.8	8.1	9.4	2.1	7.9	10.9
Natural gas	139.6	174.0	196.6	222.9	163.9	122.8	26.0	16.3	5.7	13.2	11.1	4.9
Nuclear	196.9	215.3	237.7	245.3	216.1	191.1	0.0	2.6	5.7	0.0	1.2	3.1
Renewable energy sources	69.2	80.7	96.1	136.6	165.6	200.9	3.9	14.3	31.5	3.0	9.4	18.6
Hydro	23.4	26.3	29.0	30.1	32.0	33.1	0.0	0.3	0.8	0.0	1.1	2.5
Biomass	31.1	35.4	42.2	60.8	76.3	97.4	3.3	11.4	23.7	5.8	17.6	32.2
Waste	12.3	15.9	19.3	25.7	28.3	28.2	0.0	0.5	1.0	0.2	1.9	3.7
Wind	0.1	0.4	1.9	14.3	21.8	31.9	0.4	1.7	5.1	2.6	8.4	18.9
Solar and others	0.1	0.3	0.4	1.8	3.2	6.0	0.1	0.3	0.7	7.9	8.6	13.4
Geothermal	2.2	2.5	3.3	3.8	4.0	4.4	0.1	0.1	0.2	1.9	2.0	3.6
Net Imports	**711.6**	**701.7**	**799.3**	**938.7**	**1155.7**	**1293.7**	**-35.7**	**-48.8**	**-68.1**	**-3.7**	**-4.1**	**-5.0**
Solids	75.2	73.8	91.4	91.0	142.5	241.1	1.1	16.2	43.7	1.2	12.8	22.1
Oil	510.8	491.8	519.6	563.7	610.5	630.2	-8.8	-15.5	-20.7	-1.5	-2.5	-3.2
Crude oil and Feedstocks	480.2	471.5	496.8	541.2	595.5	623.6	-8.6	-15.6	-21.4	-1.6	-2.5	-3.3
Oil products	30.6	20.3	22.8	22.5	15.0	6.6	-0.2	0.1	0.6	-0.9	0.7	10.3
Natural gas	123.5	134.8	186.2	282.0	400.7	420.1	-28.0	-49.5	-91.0	-9.0	-11.0	-17.8
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1781.7**	**1885.4**	**1952.4**	**-2.4**	**-3.5**	**-7.4**	**-0.1**	**-0.2**	**-0.4**
Solids	430.6	346.0	303.2	245.0	272.1	350.8	1.4	19.5	50.8	0.6	7.7	16.9
Oil	596.2	622.2	635.6	647.9	665.0	664.4	-5.7	-6.6	-10.0	-0.9	-1.0	-1.5
Natural gas	259.2	307.1	376.0	504.9	564.6	542.9	-2.0	-33.2	-85.4	-0.4	-5.6	-13.6
Nuclear	196.9	215.3	237.7	245.3	216.1	191.1	0.0	2.6	5.7	0.0	1.2	3.1
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	136.6	165.6	200.9	3.9	14.3	31.5	3.0	9.4	18.6
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	13.8	14.4	18.0	0.1	1.1	2.7	0.7	7.9	17.4
Oil	38.4	39.6	38.5	36.4	35.3	34.0	-0.3	-0.3	-0.4	-0.7	-0.8	-1.1
Natural gas	16.7	19.5	22.8	28.3	29.9	27.8	-0.1	-1.7	-4.3	-0.3	-5.4	-13.3
Nuclear	12.7	13.7	14.4	13.8	11.5	9.8	0.0	0.2	0.3	0.1	1.4	3.5
Renewable energy forms	4.5	5.1	5.8	7.7	8.8	10.3	0.2	0.8	1.6	3.1	9.6	19.0
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3423.3**	**3974.4**	**4453.0**	**4.1**	**25.8**	**55.9**	**0.1**	**0.7**	**1.3**
Nuclear	780.0	864.4	921.2	952.4	843.8	790.4	0.0	10.3	23.8	0.0	1.2	3.1
Hydro & wind	272.7	309.7	359.5	516.8	626.1	779.0	4.2	23.6	73.5	0.8	3.9	10.4
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1954.0	2504.6	2883.7	0.0	-8.1	-41.4	0.0	-0.3	-1.4
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**413.2**	**486.6**	**545.5**	**-0.1**	**3.7**	**4.5**	**0.0**	**0.8**	**0.8**
Solids	248.2	221.1	210.1	176.5	211.7	295.0	1.3	19.4	50.8	0.7	10.1	20.8
Oil (including refinery gas)	53.7	53.9	41.5	22.3	13.1	9.7	-1.5	-0.4	0.3	-6.2	-3.3	2.9
Gas	50.4	70.0	112.6	184.8	226.5	199.0	-0.3	-19.2	-56.2	-0.2	-7.8	-22.0
Biomass - Waste	10.3	13.6	17.5	26.1	31.6	37.7	0.3	3.9	9.6	1.2	14.0	34.0
Geothermal heat	1.9	2.1	3.0	3.5	3.7	4.1	0.1	0.1	0.2	2.1	2.3	4.1
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**806.6**	**848.5**	**883.0**	**-0.4**	**5.4**	**11.3**	**-0.1**	**0.6**	**1.3**
Refineries	641.3	675.9	710.9	729.7	765.5	787.4	-3.6	-1.5	-1.0	-0.5	-0.2	-0.1
District heating	31.7	23.1	14.5	11.1	8.9	8.6	0.3	0.1	-0.1	2.8	0.7	-1.4
Biofuels and hydrogen production	0.0	0.2	0.6	13.1	25.4	41.1	2.9	7.3	13.7	28.8	40.3	49.8
Others	127.6	81.2	68.3	52.8	48.7	45.8	-0.1	-0.4	-1.2	-0.1	-0.9	-2.4
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**76.7**	**76.5**	**76.2**	**-0.4**	**-0.7**	**-0.9**	**-0.5**	**-0.9**	**-1.2**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.2**	**121.0**	**124.1**	**-0.1**	**-0.4**	**-0.8**	**-0.1**	**-0.3**	**-0.6**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1206.8**	**1309.1**	**1376.4**	**-2.2**	**-8.8**	**-17.7**	**-0.2**	**-0.7**	**-1.3**
by sector												
Industry (1)	327.2	303.3	309.1	338.5	366.0	385.8	-0.3	-1.4	-2.7	-0.1	-0.4	-0.7
energy intensive industries	212.9	198.9	202.0	216.0	225.1	226.8	-0.3	-1.1	-2.2	-0.1	-0.5	-1.0
other industrial sectors	114.3	104.4	107.0	122.5	140.9	159.0	-0.1	-0.3	-0.5	0.0	-0.2	-0.3
Residential	268.1	277.2	279.1	307.9	325.4	331.6	-0.8	-3.7	-7.2	-0.3	-1.1	-2.1
Tertiary	140.2	147.5	154.2	173.6	191.6	212.4	-0.6	-2.7	-5.7	-0.4	-1.4	-2.6
Transport	273.7	295.6	332.0	386.8	426.0	446.7	-0.5	-1.0	-2.0	-0.1	-0.2	-0.4
by fuel (1)												
Solids	117.7	80.8	57.4	42.4	36.7	32.8	0.1	0.5	0.7	0.2	1.4	2.3
Oil	424.2	443.7	464.2	501.6	535.9	553.2	-1.8	-1.7	-1.6	-0.4	-0.3	-0.3
Gas	196.2	219.5	245.7	298.2	312.9	318.1	-1.7	-12.0	-25.3	-0.6	-3.7	-7.4
Electricity	176.5	187.9	211.3	253.7	299.0	338.6	0.3	1.9	4.3	0.1	0.7	1.3
Heat (from CHP and District Heating)	62.9	56.7	55.6	65.7	77.1	86.1	0.6	1.4	2.4	1.0	1.8	2.9
Other	32.1	35.3	40.3	45.2	47.4	47.7	0.3	1.0	1.8	0.6	2.2	3.9
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.7**	**3664.9**	**3741.2**	**4022.2**	**4278.3**	**-16.0**	**-18.4**	**-25.3**	**-0.4**	**-0.5**	**-0.6**
Electricity and Steam production	1341.0	1242.7	1228.3	1236.0	1434.0	1683.3	0.7	30.9	70.3	0.1	2.2	4.4
Energy Branch	144.2	163.9	164.0	144.7	140.9	135.6	-1.1	-2.1	-3.4	-0.7	-1.5	-2.5
Industry	713.2	644.8	605.7	542.2	539.3	538.3	-2.2	-6.5	-13.6	-0.4	-1.2	-2.5
Residential	519.7	490.4	462.6	478.3	482.2	463.3	-3.4	-13.0	-23.9	-0.7	-2.6	-4.9
Tertiary	256.8	251.0	236.7	237.4	232.2	236.6	-2.1	-8.7	-18.2	-0.9	-3.6	-7.1
Transport	794.6	859.0	967.5	1102.6	1193.7	1221.2	-7.9	-19.1	-36.5	-0.7	-1.6	-2.9
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**99.2**	**106.7**	**113.5**	**-0.4**	**-0.5**	**-0.7**	-0.4	-0.5	-0.6

See explanations on the last page of the Appendix

Source: PRIMES

EU25: HIGH OIL AND GAS PRICE SCENARIO — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	155.8	130.4	108.3	-0.2	-0.2	-0.4	-0.1	-0.2	-0.4
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.9	4.1	4.3	0.0	0.0	0.0	-0.1	-0.2	-0.4
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	7422	8601	9719	9	56	122	0.1	0.7	1.3
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.10	2.13	2.19	-0.01	-0.01	0.00	-0.3	-0.3	-0.2
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	8.1	8.7	9.3	0.0	0.0	-0.1	-0.4	-0.5	-0.6
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	327.2	278.1	237.4	-1.4	-1.3	-1.4	-0.4	-0.5	-0.6
Import Dependency %	44.8	43.6	47.2	51.2	59.5	64.2	-1.9	-2.4	-3.1	-3.5	-3.8	-4.6
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	70.9	60.2	51.0	-0.1	-0.2	-0.4	-0.1	-0.4	-0.7
Residential (Energy on Private Income)	100.0	98.1	85.8	74.3	62.4	51.6	-0.2	-0.7	-1.1	-0.3	-1.1	-2.1
Tertiary (Energy on Value added)	100.0	96.7	86.8	74.6	64.4	56.7	-0.3	-0.9	-1.5	-0.4	-1.4	-2.6
Transport (Energy on GDP)	100.0	101.1	99.3	90.4	78.7	66.2	-0.1	-0.2	-0.3	-0.1	-0.2	-0.4
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.29	0.29	0.31	0.00	0.00	0.01	-0.2	1.3	2.8
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.96	1.87	1.79	-0.01	-0.02	-0.04	-0.5	-1.2	-2.4
Industry	2.18	2.13	1.96	1.60	1.47	1.40	0.00	-0.01	-0.03	-0.3	-0.8	-1.8
Residential	1.94	1.77	1.66	1.55	1.48	1.40	-0.01	-0.02	-0.04	-0.5	-1.5	-2.8
Tertiary	1.83	1.70	1.54	1.37	1.21	1.11	-0.01	-0.03	-0.05	-0.5	-2.2	-4.6
Transport	2.90	2.91	2.91	2.85	2.80	2.73	-0.02	-0.04	-0.07	-0.6	-1.3	-2.5
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**787.5**	**957.0**	**1144.2**	**3.6**	**10.3**	**26.1**	**0.5**	**1.1**	**2.3**
Nuclear		134.7	140.3	129.8	108.5	109.6	0.0	0.5	1.8	0.0	0.4	1.6
Hydro (pumping excluded)		93.3	96.2	104.6	110.5	113.4	0.0	1.2	1.3	0.0	1.1	1.1
Wind and solar		2.5	13.0	74.8	109.4	168.8	1.6	5.3	19.6	2.2	5.1	13.2
Thermal		386.9	406.7	478.3	628.7	752.4	2.0	3.3	3.4	0.4	0.5	0.5
of which cogeneration units		*87.3*	*103.4*	*132.2*	*169.1*	*201.1*	*2.5*	*1.0*	*2.4*	*2.0*	*0.6*	*1.2*
Open cycle(incl. biomass-waste)		343.8	335.6	270.5	177.1	153.4	-0.1	1.8	6.0	0.0	1.0	4.1
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	1.5	88.4	219.8	0.5	21.8	69.9	49.8	32.7	46.6
Gas Turbines Combined Cycle		20.4	47.4	171.8	298.5	309.5	2.2	-20.3	-75.1	1.3	-6.4	-19.5
Small Gas Turbines		22.0	22.8	33.2	63.4	68.3	-0.7	0.0	2.5	-2.0	0.1	3.9
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.3	1.5	0.0	0.0	0.1	2.2	2.4	4.2
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.1	42.6	46.4	47.6	0.0	-0.5	-1.0	0.0	-1.0	-2.1
Load factor for gross electric capacities (%)		48.2	50.4	49.6	47.4	44.4	-0.2	-0.2	-0.5	-0.3	-0.4	-1.0
CHP indicator (% of electricity from CHP)		11.5	12.6	14.5	15.6	16.4	0.0	0.1	0.0	0.2	0.7	0.3
Non fossil fuels in electricity generation (%)		46.8	46.4	45.6	39.7	38.2	0.1	0.9	2.6	0.2	2.4	7.2
nuclear		33.1	31.8	27.8	21.2	17.7	0.0	0.1	0.3	-0.1	0.6	1.8
renewable energy forms		13.7	14.6	17.7	18.4	20.4	0.1	0.8	2.2	0.8	4.6	12.3
of which waste		*0.9*	*1.1*	*1.3*	*1.2*	*1.1*	*0.0*	*0.0*	*0.1*	*0.7*	*2.4*	*7.2*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6423.7**	**7492.4**	**8514.0**	**-9.1**	**-16.7**	**-24.9**	**-0.1**	**-0.2**	**-0.3**
public road transport	484.5	469.2	493.8	503.2	533.3	557.5	-0.6	0.3	1.9	-0.1	0.1	0.3
private cars and motorcycles	3593.6	3950.3	4291.6	5017.5	5775.4	6457.4	-8.1	-13.0	-17.2	-0.2	-0.2	-0.3
rail transport	408.3	371.7	402.3	414.5	477.4	535.0	-0.4	-1.9	-2.6	-0.1	-0.4	-0.5
aviation	168.5	215.5	298.3	448.1	659.5	909.8	0.0	-2.2	-7.2	0.0	-0.3	-0.8
inland navigation	28.9	31.9	33.6	40.3	46.8	54.3	0.0	0.0	0.2	-0.1	0.0	0.3
travel per person (km per capita)	10618	11233	12174	13927	16213	18583	-20	-36	-54	-0.1	-0.2	-0.3
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2687.0**	**3330.5**	**4028.0**	**-2.8**	**-8.5**	**-14.9**	**-0.1**	**-0.3**	**-0.4**
trucks	1064.3	1233.6	1482.7	1964.7	2510.7	3120.0	-1.9	-6.2	-12.5	-0.1	-0.2	-0.4
rail transport	440.2	358.0	368.0	377.9	417.8	450.4	-0.4	-2.1	-2.8	-0.1	-0.5	-0.6
inland navigation	258.1	268.2	297.0	344.4	402.0	457.5	-0.5	-0.2	0.5	-0.1	-0.1	0.1
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	230	224	0	-1	-1	-0.1	-0.3	-0.4
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**386.8**	**426.0**	**446.7**	**-0.5**	**-1.0**	**-2.0**	**-0.1**	**-0.2**	**-0.4**
public road transport	7.7	6.9	7.0	7.1	7.0	6.4	0.0	0.0	0.0	-0.1	0.1	0.0
private cars and motorcycles	138.1	146.1	157.1	168.7	168.3	160.7	-0.3	-0.3	-0.9	-0.2	-0.2	-0.6
trucks	82.9	93.2	108.5	143.7	174.0	195.0	-0.1	-0.4	-0.5	-0.1	-0.2	-0.3
rail transport	8.8	8.9	9.0	8.0	6.5	6.2	0.0	0.0	-0.1	-0.2	-0.7	-0.9
aviation	29.1	33.8	45.1	53.0	63.1	70.7	0.0	-0.2	-0.6	0.0	-0.3	-0.8
inland navigation	7.0	6.7	5.4	6.3	7.1	7.8	0.0	0.0	0.0	-0.1	0.0	0.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	36.6	32.6	28.6	0.0	0.0	-0.1	0.0	0.0	-0.3
freight transport (toe/Mtkm)	51.7	54.4	53.8	56.3	54.7	50.5	0.0	0.0	0.1	0.0	0.0	0.1

Source: PRIMES

EU15: HIGH OIL AND GAS PRICE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**773.0**	**673.5**	**623.3**	**30.0**	**38.0**	**50.3**	**4.0**	**6.0**	**8.8**
Solids	209.9	138.0	99.4	70.5	56.2	45.1	0.2	0.1	2.0	0.2	0.2	4.7
Oil	117.7	159.2	160.4	132.0	107.7	93.6	2.8	8.1	9.4	2.1	8.1	11.2
Natural gas	132.9	166.6	190.6	214.2	155.5	115.0	23.2	13.4	2.9	12.2	9.5	2.5
Nuclear	181.4	201.2	222.8	230.3	201.2	185.7	0.0	2.5	5.7	0.0	1.2	3.2
Renewable energy sources	66.3	74.4	88.1	126.0	152.9	183.9	3.9	13.9	30.4	3.2	10.0	19.8
Hydro	22.3	24.9	27.6	28.1	29.8	30.9	0.0	0.3	0.8	-0.1	1.0	2.8
Biomass	29.7	30.8	36.1	54.5	69.7	88.6	3.3	11.1	22.8	6.4	19.0	34.7
Waste	11.9	15.6	18.7	24.4	26.8	26.3	0.0	0.5	0.9	0.2	2.0	3.6
Wind	0.1	0.4	1.9	13.7	19.9	28.6	0.4	1.7	5.0	2.7	9.1	21.1
Solar and others	0.1	0.2	0.3	1.6	2.7	5.1	0.1	0.2	0.6	9.2	9.4	14.0
Geothermal	2.2	2.5	3.3	3.8	4.0	4.4	0.1	0.1	0.2	1.9	2.0	3.7
Net Imports	**645.4**	**651.3**	**737.9**	**849.8**	**1034.4**	**1150.5**	**-32.5**	**-42.5**	**-57.7**	**-3.7**	**-3.9**	**-4.8**
Solids	89.9	94.4	107.2	97.9	135.2	216.4	0.8	11.7	36.9	0.8	9.5	20.6
Oil	460.9	446.7	472.4	508.7	547.8	562.6	-8.2	-14.9	-19.6	-1.6	-2.6	-3.4
Crude oil and Feedstocks	436.8	434.7	455.5	495.5	542.9	566.4	-8.1	-15.1	-20.3	-1.6	-2.7	-3.5
Oil products	24.1	12.0	16.9	13.1	5.0	-3.7	-0.2	0.2	0.7	-1.2	4.5	-16.6
Natural gas	92.3	108.6	154.7	240.0	348.2	368.3	-25.1	-39.4	-75.0	-9.5	-10.2	-16.9
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1573.6**	**1653.3**	**1713.4**	**-2.1**	**-3.8**	**-6.1**	**-0.1**	**-0.2**	**-0.4**
Solids	302.8	237.7	212.4	168.3	191.3	261.4	1.0	11.8	38.9	0.6	6.6	17.5
Oil	545.8	575.6	586.9	591.4	601.0	595.8	-5.1	-6.1	-8.9	-0.9	-1.0	-1.5
Natural gas	222.1	273.4	338.7	454.2	503.7	483.4	-1.8	-25.9	-72.2	-0.4	-4.9	-13.0
Nuclear	181.4	201.2	222.8	230.3	201.2	185.7	0.0	2.5	5.7	0.0	1.2	3.2
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	126.0	152.9	183.9	3.9	13.9	30.4	3.2	10.0	19.8
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	10.7	11.6	15.3	0.1	0.7	2.3	0.7	6.8	17.9
Oil	41.3	42.2	40.4	37.6	36.3	34.8	-0.3	-0.3	-0.4	-0.7	-0.8	-1.1
Natural gas	16.8	20.0	23.3	28.9	30.5	28.2	-0.1	-1.5	-4.1	-0.3	-4.7	-12.7
Nuclear	13.7	14.8	15.3	14.6	12.2	10.8	0.0	0.2	0.4	0.1	1.5	3.5
Renewable energy forms	5.0	5.5	6.1	8.0	9.2	10.7	0.3	0.9	1.8	3.3	10.3	20.2
Electricity Generation in TWhe	**2139.1**	**2308.3**	**2574.1**	**3030.4**	**3471.5**	**3893.5**	**3.3**	**21.0**	**47.5**	**0.1**	**0.6**	**1.2**
Nuclear	720.1	810.1	863.7	894.0	785.2	768.8	0.0	9.8	23.7	0.0	1.3	3.2
Hydro & wind	259.8	294.2	343.8	486.3	578.7	715.4	3.9	22.8	72.8	0.8	4.1	11.3
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1650.1	2107.5	2409.3	-0.6	-11.6	-49.1	0.0	-0.5	-2.0
Fuel Inputs for Thermal Power Generation [1]	**291.8**	**295.1**	**318.3**	**337.6**	**398.4**	**446.6**	**-0.1**	**1.4**	**1.8**	**0.0**	**0.3**	**0.4**
Solids	186.1	163.9	153.6	118.6	145.6	218.2	0.9	11.8	39.0	0.8	8.8	21.8
Oil (including refinery gas)	48.7	49.6	38.3	19.1	10.7	7.1	-1.2	-0.4	0.4	-5.9	-3.5	5.4
Gas	45.1	66.0	106.3	172.1	208.8	182.4	-0.2	-14.0	-47.2	-0.1	-6.3	-20.6
Biomass - Waste	10.0	13.5	17.1	24.3	29.5	34.8	0.3	3.9	9.5	1.1	15.2	37.5
Geothermal heat	1.9	2.1	3.0	3.5	3.7	4.1	0.1	0.1	0.2	2.1	2.3	4.1
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**741.2**	**777.3**	**805.1**	**0.1**	**5.4**	**11.2**	**0.0**	**0.7**	**1.4**
Refineries	594.6	635.8	665.7	680.4	708.7	724.7	-3.1	-1.3	-0.6	-0.5	-0.2	-0.1
District heating	12.4	11.0	6.0	6.5	5.2	5.7	0.3	-0.1	-0.2	4.6	-1.1	-3.6
Biofuels and hydrogen production	0.0	0.2	0.6	13.1	24.8	38.7	2.9	7.1	12.9	28.9	40.1	50.1
Others	97.1	58.1	50.6	41.2	38.6	36.0	0.0	-0.3	-0.9	-0.1	-0.9	-2.4
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**67.1**	**66.7**	**67.0**	**-0.3**	**-0.5**	**-0.9**	**-0.5**	**-0.8**	**-1.3**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.2**	**108.2**	**110.0**	**-0.1**	**-0.3**	**-0.6**	**-0.1**	**-0.3**	**-0.5**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1074.6**	**1157.2**	**1213.9**	**-2.0**	**-7.6**	**-15.1**	**-0.2**	**-0.7**	**-1.2**
by sector												
Industry [1]	262.2	255.6	268.7	299.1	324.1	342.2	-0.3	-1.2	-2.4	-0.1	-0.4	-0.7
energy intensive industries	180.4	170.9	175.8	190.4	198.7	200.2	-0.3	-1.0	-1.9	-0.1	-0.5	-0.9
other industrial sectors	81.9	84.7	92.9	108.7	125.3	142.0	-0.1	-0.2	-0.5	-0.1	-0.2	-0.3
Residential	228.1	236.0	244.7	270.2	281.2	285.1	-0.7	-3.2	-6.0	-0.3	-1.1	-2.1
Tertiary	115.3	127.9	132.7	148.6	163.4	181.7	-0.6	-2.3	-4.9	-0.4	-1.4	-2.6
Transport	253.8	275.7	309.1	356.7	388.5	404.8	-0.4	-0.9	-1.9	-0.1	-0.2	-0.5
by fuel [1]												
Solids	76.8	47.0	36.0	28.5	25.6	23.5	0.1	0.3	0.4	0.2	1.3	1.8
Oil	391.5	414.1	430.6	460.6	487.6	500.7	-1.6	-1.4	-1.2	-0.3	-0.3	-0.2
Gas	169.7	194.9	220.3	265.0	275.0	279.3	-1.6	-10.1	-21.5	-0.6	-3.5	-7.1
Electricity	156.0	169.4	191.6	228.5	265.4	300.0	0.3	1.6	3.7	0.1	0.6	1.2
Heat (from CHP and District Heating)	35.2	39.3	42.1	52.5	61.8	68.5	0.6	1.0	1.9	1.2	1.7	2.8
Other	30.3	30.6	34.5	39.6	41.9	41.9	0.2	0.9	1.5	0.6	2.2	3.8
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.9**	**3117.5**	**3189.4**	**3412.6**	**3629.0**	**-15.5**	**-31.4**	**-39.7**	**-0.5**	**-0.9**	**-1.1**
Electricity and Steam production	997.6	947.7	948.3	952.0	1112.7	1325.3	0.1	12.7	44.7	0.0	1.2	3.5
Energy Branch	129.8	144.4	145.4	134.2	129.9	124.5	-1.0	-1.7	-3.0	-0.7	-1.3	-2.4
Industry	576.2	526.5	509.3	456.2	454.2	454.1	-2.1	-5.8	-12.2	-0.5	-1.3	-2.6
Residential	436.4	417.4	412.9	429.4	429.7	414.8	-3.0	-10.9	-19.4	-0.7	-2.5	-4.5
Tertiary	203.5	212.7	199.6	200.8	199.1	204.4	-1.8	-7.3	-15.4	-0.9	-3.5	-7.0
Transport	738.5	803.0	902.2	1016.7	1086.9	1105.8	-7.8	-18.4	-34.4	-0.8	-1.7	-3.0
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**103.5**	**110.7**	**117.7**	**-0.5**	**-1.0**	**-1.3**	-0.5	-0.9	-1.1

See explanations on the last page of the Appendix

Source: PRIMES

EU15: HIGH OIL AND GAS PRICE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	144.9	121.2	101.3	-0.2	-0.3	-0.4	-0.1	-0.2	-0.4
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	4.1	4.2	4.4	0.0	0.0	0.0	-0.1	-0.2	-0.4
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7814	8891	10009	8	54	122	0.1	0.6	1.2
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	2.03	2.06	2.12	-0.01	-0.01	-0.02	-0.3	-0.7	-0.7
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	8.2	8.7	9.3	0.0	-0.1	-0.1	-0.5	-0.9	-1.1
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	293.7	250.2	214.5	-1.4	-2.3	-2.3	-0.5	-0.9	-1.1
Import Dependency %	47.6	46.6	49.4	52.4	60.6	64.9	-1.9	-2.3	-3.0	-3.5	-3.7	-4.4
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	78.8	67.6	57.3	-0.1	-0.3	-0.4	-0.1	-0.4	-0.7
Residential (Energy on Private Income)	100.0	97.6	88.2	77.1	64.5	53.5	-0.2	-0.7	-1.1	-0.3	-1.1	-2.1
Tertiary (Energy on Value added)	100.0	101.8	90.9	78.1	67.6	60.1	-0.3	-1.0	-1.6	-0.4	-1.4	-2.6
Transport (Energy on GDP)	100.0	101.2	99.5	90.4	78.3	65.8	-0.1	-0.2	-0.3	-0.1	-0.2	-0.5
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.26	0.26	0.28	0.00	0.00	0.01	-0.3	0.4	2.0
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.96	1.88	1.80	-0.01	-0.02	-0.04	-0.5	-1.3	-2.4
Industry	2.20	2.06	1.90	1.53	1.40	1.33	-0.01	-0.01	-0.03	-0.4	-0.9	-1.9
Residential	1.91	1.77	1.69	1.59	1.53	1.46	-0.01	-0.02	-0.04	-0.4	-1.4	-2.5
Tertiary	1.76	1.66	1.50	1.35	1.22	1.12	-0.01	-0.03	-0.05	-0.5	-2.2	-4.5
Transport	2.91	2.91	2.92	2.85	2.80	2.73	-0.02	-0.04	-0.07	-0.6	-1.4	-2.6
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**691.8**	**821.7**	**975.2**	**3.1**	**9.1**	**24.2**	**0.5**	**1.1**	**2.5**
Nuclear		126.2	131.0	121.9	100.6	106.7	0.0	0.5	1.8	0.0	0.5	1.7
Hydro (pumping excluded)		87.1	89.8	96.8	102.1	104.9	-0.1	1.1	1.2	-0.1	1.1	1.2
Wind and solar		2.5	12.9	72.0	100.5	153.5	1.6	5.2	19.3	2.3	5.4	14.4
Thermal		322.9	344.8	401.1	518.5	610.1	1.6	2.4	2.0	0.4	0.5	0.3
of which cogeneration units		*59.3*	*77.1*	*104.7*	*130.1*	*147.9*	*2.3*	*0.2*	*1.5*	*2.3*	*0.1*	*1.0*
Open cycle(incl. biomass-waste)		281.8	276.9	214.3	134.4	118.2	-0.3	-1.4	4.9	-0.2	-1.0	4.3
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.9	68.6	175.1	0.4	16.9	56.1	97.7	32.8	47.2
Gas Turbines Combined Cycle		20.0	46.0	159.5	265.5	260.4	2.2	-13.7	-62.6	1.4	-4.9	-19.4
Small Gas Turbines		20.3	21.0	25.2	48.7	54.9	-0.7	0.6	3.5	-2.7	1.2	6.9
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.3	1.5	0.0	0.0	0.1	2.2	2.4	4.2
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.8	44.0	47.6	48.6	0.0	-0.4	-1.1	0.1	-0.8	-2.2
Load factor for gross electric capacities (%)		48.9	50.8	50.0	48.2	45.6	-0.2	-0.2	-0.6	-0.3	-0.5	-1.3
CHP indicator (% of electricity from CHP)		9.2	10.3	12.7	14.0	14.3	0.0	0.2	0.2	0.4	1.1	1.3
Non fossil fuels in electricity generation (%)		49.9	49.3	48.3	42.1	41.2	0.1	1.1	3.0	0.2	2.6	7.7
nuclear		35.1	33.6	29.5	22.6	19.7	0.0	0.1	0.4	-0.1	0.7	1.9
renewable energy forms		14.8	15.8	18.8	19.5	21.5	0.1	0.9	2.6	0.8	4.9	13.6
of which waste		*1.0*	*1.2*	*1.4*	*1.3*	*1.2*	*0.0*	*0.0*	*0.1*	*0.7*	*2.6*	*7.0*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5808.9**	**6685.9**	**7519.5**	**-8.3**	**-14.4**	**-20.7**	-0.1	-0.2	-0.3
public road transport	368.8	382.2	412.6	422.1	448.6	466.7	-0.5	0.2	1.5	-0.1	0.0	0.3
private cars and motorcycles	3325.6	3634.5	3938.8	4559.1	5156.3	5691.1	-7.2	-10.9	-13.2	-0.2	-0.2	-0.2
rail transport	316.4	320.9	356.0	366.3	419.3	460.2	-0.4	-1.8	-2.6	-0.1	-0.4	-0.6
aviation	157.3	201.5	281.5	421.7	615.7	847.9	0.0	-2.0	-6.6	0.0	-0.3	-0.8
inland navigation	28.3	31.4	33.0	39.7	46.0	53.5	0.0	0.0	0.2	-0.1	0.0	0.3
travel per person (km per capita)	11465	12240	13261	14978	17124	19329	-21	-37	-53	-0.1	-0.2	-0.3
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2347.9**	**2889.3**	**3487.7**	**-2.6**	**-7.4**	**-13.8**	-0.1	-0.3	-0.4
trucks	946.0	1114.6	1327.2	1740.9	2191.8	2708.6	-1.8	-5.6	-11.5	-0.1	-0.3	-0.4
rail transport	234.9	220.2	249.3	263.3	296.4	322.5	-0.3	-1.6	-2.7	-0.1	-0.5	-0.8
inland navigation	257.1	266.9	296.1	343.6	401.2	456.6	-0.5	-0.2	0.4	-0.1	-0.1	0.1
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	206	0	-1	-1	-0.1	-0.3	-0.4
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**356.7**	**388.5**	**404.8**	**-0.4**	**-0.9**	**-1.9**	-0.1	-0.2	-0.5
public road transport	6.3	5.9	5.8	6.0	5.8	5.3	0.0	0.0	0.0	-0.1	0.0	-0.1
private cars and motorcycles	130.2	136.6	145.5	153.9	150.6	141.4	-0.3	-0.3	-0.8	-0.2	-0.2	-0.6
trucks	76.0	86.5	101.0	132.6	159.0	177.0	-0.1	-0.4	-0.5	-0.1	-0.2	-0.3
rail transport	6.9	7.5	7.7	6.9	5.5	5.2	0.0	0.0	-0.1	-0.2	-0.8	-1.0
aviation	27.8	32.5	43.8	51.1	60.5	68.2	0.0	-0.2	-0.5	0.0	-0.3	-0.8
inland navigation	6.7	6.7	5.3	6.3	7.1	7.8	0.0	0.0	0.0	-0.1	0.0	0.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	37.4	33.2	29.2	0.0	0.0	-0.1	0.0	0.0	-0.4
freight transport (toe/Mtkm)	57.8	58.5	57.3	59.5	57.6	53.0	0.0	0.0	0.1	0.0	0.0	0.1

Source: PRIMES

NMS: HIGH OIL AND GAS PRICE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**120.3**	**112.0**	**97.1**	**2.9**	**6.6**	**9.1**	**2.5**	**6.3**	**10.3**
Solids	140.9	126.7	104.0	83.6	73.5	64.6	0.1	3.2	5.1	0.2	4.5	8.6
Oil	2.6	3.0	3.1	2.5	2.5	2.3	0.0	0.0	0.0	0.5	1.6	1.0
Natural gas	6.7	7.4	6.1	8.6	8.4	7.8	2.7	2.9	2.8	46.1	53.1	57.2
Nuclear	15.5	14.1	14.8	14.9	14.9	5.4	0.0	0.1	0.0	-0.1	0.8	0.4
Renewable energy sources	3.0	6.3	8.0	10.6	12.7	17.0	0.1	0.4	1.1	0.8	3.0	6.9
Hydro	1.1	1.3	1.4	2.0	2.2	2.2	0.0	0.0	0.0	1.4	1.4	-0.8
Biomass	1.4	4.6	6.1	6.3	6.6	8.8	0.0	0.3	0.9	0.8	4.2	11.1
Waste	0.5	0.3	0.5	1.4	1.5	1.8	0.0	0.0	0.1	0.4	0.3	4.6
Wind	0.0	0.0	0.0	0.6	1.9	3.3	0.0	0.0	0.1	0.1	2.2	2.3
Solar and others	0.0	0.0	0.0	0.3	0.5	0.9	0.0	0.0	0.1	1.0	5.0	9.8
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-1.7	-3.3
Net Imports	**66.3**	**50.4**	**61.4**	**88.9**	**121.3**	**143.2**	**-3.2**	**-6.3**	**-10.4**	**-3.5**	**-4.9**	**-6.8**
Solids	-14.6	-20.7	-15.9	-6.9	7.3	24.7	0.3	4.5	6.8	-3.8	156.0	38.0
Oil	49.9	45.0	47.3	55.0	62.7	67.6	-0.6	-0.6	-1.2	-1.0	-0.9	-1.7
Crude oil and Feedstocks	43.4	36.7	41.3	45.7	52.6	57.2	-0.5	-0.4	-1.1	-1.1	-0.8	-1.8
Oil products	6.5	8.3	6.0	9.3	10.1	10.4	-0.1	-0.1	-0.1	-0.6	-1.1	-1.2
Natural gas	31.2	26.2	31.5	42.0	52.5	51.7	-2.9	-10.2	-16.0	-6.5	-16.2	-23.6
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**208.1**	**232.1**	**239.0**	**-0.3**	**0.4**	**-1.3**	**-0.1**	**0.2**	**-0.5**
Solids	127.8	108.2	90.8	76.7	80.8	89.3	0.4	7.6	11.9	0.5	10.4	15.4
Oil	50.4	46.6	48.7	56.5	64.0	68.6	-0.6	-0.5	-1.1	-1.0	-0.8	-1.6
Natural gas	37.1	33.8	37.3	50.7	60.9	59.5	-0.2	-7.3	-13.2	-0.4	-10.7	-18.1
Nuclear	15.5	14.1	14.8	14.9	14.9	5.4	0.0	0.1	0.0	-0.1	0.8	0.4
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	10.6	12.7	17.0	0.1	0.4	1.1	0.8	3.0	6.9
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	36.9	34.8	37.4	0.2	3.2	5.2	0.7	10.3	16.0
Oil	21.6	22.3	24.6	27.1	27.6	28.7	-0.2	-0.3	-0.3	-0.8	-0.9	-1.1
Natural gas	15.9	16.2	18.8	24.3	26.2	24.9	-0.1	-3.2	-5.3	-0.3	-10.8	-17.7
Nuclear	6.6	6.7	7.5	7.2	6.4	2.2	0.0	0.0	0.0	0.1	0.6	0.9
Renewable energy forms	1.3	3.0	4.1	5.1	5.5	7.1	0.0	0.2	0.5	0.9	2.8	7.5
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**392.9**	**503.0**	**559.5**	**0.9**	**4.8**	**8.4**	**0.2**	**1.0**	**1.5**
Nuclear	60.0	54.3	57.4	58.5	58.6	21.5	0.0	0.4	0.1	-0.1	0.8	0.4
Hydro & wind	12.9	15.5	15.7	30.5	47.3	63.6	0.3	0.8	0.7	1.1	1.8	1.1
Thermal (incl. biomass)	243.7	230.7	250.6	303.9	397.0	474.4	0.6	3.5	7.6	0.2	0.9	1.6
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**75.6**	**88.2**	**98.8**	**0.1**	**2.3**	**2.7**	**0.1**	**2.7**	**2.8**
Solids	62.2	57.2	56.5	57.9	66.0	76.7	0.4	7.5	11.8	0.7	12.9	18.1
Oil	4.9	4.4	3.2	3.2	2.3	2.6	-0.3	-0.1	-0.1	-7.6	-2.2	-3.4
Gas	5.3	4.0	6.3	12.7	17.8	16.6	-0.1	-5.2	-9.0	-0.6	-22.5	-35.2
Biomass - Waste	0.3	0.1	0.4	1.8	2.1	2.9	0.0	0.0	0.1	1.2	-0.2	2.3
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**65.5**	**71.3**	**77.9**	**-0.5**	**0.0**	**0.1**	**-0.8**	**0.0**	**0.1**
Refineries	46.7	40.1	45.2	49.2	56.8	62.7	-0.5	-0.3	-0.5	-1.0	-0.5	-0.7
District heating	19.3	12.1	8.5	4.6	3.8	2.9	0.0	0.1	0.1	0.3	3.4	3.2
Biofuels and hydrogen production	0.0	0.0	0.0	0.1	0.6	2.4	0.0	0.2	0.8	15.1	45.5	45.0
Others	30.5	23.1	17.7	11.6	10.1	9.8	0.0	-0.1	-0.3	-0.3	-0.8	-2.8
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.6**	**9.8**	**9.3**	**0.0**	**-0.1**	**0.0**	**-0.2**	**-1.3**	**-0.3**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**12.8**	**14.2**	**0.0**	**-0.1**	**-0.2**	**-0.3**	**-0.8**	**-1.2**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**132.1**	**151.9**	**162.5**	**-0.2**	**-1.2**	**-2.6**	**-0.2**	**-0.8**	**-1.6**
by sector												
Industry	65.0	47.7	40.4	39.4	42.0	43.5	0.0	-0.2	-0.3	-0.1	-0.4	-0.8
energy intensive industries	32.5	27.9	26.2	25.6	26.4	26.6	0.0	-0.1	-0.3	-0.1	-0.5	-1.1
other industrial sectors	32.4	19.7	14.2	13.8	15.6	17.0	0.0	0.0	0.0	0.0	-0.1	-0.3
Residential	40.0	41.2	34.4	37.7	44.2	46.5	-0.1	-0.6	-1.3	-0.3	-1.2	-2.6
Tertiary	24.9	19.6	21.5	25.0	28.2	30.7	-0.1	-0.4	-0.8	-0.3	-1.4	-2.7
Transport	19.9	19.8	22.9	30.0	37.5	41.8	0.0	-0.1	-0.1	-0.1	-0.2	-0.3
by fuel												
Solids	40.9	33.8	21.4	13.9	11.1	9.3	0.0	0.2	0.3	0.2	1.7	3.4
Oil	32.7	29.6	33.6	41.0	48.4	52.5	-0.2	-0.2	-0.4	-0.6	-0.5	-0.8
Gas	26.5	24.6	25.4	33.2	37.9	38.8	-0.1	-1.9	-3.8	-0.4	-4.8	-9.0
Electricity	20.5	18.5	19.6	25.2	33.6	38.6	0.1	0.3	0.6	0.3	1.0	1.5
Heat (from CHP and District Heating)	27.7	17.4	13.5	13.2	15.3	17.6	0.0	0.4	0.6	0.2	2.3	3.3
Other	1.8	4.7	5.8	5.6	5.6	5.8	0.0	0.1	0.2	0.4	2.1	4.5
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**551.8**	**609.6**	**649.3**	**-0.5**	**13.0**	**14.4**	**-0.1**	**2.2**	**2.3**
Electricity and Steam production	343.4	295.0	280.1	283.9	321.3	358.1	0.5	18.2	25.5	0.2	6.0	7.7
Energy Branch	14.4	19.5	18.7	10.5	11.0	11.1	-0.1	-0.4	-0.4	-0.8	-3.5	-3.3
Industry	137.0	118.2	96.4	85.9	85.0	84.2	-0.1	-0.8	-1.4	-0.1	-0.9	-1.6
Residential	83.2	72.9	49.7	48.9	52.4	48.5	-0.4	-2.1	-4.5	-0.8	-3.9	-8.6
Tertiary	53.3	38.3	37.2	36.6	33.2	32.3	-0.3	-1.4	-2.8	-0.9	-4.0	-7.9
Transport	56.1	55.9	65.3	85.9	106.7	115.3	-0.1	-0.6	-2.1	-0.1	-0.6	-1.8
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**80.3**	**88.7**	**94.5**	**-0.1**	**1.9**	**2.1**	-0.1	2.2	2.3

See explanations on the last page of the Appendix

Source: PRIMES

NMS: HIGH OIL AND GAS PRICE SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	362.7	282.7	217.2	-0.5	0.4	-1.2	-0.1	0.2	-0.5
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.8	3.2	3.5	0.0	0.0	0.0	-0.1	0.2	-0.5
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	5353	7018	8092	12	67	121	0.2	1.0	1.5
Carbon intensity (t of CO2/toe of GIC)	2.94	2.87	2.76	2.65	2.63	2.72	0.00	0.05	0.07	0.0	2.0	2.8
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.5	8.5	9.4	0.0	0.2	0.2	-0.1	2.2	2.3
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	961.4	742.6	590.1	-0.8	15.8	13.1	-0.1	2.2	2.3
Import Dependency %	28.3	24.1	30.8	42.5	52.0	59.6	-1.5	-2.8	-4.0	-3.4	-5.0	-6.2
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	36.1	27.3	22.6	0.0	-0.1	-0.2	-0.1	-0.4	-0.8
Residential (Energy on Private Income)	100.0	106.5	74.2	55.8	44.8	35.1	-0.1	-0.6	-1.0	-0.3	-1.2	-2.6
Tertiary (Energy on Value added)	100.0	74.8	67.2	52.4	39.8	31.1	-0.2	-0.6	-0.8	-0.3	-1.4	-2.7
Transport (Energy on GDP)	100.0	102.9	97.4	87.5	76.5	63.6	-0.1	-0.1	-0.2	-0.1	-0.2	-0.3
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.49	0.46	0.46	0.00	0.02	0.02	0.0	4.7	5.6
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.95	1.83	1.72	0.00	-0.02	-0.04	-0.2	-1.0	-2.2
Industry	2.11	2.48	2.38	2.18	2.03	1.93	0.00	-0.01	-0.02	-0.1	-0.5	-0.9
Residential	2.08	1.77	1.44	1.30	1.19	1.04	-0.01	-0.03	-0.07	-0.5	-2.7	-6.1
Tertiary	2.14	1.95	1.73	1.46	1.17	1.05	-0.01	-0.03	-0.06	-0.6	-2.7	-5.4
Transport	2.82	2.82	2.85	2.86	2.84	2.76	0.00	-0.01	-0.04	0.0	-0.4	-1.5
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**95.6**	**135.3**	**169.0**	**0.5**	**1.2**	**1.8**	**0.5**	**0.9**	**1.1**
Nuclear		8.4	9.3	7.9	7.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		6.1	6.4	7.8	8.4	8.5	0.1	0.1	0.1	1.3	1.2	0.7
Wind and solar		0.0	0.0	2.8	8.9	15.3	0.0	0.2	0.3	0.1	1.9	2.3
Thermal		64.0	61.9	77.2	110.1	142.3	0.4	0.9	1.4	0.5	0.8	1.0
of which cogeneration units		*28.1*	*26.3*	*27.5*	*39.0*	*53.2*	*0.2*	*0.8*	*0.9*	*0.7*	*2.0*	*1.8*
Open cycle (incl. biomass-waste)		61.9	58.6	56.2	42.7	35.2	0.3	3.2	1.2	0.5	8.0	3.4
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.6	19.9	44.6	0.0	4.9	13.7	7.6	32.5	44.4
Gas Turbines Combined Cycle		0.4	1.4	12.3	32.9	49.1	0.1	-6.6	-12.5	0.4	-16.7	-20.3
Small Gas Turbines		1.7	1.8	8.1	14.6	13.4	0.0	-0.5	-1.0	0.1	-3.4	-6.8
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	36.5	40.7	43.5	0.0	-0.7	-0.5	0.1	-1.8	-1.2
Load factor for gross electric capacities (%)		43.6	47.6	46.9	42.4	37.8	-0.1	0.0	0.2	-0.3	0.1	0.4
CHP indicator (% of electricity from CHP)		29.4	30.4	28.2	27.1	30.7	-0.2	-0.3	-0.9	-0.6	-0.9	-2.8
Non fossil fuels in electricity generation (%)		23.4	23.1	24.2	22.5	17.1	0.1	0.0	-0.1	0.2	0.1	-0.9
nuclear		18.1	17.7	14.9	11.6	3.8	0.0	0.0	0.0	-0.3	-0.2	-1.1
renewable energy forms		5.3	5.4	9.3	10.9	13.2	0.1	0.1	-0.1	1.0	0.5	-0.8
of which waste		*0.0*	*0.1*	*0.6*	*0.4*	*0.4*	*0.0*	*0.0*	*0.0*	*0.8*	*-0.5*	*10.7*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**614.8**	**806.4**	**994.5**	**-0.9**	**-2.3**	**-4.2**	-0.1	-0.3	-0.4
public road transport	115.7	87.0	81.2	81.1	84.7	90.8	-0.1	0.1	0.3	-0.1	0.1	0.4
private cars and motorcycles	268.0	315.8	352.9	458.4	619.1	766.3	-0.8	-2.1	-3.9	-0.2	-0.3	-0.5
rail transport	91.9	50.8	46.3	48.2	58.1	74.8	0.0	-0.1	0.0	-0.1	-0.2	0.0
aviation	11.2	14.0	16.8	26.4	43.8	61.9	0.0	-0.2	-0.6	0.1	-0.4	-0.9
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	-0.2	-0.1	0.0
travel per person (km per capita)	6489	6227	6662	8376	11252	14384	-12	-32	-60	-0.1	-0.3	-0.4
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**339.2**	**441.1**	**540.3**	**-0.2**	**-1.1**	**-1.0**	-0.1	-0.2	-0.2
trucks	118.4	119.0	155.5	223.8	318.9	411.5	-0.1	-0.6	-1.0	-0.1	-0.2	-0.2
rail transport	205.2	137.8	118.7	114.6	121.4	127.9	-0.1	-0.4	0.0	-0.1	-0.4	0.0
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	0.0	0.2	0.6
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	591	537	491	0	-1	-1	-0.1	-0.2	-0.2
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**30.0**	**37.5**	**41.8**	**0.0**	**-0.1**	**-0.1**	-0.1	-0.2	-0.3
public road transport	1.4	1.0	1.2	1.1	1.1	1.1	0.0	0.0	0.0	-0.1	0.2	0.3
private cars and motorcycles	7.9	9.5	11.6	14.8	17.7	19.3	0.0	0.0	-0.1	-0.1	-0.2	-0.3
trucks	7.0	6.7	7.5	11.1	15.1	18.0	0.0	0.0	0.0	0.0	-0.2	-0.2
rail transport	2.0	1.4	1.3	1.1	1.0	1.0	0.0	0.0	0.0	-0.1	-0.4	-0.2
aviation	1.3	1.2	1.3	1.9	2.6	2.5	0.0	0.0	0.0	0.2	-0.3	-0.8
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.4
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	29.8	27.1	23.4	0.0	0.0	0.0	0.0	0.1	0.1
freight transport (toe/Mtkm)	24.6	28.8	30.0	34.5	35.5	34.4	0.0	0.0	0.0	0.0	0.0	0.0

Source: PRIMES

(1) EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

APPENDIX 3A

Assumptions by group of countries (EU-25, EU-15, new Member states (NMS))

APPENDIX 3A

DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS FOR THE LOW AND HIGH ECONOMIC GROWTH SCENARIOS

LOW ECONOMIC GROWTH SCENARIO
EU - 25: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	441.1	453.4	461.2	462.1	458.2	0.3	0.2	0.0	-0.1					
Average household size (persons)	2.6	2.4	2.3	2.1	2.0	-0.8	-0.8	-0.6	-0.5					
Number of households (Million)	167.0	185.8	204.2	217.9	227.6	1.1	1.0	0.6	0.4					
Gross Domestic product (in 000 MEuro'00)	**7315.2**	**8939.3**	**10881.0**	**13363.9**	**16097.4**	**2.0**	**2.0**	**2.1**	**1.9**					
Households expenditure (in 000 MEuro'00)	**4255.6**	**5161.0**	**6253.2**	**7622.0**	**9055.0**	**1.9**	**1.9**	**2.0**	**1.7**					
Gross Value Added (in 000 MEuro'00)	**6833.4**	**8350.5**	**10314.1**	**12720.1**	**15352.4**	**2.0**	**2.1**	**2.1**	**1.9**					
Industry	1485.6	1697.8	2081.1	2577.8	3116.0	1.3	2.1	2.2	1.9	21.7	20.3	20.2	20.3	20.3
iron and steel	58.7	52.5	52.3	53.1	53.1	-1.1	0.0	0.1	0.0	0.9	0.6	0.5	0.4	0.3
non ferrous metals	21.0	23.8	31.8	40.4	49.5	1.3	2.9	2.4	2.0	0.3	0.3	0.3	0.3	0.3
chemicals	158.2	195.2	245.5	307.6	372.8	2.1	2.3	2.3	1.9	2.3	2.3	2.4	2.4	2.4
petrochemicals, fertilisers and others	102.3	114.6	133.0	151.6	166.9	1.1	1.5	1.3	1.0	1.5	1.4	1.3	1.2	1.1
pharmaceuticals and cosmetics	55.9	80.6	112.4	156.0	205.9	3.7	3.4	3.3	2.8	0.8	1.0	1.1	1.2	1.3
non metallic minerals	70.9	75.5	87.3	103.4	118.5	0.6	1.5	1.7	1.4	1.0	0.9	0.8	0.8	0.8
paper, pulp, printing	121.5	147.5	181.6	223.1	262.7	2.0	2.1	2.1	1.6	1.8	1.8	1.8	1.8	1.7
paper and pulp production	22.4	27.2	31.9	37.1	41.7	1.9	1.6	1.5	1.2	0.3	0.3	0.3	0.3	0.3
printing and publishing	99.1	120.3	149.7	185.9	220.9	2.0	2.2	2.2	1.7	1.5	1.4	1.5	1.5	1.4
food, drink, tobacco	170.7	203.2	249.3	305.5	361.2	1.8	2.1	2.1	1.7	2.5	2.4	2.4	2.4	2.4
textiles and leather	103.2	86.1	86.2	89.7	91.8	-1.8	0.0	0.4	0.2	1.5	1.0	0.8	0.7	0.6
engineering	641.9	756.5	955.9	1224.8	1537.9	1.7	2.4	2.5	2.3	9.4	9.1	9.3	9.6	10.0
other industries	139.4	157.5	191.2	230.2	268.6	1.2	2.0	1.9	1.6	2.0	1.9	1.9	1.8	1.7
Construction	431.3	439.3	510.4	609.5	708.0	0.2	1.5	1.8	1.5	6.3	5.3	4.9	4.8	4.6
Services	4482.3	5708.7	7169.5	8911.5	10844.1	2.4	2.3	2.2	2.0	65.6	68.4	69.5	70.1	70.6
market services	1603.1	2154.2	2845.2	3655.7	4574.3	3.0	2.8	2.5	2.3	23.5	25.8	27.6	28.7	29.8
non-market services	1450.5	1700.4	1929.1	2223.7	2527.3	1.6	1.3	1.4	1.3	21.2	20.4	18.7	17.5	16.5
trade	1428.7	1854.1	2395.2	3032.0	3742.4	2.6	2.6	2.4	2.1	20.9	22.2	23.2	23.8	24.4
Agriculture	198.5	221.8	242.9	266.8	286.7	1.1	0.9	0.9	0.7	2.9	2.7	2.4	2.1	1.9
Energy sector	235.8	282.9	310.2	354.5	397.5	1.8	0.9	1.3	1.2	3.5	3.4	3.0	2.8	2.6

Source: PRIMES

HIGH ECONOMIC GROWTH SCENARIO
EU - 25: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	441.1	453.4	461.2	462.1	458.2	0.3	0.2	0.0	-0.1					
Average household size (persons)	2.6	2.4	2.3	2.1	2.0	-0.8	-0.8	-0.6	-0.5					
Number of households (Million)	167.0	185.8	204.2	217.9	227.6	1.1	1.0	0.6	0.4					
Gross Domestic product (in 000 MEuro'00)	**7315.2**	**8939.3**	**11983.4**	**15588.1**	**19944.3**	**2.0**	**3.0**	**2.7**	**2.5**					
Households expenditure (in 000 MEuro'00)	**4255.6**	**5161.0**	**6870.9**	**8865.2**	**11184.4**	**1.9**	**2.9**	**2.6**	**2.4**					
Gross Value Added (in 000 MEuro'00)	**6833.4**	**8350.5**	**11361.7**	**14840.7**	**19027.3**	**2.0**	**3.1**	**2.7**	**2.5**					
Industry	1485.6	1697.8	2268.7	2955.3	3765.0	1.3	2.9	2.7	2.5	21.7	20.3	20.0	19.9	19.8
iron and steel	58.7	52.5	55.0	57.4	58.9	-1.1	0.5	0.4	0.3	0.9	0.6	0.5	0.4	0.3
non ferrous metals	21.0	23.8	34.0	44.7	56.8	1.3	3.6	2.8	2.4	0.3	0.3	0.3	0.3	0.3
chemicals	158.2	195.2	268.2	353.0	449.9	2.1	3.2	2.8	2.5	2.3	2.3	2.4	2.4	2.4
petrochemicals, fertilisers and others	102.3	114.6	141.8	166.6	188.7	1.1	2.2	1.6	1.3	1.5	1.4	1.2	1.1	1.0
pharmaceuticals and cosmetics	55.9	80.6	126.4	186.4	261.2	3.7	4.6	4.0	3.4	0.8	1.0	1.1	1.3	1.4
non metallic minerals	70.9	75.5	93.4	114.9	136.7	0.6	2.1	2.1	1.8	1.0	0.9	0.8	0.8	0.7
paper, pulp, printing	121.5	147.5	194.3	248.6	305.3	2.0	2.8	2.5	2.1	1.8	1.8	1.7	1.7	1.6
paper and pulp production	22.4	27.2	33.1	39.4	45.4	1.9	2.0	1.8	1.4	0.3	0.3	0.3	0.3	0.2
printing and publishing	99.1	120.3	161.2	209.2	259.9	2.0	3.0	2.6	2.2	1.5	1.4	1.4	1.4	1.4
food, drink, tobacco	170.7	203.2	270.8	348.9	434.6	1.8	2.9	2.6	2.2	2.5	2.4	2.4	2.4	2.3
textiles and leather	103.2	86.1	91.1	97.7	103.0	-1.8	0.6	0.7	0.5	1.5	1.0	0.8	0.7	0.5
engineering	641.9	756.5	1053.7	1426.9	1897.2	1.7	3.4	3.1	2.9	9.4	9.1	9.3	9.6	10.0
other industries	139.4	157.5	208.1	263.2	322.5	1.2	2.8	2.4	2.1	2.0	1.9	1.8	1.8	1.7
Construction	431.3	439.3	558.0	702.6	862.1	0.2	2.4	2.3	2.1	6.3	5.3	4.9	4.7	4.5
Services	4482.3	5708.7	7946.3	10495.0	13610.6	2.4	3.4	2.8	2.6	65.6	68.4	69.9	70.7	71.5
market services	1603.1	2154.2	3161.9	4318.4	5761.3	3.0	3.9	3.2	2.9	23.5	25.8	27.8	29.1	30.3
non-market services	1450.5	1700.4	2127.1	2596.6	3133.2	1.6	2.3	2.0	1.9	21.2	20.4	18.7	17.5	16.5
trade	1428.7	1854.1	2657.3	3580.1	4716.1	2.6	3.7	3.0	2.8	20.9	22.2	23.4	24.1	24.8
Agriculture	198.5	221.8	252.2	283.2	311.0	1.1	1.3	1.2	0.9	2.9	2.7	2.2	1.9	1.6
Energy sector	235.8	282.9	336.5	404.5	478.7	1.8	1.8	1.9	1.7	3.5	3.4	3.0	2.7	2.5

Source: PRIMES

DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS FOR THE LOW AND HIGH ECONOMIC GROWTH SCENARIOS

LOW ECONOMIC GROWTH SCENARIO
EUROPE 15: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	366.0	378.7	387.8	390.4	389.0	0.3	0.2	0.1	0.0					
Average household size (persons)	2.6	2.4	2.2	2.1	2.0	-0.8	-0.8	-0.7	-0.5					
Number of households (Million)	141.3	157.7	174.2	187.3	197.1	1.1	1.0	0.7	0.5					
Gross Domestic product (in 000 MEuro'00)	**6982.1**	**8545.0**	**10322.0**	**12577.3**	**15055.6**	**2.0**	**1.9**	**2.0**	**1.8**					
Households expenditure (in 000 MEuro'00)	**3998.7**	**4863.3**	**5829.4**	**7010.6**	**8251.9**	**2.0**	**1.8**	**1.9**	**1.6**					
Gross Value Added (in 000 MEuro'00)	**6537.9**	**8003.5**	**9818.1**	**12010.4**	**14414.0**	**2.0**	**2.1**	**2.0**	**1.8**					
Industry	1407.4	1609.6	1953.1	2399.6	2895.7	1.4	2.0	2.1	1.9	21.5	20.1	19.9	20.0	20.1
iron and steel	54.6	49.2	48.5	48.8	48.4	-1.0	-0.1	0.1	-0.1	0.8	0.6	0.5	0.4	0.3
non ferrous metals	20.5	23.2	31.0	39.4	48.4	1.2	3.0	2.4	2.1	0.3	0.3	0.3	0.3	0.3
chemicals	152.1	188.1	233.0	289.1	349.0	2.1	2.2	2.2	1.9	2.3	2.4	2.4	2.4	2.4
petrochemicals, fertilisers and others	98.0	110.5	126.9	143.2	156.4	1.2	1.4	1.2	0.9	1.5	1.4	1.3	1.2	1.1
pharmaceuticals and cosmetics	54.1	77.6	106.1	145.9	192.6	3.7	3.2	3.2	2.8	0.8	1.0	1.1	1.2	1.3
non metallic minerals	67.5	70.2	80.1	93.9	107.2	0.4	1.3	1.6	1.3	1.0	0.9	0.8	0.8	0.7
paper, pulp, printing	117.6	141.8	172.8	210.2	246.4	1.9	2.0	2.0	1.6	1.8	1.8	1.8	1.8	1.7
paper and pulp production	21.3	26.1	30.3	35.0	39.1	2.0	1.5	1.4	1.1	0.3	0.3	0.3	0.3	0.3
printing and publishing	96.3	115.7	142.5	175.2	207.3	1.9	2.1	2.1	1.7	1.5	1.4	1.5	1.5	1.4
food, drink, tobacco	158.5	185.9	224.2	272.6	322.2	1.6	1.9	2.0	1.7	2.4	2.3	2.3	2.3	2.2
textiles and leather	94.1	79.7	78.7	81.2	82.6	-1.7	-0.1	0.3	0.2	1.4	1.0	0.8	0.7	0.6
engineering	615.4	726.0	911.5	1158.7	1453.1	1.7	2.3	2.4	2.3	9.4	9.1	9.3	9.6	10.1
other industries	127.2	145.5	173.3	205.7	238.4	1.4	1.8	1.7	1.5	1.9	1.8	1.8	1.7	1.7
Construction	407.7	418.0	480.2	565.6	650.7	0.3	1.4	1.6	1.4	6.2	5.2	4.9	4.7	4.5
Services	4330.7	5509.5	6873.4	8470.5	10234.6	2.4	2.2	2.1	1.9	66.2	68.8	70.0	70.5	71.0
market services	1568.5	2100.8	2755.8	3510.5	4361.7	3.0	2.8	2.4	2.2	24.0	26.2	28.1	29.2	30.3
non-market services	1396.3	1642.6	1849.7	2111.7	2378.0	1.6	1.2	1.3	1.2	21.4	20.5	18.8	17.6	16.5
trade	1365.9	1766.1	2267.9	2848.3	3494.9	2.6	2.5	2.3	2.1	20.9	22.1	23.1	23.7	24.2
Agriculture	179.4	201.9	220.4	240.9	257.6	1.2	0.9	0.9	0.7	2.7	2.5	2.2	2.0	1.8
Energy sector	212.7	264.6	291.0	333.8	375.5	2.2	1.0	1.4	1.2	3.3	3.3	3.0	2.8	2.6

Source: PRIMES

HIGH ECONOMIC GROWTH SCENARIO
EUROPE 15: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	366.0	378.7	387.8	390.4	389.0	0.3	0.2	0.1	0.0					
Average household size (persons)	2.6	2.4	2.2	2.1	2.0	-0.8	-0.8	-0.7	-0.5					
Number of households (Million)	141.3	157.7	174.2	187.3	197.1	1.1	1.0	0.7	0.5					
Gross Domestic product (in 000 MEuro'00)	**6982.1**	**8545.0**	**11395.6**	**14722.9**	**18750.4**	**2.0**	**2.9**	**2.6**	**2.4**					
Households expenditure (in 000 MEuro'00)	**3998.7**	**4863.3**	**6425.7**	**8193.3**	**10265.1**	**2.0**	**2.8**	**2.5**	**2.3**					
Gross Value Added (in 000 MEuro'00)	**6537.9**	**8003.5**	**10839.7**	**14059.6**	**17951.4**	**2.0**	**3.1**	**2.6**	**2.5**					
Industry	1407.4	1609.6	2134.3	2760.6	3515.2	1.4	2.9	2.6	2.4	21.5	20.1	19.7	19.6	19.6
iron and steel	54.6	49.2	51.1	52.8	53.9	-1.0	0.4	0.3	0.2	0.8	0.6	0.5	0.4	0.3
non ferrous metals	20.5	23.2	33.2	43.7	55.5	1.2	3.6	2.8	2.4	0.3	0.3	0.3	0.3	0.3
chemicals	152.1	188.1	255.2	332.8	422.9	2.1	3.1	2.7	2.4	2.3	2.4	2.4	2.4	2.4
petrochemicals, fertilisers and others	98.0	110.5	135.6	157.7	177.4	1.2	2.1	1.5	1.2	1.5	1.4	1.3	1.1	1.0
pharmaceuticals and cosmetics	54.1	77.6	119.6	175.1	245.6	3.7	4.4	3.9	3.4	0.8	1.0	1.1	1.2	1.4
non metallic minerals	67.5	70.2	85.9	104.7	124.2	0.4	2.0	2.0	1.7	1.0	0.9	0.8	0.7	0.7
paper, pulp, printing	117.6	141.8	185.2	234.8	287.3	1.9	2.7	2.4	2.0	1.8	1.8	1.7	1.7	1.6
paper and pulp production	21.3	26.1	31.5	37.2	42.6	2.0	1.9	1.7	1.4	0.3	0.3	0.3	0.3	0.2
printing and publishing	96.3	115.7	153.7	197.6	244.7	1.9	2.9	2.5	2.2	1.5	1.4	1.4	1.4	1.4
food, drink, tobacco	158.5	185.9	244.6	313.0	390.5	1.6	2.8	2.5	2.2	2.4	2.3	2.3	2.2	2.2
textiles and leather	94.1	79.7	83.3	88.7	93.1	-1.7	0.4	0.6	0.5	1.4	1.0	0.8	0.6	0.5
engineering	615.4	726.0	1006.6	1353.7	1799.5	1.7	3.3	3.0	2.9	9.4	9.1	9.3	9.6	10.0
other industries	127.2	145.5	189.3	236.3	288.3	1.4	2.7	2.2	2.0	1.9	1.8	1.7	1.7	1.6
Construction	407.7	418.0	526.5	654.8	797.1	0.3	2.3	2.2	2.0	6.2	5.2	4.9	4.7	4.4
Services	4330.7	5509.5	7633.3	10006.1	12905.2	2.4	3.3	2.7	2.6	66.2	68.8	70.4	71.2	71.9
market services	1568.5	2100.8	3067.3	4157.1	5514.9	3.0	3.9	3.1	2.9	24.0	26.2	28.3	29.6	30.7
non-market services	1396.3	1642.6	2043.3	2472.8	2961.4	1.6	2.2	1.9	1.8	21.4	20.5	18.9	17.6	16.5
trade	1365.9	1766.1	2522.8	3376.2	4428.9	2.6	3.6	3.0	2.8	20.9	22.1	23.3	24.0	24.7
Agriculture	179.4	201.9	229.3	256.3	280.2	1.2	1.3	1.1	0.9	2.7	2.5	2.1	1.8	1.6
Energy sector	212.7	264.6	316.4	381.9	453.8	2.2	1.8	1.9	1.7	3.3	3.3	2.9	2.7	2.5

Source: PRIMES

APPENDIX 3A

DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS FOR THE LOW AND HIGH ECONOMIC GROWTH SCENARIOS

LOW ECONOMIC GROWTH SCENARIO
NEW MEMBER STATES: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	75.1	74.7	73.4	71.7	69.1	-0.1	-0.2	-0.2	-0.4					
Average household size (persons)	2.9	2.7	2.4	2.3	2.3	-0.9	-0.8	-0.4	-0.3					
Number of households (Million)	25.7	28.1	30.0	30.5	30.5	0.9	0.7	0.2	0.0					
Gross Domestic product (in 000 MEuro'00)	**333.1**	**394.3**	**559.0**	**786.6**	**1041.8**	**1.7**	**3.6**	**3.5**	**2.8**					
Households expenditure (in 000 MEuro'00)	**256.9**	**297.6**	**423.8**	**611.4**	**803.1**	**1.5**	**3.6**	**3.7**	**2.8**					
Gross Value Added (in 000 MEuro'00)	**295.5**	**347.0**	**496.0**	**709.7**	**938.3**	**1.6**	**3.6**	**3.6**	**2.8**					
Industry	78.1	88.2	128.0	178.2	220.3	1.2	3.8	3.4	2.1	26.4	25.4	25.8	25.1	23.5
iron and steel	4.1	3.3	3.9	4.3	4.6	-2.2	1.6	1.1	0.7	1.4	1.0	0.8	0.6	0.5
non ferrous metals	0.5	0.7	0.8	1.0	1.2	2.6	2.0	2.4	1.3	0.2	0.2	0.2	0.1	0.1
chemicals	6.1	7.1	12.4	18.5	23.8	1.5	5.8	4.0	2.6	2.1	2.0	2.5	2.6	2.5
petrochemicals, fertilisers and others	4.3	4.1	6.1	8.4	10.5	-0.5	4.0	3.3	2.2	1.5	1.2	1.2	1.2	1.1
pharmaceuticals and cosmetics	1.8	3.0	6.3	10.1	13.3	5.2	7.8	4.7	2.8	0.6	0.9	1.3	1.4	1.4
non metallic minerals	3.4	5.3	7.2	9.5	11.3	4.6	3.0	2.9	1.8	1.2	1.5	1.4	1.3	1.2
paper, pulp, printing	3.9	5.7	8.8	12.9	16.3	3.8	4.4	3.9	2.4	1.3	1.6	1.8	1.8	1.7
paper and pulp production	1.1	1.1	1.5	2.1	2.6	0.0	3.1	3.4	2.1	0.4	0.3	0.3	0.3	0.3
printing and publishing	2.8	4.6	7.2	10.7	13.6	5.0	4.7	4.0	2.4	1.0	1.3	1.5	1.5	1.5
food, drink, tobacco	12.2	17.3	25.1	32.9	39.0	3.6	3.8	2.7	1.7	4.1	5.0	5.1	4.6	4.2
textiles and leather	9.1	6.4	7.5	8.5	9.1	-3.4	1.6	1.2	0.7	3.1	1.8	1.5	1.2	1.0
engineering	26.6	30.4	44.4	66.1	84.8	1.4	3.8	4.1	2.5	9.0	8.8	9.0	9.3	9.0
other industries	12.2	12.0	17.9	24.5	30.2	-0.2	4.1	3.2	2.1	4.1	3.4	3.6	3.5	3.2
Construction	23.7	21.3	30.2	43.9	57.4	-1.0	3.5	3.8	2.7	8.0	6.1	6.1	6.2	6.1
Services	151.6	199.2	296.1	441.0	609.5	2.8	4.0	4.1	3.3	51.3	57.4	59.7	62.1	65.0
market services	34.6	53.4	89.4	145.3	212.7	4.4	5.3	5.0	3.9	11.7	15.4	18.0	20.5	22.7
non-market services	54.1	57.9	79.4	112.0	149.3	0.7	3.2	3.5	2.9	18.3	16.7	16.0	15.8	15.9
trade	62.8	88.0	127.3	183.7	247.5	3.4	3.8	3.7	3.0	21.3	25.3	25.7	25.9	26.4
Agriculture	19.0	19.9	22.5	25.9	29.2	0.5	1.2	1.4	1.2	6.4	5.7	4.5	3.7	3.1
Energy sector	23.1	18.3	19.2	20.7	22.0	-2.3	0.5	0.8	0.6	7.8	5.3	3.9	2.9	2.3

Source: PRIMES

HIGH ECONOMIC GROWTH SCENARIO
NEW MEMBER STATES: KEY DEMOGRAPHIC AND ECONOMIC ASSUMPTIONS

	1990	2000	2010	2020	2030	'90-'00	'00-'10	'10-'20	'20-'30	1990	2000	2010	2020	2030
						Annual % Change				% Structure of total value added				
Main Demographic Assumptions														
Population (Million)	75.1	74.7	73.4	71.7	69.1	-0.1	-0.2	-0.2	-0.4					
Average household size (persons)	2.9	2.7	2.4	2.3	2.3	-0.9	-0.8	-0.4	-0.3					
Number of households (Million)	25.7	28.1	30.0	30.5	30.5	0.9	0.7	0.2	0.0					
Gross Domestic product (in 000 MEuro'00)	**333.1**	**394.3**	**587.8**	**865.2**	**1193.9**	**1.7**	**4.1**	**3.9**	**3.3**					
Households expenditure (in 000 MEuro'00)	**256.9**	**297.6**	**445.2**	**671.9**	**919.4**	**1.5**	**4.1**	**4.2**	**3.2**					
Gross Value Added (in 000 MEuro'00)	**295.5**	**347.0**	**521.9**	**781.1**	**1075.9**	**1.6**	**4.2**	**4.1**	**3.3**					
Industry	78.1	88.2	134.4	194.7	249.7	1.2	4.3	3.8	2.5	26.4	25.4	25.8	24.9	23.2
iron and steel	4.1	3.3	4.0	4.6	5.0	-2.2	1.8	1.3	0.9	1.4	1.0	0.8	0.6	0.5
non ferrous metals	0.5	0.7	0.8	1.1	1.3	2.6	2.4	2.7	1.5	0.2	0.2	0.2	0.1	0.1
chemicals	6.1	7.1	13.0	20.2	27.0	1.5	6.3	4.5	2.9	2.1	2.0	2.5	2.6	2.5
petrochemicals, fertilisers and others	4.3	4.1	6.3	8.9	11.3	-0.5	4.4	3.5	2.4	1.5	1.2	1.2	1.1	1.1
pharmaceuticals and cosmetics	1.8	3.0	6.7	11.3	15.6	5.2	8.5	5.3	3.3	0.6	0.9	1.3	1.4	1.5
non metallic minerals	3.4	5.3	7.5	10.2	12.5	4.6	3.4	3.2	2.0	1.2	1.5	1.4	1.3	1.2
paper, pulp, printing	3.9	5.7	9.1	13.8	18.0	3.8	4.8	4.2	2.7	1.3	1.6	1.7	1.8	1.7
paper and pulp production	1.1	1.1	1.6	2.2	2.8	0.0	3.3	3.6	2.3	0.4	0.3	0.3	0.3	0.3
printing and publishing	2.8	4.6	7.5	11.6	15.2	5.0	5.1	4.4	2.8	1.0	1.3	1.4	1.5	1.4
food, drink, tobacco	12.2	17.3	26.2	35.9	44.1	3.6	4.3	3.2	2.1	4.1	5.0	5.0	4.6	4.1
textiles and leather	9.1	6.4	7.7	8.9	9.9	-3.4	1.9	1.4	1.0	3.1	1.8	1.5	1.1	0.9
engineering	26.6	30.4	47.2	73.2	97.8	1.4	4.5	4.5	2.9	9.0	8.8	9.0	9.4	9.1
other industries	12.2	12.0	18.8	26.8	34.3	-0.2	4.6	3.6	2.5	4.1	3.4	3.6	3.4	3.2
Construction	23.7	21.3	31.5	47.9	65.0	-1.0	4.0	4.3	3.1	8.0	6.1	6.0	6.1	6.0
Services	151.6	199.2	312.9	489.0	705.5	2.8	4.6	4.6	3.7	51.3	57.4	60.0	62.6	65.6
market services	34.6	53.4	94.6	161.3	246.4	4.4	5.9	5.5	4.3	11.7	15.4	18.1	20.7	22.9
non-market services	54.1	57.9	83.8	123.8	171.9	0.7	3.8	4.0	3.3	18.3	16.7	16.1	15.8	16.0
trade	62.8	88.0	134.5	203.9	287.2	3.4	4.3	4.2	3.5	21.3	25.3	25.8	26.1	26.7
Agriculture	19.0	19.9	23.0	26.9	30.8	0.5	1.4	1.6	1.4	6.4	5.7	4.4	3.4	2.9
Energy sector	23.1	18.3	20.2	22.6	24.9	-2.3	1.0	1.2	1.0	7.8	5.3	3.9	2.9	2.3

Source: PRIMES

APPENDIX 3B

Summary energy balances and indicators by group of countries (EU-25, EU-15, new Member states (NMS)) – comparison to baseline

- Low growth case
- High growth case

EU25: LOW ECONOMIC GROWTH SCENARIO — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**853.0**	**724.7**	**641.2**	**-7.4**	**-16.2**	**-19.7**	**-0.9**	**-2.2**	**-3.0**
Solids	350.8	264.7	203.4	152.6	118.1	98.7	-1.2	-8.2	-3.9	-0.8	-6.5	-3.8
Oil	120.3	162.2	163.5	131.0	101.3	85.3	-0.7	-0.7	-1.1	-0.5	-0.7	-1.3
Natural gas	139.6	174.0	196.6	194.7	146.6	115.5	-2.1	-0.9	-1.6	-1.1	-0.6	-1.4
Nuclear	196.9	215.3	237.7	245.2	211.6	180.0	0.0	-1.9	-5.3	0.0	-0.9	-2.9
Renewable energy sources	69.2	80.7	96.1	129.4	146.9	161.7	-3.3	-4.4	-7.8	-2.5	-2.9	-4.6
Hydro	23.4	26.3	29.0	29.8	31.5	31.7	-0.3	-0.2	-0.6	-0.9	-0.6	-1.7
Biomass	31.1	35.4	42.2	55.9	62.3	68.9	-1.6	-2.6	-4.8	-2.8	-4.1	-6.5
Waste	12.3	15.9	19.3	25.3	27.5	26.5	-0.4	-0.3	-0.7	-1.7	-0.9	-2.5
Wind	0.1	0.4	1.9	13.0	19.2	26.1	-0.9	-0.9	-0.7	-6.3	-4.4	-2.7
Solar and others	0.1	0.3	0.4	1.6	2.8	4.8	-0.1	-0.2	-0.5	-3.5	-5.2	-8.7
Geothermal	2.2	2.5	3.3	3.7	3.7	3.7	0.0	-0.2	-0.5	-0.8	-5.8	-12.3
Net Imports	**711.6**	**701.7**	**799.3**	**925.5**	**1120.3**	**1230.0**	**-49.0**	**-84.3**	**-131.8**	**-5.0**	**-7.0**	**-9.7**
Solids	75.2	73.8	91.4	85.3	111.4	173.5	-4.6	-14.9	-23.9	-5.1	-11.8	-12.1
Oil	510.8	491.8	519.6	546.6	586.6	594.4	-25.9	-39.4	-56.5	-4.5	-6.3	-8.7
Crude oil and Feedstocks	480.2	471.5	496.8	524.0	570.8	586.3	-25.8	-40.2	-58.6	-4.7	-6.6	-9.1
Oil products	30.6	20.3	22.8	22.6	15.8	8.1	-0.1	0.8	2.1	-0.5	5.5	35.1
Natural gas	123.5	134.8	186.2	291.5	420.2	459.7	-18.5	-30.0	-51.4	-6.0	-6.7	-10.1
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1730.2**	**1792.3**	**1813.7**	**-54.0**	**-96.6**	**-146.0**	**-3.0**	**-5.1**	**-7.5**
Solids	430.6	346.0	303.2	237.9	229.6	272.2	-5.8	-23.1	-27.8	-2.4	-9.1	-9.3
Oil	596.2	622.2	635.6	629.3	635.3	622.2	-24.2	-36.3	-52.2	-3.7	-5.4	-7.7
Natural gas	259.2	307.1	376.0	486.3	566.8	575.2	-20.6	-30.9	-53.0	-4.1	-5.2	-8.4
Nuclear	196.9	215.3	237.7	245.2	211.6	180.0	0.0	-1.9	-5.3	0.0	-0.9	-2.9
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	129.4	146.9	161.7	-3.3	-4.4	-7.8	-2.5	-2.9	-4.6
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	13.7	12.8	15.0	0.1	-0.6	-0.3	0.7	-4.2	-1.9
Oil	38.4	39.6	38.5	36.4	35.4	34.3	-0.3	-0.1	-0.1	-0.7	-0.3	-0.3
Natural gas	16.7	19.5	22.8	28.1	31.6	31.7	-0.3	0.0	-0.3	-1.1	-0.1	-1.1
Nuclear	12.7	13.7	14.4	14.2	11.8	9.9	0.4	0.5	0.5	3.1	4.5	5.0
Renewable energy forms	4.5	5.1	5.8	7.5	8.2	8.9	0.0	0.2	0.3	0.6	2.3	3.1
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3296.2**	**3723.4**	**4034.1**	**-122.9**	**-225.2**	**-363.1**	**-3.6**	**-5.7**	**-8.3**
Nuclear	780.0	864.4	921.2	952.3	826.1	744.4	-0.1	-7.4	-22.1	0.0	-0.9	-2.9
Hydro & wind	272.7	309.7	359.5	499.1	589.8	688.2	-13.5	-12.7	-17.3	-2.6	-2.1	-2.4
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1844.8	2307.6	2601.4	-109.3	-205.1	-323.7	-5.6	-8.2	-11.1
Fuel Inputs for Thermal Power Generation [1]	**364.4**	**360.8**	**384.6**	**393.4**	**446.9**	**485.4**	**-19.9**	**-36.0**	**-55.5**	**-4.8**	**-7.5**	**-10.3**
Solids	248.2	221.1	210.1	170.6	170.9	218.6	-4.6	-21.4	-25.6	-2.6	-11.1	-10.5
Oil (including refinery gas)	53.7	53.9	41.5	20.1	13.2	9.3	-3.6	-0.4	-0.1	-15.2	-2.7	-1.5
Gas	50.4	70.0	112.6	174.3	232.3	227.9	-10.8	-13.4	-27.4	-5.8	-5.5	-10.7
Biomass - Waste	10.3	13.6	17.5	25.0	27.0	26.2	-0.9	-0.6	-1.9	-3.3	-2.3	-6.8
Geothermal heat	1.9	2.1	3.0	3.4	3.4	3.4	0.0	-0.2	-0.5	0.0	-5.6	-12.5
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**777.4**	**797.0**	**803.6**	**-29.7**	**-46.2**	**-68.1**	**-3.7**	**-5.5**	**-7.8**
Refineries	641.3	675.9	710.9	705.1	723.3	724.6	-28.2	-43.7	-63.8	-3.8	-5.7	-8.1
District heating	31.7	23.1	14.5	10.4	8.6	8.0	-0.4	-0.3	-0.8	-3.5	-3.1	-8.6
Biofuels and hydrogen production	0.0	0.2	0.6	9.9	17.2	25.5	-0.3	-0.9	-2.0	-3.2	-5.1	-7.3
Others	127.6	81.2	68.3	52.0	47.9	45.4	-0.8	-1.2	-1.6	-1.6	-2.5	-3.3
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**74.9**	**73.7**	**71.8**	**-2.2**	**-3.5**	**-5.3**	**-2.8**	**-4.6**	**-6.9**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**111.1**	**116.3**	**117.8**	**-3.2**	**-5.1**	**-7.1**	**-2.8**	**-4.2**	**-5.7**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1170.1**	**1248.4**	**1289.1**	**-38.9**	**-69.5**	**-105.0**	**-3.2**	**-5.3**	**-7.5**
by sector												
Industry [1]	327.2	303.3	309.1	329.2	350.9	363.8	-9.6	-16.5	-24.7	-2.8	-4.5	-6.4
energy intensive industries	212.9	198.9	202.0	211.3	218.3	218.1	-5.0	-7.9	-10.9	-2.3	-3.5	-4.8
other industrial sectors	114.3	104.4	107.0	117.9	132.6	145.6	-4.6	-8.6	-13.9	-3.8	-6.1	-8.7
Residential	268.1	277.2	279.1	299.1	312.0	313.7	-9.5	-17.1	-25.1	-3.1	-5.2	-7.4
Tertiary	140.2	147.5	154.2	168.3	184.1	202.1	-6.0	-10.3	-16.0	-3.4	-5.3	-7.3
Transport	273.7	295.6	332.0	373.4	401.4	409.5	-13.8	-25.6	-39.2	-3.6	-6.0	-8.7
by fuel (1)												
Solids	117.7	80.8	57.4	41.4	35.1	30.7	-0.8	-1.1	-1.4	-2.0	-3.1	-4.4
Oil	424.2	443.7	464.2	486.6	507.1	509.7	-16.9	-30.4	-45.0	-3.3	-5.7	-8.1
Gas	196.2	219.5	245.7	291.1	308.6	319.8	-8.8	-16.3	-23.6	-2.9	-5.0	-6.9
Electricity	176.5	187.9	211.3	244.0	279.8	306.4	-9.4	-17.2	-28.0	-3.7	-5.8	-8.4
Heat (from CHP and District Heating)	62.9	56.7	55.6	63.0	72.8	78.4	-2.0	-2.9	-5.3	-3.1	-3.8	-6.3
Other	32.1	35.3	40.3	44.0	44.9	44.1	-0.9	-1.5	-1.8	-2.1	-3.3	-3.8
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.6**	**3664.9**	**3622.4**	**3782.1**	**3933.7**	**-134.8**	**-258.5**	**-369.9**	**-3.6**	**-6.4**	**-8.6**
Electricity and Steam production	1341.0	1242.7	1228.3	1179.5	1284.1	1445.7	-55.8	-118.9	-167.3	-4.5	-8.5	-10.4
Energy Branch	144.2	163.9	164.0	141.3	136.4	129.5	-4.5	-6.7	-9.6	-3.1	-4.7	-6.9
Industry	713.2	644.8	605.7	529.6	520.7	515.8	-14.8	-25.1	-36.2	-2.7	-4.6	-6.6
Residential	519.7	490.4	462.6	468.7	472.7	458.4	-12.9	-22.4	-28.8	-2.7	-4.5	-5.9
Tertiary	256.8	251.0	236.7	233.4	230.2	239.4	-6.1	-10.8	-15.4	-2.6	-4.5	-6.0
Transport	794.6	858.8	967.5	1069.8	1138.1	1145.0	-40.6	-74.6	-112.6	-3.7	-6.2	-9.0
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**96.1**	**100.3**	**104.4**	**-3.6**	**-6.9**	**-9.8**	-3.6	-6.4	-8.6

See explanations on the last page of the Appendix

Source: PRIMES

EU25: LOW ECONOMIC GROWTH SCENARIO — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	10881	13364	16097	-552	-1098	-1923	-4.8	-7.6	-10.7
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	159.0	134.1	112.7	3.0	3.5	3.9	1.9	2.7	3.6
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.8	3.9	4.0	-0.1	-0.2	-0.3	-3.0	-5.1	-7.5
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	7147	8057	8805	-266	-487	-792	-3.6	-5.7	-8.3
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.09	2.11	2.17	-0.01	-0.03	-0.03	-0.6	-1.4	-1.2
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	7.9	8.2	8.6	-0.3	-0.6	-0.8	-3.6	-6.4	-8.6
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	332.9	283.0	244.4	4.3	3.6	5.6	1.3	1.3	2.3
Import Dependency %	44.8	43.6	47.2	52.0	60.7	65.7	-1.1	-1.2	-1.6	-2.0	-1.9	-2.4
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	71.8	61.8	53.0	0.9	1.3	1.7	1.2	2.2	3.3
Residential (Energy on Private Income)	100.0	98.1	85.8	75.9	65.0	55.0	1.5	1.9	2.2	2.0	3.0	4.3
Tertiary (Energy on Value added)	100.0	96.7	86.8	75.8	67.0	60.6	0.9	1.7	2.4	1.2	2.6	4.1
Transport (Energy on GDP)	100.0	101.1	99.3	91.7	80.3	68.0	1.2	1.4	1.4	1.3	1.7	2.2
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.29	0.28	0.29	0.00	-0.01	-0.01	-1.1	-3.3	-2.7
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.97	1.89	1.83	0.00	0.00	0.00	0.1	-0.1	0.0
Industry	2.18	2.13	1.96	1.61	1.48	1.42	0.00	0.00	0.00	0.1	-0.1	-0.2
Residential	1.94	1.77	1.66	1.57	1.52	1.46	0.01	0.01	0.02	0.4	0.7	1.6
Tertiary	1.83	1.70	1.54	1.39	1.25	1.18	0.01	0.01	0.02	0.9	0.9	1.4
Transport	2.90	2.91	2.91	2.86	2.84	2.80	0.00	0.00	-0.01	-0.1	-0.2	-0.2
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**758.9**	**896.2**	**1034.8**	**-25.0**	**-50.5**	**-83.4**	**-3.2**	**-5.3**	**-7.5**
Nuclear		134.7	140.3	129.8	108.2	105.8	0.0	0.2	-2.0	0.0	0.2	-1.9
Hydro (pumping excluded)		93.3	96.2	104.3	108.8	110.7	-0.3	-0.5	-1.4	-0.3	-0.4	-1.3
Wind and solar		2.5	13.0	68.7	100.5	145.0	-4.5	-3.6	-4.2	-6.1	-3.4	-2.8
Thermal		386.9	406.7	456.1	578.6	673.3	-20.2	-46.7	-75.7	-4.2	-7.5	-10.1
of which cogeneration units		*87.3*	*103.4*	*128.5*	*161.7*	*187.8*	*-1.2*	*-6.4*	*-10.9*	*-0.9*	*-3.8*	*-5.5*
Open cycle(incl. biomass-waste)		343.8	335.6	266.2	168.2	139.1	-4.4	-7.1	-8.3	-1.6	-4.1	-5.6
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.6	50.7	127.4	-0.4	-16.0	-22.5	-38.6	-24.0	-15.0
Gas Turbines Combined Cycle		20.4	47.4	156.3	299.1	341.1	-13.2	-19.7	-43.5	-7.8	-6.2	-11.3
Small Gas Turbines		22.0	22.8	31.8	59.5	64.5	-2.2	-3.8	-1.2	-6.4	-6.0	-1.9
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.2	1.2	0.0	-0.1	-0.2	0.0	-5.8	-12.9
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.1	42.3	46.6	48.3	-0.3	-0.3	-0.3	-0.7	-0.6	-0.7
Load factor for gross electric capacities (%)		48.2	50.4	49.6	47.4	44.5	-0.2	-0.2	-0.4	-0.4	-0.4	-0.9
CHP indicator (% of electricity from CHP)		11.5	12.6	14.6	15.9	16.9	0.2	0.4	0.6	1.5	2.4	3.8
Non fossil fuels in electricity generation (%)		46.8	46.4	46.6	40.5	37.7	1.2	1.7	2.1	2.6	4.4	5.9
nuclear		33.1	31.8	28.9	22.2	18.5	1.0	1.1	1.0	3.7	5.1	5.9
renewable energy forms		13.7	14.6	17.7	18.3	19.3	0.2	0.6	1.1	0.9	3.7	5.9
of which waste		*0.9*	*1.1*	*1.3*	*1.2*	*1.0*	*0.0*	*0.0*	*0.1*	*0.5*	*4.0*	*5.8*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6338.8**	**7309.5**	**8198.0**	**-94.0**	**-199.6**	**-340.9**	-1.5	-2.7	-4.0
public road transport	484.5	469.2	493.8	504.6	532.2	554.0	0.7	-0.8	-1.7	0.1	-0.1	-0.3
private cars and motorcycles	3593.6	3950.3	4291.6	4964.9	5680.5	6314.1	-60.7	-107.8	-160.5	-1.2	-1.9	-2.5
rail transport	408.3	371.7	402.3	413.5	470.8	522.1	-1.4	-8.5	-15.5	-0.3	-1.8	-2.9
aviation	168.5	215.5	298.3	416.4	580.8	756.7	-31.7	-80.8	-160.4	-7.1	-12.2	-17.5
inland navigation	28.9	31.9	33.6	39.4	45.1	51.3	-1.0	-1.7	-2.8	-2.4	-3.6	-5.2
travel per person (km per capita)	10618	11233	12174	13743	15817	17893	-204	-432	-744	-1.5	-2.7	-4.0
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2559.8**	**3090.9**	**3635.5**	**-130.0**	**-248.1**	**-407.3**	-4.8	-7.4	-10.1
trucks	1064.3	1233.6	1482.7	1847.5	2295.8	2769.0	-119.1	-221.0	-363.6	-6.1	-8.8	-11.6
rail transport	440.2	358.0	368.0	376.1	410.8	438.4	-2.2	-9.0	-14.8	-0.6	-2.2	-3.3
inland navigation	258.1	268.2	297.0	336.1	384.3	428.1	-8.7	-18.0	-28.9	-2.5	-4.5	-6.3
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	231	226	0	0	1	0.0	0.2	0.7
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**373.4**	**401.4**	**409.5**	**-13.8**	**-25.6**	**-39.2**	-3.6	-6.0	-8.7
public road transport	7.7	6.9	7.0	7.1	6.9	6.3	0.0	0.0	0.0	0.0	-0.4	-0.8
private cars and motorcycles	138.1	146.1	157.1	166.9	165.4	157.3	-2.1	-3.2	-4.2	-1.2	-1.9	-2.6
trucks	82.9	93.2	108.5	135.4	159.6	173.7	-8.4	-14.8	-21.8	-5.8	-8.5	-11.2
rail transport	8.8	8.9	9.0	8.0	6.5	6.1	0.0	-0.1	-0.2	-0.4	-1.5	-2.6
aviation	29.1	33.8	45.1	49.9	56.1	58.7	-3.1	-7.1	-12.5	-5.9	-11.3	-17.5
inland navigation	7.0	6.7	5.4	6.2	6.8	7.4	-0.1	-0.3	-0.4	-2.1	-3.7	-5.3
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	36.4	32.0	27.8	-0.3	-0.5	-0.9	-0.8	-1.7	-3.0
freight transport (toe/Mtkm)	51.7	54.4	53.8	55.9	54.2	50.0	-0.5	-0.5	-0.5	-0.8	-0.9	-0.9

Source: PRIMES

EU15: LOW ECONOMIC GROWTH SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**736.0**	**620.1**	**553.5**	**-7.0**	**-15.4**	**-19.4**	**-0.9**	**-2.4**	**-3.4**
Solids	209.9	138.0	99.4	69.4	48.4	39.2	-1.0	-7.7	-3.8	-1.4	-13.7	-8.9
Oil	117.7	159.2	160.4	128.5	98.9	83.0	-0.7	-0.7	-1.1	-0.5	-0.7	-1.3
Natural gas	132.9	166.6	190.6	188.9	141.2	110.6	-2.1	-0.9	-1.6	-1.1	-0.6	-1.4
Nuclear	181.4	201.2	222.8	230.3	196.8	174.7	0.0	-1.9	-5.3	0.0	-1.0	-2.9
Renewable energy sources	66.3	74.4	88.1	118.9	134.8	146.0	-3.2	-4.1	-7.6	-2.6	-3.0	-4.9
Hydro	22.3	24.9	27.6	27.8	29.3	29.5	-0.3	-0.2	-0.6	-1.0	-0.7	-1.9
Biomass	29.7	30.8	36.1	49.6	56.0	61.0	-1.6	-2.6	-4.7	-3.0	-4.4	-7.2
Waste	11.9	15.6	18.7	23.9	26.0	24.7	-0.4	-0.3	-0.7	-1.8	-1.0	-2.7
Wind	0.1	0.4	1.9	12.4	17.5	22.9	-0.9	-0.7	-0.7	-6.6	-4.1	-3.0
Solar and others	0.1	0.2	0.3	1.4	2.3	4.1	-0.1	-0.1	-0.4	-3.7	-5.5	-9.5
Geothermal	2.2	2.5	3.3	3.7	3.7	3.7	0.0	-0.2	-0.5	-0.8	-5.8	-12.3
Net Imports	**645.4**	**651.3**	**737.9**	**836.2**	**996.9**	**1084.3**	**-46.1**	**-80.0**	**-123.9**	**-5.2**	**-7.4**	**-10.3**
Solids	89.9	94.4	107.2	92.9	108.6	157.4	-4.1	-14.8	-22.1	-4.2	-12.0	-12.3
Oil	460.9	446.7	472.4	491.9	524.9	528.2	-25.0	-37.9	-54.0	-4.8	-6.7	-9.3
Crude oil and Feedstocks	436.8	434.7	455.5	478.5	518.9	530.1	-25.1	-39.1	-56.6	-5.0	-7.0	-9.6
Oil products	24.1	12.0	16.9	13.4	6.0	-1.9	0.1	1.2	2.6	0.8	24.8	-57.9
Natural gas	92.3	108.6	154.7	248.1	360.2	395.5	-16.9	-27.3	-47.9	-6.4	-7.0	-10.8
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1525.1**	**1565.6**	**1581.6**	**-50.6**	**-91.6**	**-137.9**	**-3.2**	**-5.5**	**-8.0**
Solids	302.8	237.7	212.4	162.3	157.0	196.6	-5.1	-22.5	-25.9	-3.0	-12.5	-11.6
Oil	545.8	575.6	586.9	573.2	572.3	555.1	-23.3	-34.8	-49.6	-3.9	-5.7	-8.2
Natural gas	222.1	273.4	338.7	437.0	501.4	506.1	-19.1	-28.2	-49.5	-4.2	-5.3	-8.9
Nuclear	181.4	201.2	222.8	230.3	196.8	174.7	0.0	-1.9	-5.3	0.0	-1.0	-2.9
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	118.9	134.8	146.0	-3.2	-4.1	-7.6	-2.6	-3.0	-4.9
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	10.6	10.0	12.4	0.0	-0.8	-0.5	0.2	-7.4	-3.9
Oil	41.3	42.2	40.4	37.6	36.6	35.1	-0.3	-0.1	-0.1	-0.7	-0.2	-0.2
Natural gas	16.8	20.0	23.3	28.7	32.0	32.0	-0.3	0.1	-0.3	-1.0	0.2	-1.0
Nuclear	13.7	14.8	15.3	15.1	12.6	11.0	0.5	0.6	0.6	3.3	4.8	5.5
Renewable energy forms	5.0	5.5	6.1	7.8	8.6	9.2	0.0	0.2	0.3	0.6	2.7	3.3
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**2911.4**	**3238.0**	**3504.8**	**-115.7**	**-212.5**	**-341.2**	**-3.8**	**-6.2**	**-8.9**
Nuclear	720.1	810.1	863.7	893.9	768.0	723.0	0.0	-7.4	-22.1	0.0	-1.0	-3.0
Hydro & wind	259.8	294.2	343.8	469.0	544.8	625.5	-13.5	-11.1	-17.1	-2.8	-2.0	-2.7
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1548.5	1925.2	2156.4	-102.2	-194.0	-302.0	-6.2	-9.2	-12.3
Fuel Inputs for Thermal Power Generation (1)	**291.8**	**295.1**	**318.3**	**319.4**	**362.7**	**393.1**	**-18.4**	**-34.2**	**-51.7**	**-5.4**	**-8.6**	**-11.6**
Solids	186.1	163.9	153.6	113.7	112.9	155.4	-3.9	-20.9	-23.8	-3.4	-15.6	-13.3
Oil (including refinery gas)	48.7	49.6	38.3	16.8	10.8	6.9	-3.5	-0.4	0.2	-17.2	-3.2	2.5
Gas	45.1	66.0	106.3	162.3	210.6	204.0	-10.1	-12.2	-25.6	-5.8	-5.5	-11.2
Biomass - Waste	10.0	13.5	17.1	23.1	25.0	23.4	-0.9	-0.7	-1.9	-3.6	-2.6	-7.6
Geothermal heat	1.9	2.1	3.0	3.4	3.4	3.4	0.0	-0.2	-0.5	0.0	-5.6	-12.5
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**712.3**	**727.1**	**728.4**	**-28.8**	**-44.7**	**-65.4**	**-3.9**	**-5.8**	**-8.2**
Refineries	594.6	635.8	665.7	656.1	667.4	663.7	-27.5	-42.5	-61.6	-4.0	-6.0	-8.5
District heating	12.4	11.0	6.0	6.0	5.0	5.4	-0.2	-0.2	-0.6	-4.0	-3.3	-10.1
Biofuels and hydrogen production	0.0	0.2	0.6	9.8	16.8	23.8	-0.3	-0.9	-1.9	-3.2	-5.1	-7.6
Others	97.1	58.1	50.6	40.5	37.8	35.6	-0.7	-1.1	-1.3	-1.8	-2.8	-3.5
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**65.3**	**63.9**	**62.7**	**-2.1**	**-3.4**	**-5.1**	**-3.1**	**-5.1**	**-7.5**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**100.3**	**103.7**	**104.0**	**-3.0**	**-4.8**	**-6.6**	**-2.9**	**-4.4**	**-5.9**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1039.9**	**1098.9**	**1129.5**	**-36.7**	**-65.9**	**-99.5**	**-3.4**	**-5.7**	**-8.1**
by sector												
Industry (1)	262.2	255.6	268.7	290.3	309.3	320.7	-9.1	-16.0	-23.9	-3.0	-4.9	-6.9
energy intensive industries	180.4	170.9	175.8	185.8	191.8	191.3	-4.9	-7.9	-10.9	-2.5	-4.0	-5.4
other industrial sectors	81.9	84.7	92.9	104.5	117.5	129.4	-4.3	-8.1	-13.1	-3.9	-6.4	-9.2
Residential	228.1	236.0	244.7	262.1	268.6	268.0	-8.8	-15.8	-23.0	-3.2	-5.5	-7.9
Tertiary	115.3	127.9	132.7	143.7	156.3	171.8	-5.5	-9.5	-14.9	-3.7	-5.7	-8.0
Transport	253.8	275.7	309.1	343.8	364.7	369.0	-13.3	-24.7	-37.7	-3.7	-6.3	-9.3
by fuel (1)												
Solids	76.8	47.0	36.0	27.6	24.2	21.8	-0.8	-1.1	-1.3	-2.7	-4.3	-5.7
Oil	391.5	414.1	430.6	445.9	459.7	458.6	-16.3	-29.3	-43.3	-3.5	-6.0	-8.6
Gas	169.7	194.9	220.3	258.5	270.0	278.7	-8.1	-15.0	-22.1	-3.0	-5.3	-7.4
Electricity	156.0	169.4	191.6	219.4	247.5	269.9	-8.9	-16.3	-26.4	-3.9	-6.2	-8.9
Heat (from CHP and District Heating)	35.2	39.3	42.1	50.1	57.9	61.8	-1.8	-2.8	-4.8	-3.4	-4.6	-7.2
Other	30.3	30.6	34.5	38.4	39.5	38.7	-0.9	-1.4	-1.7	-2.3	-3.5	-4.1
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.7**	**3117.5**	**3078.8**	**3197.5**	**3320.6**	**-126.1**	**-246.5**	**-348.1**	**-3.9**	**-7.2**	**-9.5**
Electricity and Steam production	997.6	947.7	948.3	901.0	986.2	1125.6	-51.0	-113.8	-154.9	-5.4	-10.3	-12.1
Energy Branch	129.8	144.4	145.4	130.8	125.2	118.3	-4.4	-6.5	-9.3	-3.2	-4.9	-7.3
Industry	576.2	526.5	509.3	444.5	436.3	431.9	-13.8	-23.7	-34.4	-3.0	-5.1	-7.4
Residential	436.4	417.4	412.9	420.3	419.8	407.5	-12.1	-20.9	-26.6	-2.8	-4.7	-6.1
Tertiary	203.5	212.7	199.6	197.0	196.4	205.5	-5.6	-9.9	-14.3	-2.8	-4.8	-6.5
Transport	738.5	802.9	902.2	985.2	1033.5	1031.7	-39.3	-71.8	-108.5	-3.8	-6.5	-9.5
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**99.9**	**103.7**	**107.7**	**-4.1**	**-8.0**	**-11.3**	-3.9	-7.2	-9.5

See explanations on the last page of the Appendix

Source: PRIMES

EU15: LOW ECONOMIC GROWTH SCENARIO — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10322	12577	15056	-537	-1064	-1864	-4.9	-7.8	-11.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	147.7	124.5	105.0	2.6	3.0	3.4	1.8	2.5	3.4
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	3.9	4.0	4.1	-0.1	-0.2	-0.4	-3.2	-5.5	-8.0
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7507	8293	9009	-298	-544	-877	-3.8	-6.2	-8.9
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	2.02	2.04	2.10	-0.02	-0.04	-0.03	-0.7	-1.7	-1.6
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	7.9	8.2	8.5	-0.3	-0.6	-0.9	-3.9	-7.2	-9.5
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	298.3	254.2	220.6	3.1	1.8	3.7	1.1	0.7	1.7
Import Dependency %	47.6	46.6	49.4	53.2	61.7	66.2	-1.1	-1.2	-1.6	-2.0	-2.0	-2.4
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	79.8	69.2	59.4	0.9	1.3	1.7	1.1	2.0	3.0
Residential (Energy on Private Income)	100.0	97.6	88.2	78.8	67.2	56.9	1.6	1.9	2.3	2.0	3.0	4.3
Tertiary (Energy on Value added)	100.0	101.8	90.9	79.2	70.2	64.0	0.9	1.6	2.3	1.1	2.3	3.8
Transport (Energy on GDP)	100.0	101.2	99.5	91.6	79.8	67.4	1.2	1.2	1.3	1.3	1.6	2.0
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.26	0.25	0.26	0.00	-0.01	-0.01	-1.7	-4.7	-3.8
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.97	1.90	1.84	0.00	0.00	0.00	0.1	-0.1	0.0
Industry	2.20	2.06	1.90	1.53	1.41	1.35	0.00	0.00	-0.01	0.0	-0.2	-0.5
Residential	1.91	1.77	1.69	1.60	1.56	1.52	0.01	0.01	0.03	0.5	0.9	1.9
Tertiary	1.76	1.66	1.50	1.37	1.26	1.20	0.01	0.01	0.02	0.9	0.9	1.6
Transport	2.91	2.91	2.92	2.87	2.83	2.80	0.00	0.00	-0.01	-0.1	-0.2	-0.3
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**665.2**	**766.0**	**874.0**	**-23.5**	**-46.6**	**-77.0**	**-3.4**	**-5.7**	**-8.1**
Nuclear		126.2	131.0	121.9	100.3	102.9	0.0	0.2	-2.0	0.0	0.2	-1.9
Hydro (pumping excluded)		87.1	89.8	96.6	100.5	102.3	-0.3	-0.5	-1.4	-0.4	-0.5	-1.4
Wind and solar		2.5	12.9	65.9	92.5	130.1	-4.5	-2.9	-4.1	-6.4	-3.0	-3.1
Thermal		322.9	344.8	380.8	472.7	538.6	-18.7	-43.4	-69.5	-4.7	-8.4	-11.4
of which cogeneration units		*59.3*	*77.1*	*101.6*	*124.0*	*136.7*	*-0.7*	*-5.9*	*-9.7*	*-0.7*	*-4.6*	*-6.6*
Open cycle(incl. biomass-waste)		281.8	276.9	210.7	128.2	104.5	-3.9	-7.6	-8.9	-1.8	-5.6	-7.8
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.0	36.6	97.8	-0.4	-15.0	-21.2	-95.2	-29.1	-17.8
Gas Turbines Combined Cycle		20.0	46.0	145.1	261.7	284.1	-12.2	-17.5	-38.9	-7.7	-6.3	-12.0
Small Gas Turbines		20.3	21.0	23.7	45.0	51.1	-2.2	-3.2	-0.3	-8.4	-6.7	-0.6
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.2	1.2	0.0	-0.1	-0.2	0.0	-5.8	-12.9
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.8	43.7	47.8	49.4	-0.3	-0.2	-0.3	-0.6	-0.4	-0.6
Load factor for gross electric capacities (%)		48.9	50.8	50.0	48.3	45.8	-0.2	-0.2	-0.4	-0.4	-0.4	-0.8
CHP indicator (% of electricity from CHP)		9.2	10.3	12.9	14.2	14.6	0.2	0.4	0.5	1.7	2.6	3.5
Non fossil fuels in electricity generation (%)		49.9	49.3	49.6	43.1	40.7	1.3	2.0	2.5	2.8	4.9	6.4
nuclear		35.1	33.6	30.7	23.7	20.6	1.2	1.2	1.3	4.0	5.5	6.5
renewable energy forms		14.8	15.8	18.8	19.4	20.1	0.2	0.8	1.2	0.9	4.2	6.3
of which waste		*1.0*	*1.2*	*1.4*	*1.3*	*1.1*	*0.0*	*0.1*	*0.1*	*0.6*	*4.3*	*6.4*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5727.3**	**6510.6**	**7218.2**	**-89.8**	**-189.8**	**-322.0**	**-1.5**	**-2.8**	**-4.3**
public road transport	368.8	382.2	412.6	423.2	447.3	463.2	0.5	-1.1	-2.0	0.1	-0.2	-0.4
private cars and motorcycles	3325.6	3634.5	3938.8	4508.3	5065.0	5554.6	-58.0	-102.1	-149.7	-1.3	-2.0	-2.6
rail transport	316.4	320.9	356.0	365.6	413.3	448.9	-1.1	-7.8	-13.9	-0.3	-1.9	-3.0
aviation	157.3	201.5	281.5	391.5	540.6	701.0	-30.2	-77.1	-153.5	-7.2	-12.5	-18.0
inland navigation	28.3	31.4	33.0	38.7	44.4	50.5	-1.0	-1.7	-2.8	-2.4	-3.6	-5.3
travel per person (km per capita)	11465	12240	13261	14768	16675	18555	-232	-486	-828	-1.5	-2.8	-4.3
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2225.4**	**2661.8**	**3115.0**	**-125.0**	**-235.0**	**-386.5**	**-5.3**	**-8.1**	**-11.0**
trucks	946.0	1114.6	1327.2	1629.0	1989.2	2377.3	-113.7	-208.2	-342.8	-6.5	-9.5	-12.6
rail transport	234.9	220.2	249.3	261.0	289.2	310.5	-2.6	-8.8	-14.8	-1.0	-3.0	-4.5
inland navigation	257.1	266.9	296.1	335.3	383.4	427.2	-8.7	-18.0	-28.9	-2.5	-4.5	-6.3
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	207	-1	-1	0	-0.4	-0.3	0.0
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**343.8**	**364.7**	**369.0**	**-13.3**	**-24.7**	**-37.7**	**-3.7**	**-6.3**	**-9.3**
public road transport	6.3	5.9	5.8	6.0	5.8	5.3	0.0	0.0	-0.1	0.0	-0.5	-1.0
private cars and motorcycles	130.2	136.6	145.5	152.2	147.8	138.2	-2.0	-3.1	-4.0	-1.3	-2.0	-2.8
trucks	76.0	86.5	101.0	124.6	145.1	156.5	-8.1	-14.2	-20.9	-6.1	-8.9	-11.8
rail transport	6.9	7.5	7.7	6.8	5.5	5.1	0.0	-0.1	-0.2	-0.5	-1.7	-2.9
aviation	27.8	32.5	43.8	48.1	53.7	56.5	-3.0	-6.9	-12.2	-5.9	-11.4	-17.8
inland navigation	6.7	6.7	5.3	6.1	6.8	7.3	-0.1	-0.3	-0.4	-2.1	-3.7	-5.3
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	37.1	32.6	28.4	-0.3	-0.6	-1.0	-0.8	-1.8	-3.3
freight transport (toe/Mtkm)	57.8	58.5	57.3	59.1	57.2	52.7	-0.4	-0.4	-0.3	-0.6	-0.6	-0.5

Source: PRIMES

NMS: LOW ECONOMIC GROWTH SCENARIO — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**116.9**	**104.6**	**87.7**	**-0.4**	**-0.8**	**-0.3**	**-0.3**	**-0.8**	**-0.3**
Solids	140.9	126.7	104.0	83.2	69.7	59.5	-0.3	-0.5	0.0	-0.3	-0.8	0.0
Oil	2.6	3.0	3.1	2.5	2.4	2.3	0.0	0.0	0.0	-0.4	-0.4	-1.1
Natural gas	6.7	7.4	6.1	5.9	5.4	4.9	0.0	0.0	0.0	-0.4	-0.8	-0.8
Nuclear	15.5	14.1	14.8	14.9	14.8	5.3	0.0	0.0	0.0	-0.2	0.0	0.0
Renewable energy sources	3.0	6.3	8.0	10.4	12.1	15.7	-0.1	-0.2	-0.2	-0.5	-1.8	-1.1
Hydro	1.1	1.3	1.4	2.0	2.1	2.2	0.0	0.0	0.0	-0.2	0.4	-0.1
Biomass	1.4	4.6	6.1	6.2	6.3	7.8	0.0	-0.1	-0.1	-0.6	-1.2	-1.4
Waste	0.5	0.3	0.5	1.4	1.5	1.8	0.0	0.0	0.0	0.0	0.6	-0.3
Wind	0.0	0.0	0.0	0.6	1.7	3.2	0.0	-0.1	0.0	0.2	-7.8	-0.4
Solar and others	0.0	0.0	0.0	0.3	0.5	0.8	0.0	0.0	0.0	-2.3	-3.6	-4.8
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-5.0	-6.2	-7.4
Net Imports	**66.3**	**50.4**	**61.4**	**89.2**	**123.3**	**145.7**	**-2.9**	**-4.2**	**-7.9**	**-3.2**	**-3.3**	**-5.2**
Solids	-14.6	-20.7	-15.9	-7.7	2.8	16.1	-0.5	0.0	-1.8	6.6	-1.3	-10.3
Oil	49.9	45.0	47.3	54.7	61.7	66.2	-0.9	-1.5	-2.6	-1.6	-2.4	-3.8
Crude oil and Feedstocks	43.4	36.7	41.3	45.5	51.9	56.2	-0.7	-1.1	-2.1	-1.5	-2.2	-3.6
Oil products	6.5	8.3	6.0	9.2	9.8	10.0	-0.2	-0.4	-0.5	-2.5	-3.6	-4.7
Natural gas	31.2	26.2	31.5	43.4	60.0	64.2	-1.6	-2.7	-3.5	-3.5	-4.3	-5.1
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**205.1**	**226.7**	**232.1**	**-3.3**	**-5.0**	**-8.1**	**-1.6**	**-2.2**	**-3.4**
Solids	127.8	108.2	90.8	75.5	72.6	75.6	-0.8	-0.6	-1.9	-1.0	-0.8	-2.4
Oil	50.4	46.6	48.7	56.1	63.0	67.2	-0.9	-1.5	-2.6	-1.6	-2.3	-3.7
Natural gas	37.1	33.8	37.3	49.3	65.4	69.1	-1.6	-2.7	-3.5	-3.1	-4.0	-4.9
Nuclear	15.5	14.1	14.8	14.9	14.8	5.3	0.0	0.0	0.0	-0.2	0.0	0.0
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	10.4	12.1	15.7	-0.1	-0.2	-0.2	-0.5	-1.8	-1.1
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	36.8	32.0	32.6	0.2	0.4	0.3	0.6	1.4	1.0
Oil	21.6	22.3	24.6	27.4	27.8	28.9	0.0	0.0	-0.1	0.0	-0.2	-0.3
Natural gas	15.9	16.2	18.8	24.0	28.9	29.8	-0.4	-0.6	-0.5	-1.5	-1.9	-1.5
Nuclear	6.6	6.7	7.5	7.3	6.5	2.3	0.1	0.1	0.1	1.4	2.2	3.5
Renewable energy forms	1.3	3.0	4.1	5.1	5.4	6.8	0.1	0.0	0.2	1.1	0.4	2.4
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**384.8**	**485.4**	**529.2**	**-7.2**	**-12.8**	**-21.9**	**-1.8**	**-2.6**	**-4.0**
Nuclear	60.0	54.3	57.4	58.4	58.1	21.5	-0.1	0.0	0.0	-0.2	0.0	0.0
Hydro & wind	12.9	15.5	15.7	30.1	44.9	62.7	0.0	-1.6	-0.2	-0.1	-3.4	-0.3
Thermal (incl. biomass)	243.7	230.7	250.6	296.3	382.4	445.1	-7.1	-11.1	-21.7	-2.3	-2.8	-4.6
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**74.0**	**84.2**	**92.3**	**-1.5**	**-1.7**	**-3.8**	**-1.9**	**-2.0**	**-4.0**
Solids	62.2	57.2	56.5	56.9	58.0	63.2	-0.6	-0.5	-1.7	-1.1	-0.9	-2.7
Oil	4.9	4.4	3.2	3.3	2.4	2.4	-0.1	0.0	-0.3	-3.0	-0.1	-11.6
Gas	5.3	4.0	6.3	12.0	21.7	23.9	-0.7	-1.2	-1.8	-5.9	-5.4	-6.9
Biomass - Waste	0.3	0.1	0.4	1.8	2.1	2.8	0.0	0.0	0.0	0.0	0.7	-0.2
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**65.1**	**69.9**	**75.1**	**-0.9**	**-1.4**	**-2.7**	**-1.4**	**-2.0**	**-3.4**
Refineries	46.7	40.1	45.2	49.0	55.9	61.0	-0.7	-1.2	-2.2	-1.4	-2.1	-3.5
District heating	19.3	12.1	8.5	4.4	3.5	2.7	-0.1	-0.1	-0.2	-2.8	-3.0	-5.4
Biofuels and hydrogen production	0.0	0.0	0.0	0.1	0.4	1.6	0.0	0.0	-0.1	-1.4	-2.3	-3.1
Others	30.5	23.1	17.7	11.5	10.0	9.8	-0.1	-0.1	-0.3	-0.8	-1.2	-2.8
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.6**	**9.8**	**9.1**	**-0.1**	**-0.1**	**-0.2**	**-0.8**	**-1.2**	**-2.3**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**10.8**	**12.6**	**13.8**	**-0.2**	**-0.3**	**-0.5**	**-1.9**	**-2.6**	**-3.7**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**130.2**	**149.5**	**159.6**	**-2.2**	**-3.6**	**-5.5**	**-1.6**	**-2.3**	**-3.3**
by sector												
Industry	65.0	47.7	40.4	38.9	41.6	43.1	-0.5	-0.5	-0.8	-1.3	-1.2	-1.8
energy intensive industries	32.5	27.9	26.2	25.5	26.6	26.9	-0.2	0.0	0.0	-0.6	0.1	0.0
other industrial sectors	32.4	19.7	14.2	13.5	15.1	16.2	-0.4	-0.5	-0.8	-2.6	-3.3	-4.6
Residential	40.0	41.2	34.4	37.1	43.4	45.7	-0.7	-1.3	-2.1	-1.9	-3.0	-4.4
Tertiary	24.9	19.6	21.5	24.6	27.8	30.3	-0.5	-0.8	-1.2	-2.1	-2.8	-3.7
Transport	19.9	19.8	22.9	29.6	36.6	40.5	-0.4	-1.0	-1.4	-1.4	-2.5	-3.4
by fuel												
Solids	40.9	33.8	21.4	13.8	10.9	8.9	-0.1	0.0	-0.1	-0.6	-0.4	-1.0
Oil	32.7	29.6	33.6	40.7	47.4	51.1	-0.6	-1.1	-1.7	-1.4	-2.4	-3.3
Gas	26.5	24.6	25.4	32.6	38.6	41.1	-0.7	-1.3	-1.5	-2.1	-3.2	-3.5
Electricity	20.5	18.5	19.6	24.6	32.3	36.5	-0.5	-0.9	-1.6	-2.1	-2.8	-4.2
Heat (from CHP and District Heating)	27.7	17.4	13.5	12.9	14.9	16.6	-0.3	-0.1	-0.5	-2.1	-0.6	-2.7
Other	1.8	4.7	5.8	5.6	5.4	5.4	0.0	-0.1	-0.1	-0.8	-1.6	-1.8
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**543.6**	**584.7**	**613.2**	**-8.7**	**-12.0**	**-21.8**	**-1.6**	**-2.0**	**-3.4**
Electricity and Steam production	343.4	295.0	280.1	278.5	297.9	320.1	-4.9	-5.2	-12.5	-1.7	-1.7	-3.7
Energy Branch	14.4	19.5	18.7	10.5	11.2	11.2	-0.1	-0.2	-0.3	-0.8	-1.5	-2.2
Industry	137.0	118.2	96.4	85.0	84.4	83.8	-1.0	-1.4	-1.7	-1.2	-1.6	-2.0
Residential	83.2	72.9	49.7	48.4	53.0	50.8	-0.9	-1.6	-2.1	-1.7	-2.9	-4.0
Tertiary	53.3	38.3	37.2	36.4	33.7	33.9	-0.5	-0.8	-1.1	-1.5	-2.4	-3.2
Transport	56.1	55.9	65.3	84.7	104.5	113.3	-1.3	-2.8	-4.1	-1.5	-2.6	-3.5
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**79.1**	**85.1**	**89.2**	**-1.3**	**-1.7**	**-3.2**	-1.6	-2.0	-3.4

See explanations on the last page of the Appendix

Source: PRIMES

NMS: LOW ECONOMIC GROWTH SCENARIO							SUMMARY ENERGY BALANCE AND INDICATORS (B)					
Mtoe	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
							Difference from Baseline			**% diff. from Baseline**		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	559	787	1042	-15	-34	-59	-2.6	-4.2	-5.3
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	366.9	288.2	222.8	3.8	5.9	4.5	1.0	2.1	2.0
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.8	3.2	3.4	0.0	-0.1	-0.1	-1.6	-2.2	-3.4
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	5243	6774	7654	-98	-178	-316	-1.8	-2.6	-4.0
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.65	2.58	2.64	0.00	0.00	0.00	0.0	0.2	0.0
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.4	8.2	8.9	-0.1	-0.2	-0.3	-1.6	-2.0	-3.4
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	972.4	743.3	588.6	10.1	16.5	11.6	1.1	2.3	2.0
Import Dependency %	28.3	24.1	30.8	43.3	54.1	62.4	-0.7	-0.6	-1.2	-1.6	-1.2	-1.8
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	36.6	28.1	23.5	0.5	0.7	0.8	1.3	2.5	3.3
Residential (Energy on Private Income)	100.0	106.5	74.2	56.1	45.6	36.5	0.1	0.2	0.4	0.3	0.5	1.2
Tertiary (Energy on Value added)	100.0	74.8	67.2	52.9	40.8	32.6	0.3	0.5	0.6	0.6	1.2	1.9
Transport (Energy on GDP)	100.0	102.9	97.4	88.6	78.0	65.1	1.0	1.3	1.3	1.2	1.7	2.0
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.50	0.44	0.43	0.00	0.00	0.00	0.1	0.3	-0.2
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.96	1.84	1.77	0.00	0.00	0.00	0.2	0.0	0.2
Industry	2.11	2.48	2.38	2.18	2.03	1.95	0.00	-0.01	0.00	0.1	-0.5	-0.2
Residential	2.08	1.77	1.44	1.31	1.22	1.11	0.00	0.00	0.00	0.1	0.1	0.4
Tertiary	2.14	1.95	1.73	1.48	1.21	1.12	0.01	0.00	0.01	0.7	0.4	0.5
Transport	2.82	2.82	2.85	2.86	2.85	2.80	0.00	0.00	0.00	-0.1	-0.1	-0.1
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**93.7**	**130.2**	**160.9**	**-1.5**	**-3.9**	**-6.3**	**-1.5**	**-2.9**	**-3.8**
Nuclear		8.4	9.3	7.9	7.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		6.1	6.4	7.7	8.3	8.4	0.0	0.0	0.0	0.0	0.4	0.0
Wind and solar		0.0	0.0	2.8	8.0	14.9	0.0	-0.7	-0.1	0.2	-7.9	-0.4
Thermal		64.0	61.9	75.3	106.0	134.7	-1.5	-3.3	-6.3	-1.9	-3.0	-4.4
of which cogeneration units		*28.1*	*26.3*	*26.9*	*37.8*	*51.1*	*-0.5*	*-0.5*	*-1.2*	*-1.7*	*-1.2*	*-2.3*
Open cycle (incl. biomass-waste)		61.9	58.6	55.5	40.0	34.6	-0.4	0.5	0.6	-0.8	1.2	1.7
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.6	14.0	29.6	0.1	-1.0	-1.3	11.4	-6.3	-4.3
Gas Turbines Combined Cycle		0.4	1.4	11.2	37.4	57.0	-1.1	-2.2	-4.6	-8.7	-5.5	-7.4
Small Gas Turbines		1.7	1.8	8.0	14.5	13.5	0.0	-0.6	-0.9	0.1	-4.0	-6.5
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	36.3	41.1	43.7	-0.1	-0.3	-0.3	-0.3	-0.8	-0.6
Load factor for gross electric capacities (%)		43.6	47.6	46.9	42.6	37.6	-0.1	0.2	-0.1	-0.3	0.4	-0.2
CHP indicator (% of electricity from CHP)		29.4	30.4	28.2	27.3	32.3	-0.1	0.0	0.7	-0.4	0.0	2.1
Non fossil fuels in electricity generation (%)		23.4	23.1	24.6	22.8	17.9	0.4	0.3	0.7	1.7	1.2	3.8
nuclear		18.1	17.7	15.2	12.0	4.1	0.2	0.3	0.2	1.7	2.6	4.1
renewable energy forms		5.3	5.4	9.4	10.8	13.9	0.2	0.0	0.5	1.8	-0.3	3.8
of which waste		*0.0*	*0.1*	*0.6*	*0.5*	*0.4*	*0.0*	*0.0*	*0.0*	*1.9*	*4.3*	*3.4*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**611.5**	**798.9**	**979.8**	**-4.2**	**-9.8**	**-18.9**	**-0.7**	**-1.2**	**-1.9**
public road transport	115.7	87.0	81.2	81.4	84.9	90.8	0.2	0.3	0.3	0.2	0.4	0.4
private cars and motorcycles	268.0	315.8	352.9	456.6	615.5	759.4	-2.7	-5.7	-10.7	-0.6	-0.9	-1.4
rail transport	91.9	50.8	46.3	47.9	57.5	73.1	-0.3	-0.7	-1.6	-0.5	-1.3	-2.2
aviation	11.2	14.0	16.8	25.0	40.3	55.6	-1.5	-3.7	-6.9	-5.5	-8.4	-11.0
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	0.2	-0.2	-0.3
travel per person (km per capita)	6489	6227	6662	8331	11147	14171	-57	-137	-273	-0.7	-1.2	-1.9
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**334.4**	**429.1**	**520.5**	**-5.0**	**-13.1**	**-20.8**	**-1.5**	**-3.0**	**-3.8**
trucks	118.4	119.0	155.5	218.5	306.7	391.7	-5.4	-12.8	-20.8	-2.4	-4.0	-5.0
rail transport	205.2	137.8	118.7	115.1	121.6	127.9	0.4	-0.2	-0.1	0.3	-0.2	-0.1
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	0.2	0.4	0.6
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	598	546	500	7	7	8	1.2	1.3	1.6
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**29.6**	**36.6**	**40.5**	**-0.4**	**-1.0**	**-1.4**	**-1.4**	**-2.5**	**-3.4**
public road transport	1.4	1.0	1.2	1.2	1.1	1.1	0.0	0.0	0.0	0.3	0.4	0.4
private cars and motorcycles	7.9	9.5	11.6	14.7	17.6	19.1	-0.1	-0.1	-0.3	-0.6	-0.8	-1.3
trucks	7.0	6.7	7.5	10.8	14.5	17.2	-0.3	-0.6	-0.9	-2.4	-4.0	-5.0
rail transport	2.0	1.4	1.3	1.1	1.0	1.0	0.0	0.0	0.0	0.1	-0.3	-0.7
aviation	1.3	1.2	1.3	1.8	2.4	2.2	-0.1	-0.2	-0.3	-5.1	-7.9	-10.5
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.4
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	29.7	27.0	23.3	-0.1	-0.1	-0.1	-0.3	-0.4	-0.3
freight transport (toe/Mtkm)	24.6	28.8	30.0	34.3	35.1	34.1	-0.3	-0.3	-0.4	-0.7	-0.9	-1.0

Source: PRIMES

EU25: HIGH ECONOMIC GROWTH CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**867.6**	**755.0**	**684.2**	**7.3**	**14.2**	**23.3**	**0.9**	**1.9**	**3.5**
Solids	350.8	264.7	203.4	153.5	126.5	105.8	-0.3	0.1	3.3	-0.2	0.1	3.2
Oil	120.3	162.2	163.5	132.8	103.3	87.5	1.1	1.2	1.1	0.8	1.2	1.3
Natural gas	139.6	174.0	196.6	198.8	148.9	118.5	1.9	1.3	1.3	1.0	0.9	1.1
Nuclear	196.9	215.3	237.7	245.3	215.3	187.5	0.0	1.8	2.1	0.0	0.8	1.2
Renewable energy sources	69.2	80.7	96.1	137.2	161.1	184.9	4.6	9.8	15.5	3.4	6.5	9.1
Hydro	23.4	26.3	29.0	30.4	32.0	33.1	0.2	0.4	0.8	0.8	1.2	2.5
Biomass	31.1	35.4	42.2	59.9	71.0	81.9	2.4	6.0	8.2	4.2	9.3	11.1
Waste	12.3	15.9	19.3	26.7	29.5	30.8	1.0	1.8	3.7	3.9	6.4	13.5
Wind	0.1	0.4	1.9	14.7	21.4	29.2	0.7	1.3	2.4	5.4	6.6	9.0
Solar and others	0.1	0.3	0.4	1.7	3.1	5.6	0.0	0.1	0.3	2.3	4.5	5.7
Geothermal	2.2	2.5	3.3	3.9	4.1	4.4	0.1	0.1	0.1	2.8	2.8	2.8
Net Imports	**711.6**	**701.7**	**799.3**	**1022.7**	**1292.4**	**1487.2**	**48.2**	**87.9**	**125.4**	**5.0**	**7.3**	**9.2**
Solids	75.2	73.8	91.4	92.6	141.1	216.1	2.7	14.8	18.7	3.0	11.8	9.4
Oil	510.8	491.8	519.6	598.0	666.8	710.1	25.5	40.9	59.1	4.5	6.5	9.1
Crude oil and Feedstocks	480.2	471.5	496.8	576.6	654.3	707.8	26.8	43.2	62.9	4.9	7.1	9.7
Oil products	30.6	20.3	22.8	21.5	12.6	2.2	-1.2	-2.4	-3.7	-5.5	-15.9	-62.6
Natural gas	123.5	134.8	186.2	330.0	482.4	558.7	20.0	32.2	47.6	6.5	7.2	9.3
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1837.9**	**1987.9**	**2103.9**	**53.8**	**99.0**	**144.2**	**3.0**	**5.2**	**7.4**
Solids	430.6	346.0	303.2	246.1	267.6	321.8	2.4	14.9	21.9	1.0	5.9	7.3
Oil	596.2	622.2	635.6	678.4	710.6	730.1	24.9	39.0	55.7	3.8	5.8	8.3
Natural gas	259.2	307.1	376.0	528.8	631.3	677.2	21.9	33.5	49.0	4.3	5.6	7.8
Nuclear	196.9	215.3	237.7	245.3	215.3	187.5	0.0	1.8	2.1	0.0	0.8	1.2
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	137.2	161.1	184.9	4.6	9.8	15.5	3.4	6.5	9.1
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	13.4	13.5	15.3	-0.3	0.1	0.0	-2.0	0.6	0.0
Oil	38.4	39.6	38.5	36.9	35.7	34.7	0.3	0.2	0.3	0.8	0.5	0.8
Natural gas	16.7	19.5	22.8	28.8	31.8	32.2	0.4	0.1	0.1	1.3	0.3	0.4
Nuclear	12.7	13.7	14.4	13.3	10.8	8.9	-0.4	-0.5	-0.5	-2.9	-4.2	-5.8
Renewable energy forms	4.5	5.1	5.8	7.5	8.1	8.8	0.0	0.1	0.1	0.4	1.2	1.7
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3551.1**	**4204.0**	**4794.2**	**132.0**	**255.3**	**397.1**	**3.9**	**6.5**	**9.0**
Nuclear	780.0	864.4	921.2	952.4	840.6	775.4	-0.1	7.1	8.9	0.0	0.8	1.2
Hydro & wind	272.7	309.7	359.5	524.2	622.2	743.9	11.6	19.7	38.4	2.3	3.3	5.4
Thermal (incl. biomass)	1402.9	1434.7	1617.2	2074.5	2741.2	3274.9	120.5	228.5	349.8	6.2	9.1	12.0
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**433.2**	**521.4**	**599.8**	**19.9**	**38.6**	**58.9**	**4.8**	**8.0**	**10.9**
Solids	248.2	221.1	210.1	178.9	208.9	268.9	3.7	16.6	24.7	2.1	8.6	10.1
Oil (including refinery gas)	53.7	53.9	41.5	26.7	15.6	12.3	3.0	2.1	2.8	12.4	15.4	30.0
Gas	50.4	70.0	112.6	196.8	261.7	280.8	11.7	15.9	25.5	6.3	6.5	10.0
Biomass - Waste	10.3	13.6	17.5	27.3	31.5	33.8	1.5	3.8	5.7	5.8	13.9	20.2
Geothermal heat	1.9	2.1	3.0	3.5	3.7	4.0	0.1	0.1	0.1	2.5	2.4	2.4
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**834.8**	**888.0**	**936.2**	**27.7**	**44.9**	**64.5**	**3.4**	**5.3**	**7.4**
Refineries	641.3	675.9	710.9	762.9	814.0	856.1	29.6	47.0	67.7	4.0	6.1	8.6
District heating	31.7	23.1	14.5	10.6	9.2	9.0	-0.1	0.4	0.2	-1.3	4.1	2.5
Biofuels and hydrogen production	0.0	0.2	0.6	10.5	19.0	29.3	0.3	0.9	1.9	3.1	5.0	6.8
Others	127.6	81.2	68.3	50.7	45.7	41.8	-2.1	-3.4	-5.2	-4.0	-7.0	-11.0
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**79.3**	**81.1**	**83.0**	**2.2**	**3.9**	**5.8**	**2.9**	**5.1**	**7.5**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**117.8**	**126.9**	**132.3**	**3.5**	**5.5**	**7.4**	**3.0**	**4.5**	**5.9**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1249.2**	**1389.7**	**1498.1**	**40.2**	**71.8**	**104.0**	**3.3**	**5.5**	**7.5**
by sector												
Industry (1)	327.2	303.3	309.1	350.4	387.0	416.2	11.6	19.6	27.8	3.4	5.3	7.1
energy intensive industries	212.9	198.9	202.0	222.4	236.2	242.2	6.1	9.9	13.1	2.8	4.4	5.7
other industrial sectors	114.3	104.4	107.0	128.0	150.8	174.1	5.4	9.7	14.6	4.4	6.8	9.2
Residential	268.1	277.2	279.1	318.0	346.4	363.1	9.4	17.3	24.3	3.0	5.2	7.2
Tertiary	140.2	147.5	154.2	180.1	204.6	233.1	5.8	10.2	15.0	3.3	5.3	6.9
Transport	273.7	295.6	332.0	400.7	451.8	485.7	13.5	24.8	37.0	3.5	5.8	8.2
by fuel (1)												
Solids	117.7	80.8	57.4	43.3	37.8	34.0	1.1	1.7	1.9	2.5	4.6	5.9
Oil	424.2	443.7	464.2	521.1	568.3	600.1	17.6	30.7	45.4	3.5	5.7	8.2
Gas	196.2	219.5	245.7	307.9	338.1	360.3	8.0	13.2	16.9	2.7	4.1	4.9
Electricity	176.5	187.9	211.3	263.2	316.4	364.7	9.9	19.3	30.3	3.9	6.5	9.1
Heat (from CHP and District Heating)	62.9	56.7	55.6	67.3	79.8	88.9	2.3	4.0	5.3	3.5	5.3	6.3
Other	32.1	35.3	40.3	46.3	49.3	50.1	1.4	2.9	4.2	3.1	6.2	9.1
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.6**	**3664.9**	**3887.4**	**4285.7**	**4660.5**	**130.2**	**245.0**	**356.9**	**3.5**	**6.1**	**8.3**
Electricity and Steam production	1341.0	1242.7	1228.3	1284.2	1509.8	1775.4	48.9	106.8	162.4	4.0	7.6	10.1
Energy Branch	144.2	163.9	164.0	150.9	151.8	152.2	5.1	8.8	13.2	3.5	6.1	9.5
Industry	713.2	644.8	605.7	561.5	572.9	588.7	17.1	27.1	36.8	3.1	5.0	6.7
Residential	519.7	490.4	462.6	494.5	515.6	513.4	12.9	20.5	26.2	2.7	4.1	5.4
Tertiary	256.8	251.0	236.7	245.9	250.4	266.4	6.4	9.5	11.6	2.7	4.0	4.5
Transport	794.6	858.8	967.5	1150.3	1285.1	1364.3	39.9	72.4	106.7	3.6	6.0	8.5
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**103.1**	**113.7**	**123.6**	**3.5**	**6.5**	**9.5**	3.5	6.1	8.3

See explanations on the last page of the Appendix

Source: PRIMES

EU25: HIGH ECONOMIC GROWTH CASE							SUMMARY ENERGY BALANCE AND INDICATORS (B)					
Mtoe	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
							Difference from Baseline			**% diff. from Baseline**		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11983	15588	19944	550	1126	1924	4.8	7.8	10.7
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	153.4	127.5	105.5	-2.7	-3.1	-3.3	-1.7	-2.4	-3.0
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	4.0	4.3	4.6	0.1	0.2	0.3	3.0	5.2	7.4
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	7699	9097	10464	286	552	867	3.9	6.5	9.0
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.12	2.16	2.22	0.01	0.02	0.02	0.4	0.8	0.9
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	8.4	9.3	10.2	0.3	0.5	0.8	3.5	6.1	8.3
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	324.4	274.9	233.7	-4.2	-4.5	-5.1	-1.3	-1.6	-2.2
Import Dependency %	44.8	43.6	47.2	54.1	63.1	68.5	1.0	1.2	1.2	1.9	1.9	1.7
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	70.1	59.4	50.2	-0.8	-1.0	-1.1	-1.2	-1.7	-2.2
Residential (Energy on Private Income)	100.0	98.1	85.8	73.5	62.0	51.5	-1.0	-1.1	-1.2	-1.3	-1.7	-2.3
Tertiary (Energy on Value added)	100.0	96.7	86.8	73.3	63.4	55.9	-1.5	-1.9	-2.3	-2.0	-2.9	-4.0
Transport (Energy on GDP)	100.0	101.1	99.3	89.4	77.5	65.1	-1.1	-1.5	-1.5	-1.3	-1.8	-2.2
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.29	0.29	0.30	0.00	0.00	0.00	0.2	1.3	1.4
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.96	1.89	1.82	0.00	0.00	-0.01	-0.1	-0.2	-0.3
Industry	2.18	2.13	1.96	1.60	1.48	1.41	0.00	-0.01	-0.01	-0.3	-0.3	-0.4
Residential	1.94	1.77	1.66	1.56	1.49	1.41	-0.01	-0.02	-0.02	-0.4	-1.1	-1.7
Tertiary	1.83	1.70	1.54	1.37	1.22	1.14	-0.01	-0.02	-0.03	-0.6	-1.2	-2.2
Transport	2.90	2.91	2.91	2.87	2.84	2.81	0.00	0.00	0.01	0.1	0.2	0.2
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**811.9**	**1005.4**	**1215.3**	**28.0**	**58.7**	**97.1**	**3.6**	**6.2**	**8.7**
Nuclear		134.7	140.3	129.8	108.0	108.0	0.0	0.0	0.2	0.0	0.0	0.2
Hydro (pumping excluded)		93.3	96.2	105.3	110.5	113.2	0.7	1.3	1.0	0.6	1.2	0.9
Wind and solar		2.5	13.0	77.0	108.8	158.8	3.8	4.7	9.6	5.2	4.6	6.4
Thermal		386.9	406.7	499.8	678.0	835.3	23.5	52.7	86.3	4.9	8.4	11.5
of which cogeneration units		*87.3*	*103.4*	*133.7*	*177.2*	*218.2*	*4.1*	*9.1*	*19.5*	*3.1*	*5.4*	*9.8*
Open cycle(incl. biomass-waste)		343.8	335.6	271.0	179.0	156.0	0.4	3.7	8.6	0.2	2.1	5.9
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	3.1	84.8	178.1	2.1	18.1	28.2	216.5	27.2	18.8
Gas Turbines Combined Cycle		20.4	47.4	189.5	346.6	427.9	19.9	27.8	43.3	11.7	8.7	11.3
Small Gas Turbines		22.0	22.8	35.0	66.3	70.4	1.1	3.0	4.7	3.1	4.7	7.1
Fuel Cells		0.0	0.0	0.0	0.0	1.4	0.0	0.0	1.4			
Geothermal heat		0.7	1.0	1.2	1.3	1.4	0.0	0.0	0.0	2.6	2.5	2.5
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.1	43.1	47.2	49.0	0.5	0.4	0.4	1.2	0.9	0.8
Load factor for gross electric capacities (%)		48.2	50.4	49.9	47.7	45.0	0.1	0.1	0.1	0.3	0.2	0.3
CHP indicator (% of electricity from CHP)		11.5	12.6	14.4	15.2	16.3	-0.1	-0.3	0.0	-0.5	-2.0	-0.3
Non fossil fuels in electricity generation (%)		46.8	46.4	44.3	37.3	34.1	-1.2	-1.4	-1.5	-2.6	-3.6	-4.2
nuclear		33.1	31.8	26.8	20.0	16.2	-1.0	-1.1	-1.3	-3.7	-5.3	-7.2
renewable energy forms		13.7	14.6	17.4	17.4	17.9	-0.1	-0.3	-0.2	-0.8	-1.5	-1.4
of which waste		*0.9*	*1.1*	*1.3*	*1.2*	*1.0*	*0.0*	*0.0*	*0.1*	*1.7*	*-1.9*	*5.8*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6518.3**	**7687.6**	**8841.3**	**85.5**	**178.5**	**302.4**	**1.3**	**2.4**	**3.5**
public road transport	484.5	469.2	493.8	506.8	539.1	565.7	2.9	6.1	10.1	0.6	1.1	1.8
private cars and motorcycles	3593.6	3950.3	4291.6	5071.6	5872.9	6603.8	46.0	84.6	129.3	0.9	1.5	2.0
rail transport	408.3	371.7	402.3	416.8	484.6	547.9	1.9	5.3	10.3	0.5	1.1	1.9
aviation	168.5	215.5	298.3	481.9	742.3	1066.7	33.8	80.6	149.7	7.5	12.2	16.3
inland navigation	28.9	31.9	33.6	41.3	48.6	57.2	0.9	1.8	3.1	2.2	3.9	5.7
travel per person (km per capita)	10618	11233	12174	14133	16636	19297	185	386	660	1.3	2.4	3.5
Freight transport activity (Gpkm)	**1762.6**	**1859.8**	**2147.6**	**2806.2**	**3573.5**	**4434.5**	**116.4**	**234.5**	**391.7**	**4.3**	**7.0**	**9.7**
trucks	1064.3	1233.6	1482.7	2068.8	2722.5	3478.3	102.1	205.6	345.8	5.2	8.2	11.0
rail transport	440.2	358.0	368.0	382.0	427.9	466.5	3.7	8.0	13.3	1.0	1.9	2.9
inland navigation	258.1	268.2	297.0	355.5	423.1	489.7	10.6	20.9	32.6	3.1	5.2	7.1
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	234	229	222	-1	-2	-2	-0.5	-0.7	-0.9
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**400.7**	**451.8**	**485.7**	**13.5**	**24.8**	**37.0**	**3.5**	**5.8**	**8.2**
public road transport	7.7	6.9	7.0	7.2	7.0	6.5	0.1	0.1	0.1	0.7	1.3	2.0
private cars and motorcycles	138.1	146.1	157.1	170.4	171.0	164.4	1.5	2.3	2.9	0.9	1.4	1.8
trucks	82.9	93.2	108.5	151.3	188.4	216.4	7.5	14.0	20.9	5.2	8.0	10.7
rail transport	8.8	8.9	9.0	8.0	6.6	6.4	0.0	0.1	0.1	0.5	1.0	1.9
aviation	29.1	33.8	45.1	57.2	71.2	83.7	4.2	7.9	12.5	7.9	12.6	17.5
inland navigation	7.0	6.7	5.4	6.5	7.5	8.3	0.2	0.3	0.5	2.9	4.9	6.8
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	37.0	33.2	29.4	0.4	0.6	0.8	1.1	1.9	2.7
freight transport (toe/Mtkm)	51.7	54.4	53.8	56.8	55.1	50.8	0.4	0.4	0.4	0.7	0.8	0.7

Source: PRIMES

EU15: HIGH ECONOMIC GROWTH CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**750.2**	**649.2**	**594.4**	**7.2**	**13.7**	**21.5**	**1.0**	**2.2**	**3.7**
Solids	209.9	138.0	99.4	70.1	56.1	45.2	-0.2	0.0	2.2	-0.3	0.0	5.1
Oil	117.7	159.2	160.4	130.3	100.8	85.2	1.1	1.2	1.1	0.8	1.2	1.3
Natural gas	132.9	166.6	190.6	192.9	143.3	113.4	1.9	1.2	1.3	1.0	0.9	1.1
Nuclear	181.4	201.2	222.8	230.3	200.5	182.1	0.0	1.8	2.1	0.0	0.9	1.2
Renewable energy sources	66.3	74.4	88.1	126.6	148.5	168.3	4.5	9.6	14.8	3.7	6.9	9.6
Hydro	22.3	24.9	27.6	28.4	29.9	30.8	0.2	0.3	0.8	0.8	1.2	2.6
Biomass	29.7	30.8	36.1	53.6	64.5	73.7	2.4	5.9	8.0	4.6	10.1	12.1
Waste	11.9	15.6	18.7	25.3	28.0	28.7	1.0	1.8	3.3	4.1	6.7	12.8
Wind	0.1	0.4	1.9	14.1	19.5	26.0	0.8	1.3	2.4	5.6	7.3	10.1
Solar and others	0.1	0.2	0.3	1.5	2.6	4.7	0.0	0.1	0.2	2.4	4.5	5.5
Geothermal	2.2	2.5	3.3	3.9	4.1	4.4	0.1	0.1	0.1	2.8	2.8	2.8
Net Imports	**645.4**	**651.3**	**737.9**	**927.7**	**1156.4**	**1321.5**	**45.4**	**79.5**	**113.2**	**5.1**	**7.4**	**9.4**
Solids	89.9	94.4	107.2	99.5	136.9	197.2	2.4	13.5	17.7	2.5	10.9	9.9
Oil	460.9	446.7	472.4	541.6	601.3	637.6	24.7	38.5	55.4	4.8	6.8	9.5
Crude oil and Feedstocks	436.8	434.7	455.5	529.7	599.2	646.4	26.1	41.3	59.7	5.2	7.4	10.2
Oil products	24.1	12.0	16.9	11.9	2.0	-8.8	-1.4	-2.7	-4.3	-10.6	-57.5	96.5
Natural gas	92.3	108.6	154.7	283.3	415.0	483.5	18.3	27.5	40.1	6.9	7.1	9.0
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1626.6**	**1747.4**	**1849.7**	**50.9**	**90.2**	**130.2**	**3.2**	**5.4**	**7.6**
Solids	302.8	237.7	212.4	169.6	193.0	242.5	2.2	13.5	19.9	1.3	7.5	9.0
Oil	545.8	575.6	586.9	620.5	643.8	656.6	24.0	36.7	52.0	4.0	6.0	8.6
Natural gas	222.1	273.4	338.7	476.2	558.3	596.9	20.2	28.7	41.4	4.4	5.4	7.4
Nuclear	181.4	201.2	222.8	230.3	200.5	182.1	0.0	1.8	2.1	0.0	0.9	1.2
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	126.6	148.5	168.3	4.5	9.6	14.8	3.7	6.9	9.6
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	10.4	11.0	13.1	-0.2	0.2	0.2	-1.8	2.0	1.3
Oil	41.3	42.2	40.4	38.1	36.8	35.5	0.3	0.2	0.3	0.8	0.6	0.9
Natural gas	16.8	20.0	23.3	29.3	32.0	32.3	0.3	0.0	0.0	1.2	0.0	-0.1
Nuclear	13.7	14.8	15.3	14.2	11.5	9.8	-0.5	-0.5	-0.6	-3.1	-4.3	-5.9
Renewable energy forms	5.0	5.5	6.1	7.8	8.5	9.1	0.0	0.1	0.2	0.4	1.4	1.9
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**3151.2**	**3680.9**	**4202.5**	**124.1**	**230.4**	**356.4**	**4.1**	**6.7**	**9.3**
Nuclear	720.1	810.1	863.7	894.0	782.5	754.0	0.0	7.1	8.9	0.0	0.9	1.2
Hydro & wind	259.8	294.2	343.8	493.9	575.3	680.4	11.4	19.4	37.9	2.4	3.5	5.9
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1763.3	2323.1	2768.1	112.6	203.9	309.7	6.8	9.6	12.6
Fuel Inputs for Thermal Power Generation (1)	**291.8**	**295.1**	**318.3**	**356.6**	**431.5**	**497.2**	**18.9**	**34.6**	**52.4**	**5.6**	**8.7**	**11.8**
Solids	186.1	163.9	153.6	121.3	149.6	202.7	3.6	15.8	23.4	3.1	11.8	13.1
Oil (including refinery gas)	48.7	49.6	38.3	23.2	13.1	9.3	2.9	1.9	2.6	14.2	17.4	37.7
Gas	45.1	66.0	106.3	182.8	235.4	249.9	10.5	12.6	20.3	6.1	5.6	8.8
Biomass - Waste	10.0	13.5	17.1	25.8	29.8	31.4	1.8	4.2	6.0	7.5	16.3	23.9
Geothermal heat	1.9	2.1	3.0	3.5	3.7	4.0	0.1	0.1	0.1	2.5	2.4	2.4
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**768.0**	**814.3**	**854.8**	**26.9**	**42.5**	**60.9**	**3.6**	**5.5**	**7.7**
Refineries	594.6	635.8	665.7	712.5	754.9	789.6	28.9	45.0	64.3	4.2	6.3	8.9
District heating	12.4	11.0	6.0	6.1	5.6	6.2	-0.1	0.4	0.2	-1.7	7.1	4.1
Biofuels and hydrogen production	0.0	0.2	0.6	10.4	18.6	27.6	0.3	0.9	1.8	3.1	5.0	6.9
Others	97.1	58.1	50.6	39.0	35.2	31.4	-2.2	-3.7	-5.4	-5.4	-9.6	-14.8
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**69.5**	**70.9**	**73.2**	**2.1**	**3.6**	**5.3**	**3.1**	**5.3**	**7.8**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**106.6**	**113.4**	**117.1**	**3.3**	**4.9**	**6.6**	**3.2**	**4.6**	**5.9**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1114.6**	**1230.3**	**1323.2**	**38.0**	**65.5**	**94.2**	**3.5**	**5.6**	**7.7**
by sector												
Industry (1)	262.2	255.6	268.7	310.0	342.5	369.0	10.6	17.3	24.4	3.5	5.3	7.1
energy intensive industries	180.4	170.9	175.8	196.2	208.1	213.2	5.5	8.4	11.1	2.9	4.2	5.5
other industrial sectors	81.9	84.7	92.9	113.9	134.4	155.8	5.1	8.8	13.3	4.7	7.0	9.4
Residential	228.1	236.0	244.7	279.7	299.8	312.7	8.8	15.5	21.6	3.3	5.4	7.4
Tertiary	115.3	127.9	132.7	154.6	174.9	200.0	5.5	9.2	13.3	3.7	5.6	7.1
Transport	253.8	275.7	309.1	370.3	412.9	441.6	13.1	23.5	34.9	3.7	6.0	8.6
by fuel (1)												
Solids	76.8	47.0	36.0	29.2	26.3	24.3	0.8	1.1	1.3	2.9	4.3	5.4
Oil	391.5	414.1	430.6	479.2	518.1	544.7	17.0	29.1	42.8	3.7	6.0	8.5
Gas	169.7	194.9	220.3	274.3	297.0	315.8	7.7	12.0	14.9	2.9	4.2	5.0
Electricity	156.0	169.4	191.6	237.6	281.3	323.7	9.3	17.5	27.4	4.1	6.6	9.2
Heat (from CHP and District Heating)	35.2	39.3	42.1	54.0	64.2	71.2	2.2	3.4	4.6	4.2	5.7	6.9
Other	30.3	30.6	34.5	40.3	43.3	43.5	1.0	2.3	3.2	2.6	5.7	7.9
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.7**	**3117.5**	**3328.2**	**3666.7**	**3991.9**	**123.3**	**222.7**	**323.3**	**3.8**	**6.5**	**8.8**
Electricity and Steam production	997.6	947.7	948.3	997.7	1194.9	1424.5	45.8	94.9	144.0	4.8	8.6	11.2
Energy Branch	129.8	144.4	145.4	140.0	140.0	140.2	4.9	8.3	12.6	3.6	6.3	9.9
Industry	576.2	526.5	509.3	473.9	483.3	497.9	15.6	23.3	31.5	3.4	5.1	6.8
Residential	436.4	417.4	412.9	444.8	459.4	458.3	12.4	18.8	24.1	2.9	4.3	5.6
Tertiary	203.5	212.7	199.6	208.7	215.1	230.1	6.1	8.7	10.3	3.0	4.2	4.7
Transport	738.5	802.9	902.2	1063.1	1174.1	1240.8	38.6	68.7	100.7	3.8	6.2	8.8
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**108.0**	**119.0**	**129.5**	**4.0**	**7.2**	**10.5**	**3.8**	**6.5**	**8.8**

See explanations on the last page of the Appendix

Source: PRIMES

EU15: HIGH ECONOMIC GROWTH CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	11396	14723	18750	537	1082	1831	4.9	7.9	10.8
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	142.7	118.7	98.6	-2.4	-2.8	-3.0	-1.6	-2.3	-2.9
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	4.2	4.5	4.8	0.1	0.2	0.3	3.2	5.4	7.6
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	8125	9427	10803	320	590	916	4.1	6.7	9.3
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	2.05	2.10	2.16	0.01	0.02	0.02	0.6	1.0	1.2
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	8.6	9.4	10.3	0.3	0.6	0.8	3.8	6.5	8.8
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	292.1	249.0	212.9	-3.1	-3.4	-3.9	-1.0	-1.4	-1.8
Import Dependency %	47.6	46.6	49.4	55.3	64.0	69.0	1.0	1.2	1.1	1.8	1.8	1.7
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	78.0	66.6	56.3	-0.9	-1.2	-1.4	-1.2	-1.8	-2.4
Residential (Energy on Private Income)	100.0	97.6	88.2	76.3	64.2	53.4	-0.9	-1.1	-1.2	-1.2	-1.6	-2.2
Tertiary (Energy on Value added)	100.0	101.8	90.9	76.9	66.7	59.3	-1.4	-1.9	-2.4	-1.8	-2.7	-3.8
Transport (Energy on GDP)	100.0	101.2	99.5	89.4	77.1	64.8	-1.1	-1.4	-1.3	-1.2	-1.7	-2.0
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.26	0.27	0.28	0.00	0.01	0.01	0.7	2.0	2.2
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.97	1.90	1.83	0.00	0.00	-0.01	-0.1	-0.2	-0.3
Industry	2.20	2.06	1.90	1.53	1.41	1.35	0.00	0.00	0.00	-0.1	-0.2	-0.3
Residential	1.91	1.77	1.69	1.59	1.53	1.47	-0.01	-0.02	-0.03	-0.4	-1.1	-1.7
Tertiary	1.76	1.66	1.50	1.35	1.23	1.15	-0.01	-0.02	-0.03	-0.6	-1.3	-2.3
Transport	2.91	2.91	2.92	2.87	2.84	2.81	0.00	0.00	0.01	0.1	0.2	0.2
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**714.8**	**864.7**	**1036.2**	**26.0**	**52.1**	**85.2**	**3.8**	**6.4**	**9.0**
Nuclear		126.2	131.0	121.9	100.1	105.2	0.0	0.0	0.2	0.0	0.0	0.2
Hydro (pumping excluded)		87.1	89.8	97.6	102.2	104.7	0.6	1.2	0.9	0.6	1.2	0.9
Wind and solar		2.5	12.9	74.2	100.1	143.7	3.8	4.7	9.4	5.4	4.9	7.0
Thermal		322.9	344.8	421.1	562.3	682.7	21.6	46.2	74.6	5.4	9.0	12.3
of which cogeneration units		*59.3*	*77.1*	*106.1*	*137.5*	*163.2*	*3.8*	*7.5*	*16.8*	*3.7*	*5.8*	*11.5*
Open cycle(incl. biomass-waste)		281.8	276.9	214.9	138.6	120.8	0.3	2.9	7.4	0.1	2.1	6.6
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	2.5	69.4	146.3	2.1	17.7	27.3	460.6	34.3	23.0
Gas Turbines Combined Cycle		20.0	46.0	175.5	301.7	357.2	18.2	22.4	34.2	11.6	8.0	10.6
Small Gas Turbines		20.3	21.0	26.9	51.3	55.6	1.0	3.2	4.2	4.0	6.6	8.2
Fuel Cells		0.0	0.0	0.0	0.0	1.4	0.0	0.0	1.4			
Geothermal heat		0.7	1.0	1.2	1.3	1.4	0.0	0.0	0.0	2.6	2.5	2.5
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.8	44.4	48.3	49.9	0.5	0.3	0.2	1.1	0.7	0.5
Load factor for gross electric capacities (%)		48.9	50.8	50.3	48.6	46.3	0.2	0.1	0.1	0.3	0.2	0.3
CHP indicator (% of electricity from CHP)		9.2	10.3	12.6	13.6	14.1	0.0	-0.3	0.0	0.1	-1.9	0.1
Non fossil fuels in electricity generation (%)		49.9	49.3	46.9	39.6	36.7	-1.3	-1.4	-1.6	-2.7	-3.5	-4.1
nuclear		35.1	33.6	28.4	21.3	17.9	-1.2	-1.2	-1.4	-3.9	-5.4	-7.4
renewable energy forms		14.8	15.8	18.5	18.4	18.7	-0.1	-0.2	-0.2	-0.7	-1.2	-0.8
of which waste		*1.0*	*1.2*	*1.5*	*1.3*	*1.2*	*0.1*	*0.0*	*0.1*	*3.8*	*0.5*	*8.3*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5897.9**	**6864.2**	**7816.5**	**80.8**	**163.9**	**276.3**	**1.4**	**2.4**	**3.7**
public road transport	368.8	382.2	412.6	425.5	454.1	474.2	2.8	5.7	9.1	0.7	1.3	1.9
private cars and motorcycles	3325.6	3634.5	3938.8	4609.0	5241.7	5816.7	42.7	74.5	112.3	0.9	1.4	2.0
rail transport	316.4	320.9	356.0	368.4	425.8	471.5	1.7	4.7	8.7	0.5	1.1	1.9
aviation	157.3	201.5	281.5	454.4	694.8	997.8	32.7	77.1	143.2	7.8	12.5	16.8
inland navigation	28.3	31.4	33.0	40.6	47.9	56.4	0.9	1.8	3.1	2.2	4.0	5.7
travel per person (km per capita)	11465	12240	13261	15208	17581	20093	208	420	710	1.4	2.4	3.7
Freight transport activity (Gpkm)	**1438.0**	**1601.7**	**1872.6**	**2461.9**	**3114.7**	**3859.0**	**111.5**	**218.0**	**357.4**	**4.7**	**7.5**	**10.2**
trucks	946.0	1114.6	1327.2	1840.1	2386.8	3033.3	97.3	189.5	313.2	5.6	8.6	11.5
rail transport	234.9	220.2	249.3	267.2	305.6	336.9	3.6	7.6	11.6	1.3	2.6	3.6
inland navigation	257.1	266.9	296.1	354.7	422.3	488.8	10.6	20.9	32.6	3.1	5.2	7.1
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	206	0	-1	-1	-0.2	-0.4	-0.6
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**370.3**	**412.9**	**441.6**	**13.1**	**23.5**	**34.9**	**3.7**	**6.0**	**8.6**
public road transport	6.3	5.9	5.8	6.0	5.9	5.4	0.1	0.1	0.1	0.8	1.4	2.1
private cars and motorcycles	130.2	136.6	145.5	155.6	153.0	144.7	1.4	2.1	2.4	0.9	1.4	1.7
trucks	76.0	86.5	101.0	140.0	172.6	196.9	7.3	13.2	19.4	5.5	8.3	11.0
rail transport	6.9	7.5	7.7	6.9	5.6	5.4	0.0	0.1	0.1	0.6	1.1	1.9
aviation	27.8	32.5	43.8	55.3	68.4	81.0	4.1	7.7	12.2	8.1	12.8	17.8
inland navigation	6.7	6.7	5.3	6.4	7.4	8.3	0.2	0.3	0.5	2.9	4.9	6.8
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	37.8	33.9	30.2	0.4	0.7	0.9	1.2	2.0	3.0
freight transport (toe/Mtkm)	57.8	58.5	57.3	59.8	57.9	53.2	0.3	0.3	0.3	0.6	0.6	0.5

Source: PRIMES

NMS: HIGH ECONOMIC GROWTH CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**117.4**	**105.8**	**89.9**	**0.1**	**0.4**	**1.9**	**0.1**	**0.4**	**2.1**
Solids	140.9	126.7	104.0	83.4	70.4	60.5	0.0	0.1	1.0	0.0	0.2	1.8
Oil	2.6	3.0	3.1	2.5	2.5	2.3	0.0	0.0	0.0	0.7	1.0	1.5
Natural gas	6.7	7.4	6.1	6.0	5.5	5.0	0.1	0.1	0.1	0.8	1.2	1.5
Nuclear	15.5	14.1	14.8	14.9	14.8	5.3	0.0	0.0	0.0	-0.1	-0.1	0.0
Renewable energy sources	3.0	6.3	8.0	10.6	12.6	16.6	0.1	0.2	0.7	0.7	1.7	4.4
Hydro	1.1	1.3	1.4	2.0	2.2	2.2	0.0	0.0	0.0	0.7	1.1	1.1
Biomass	1.4	4.6	6.1	6.3	6.5	8.1	0.1	0.1	0.2	0.8	2.0	2.4
Waste	0.5	0.3	0.5	1.4	1.5	2.2	0.0	0.0	0.4	0.2	2.0	23.2
Wind	0.0	0.0	0.0	0.6	1.9	3.2	0.0	0.0	0.0	0.0	0.4	0.6
Solar and others	0.0	0.0	0.0	0.3	0.5	0.9	0.0	0.0	0.1	1.9	4.7	6.6
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	3.8	5.7
Net Imports	**66.3**	**50.4**	**61.4**	**95.0**	**136.0**	**165.7**	**2.9**	**8.4**	**12.2**	**3.1**	**6.6**	**7.9**
Solids	-14.6	-20.7	-15.9	-6.9	4.2	18.8	0.3	1.3	0.9	-3.7	46.9	5.1
Oil	49.9	45.0	47.3	56.5	65.6	72.5	0.9	2.3	3.7	1.6	3.7	5.4
Crude oil and Feedstocks	43.4	36.7	41.3	46.9	55.0	61.4	0.7	2.0	3.1	1.5	3.7	5.4
Oil products	6.5	8.3	6.0	9.6	10.5	11.1	0.2	0.4	0.6	1.8	3.7	5.6
Natural gas	31.2	26.2	31.5	46.7	67.4	75.2	1.7	4.7	7.5	3.8	7.6	11.1
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**211.3**	**240.6**	**254.2**	**2.9**	**8.8**	**14.0**	**1.4**	**3.8**	**5.8**
Solids	127.8	108.2	90.8	76.5	74.6	79.4	0.2	1.5	2.0	0.3	2.0	2.5
Oil	50.4	46.6	48.7	57.9	66.8	73.5	0.9	2.3	3.7	1.5	3.6	5.3
Natural gas	37.1	33.8	37.3	52.6	72.9	80.2	1.8	4.8	7.6	3.5	7.0	10.4
Nuclear	15.5	14.1	14.8	14.9	14.8	5.3	0.0	0.0	0.0	-0.1	-0.1	0.0
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	10.6	12.6	16.6	0.1	0.2	0.7	0.7	1.7	4.4
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	36.2	31.0	31.2	-0.4	-0.5	-1.0	-1.1	-1.7	-3.1
Oil	21.6	22.3	24.6	27.4	27.8	28.9	0.0	0.0	-0.1	0.1	-0.2	-0.4
Natural gas	15.9	16.2	18.8	24.9	30.3	31.6	0.5	0.9	1.3	2.0	3.1	4.4
Nuclear	6.6	6.7	7.5	7.1	6.2	2.1	-0.1	-0.2	-0.1	-1.5	-3.7	-5.5
Renewable energy forms	1.3	3.0	4.1	5.0	5.2	6.5	0.0	-0.1	-0.1	-0.7	-2.0	-1.3
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**400.0**	**523.1**	**591.7**	**7.9**	**24.9**	**40.6**	**2.0**	**5.0**	**7.4**
Nuclear	60.0	54.3	57.4	58.5	58.1	21.5	-0.1	0.0	0.0	-0.1	-0.1	0.0
Hydro & wind	12.9	15.5	15.7	30.3	46.9	63.4	0.2	0.4	0.5	0.6	0.8	0.8
Thermal (incl. biomass)	243.7	230.7	250.6	311.2	418.1	506.9	7.8	24.6	40.1	2.6	6.2	8.6
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**76.6**	**89.9**	**102.6**	**1.1**	**4.0**	**6.5**	**1.4**	**4.7**	**6.7**
Solids	62.2	57.2	56.5	57.6	59.4	66.2	0.0	0.8	1.3	0.1	1.4	2.0
Oil	4.9	4.4	3.2	3.5	2.5	3.0	0.1	0.1	0.3	2.2	6.0	10.6
Gas	5.3	4.0	6.3	14.0	26.3	30.9	1.3	3.4	5.3	9.8	14.7	20.5
Biomass - Waste	0.3	0.1	0.4	1.5	1.7	2.5	-0.3	-0.3	-0.4	-16.5	-16.8	-12.5
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**66.8**	**73.7**	**81.4**	**0.8**	**2.4**	**3.7**	**1.2**	**3.3**	**4.7**
Refineries	46.7	40.1	45.2	50.5	59.1	66.5	0.7	2.1	3.3	1.5	3.6	5.3
District heating	19.3	12.1	8.5	4.5	3.6	2.8	0.0	0.0	0.0	-0.7	-0.2	-0.8
Biofuels and hydrogen production	0.0	0.0	0.0	0.1	0.4	1.8	0.0	0.0	0.1	1.4	3.3	4.9
Others	30.5	23.1	17.7	11.7	10.5	10.4	0.1	0.3	0.2	0.8	3.0	2.5
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.8**	**10.2**	**9.8**	**0.1**	**0.3**	**0.5**	**1.5**	**3.3**	**5.2**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.2**	**13.5**	**15.2**	**0.2**	**0.5**	**0.9**	**1.7**	**4.1**	**6.0**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**134.6**	**159.4**	**174.9**	**2.2**	**6.3**	**9.8**	**1.7**	**4.1**	**5.9**
by sector												
Industry	65.0	47.7	40.4	40.4	44.4	47.3	0.9	2.3	3.4	2.4	5.5	7.7
energy intensive industries	32.5	27.9	26.2	26.3	28.0	29.0	0.6	1.5	2.1	2.4	5.6	7.8
other industrial sectors	32.4	19.7	14.2	14.1	16.4	18.3	0.3	0.8	1.3	2.3	5.2	7.5
Residential	40.0	41.2	34.4	38.3	46.5	50.4	0.5	1.8	2.7	1.4	4.0	5.6
Tertiary	24.9	19.6	21.5	25.4	29.6	33.1	0.3	1.0	1.6	1.3	3.5	5.2
Transport	19.9	19.8	22.9	30.5	38.8	44.1	0.4	1.2	2.1	1.4	3.3	5.0
by fuel												
Solids	40.9	33.8	21.4	14.1	11.5	9.6	0.2	0.6	0.6	1.7	5.3	7.0
Oil	32.7	29.6	33.6	41.9	50.2	55.4	0.6	1.6	2.6	1.5	3.3	4.9
Gas	26.5	24.6	25.4	33.6	41.0	44.6	0.3	1.2	2.0	1.0	3.0	4.6
Electricity	20.5	18.5	19.6	25.7	35.1	41.0	0.6	1.8	3.0	2.3	5.4	7.8
Heat (from CHP and District Heating)	27.7	17.4	13.5	13.3	15.6	17.7	0.1	0.6	0.7	0.9	4.0	3.9
Other	1.8	4.7	5.8	6.0	6.0	6.5	0.4	0.6	1.0	6.7	10.4	18.0
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**559.2**	**619.0**	**668.6**	**6.9**	**22.3**	**33.6**	**1.3**	**3.7**	**5.3**
Electricity and Steam production	343.4	295.0	280.1	286.5	314.9	350.9	3.2	11.9	18.4	1.1	3.9	5.5
Energy Branch	14.4	19.5	18.7	10.8	11.8	12.0	0.2	0.4	0.6	2.1	3.9	5.1
Industry	137.0	118.2	96.4	87.6	89.6	90.9	1.5	3.8	5.3	1.8	4.5	6.2
Residential	83.2	72.9	49.7	49.8	56.2	55.0	0.5	1.7	2.1	0.9	3.0	3.9
Tertiary	53.3	38.3	37.2	37.2	35.4	36.2	0.3	0.9	1.2	0.8	2.5	3.5
Transport	56.1	55.9	65.3	87.2	111.1	123.5	1.3	3.7	6.1	1.5	3.4	5.2
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**81.3**	**90.0**	**97.3**	**1.0**	**3.2**	**4.9**	1.3	3.7	5.3

See explanations on the last page of the Appendix

Source: PRIMES

NMS: HIGH ECONOMIC GROWTH CASE							SUMMARY ENERGY BALANCE AND INDICATORS (B)					
Mtoe	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
							Difference from Baseline			**% diff. from Baseline**		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	588	865	1194	14	44	93	2.4	5.4	8.5
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	359.6	278.0	212.9	-3.6	-4.3	-5.4	-1.0	-1.5	-2.5
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.9	3.4	3.7	0.0	0.1	0.2	1.4	3.8	5.8
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	5449	7299	8558	108	347	588	2.0	5.0	7.4
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.65	2.57	2.63	0.00	0.00	-0.01	-0.1	-0.1	-0.5
CO2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.6	8.6	9.7	0.1	0.3	0.5	1.3	3.7	5.3
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	951.4	715.4	560.0	-10.9	-11.4	-17.0	-1.1	-1.6	-2.9
Import Dependency %	28.3	24.1	30.8	44.7	56.2	64.8	0.7	1.5	1.3	1.7	2.7	2.0
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	36.2	27.4	22.8	0.0	0.0	0.0	0.1	0.1	-0.1
Residential (Energy on Private Income)	100.0	106.5	74.2	55.2	44.4	35.2	-0.8	-0.9	-0.8	-1.4	-2.0	-2.4
Tertiary (Energy on Value added)	100.0	74.8	67.2	51.9	39.4	30.9	-0.6	-1.0	-1.1	-1.2	-2.5	-3.5
Transport (Energy on GDP)	100.0	102.9	97.4	86.8	75.1	61.8	-0.8	-1.5	-2.0	-1.0	-2.0	-3.2
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.49	0.43	0.43	0.00	0.00	0.00	-0.5	-0.7	-0.9
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.95	1.83	1.75	-0.01	-0.01	-0.01	-0.3	-0.6	-0.8
Industry	2.11	2.48	2.38	2.17	2.02	1.92	-0.01	-0.02	-0.03	-0.6	-1.0	-1.3
Residential	2.08	1.77	1.44	1.30	1.21	1.09	-0.01	-0.01	-0.02	-0.5	-0.9	-1.6
Tertiary	2.14	1.95	1.73	1.47	1.19	1.09	-0.01	-0.01	-0.02	-0.5	-1.0	-1.6
Transport	2.82	2.82	2.85	2.86	2.86	2.80	0.00	0.00	0.00	0.1	0.1	0.1
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**97.1**	**140.7**	**179.0**	**1.9**	**6.6**	**11.9**	**2.0**	**4.9**	**7.1**
Nuclear		8.4	9.3	7.9	7.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		6.1	6.4	7.7	8.3	8.5	0.1	0.1	0.1	0.7	0.8	0.8
Wind and solar		0.0	0.0	2.8	8.8	15.1	0.0	0.0	0.2	0.0	0.4	1.0
Thermal		64.0	61.9	78.7	115.7	152.6	1.9	6.5	11.7	2.5	5.9	8.3
of which cogeneration units		*28.1*	*26.3*	*27.6*	*39.7*	*55.0*	*0.3*	*1.5*	*2.7*	*1.1*	*4.0*	*5.2*
Open cycle (incl. biomass-waste)		61.9	58.6	56.1	40.4	35.3	0.2	0.9	1.2	0.3	2.2	3.6
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.5	15.4	31.8	0.0	0.4	0.8	1.2	2.7	2.7
Gas Turbines Combined Cycle		0.4	1.4	14.0	44.9	70.7	1.7	5.4	9.2	13.8	13.7	14.9
Small Gas Turbines		1.7	1.8	8.1	15.0	14.8	0.0	-0.2	0.4	0.1	-1.2	2.9
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	36.8	42.0	44.7	0.4	0.6	0.7	1.1	1.4	1.7
Load factor for gross electric capacities (%)		43.6	47.6	47.0	42.4	37.7	0.0	0.0	0.1	0.0	0.1	0.3
CHP indicator (% of electricity from CHP)		29.4	30.4	27.9	26.9	31.5	-0.4	-0.4	-0.2	-1.5	-1.6	-0.5
Non fossil fuels in electricity generation (%)		23.4	23.1	23.5	21.3	16.0	-0.7	-1.2	-1.3	-2.9	-5.4	-7.5
nuclear		18.1	17.7	14.6	11.1	3.6	-0.3	-0.6	-0.3	-2.1	-4.8	-6.8
renewable energy forms		5.3	5.4	8.9	10.2	12.3	-0.4	-0.7	-1.0	-4.1	-6.1	-7.7
of which waste		*0.0*	*0.1*	*0.4*	*0.2*	*0.2*	*-0.2*	*-0.2*	*-0.2*	*-38.8*	*-54.8*	*-51.2*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**620.4**	**823.3**	**1024.8**	**4.7**	**14.6**	**26.1**	**0.8**	**1.8**	**2.6**
public road transport	115.7	87.0	81.2	81.3	85.0	91.5	0.1	0.5	1.0	0.1	0.6	1.1
private cars and motorcycles	268.0	315.8	352.9	462.6	631.2	787.1	3.3	10.0	16.9	0.7	1.6	2.2
rail transport	91.9	50.8	46.3	48.4	58.8	76.4	0.2	0.6	1.6	0.4	1.1	2.2
aviation	11.2	14.0	16.8	27.5	47.5	69.0	1.1	3.5	6.5	4.1	8.0	10.3
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	0.6	1.2	1.8
travel per person (km per capita)	6489	6227	6662	8452	11488	14821	64	204	377	0.8	1.8	2.6
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**344.3**	**458.8**	**575.5**	**4.9**	**16.6**	**34.2**	**1.5**	**3.8**	**6.3**
trucks	118.4	119.0	155.5	228.7	335.7	445.0	4.8	16.2	32.6	2.1	5.1	7.9
rail transport	205.2	137.8	118.7	114.8	122.3	129.6	0.1	0.4	1.7	0.1	0.3	1.3
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	0.1	0.7	1.8
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	586	530	482	-6	-8	-10	-0.9	-1.6	-2.0
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**30.5**	**38.8**	**44.1**	**0.4**	**1.2**	**2.1**	**1.4**	**3.3**	**5.0**
public road transport	1.4	1.0	1.2	1.2	1.1	1.1	0.0	0.0	0.0	0.1	0.5	1.0
private cars and motorcycles	7.9	9.5	11.6	14.9	18.0	19.8	0.1	0.3	0.4	0.7	1.6	2.2
trucks	7.0	6.7	7.5	11.3	15.9	19.5	0.2	0.8	1.4	2.2	5.1	7.9
rail transport	2.0	1.4	1.3	1.1	1.0	1.0	0.0	0.0	0.0	0.2	0.5	1.5
aviation	1.3	1.2	1.3	1.9	2.8	2.7	0.1	0.2	0.2	3.8	7.3	9.5
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	1.9
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	29.8	27.2	23.4	0.1	0.1	0.1	0.2	0.4	0.3
freight transport (toe/Mtkm)	24.6	28.8	30.0	34.7	35.9	34.9	0.2	0.4	0.4	0.6	1.1	1.3

Source: PRIMES

[(1)] EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

APPENDIX 4

Summary energy balances and indicators by group of countries (EU-25, EU-15, new Member states (NMS)) – comparison to baseline

EU25: EFFICIENCY CASE WITH HIGH RENEWABLES — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**887.2**	**770.6**	**673.5**	**26.9**	**29.7**	**12.6**	**3.1**	**4.0**	**1.9**
Solids	350.8	264.7	203.4	139.3	108.9	78.0	-14.5	-17.5	-24.6	-9.4	-13.8	-24.0
Oil	120.3	162.2	163.5	129.6	100.7	85.6	-2.1	-1.4	-0.9	-1.6	-1.4	-1.0
Natural gas	139.6	174.0	196.6	192.0	148.4	118.7	-4.9	0.8	1.6	-2.5	0.5	1.3
Nuclear	196.9	215.3	237.7	222.3	185.1	148.4	-22.9	-28.4	-36.9	-9.4	-13.3	-19.9
Renewable energy sources	69.2	80.7	96.1	204.0	227.5	242.9	71.3	76.2	73.4	53.8	50.4	43.3
Hydro	23.4	26.3	29.0	30.5	32.5	34.0	0.4	0.8	1.8	1.3	2.7	5.5
Biomass	31.1	35.4	42.2	117.2	125.2	125.2	59.8	60.3	51.6	104.0	92.8	70.0
Waste	12.3	15.9	19.3	27.8	31.2	32.5	2.1	3.5	5.3	8.2	12.5	19.5
Wind	0.1	0.4	1.9	14.7	23.6	33.4	0.8	3.5	6.5	5.5	17.3	24.4
Solar and others	0.1	0.3	0.4	9.8	10.7	12.8	8.1	7.8	7.5	479.4	262.9	141.5
Geothermal	2.2	2.5	3.3	4.0	4.4	5.0	0.2	0.4	0.7	5.9	10.5	17.0
Net Imports	**711.6**	**701.7**	**799.3**	**842.9**	**983.5**	**1073.8**	**-131.6**	**-221.0**	**-288.0**	**-13.5**	**-18.3**	**-21.1**
Solids	75.2	73.8	91.4	73.4	72.9	109.5	-16.5	-53.4	-87.9	-18.4	-42.3	-44.5
Oil	510.8	491.8	519.6	512.1	548.9	563.7	-60.3	-77.0	-87.2	-10.5	-12.3	-13.4
Crude oil and Feedstocks	480.2	471.5	496.8	491.8	537.3	560.4	-58.0	-73.8	-84.6	-10.5	-12.1	-13.1
Oil products	30.6	20.3	22.8	20.3	11.7	3.3	-2.4	-3.3	-2.7	-10.5	-21.9	-44.3
Natural gas	123.5	134.8	186.2	255.3	359.7	398.2	-54.7	-90.6	-112.9	-17.7	-20.1	-22.1
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1679.5**	**1697.6**	**1684.3**	**-104.7**	**-191.3**	**-275.4**	**-5.9**	**-10.1**	**-14.1**
Solids	430.6	346.0	303.2	212.7	181.8	187.5	-31.0	-70.9	-112.5	-12.7	-28.1	-37.5
Oil	596.2	622.2	635.6	591.1	593.1	586.3	-62.5	-78.5	-88.1	-9.6	-11.7	-13.1
Natural gas	259.2	307.1	376.0	447.3	508.0	516.9	-59.6	-89.7	-111.3	-11.8	-15.0	-17.7
Nuclear	196.9	215.3	237.7	222.3	185.1	148.4	-22.9	-28.4	-36.9	-9.4	-13.3	-19.9
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	204.0	227.5	242.9	71.3	76.2	73.4	53.8	50.4	43.3
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	12.7	10.7	11.1	-1.0	-2.7	-4.2	-7.3	-20.0	-27.3
Oil	38.4	39.6	38.5	35.2	34.9	34.8	-1.4	-0.6	0.4	-3.9	-1.7	1.2
Natural gas	16.7	19.5	22.8	26.6	29.9	30.7	-1.8	-1.7	-1.4	-6.3	-5.4	-4.3
Nuclear	12.7	13.7	14.4	13.2	10.9	8.8	-0.5	-0.4	-0.6	-3.7	-3.5	-6.8
Renewable energy forms	4.5	5.1	5.8	12.1	13.4	14.4	4.7	5.4	5.8	63.4	67.3	66.7
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3192.4**	**3521.4**	**3695.1**	**-226.7**	**-427.2**	**-702.1**	**-6.6**	**-10.8**	**-16.0**
Nuclear	780.0	864.4	921.2	863.5	720.6	612.3	-88.9	-112.9	-154.2	-9.3	-13.5	-20.1
Hydro & wind	272.7	309.7	359.5	526.1	654.6	805.9	13.5	52.1	100.4	2.6	8.7	14.2
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1802.8	2146.3	2276.9	-151.3	-366.4	-648.2	-7.7	-14.6	-22.2
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**371.0**	**397.0**	**395.6**	**-42.3**	**-85.9**	**-145.4**	**-10.2**	**-17.8**	**-26.9**
Solids	248.2	221.1	210.1	147.7	124.6	134.4	-27.5	-67.7	-109.7	-15.7	-35.2	-44.9
Oil (including refinery gas)	53.7	53.9	41.5	14.8	13.7	8.4	-9.0	0.1	-1.0	-37.8	0.9	-10.7
Gas	50.4	70.0	112.6	150.3	191.9	179.1	-34.8	-53.8	-76.1	-18.8	-21.9	-29.8
Biomass - Waste	10.3	13.6	17.5	54.5	62.7	68.8	28.7	35.0	40.7	111.0	126.4	144.5
Geothermal heat	1.9	2.1	3.0	3.7	4.1	4.7	0.3	0.5	0.8	8.1	13.0	19.5
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**784.1**	**796.8**	**800.0**	**-23.0**	**-46.3**	**-71.7**	**-2.9**	**-5.5**	**-8.2**
Refineries	641.3	675.9	710.9	689.7	703.9	709.2	-43.6	-63.1	-79.3	-5.9	-8.2	-10.1
District heating	31.7	23.1	14.5	9.3	7.9	6.6	-1.4	-1.0	-2.1	-13.3	-11.0	-24.3
Biofuels and hydrogen production	0.0	0.2	0.6	34.3	37.3	38.4	24.1	19.1	10.9	236.4	105.5	39.8
Others	127.6	81.2	68.3	50.7	47.7	45.8	-2.1	-1.4	-1.2	-4.0	-2.8	-2.5
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**71.0**	**69.2**	**67.1**	**-6.0**	**-8.0**	**-10.1**	**-7.8**	**-10.4**	**-13.1**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.5**	**121.5**	**124.9**	**0.2**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1147.0**	**1201.3**	**1241.9**	**-61.9**	**-116.6**	**-152.2**	**-5.1**	**-8.8**	**-10.9**
by sector												
Industry (1)	327.2	303.3	309.1	329.5	351.4	376.2	-9.4	-16.0	-12.3	-2.8	-4.3	-3.2
energy intensive industries	212.9	198.9	202.0	210.1	216.4	220.7	-6.2	-9.9	-8.3	-2.9	-4.4	-3.6
other industrial sectors	114.3	104.4	107.0	119.3	135.1	155.5	-3.2	-6.1	-3.9	-2.6	-4.3	-2.5
Residential	268.1	277.2	279.1	293.8	298.7	296.1	-14.9	-30.4	-42.7	-4.8	-9.2	-12.6
Tertiary	140.2	147.5	154.2	154.5	168.6	181.0	-19.8	-25.8	-37.1	-11.4	-13.3	-17.0
Transport	273.7	295.6	332.0	369.4	382.6	388.6	-17.8	-44.4	-60.1	-4.6	-10.4	-13.4
by fuel (1)												
Solids	117.7	80.8	57.4	40.0	33.9	30.1	-2.3	-2.2	-2.0	-5.4	-6.1	-6.2
Oil	424.2	443.7	464.2	471.4	477.5	480.6	-32.1	-60.1	-74.1	-6.4	-11.2	-13.4
Gas	196.2	219.5	245.7	277.3	291.2	310.5	-22.6	-33.7	-32.9	-7.5	-10.4	-9.6
Electricity	176.5	187.9	211.3	236.3	264.8	281.5	-17.1	-32.3	-52.9	-6.7	-10.9	-15.8
Heat (from CHP and District Heating)	62.9	56.7	55.6	60.3	70.5	80.5	-4.7	-5.2	-3.2	-7.2	-6.9	-3.8
Other	32.1	35.3	40.3	61.8	63.3	58.7	16.8	16.9	12.8	37.5	36.4	27.8
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.9**	**3664.9**	**3309.4**	**3319.1**	**3336.4**	**-447.7**	**-721.5**	**-967.2**	**-11.9**	**-17.9**	**-22.5**
Electricity and Steam production	1341.0	1242.7	1228.3	1012.3	1006.3	992.7	-223.0	-396.8	-620.4	-18.1	-28.3	-38.5
Energy Branch	144.2	163.9	164.0	133.3	128.6	124.0	-12.5	-14.4	-15.0	-8.6	-10.1	-10.8
Industry	713.2	644.8	605.7	506.7	494.7	508.4	-37.7	-51.1	-43.5	-6.9	-9.4	-7.9
Residential	519.7	490.4	462.6	444.2	438.7	432.3	-37.4	-56.4	-54.9	-7.8	-11.4	-11.3
Tertiary	256.8	251.0	236.7	207.6	211.6	224.1	-32.0	-29.3	-30.7	-13.4	-12.2	-12.0
Transport	794.6	859.1	967.5	1005.3	1039.2	1054.9	-105.2	-173.5	-202.8	-9.5	-14.3	-16.1
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**87.8**	**88.1**	**88.5**	**-11.9**	**-19.1**	**-25.7**	-11.9	-17.9	-22.5

See explanations on the last page of the Appendix

Source: PRIMES

EU25: EFFICIENCY CASE WITH HIGH RENEWABLES — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	146.9	117.4	93.5	-9.2	-13.2	-15.3	-5.9	-10.1	-14.1
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.6	3.7	3.7	-0.2	-0.4	-0.6	-5.9	-10.1	-14.1
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	6922	7620	8065	-492	-924	-1532	-6.6	-10.8	-16.0
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	1.97	1.96	1.98	-0.14	-0.18	-0.22	-6.4	-8.6	-9.8
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	7.2	7.2	7.3	-1.0	-1.6	-2.1	-11.9	-17.9	-22.5
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	289.5	229.5	185.1	-39.2	-49.9	-53.7	-11.9	-17.9	-22.5
Import Dependency %	44.8	43.6	47.2	48.7	56.1	61.5	-4.4	-5.8	-5.9	-8.3	-9.4	-8.7
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	69.0	57.8	49.7	-2.0	-2.6	-1.6	-2.8	-4.3	-3.2
Residential (Energy on Private Income)	100.0	98.1	85.8	70.9	57.3	46.1	-3.6	-5.8	-6.6	-4.8	-9.2	-12.6
Tertiary (Energy on Value added)	100.0	96.7	86.8	66.4	56.6	48.3	-8.5	-8.7	-9.9	-11.4	-13.3	-17.0
Transport (Energy on GDP)	100.0	101.1	99.3	86.3	70.7	57.6	-4.2	-8.2	-8.9	-4.6	-10.4	-13.4
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.26	0.23	0.21	-0.04	-0.06	-0.09	-12.1	-20.2	-28.7
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.89	1.82	1.79	-0.08	-0.07	-0.04	-4.0	-3.9	-2.3
Industry	2.18	2.13	1.96	1.54	1.41	1.35	-0.07	-0.08	-0.07	-4.3	-5.2	-4.9
Residential	1.94	1.77	1.66	1.51	1.47	1.46	-0.05	-0.04	0.02	-3.1	-2.4	1.5
Tertiary	1.83	1.70	1.54	1.34	1.26	1.24	-0.03	0.02	0.07	-2.2	1.3	6.0
Transport	2.90	2.91	2.91	2.72	2.72	2.71	-0.15	-0.12	-0.09	-5.1	-4.4	-3.1
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**757.6**	**870.4**	**983.2**	**-26.3**	**-76.3**	**-135.0**	**-3.4**	**-8.1**	**-12.1**
Nuclear		134.7	140.3	129.8	102.5	91.6	0.0	-5.5	-16.2	0.0	-5.1	-15.0
Hydro (pumping excluded)		93.3	96.2	108.3	114.7	118.1	3.7	5.4	6.0	3.5	4.9	5.3
Wind and solar		2.5	13.0	74.9	122.8	179.3	1.8	18.7	30.1	2.4	18.0	20.1
Thermal		386.9	406.7	444.5	530.5	594.2	-31.7	-94.9	-154.8	-6.7	-15.2	-20.7
of which cogeneration units		*87.3*	*103.4*	*155.3*	*234.8*	*269.6*	*25.7*	*66.7*	*71.0*	*19.8*	*39.7*	*35.7*
Open cycle(incl. biomass-waste)		343.8	335.6	276.9	177.7	158.3	6.3	2.3	11.0	2.3	1.3	7.4
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	3.2	18.1	47.6	2.2	-48.5	-102.4	228.2	-72.8	-68.3
Gas Turbines Combined Cycle		20.4	47.4	136.6	277.5	266.0	-32.9	-41.3	-118.6	-19.4	-12.9	-30.8
Small Gas Turbines		22.0	22.8	26.5	55.5	56.3	-7.5	-7.9	-9.5	-22.0	-12.4	-14.4
Fuel Cells		0.0	0.0	0.0	0.3	64.3	0.0	0.3	64.3			
Geothermal heat		0.7	1.0	1.3	1.5	1.7	0.1	0.2	0.3	8.5	13.6	20.3
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.2	44.0	49.1	52.7	1.4	2.3	4.0	3.4	4.9	8.2
Load factor for gross electric capacities (%)		48.2	50.4	48.1	46.2	42.9	-1.7	-1.4	-2.0	-3.4	-3.0	-4.4
CHP indicator (% of electricity from CHP)		11.5	12.6	21.4	26.1	28.9	6.9	10.6	12.6	48.1	68.1	77.1
Non fossil fuels in electricity generation (%)		46.8	46.4	51.2	47.4	47.5	5.7	8.7	11.9	12.6	22.4	33.4
nuclear		33.1	31.8	27.0	20.5	16.6	-0.8	-0.6	-0.9	-2.9	-3.1	-4.9
renewable energy forms		13.7	14.6	24.1	26.9	30.9	6.5	9.3	12.7	37.1	52.8	70.1
of which waste		*0.9*	*1.1*	*1.0*	*0.5*	*0.9*	*-0.4*	*-0.7*	*-0.1*	*-27.4*	*-59.4*	*-10.3*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6438.1**	**7517.0**	**8552.0**	**5.3**	**8.0**	**13.1**	**0.1**	**0.1**	**0.2**
public road transport	484.5	469.2	493.8	505.4	535.9	560.6	1.5	2.9	5.0	0.3	0.5	0.9
private cars and motorcycles	3593.6	3950.3	4291.6	5027.0	5791.8	6483.6	1.5	3.5	9.0	0.0	0.1	0.1
rail transport	408.3	371.7	402.3	413.7	477.9	536.0	-1.2	-1.4	-1.6	-0.3	-0.3	-0.3
aviation	168.5	215.5	298.3	451.5	664.6	917.3	3.4	3.0	0.3	0.8	0.4	0.0
inland navigation	28.9	31.9	33.6	40.4	46.9	54.4	0.1	0.2	0.4	0.1	0.3	0.6
travel per person (km per capita)	10618	11233	12174	13959	16267	18666	11	17	29	0.1	0.1	0.2
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2689.8**	**3336.8**	**4039.7**	**0.0**	**-2.2**	**-3.2**	**0.0**	**-0.1**	**-0.1**
trucks	1064.3	1233.6	1482.7	1967.6	2516.0	3130.0	0.9	-0.9	-2.6	0.0	0.0	-0.1
rail transport	440.2	358.0	368.0	377.2	417.9	450.8	-1.1	-1.9	-2.4	-0.3	-0.5	-0.5
inland navigation	258.1	268.2	297.0	345.0	402.9	458.8	0.2	0.6	1.8	0.0	0.2	0.4
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	231	224	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**369.4**	**382.6**	**388.6**	**-17.8**	**-44.4**	**-60.1**	**-4.6**	**-10.4**	**-13.4**
public road transport	7.7	6.9	7.0	7.0	6.4	5.8	-0.2	-0.5	-0.6	-2.5	-7.4	-9.2
private cars and motorcycles	138.1	146.1	157.1	166.0	159.8	150.7	-3.0	-8.9	-10.8	-1.8	-5.3	-6.7
trucks	82.9	93.2	108.5	142.2	157.7	165.5	-1.7	-16.8	-30.1	-1.1	-9.6	-15.4
rail transport	8.8	8.9	9.0	7.4	5.8	5.6	-0.6	-0.7	-0.6	-7.3	-11.0	-9.8
aviation	29.1	33.8	45.1	40.6	46.0	53.6	-12.4	-17.3	-17.6	-23.4	-27.3	-24.8
inland navigation	7.0	6.7	5.4	6.2	6.9	7.4	0.0	-0.2	-0.4	-0.8	-3.3	-5.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	34.1	28.9	25.2	-2.5	-3.6	-3.5	-6.9	-11.2	-12.2
freight transport (toe/Mtkm)	51.7	54.4	53.8	55.7	49.5	42.9	-0.7	-5.1	-7.6	-1.2	-9.4	-15.0

Source: PRIMES

EU15: EFFICIENCY CASE WITH HIGH RENEWABLES — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**773.9**	**663.8**	**586.2**	**30.9**	**28.4**	**13.3**	**4.2**	**4.5**	**2.3**
Solids	209.9	138.0	99.4	65.2	43.0	23.5	-5.1	-13.1	-19.5	-7.3	-23.3	-45.3
Oil	117.7	159.2	160.4	127.2	98.3	83.3	-2.0	-1.4	-0.8	-1.6	-1.4	-1.0
Natural gas	132.9	166.6	190.6	186.1	143.0	113.8	-4.9	0.9	1.6	-2.5	0.6	1.5
Nuclear	181.4	201.2	222.8	207.8	170.3	143.1	-22.5	-28.4	-36.9	-9.8	-14.3	-20.5
Renewable energy sources	66.3	74.4	88.1	187.5	209.3	222.4	65.4	70.3	68.8	53.5	50.6	44.8
Hydro	22.3	24.9	27.6	28.5	30.3	31.9	0.4	0.8	1.8	1.3	2.7	6.1
Biomass	29.7	30.8	36.1	105.0	113.2	112.5	53.8	54.6	46.7	105.2	93.3	71.0
Waste	11.9	15.6	18.7	26.8	30.0	30.9	2.5	3.8	5.5	10.1	14.4	21.8
Wind	0.1	0.4	1.9	14.0	21.7	30.7	0.7	3.5	7.1	5.4	19.1	29.9
Solar and others	0.1	0.2	0.3	9.2	9.7	11.5	7.8	7.2	7.0	546.7	295.0	155.0
Geothermal	2.2	2.5	3.3	4.0	4.4	5.0	0.2	0.4	0.7	6.0	10.5	17.0
Net Imports	**645.4**	**651.3**	**737.9**	**762.2**	**887.8**	**965.9**	**-120.0**	**-189.1**	**-242.3**	**-13.6**	**-17.6**	**-20.1**
Solids	89.9	94.4	107.2	82.3	80.5	112.7	-14.7	-42.9	-66.8	-15.2	-34.8	-37.2
Oil	460.9	446.7	472.4	461.1	495.1	506.3	-55.8	-67.7	-75.9	-10.8	-12.0	-13.0
Crude oil and Feedstocks	436.8	434.7	455.5	449.3	491.9	511.7	-54.3	-66.1	-75.0	-10.8	-11.8	-12.8
Oil products	24.1	12.0	16.9	11.8	3.2	-5.4	-1.5	-1.6	-0.9	-11.2	-33.4	19.6
Natural gas	92.3	108.6	154.7	215.5	309.0	343.7	-49.5	-78.6	-99.7	-18.7	-20.3	-22.5
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1486.6**	**1496.4**	**1490.4**	**-89.2**	**-160.8**	**-229.0**	**-5.7**	**-9.7**	**-13.3**
Solids	302.8	237.7	212.4	147.5	123.5	136.3	-19.9	-56.0	-86.3	-11.9	-31.2	-38.8
Oil	545.8	575.6	586.9	538.7	538.1	528.0	-57.8	-69.0	-76.7	-9.7	-11.4	-12.7
Natural gas	222.1	273.4	338.7	401.6	451.9	457.6	-54.4	-77.7	-98.0	-11.9	-14.7	-17.6
Nuclear	181.4	201.2	222.8	207.8	170.3	143.1	-22.5	-28.4	-36.9	-9.8	-14.3	-20.5
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	187.5	209.3	222.4	65.4	70.3	68.8	53.5	50.6	44.8
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	9.9	8.3	9.1	-0.7	-2.6	-3.8	-6.6	-23.8	-29.4
Oil	41.3	42.2	40.4	36.2	36.0	35.4	-1.6	-0.7	0.3	-4.3	-1.8	0.7
Natural gas	16.8	20.0	23.3	27.0	30.2	30.7	-1.9	-1.8	-1.6	-6.6	-5.5	-5.0
Nuclear	13.7	14.8	15.3	14.0	11.4	9.6	-0.6	-0.6	-0.9	-4.3	-5.1	-8.3
Renewable energy forms	5.0	5.5	6.1	12.6	14.0	14.9	4.9	5.6	6.0	62.7	66.8	67.1
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**2831.3**	**3087.6**	**3255.5**	**-195.8**	**-362.9**	**-590.6**	**-6.5**	**-10.5**	**-15.4**
Nuclear	720.1	810.1	863.7	806.8	662.6	590.9	-87.2	-112.8	-154.2	-9.7	-14.5	-20.7
Hydro & wind	259.8	294.2	343.8	495.0	607.5	749.7	12.5	51.5	107.1	2.6	9.3	16.7
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1529.5	1817.5	1914.9	-121.2	-301.7	-543.5	-7.3	-14.2	-22.1
Fuel Inputs for Thermal Power Generation (1)	**291.8**	**295.1**	**318.3**	**305.1**	**328.2**	**329.6**	**-32.7**	**-68.7**	**-115.2**	**-9.7**	**-17.3**	**-25.9**
Solids	186.1	163.9	153.6	100.6	80.0	94.9	-17.1	-53.7	-84.3	-14.5	-40.2	-47.0
Oil (including refinery gas)	48.7	49.6	38.3	11.9	11.7	6.6	-8.5	0.6	-0.2	-41.6	5.5	-3.3
Gas	45.1	66.0	106.3	139.8	175.1	160.3	-32.6	-47.7	-69.3	-18.9	-21.4	-30.2
Biomass - Waste	10.0	13.5	17.1	49.2	57.3	63.1	25.2	31.7	37.8	104.9	123.6	149.2
Geothermal heat	1.9	2.1	3.0	3.7	4.1	4.7	0.3	0.5	0.8	8.1	13.0	19.5
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**719.4**	**730.6**	**730.4**	**-21.7**	**-41.3**	**-63.5**	**-2.9**	**-5.3**	**-8.0**
Refineries	594.6	635.8	665.7	642.2	653.0	654.4	-41.3	-56.9	-70.8	-6.0	-8.0	-9.8
District heating	12.4	11.0	6.0	5.2	4.9	4.5	-1.0	-0.3	-1.4	-16.7	-6.3	-23.8
Biofuels and hydrogen production	0.0	0.2	0.6	32.2	34.5	34.9	22.1	16.8	9.2	218.1	94.8	35.5
Others	97.1	58.1	50.6	39.7	38.1	36.5	-1.5	-0.8	-0.4	-3.6	-2.1	-1.1
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**62.2**	**60.6**	**59.0**	**-5.2**	**-6.7**	**-8.8**	**-7.7**	**-10.0**	**-13.0**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.5**	**108.5**	**110.6**	**0.2**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1022.7**	**1066.7**	**1101.2**	**-53.9**	**-98.1**	**-127.8**	**-5.0**	**-8.4**	**-10.4**
by sector												
Industry (1)	262.2	255.6	268.7	291.1	311.5	333.9	-8.3	-13.8	-10.7	-2.8	-4.2	-3.1
energy intensive industries	180.4	170.9	175.8	185.2	191.3	194.9	-5.4	-8.5	-7.2	-2.9	-4.2	-3.6
other industrial sectors	81.9	84.7	92.9	105.9	120.2	139.0	-2.8	-5.4	-3.5	-2.6	-4.3	-2.4
Residential	228.1	236.0	244.7	258.0	259.8	256.2	-12.9	-24.6	-34.9	-4.7	-8.6	-12.0
Tertiary	115.3	127.9	132.7	132.6	144.8	156.9	-16.6	-20.9	-29.7	-11.1	-12.6	-15.9
Transport	253.8	275.7	309.1	340.9	350.6	354.1	-16.3	-38.8	-52.6	-4.6	-10.0	-12.9
by fuel (1)												
Solids	76.8	47.0	36.0	26.5	23.7	21.6	-1.9	-1.5	-1.4	-6.6	-5.9	-6.2
Oil	391.5	414.1	430.6	432.4	435.7	436.7	-29.7	-53.3	-65.2	-6.4	-10.9	-13.0
Gas	169.7	194.9	220.3	246.5	256.3	273.3	-20.1	-28.8	-27.5	-7.5	-10.1	-9.1
Electricity	156.0	169.4	191.6	213.3	236.2	251.4	-14.9	-27.7	-44.8	-6.5	-10.5	-15.1
Heat (from CHP and District Heating)	35.2	39.3	42.1	47.8	57.0	65.3	-4.0	-3.7	-1.3	-7.7	-6.1	-1.9
Other	30.3	30.6	34.5	56.0	57.8	52.7	16.7	16.8	12.4	42.5	41.1	30.7
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3052.0**	**3117.5**	**2827.0**	**2836.6**	**2869.2**	**-377.9**	**-607.4**	**-799.4**	**-11.8**	**-17.6**	**-21.8**
Electricity and Steam production	997.6	947.7	948.3	779.0	776.2	781.2	-172.9	-323.8	-499.3	-18.2	-29.4	-39.0
Energy Branch	129.8	144.4	145.4	123.4	118.6	114.0	-11.8	-13.0	-13.6	-8.7	-9.9	-10.6
Industry	576.2	526.5	509.3	424.1	414.6	428.6	-34.2	-45.4	-37.8	-7.5	-9.9	-8.1
Residential	436.4	417.4	412.9	397.3	392.1	387.4	-35.1	-48.5	-46.8	-8.1	-11.0	-10.8
Tertiary	203.5	212.7	199.6	174.9	182.0	194.9	-27.7	-24.4	-24.9	-13.7	-11.8	-11.3
Transport	738.5	803.2	902.2	928.3	953.1	963.1	-96.2	-152.2	-177.1	-9.4	-13.8	-15.5
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**91.7**	**92.0**	**93.1**	**-12.3**	**-19.7**	**-25.9**	-11.8	-17.6	-21.8

See explanations on the last page of the Appendix

Source: PRIMES

EU15: EFFICIENCY CASE WITH HIGH RENEWABLES — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	136.9	109.7	88.1	-8.2	-11.8	-13.5	-5.7	-9.7	-13.3
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	3.8	3.8	3.8	-0.2	-0.4	-0.6	-5.7	-9.7	-13.3
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7300	7908	8368	-505	-929	-1518	-6.5	-10.5	-15.4
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	1.90	1.90	1.93	-0.13	-0.18	-0.21	-6.5	-8.8	-9.8
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	7.3	7.3	7.4	-1.0	-1.6	-2.1	-11.8	-17.6	-21.8
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.3	364.8	260.3	207.9	169.6	-34.8	-44.5	-47.2	-11.8	-17.6	-21.8
Import Dependency %	47.6	46.6	49.4	49.6	57.2	62.2	-4.7	-5.7	-5.6	-8.6	-9.0	-8.3
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	76.7	65.0	55.9	-2.2	-2.9	-1.8	-2.8	-4.2	-3.1
Residential (Energy on Private Income)	100.0	97.6	88.2	73.6	59.6	48.1	-3.7	-5.6	-6.5	-4.7	-8.6	-12.0
Tertiary (Energy on Value added)	100.0	101.8	90.9	69.7	59.9	51.9	-8.7	-8.6	-9.8	-11.1	-12.6	-15.9
Transport (Energy on GDP)	100.0	101.2	99.5	86.4	70.7	57.6	-4.1	-7.8	-8.5	-4.6	-10.0	-12.9
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.23	0.21	0.19	-0.03	-0.06	-0.08	-12.3	-21.8	-29.8
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.88	1.82	1.79	-0.09	-0.08	-0.05	-4.3	-4.2	-2.5
Industry	2.20	2.06	1.90	1.46	1.33	1.28	-0.07	-0.08	-0.07	-4.8	-5.9	-5.2
Residential	1.91	1.77	1.69	1.54	1.51	1.51	-0.06	-0.04	0.02	-3.5	-2.6	1.4
Tertiary	1.76	1.66	1.50	1.32	1.26	1.24	-0.04	0.01	0.06	-2.9	0.9	5.5
Transport	2.91	2.91	2.92	2.72	2.72	2.72	-0.15	-0.12	-0.08	-5.1	-4.2	-3.0
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**668.0**	**751.4**	**846.2**	**-20.7**	**-61.2**	**-104.8**	**-3.0**	**-7.5**	**-11.0**
Nuclear		126.2	131.0	121.9	94.6	88.8	0.0	-5.5	-16.2	0.0	-5.5	-15.4
Hydro (pumping excluded)		87.1	89.8	100.4	106.0	109.3	3.5	5.0	5.6	3.6	4.9	5.4
Wind and solar		2.5	12.9	71.8	113.2	163.9	1.5	17.9	29.7	2.1	18.8	22.1
Thermal		322.9	344.8	373.8	437.6	484.2	-25.7	-78.5	-123.9	-6.4	-15.2	-20.4
of which cogeneration units		*59.3*	*77.1*	*122.9*	*190.3*	*217.5*	*20.6*	*60.4*	*71.1*	*20.1*	*46.5*	*48.6*
Open cycle(incl. biomass-waste)		281.8	276.9	224.0	141.8	127.9	9.4	6.0	14.6	4.4	4.4	12.9
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	2.7	10.9	38.4	2.3	-40.8	-80.6	495.8	-78.9	-67.7
Gas Turbines Combined Cycle		20.0	46.0	126.1	240.8	222.2	-31.2	-38.4	-100.8	-19.8	-13.8	-31.2
Small Gas Turbines		20.3	21.0	19.7	42.4	44.7	-6.2	-5.8	-6.7	-24.0	-12.0	-13.0
Fuel Cells		0.0	0.0	0.0	0.3	49.2	0.0	0.3	49.2			
Geothermal heat		0.7	1.0	1.3	1.5	1.7	0.1	0.2	0.3	8.5	13.6	20.3
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.9	45.4	50.4	53.2	1.4	2.4	3.6	3.3	4.9	7.2
Load factor for gross electric capacities (%)		48.9	50.8	48.4	46.9	43.9	-1.8	-1.6	-2.2	-3.6	-3.2	-4.9
CHP indicator (% of electricity from CHP)		9.2	10.3	19.3	24.3	26.9	6.7	10.5	12.8	53.1	76.2	90.3
Non fossil fuels in electricity generation (%)		49.9	49.3	53.8	49.8	50.7	5.6	8.8	12.4	11.6	21.3	32.5
nuclear		35.1	33.6	28.5	21.5	18.2	-1.0	-1.0	-1.2	-3.5	-4.5	-6.3
renewable energy forms		14.8	15.8	25.3	28.4	32.5	6.6	9.8	13.7	35.4	52.5	72.3
of which waste		*1.0*	*1.2*	*1.0*	*0.5*	*1.0*	*-0.4*	*-0.8*	*-0.1*	*-26.7*	*-60.9*	*-9.9*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5822.2**	**6707.6**	**7551.5**	**5.1**	**7.2**	**11.3**	**0.1**	**0.1**	**0.1**
public road transport	368.8	382.2	412.6	424.2	451.0	469.6	1.5	2.6	4.4	0.4	0.6	0.9
private cars and motorcycles	3325.6	3634.5	3938.8	4567.7	5170.0	5712.0	1.4	2.9	7.7	0.0	0.1	0.1
rail transport	316.4	320.9	356.0	365.5	419.7	461.0	-1.2	-1.4	-1.8	-0.3	-0.3	-0.4
aviation	157.3	201.5	281.5	425.1	620.7	855.2	3.4	3.0	0.7	0.8	0.5	0.1
inland navigation	28.3	31.4	33.0	39.8	46.2	53.7	0.1	0.1	0.3	0.1	0.3	0.7
travel per person (km per capita)	11465	12240	13261	15012	17179	19412	13	18	29	0.1	0.1	0.1
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2350.3**	**2895.1**	**3498.3**	**-0.1**	**-1.7**	**-3.2**	**0.0**	**-0.1**	**-0.1**
trucks	946.0	1114.6	1327.2	1743.7	2196.8	2717.9	0.9	-0.5	-2.2	0.1	0.0	-0.1
rail transport	234.9	220.2	249.3	262.5	296.3	322.5	-1.2	-1.8	-2.7	-0.4	-0.6	-0.8
inland navigation	257.1	266.9	296.1	344.2	402.0	457.9	0.2	0.6	1.7	0.0	0.2	0.4
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	207	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**340.9**	**350.6**	**354.1**	**-16.3**	**-38.8**	**-52.6**	**-4.6**	**-10.0**	**-12.9**
public road transport	6.3	5.9	5.8	5.8	5.4	4.9	-0.2	-0.4	-0.4	-2.5	-7.0	-7.8
private cars and motorcycles	130.2	136.6	145.5	152.0	144.1	134.8	-2.2	-6.8	-7.5	-1.4	-4.5	-5.3
trucks	76.0	86.5	101.0	131.3	144.7	150.4	-1.5	-14.7	-27.0	-1.1	-9.2	-15.2
rail transport	6.9	7.5	7.7	6.3	5.0	4.8	-0.5	-0.6	-0.4	-7.6	-10.5	-8.3
aviation	27.8	32.5	43.8	39.3	44.5	51.9	-11.9	-16.1	-16.8	-23.2	-26.6	-24.5
inland navigation	6.7	6.7	5.3	6.2	6.8	7.3	0.0	-0.2	-0.4	-0.8	-3.3	-5.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	34.8	29.6	26.0	-2.6	-3.6	-3.4	-6.8	-10.8	-11.4
freight transport (toe/Mtkm)	57.8	58.5	57.3	58.8	52.4	45.1	-0.7	-5.2	-7.8	-1.1	-9.0	-14.8

Source: PRIMES

NMS: EFFICIENCY CASE WITH HIGH RENEWABLES — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**113.4**	**106.7**	**87.4**	**-4.0**	**1.4**	**-0.6**	**-3.4**	**1.3**	**-0.7**
Solids	140.9	126.7	104.0	74.1	65.9	54.4	-9.4	-4.4	-5.1	-11.3	-6.3	-8.5
Oil	2.6	3.0	3.1	2.4	2.4	2.2	-0.1	0.0	-0.1	-3.5	-1.8	-2.6
Natural gas	6.7	7.4	6.1	5.9	5.4	4.9	0.0	-0.1	-0.1	0.0	-1.0	-1.5
Nuclear	15.5	14.1	14.8	14.5	14.8	5.3	-0.5	0.0	0.0	-3.0	-0.3	-0.2
Renewable energy sources	3.0	6.3	8.0	16.5	18.3	20.5	6.0	5.9	4.6	56.9	47.7	28.8
Hydro	1.1	1.3	1.4	2.0	2.2	2.1	0.0	0.0	0.0	1.4	2.1	-2.2
Biomass	1.4	4.6	6.1	12.2	12.0	12.8	5.9	5.6	4.8	94.6	88.1	60.9
Waste	0.5	0.3	0.5	1.0	1.2	1.5	-0.3	-0.3	-0.2	-25.5	-21.4	-13.1
Wind	0.0	0.0	0.0	0.6	1.9	2.7	0.1	0.0	-0.5	9.7	0.4	-16.3
Solar and others	0.0	0.0	0.0	0.6	1.1	1.3	0.3	0.5	0.5	115.0	108.1	66.6
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-15.5	-19.8	-24.3
Net Imports	**66.3**	**50.4**	**61.4**	**80.6**	**95.7**	**107.9**	**-11.5**	**-31.9**	**-45.7**	**-12.5**	**-25.0**	**-29.8**
Solids	-14.6	-20.7	-15.9	-8.9	-7.6	-3.2	-1.8	-10.5	-21.1	24.5	-365.9	-117.9
Oil	49.9	45.0	47.3	51.0	53.9	57.4	-4.6	-9.4	-11.3	-8.2	-14.8	-16.5
Crude oil and Feedstocks	43.4	36.7	41.3	42.5	45.4	48.7	-3.7	-7.7	-9.6	-7.9	-14.5	-16.4
Oil products	6.5	8.3	6.0	8.5	8.5	8.7	-0.9	-1.7	-1.8	-9.5	-16.5	-16.9
Natural gas	31.2	26.2	31.5	39.7	50.7	54.5	-5.2	-12.0	-13.2	-11.6	-19.1	-19.5
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**192.9**	**201.2**	**193.9**	**-15.5**	**-30.5**	**-46.4**	**-7.4**	**-13.2**	**-19.3**
Solids	127.8	108.2	90.8	65.2	58.3	51.2	-11.1	-14.9	-26.2	-14.6	-20.4	-33.9
Oil	50.4	46.6	48.7	52.4	55.0	58.3	-4.7	-9.4	-11.4	-8.2	-14.6	-16.4
Natural gas	37.1	33.8	37.3	45.7	56.1	59.4	-5.2	-12.1	-13.3	-10.3	-17.7	-18.3
Nuclear	15.5	14.1	14.8	14.5	14.8	5.3	-0.5	0.0	0.0	-3.0	-0.3	-0.2
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	16.5	18.3	20.5	6.0	5.9	4.6	56.9	47.7	28.8
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	33.8	29.0	26.4	-2.8	-2.6	-5.8	-7.7	-8.3	-18.0
Oil	21.6	22.3	24.6	27.1	27.4	30.1	-0.2	-0.5	1.1	-0.8	-1.7	3.6
Natural gas	15.9	16.2	18.8	23.7	27.9	30.6	-0.7	-1.5	0.4	-3.1	-5.2	1.2
Nuclear	6.6	6.7	7.5	7.5	7.4	2.8	0.3	0.9	0.5	4.7	14.8	23.7
Renewable energy forms	1.3	3.0	4.1	8.5	9.1	10.6	3.5	3.7	3.9	69.6	70.1	59.6
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**361.1**	**433.9**	**439.6**	**-30.9**	**-64.3**	**-111.5**	**-7.9**	**-12.9**	**-20.2**
Nuclear	60.0	54.3	57.4	56.7	58.0	21.4	-1.8	-0.2	0.0	-3.1	-0.3	-0.2
Hydro & wind	12.9	15.5	15.7	31.1	47.1	56.2	1.0	0.6	-6.7	3.2	1.3	-10.7
Thermal (incl. biomass)	243.7	230.7	250.6	273.3	328.8	362.1	-30.1	-64.8	-104.7	-9.9	-16.5	-22.4
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**65.8**	**68.7**	**66.0**	**-9.6**	**-17.2**	**-30.1**	**-12.8**	**-20.0**	**-31.4**
Solids	62.2	57.2	56.5	47.1	44.5	39.5	-10.4	-14.0	-25.5	-18.1	-23.9	-39.2
Oil	4.9	4.4	3.2	2.9	1.9	1.9	-0.5	-0.5	-0.8	-15.4	-20.3	-29.4
Gas	5.3	4.0	6.3	10.6	16.8	18.8	-2.2	-6.1	-6.8	-17.1	-26.5	-26.6
Biomass - Waste	0.3	0.1	0.4	5.3	5.4	5.7	3.5	3.3	2.9	191.4	161.5	102.8
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**64.7**	**66.2**	**69.6**	**-1.3**	**-5.0**	**-8.2**	**-1.9**	**-7.1**	**-10.5**
Refineries	46.7	40.1	45.2	47.5	50.9	54.7	-2.3	-6.1	-8.4	-4.6	-10.8	-13.4
District heating	19.3	12.1	8.5	4.2	3.0	2.1	-0.4	-0.6	-0.7	-8.6	-17.8	-25.4
Biofuels and hydrogen production	0.0	0.0	0.0	2.1	2.8	3.5	2.0	2.3	1.8	3064.6	552.5	105.5
Others	30.5	23.1	17.7	11.0	9.6	9.3	-0.6	-0.6	-0.8	-5.4	-5.8	-7.6
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**8.8**	**8.6**	**8.0**	**-0.8**	**-1.3**	**-1.3**	**-8.5**	**-12.9**	**-13.8**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**13.0**	**14.4**	**0.0**	**0.0**	**0.0**	**0.3**	**0.2**	**0.0**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**124.4**	**134.6**	**140.7**	**-8.0**	**-18.5**	**-24.4**	**-6.0**	**-12.1**	**-14.8**
by sector												
Industry	65.0	47.7	40.4	38.3	40.0	42.3	-1.1	-2.1	-1.6	-2.9	-5.1	-3.7
energy intensive industries	32.5	27.9	26.2	24.9	25.1	25.7	-0.7	-1.4	-1.1	-2.8	-5.4	-4.3
other industrial sectors	32.4	19.7	14.2	13.4	14.9	16.5	-0.4	-0.7	-0.5	-3.0	-4.7	-2.8
Residential	40.0	41.2	34.4	35.7	38.9	40.0	-2.0	-5.9	-7.8	-5.3	-13.1	-16.4
Tertiary	24.9	19.6	21.5	21.9	23.7	24.1	-3.2	-4.9	-7.4	-12.9	-17.1	-23.5
Transport	19.9	19.8	22.9	28.4	32.0	34.4	-1.6	-5.6	-7.6	-5.3	-14.8	-18.0
by fuel												
Solids	40.9	33.8	21.4	13.5	10.2	8.5	-0.4	-0.7	-0.6	-2.9	-6.7	-6.2
Oil	32.7	29.6	33.6	38.9	41.8	43.9	-2.3	-6.8	-8.9	-5.7	-14.0	-16.9
Gas	26.5	24.6	25.4	30.8	34.9	37.2	-2.5	-4.9	-5.4	-7.6	-12.4	-12.7
Electricity	20.5	18.5	19.6	23.0	28.6	30.0	-2.1	-4.6	-8.0	-8.5	-13.9	-21.1
Heat (from CHP and District Heating)	27.7	17.4	13.5	12.5	13.5	15.1	-0.7	-1.5	-1.9	-5.3	-10.0	-11.1
Other	1.8	4.7	5.8	5.8	5.5	6.0	0.1	0.1	0.4	2.5	1.3	7.4
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**482.4**	**482.5**	**467.1**	**-69.8**	**-114.1**	**-167.8**	**-12.6**	**-19.1**	**-26.4**
Electricity and Steam production	343.4	295.0	280.1	233.3	230.1	211.4	-50.1	-73.0	-121.1	-17.7	-24.1	-36.4
Energy Branch	14.4	19.5	18.7	9.9	10.0	10.0	-0.7	-1.4	-1.4	-6.3	-12.3	-12.4
Industry	137.0	118.2	96.4	82.6	80.1	79.8	-3.5	-5.6	-5.7	-4.0	-6.6	-6.7
Residential	83.2	72.9	49.7	46.9	46.7	44.9	-2.4	-7.9	-8.1	-4.8	-14.4	-15.3
Tertiary	53.3	38.3	37.2	32.7	29.6	29.2	-4.3	-4.9	-5.8	-11.5	-14.2	-16.5
Transport	56.1	55.9	65.3	77.0	86.1	91.7	-9.0	-21.3	-25.7	-10.4	-19.8	-21.9
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**70.2**	**70.2**	**68.0**	**-10.2**	**-16.6**	**-24.4**	-12.6	-19.1	-26.4

See explanations on the last page of the Appendix

Source: PRIMES

NMS: EFFICIENCY CASE WITH HIGH RENEWABLES — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	336.1	245.1	176.2	-27.0	-37.2	-42.1	-7.4	-13.2	-19.3
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.6	2.8	2.8	-0.2	-0.4	-0.7	-7.4	-13.2	-19.3
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	4920	6054	6358	-421	-898	-1612	-7.9	-12.9	-20.2
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.50	2.40	2.41	-0.15	-0.18	-0.23	-5.6	-6.9	-8.8
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	6.6	6.7	6.8	-1.0	-1.6	-2.4	-12.6	-19.1	-26.4
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	840.6	587.8	424.5	-121.7	-139.0	-152.5	-12.6	-19.1	-26.4
Import Dependency %	28.3	24.1	30.8	41.6	47.3	55.3	-2.4	-7.5	-8.3	-5.5	-13.7	-13.1
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	35.1	26.0	21.9	-1.0	-1.4	-0.8	-2.9	-5.1	-3.7
Residential (Energy on Private Income)	100.0	106.5	74.2	53.0	39.4	30.2	-3.0	-5.9	-5.9	-5.3	-13.1	-16.4
Tertiary (Energy on Value added)	100.0	74.8	67.2	45.8	33.5	24.4	-6.8	-6.9	-7.5	-12.9	-17.1	-23.5
Transport (Energy on GDP)	100.0	102.9	97.4	83.0	65.3	52.3	-4.6	-11.4	-11.5	-5.3	-14.8	-18.0
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.44	0.38	0.33	-0.05	-0.06	-0.10	-10.9	-13.3	-22.8
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.92	1.80	1.75	-0.03	-0.04	-0.02	-1.5	-2.3	-0.9
Industry	2.11	2.48	2.38	2.15	2.00	1.89	-0.03	-0.03	-0.06	-1.2	-1.6	-3.1
Residential	2.08	1.77	1.44	1.31	1.20	1.12	0.01	-0.02	0.01	0.5	-1.5	1.3
Tertiary	2.14	1.95	1.73	1.50	1.25	1.21	0.02	0.04	0.10	1.6	3.5	9.1
Transport	2.82	2.82	2.85	2.71	2.69	2.67	-0.16	-0.17	-0.13	-5.4	-5.9	-4.7
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**89.6**	**119.0**	**137.0**	**-5.5**	**-15.1**	**-30.2**	**-5.8**	**-11.3**	**-18.0**
Nuclear		8.4	9.3	7.9	7.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		6.1	6.4	7.9	8.6	8.8	0.2	0.4	0.4	2.9	4.6	4.4
Wind and solar		0.0	0.0	3.1	9.6	15.3	0.3	0.8	0.4	10.3	9.7	2.4
Thermal		64.0	61.9	70.7	92.9	110.0	-6.0	-16.4	-30.9	-7.9	-15.0	-21.9
of which cogeneration units		*28.1*	*26.3*	*32.4*	*44.5*	*52.2*	*5.1*	*6.3*	*-0.1*	*18.5*	*16.5*	*-0.3*
Open cycle (incl. biomass-waste)		61.9	58.6	52.9	35.9	30.4	-3.0	-3.7	-3.6	-5.4	-9.3	-10.7
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.5	7.2	9.1	0.0	-7.8	-21.8	-7.9	-51.7	-70.5
Gas Turbines Combined Cycle		0.4	1.4	10.6	36.7	43.8	-1.7	-2.8	-17.8	-14.2	-7.2	-28.9
Small Gas Turbines		1.7	1.8	6.8	13.1	11.6	-1.2	-2.1	-2.8	-15.4	-13.7	-19.2
Fuel Cells		0.0	0.0	0.0	0.0	15.1	0.0	0.0	15.1			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	37.7	43.2	49.9	1.2	1.8	5.9	3.4	4.4	13.4
Load factor for gross electric capacities (%)		43.6	47.6	46.0	41.6	36.6	-1.0	-0.8	-1.0	-2.2	-1.8	-2.7
CHP indicator (% of electricity from CHP)		29.4	30.4	37.3	38.5	43.9	9.0	11.2	12.2	31.6	40.8	38.7
Non fossil fuels in electricity generation (%)		23.4	23.1	30.7	30.0	23.9	6.6	7.5	6.7	27.1	33.3	38.8
nuclear		18.1	17.7	15.7	13.4	4.9	0.8	1.7	1.0	5.2	14.5	25.1
renewable energy forms		5.3	5.4	15.0	16.6	19.1	5.8	5.8	5.7	62.5	53.6	42.7
of which waste		*0.0*	*0.1*	*0.4*	*0.3*	*0.3*	*-0.2*	*-0.1*	*-0.1*	*-40.6*	*-30.5*	*-30.1*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**615.9**	**809.5**	**1000.5**	**0.2**	**0.8**	**1.8**	**0.0**	**0.1**	**0.2**
public road transport	115.7	87.0	81.2	81.2	84.9	91.1	0.0	0.3	0.6	0.0	0.3	0.6
private cars and motorcycles	268.0	315.8	352.9	459.3	621.8	771.6	0.1	0.6	1.4	0.0	0.1	0.2
rail transport	91.9	50.8	46.3	48.2	58.2	75.0	0.0	0.0	0.2	0.0	0.0	0.3
aviation	11.2	14.0	16.8	26.5	43.9	62.1	0.1	-0.1	-0.4	0.2	-0.2	-0.6
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	0.1	0.2	0.5
travel per person (km per capita)	6489	6227	6662	8391	11295	14471	3	11	26	0.0	0.1	0.2
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**339.4**	**441.7**	**541.3**	**0.1**	**-0.5**	**0.1**	**0.0**	**-0.1**	**0.0**
trucks	118.4	119.0	155.5	223.9	319.2	412.1	0.0	-0.3	-0.3	0.0	-0.1	-0.1
rail transport	205.2	137.8	118.7	114.7	121.7	128.3	0.1	-0.2	0.4	0.0	-0.1	0.3
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	0.1	0.4	0.8
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	591	538	492	0	-1	0	0.0	-0.1	0.0
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**28.4**	**32.0**	**34.4**	**-1.6**	**-5.6**	**-7.6**	**-5.3**	**-14.8**	**-18.0**
public road transport	1.4	1.0	1.2	1.1	1.0	0.9	0.0	-0.1	-0.2	-2.5	-9.1	-16.1
private cars and motorcycles	7.9	9.5	11.6	14.0	15.6	16.0	-0.8	-2.1	-3.4	-5.5	-11.8	-17.4
trucks	7.0	6.7	7.5	10.9	13.0	15.0	-0.2	-2.1	-3.0	-1.7	-14.0	-16.8
rail transport	2.0	1.4	1.3	1.1	0.9	0.8	-0.1	-0.1	-0.2	-5.1	-14.0	-17.6
aviation	1.3	1.2	1.3	1.4	1.5	1.7	-0.5	-1.1	-0.8	-26.7	-43.0	-32.2
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-2.9	-5.5
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	27.5	22.9	18.9	-2.2	-4.2	-4.4	-7.5	-15.6	-18.9
freight transport (toe/Mtkm)	24.6	28.8	30.0	33.9	30.6	28.6	-0.6	-4.9	-5.9	-1.9	-13.8	-17.0

Source: PRIMES

(1) EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

APPENDIX 5

Summary energy balances and indicators by group of countries
(EU-25, EU-15, new Member states (NMS)) – comparison to baseline

EU25: NEW NUCLEAR TECHNOLOGY ACCEPTED — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**859.9**	**789.2**	**794.2**	**-0.5**	**48.4**	**133.3**	**-0.1**	**6.5**	**20.2**
Solids	350.8	264.7	203.4	153.7	113.3	93.3	-0.2	-13.1	-9.2	-0.1	-10.3	-9.0
Oil	120.3	162.2	163.5	131.7	102.1	86.4	0.0	0.0	0.0	0.0	0.0	0.0
Natural gas	139.6	174.0	196.6	196.9	147.5	116.7	0.0	0.0	-0.4	0.0	0.0	-0.3
Nuclear	196.9	215.3	237.7	245.0	276.5	330.2	-0.3	63.0	144.9	-0.1	29.5	78.2
Renewable energy sources	69.2	80.7	96.1	132.7	149.8	167.5	0.0	-1.5	-1.9	0.0	-1.0	-1.1
Hydro	23.4	26.3	29.0	30.1	31.5	31.9	0.0	-0.1	-0.3	0.0	-0.4	-1.0
Biomass	31.1	35.4	42.2	57.4	64.6	73.1	0.0	-0.3	-0.6	-0.1	-0.5	-0.8
Waste	12.3	15.9	19.3	25.7	26.9	27.0	0.0	-0.9	-0.2	0.0	-3.1	-0.6
Wind	0.1	0.4	1.9	13.9	19.8	25.9	0.0	-0.3	-0.9	-0.1	-1.3	-3.5
Solar and others	0.1	0.3	0.4	1.8	3.0	5.3	0.1	0.1	0.0	4.2	2.4	0.9
Geothermal	2.2	2.5	3.3	3.8	4.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
Net Imports	**711.6**	**701.7**	**799.3**	**974.0**	**1183.4**	**1299.2**	**-0.5**	**-21.1**	**-62.7**	**0.0**	**-1.8**	**-4.6**
Solids	75.2	73.8	91.4	89.7	117.0	159.0	-0.2	-9.3	-38.4	-0.2	-7.4	-19.4
Oil	510.8	491.8	519.6	572.3	624.9	650.7	-0.2	-1.1	-0.2	0.0	-0.2	0.0
Crude oil and Feedstocks	480.2	471.5	496.8	549.6	610.0	644.8	-0.2	-1.1	-0.1	0.0	-0.2	0.0
Oil products	30.6	20.3	22.8	22.7	14.9	5.9	0.0	0.0	-0.1	-0.1	-0.2	-1.1
Natural gas	123.5	134.8	186.2	309.9	441.7	489.7	-0.1	-8.5	-21.4	0.0	-1.9	-4.2
Electricity	2.2	1.4	2.1	2.1	-0.1	-0.3	0.0	-2.2	-2.7	0.0	-107.2	-113.3
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1783.2**	**1916.2**	**2030.4**	**-0.9**	**27.3**	**70.7**	**-0.1**	**1.4**	**3.6**
Solids	430.6	346.0	303.2	243.4	230.3	252.3	-0.3	-22.3	-47.6	-0.1	-8.8	-15.9
Oil	596.2	622.2	635.6	653.3	670.5	674.2	-0.2	-1.1	-0.2	0.0	-0.2	0.0
Natural gas	259.2	307.1	376.0	506.8	589.2	606.5	-0.1	-8.5	-21.8	0.0	-1.4	-3.5
Nuclear	196.9	215.3	237.7	245.0	276.5	330.2	-0.3	63.0	144.9	-0.1	29.5	78.2
Electricity	2.2	1.4	2.1	2.1	-0.1	-0.3	0.0	-2.2	-2.7	0.0	-107.2	-113.3
Renewable energy forms	69.2	80.7	96.1	132.7	149.8	167.5	0.0	-1.5	-1.9	0.0	-1.0	-1.1
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	13.6	12.0	12.4	0.0	-1.4	-2.9	-0.1	-10.1	-18.8
Oil	38.4	39.6	38.5	36.6	35.0	33.2	0.0	-0.6	-1.2	0.0	-1.6	-3.5
Natural gas	16.7	19.5	22.8	28.4	30.7	29.9	0.0	-0.9	-2.2	0.0	-2.8	-6.8
Nuclear	12.7	13.7	14.4	13.7	14.4	16.3	0.0	3.1	6.8	-0.1	27.6	72.0
Renewable energy forms	4.5	5.1	5.8	7.4	7.8	8.3	0.0	-0.2	-0.4	0.1	-2.4	-4.6
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3417.9**	**3980.2**	**4437.5**	**-1.2**	**31.5**	**40.4**	**0.0**	**0.8**	**0.9**
Nuclear	780.0	864.4	921.2	953.6	1066.3	1250.8	1.2	232.7	484.3	0.1	27.9	63.2
Hydro & wind	272.7	309.7	359.5	512.5	598.1	690.4	-0.1	-4.3	-15.1	0.0	-0.7	-2.1
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1951.7	2315.8	2496.3	-2.3	-196.9	-428.8	-0.1	-7.8	-14.7
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**412.9**	**450.2**	**472.2**	**-0.4**	**-32.7**	**-68.7**	**-0.1**	**-6.8**	**-12.7**
Solids	248.2	221.1	210.1	174.9	170.1	196.7	-0.3	-22.2	-47.4	-0.1	-11.6	-19.4
Oil (including refinery gas)	53.7	53.9	41.5	23.7	13.1	9.5	0.0	-0.4	0.1	-0.1	-2.9	0.6
Gas	50.4	70.0	112.6	185.0	236.7	234.6	-0.1	-9.0	-20.6	-0.1	-3.7	-8.1
Biomass - Waste	10.3	13.6	17.5	25.8	26.6	27.4	0.0	-1.1	-0.7	0.0	-3.9	-2.5
Geothermal heat	1.9	2.1	3.0	3.4	3.6	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**806.8**	**842.1**	**871.1**	**-0.2**	**-1.1**	**-0.6**	**0.0**	**-0.1**	**-0.1**
Refineries	641.3	675.9	710.9	733.1	765.9	788.2	-0.2	-1.1	-0.2	0.0	-0.1	0.0
District heating	31.7	23.1	14.5	10.7	9.0	8.5	-0.1	0.1	-0.3	-0.5	1.1	-3.3
Biofuels and hydrogen production	0.0	0.2	0.6	10.2	18.1	27.4	0.0	0.0	0.0	0.0	-0.1	-0.2
Others	127.6	81.2	68.3	52.8	49.1	46.9	0.0	0.0	-0.1	0.0	-0.1	-0.1
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**77.1**	**77.1**	**77.2**	**0.0**	**-0.1**	**0.0**	**0.0**	**-0.1**	**0.0**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.3**	**121.4**	**124.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1208.7**	**1317.9**	**1394.0**	**-0.3**	**0.1**	**-0.1**	**0.0**	**0.0**	**0.0**
by sector												
Industry (1)	327.2	303.3	309.1	338.9	367.6	388.8	0.0	0.2	0.3	0.0	0.1	0.1
energy intensive industries	212.9	198.9	202.0	216.3	226.4	229.2	0.0	0.1	0.2	0.0	0.1	0.1
other industrial sectors	114.3	104.4	107.0	122.5	141.2	159.6	0.0	0.1	0.1	0.0	0.0	0.1
Residential	268.1	277.2	279.1	308.6	329.3	338.9	0.0	0.2	0.1	0.0	0.1	0.0
Tertiary	140.2	147.5	154.2	174.2	194.4	218.2	0.0	0.0	0.1	0.0	0.0	0.0
Transport	273.7	295.6	332.0	387.0	426.7	448.2	-0.2	-0.3	-0.5	-0.1	-0.1	-0.1
by fuel (1)												
Solids	117.7	80.8	57.4	42.2	36.0	31.9	0.0	-0.1	-0.2	-0.1	-0.3	-0.6
Oil	424.2	443.7	464.2	503.3	536.7	554.4	-0.2	-0.8	-0.3	0.0	-0.2	-0.1
Gas	196.2	219.5	245.7	299.9	325.4	342.4	0.0	0.6	-1.0	0.0	0.2	-0.3
Electricity	176.5	187.9	211.3	253.3	297.5	335.0	-0.1	0.4	0.7	0.0	0.1	0.2
Heat (from CHP and District Heating)	62.9	56.7	55.6	65.0	75.8	84.0	-0.1	0.0	0.3	-0.1	0.0	0.4
Other	32.1	35.3	40.3	45.0	46.4	46.3	0.0	0.0	0.5	0.1	0.0	1.0
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.6**	**3664.9**	**3755.1**	**3926.6**	**4062.9**	**-2.0**	**-114.1**	**-240.7**	**-0.1**	**-2.8**	**-5.6**
Electricity and Steam production	1341.0	1242.7	1228.3	1233.7	1290.8	1376.5	-1.6	-112.3	-236.6	-0.1	-8.0	-14.7
Energy Branch	144.2	163.9	164.0	145.7	142.7	138.9	0.0	-0.3	-0.2	0.0	-0.2	-0.1
Industry	713.2	644.8	605.7	544.3	545.9	549.0	-0.1	0.1	-2.9	0.0	0.0	-0.5
Residential	519.7	490.4	462.6	481.8	494.8	487.5	0.1	-0.4	0.3	0.0	-0.1	0.1
Tertiary	256.8	251.0	236.7	239.7	240.6	254.6	0.2	-0.4	-0.2	0.1	-0.1	-0.1
Transport	794.6	858.8	967.5	1109.9	1211.9	1256.4	-0.6	-0.9	-1.2	-0.1	-0.1	-0.1
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**99.6**	**104.2**	**107.8**	**-0.1**	**-3.0**	**-6.4**	-0.1	-2.8	-5.6

See explanations on the last page of the Appendix

Source: PRIMES

EU25: NEW NUCLEAR TECHNOLOGY ACCEPTED							SUMMARY ENERGY BALANCE AND INDICATORS (B)					
Mtoe	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
							Difference from Baseline			**% diff. from Baseline**		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	156.0	132.5	112.7	-0.1	1.9	3.9	-0.1	1.4	3.6
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.9	4.1	4.4	0.0	0.1	0.2	-0.1	1.4	3.6
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	7410	8613	9686	-3	68	88	0.0	0.8	0.9
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.11	2.05	2.00	0.00	-0.09	-0.19	0.0	-4.2	-8.9
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	8.1	8.5	8.9	0.0	-0.2	-0.5	-0.1	-2.8	-5.6
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	328.4	271.5	225.5	-0.2	-7.9	-13.4	-0.1	-2.8	-5.6
Import Dependency %	44.8	43.6	47.2	53.1	60.0	62.1	0.0	-1.9	-5.3	0.0	-3.1	-7.8
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	71.0	60.5	51.4	0.0	0.0	0.0	0.0	0.1	0.1
Residential (Energy on Private Income)	100.0	98.1	85.8	74.4	63.1	52.8	0.0	0.0	0.0	0.0	0.1	0.0
Tertiary (Energy on Value added)	100.0	96.7	86.8	74.8	65.3	58.2	0.0	0.0	0.0	0.0	0.0	0.0
Transport (Energy on GDP)	100.0	101.1	99.3	90.5	78.8	66.5	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.29	0.26	0.25	0.00	-0.02	-0.05	-0.1	-8.6	-15.4
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.97	1.89	1.83	0.00	0.00	0.00	0.0	-0.1	-0.1
Industry	2.18	2.13	1.96	1.61	1.49	1.41	0.00	0.00	-0.01	0.0	0.0	-0.6
Residential	1.94	1.77	1.66	1.56	1.50	1.44	0.00	0.00	0.00	0.0	-0.1	0.0
Tertiary	1.83	1.70	1.54	1.38	1.24	1.17	0.00	0.00	0.00	0.1	-0.2	-0.1
Transport	2.90	2.91	2.91	2.87	2.84	2.80	0.00	0.00	0.00	0.0	0.0	0.0
Electricity and steam generation												
Generation Capacity in GWe		**617.4**	**656.2**	**783.9**	**953.6**	**1137.5**	**0.0**	**6.9**	**19.3**	**0.0**	**0.7**	**1.7**
Nuclear		134.7	140.3	129.8	146.8	199.5	0.1	38.8	91.7	0.0	35.9	85.0
Hydro (pumping excluded)		93.3	96.2	104.7	108.9	111.7	0.0	-0.4	-0.5	0.0	-0.4	-0.4
Wind and solar		2.5	13.0	73.1	102.4	144.2	0.0	-1.7	-5.0	0.0	-1.6	-3.3
Thermal		386.9	406.7	476.3	595.5	682.1	0.0	-29.8	-67.0	0.0	-4.8	-8.9
of which cogeneration units		*87.3*	*103.4*	*129.4*	*171.1*	*205.4*	*-0.3*	*3.0*	*6.7*	*-0.2*	*1.8*	*3.4*
Open cycle(incl. biomass-waste)		343.8	335.6	271.3	176.3	145.3	0.7	1.0	-2.0	0.3	0.6	-1.4
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.7	50.4	113.9	-0.2	-16.2	-36.0	-23.0	-24.3	-24.0
Gas Turbines Combined Cycle		20.4	47.4	169.2	303.1	353.9	-0.4	-15.6	-30.7	-0.2	-4.9	-8.0
Small Gas Turbines		22.0	22.8	33.8	64.4	67.5	-0.1	1.1	1.7	-0.3	1.7	2.6
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.1	42.6	46.4	47.9	0.0	-0.4	-0.8	0.0	-0.9	-1.5
Load factor for gross electric capacities (%)		48.2	50.4	49.8	47.6	44.5	0.0	0.0	-0.4	0.0	0.1	-0.8
CHP indicator (% of electricity from CHP)		11.5	12.6	14.4	14.9	16.5	0.0	-0.6	0.2	-0.3	-3.8	1.1
Non fossil fuels in electricity generation (%)		46.8	46.4	45.5	44.1	45.8	0.0	5.3	10.2	0.1	13.7	28.7
nuclear		33.1	31.8	27.9	26.8	28.2	0.0	5.7	10.8	0.2	26.9	61.7
renewable energy forms		13.7	14.6	17.6	17.3	17.6	0.0	-0.4	-0.5	0.0	-2.0	-3.0
of which waste		*0.9*	*1.1*	*1.3*	*1.1*	*1.0*	*0.0*	*-0.1*	*0.0*	*-0.3*	*-6.4*	*-1.9*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6428.4**	**7502.8**	**8534.1**	**-4.4**	**-6.2**	**-4.7**	**-0.1**	**-0.1**	**-0.1**
public road transport	484.5	469.2	493.8	503.8	533.8	557.9	0.0	0.8	2.2	0.0	0.2	0.4
private cars and motorcycles	3593.6	3950.3	4291.6	5021.2	5781.9	6466.9	-4.3	-6.5	-7.7	-0.1	-0.1	-0.1
rail transport	408.3	371.7	402.3	414.9	478.4	536.6	0.0	-0.9	-1.0	0.0	-0.2	-0.2
aviation	168.5	215.5	298.3	448.1	661.9	918.6	0.0	0.3	1.6	0.0	0.0	0.2
inland navigation	28.9	31.9	33.6	40.4	46.8	54.2	0.0	0.0	0.1	0.0	0.0	0.1
travel per person (km per capita)	10618	11233	12174	13938	16236	18627	-10	-13	-10	-0.1	-0.1	-0.1
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2689.4**	**3335.9**	**4039.2**	**-0.4**	**-3.0**	**-3.6**	**0.0**	**-0.1**	**-0.1**
trucks	1064.3	1233.6	1482.7	1966.3	2514.7	3128.8	-0.4	-2.2	-3.8	0.0	-0.1	-0.1
rail transport	440.2	358.0	368.0	378.3	418.7	451.9	0.0	-1.2	-1.3	0.0	-0.3	-0.3
inland navigation	258.1	268.2	297.0	344.8	402.6	458.5	0.0	0.4	1.5	0.0	0.1	0.3
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	231	224	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**387.0**	**426.7**	**448.2**	**-0.2**	**-0.3**	**-0.5**	**-0.1**	**-0.1**	**-0.1**
public road transport	7.7	6.9	7.0	7.1	7.0	6.4	0.0	0.0	0.0	0.0	0.2	0.4
private cars and motorcycles	138.1	146.1	157.1	168.7	168.4	161.1	-0.2	-0.2	-0.4	-0.1	-0.1	-0.3
trucks	82.9	93.2	108.5	143.8	174.3	195.3	0.0	-0.1	-0.2	0.0	-0.1	-0.1
rail transport	8.8	8.9	9.0	8.0	6.5	6.2	0.0	0.0	0.0	0.0	-0.1	-0.1
aviation	29.1	33.8	45.1	53.0	63.3	71.3	0.0	0.0	0.1	0.0	0.0	0.2
inland navigation	7.0	6.7	5.4	6.3	7.1	7.8	0.0	0.0	0.0	0.0	0.1	0.4
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	36.6	32.6	28.6	0.0	0.0	0.0	0.0	0.0	-0.1
freight transport (toe/Mtkm)	51.7	54.4	53.8	56.3	54.7	50.5	0.0	0.0	0.0	0.0	0.0	0.0

Source: PRIMES

EU15: NEW NUCLEAR TECHNOLOGY ACCEPTED — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**742.9**	**683.2**	**692.5**	**-0.1**	**47.7**	**119.6**	**0.0**	**7.5**	**20.9**
Solids	209.9	138.0	99.4	70.2	43.1	34.2	-0.2	-13.0	-8.9	-0.2	-23.2	-20.7
Oil	117.7	159.2	160.4	129.2	99.6	84.1	0.0	0.0	0.0	0.0	0.0	0.0
Natural gas	132.9	166.6	190.6	191.0	142.1	111.9	0.0	0.0	-0.3	0.0	0.0	-0.2
Nuclear	181.4	201.2	222.8	230.4	260.9	310.6	0.1	62.2	130.6	0.0	31.3	72.6
Renewable energy sources	66.3	74.4	88.1	122.2	137.5	151.7	0.0	-1.5	-1.9	0.0	-1.1	-1.2
Hydro	22.3	24.9	27.6	28.1	29.4	29.8	0.0	-0.1	-0.3	0.0	-0.4	-1.0
Biomass	29.7	30.8	36.1	51.2	58.2	65.2	0.0	-0.3	-0.6	-0.1	-0.5	-0.9
Waste	11.9	15.6	18.7	24.3	25.4	25.3	0.0	-0.9	-0.1	0.0	-3.3	-0.6
Wind	0.1	0.4	1.9	13.3	18.0	22.7	0.0	-0.3	-0.9	-0.1	-1.4	-3.8
Solar and others	0.1	0.2	0.3	1.5	2.5	4.5	0.1	0.1	0.0	4.8	2.7	0.8
Geothermal	2.2	2.5	3.3	3.8	4.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
Net Imports	**645.4**	**651.3**	**737.9**	**881.7**	**1056.6**	**1154.9**	**-0.5**	**-20.4**	**-53.4**	**-0.1**	**-1.9**	**-4.4**
Solids	89.9	94.4	107.2	96.9	114.4	146.7	-0.1	-9.0	-32.8	-0.2	-7.3	-18.3
Oil	460.9	446.7	472.4	516.7	561.7	582.0	-0.2	-1.1	-0.2	0.0	-0.2	0.0
Crude oil and Feedstocks	436.8	434.7	455.5	503.4	556.9	586.5	-0.1	-1.1	-0.2	0.0	-0.2	0.0
Oil products	24.1	12.0	16.9	13.3	4.7	-4.6	0.0	0.0	-0.1	-0.2	-0.7	1.4
Natural gas	92.3	108.6	154.7	264.8	379.4	425.5	-0.2	-8.1	-17.9	-0.1	-2.1	-4.0
Electricity	2.3	1.5	3.7	3.3	1.1	0.8	0.0	-2.2	-2.4	0.0	-67.5	-76.1
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1575.1**	**1684.5**	**1785.7**	**-0.6**	**27.3**	**66.2**	**0.0**	**1.6**	**3.9**
Solids	302.8	237.7	212.4	167.1	157.5	180.9	-0.3	-22.0	-41.7	-0.2	-12.3	-18.7
Oil	545.8	575.6	586.9	596.4	606.0	604.4	-0.2	-1.1	-0.3	0.0	-0.2	0.0
Natural gas	222.1	273.4	338.7	455.8	521.5	537.4	-0.2	-8.1	-18.2	-0.1	-1.5	-3.3
Nuclear	181.4	201.2	222.8	230.4	260.9	310.6	0.1	62.2	130.6	0.0	31.3	72.6
Electricity	2.3	1.5	3.7	3.3	1.1	0.8	0.0	-2.2	-2.4	0.0	-67.5	-76.1
Renewable energy forms	66.3	74.4	88.1	122.2	137.5	151.7	0.0	-1.5	-1.9	0.0	-1.1	-1.2
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	10.6	9.4	10.1	0.0	-1.5	-2.8	-0.1	-13.7	-21.7
Oil	41.3	42.2	40.4	37.9	36.0	33.8	0.0	-0.7	-1.3	0.0	-1.8	-3.7
Natural gas	16.8	20.0	23.3	28.9	31.0	30.1	0.0	-1.0	-2.2	0.0	-3.1	-6.9
Nuclear	13.7	14.8	15.3	14.6	15.5	17.4	0.0	3.5	6.9	0.1	29.2	66.2
Renewable energy forms	5.0	5.5	6.1	7.8	8.2	8.5	0.0	-0.2	-0.4	0.1	-2.7	-4.9
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**3026.5**	**3482.8**	**3884.1**	**-0.6**	**32.4**	**38.1**	**0.0**	**0.9**	**1.0**
Nuclear	720.1	810.1	863.7	896.2	1004.5	1169.7	2.2	229.2	424.6	0.2	29.6	57.0
Hydro & wind	259.8	294.2	343.8	482.3	551.7	628.4	-0.2	-4.3	-14.2	0.0	-0.8	-2.2
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1648.0	1926.6	2086.0	-2.7	-192.5	-372.4	-0.2	-9.1	-15.1
Fuel Inputs for Thermal Power Generation (1)	**291.8**	**295.1**	**318.3**	**337.3**	**365.1**	**385.8**	**-0.4**	**-31.9**	**-59.1**	**-0.1**	**-8.0**	**-13.3**
Solids	186.1	163.9	153.6	117.4	111.9	137.8	-0.3	-21.9	-41.5	-0.2	-16.3	-23.1
Oil (including refinery gas)	48.7	49.6	38.3	20.3	10.7	6.8	0.0	-0.4	0.0	0.0	-3.5	0.4
Gas	45.1	66.0	106.3	172.2	214.2	212.6	-0.2	-8.6	-17.0	-0.1	-3.9	-7.4
Biomass - Waste	10.0	13.5	17.1	24.0	24.5	24.7	0.0	-1.1	-0.6	0.0	-4.2	-2.5
Geothermal heat	1.9	2.1	3.0	3.4	3.6	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**740.9**	**770.8**	**793.2**	**-0.2**	**-1.0**	**-0.7**	**0.0**	**-0.1**	**-0.1**
Refineries	594.6	635.8	665.7	683.4	708.8	725.0	-0.2	-1.1	-0.2	0.0	-0.2	0.0
District heating	12.4	11.0	6.0	6.2	5.4	5.6	0.0	0.2	-0.4	0.0	2.9	-6.1
Biofuels and hydrogen production	0.0	0.2	0.6	10.1	17.7	25.7	0.0	0.0	0.0	0.0	-0.1	-0.2
Others	97.1	58.1	50.6	41.2	38.9	36.8	0.0	0.0	-0.1	0.0	-0.1	-0.2
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**67.4**	**67.2**	**67.9**	**0.0**	**-0.1**	**0.0**	**0.0**	**-0.1**	**0.0**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.3**	**108.5**	**110.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1076.3**	**1164.9**	**1228.9**	**-0.3**	**0.1**	**-0.1**	**0.0**	**0.0**	**0.0**
by sector												
Industry (1)	262.2	255.6	268.7	299.4	325.5	344.9	0.0	0.2	0.2	0.0	0.1	0.1
energy intensive industries	180.4	170.9	175.8	190.7	199.8	202.3	0.0	0.1	0.2	0.0	0.1	0.1
other industrial sectors	81.9	84.7	92.9	108.7	125.6	142.6	0.0	0.1	0.1	0.0	0.1	0.1
Residential	228.1	236.0	244.7	270.9	284.5	291.1	0.0	0.2	0.1	0.0	0.1	0.0
Tertiary	115.3	127.9	132.7	149.1	165.8	186.7	0.0	0.1	0.1	0.0	0.0	0.0
Transport	253.8	275.7	309.1	356.9	389.1	406.3	-0.2	-0.3	-0.5	-0.1	-0.1	-0.1
by fuel (1)												
Solids	76.8	47.0	36.0	28.4	25.1	22.9	0.0	-0.1	-0.2	-0.1	-0.5	-0.9
Oil	391.5	414.1	430.6	462.0	488.2	501.6	-0.2	-0.8	-0.3	0.0	-0.2	-0.1
Gas	169.7	194.9	220.3	266.6	285.5	299.7	-0.1	0.5	-1.1	0.0	0.2	-0.4
Electricity	156.0	169.4	191.6	228.2	264.3	297.0	-0.1	0.5	0.7	0.0	0.2	0.2
Heat (from CHP and District Heating)	35.2	39.3	42.1	51.8	60.8	67.0	0.0	0.1	0.4	0.0	0.1	0.6
Other	30.3	30.6	34.5	39.4	41.0	40.7	0.0	0.0	0.4	0.1	0.0	0.9
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.7**	**3117.5**	**3202.7**	**3332.3**	**3459.6**	**-2.2**	**-111.7**	**-209.1**	**-0.1**	**-3.2**	**-5.7**
Electricity and Steam production	997.6	947.7	948.3	950.4	990.2	1075.7	-1.5	-109.8	-204.8	-0.2	-10.0	-16.0
Energy Branch	129.8	144.4	145.4	135.1	131.4	127.4	0.0	-0.3	-0.2	0.0	-0.2	-0.1
Industry	576.2	526.5	509.3	458.2	460.1	463.5	-0.1	0.1	-2.9	0.0	0.0	-0.6
Residential	436.4	417.4	412.9	432.4	440.2	434.5	0.0	-0.5	0.3	0.0	-0.1	0.1
Tertiary	203.5	212.7	199.6	202.7	206.0	219.5	0.1	-0.4	-0.3	0.1	-0.2	-0.1
Transport	738.5	802.9	902.2	1023.9	1104.5	1139.0	-0.6	-0.8	-1.2	-0.1	-0.1	-0.1
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**103.9**	**108.1**	**112.2**	**-0.1**	**-3.6**	**-6.8**	-0.1	-3.2	-5.7

See explanations on the last page of the Appendix

Source: PRIMES

EU15: NEW NUCLEAR TECHNOLOGY ACCEPTED								SUMMARY ENERGY BALANCE AND INDICATORS (B)					
Mtoe	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
							Difference from Baseline			**% diff. from Baseline**		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	145.1	123.5	105.5	-0.1	2.0	3.9	0.0	1.6	3.9
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	4.1	4.3	4.6	0.0	0.1	0.2	0.0	1.6	3.9
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7804	8920	9984	-2	83	98	0.0	0.9	1.0
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	2.03	1.98	1.94	0.00	-0.10	-0.20	0.0	-4.8	-9.2
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	8.3	8.5	8.9	0.0	-0.3	-0.5	-0.1	-3.2	-5.7
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	294.9	244.3	204.5	-0.2	-8.2	-12.4	-0.1	-3.2	-5.7
Import Dependency %	47.6	46.6	49.4	54.3	60.7	62.5	0.0	-2.2	-5.3	0.0	-3.4	-7.8
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	78.9	67.9	57.8	0.0	0.0	0.0	0.0	0.1	0.1
Residential (Energy on Private Income)	100.0	97.6	88.2	77.2	65.3	54.6	0.0	0.0	0.0	0.0	0.1	0.0
Tertiary (Energy on Value added)	100.0	101.8	90.9	78.4	68.6	61.7	0.0	0.0	0.0	0.0	0.0	0.0
Transport (Energy on GDP)	100.0	101.2	99.5	90.4	78.5	66.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.26	0.23	0.23	0.00	-0.03	-0.05	-0.1	-10.7	-16.8
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.97	1.90	1.84	0.00	0.00	0.00	0.0	-0.1	-0.2
Industry	2.20	2.06	1.90	1.53	1.41	1.34	0.00	0.00	-0.01	0.0	0.0	-0.7
Residential	1.91	1.77	1.69	1.60	1.55	1.49	0.00	0.00	0.00	0.0	-0.2	0.0
Tertiary	1.76	1.66	1.50	1.36	1.24	1.18	0.00	0.00	0.00	0.1	-0.2	-0.2
Transport	2.91	2.91	2.92	2.87	2.84	2.80	0.00	0.00	0.00	0.0	0.0	0.0
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**688.7**	**819.6**	**969.9**	**0.0**	**7.0**	**18.9**	**0.0**	**0.9**	**2.0**
Nuclear		126.2	131.0	121.9	138.3	188.0	0.1	38.2	83.0	0.0	38.2	79.1
Hydro (pumping excluded)		87.1	89.8	97.0	100.6	103.3	0.0	-0.4	-0.4	0.0	-0.4	-0.4
Wind and solar		2.5	12.9	70.4	93.7	129.3	0.0	-1.7	-4.9	0.0	-1.7	-3.6
Thermal		322.9	344.8	399.5	486.9	549.2	0.0	-29.2	-58.9	0.0	-5.7	-9.7
of which cogeneration units		*59.3*	*77.1*	*102.0*	*132.9*	*153.7*	*-0.3*	*3.0*	*7.3*	*-0.3*	*2.3*	*5.0*
Open cycle(incl. biomass-waste)		281.8	276.9	215.4	136.9	113.5	0.7	1.1	0.2	0.3	0.8	0.1
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.2	35.3	84.6	-0.2	-16.3	-34.4	-47.7	-31.6	-28.9
Gas Turbines Combined Cycle		20.0	46.0	156.9	264.1	296.7	-0.4	-15.2	-26.3	-0.3	-5.4	-8.1
Small Gas Turbines		20.3	21.0	25.8	49.3	53.0	-0.1	1.2	1.6	-0.4	2.4	3.1
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.8	43.9	47.6	49.0	0.0	-0.4	-0.7	0.0	-0.8	-1.4
Load factor for gross electric capacities (%)		48.9	50.8	50.2	48.5	45.7	0.0	0.0	-0.4	0.0	0.1	-1.0
CHP indicator (% of electricity from CHP)		9.2	10.3	12.6	13.2	14.4	0.0	-0.7	0.3	-0.4	-4.8	1.9
Non fossil fuels in electricity generation (%)		49.9	49.3	48.3	47.0	48.4	0.1	5.9	10.2	0.1	14.5	26.6
nuclear		35.1	33.6	29.6	28.8	30.1	0.1	6.4	10.7	0.3	28.4	55.5
renewable energy forms		14.8	15.8	18.7	18.2	18.3	0.0	-0.4	-0.6	0.0	-2.3	-3.1
of which waste		*1.0*	*1.2*	*1.4*	*1.2*	*1.1*	*0.0*	*-0.1*	*0.0*	*-0.4*	*-6.7*	*-1.9*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5812.6**	**6693.8**	**7534.3**	**-4.5**	**-6.6**	**-5.9**	**-0.1**	**-0.1**	**-0.1**
public road transport	368.8	382.2	412.6	422.6	449.0	466.8	0.0	0.6	1.7	0.0	0.1	0.4
private cars and motorcycles	3325.6	3634.5	3938.8	4561.9	5160.4	5695.7	-4.4	-6.8	-8.7	-0.1	-0.1	-0.2
rail transport	316.4	320.9	356.0	366.7	420.2	461.7	0.0	-0.9	-1.1	0.0	-0.2	-0.2
aviation	157.3	201.5	281.5	421.7	618.1	856.7	0.0	0.5	2.1	0.0	0.1	0.3
inland navigation	28.3	31.4	33.0	39.7	46.0	53.4	0.0	0.0	0.1	0.0	0.0	0.1
travel per person (km per capita)	11465	12240	13261	14988	17144	19367	-12	-17	-15	-0.1	-0.1	-0.1
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2350.0**	**2894.3**	**3497.9**	**-0.5**	**-2.5**	**-3.6**	**0.0**	**-0.1**	**-0.1**
trucks	946.0	1114.6	1327.2	1742.4	2195.4	2716.6	-0.4	-1.9	-3.6	0.0	-0.1	-0.1
rail transport	234.9	220.2	249.3	263.6	297.1	323.7	-0.1	-0.9	-1.6	0.0	-0.3	-0.5
inland navigation	257.1	266.9	296.1	344.0	401.8	457.6	0.0	0.4	1.5	0.0	0.1	0.3
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	207	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**356.9**	**389.1**	**406.3**	**-0.2**	**-0.3**	**-0.5**	**-0.1**	**-0.1**	**-0.1**
public road transport	6.3	5.9	5.8	6.0	5.8	5.3	0.0	0.0	0.0	0.0	0.1	0.3
private cars and motorcycles	130.2	136.6	145.5	154.0	150.7	141.8	-0.2	-0.2	-0.5	-0.1	-0.2	-0.3
trucks	76.0	86.5	101.0	132.7	159.2	177.2	0.0	-0.1	-0.2	0.0	-0.1	-0.1
rail transport	6.9	7.5	7.7	6.9	5.6	5.3	0.0	0.0	0.0	0.0	-0.1	-0.2
aviation	27.8	32.5	43.8	51.1	60.7	68.9	0.0	0.0	0.1	0.0	0.1	0.2
inland navigation	6.7	6.7	5.3	6.3	7.1	7.8	0.0	0.0	0.0	0.0	0.1	0.4
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	37.4	33.2	29.3	0.0	0.0	0.0	0.0	0.0	-0.1
freight transport (toe/Mtkm)	57.8	58.5	57.3	59.5	57.6	52.9	0.0	0.0	0.0	0.0	0.0	0.0

Source: PRIMES

NMS: NEW NUCLEAR TECHNOLOGY ACCEPTED — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**116.9**	**106.0**	**101.8**	**-0.4**	**0.7**	**13.8**	**-0.3**	**0.6**	**15.6**
Solids	140.9	126.7	104.0	83.5	70.2	59.1	0.0	-0.1	-0.3	0.0	-0.1	-0.6
Oil	2.6	3.0	3.1	2.5	2.4	2.3	0.0	0.0	0.0	0.0	0.0	0.1
Natural gas	6.7	7.4	6.1	5.9	5.5	4.8	0.0	0.0	-0.1	0.0	0.0	-2.2
Nuclear	15.5	14.1	14.8	14.5	15.6	19.6	-0.4	0.7	14.3	-2.7	4.8	267.0
Renewable energy sources	3.0	6.3	8.0	10.5	12.4	15.8	0.0	0.0	-0.1	0.0	0.0	-0.4
Hydro	1.1	1.3	1.4	2.0	2.1	2.2	0.0	0.0	0.0	0.3	-0.1	-1.1
Biomass	1.4	4.6	6.1	6.3	6.4	7.9	0.0	0.0	0.0	0.0	0.0	0.0
Waste	0.5	0.3	0.5	1.4	1.5	1.8	0.0	0.0	0.0	0.0	-0.1	-0.2
Wind	0.0	0.0	0.0	0.6	1.9	3.1	0.0	0.0	-0.1	-0.4	-0.2	-1.6
Solar and others	0.0	0.0	0.0	0.3	0.5	0.8	0.0	0.0	0.0	0.4	1.1	1.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Net Imports	**66.3**	**50.4**	**61.4**	**92.2**	**126.9**	**144.3**	**0.1**	**-0.7**	**-9.3**	**0.1**	**-0.6**	**-6.1**
Solids	-14.6	-20.7	-15.9	-7.2	2.6	12.3	0.0	-0.3	-5.6	0.2	-9.8	-31.4
Oil	49.9	45.0	47.3	55.6	63.2	68.8	0.0	0.0	0.0	0.0	0.0	0.0
Crude oil and Feedstocks	43.4	36.7	41.3	46.2	53.1	58.3	0.0	0.0	0.0	0.0	0.0	0.0
Oil products	6.5	8.3	6.0	9.4	10.2	10.5	0.0	0.0	0.0	0.1	0.0	0.0
Natural gas	31.2	26.2	31.5	45.1	62.3	64.2	0.1	-0.4	-3.5	0.2	-0.6	-5.1
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-1.1	0.0	0.0	-0.3	0.0	0.0	30.5
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**208.1**	**231.7**	**244.7**	**-0.3**	**-0.1**	**4.4**	**-0.2**	**0.0**	**1.8**
Solids	127.8	108.2	90.8	76.3	72.8	71.5	0.0	-0.3	-6.0	0.0	-0.5	-7.7
Oil	50.4	46.6	48.7	57.0	64.5	69.8	0.0	0.0	0.0	0.0	0.0	0.0
Natural gas	37.1	33.8	37.3	51.0	67.7	69.1	0.1	-0.4	-3.6	0.2	-0.6	-4.9
Nuclear	15.5	14.1	14.8	14.5	15.6	19.6	-0.4	0.7	14.3	-2.7	4.8	267.0
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-1.1	0.0	0.0	-0.3	0.0	0.0	30.5
Renewable energy forms	3.0	6.3	8.0	10.5	12.4	15.8	0.0	0.0	-0.1	0.0	0.0	-0.4
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	36.7	31.4	29.2	0.1	-0.1	-3.0	0.1	-0.5	-9.4
Oil	21.6	22.3	24.6	27.4	27.8	28.5	0.0	0.0	-0.5	0.1	0.0	-1.8
Natural gas	15.9	16.2	18.8	24.5	29.2	28.2	0.1	-0.2	-2.0	0.4	-0.6	-6.7
Nuclear	6.6	6.7	7.5	7.0	6.7	8.0	-0.2	0.3	5.8	-2.6	4.9	260.4
Renewable energy forms	1.3	3.0	4.1	5.0	5.3	6.5	0.0	0.0	-0.1	0.2	0.0	-2.2
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**391.4**	**497.4**	**553.4**	**-0.6**	**-0.8**	**2.3**	**-0.2**	**-0.2**	**0.4**
Nuclear	60.0	54.3	57.4	57.5	61.7	81.1	-1.0	3.6	59.7	-1.7	6.1	278.2
Hydro & wind	12.9	15.5	15.7	30.2	46.4	62.0	0.0	-0.1	-0.9	0.1	-0.2	-1.4
Thermal (incl. biomass)	243.7	230.7	250.6	303.7	389.2	410.3	0.4	-4.3	-56.5	0.1	-1.1	-12.1
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**75.5**	**85.1**	**86.5**	**0.0**	**-0.8**	**-9.6**	**0.1**	**-0.9**	**-10.0**
Solids	62.2	57.2	56.5	57.5	58.2	59.0	0.0	-0.3	-6.0	0.0	-0.6	-9.2
Oil	4.9	4.4	3.2	3.4	2.4	2.7	0.0	0.0	0.0	-0.6	0.0	1.2
Gas	5.3	4.0	6.3	12.8	22.5	22.0	0.0	-0.4	-3.7	0.4	-1.8	-14.2
Biomass - Waste	0.3	0.1	0.4	1.8	2.1	2.8	0.0	0.0	-0.1	0.0	-0.1	-2.4
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**65.9**	**71.2**	**77.9**	**-0.1**	**-0.1**	**0.1**	**-0.1**	**-0.1**	**0.1**
Refineries	46.7	40.1	45.2	49.7	57.0	63.2	0.0	0.0	0.0	0.0	0.0	0.0
District heating	19.3	12.1	8.5	4.5	3.6	2.9	-0.1	-0.1	0.1	-1.1	-1.4	2.8
Biofuels and hydrogen production	0.0	0.0	0.0	0.1	0.4	1.7	0.0	0.0	0.0	0.0	0.0	0.1
Others	30.5	23.1	17.7	11.6	10.2	10.1	0.0	0.0	0.0	0.0	0.0	0.0
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.7**	**9.9**	**9.3**	**0.0**	**0.0**	**0.0**	**-0.1**	**-0.1**	**-0.2**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**12.9**	**14.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**132.3**	**153.0**	**165.1**	**0.0**	**-0.1**	**0.0**	**0.0**	**0.0**	**0.0**
by sector												
Industry	65.0	47.7	40.4	39.5	42.1	43.9	0.0	0.0	0.0	0.0	0.0	0.0
energy intensive industries	32.5	27.9	26.2	25.6	26.5	26.9	0.0	0.0	0.0	0.0	0.0	0.0
other industrial sectors	32.4	19.7	14.2	13.8	15.6	17.0	0.0	0.0	0.0	0.0	0.0	0.1
Residential	40.0	41.2	34.4	37.7	44.7	47.8	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary	24.9	19.6	21.5	25.1	28.6	31.5	0.0	0.0	0.0	0.0	-0.1	0.0
Transport	19.9	19.8	22.9	30.0	37.6	42.0	0.0	0.0	0.0	0.0	0.0	0.0
by fuel												
Solids	40.9	33.8	21.4	13.9	10.9	9.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil	32.7	29.6	33.6	41.3	48.6	52.9	0.0	0.0	0.0	0.0	0.0	0.0
Gas	26.5	24.6	25.4	33.4	39.9	42.7	0.1	0.1	0.1	0.2	0.1	0.2
Electricity	20.5	18.5	19.6	25.0	33.2	38.0	0.0	-0.1	0.0	-0.2	-0.2	-0.1
Heat (from CHP and District Heating)	27.7	17.4	13.5	13.1	14.9	16.9	-0.1	0.0	-0.1	-0.4	-0.3	-0.5
Other	1.8	4.7	5.8	5.6	5.4	5.6	0.0	0.0	0.1	0.0	0.1	1.3
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**552.4**	**594.3**	**603.3**	**0.1**	**-2.4**	**-31.6**	**0.0**	**-0.4**	**-5.0**
Electricity and Steam production	343.4	295.0	280.1	283.3	300.6	300.8	-0.1	-2.5	-31.8	0.0	-0.8	-9.5
Energy Branch	14.4	19.5	18.7	10.6	11.4	11.4	0.0	0.0	0.0	0.0	0.0	0.0
Industry	137.0	118.2	96.4	86.1	85.8	85.5	0.1	0.0	0.0	0.1	0.0	0.0
Residential	83.2	72.9	49.7	49.4	54.6	53.0	0.1	0.1	0.0	0.1	0.1	0.1
Tertiary	53.3	38.3	37.2	37.0	34.6	35.1	0.1	0.1	0.1	0.2	0.2	0.2
Transport	56.1	55.9	65.3	86.0	107.3	117.4	0.0	0.0	0.0	0.0	0.0	0.0
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**80.4**	**86.5**	**87.8**	**0.0**	**-0.3**	**-4.6**	0.0	-0.4	-5.0

See explanations on the last page of the Appendix

Source: PRIMES

NMS: NEW NUCLEAR TECHNOLOGY ACCEPTED — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	362.6	282.2	222.4	-0.6	-0.1	4.0	-0.2	0.0	1.8
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.8	3.2	3.5	0.0	0.0	0.1	-0.2	0.0	1.8
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	5333	6940	8004	-8	-11	33	-0.2	-0.2	0.4
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.65	2.56	2.47	0.00	-0.01	-0.18	0.2	-0.4	-6.7
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.5	8.3	8.7	0.0	0.0	-0.5	0.0	-0.4	-5.0
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	962.5	723.9	548.3	0.3	-2.9	-28.8	0.0	-0.4	-5.0
Import Dependency %	28.3	24.1	30.8	44.1	54.5	58.6	0.1	-0.3	-4.9	0.2	-0.5	-7.8
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	36.1	27.4	22.8	0.0	0.0	0.0	0.0	0.0	0.0
Residential (Energy on Private Income)	100.0	106.5	74.2	56.0	45.3	36.1	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary (Energy on Value added)	100.0	74.8	67.2	52.5	40.3	32.0	0.0	0.0	0.0	0.0	-0.1	0.0
Transport (Energy on GDP)	100.0	102.9	97.4	87.6	76.6	63.8	0.0	0.0	0.0	0.0	0.0	0.0
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.50	0.43	0.39	0.00	0.00	-0.04	0.2	-0.6	-9.7
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.95	1.84	1.76	0.00	0.00	0.00	0.1	0.1	0.0
Industry	2.11	2.48	2.38	2.18	2.04	1.95	0.00	0.00	0.00	0.1	0.0	0.0
Residential	2.08	1.77	1.44	1.31	1.22	1.11	0.00	0.00	0.00	0.2	0.2	0.1
Tertiary	2.14	1.95	1.73	1.48	1.21	1.11	0.00	0.00	0.00	0.2	0.2	0.3
Transport	2.82	2.82	2.85	2.86	2.86	2.80	0.00	0.00	0.00	0.0	0.0	0.0
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**95.2**	**134.1**	**167.6**	**0.0**	**0.0**	**0.4**	**0.0**	**0.0**	**0.3**
Nuclear		8.4	9.3	7.9	8.5	11.5	0.0	0.6	8.7	0.0	7.2	304.4
Hydro (pumping excluded)		6.1	6.4	7.7	8.2	8.4	0.0	0.0	-0.1	0.3	-0.1	-0.6
Wind and solar		0.0	0.0	2.8	8.7	14.9	0.0	0.0	-0.1	-0.5	-0.2	-0.7
Thermal		64.0	61.9	76.8	108.6	132.9	0.0	-0.6	-8.1	0.0	-0.5	-5.7
of which cogeneration units		*28.1*	*26.3*	*27.4*	*38.2*	*51.7*	*0.0*	*0.0*	*-0.6*	*0.1*	*-0.1*	*-1.1*
Open cycle (incl. biomass-waste)		61.9	58.6	55.9	39.4	31.8	0.0	-0.2	-2.2	0.0	-0.4	-6.4
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.5	15.1	29.3	0.0	0.1	-1.6	-1.1	0.9	-5.2
Gas Turbines Combined Cycle		0.4	1.4	12.3	39.1	57.2	0.0	-0.4	-4.4	0.2	-1.1	-7.1
Small Gas Turbines		1.7	1.8	8.0	15.1	14.5	0.0	-0.1	0.1	0.0	-0.6	0.8
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	36.5	41.3	43.2	0.0	-0.1	-0.8	0.0	-0.2	-1.8
Load factor for gross electric capacities (%)		43.6	47.6	46.9	42.4	37.7	-0.1	-0.1	0.1	-0.2	-0.1	0.1
CHP indicator (% of electricity from CHP)		29.4	30.4	28.4	27.3	31.2	0.0	0.0	-0.4	0.2	-0.1	-1.4
Non fossil fuels in electricity generation (%)		23.4	23.1	24.0	23.2	27.7	-0.2	0.7	10.5	-0.9	3.3	60.9
nuclear		18.1	17.7	14.7	12.4	14.7	-0.2	0.7	10.8	-1.6	6.3	276.6
renewable energy forms		5.3	5.4	9.3	10.8	13.1	0.0	0.0	-0.3	0.3	0.0	-2.0
of which waste		*0.0*	*0.1*	*0.6*	*0.4*	*0.3*	*0.0*	*0.0*	*0.0*	*0.2*	*-0.2*	*-3.1*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**615.8**	**809.1**	**999.9**	**0.1**	**0.4**	**1.2**	**0.0**	**0.0**	**0.1**
public road transport	115.7	87.0	81.2	81.2	84.8	91.0	0.0	0.3	0.6	0.0	0.3	0.6
private cars and motorcycles	268.0	315.8	352.9	459.3	621.5	771.2	0.1	0.3	1.0	0.0	0.1	0.1
rail transport	91.9	50.8	46.3	48.2	58.2	74.9	0.0	0.0	0.2	0.0	-0.1	0.2
aviation	11.2	14.0	16.8	26.4	43.8	62.0	0.0	-0.2	-0.5	0.0	-0.4	-0.8
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	0.1	0.2	0.4
travel per person (km per capita)	6489	6227	6662	8390	11289	14461	2	5	17	0.0	0.0	0.1
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**339.4**	**441.6**	**541.3**	**0.0**	**-0.6**	**0.0**	**0.0**	**-0.1**	**0.0**
trucks	118.4	119.0	155.5	223.9	319.2	412.2	0.0	-0.3	-0.2	0.0	-0.1	-0.1
rail transport	205.2	137.8	118.7	114.7	121.6	128.2	0.0	-0.3	0.3	0.0	-0.2	0.2
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	0.1	0.4	0.8
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	591	538	492	0	-1	0	0.0	-0.1	0.0
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**30.0**	**37.6**	**42.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
public road transport	1.4	1.0	1.2	1.1	1.1	1.1	0.0	0.0	0.0	0.0	0.3	0.6
private cars and motorcycles	7.9	9.5	11.6	14.8	17.7	19.4	0.0	0.0	0.0	0.0	0.0	0.1
trucks	7.0	6.7	7.5	11.1	15.1	18.1	0.0	0.0	0.0	0.0	-0.1	-0.1
rail transport	2.0	1.4	1.3	1.1	1.0	1.0	0.0	0.0	0.0	0.0	-0.1	0.2
aviation	1.3	1.2	1.3	1.9	2.6	2.5	0.0	0.0	0.0	0.0	-0.3	-0.7
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.7
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	29.8	27.1	23.3	0.0	0.0	0.0	0.0	0.0	-0.1
freight transport (toe/Mtkm)	24.6	28.8	30.0	34.5	35.5	34.4	0.0	0.0	0.0	0.0	0.0	-0.1

Source: PRIMES

[1] EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

APPENDIX 6

Summary energy balances and indicators by group of countries (EU-25, EU-15, new Member states (NMS)) – comparison to baseline

APPENDIX 6

PROMOTING RAIL AND IMPROVED LOAD FACTORS SCENARIO - OPTION C OF THE TRANSPORT WHITE PAPER ACHIEVED IN 2010

EU25: PROMOTING RAIL AND IMPROVED LOAD FACTORS — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**858.6**	**738.7**	**659.1**	**-1.7**	**-2.2**	**-1.9**	**-0.2**	**-0.3**	**-0.3**
Solids	350.8	264.7	203.4	153.9	126.5	102.6	0.1	0.1	0.1	0.1	0.1	0.1
Oil	120.3	162.2	163.5	131.1	101.8	86.3	-0.6	-0.3	-0.1	-0.4	-0.3	-0.1
Natural gas	139.6	174.0	196.6	196.9	147.6	117.1	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	196.9	215.3	237.7	245.3	213.5	185.4	0.0	0.0	0.1	0.0	0.0	0.0
Renewable energy sources	69.2	80.7	96.1	131.4	149.3	167.5	-1.3	-2.0	-1.9	-1.0	-1.3	-1.1
Hydro	23.4	26.3	29.0	30.1	31.7	32.2	0.0	0.0	0.0	0.0	0.0	0.0
Biomass	31.1	35.4	42.2	56.2	62.9	71.6	-1.3	-2.0	-2.1	-2.2	-3.1	-2.9
Waste	12.3	15.9	19.3	25.7	27.7	27.1	0.0	0.0	0.0	0.0	-0.1	-0.1
Wind	0.1	0.4	1.9	13.9	20.1	27.0	0.0	0.0	0.2	0.1	0.1	0.8
Solar and others	0.1	0.3	0.4	1.7	3.0	5.3	0.0	0.0	0.0	-0.1	0.0	0.1
Geothermal	2.2	2.5	3.3	3.8	4.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
Net Imports	**711.6**	**701.7**	**799.3**	**921.3**	**1152.5**	**1321.5**	**-53.1**	**-52.0**	**-40.3**	**-5.5**	**-4.3**	**-3.0**
Solids	75.2	73.8	91.4	90.2	127.1	198.4	0.3	0.8	1.0	0.4	0.6	0.5
Oil	510.8	491.8	519.6	518.9	572.8	609.5	-53.5	-53.1	-41.4	-9.4	-8.5	-6.4
Crude oil and Feedstocks	480.2	471.5	496.8	496.5	558.1	603.1	-53.2	-53.0	-41.8	-9.7	-8.7	-6.5
Oil products	30.6	20.3	22.8	22.4	14.8	6.4	-0.3	-0.2	0.4	-1.3	-1.1	6.8
Natural gas	123.5	134.8	186.2	310.1	450.6	511.2	0.1	0.4	0.1	0.0	0.1	0.0
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1730.9**	**1836.5**	**1919.4**	**-53.2**	**-52.4**	**-40.4**	**-3.0**	**-2.8**	**-2.1**
Solids	430.6	346.0	303.2	244.1	253.6	301.1	0.4	0.9	1.1	0.2	0.4	0.4
Oil	596.2	622.2	635.6	601.1	619.9	634.7	-52.4	-51.7	-39.7	-8.0	-7.7	-5.9
Natural gas	259.2	307.1	376.0	507.0	598.1	628.3	0.1	0.4	0.1	0.0	0.1	0.0
Nuclear	196.9	215.3	237.7	245.3	213.5	185.4	0.0	0.0	0.1	0.0	0.0	0.0
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	131.4	149.3	167.5	-1.3	-2.0	-1.9	-1.0	-1.3	-1.1
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	14.1	13.8	15.7	0.4	0.4	0.4	3.2	3.2	2.5
Oil	38.4	39.6	38.5	34.7	33.8	33.1	-1.9	-1.8	-1.3	-5.2	-5.1	-3.9
Natural gas	16.7	19.5	22.8	29.3	32.6	32.7	0.9	0.9	0.7	3.1	2.9	2.1
Nuclear	12.7	13.7	14.4	14.2	11.6	9.7	0.4	0.3	0.2	3.1	2.9	2.1
Renewable energy forms	4.5	5.1	5.8	7.6	8.1	8.7	0.2	0.1	0.1	2.1	1.5	0.9
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3424.1**	**3958.2**	**4410.4**	**4.9**	**9.5**	**13.3**	**0.1**	**0.2**	**0.3**
Nuclear	780.0	864.4	921.2	952.5	833.6	766.8	0.0	0.0	0.3	0.0	0.0	0.0
Hydro & wind	272.7	309.7	359.5	512.8	602.6	708.0	0.1	0.1	2.5	0.0	0.0	0.4
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1958.8	2522.0	2935.6	4.8	9.3	10.5	0.2	0.4	0.4
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**414.0**	**484.5**	**542.6**	**0.8**	**1.6**	**1.6**	**0.2**	**0.3**	**0.3**
Solids	248.2	221.1	210.1	175.6	193.2	245.3	0.4	0.9	1.1	0.2	0.5	0.5
Oil (including refinery gas)	53.7	53.9	41.5	23.8	13.5	9.5	0.1	0.0	0.1	0.3	0.1	0.6
Gas	50.4	70.0	112.6	185.4	246.4	255.5	0.3	0.7	0.3	0.2	0.3	0.1
Biomass - Waste	10.3	13.6	17.5	25.8	27.7	28.3	0.0	0.0	0.1	0.1	0.2	0.5
Geothermal heat	1.9	2.1	3.0	3.4	3.6	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**749.2**	**784.7**	**824.6**	**-57.9**	**-58.4**	**-47.1**	**-7.2**	**-6.9**	**-5.4**
Refineries	641.3	675.9	710.9	676.7	710.5	743.6	-56.5	-56.5	-44.9	-7.7	-7.4	-5.7
District heating	31.7	23.1	14.5	10.7	8.9	8.8	-0.1	0.0	0.0	-0.5	0.3	0.2
Biofuels and hydrogen production	0.0	0.2	0.6	8.9	16.1	25.2	-1.3	-2.0	-2.2	-12.5	-11.1	-8.1
Others	127.6	81.2	68.3	52.8	49.1	47.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**74.4**	**74.6**	**75.2**	**-2.7**	**-2.6**	**-2.0**	**-3.5**	**-3.4**	**-2.6**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.3**	**121.4**	**124.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1158.6**	**1267.9**	**1355.4**	**-50.4**	**-49.9**	**-38.7**	**-4.2**	**-3.8**	**-2.8**
by sector												
Industry (1)	327.2	303.3	309.1	338.9	367.4	388.5	0.0	0.0	0.0	0.0	0.0	0.0
energy intensive industries	212.9	198.9	202.0	216.3	226.2	229.0	0.0	0.0	0.0	0.0	0.0	0.0
other industrial sectors	114.3	104.4	107.0	122.5	141.1	159.5	0.0	0.0	0.0	0.0	0.0	0.0
Residential	268.1	277.2	279.1	308.6	329.2	338.8	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary	140.2	147.5	154.2	174.3	194.4	218.2	0.0	0.0	0.0	0.0	0.0	0.0
Transport	273.7	295.6	332.0	336.9	377.0	409.9	-50.4	-50.0	-38.8	-13.0	-11.7	-8.7
by fuel (1)												
Solids	117.7	80.8	57.4	42.3	36.2	32.1	0.0	0.0	0.0	0.0	0.0	0.0
Oil	424.2	443.7	464.2	452.9	487.2	515.4	-50.5	-50.4	-39.4	-10.0	-9.4	-7.1
Gas	196.2	219.5	245.7	299.8	324.6	343.1	-0.2	-0.3	-0.3	-0.1	-0.1	-0.1
Electricity	176.5	187.9	211.3	253.7	297.8	335.4	0.4	0.7	1.0	0.1	0.2	0.3
Heat (from CHP and District Heating)	62.9	56.7	55.6	65.0	75.9	83.7	0.0	0.1	0.0	-0.1	0.2	0.0
Other	32.1	35.3	40.3	44.9	46.3	45.8	-0.1	-0.1	-0.1	-0.1	-0.3	-0.2
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.6**	**3664.9**	**3603.1**	**3891.5**	**4190.3**	**-154.0**	**-149.2**	**-113.3**	**-4.1**	**-3.7**	**-2.6**
Electricity and Steam production	1341.0	1242.7	1228.3	1237.7	1408.4	1618.5	2.4	5.3	5.4	0.2	0.4	0.3
Energy Branch	144.2	163.9	164.0	137.5	134.9	132.8	-8.3	-8.1	-6.2	-5.7	-5.7	-4.5
Industry	713.2	644.8	605.7	544.3	545.7	551.8	-0.1	-0.1	-0.1	0.0	0.0	0.0
Residential	519.7	490.4	462.6	481.9	495.4	487.6	0.2	0.2	0.5	0.0	0.0	0.1
Tertiary	256.8	251.0	236.7	239.6	241.2	255.1	0.1	0.3	0.3	0.0	0.1	0.1
Transport	794.6	858.8	967.5	962.1	1065.9	1144.4	-148.4	-146.8	-113.2	-13.4	-12.1	-9.0
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**95.6**	**103.2**	**111.2**	**-4.1**	**-4.0**	**-3.0**	-4.1	-3.7	-2.6

See explanations on the last page of the Appendix

Source: PRIMES

PROMOTING RAIL AND IMPROVED LOAD FACTORS SCENARIO - OPTION C OF THE TRANSPORT WHITE PAPER ACHIEVED IN 2010

EU25: PROMOTING RAIL AND IMPROVED LOAD FACTORS — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	151.4	127.0	106.5	-4.7	-3.6	-2.2	-3.0	-2.8	-2.1
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.8	4.0	4.2	-0.1	-0.1	-0.1	-3.0	-2.8	-2.1
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	7424	8565	9626	11	21	29	0.1	0.2	0.3
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.08	2.12	2.18	-0.02	-0.02	-0.01	-1.2	-0.9	-0.6
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	7.8	8.4	9.1	-0.3	-0.3	-0.2	-4.1	-3.7	-2.6
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	315.2	269.1	232.5	-13.5	-10.3	-6.3	-4.1	-3.7	-2.6
Import Dependency %	44.8	43.6	47.2	51.8	60.9	66.7	-1.3	-1.0	-0.6	-2.5	-1.6	-0.9
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	71.0	60.5	51.3	0.0	0.0	0.0	0.0	0.0	0.0
Residential (Energy on Private Income)	100.0	98.1	85.8	74.4	63.1	52.7	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary (Energy on Value added)	100.0	96.7	86.8	74.9	65.3	58.2	0.0	0.0	0.0	0.0	0.0	0.0
Transport (Energy on GDP)	100.0	101.1	99.3	78.7	69.7	60.8	-11.8	-9.2	-5.8	-13.0	-11.7	-8.7
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.29	0.29	0.30	0.00	0.00	0.00	0.1	0.2	0.1
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.92	1.85	1.80	-0.04	-0.04	-0.03	-2.2	-2.2	-1.7
Industry	2.18	2.13	1.96	1.61	1.49	1.42	0.00	0.00	0.00	0.0	0.0	0.0
Residential	1.94	1.77	1.66	1.56	1.50	1.44	0.00	0.00	0.00	0.1	0.0	0.1
Tertiary	1.83	1.70	1.54	1.38	1.24	1.17	0.00	0.00	0.00	0.0	0.1	0.1
Transport	2.90	2.91	2.91	2.86	2.83	2.79	-0.01	-0.01	-0.01	-0.4	-0.4	-0.4
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**784.8**	**948.5**	**1121.4**	**0.9**	**1.8**	**3.2**	**0.1**	**0.2**	**0.3**
Nuclear		134.7	140.3	129.8	108.0	107.8	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		93.3	96.2	104.7	109.3	112.2	0.0	0.0	0.0	0.0	0.0	0.0
Wind and solar		2.5	13.0	73.2	104.1	150.1	0.0	0.0	0.9	0.0	0.0	0.6
Thermal		386.9	406.7	477.2	627.1	751.3	0.9	1.8	2.3	0.2	0.3	0.3
of which cogeneration units		*87.3*	*103.4*	*129.6*	*168.4*	*198.9*	*-0.1*	*0.2*	*0.2*	*-0.1*	*0.1*	*0.1*
Open cycle(incl. biomass-waste)		343.8	335.6	270.7	175.5	147.1	0.1	0.2	-0.2	0.0	0.1	-0.1
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	1.1	67.1	151.2	0.1	0.5	1.3	12.1	0.7	0.9
Gas Turbines Combined Cycle		20.4	47.4	170.0	319.7	385.3	0.4	1.0	0.7	0.3	0.3	0.2
Small Gas Turbines		22.0	22.8	34.1	63.5	66.2	0.2	0.1	0.4	0.5	0.2	0.7
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.1	42.6	46.9	48.7	0.0	0.0	0.0	0.0	0.0	0.0
Load factor for gross electric capacities (%)		48.2	50.4	49.8	47.6	44.9	0.0	0.0	0.0	0.0	0.0	0.0
CHP indicator (% of electricity from CHP)		11.5	12.6	14.4	15.5	16.2	-0.1	0.0	-0.1	-0.4	-0.1	-0.5
Non fossil fuels in electricity generation (%)		46.8	46.4	45.4	38.6	35.6	-0.1	-0.1	0.0	-0.1	-0.2	-0.1
nuclear		33.1	31.8	27.8	21.1	17.4	0.0	0.0	0.0	-0.1	-0.2	-0.3
renewable energy forms		13.7	14.6	17.6	17.6	18.2	0.0	0.0	0.0	-0.1	-0.2	0.1
of which waste		*0.9*	*1.1*	*1.3*	*1.2*	*1.0*	*0.0*	*0.0*	*0.0*	*-0.1*	*-0.2*	*0.1*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6427.7**	**7504.0**	**8536.0**	**-5.1**	**-5.0**	**-2.9**	**-0.1**	**-0.1**	**0.0**
public road transport	484.5	469.2	493.8	560.0	595.6	624.2	56.1	62.6	68.6	11.1	11.7	12.3
private cars and motorcycles	3593.6	3950.3	4291.6	4922.4	5686.1	6380.3	-103.1	-102.2	-94.3	-2.1	-1.8	-1.5
rail transport	408.3	371.7	402.3	503.2	581.3	654.1	88.3	102.0	116.5	21.3	21.3	21.7
aviation	168.5	215.5	298.3	402.8	595.3	824.2	-45.3	-66.3	-92.9	-10.1	-10.0	-10.1
inland navigation	28.9	31.9	33.6	39.3	45.7	53.2	-1.1	-1.0	-0.9	-2.7	-2.2	-1.6
travel per person (km per capita)	10618	11233	12174	13936	16239	18631	-11	-11	-6	-0.1	-0.1	0.0
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2688.8**	**3336.1**	**4039.8**	**-1.0**	**-2.9**	**-3.0**	**0.0**	**-0.1**	**-0.1**
trucks	1064.3	1233.6	1482.7	1850.5	2378.7	2974.2	-116.1	-138.2	-158.4	-5.9	-5.5	-5.1
rail transport	440.2	358.0	368.0	465.6	520.4	565.9	87.3	100.6	112.7	23.1	24.0	24.9
inland navigation	258.1	268.2	297.0	372.7	437.0	499.7	27.8	34.7	42.6	8.1	8.6	9.3
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	231	224	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**336.9**	**377.0**	**409.9**	**-50.4**	**-50.0**	**-38.8**	**-13.0**	**-11.7**	**-8.7**
public road transport	7.7	6.9	7.0	7.4	7.4	7.0	0.3	0.4	0.6	3.6	5.8	9.5
private cars and motorcycles	138.1	146.1	157.1	150.6	148.9	142.3	-18.4	-19.8	-19.3	-10.9	-11.7	-11.9
trucks	82.9	93.2	108.5	120.3	151.3	181.5	-23.5	-23.1	-14.0	-16.4	-13.3	-7.2
rail transport	8.8	8.9	9.0	8.4	7.4	7.4	0.4	0.8	1.1	5.1	12.7	18.0
aviation	29.1	33.8	45.1	43.9	54.8	63.6	-9.1	-8.5	-7.7	-17.1	-13.5	-10.7
inland navigation	7.0	6.7	5.4	6.3	7.2	8.2	0.0	0.1	0.4	-0.6	1.8	5.4
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	32.5	28.9	25.7	-4.2	-3.6	-3.0	-11.4	-11.1	-10.4
freight transport (toe/Mtkm)	51.7	54.4	53.8	47.7	47.9	47.2	-8.7	-6.8	-3.3	-15.4	-12.4	-6.5

Source: PRIMES

PROMOTING RAIL AND IMPROVED LOAD FACTORS SCENARIO - OPTION C OF THE TRANSPORT WHITE PAPER ACHIEVED IN 2010

EU15: PROMOTING RAIL AND IMPROVED LOAD FACTORS — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**741.3**	**633.2**	**571.1**	**-1.7**	**-2.2**	**-1.8**	**-0.2**	**-0.3**	**-0.3**
Solids	209.9	138.0	99.4	70.4	56.1	43.0	0.0	0.0	0.0	0.0	0.0	-0.1
Oil	117.7	159.2	160.4	128.7	99.4	84.1	-0.5	-0.3	-0.1	-0.4	-0.3	-0.1
Natural gas	132.9	166.6	190.6	191.0	142.1	112.2	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	181.4	201.2	222.8	230.3	198.7	180.0	0.0	0.0	0.1	0.0	0.0	0.0
Renewable energy sources	66.3	74.4	88.1	120.9	137.0	151.8	-1.3	-2.0	-1.7	-1.0	-1.4	-1.1
Hydro	22.3	24.9	27.6	28.1	29.5	30.1	0.0	0.0	0.0	0.0	0.0	0.0
Biomass	29.7	30.8	36.1	49.9	56.6	63.8	-1.3	-1.9	-1.9	-2.5	-3.3	-3.0
Waste	11.9	15.6	18.7	24.3	26.2	25.4	0.0	0.0	0.0	0.0	-0.1	-0.1
Wind	0.1	0.4	1.9	13.3	18.2	23.8	0.0	0.0	0.2	0.1	0.0	0.9
Solar and others	0.1	0.2	0.3	1.4	2.4	4.5	0.0	0.0	0.0	-0.1	0.0	0.2
Geothermal	2.2	2.5	3.3	3.8	4.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
Net Imports	**645.4**	**651.3**	**737.9**	**833.3**	**1029.9**	**1172.2**	**-48.9**	**-47.1**	**-36.0**	**-5.5**	**-4.4**	**-3.0**
Solids	89.9	94.4	107.2	97.4	124.2	180.4	0.3	0.8	1.0	0.3	0.6	0.5
Oil	460.9	446.7	472.4	467.5	514.6	545.2	-49.4	-48.1	-37.0	-9.6	-8.5	-6.4
Crude oil and Feedstocks	436.8	434.7	455.5	453.9	509.4	548.8	-49.7	-48.6	-37.9	-9.9	-8.7	-6.5
Oil products	24.1	12.0	16.9	13.6	5.2	-3.6	0.3	0.4	0.9	2.1	9.2	-19.1
Natural gas	92.3	108.6	154.7	265.1	387.8	443.5	0.1	0.3	0.1	0.0	0.1	0.0
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1526.7**	**1609.6**	**1683.4**	**-49.0**	**-47.6**	**-36.1**	**-3.1**	**-2.9**	**-2.1**
Solids	302.8	237.7	212.4	167.8	180.3	223.4	0.4	0.8	0.9	0.2	0.4	0.4
Oil	545.8	575.6	586.9	548.3	560.4	569.3	-48.2	-46.7	-35.4	-8.1	-7.7	-5.8
Natural gas	222.1	273.4	338.7	456.1	529.9	555.6	0.1	0.3	0.1	0.0	0.1	0.0
Nuclear	181.4	201.2	222.8	230.3	198.7	180.0	0.0	0.0	0.1	0.0	0.0	0.0
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	120.9	137.0	151.8	-1.3	-2.0	-1.7	-1.0	-1.4	-1.1
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	11.0	11.2	13.3	0.4	0.4	0.3	3.4	3.4	2.6
Oil	41.3	42.2	40.4	35.9	34.8	33.8	-1.9	-1.8	-1.3	-5.1	-5.0	-3.8
Natural gas	16.8	20.0	23.3	29.9	32.9	33.0	0.9	1.0	0.7	3.2	3.0	2.2
Nuclear	13.7	14.8	15.3	15.1	12.3	10.7	0.5	0.4	0.2	3.2	3.0	2.2
Renewable energy forms	5.0	5.5	6.1	7.9	8.5	9.0	0.2	0.1	0.1	2.1	1.5	1.0
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**3031.2**	**3458.5**	**3857.4**	**4.1**	**8.1**	**11.3**	**0.1**	**0.2**	**0.3**
Nuclear	720.1	810.1	863.7	894.0	775.4	745.4	0.0	0.0	0.3	0.0	0.0	0.0
Hydro & wind	259.8	294.2	343.8	482.5	556.0	645.1	0.0	0.1	2.5	0.0	0.0	0.4
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1654.7	2127.1	2466.9	4.1	7.9	8.5	0.2	0.4	0.3
Fuel Inputs for Thermal Power Generation (1)	**291.8**	**295.1**	**318.3**	**338.5**	**398.4**	**446.3**	**0.7**	**1.4**	**1.4**	**0.2**	**0.4**	**0.3**
Solids	186.1	163.9	153.6	118.0	134.6	180.2	0.4	0.8	0.9	0.3	0.6	0.5
Oil (including refinery gas)	48.7	49.6	38.3	20.4	11.1	6.8	0.0	0.0	0.0	0.2	0.0	0.2
Gas	45.1	66.0	106.3	172.6	223.4	229.9	0.3	0.6	0.4	0.2	0.3	0.2
Biomass - Waste	10.0	13.5	17.1	24.0	25.7	25.5	0.0	0.0	0.1	0.1	0.2	0.5
Geothermal heat	1.9	2.1	3.0	3.4	3.6	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**687.0**	**718.0**	**751.1**	**-54.1**	**-53.8**	**-42.8**	**-7.3**	**-7.0**	**-5.4**
Refineries	594.6	635.8	665.7	630.7	658.0	684.5	-52.8	-51.9	-40.8	-7.7	-7.3	-5.6
District heating	12.4	11.0	6.0	6.2	5.3	5.9	0.0	0.1	0.0	-0.2	1.3	-0.2
Biofuels and hydrogen production	0.0	0.2	0.6	8.9	15.8	23.7	-1.3	-2.0	-2.1	-12.5	-11.1	-8.0
Others	97.1	58.1	50.6	41.2	38.9	36.9	0.0	0.0	0.0	0.0	0.0	0.0
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**64.9**	**64.8**	**66.0**	**-2.6**	**-2.4**	**-1.8**	**-3.8**	**-3.6**	**-2.7**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.3**	**108.5**	**110.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1030.2**	**1119.6**	**1194.5**	**-46.4**	**-45.2**	**-34.5**	**-4.3**	**-3.9**	**-2.8**
by sector												
Industry (1)	262.2	255.6	268.7	299.4	325.3	344.6	0.0	0.0	0.0	0.0	0.0	0.0
energy intensive industries	180.4	170.9	175.8	190.7	199.7	202.2	0.0	0.0	0.0	0.0	0.0	0.0
other industrial sectors	81.9	84.7	92.9	108.7	125.6	142.5	0.0	0.0	0.0	0.0	0.0	0.0
Residential	228.1	236.0	244.7	270.9	284.4	291.1	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary	115.3	127.9	132.7	149.2	165.8	186.7	0.0	0.0	0.0	0.0	0.0	0.0
Transport	253.8	275.7	309.1	310.8	344.1	372.1	-46.4	-45.3	-34.6	-13.0	-11.6	-8.5
by fuel (1)												
Solids	76.8	47.0	36.0	28.4	25.2	23.1	0.0	0.0	0.0	0.0	0.0	0.0
Oil	391.5	414.1	430.6	415.7	443.4	466.8	-46.5	-45.6	-35.0	-10.1	-9.3	-7.0
Gas	169.7	194.9	220.3	266.4	284.7	300.5	-0.2	-0.3	-0.3	-0.1	-0.1	-0.1
Electricity	156.0	169.4	191.6	228.6	264.4	297.2	0.3	0.6	0.9	0.1	0.2	0.3
Heat (from CHP and District Heating)	35.2	39.3	42.1	51.9	60.9	66.6	0.0	0.2	0.0	0.0	0.3	0.0
Other	30.3	30.6	34.5	39.3	40.9	40.2	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.7**	**3117.5**	**3063.0**	**3308.8**	**3567.4**	**-141.9**	**-135.2**	**-101.3**	**-4.4**	**-3.9**	**-2.8**
Electricity and Steam production	997.6	947.7	948.3	954.2	1104.6	1285.1	2.2	4.6	4.6	0.2	0.4	0.4
Energy Branch	129.8	144.4	145.4	127.4	124.1	121.8	-7.8	-7.5	-5.7	-5.8	-5.7	-4.5
Industry	576.2	526.5	509.3	458.2	459.8	466.2	-0.2	-0.2	-0.2	0.0	0.0	0.0
Residential	436.4	417.4	412.9	432.5	440.8	434.7	0.2	0.2	0.5	0.0	0.0	0.1
Tertiary	203.5	212.7	199.6	202.7	206.7	220.1	0.1	0.3	0.3	0.1	0.1	0.1
Transport	738.5	802.9	902.2	888.0	972.8	1039.4	-136.5	-132.5	-100.7	-13.3	-12.0	-8.8
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**99.4**	**107.4**	**115.7**	-4.6	-4.4	-3.3	-4.4	-3.9	-2.8

See explanations on the last page of the Appendix

Source: PRIMES

PROMOTING RAIL AND IMPROVED LOAD FACTORS SCENARIO - OPTION C OF THE TRANSPORT WHITE PAPER ACHIEVED IN 2010

EU15: PROMOTING RAIL AND IMPROVED LOAD FACTORS — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	140.6	118.0	99.5	-4.5	-3.5	-2.1	-3.1	-2.9	-2.1
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	3.9	4.1	4.3	-0.1	-0.1	-0.1	-3.1	-2.9	-2.1
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7816	8858	9916	11	21	29	0.1	0.2	0.3
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	2.01	2.06	2.12	-0.03	-0.02	-0.01	-1.4	-1.1	-0.7
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	7.9	8.5	9.2	-0.4	-0.3	-0.3	-4.4	-3.9	-2.8
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	282.1	242.6	210.8	-13.1	-9.9	-6.0	-4.4	-3.9	-2.8
Import Dependency %	47.6	46.6	49.4	52.9	61.9	67.2	-1.4	-1.0	-0.6	-2.5	-1.5	-0.9
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	78.9	67.8	57.7	0.0	0.0	0.0	0.0	0.0	0.0
Residential (Energy on Private Income)	100.0	97.6	88.2	77.2	65.2	54.6	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary (Energy on Value added)	100.0	101.8	90.9	78.4	68.6	61.7	0.0	0.0	0.0	0.0	0.0	0.0
Transport (Energy on GDP)	100.0	101.2	99.5	78.7	69.4	60.5	-11.7	-9.1	-5.6	-13.0	-11.6	-8.5
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.26	0.26	0.28	0.00	0.00	0.00	0.1	0.2	0.1
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.92	1.86	1.81	-0.04	-0.04	-0.03	-2.2	-2.2	-1.7
Industry	2.20	2.06	1.90	1.53	1.41	1.35	0.00	0.00	0.00	0.0	0.0	0.0
Residential	1.91	1.77	1.69	1.60	1.55	1.49	0.00	0.00	0.00	0.0	0.0	0.1
Tertiary	1.76	1.66	1.50	1.36	1.25	1.18	0.00	0.00	0.00	0.1	0.1	0.1
Transport	2.91	2.91	2.92	2.86	2.83	2.79	-0.01	-0.01	-0.01	-0.4	-0.4	-0.4
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**689.5**	**814.2**	**953.9**	**0.7**	**1.6**	**2.9**	**0.1**	**0.2**	**0.3**
Nuclear		126.2	131.0	121.9	100.1	104.9	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		87.1	89.8	97.0	101.0	103.7	0.0	0.0	0.0	0.0	0.0	0.0
Wind and solar		2.5	12.9	70.4	95.4	135.1	0.0	0.0	0.9	0.0	0.0	0.7
Thermal		322.9	344.8	400.2	517.7	610.1	0.7	1.6	2.0	0.2	0.3	0.3
of which cogeneration units		*59.3*	*77.1*	*102.2*	*130.0*	*146.1*	*-0.1*	*0.1*	*-0.3*	*-0.1*	*0.1*	*-0.2*
Open cycle(incl. biomass-waste)		281.8	276.9	214.8	136.2	113.7	0.1	0.5	0.3	0.1	0.3	0.3
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.6	51.8	119.7	0.1	0.2	0.7	29.4	0.3	0.6
Gas Turbines Combined Cycle		20.0	46.0	157.6	280.0	323.6	0.3	0.8	0.6	0.2	0.3	0.2
Small Gas Turbines		20.3	21.0	26.1	48.3	51.8	0.2	0.2	0.4	0.7	0.3	0.8
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.7	1.0	1.2	1.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.8	43.9	48.0	49.7	0.0	0.0	0.0	0.0	0.0	0.0
Load factor for gross electric capacities (%)		48.9	50.8	50.2	48.5	46.2	0.0	0.0	0.0	0.0	0.0	0.0
CHP indicator (% of electricity from CHP)		9.2	10.3	12.6	13.8	14.1	0.0	0.0	-0.1	-0.3	-0.1	-0.4
Non fossil fuels in electricity generation (%)		49.9	49.3	48.1	41.0	38.2	-0.1	-0.1	0.0	-0.1	-0.2	-0.1
nuclear		35.1	33.6	29.5	22.4	19.3	0.0	-0.1	0.0	-0.1	-0.2	-0.3
renewable energy forms		14.8	15.8	18.6	18.6	18.9	0.0	0.0	0.0	-0.1	-0.2	0.1
of which waste		*1.0*	*1.2*	*1.4*	*1.3*	*1.1*	*0.0*	*0.0*	*0.0*	*-0.1*	*-0.2*	*0.1*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5811.6**	**6694.5**	**7535.4**	**-5.5**	**-5.8**	**-4.8**	**-0.1**	**-0.1**	**-0.1**
public road transport	368.8	382.2	412.6	480.4	512.3	534.9	57.7	63.8	69.7	13.7	14.2	15.0
private cars and motorcycles	3325.6	3634.5	3938.8	4471.6	5075.0	5622.5	-94.7	-92.1	-81.8	-2.1	-1.8	-1.4
rail transport	316.4	320.9	356.0	444.2	510.1	562.3	77.5	89.0	99.5	21.1	21.1	21.5
aviation	157.3	201.5	281.5	376.8	552.2	763.2	-44.9	-65.5	-91.3	-10.6	-10.6	-10.7
inland navigation	28.3	31.4	33.0	38.6	45.0	52.5	-1.1	-1.0	-0.9	-2.8	-2.3	-1.6
travel per person (km per capita)	11465	12240	13261	14985	17146	19370	-14	-15	-12	-0.1	-0.1	-0.1
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2349.6**	**2894.7**	**3498.8**	**-0.8**	**-2.1**	**-2.8**	**0.0**	**-0.1**	**-0.1**
trucks	946.0	1114.6	1327.2	1653.2	2091.7	2598.6	-89.5	-105.7	-121.6	-5.1	-4.8	-4.5
rail transport	234.9	220.2	249.3	324.5	366.8	401.3	60.8	68.8	76.0	23.1	23.1	23.4
inland navigation	257.1	266.9	296.1	372.0	436.3	498.9	28.0	34.9	42.7	8.1	8.7	9.4
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	207	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**310.8**	**344.1**	**372.1**	**-46.4**	**-45.3**	**-34.6**	**-13.0**	**-11.6**	**-8.5**
public road transport	6.3	5.9	5.8	6.2	6.2	5.9	0.2	0.4	0.6	3.6	6.7	11.5
private cars and motorcycles	130.2	136.6	145.5	137.4	133.2	125.3	-16.8	-17.7	-16.9	-10.9	-11.7	-11.9
trucks	76.0	86.5	101.0	111.4	138.8	165.4	-21.4	-20.6	-12.1	-16.1	-12.9	-6.8
rail transport	6.9	7.5	7.7	7.2	6.3	6.2	0.3	0.7	0.9	5.0	12.9	17.9
aviation	27.8	32.5	43.8	42.4	52.4	61.2	-8.7	-8.2	-7.6	-17.1	-13.6	-11.0
inland navigation	6.7	6.7	5.3	6.2	7.2	8.2	0.0	0.1	0.4	-0.6	1.8	5.4
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	33.1	29.5	26.3	-4.3	-3.7	-3.1	-11.5	-11.2	-10.4
freight transport (toe/Mtkm)	57.8	58.5	57.3	50.5	50.6	49.7	-9.0	-7.0	-3.2	-15.1	-12.1	-6.1

Source: PRIMES

PROMOTING RAIL AND IMPROVED LOAD FACTORS SCENARIO - OPTION C OF THE TRANSPORT WHITE PAPER ACHIEVED IN 2010

NMS: PROMOTING RAIL AND IMPROVED LOAD FACTORS — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**117.3**	**105.4**	**88.0**	**0.0**	**0.1**	**0.0**	**0.0**	**0.1**	**0.0**
Solids	140.9	126.7	104.0	83.5	70.4	59.6	0.1	0.1	0.2	0.1	0.2	0.3
Oil	2.6	3.0	3.1	2.4	2.4	2.3	-0.1	0.0	0.0	-3.3	-1.0	-0.6
Natural gas	6.7	7.4	6.1	5.9	5.5	4.9	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	15.5	14.1	14.8	14.9	14.8	5.3	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy sources	3.0	6.3	8.0	10.5	12.3	15.7	0.0	0.0	-0.2	0.0	-0.4	-1.1
Hydro	1.1	1.3	1.4	2.0	2.1	2.2	0.0	0.0	0.0	0.4	0.1	0.1
Biomass	1.4	4.6	6.1	6.3	6.3	7.8	0.0	0.0	-0.2	-0.1	-0.8	-2.2
Waste	0.5	0.3	0.5	1.4	1.5	1.8	0.0	0.0	0.0	-0.1	-0.2	-0.1
Wind	0.0	0.0	0.0	0.6	1.9	3.2	0.0	0.0	0.0	0.0	0.1	0.0
Solar and others	0.0	0.0	0.0	0.3	0.5	0.8	0.0	0.0	0.0	0.0	0.0	-0.1
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Imports	**66.3**	**50.4**	**61.4**	**88.0**	**122.6**	**149.2**	**-4.2**	**-4.9**	**-4.3**	**-4.5**	**-3.9**	**-2.8**
Solids	-14.6	-20.7	-15.9	-7.2	2.9	18.0	0.0	0.0	0.0	0.1	0.2	0.3
Oil	49.9	45.0	47.3	51.4	58.2	64.4	-4.2	-5.0	-4.4	-7.5	-8.0	-6.4
Crude oil and Feedstocks	43.4	36.7	41.3	42.6	48.6	54.4	-3.6	-4.4	-3.9	-7.8	-8.3	-6.7
Oil products	6.5	8.3	6.0	8.8	9.6	10.0	-0.6	-0.6	-0.4	-6.2	-6.0	-4.3
Natural gas	31.2	26.2	31.5	45.0	62.8	67.7	0.0	0.1	0.0	0.0	0.1	0.0
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**204.3**	**226.9**	**236.0**	**-4.2**	**-4.8**	**-4.3**	**-2.0**	**-2.1**	**-1.8**
Solids	127.8	108.2	90.8	76.3	73.3	77.6	0.0	0.1	0.2	0.1	0.2	0.3
Oil	50.4	46.6	48.7	52.8	59.5	65.4	-4.2	-5.0	-4.3	-7.4	-7.8	-6.2
Natural gas	37.1	33.8	37.3	50.9	68.2	72.7	0.0	0.1	0.0	0.0	0.1	0.0
Nuclear	15.5	14.1	14.8	14.9	14.8	5.3	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	10.5	12.3	15.7	0.0	0.0	-0.2	0.0	-0.4	-1.1
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	37.4	32.3	32.9	0.8	0.7	0.7	2.1	2.3	2.1
Oil	21.6	22.3	24.6	25.9	26.2	27.7	-1.5	-1.6	-1.3	-5.5	-5.8	-4.5
Natural gas	15.9	16.2	18.8	24.9	30.1	30.8	0.5	0.7	0.5	2.0	2.3	1.8
Nuclear	6.6	6.7	7.5	7.3	6.5	2.3	0.1	0.1	0.0	2.0	2.1	1.8
Renewable energy forms	1.3	3.0	4.1	5.1	5.4	6.7	0.1	0.1	0.0	2.0	1.7	0.7
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**392.9**	**499.6**	**553.1**	**0.8**	**1.4**	**2.0**	**0.2**	**0.3**	**0.4**
Nuclear	60.0	54.3	57.4	58.5	58.1	21.5	0.0	0.0	0.0	0.0	0.0	0.0
Hydro & wind	12.9	15.5	15.7	30.3	46.6	62.9	0.1	0.0	0.0	0.3	0.1	0.0
Thermal (incl. biomass)	243.7	230.7	250.6	304.1	394.9	468.7	0.7	1.4	2.0	0.2	0.4	0.4
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**75.6**	**86.1**	**96.3**	**0.1**	**0.2**	**0.2**	**0.1**	**0.3**	**0.2**
Solids	62.2	57.2	56.5	57.6	58.7	65.1	0.0	0.1	0.2	0.1	0.2	0.3
Oil	4.9	4.4	3.2	3.4	2.4	2.7	0.0	0.0	0.0	0.6	0.3	1.8
Gas	5.3	4.0	6.3	12.8	23.0	25.6	0.0	0.1	0.0	0.1	0.4	-0.2
Biomass - Waste	0.3	0.1	0.4	1.8	2.1	2.8	0.0	0.0	0.0	0.0	0.0	0.1
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**62.2**	**66.7**	**73.5**	**-3.8**	**-4.6**	**-4.2**	**-5.7**	**-6.5**	**-5.4**
Refineries	46.7	40.1	45.2	46.0	52.5	59.1	-3.7	-4.5	-4.1	-7.5	-7.9	-6.5
District heating	19.3	12.1	8.5	4.5	3.6	2.8	0.0	0.0	0.0	-1.0	-1.0	1.1
Biofuels and hydrogen production	0.0	0.0	0.0	0.1	0.4	1.5	0.0	-0.1	-0.2	-13.4	-12.6	-10.4
Others	30.5	23.1	17.7	11.6	10.2	10.1	0.0	0.0	0.0	0.0	0.0	-0.1
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.5**	**9.7**	**9.2**	**-0.2**	**-0.2**	**-0.1**	**-1.6**	**-1.7**	**-1.5**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**12.9**	**14.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**128.4**	**148.3**	**160.9**	**-4.0**	**-4.8**	**-4.2**	**-3.0**	**-3.1**	**-2.5**
by sector												
Industry	65.0	47.7	40.4	39.5	42.1	43.9	0.0	0.0	0.0	0.0	0.0	0.0
energy intensive industries	32.5	27.9	26.2	25.6	26.5	26.9	0.0	0.0	0.0	0.0	0.0	0.0
other industrial sectors	32.4	19.7	14.2	13.8	15.6	17.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	40.0	41.2	34.4	37.7	44.8	47.8	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary	24.9	19.6	21.5	25.1	28.6	31.5	0.0	0.0	0.0	0.0	0.0	0.0
Transport	19.9	19.8	22.9	26.0	32.8	37.8	-4.0	-4.8	-4.2	-13.3	-12.7	-10.0
by fuel												
Solids	40.9	33.8	21.4	13.9	10.9	9.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil	32.7	29.6	33.6	37.3	43.7	48.5	-4.0	-4.8	-4.3	-9.7	-10.0	-8.2
Gas	26.5	24.6	25.4	33.3	39.9	42.6	0.0	0.0	0.0	0.1	0.1	0.0
Electricity	20.5	18.5	19.6	25.2	33.4	38.2	0.1	0.1	0.1	0.2	0.3	0.4
Heat (from CHP and District Heating)	27.7	17.4	13.5	13.1	15.0	17.0	-0.1	0.0	0.0	-0.5	-0.2	0.1
Other	1.8	4.7	5.8	5.6	5.4	5.5	0.0	0.0	0.0	0.0	-0.1	-0.2
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**540.1**	**582.6**	**622.9**	**-12.1**	**-14.0**	**-12.0**	**-2.2**	**-2.4**	**-1.9**
Electricity and Steam production	343.4	295.0	280.1	283.5	303.8	333.4	0.2	0.7	0.9	0.1	0.2	0.3
Energy Branch	14.4	19.5	18.7	10.1	10.8	10.9	-0.5	-0.6	-0.5	-4.4	-4.9	-4.3
Industry	137.0	118.2	96.4	86.1	85.9	85.6	0.0	0.1	0.1	0.1	0.1	0.1
Residential	83.2	72.9	49.7	49.4	54.5	52.9	0.1	0.0	-0.1	0.1	0.0	-0.1
Tertiary	53.3	38.3	37.2	36.9	34.5	35.0	0.0	0.0	0.0	0.0	0.0	0.1
Transport	56.1	55.9	65.3	74.1	93.1	105.0	-11.9	-14.3	-12.4	-13.9	-13.3	-10.6
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**78.6**	**84.8**	**90.6**	**-1.8**	**-2.0**	**-1.7**	-2.2	-2.4	-1.9

See explanations on the last page of the Appendix

Source: PRIMES

PROMOTING RAIL AND IMPROVED LOAD FACTORS SCENARIO - OPTION C OF THE TRANSPORT WHITE PAPER ACHIEVED IN 2010

NMS: PROMOTING RAIL AND IMPROVED LOAD FACTORS — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	355.9	276.4	214.4	-7.2	-5.9	-3.9	-2.0	-2.1	-1.8
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.8	3.2	3.4	-0.1	-0.1	-0.1	-2.0	-2.1	-1.8
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	5352	6972	7999	11	20	29	0.2	0.3	0.4
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.64	2.57	2.64	-0.01	-0.01	0.00	-0.2	-0.3	-0.1
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.4	8.1	9.0	-0.2	-0.2	-0.2	-2.2	-2.4	-1.9
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	941.1	709.7	566.1	-21.1	-17.1	-10.9	-2.2	-2.4	-1.9
Import Dependency %	28.3	24.1	30.8	42.9	53.8	62.9	-1.1	-1.0	-0.7	-2.6	-1.8	-1.0
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	36.1	27.4	22.8	0.0	0.0	0.0	0.0	0.0	0.0
Residential (Energy on Private Income)	100.0	106.5	74.2	55.9	45.4	36.1	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary (Energy on Value added)	100.0	74.8	67.2	52.5	40.4	32.0	0.0	0.0	0.0	0.0	0.0	0.0
Transport (Energy on GDP)	100.0	102.9	97.4	76.0	66.9	57.5	-11.6	-9.7	-6.4	-13.3	-12.7	-10.0
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.50	0.44	0.43	0.00	0.00	0.00	0.1	0.1	0.0
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.92	1.81	1.73	-0.03	-0.04	-0.03	-1.6	-2.0	-1.8
Industry	2.11	2.48	2.38	2.18	2.04	1.95	0.00	0.00	0.00	0.0	0.1	0.1
Residential	2.08	1.77	1.44	1.31	1.22	1.11	0.00	0.00	0.00	0.2	0.0	-0.2
Tertiary	2.14	1.95	1.73	1.47	1.21	1.11	0.00	0.00	0.00	-0.1	0.0	0.1
Transport	2.82	2.82	2.85	2.84	2.84	2.78	-0.02	-0.02	-0.02	-0.7	-0.7	-0.7
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**95.3**	**134.3**	**167.5**	**0.2**	**0.2**	**0.3**	**0.2**	**0.2**	**0.2**
Nuclear		8.4	9.3	7.9	7.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		6.1	6.4	7.7	8.3	8.4	0.0	0.0	0.0	0.4	0.1	0.0
Wind and solar		0.0	0.0	2.8	8.7	15.0	0.0	0.0	0.0	0.0	0.2	0.0
Thermal		64.0	61.9	76.9	109.4	141.2	0.1	0.2	0.3	0.2	0.2	0.2
of which cogeneration units		*28.1*	*26.3*	*27.4*	*38.4*	*52.8*	*0.1*	*0.1*	*0.5*	*0.2*	*0.4*	*1.0*
Open cycle (incl. biomass-waste)		61.9	58.6	55.9	39.3	33.5	0.0	-0.2	-0.5	0.0	-0.6	-1.6
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.5	15.3	31.5	0.0	0.3	0.6	-3.2	1.9	2.0
Gas Turbines Combined Cycle		0.4	1.4	12.5	39.7	61.7	0.2	0.2	0.2	1.3	0.4	0.3
Small Gas Turbines		1.7	1.8	8.0	15.1	14.5	0.0	0.0	0.1	0.0	-0.1	0.4
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	36.5	41.4	44.1	0.0	0.0	0.1	0.1	0.1	0.2
Load factor for gross electric capacities (%)		43.6	47.6	47.0	42.5	37.7	0.0	0.0	0.1	0.0	0.1	0.2
CHP indicator (% of electricity from CHP)		29.4	30.4	28.1	27.3	31.4	-0.2	0.0	-0.3	-0.6	-0.1	-0.8
Non fossil fuels in electricity generation (%)		23.4	23.1	24.2	22.4	17.2	0.0	-0.1	-0.1	-0.1	-0.3	-0.3
nuclear		18.1	17.7	14.9	11.6	3.9	0.0	0.0	0.0	-0.2	-0.3	-0.4
renewable energy forms		5.3	5.4	9.3	10.8	13.3	0.0	0.0	0.0	0.1	-0.2	-0.3
of which waste		*0.0*	*0.1*	*0.6*	*0.4*	*0.4*	*0.0*	*0.0*	*0.0*	*-0.2*	*-0.3*	*-0.5*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**616.0**	**809.5**	**1000.6**	**0.4**	**0.8**	**1.9**	**0.1**	**0.1**	**0.2**
public road transport	115.7	87.0	81.2	79.6	83.3	89.3	-1.6	-1.3	-1.1	-2.0	-1.5	-1.3
private cars and motorcycles	268.0	315.8	352.9	450.8	611.1	757.7	-8.4	-10.1	-12.5	-1.8	-1.6	-1.6
rail transport	91.9	50.8	46.3	59.0	71.3	91.7	10.8	13.0	17.0	22.4	22.4	22.7
aviation	11.2	14.0	16.8	26.0	43.1	61.0	-0.4	-0.8	-1.5	-1.6	-1.9	-2.4
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	-1.0	-0.7	-0.6
travel per person (km per capita)	6489	6227	6662	8393	11295	14471	5	11	27	0.1	0.1	0.2
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**339.2**	**441.4**	**541.1**	**-0.2**	**-0.8**	**-0.2**	**-0.1**	**-0.2**	**0.0**
trucks	118.4	119.0	155.5	197.3	287.0	375.6	-26.6	-32.5	-36.8	-11.9	-10.2	-8.9
rail transport	205.2	137.8	118.7	141.2	153.7	164.7	26.5	31.8	36.7	23.1	26.1	28.7
inland navigation	1.0	1.3	0.8	0.7	0.7	0.8	-0.1	-0.1	-0.1	-16.9	-14.1	-12.1
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	591	538	492	0	-1	0	-0.1	-0.2	0.0
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**26.0**	**32.8**	**37.8**	**-4.0**	**-4.8**	**-4.2**	**-13.3**	**-12.7**	**-10.0**
public road transport	1.4	1.0	1.2	1.2	1.1	1.1	0.0	0.0	0.0	3.4	0.9	-0.6
private cars and motorcycles	7.9	9.5	11.6	13.2	15.6	17.0	-1.6	-2.1	-2.3	-10.7	-11.8	-12.0
trucks	7.0	6.7	7.5	8.9	12.6	16.1	-2.2	-2.5	-2.0	-19.6	-16.7	-10.8
rail transport	2.0	1.4	1.3	1.2	1.1	1.2	0.1	0.1	0.2	5.9	11.5	18.3
aviation	1.3	1.2	1.3	1.5	2.3	2.4	-0.3	-0.3	-0.1	-17.7	-10.7	-3.3
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-5.7	-6.2	-6.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	26.7	24.2	21.0	-3.0	-2.9	-2.4	-10.2	-10.6	-10.2
freight transport (toe/Mtkm)	24.6	28.8	30.0	28.3	30.0	31.0	-6.2	-5.5	-3.4	-18.1	-15.5	-9.9

Source: PRIMES

(1) EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

APPENDIX 7

Summary energy balances and indicators by group of countries (EU-25, EU-15, new Member states (NMS)) – comparison to baseline

- Energy policy options case: combination of the high efficiency and renewables case in chapter 4 (appendix 4) and the high nuclear case in chapter 5 (appendix 5)
- Extended policy options case: high efficiency and renewables case in chapter 4 (appendix 4) plus promoting rail and improved load factor case in chapter 6 (appendix 6) plus economic instruments (taxation and emission trading)
- Full policy options case: combination of all the options in the two above cases

EU25: ENERGY POLICY OPTIONS CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**887.2**	**808.0**	**769.2**	**26.9**	**67.1**	**108.3**	**3.1**	**9.1**	**16.4**
Solids	350.8	264.7	203.4	139.3	104.8	75.6	-14.5	-21.6	-26.9	-9.4	-17.1	-26.2
Oil	120.3	162.2	163.5	129.6	100.7	85.6	-2.1	-1.4	-0.9	-1.6	-1.4	-1.0
Natural gas	139.6	174.0	196.6	192.0	148.4	118.7	-4.9	0.8	1.6	-2.5	0.5	1.3
Nuclear	196.9	215.3	237.7	222.3	227.3	248.3	-22.9	13.8	63.0	-9.4	6.5	34.0
Renewable energy sources	69.2	80.7	96.1	204.0	226.8	241.1	71.3	75.5	71.6	53.8	49.9	42.2
Hydro	23.4	26.3	29.0	30.5	32.5	33.8	0.4	0.9	1.5	1.3	2.7	4.8
Biomass	31.1	35.4	42.2	117.2	124.5	125.8	59.8	59.6	52.1	104.0	91.8	70.6
Waste	12.3	15.9	19.3	27.8	31.2	30.9	2.1	3.5	3.7	8.2	12.5	13.8
Wind	0.1	0.4	1.9	14.7	23.5	33.0	0.8	3.4	6.1	5.5	16.9	22.9
Solar and others	0.1	0.3	0.4	9.8	10.7	12.8	8.1	7.8	7.5	479.4	263.0	141.2
Geothermal	2.2	2.5	3.3	4.0	4.4	4.9	0.2	0.4	0.6	5.9	10.5	14.7
Net Imports	**711.6**	**701.7**	**799.3**	**842.9**	**966.4**	**1034.6**	**-131.6**	**-238.1**	**-327.3**	**-13.5**	**-19.8**	**-24.0**
Solids	75.2	73.8	91.4	73.4	67.2	96.2	-16.5	-59.1	-101.2	-18.4	-46.8	-51.3
Oil	510.8	491.8	519.6	512.1	548.9	563.7	-60.3	-77.1	-87.3	-10.5	-12.3	-13.4
Crude oil and Feedstocks	480.2	471.5	496.8	491.8	537.2	560.3	-58.0	-73.8	-84.6	-10.5	-12.1	-13.1
Oil products	30.6	20.3	22.8	20.3	11.7	3.4	-2.4	-3.3	-2.6	-10.5	-21.9	-44.0
Natural gas	123.5	134.8	186.2	255.3	350.5	375.0	-54.7	-99.7	-136.1	-17.7	-22.1	-26.6
Electricity	2.2	1.4	2.1	2.1	-0.1	-0.3	0.0	-2.2	-2.7	0.0	-107.2	-113.9
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1679.5**	**1717.9**	**1740.8**	**-104.7**	**-171.0**	**-218.9**	**-5.9**	**-9.1**	**-11.2**
Solids	430.6	346.0	303.2	212.7	171.9	171.9	-31.0	-80.7	-128.1	-12.7	-32.0	-42.7
Oil	596.2	622.2	635.6	591.1	593.1	586.3	-62.5	-78.5	-88.2	-9.6	-11.7	-13.1
Natural gas	259.2	307.1	376.0	447.3	498.9	493.7	-59.6	-98.9	-134.6	-11.8	-16.5	-21.4
Nuclear	196.9	215.3	237.7	222.3	227.3	248.3	-22.9	13.8	63.0	-9.4	6.5	34.0
Electricity	2.2	1.4	2.1	2.1	-0.1	-0.3	0.0	-2.2	-2.7	0.0	-107.2	-113.9
Renewable energy forms	69.2	80.7	96.1	204.0	226.8	241.1	71.3	75.5	71.6	53.8	49.9	42.2
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	12.7	10.0	9.9	-1.0	-3.4	-5.4	-7.3	-25.2	-35.5
Oil	38.4	39.6	38.5	35.2	34.5	33.7	-1.4	-1.0	-0.7	-3.9	-2.9	-2.1
Natural gas	16.7	19.5	22.8	26.6	29.0	28.4	-1.8	-2.6	-3.7	-6.3	-8.2	-11.5
Nuclear	12.7	13.7	14.4	13.2	13.2	14.3	-0.5	1.9	4.8	-3.7	17.1	50.8
Renewable energy forms	4.5	5.1	5.8	12.1	13.2	13.8	4.7	5.2	5.2	63.4	64.8	60.1
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3192.4**	**3551.3**	**3734.9**	**-226.7**	**-397.4**	**-662.3**	**-6.6**	**-10.1**	**-15.1**
Nuclear	780.0	864.4	921.2	863.5	884.2	946.3	-88.9	50.7	179.8	-9.3	6.1	23.5
Hydro & wind	272.7	309.7	359.5	526.1	653.8	798.1	13.5	51.3	92.6	2.6	8.5	13.1
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1802.8	2013.2	1990.5	-151.3	-499.5	-934.6	-7.7	-19.9	-32.0
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**371.0**	**377.6**	**354.2**	**-42.3**	**-105.3**	**-186.7**	**-10.2**	**-21.8**	**-34.5**
Solids	248.2	221.1	210.1	147.7	114.9	118.9	-27.5	-77.5	-125.3	-15.7	-40.3	-51.3
Oil (including refinery gas)	53.7	53.9	41.5	14.8	13.6	8.8	-9.0	0.1	-0.6	-37.8	0.8	-6.7
Gas	50.4	70.0	112.6	150.3	182.9	156.6	-34.8	-62.8	-98.6	-18.8	-25.6	-38.6
Biomass - Waste	10.3	13.6	17.5	54.5	62.1	65.4	28.7	34.4	37.2	111.0	124.2	132.2
Geothermal heat	1.9	2.1	3.0	3.7	4.1	4.6	0.3	0.5	0.7	8.1	13.0	17.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**784.1**	**796.9**	**800.3**	**-23.0**	**-46.2**	**-71.3**	**-2.9**	**-5.5**	**-8.2**
Refineries	641.3	675.9	710.9	689.7	703.9	709.0	-43.6	-63.1	-79.4	-5.9	-8.2	-10.1
District heating	31.7	23.1	14.5	9.3	8.0	7.2	-1.4	-0.8	-1.6	-13.3	-9.5	-18.4
Biofuels and hydrogen production	0.0	0.2	0.6	34.3	37.3	38.4	24.1	19.1	10.9	236.4	105.5	39.7
Others	127.6	81.2	68.3	50.7	47.7	45.8	-2.1	-1.4	-1.2	-4.0	-2.9	-2.6
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**71.0**	**69.2**	**67.1**	**-6.0**	**-8.0**	**-10.1**	**-7.8**	**-10.4**	**-13.1**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.5**	**121.5**	**124.9**	**0.2**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1147.0**	**1201.4**	**1242.6**	**-61.9**	**-116.4**	**-151.5**	**-5.1**	**-8.8**	**-10.9**
by sector												
Industry (1)	327.2	303.3	309.1	329.5	351.5	376.7	-9.4	-15.9	-11.8	-2.8	-4.3	-3.0
energy intensive industries	212.9	198.9	202.0	210.1	216.4	221.0	-6.2	-9.8	-8.0	-2.9	-4.4	-3.5
other industrial sectors	114.3	104.4	107.0	119.3	135.1	155.7	-3.2	-6.1	-3.8	-2.6	-4.3	-2.4
Residential	268.1	277.2	279.1	293.8	298.7	296.3	-14.9	-30.4	-42.5	-4.8	-9.2	-12.5
Tertiary	140.2	147.5	154.2	154.5	168.6	181.1	-19.8	-25.7	-37.0	-11.4	-13.2	-17.0
Transport	273.7	295.6	332.0	369.4	382.6	388.5	-17.8	-44.4	-60.2	-4.6	-10.4	-13.4
by fuel (1)												
Solids	117.7	80.8	57.4	40.0	33.9	30.1	-2.3	-2.2	-2.0	-5.4	-6.2	-6.3
Oil	424.2	443.7	464.2	471.4	477.5	480.2	-32.1	-60.1	-74.5	-6.4	-11.2	-13.4
Gas	196.2	219.5	245.7	277.3	291.0	310.1	-22.6	-33.9	-33.4	-7.5	-10.4	-9.7
Electricity	176.5	187.9	211.3	236.3	265.1	282.0	-17.1	-32.0	-52.3	-6.7	-10.8	-15.6
Heat (from CHP and District Heating)	62.9	56.7	55.6	60.3	70.8	79.6	-4.7	-5.0	-4.0	-7.2	-6.6	-4.8
Other	32.1	35.3	40.3	61.8	63.2	60.6	16.8	16.8	14.7	37.5	36.1	32.0
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.9**	**3664.9**	**3309.4**	**3258.0**	**3220.3**	**-447.7**	**-782.6**	**-1083.3**	**-11.9**	**-19.4**	**-25.2**
Electricity and Steam production	1341.0	1242.7	1228.3	1012.3	945.9	879.4	-223.0	-457.2	-733.7	-18.1	-32.6	-45.5
Energy Branch	144.2	163.9	164.0	133.3	128.6	123.7	-12.5	-14.4	-15.3	-8.6	-10.1	-11.0
Industry	713.2	644.8	605.7	506.7	494.4	506.6	-37.7	-51.4	-45.3	-6.9	-9.4	-8.2
Residential	519.7	490.4	462.6	444.2	438.7	432.0	-37.4	-56.5	-55.1	-7.8	-11.4	-11.3
Tertiary	256.8	251.0	236.7	207.6	211.3	223.8	-32.0	-29.6	-31.0	-13.4	-12.3	-12.2
Transport	794.6	859.1	967.5	1005.3	1039.1	1054.8	-105.2	-173.6	-202.8	-9.5	-14.3	-16.1
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**87.8**	**86.4**	**85.4**	**-11.9**	**-20.8**	**-28.7**	-11.9	-19.4	-25.2

See explanations on the last page of the Appendix

Source: PRIMES

EU25: ENERGY POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	146.9	118.8	96.6	-9.2	-11.8	-12.1	-5.9	-9.1	-11.2
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.6	3.7	3.8	-0.2	-0.4	-0.5	-5.9	-9.1	-11.2
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	6922	7685	8152	-492	-860	-1445	-6.6	-10.1	-15.1
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	1.97	1.90	1.85	-0.14	-0.24	-0.35	-6.4	-11.3	-15.8
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	7.2	7.1	7.0	-1.0	-1.7	-2.4	-11.9	-19.4	-25.2
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	289.5	225.3	178.7	-39.2	-54.1	-60.1	-11.9	-19.4	-25.2
Import Dependency %	44.8	43.6	47.2	48.7	54.5	57.4	-4.4	-7.5	-10.0	-8.3	-12.0	-14.8
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	69.0	57.9	49.8	-2.0	-2.6	-1.6	-2.8	-4.3	-3.0
Residential (Energy on Private Income)	100.0	98.1	85.8	70.9	57.3	46.1	-3.6	-5.8	-6.6	-4.8	-9.2	-12.5
Tertiary (Energy on Value added)	100.0	96.7	86.8	66.4	56.6	48.3	-8.5	-8.6	-9.9	-11.4	-13.2	-17.0
Transport (Energy on GDP)	100.0	101.1	99.3	86.3	70.7	57.6	-4.2	-8.2	-8.9	-4.6	-10.4	-13.4
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.26	0.21	0.19	-0.04	-0.07	-0.11	-12.1	-25.6	-37.2
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.89	1.82	1.78	-0.08	-0.08	-0.05	-4.0	-4.0	-2.5
Industry	2.18	2.13	1.96	1.54	1.41	1.34	-0.07	-0.08	-0.08	-4.3	-5.3	-5.3
Residential	1.94	1.77	1.66	1.51	1.47	1.46	-0.05	-0.04	0.02	-3.1	-2.4	1.4
Tertiary	1.83	1.70	1.54	1.34	1.25	1.24	-0.03	0.01	0.07	-2.2	1.1	5.8
Transport	2.90	2.91	2.91	2.72	2.72	2.71	-0.15	-0.12	-0.09	-5.1	-4.4	-3.1
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**757.6**	**874.2**	**997.9**	**-26.3**	**-72.5**	**-120.3**	**-3.4**	**-7.7**	**-10.8**
Nuclear		134.7	140.3	129.8	125.6	153.3	0.0	17.6	45.5	0.0	16.3	42.2
Hydro (pumping excluded)		93.3	96.2	108.3	114.6	117.7	3.7	5.3	5.5	3.5	4.9	4.9
Wind and solar		2.5	13.0	74.9	122.4	176.2	1.8	18.3	27.0	2.4	17.6	18.1
Thermal		386.9	406.7	444.5	511.5	550.7	-31.7	-113.8	-198.4	-6.7	-18.2	-26.5
of which cogeneration units		*87.3*	*103.4*	*155.3*	*235.1*	*266.6*	*25.7*	*67.0*	*67.9*	*19.8*	*39.8*	*34.2*
Open cycle(incl. biomass-waste)		343.8	335.6	276.9	176.9	153.3	6.3	1.6	6.0	2.3	0.9	4.0
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	3.2	13.3	40.1	2.2	-53.3	-109.8	228.2	-80.0	-73.3
Gas Turbines Combined Cycle		20.4	47.4	136.6	263.9	237.4	-32.9	-54.8	-147.2	-19.4	-17.2	-38.3
Small Gas Turbines		22.0	22.8	26.5	55.5	59.8	-7.5	-7.8	-5.9	-22.0	-12.3	-9.0
Fuel Cells		0.0	0.0	0.0	0.4	58.3	0.0	0.4	58.3			
Geothermal heat		0.7	1.0	1.3	1.5	1.7	0.1	0.2	0.3	8.5	13.6	20.3
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.2	44.0	48.6	51.7	1.4	1.7	3.0	3.4	3.7	6.2
Load factor for gross electric capacities (%)		48.2	50.4	48.1	46.4	42.7	-1.7	-1.2	-2.2	-3.4	-2.6	-4.8
CHP indicator (% of electricity from CHP)		11.5	12.6	21.4	25.5	27.5	6.9	10.0	11.2	48.1	64.3	68.9
Non fossil fuels in electricity generation (%)		46.8	46.4	51.2	51.5	55.2	5.7	12.8	19.6	12.6	33.0	55.0
nuclear		33.1	31.8	27.0	24.9	25.3	-0.8	3.8	7.9	-2.9	18.0	45.3
renewable energy forms		13.7	14.6	24.1	26.6	29.9	6.5	9.0	11.7	37.1	51.0	64.3
of which waste		*0.9*	*1.1*	*1.0*	*0.5*	*0.5*	*-0.4*	*-0.7*	*-0.5*	*-27.4*	*-60.8*	*-49.7*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6438.1**	**7517.1**	**8552.1**	**5.3**	**8.0**	**13.2**	**0.1**	**0.1**	**0.2**
public road transport	484.5	469.2	493.8	505.4	535.8	560.6	1.5	2.9	5.0	0.3	0.5	0.9
private cars and motorcycles	3593.6	3950.3	4291.6	5027.0	5791.7	6483.4	1.5	3.4	8.9	0.0	0.1	0.1
rail transport	408.3	371.7	402.3	413.7	478.0	536.3	-1.2	-1.3	-1.3	-0.3	-0.3	-0.2
aviation	168.5	215.5	298.3	451.5	664.6	917.3	3.4	2.9	0.3	0.8	0.4	0.0
inland navigation	28.9	31.9	33.6	40.4	46.9	54.4	0.1	0.2	0.3	0.1	0.3	0.6
travel per person (km per capita)	10618	11233	12174	13959	16267	18666	11	17	29	0.1	0.1	0.2
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2689.8**	**3336.8**	**4039.7**	**0.0**	**-2.2**	**-3.2**	**0.0**	**-0.1**	**-0.1**
trucks	1064.3	1233.6	1482.7	1967.6	2515.9	3129.9	0.9	-1.0	-2.7	0.0	0.0	-0.1
rail transport	440.2	358.0	368.0	377.2	418.0	451.0	-1.1	-1.8	-2.2	-0.3	-0.4	-0.5
inland navigation	258.1	268.2	297.0	345.0	402.9	458.8	0.2	0.6	1.7	0.0	0.2	0.4
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	231	224	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**369.4**	**382.6**	**388.5**	**-17.8**	**-44.4**	**-60.2**	**-4.6**	**-10.4**	**-13.4**
public road transport	7.7	6.9	7.0	7.0	6.4	5.8	-0.2	-0.5	-0.6	-2.5	-7.4	-9.2
private cars and motorcycles	138.1	146.1	157.1	166.0	159.8	150.7	-3.0	-8.9	-10.8	-1.8	-5.3	-6.7
trucks	82.9	93.2	108.5	142.2	157.7	165.4	-1.7	-16.8	-30.1	-1.1	-9.6	-15.4
rail transport	8.8	8.9	9.0	7.4	5.8	5.6	-0.6	-0.7	-0.6	-7.3	-10.9	-9.7
aviation	29.1	33.8	45.1	40.6	46.0	53.6	-12.4	-17.3	-17.6	-23.4	-27.3	-24.8
inland navigation	7.0	6.7	5.4	6.2	6.9	7.4	0.0	-0.2	-0.4	-0.8	-3.3	-5.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	34.1	28.9	25.2	-2.5	-3.6	-3.5	-6.9	-11.2	-12.2
freight transport (toe/Mtkm)	51.7	54.4	53.8	55.7	49.5	42.9	-0.7	-5.1	-7.6	-1.2	-9.4	-15.0

Source: PRIMES

EU15: ENERGY POLICY OPTIONS CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**773.9**	**700.9**	**680.3**	**30.9**	**65.4**	**107.4**	**4.2**	**10.3**	**18.7**
Solids	209.9	138.0	99.4	65.2	39.0	21.3	-5.1	-17.1	-21.7	-7.3	-30.5	-50.5
Oil	117.7	159.2	160.4	127.2	98.3	83.3	-2.0	-1.4	-0.8	-1.6	-1.4	-1.0
Natural gas	132.9	166.6	190.6	186.1	143.0	113.8	-4.9	0.9	1.6	-2.5	0.6	1.5
Nuclear	181.4	201.2	222.8	207.8	212.1	241.1	-22.5	13.4	61.1	-9.8	6.7	34.0
Renewable energy sources	66.3	74.4	88.1	187.5	208.6	220.7	65.4	69.6	67.1	53.5	50.1	43.7
Hydro	22.3	24.9	27.6	28.5	30.3	31.6	0.4	0.8	1.6	1.3	2.7	5.3
Biomass	29.7	30.8	36.1	105.0	112.6	113.1	53.8	54.0	47.3	105.2	92.2	72.0
Waste	11.9	15.6	18.7	26.8	30.0	29.4	2.5	3.8	4.0	10.1	14.5	15.6
Wind	0.1	0.4	1.9	14.0	21.6	30.3	0.7	3.4	6.7	5.4	18.7	28.2
Solar and others	0.1	0.2	0.3	9.2	9.7	11.4	7.8	7.2	6.9	546.7	295.1	154.6
Geothermal	2.2	2.5	3.3	4.0	4.4	4.9	0.2	0.4	0.6	6.0	10.5	14.7
Net Imports	**645.4**	**651.3**	**737.9**	**762.2**	**871.0**	**927.6**	**-120.0**	**-206.0**	**-280.7**	**-13.6**	**-19.1**	**-23.2**
Solids	89.9	94.4	107.2	82.3	75.1	99.9	-14.7	-48.3	-79.6	-15.2	-39.2	-44.4
Oil	460.9	446.7	472.4	461.1	495.0	506.2	-55.8	-67.7	-76.0	-10.8	-12.0	-13.0
Crude oil and Feedstocks	436.8	434.7	455.5	449.3	491.9	511.6	-54.3	-66.1	-75.1	-10.8	-11.8	-12.8
Oil products	24.1	12.0	16.9	11.8	3.2	-5.4	-1.5	-1.6	-0.9	-11.2	-33.7	19.6
Natural gas	92.3	108.6	154.7	215.5	299.8	320.7	-49.5	-87.7	-122.7	-18.7	-22.6	-27.7
Electricity	2.3	1.5	3.7	3.3	1.1	0.8	0.0	-2.2	-2.4	0.0	-67.5	-76.1
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1486.6**	**1516.6**	**1546.2**	**-89.2**	**-140.5**	**-173.3**	**-5.7**	**-8.5**	**-10.1**
Solids	302.8	237.7	212.4	147.5	114.0	121.2	-19.9	-65.5	-101.3	-11.9	-36.5	-45.5
Oil	545.8	575.6	586.9	538.7	538.0	527.9	-57.8	-69.1	-76.8	-9.7	-11.4	-12.7
Natural gas	222.1	273.4	338.7	401.6	442.8	434.5	-54.4	-86.8	-121.0	-11.9	-16.4	-21.8
Nuclear	181.4	201.2	222.8	207.8	212.1	241.1	-22.5	13.4	61.1	-9.8	6.7	34.0
Electricity	2.3	1.5	3.7	3.3	1.1	0.8	0.0	-2.2	-2.4	0.0	-67.5	-76.1
Renewable energy forms	66.3	74.4	88.1	187.5	208.6	220.7	65.4	69.6	67.1	53.5	50.1	43.7
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	9.9	7.5	7.8	-0.7	-3.3	-5.1	-6.6	-30.6	-39.4
Oil	41.3	42.2	40.4	36.2	35.5	34.1	-1.6	-1.2	-1.0	-4.3	-3.2	-2.9
Natural gas	16.8	20.0	23.3	27.0	29.2	28.1	-1.9	-2.8	-4.2	-6.6	-8.6	-13.0
Nuclear	13.7	14.8	15.3	14.0	14.0	15.6	-0.6	2.0	5.1	-4.3	16.6	49.0
Renewable energy forms	5.0	5.5	6.1	12.6	13.8	14.3	4.9	5.4	5.3	62.7	64.0	59.8
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**2831.3**	**3117.5**	**3291.9**	**-195.8**	**-333.0**	**-554.2**	**-6.5**	**-9.6**	**-14.4**
Nuclear	720.1	810.1	863.7	806.8	824.2	916.7	-87.2	48.8	171.6	-9.7	6.3	23.0
Hydro & wind	259.8	294.2	343.8	495.0	606.7	742.0	12.5	50.8	99.4	2.6	9.1	15.5
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1529.5	1686.6	1633.3	-121.2	-432.6	-825.1	-7.3	-20.4	-33.6
Fuel Inputs for Thermal Power Generation (1)	**291.8**	**295.1**	**318.3**	**305.1**	**309.3**	**289.1**	**-32.7**	**-87.7**	**-155.7**	**-9.7**	**-22.1**	**-35.0**
Solids	186.1	163.9	153.6	100.6	70.6	79.9	-17.1	-63.2	-99.3	-14.5	-47.2	-55.4
Oil (including refinery gas)	48.7	49.6	38.3	11.9	11.7	6.9	-8.5	0.6	0.1	-41.6	5.3	1.7
Gas	45.1	66.0	106.3	139.8	166.2	138.0	-32.6	-56.6	-91.6	-18.9	-25.4	-39.9
Biomass - Waste	10.0	13.5	17.1	49.2	56.7	59.7	25.2	31.1	34.4	104.9	121.2	136.0
Geothermal heat	1.9	2.1	3.0	3.7	4.1	4.6	0.3	0.5	0.7	8.1	13.0	17.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**719.4**	**730.7**	**730.7**	**-21.7**	**-41.2**	**-63.2**	**-2.9**	**-5.3**	**-8.0**
Refineries	594.6	635.8	665.7	642.2	653.0	654.3	-41.3	-57.0	-71.0	-6.0	-8.0	-9.8
District heating	12.4	11.0	6.0	5.2	5.0	5.1	-1.0	-0.2	-0.9	-16.7	-3.3	-15.1
Biofuels and hydrogen production	0.0	0.2	0.6	32.2	34.5	34.9	22.1	16.8	9.2	218.1	94.8	35.5
Others	97.1	58.1	50.6	39.7	38.1	36.4	-1.5	-0.8	-0.5	-3.6	-2.1	-1.2
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**62.2**	**60.6**	**59.0**	**-5.2**	**-6.7**	**-8.8**	**-7.7**	**-10.0**	**-13.0**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.5**	**108.5**	**110.5**	**0.2**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1022.7**	**1066.8**	**1101.9**	**-53.9**	**-97.9**	**-127.1**	**-5.0**	**-8.4**	**-10.3**
by sector												
Industry (1)	262.2	255.6	268.7	291.1	311.5	334.4	-8.3	-13.8	-10.2	-2.8	-4.2	-3.0
energy intensive industries	180.4	170.9	175.8	185.2	191.3	195.3	-5.4	-8.4	-6.8	-2.9	-4.2	-3.4
other industrial sectors	81.9	84.7	92.9	105.9	120.2	139.1	-2.8	-5.3	-3.4	-2.6	-4.3	-2.4
Residential	228.1	236.0	244.7	258.0	259.8	256.4	-12.9	-24.5	-34.7	-4.7	-8.6	-11.9
Tertiary	115.3	127.9	132.7	132.6	144.9	157.0	-16.6	-20.8	-29.6	-11.1	-12.6	-15.9
Transport	253.8	275.7	309.1	340.9	350.6	354.1	-16.3	-38.8	-52.6	-4.6	-10.0	-12.9
by fuel (1)												
Solids	76.8	47.0	36.0	26.5	23.7	21.6	-1.9	-1.5	-1.5	-6.6	-5.9	-6.3
Oil	391.5	414.1	430.6	432.4	435.7	436.3	-29.7	-53.3	-65.6	-6.4	-10.9	-13.1
Gas	169.7	194.9	220.3	246.5	256.0	272.8	-20.1	-29.0	-28.0	-7.5	-10.2	-9.3
Electricity	156.0	169.4	191.6	213.3	236.5	252.0	-14.9	-27.3	-44.3	-6.5	-10.4	-14.9
Heat (from CHP and District Heating)	35.2	39.3	42.1	47.8	57.3	64.5	-4.0	-3.5	-2.1	-7.7	-5.7	-3.2
Other	30.3	30.6	34.5	56.0	57.7	54.6	16.7	16.7	14.3	42.5	40.7	35.4
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3052.0**	**3117.5**	**2827.0**	**2777.0**	**2755.6**	**-377.9**	**-667.0**	**-913.0**	**-11.8**	**-19.4**	**-24.9**
Electricity and Steam production	997.6	947.7	948.3	779.0	717.3	670.3	-172.9	-382.6	-610.2	-18.2	-34.8	-47.7
Energy Branch	129.8	144.4	145.4	123.4	118.6	113.7	-11.8	-13.1	-13.9	-8.7	-9.9	-10.9
Industry	576.2	526.5	509.3	424.1	414.3	426.8	-34.2	-45.8	-39.5	-7.5	-9.9	-8.5
Residential	436.4	417.4	412.9	397.3	392.0	387.1	-35.1	-48.6	-47.1	-8.1	-11.0	-10.8
Tertiary	203.5	212.7	199.6	174.9	181.7	194.5	-27.7	-24.7	-25.2	-13.7	-12.0	-11.5
Transport	738.5	803.2	902.2	928.3	953.1	963.1	-96.2	-152.3	-177.1	-9.4	-13.8	-15.5
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**91.7**	**90.1**	**89.4**	**-12.3**	**-21.6**	**-29.6**	-11.8	-19.4	-24.9

See explanations on the last page of the Appendix

Source: PRIMES

EU15: ENERGY POLICY OPTIONS CASE							SUMMARY ENERGY BALANCE AND INDICATORS (B)					
Mtoe	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
							Difference from Baseline			**% diff. from Baseline**		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	136.9	111.2	91.4	-8.2	-10.3	-10.2	-5.7	-8.5	-10.1
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	3.8	3.9	4.0	-0.2	-0.4	-0.4	-5.7	-8.5	-10.1
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7300	7984	8462	-505	-853	-1425	-6.5	-9.6	-14.4
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	1.90	1.83	1.78	-0.13	-0.25	-0.35	-6.5	-11.9	-16.5
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	7.3	7.1	7.1	-1.0	-1.7	-2.3	-11.8	-19.4	-24.9
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.3	364.8	260.3	203.6	162.9	-34.8	-48.9	-54.0	-11.8	-19.4	-24.9
Import Dependency %	47.6	46.6	49.4	49.6	55.4	57.7	-4.7	-7.5	-10.1	-8.6	-11.9	-15.0
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	76.7	65.0	56.0	-2.2	-2.9	-1.7	-2.8	-4.2	-3.0
Residential (Energy on Private Income)	100.0	97.6	88.2	73.6	59.6	48.1	-3.7	-5.6	-6.5	-4.7	-8.6	-11.9
Tertiary (Energy on Value added)	100.0	101.8	90.9	69.7	59.9	51.9	-8.7	-8.6	-9.8	-11.1	-12.6	-15.9
Transport (Energy on GDP)	100.0	101.2	99.5	86.4	70.7	57.6	-4.1	-7.8	-8.6	-4.6	-10.0	-12.9
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.23	0.19	0.16	-0.03	-0.07	-0.11	-12.3	-28.4	-40.2
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.88	1.82	1.79	-0.09	-0.08	-0.05	-4.3	-4.2	-2.7
Industry	2.20	2.06	1.90	1.46	1.33	1.28	-0.07	-0.08	-0.08	-4.8	-6.0	-5.7
Residential	1.91	1.77	1.69	1.54	1.51	1.51	-0.06	-0.04	0.02	-3.5	-2.6	1.2
Tertiary	1.76	1.66	1.50	1.32	1.25	1.24	-0.04	0.01	0.06	-2.9	0.7	5.2
Transport	2.91	2.91	2.92	2.72	2.72	2.72	-0.15	-0.12	-0.08	-5.1	-4.2	-3.0
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**668.0**	**755.2**	**860.7**	**-20.7**	**-57.4**	**-90.3**	**-3.0**	**-7.1**	**-9.5**
Nuclear		126.2	131.0	121.9	117.5	149.3	0.0	17.4	44.3	0.0	17.4	42.2
Hydro (pumping excluded)		87.1	89.8	100.4	106.0	108.9	3.5	4.9	5.2	3.6	4.9	5.0
Wind and solar		2.5	12.9	71.8	112.9	160.9	1.5	17.5	26.7	2.1	18.4	19.9
Thermal		322.9	344.8	373.8	418.9	441.7	-25.7	-97.2	-166.4	-6.4	-18.8	-27.4
of which cogeneration units		*59.3*	*77.1*	*122.9*	*190.5*	*214.2*	*20.6*	*60.6*	*67.8*	*20.1*	*46.6*	*46.3*
Open cycle(incl. biomass-waste)		281.8	276.9	224.0	141.2	123.0	9.4	5.5	9.6	4.4	4.0	8.5
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	2.7	6.1	31.2	2.3	-45.5	-87.8	495.8	-88.2	-73.8
Gas Turbines Combined Cycle		20.0	46.0	126.1	227.2	194.3	-31.2	-52.0	-128.7	-19.8	-18.6	-39.9
Small Gas Turbines		20.3	21.0	19.7	42.5	48.2	-6.2	-5.6	-3.2	-24.0	-11.7	-6.3
Fuel Cells		0.0	0.0	0.0	0.4	43.5	0.0	0.4	43.5			
Geothermal heat		0.7	1.0	1.3	1.5	1.7	0.1	0.2	0.3	8.5	13.6	20.3
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.9	45.4	49.7	52.1	1.4	1.7	2.4	3.3	3.6	4.9
Load factor for gross electric capacities (%)		48.9	50.8	48.4	47.1	43.7	-1.8	-1.4	-2.5	-3.6	-2.8	-5.4
CHP indicator (% of electricity from CHP)		9.2	10.3	19.3	23.7	25.5	6.7	9.9	11.3	53.1	71.7	80.3
Non fossil fuels in electricity generation (%)		49.9	49.3	53.8	54.4	59.2	5.6	13.4	21.0	11.6	32.5	54.8
nuclear		35.1	33.6	28.5	26.4	27.8	-1.0	4.0	8.5	-3.5	17.7	43.7
renewable energy forms		14.8	15.8	25.3	28.0	31.4	6.6	9.4	12.5	35.4	50.5	66.2
of which waste		*1.0*	*1.2*	*1.0*	*0.5*	*0.5*	*-0.4*	*-0.8*	*-0.5*	*-26.7*	*-62.4*	*-50.9*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5822.2**	**6707.6**	**7551.6**	**5.1**	**7.3**	**11.4**	**0.1**	**0.1**	**0.2**
public road transport	368.8	382.2	412.6	424.2	451.0	469.6	1.5	2.6	4.4	0.4	0.6	0.9
private cars and motorcycles	3325.6	3634.5	3938.8	4567.7	5169.9	5711.9	1.4	2.8	7.5	0.0	0.1	0.1
rail transport	316.4	320.9	356.0	365.5	419.8	461.2	-1.2	-1.3	-1.6	-0.3	-0.3	-0.3
aviation	157.3	201.5	281.5	425.1	620.7	855.2	3.4	3.0	0.7	0.8	0.5	0.1
inland navigation	28.3	31.4	33.0	39.8	46.2	53.7	0.1	0.1	0.3	0.1	0.3	0.6
travel per person (km per capita)	11465	12240	13261	15012	17179	19412	13	19	29	0.1	0.1	0.2
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2350.3**	**2895.1**	**3498.3**	**-0.1**	**-1.7**	**-3.2**	**0.0**	**-0.1**	**-0.1**
trucks	946.0	1114.6	1327.2	1743.7	2196.7	2717.8	0.9	-0.6	-2.4	0.1	0.0	-0.1
rail transport	234.9	220.2	249.3	262.5	296.4	322.7	-1.2	-1.7	-2.6	-0.4	-0.6	-0.8
inland navigation	257.1	266.9	296.1	344.2	402.0	457.9	0.2	0.6	1.7	0.0	0.2	0.4
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	207	0	0	0	0.0	-0.1	-0.1
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**340.9**	**350.6**	**354.1**	**-16.3**	**-38.8**	**-52.6**	**-4.6**	**-10.0**	**-12.9**
public road transport	6.3	5.9	5.8	5.8	5.4	4.9	-0.2	-0.4	-0.4	-2.5	-7.0	-7.8
private cars and motorcycles	130.2	136.6	145.5	152.0	144.1	134.8	-2.2	-6.8	-7.5	-1.4	-4.5	-5.3
trucks	76.0	86.5	101.0	131.3	144.7	150.4	-1.5	-14.7	-27.0	-1.1	-9.2	-15.2
rail transport	6.9	7.5	7.7	6.3	5.0	4.8	-0.5	-0.6	-0.4	-7.6	-10.4	-8.2
aviation	27.8	32.5	43.8	39.3	44.5	51.9	-11.9	-16.1	-16.8	-23.2	-26.6	-24.5
inland navigation	6.7	6.7	5.3	6.2	6.8	7.3	0.0	-0.2	-0.4	-0.8	-3.3	-5.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	34.8	29.6	26.0	-2.6	-3.6	-3.4	-6.8	-10.8	-11.4
freight transport (toe/Mtkm)	57.8	58.5	57.3	58.8	52.4	45.1	-0.7	-5.2	-7.8	-1.1	-9.0	-14.8

Source: PRIMES

NMS: ENERGY POLICY OPTIONS CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**113.4**	**107.1**	**89.0**	**-4.0**	**1.7**	**1.0**	**-3.4**	**1.6**	**1.1**
Solids	140.9	126.7	104.0	74.1	65.8	54.3	-9.4	-4.5	-5.2	-11.3	-6.4	-8.7
Oil	2.6	3.0	3.1	2.4	2.4	2.2	-0.1	0.0	-0.1	-3.5	-1.8	-2.6
Natural gas	6.7	7.4	6.1	5.9	5.4	4.9	0.0	-0.1	-0.1	0.0	-1.0	-2.0
Nuclear	15.5	14.1	14.8	14.5	15.2	7.2	-0.5	0.4	1.8	-3.0	2.6	34.3
Renewable energy sources	3.0	6.3	8.0	16.5	18.3	20.4	6.0	5.9	4.5	56.9	47.6	28.0
Hydro	1.1	1.3	1.4	2.0	2.2	2.1	0.0	0.0	0.0	1.4	2.0	-2.2
Biomass	1.4	4.6	6.1	12.2	12.0	12.7	5.9	5.6	4.7	94.6	88.1	59.4
Waste	0.5	0.3	0.5	1.0	1.2	1.5	-0.3	-0.3	-0.2	-25.5	-21.4	-13.1
Wind	0.0	0.0	0.0	0.6	1.9	2.7	0.1	0.0	-0.5	9.7	0.1	-16.5
Solar and others	0.0	0.0	0.0	0.6	1.1	1.3	0.3	0.5	0.5	115.0	108.1	66.7
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-15.5	-19.8	-24.3
Net Imports	**66.3**	**50.4**	**61.4**	**80.6**	**95.4**	**107.0**	**-11.5**	**-32.2**	**-46.6**	**-12.5**	**-25.2**	**-30.3**
Solids	-14.6	-20.7	-15.9	-8.9	-7.9	-3.7	-1.8	-10.8	-21.6	24.5	-376.6	-120.4
Oil	49.9	45.0	47.3	51.0	53.9	57.4	-4.6	-9.4	-11.3	-8.2	-14.8	-16.5
Crude oil and Feedstocks	43.4	36.7	41.3	42.5	45.4	48.7	-3.7	-7.7	-9.6	-7.9	-14.5	-16.4
Oil products	6.5	8.3	6.0	8.5	8.5	8.7	-0.9	-1.7	-1.8	-9.5	-16.5	-16.7
Natural gas	31.2	26.2	31.5	39.7	50.7	54.3	-5.2	-12.0	-13.4	-11.6	-19.1	-19.8
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-1.1	0.0	0.0	-0.3	0.0	0.0	32.3
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**192.9**	**201.3**	**194.7**	**-15.5**	**-30.5**	**-45.6**	**-7.4**	**-13.1**	**-19.0**
Solids	127.8	108.2	90.8	65.2	57.9	50.7	-11.1	-15.3	-26.7	-14.6	-20.9	-34.5
Oil	50.4	46.6	48.7	52.4	55.0	58.4	-4.7	-9.4	-11.4	-8.2	-14.6	-16.3
Natural gas	37.1	33.8	37.3	45.7	56.1	59.1	-5.2	-12.0	-13.5	-10.3	-17.7	-18.6
Nuclear	15.5	14.1	14.8	14.5	15.2	7.2	-0.5	0.4	1.8	-3.0	2.6	34.3
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-1.1	0.0	0.0	-0.3	0.0	0.0	32.3
Renewable energy forms	3.0	6.3	8.0	16.5	18.3	20.4	6.0	5.9	4.5	56.9	47.6	28.0
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	33.8	28.8	26.0	-2.8	-2.8	-6.2	-7.7	-8.9	-19.2
Oil	21.6	22.3	24.6	27.1	27.3	30.0	-0.2	-0.5	1.0	-0.8	-1.7	3.3
Natural gas	15.9	16.2	18.8	23.7	27.9	30.4	-0.7	-1.5	0.1	-3.1	-5.2	0.4
Nuclear	6.6	6.7	7.5	7.5	7.6	3.7	0.3	1.2	1.5	4.7	18.1	65.8
Renewable energy forms	1.3	3.0	4.1	8.5	9.1	10.5	3.5	3.7	3.8	69.6	70.0	58.0
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**361.1**	**433.8**	**443.0**	**-30.9**	**-64.4**	**-108.1**	**-7.9**	**-12.9**	**-19.6**
Nuclear	60.0	54.3	57.4	56.7	60.0	29.7	-1.8	1.9	8.2	-3.1	3.2	38.4
Hydro & wind	12.9	15.5	15.7	31.1	47.0	56.1	1.0	0.5	-6.8	3.2	1.2	-10.8
Thermal (incl. biomass)	243.7	230.7	250.6	273.3	326.7	357.2	-30.1	-66.8	-109.5	-9.9	-17.0	-23.5
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**65.8**	**68.3**	**65.2**	**-9.6**	**-17.6**	**-31.0**	**-12.8**	**-20.4**	**-32.2**
Solids	62.2	57.2	56.5	47.1	44.3	39.0	-10.4	-14.3	-26.0	-18.1	-24.4	-40.0
Oil	4.9	4.4	3.2	2.9	1.9	1.9	-0.5	-0.5	-0.7	-15.4	-20.3	-28.0
Gas	5.3	4.0	6.3	10.6	16.8	18.6	-2.2	-6.2	-7.0	-17.1	-26.8	-27.3
Biomass - Waste	0.3	0.1	0.4	5.3	5.4	5.6	3.5	3.3	2.8	191.4	161.3	98.3
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**64.7**	**66.2**	**69.6**	**-1.3**	**-5.1**	**-8.2**	**-1.9**	**-7.1**	**-10.5**
Refineries	46.7	40.1	45.2	47.5	50.9	54.8	-2.3	-6.1	-8.4	-4.6	-10.8	-13.3
District heating	19.3	12.1	8.5	4.2	3.0	2.1	-0.4	-0.7	-0.7	-8.6	-18.3	-25.4
Biofuels and hydrogen production	0.0	0.0	0.0	2.1	2.8	3.4	2.0	2.3	1.8	3064.6	552.5	104.2
Others	30.5	23.1	17.7	11.0	9.6	9.3	-0.6	-0.6	-0.8	-5.4	-5.8	-7.7
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**8.8**	**8.6**	**8.0**	**-0.8**	**-1.3**	**-1.3**	**-8.5**	**-13.1**	**-13.7**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**13.0**	**14.4**	**0.0**	**0.0**	**0.0**	**0.3**	**0.2**	**0.0**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**124.4**	**134.6**	**140.7**	**-8.0**	**-18.5**	**-24.4**	**-6.0**	**-12.1**	**-14.8**
by sector												
Industry	65.0	47.7	40.4	38.3	40.0	42.3	-1.1	-2.1	-1.6	-2.9	-5.1	-3.7
energy intensive industries	32.5	27.9	26.2	24.9	25.1	25.7	-0.7	-1.4	-1.1	-2.8	-5.4	-4.3
other industrial sectors	32.4	19.7	14.2	13.4	14.9	16.5	-0.4	-0.7	-0.5	-3.0	-4.7	-2.8
Residential	40.0	41.2	34.4	35.7	38.9	39.9	-2.0	-5.9	-7.8	-5.3	-13.1	-16.4
Tertiary	24.9	19.6	21.5	21.9	23.7	24.1	-3.2	-4.9	-7.4	-12.9	-17.1	-23.5
Transport	19.9	19.8	22.9	28.4	32.0	34.4	-1.6	-5.6	-7.6	-5.3	-14.8	-18.0
by fuel												
Solids	40.9	33.8	21.4	13.5	10.2	8.5	-0.4	-0.7	-0.6	-2.9	-6.7	-6.2
Oil	32.7	29.6	33.6	38.9	41.8	43.9	-2.3	-6.8	-8.9	-5.7	-14.0	-16.9
Gas	26.5	24.6	25.4	30.8	34.9	37.2	-2.5	-4.9	-5.4	-7.6	-12.3	-12.7
Electricity	20.5	18.5	19.6	23.0	28.6	30.0	-2.1	-4.6	-8.0	-8.5	-13.9	-21.1
Heat (from CHP and District Heating)	27.7	17.4	13.5	12.5	13.5	15.1	-0.7	-1.5	-1.9	-5.3	-10.1	-11.1
Other	1.8	4.7	5.8	5.8	5.5	6.0	0.1	0.1	0.4	2.5	1.4	7.5
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**482.4**	**481.0**	**464.7**	**-69.8**	**-115.6**	**-170.3**	**-12.6**	**-19.4**	**-26.8**
Electricity and Steam production	343.4	295.0	280.1	233.3	228.5	209.0	-50.1	-74.5	-123.5	-17.7	-24.6	-37.1
Energy Branch	14.4	19.5	18.7	9.9	10.0	10.0	-0.7	-1.4	-1.5	-6.3	-12.3	-12.8
Industry	137.0	118.2	96.4	82.6	80.1	79.8	-3.5	-5.6	-5.7	-4.0	-6.6	-6.7
Residential	83.2	72.9	49.7	46.9	46.7	44.9	-2.4	-7.9	-8.1	-4.8	-14.4	-15.3
Tertiary	53.3	38.3	37.2	32.7	29.6	29.2	-4.3	-4.9	-5.8	-11.5	-14.2	-16.5
Transport	56.1	55.9	65.3	77.0	86.1	91.7	-9.0	-21.3	-25.7	-10.4	-19.8	-21.9
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**70.2**	**70.0**	**67.6**	**-10.2**	**-16.8**	**-24.8**	-12.6	-19.4	-26.8

See explanations on the last page of the Appendix

Source: PRIMES

NMS: ENERGY POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	336.1	245.2	176.9	-27.0	-37.1	-41.5	-7.4	-13.1	-19.0
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.6	2.8	2.8	-0.2	-0.4	-0.7	-7.4	-13.1	-19.0
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	4920	6052	6407	-421	-899	-1563	-7.9	-12.9	-19.6
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.50	2.39	2.39	-0.15	-0.18	-0.26	-5.6	-7.2	-9.7
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	6.6	6.7	6.7	-1.0	-1.6	-2.5	-12.6	-19.4	-26.8
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	840.6	585.9	422.3	-121.7	-140.9	-154.7	-12.6	-19.4	-26.8
Import Dependency %	28.3	24.1	30.8	41.6	47.1	54.6	-2.4	-7.6	-9.0	-5.5	-14.0	-14.1
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	35.1	26.0	21.9	-1.0	-1.4	-0.8	-2.9	-5.1	-3.7
Residential (Energy on Private Income)	100.0	106.5	74.2	53.0	39.4	30.2	-3.0	-6.0	-5.9	-5.3	-13.1	-16.4
Tertiary (Energy on Value added)	100.0	74.8	67.2	45.8	33.5	24.4	-6.8	-6.9	-7.5	-12.9	-17.1	-23.5
Transport (Energy on GDP)	100.0	102.9	97.4	83.0	65.3	52.3	-4.6	-11.4	-11.5	-5.3	-14.8	-18.0
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.44	0.38	0.33	-0.05	-0.06	-0.10	-10.9	-13.8	-24.1
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.92	1.80	1.75	-0.03	-0.04	-0.02	-1.5	-2.3	-0.9
Industry	2.11	2.48	2.38	2.15	2.00	1.89	-0.03	-0.03	-0.06	-1.2	-1.6	-3.1
Residential	2.08	1.77	1.44	1.31	1.20	1.12	0.01	-0.02	0.01	0.5	-1.5	1.3
Tertiary	2.14	1.95	1.73	1.50	1.25	1.21	0.02	0.04	0.10	1.6	3.6	9.1
Transport	2.82	2.82	2.85	2.71	2.69	2.67	-0.16	-0.17	-0.13	-5.4	-5.9	-4.7
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**89.6**	**118.9**	**137.1**	**-5.5**	**-15.2**	**-30.1**	**-5.8**	**-11.3**	**-18.0**
Nuclear		8.4	9.3	7.9	8.1	4.1	0.0	0.2	1.2	0.0	3.0	42.7
Hydro (pumping excluded)		6.1	6.4	7.9	8.6	8.8	0.2	0.4	0.4	2.9	4.6	4.4
Wind and solar		0.0	0.0	3.1	9.6	15.3	0.3	0.8	0.3	10.3	9.5	2.3
Thermal		64.0	61.9	70.7	92.6	108.9	-6.0	-16.6	-32.0	-7.9	-15.2	-22.7
of which cogeneration units		*28.1*	*26.3*	*32.4*	*44.6*	*52.4*	*5.1*	*6.4*	*0.1*	*18.5*	*16.8*	*0.2*
Open cycle (incl. biomass-waste)		61.9	58.6	52.9	35.7	30.4	-3.0	-3.9	-3.7	-5.4	-9.7	-10.8
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.5	7.2	8.9	0.0	-7.8	-22.1	-7.9	-52.0	-71.3
Gas Turbines Combined Cycle		0.4	1.4	10.6	36.7	43.2	-1.7	-2.8	-18.4	-14.2	-7.1	-29.9
Small Gas Turbines		1.7	1.8	6.8	13.0	11.7	-1.2	-2.2	-2.7	-15.4	-14.2	-18.9
Fuel Cells		0.0	0.0	0.0	0.0	14.9	0.0	0.0	14.9			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	37.7	43.2	49.8	1.2	1.8	5.9	3.4	4.3	13.3
Load factor for gross electric capacities (%)		43.6	47.6	46.0	41.6	36.9	-1.0	-0.8	-0.7	-2.2	-1.8	-2.0
CHP indicator (% of electricity from CHP)		29.4	30.4	37.3	38.4	43.1	9.0	11.1	11.5	31.6	40.4	36.3
Non fossil fuels in electricity generation (%)		23.4	23.1	30.7	30.4	25.4	6.6	7.9	8.2	27.1	35.3	47.6
nuclear		18.1	17.7	15.7	13.8	6.7	0.8	2.2	2.8	5.2	18.6	72.1
renewable energy forms		5.3	5.4	15.0	16.6	18.7	5.8	5.8	5.4	62.5	53.4	40.4
of which waste		*0.0*	*0.1*	*0.4*	*0.3*	*0.2*	*-0.2*	*-0.1*	*-0.1*	*-40.6*	*-30.7*	*-30.7*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**615.9**	**809.5**	**1000.5**	**0.2**	**0.8**	**1.8**	**0.0**	**0.1**	**0.2**
public road transport	115.7	87.0	81.2	81.2	84.9	91.1	0.0	0.3	0.6	0.0	0.3	0.6
private cars and motorcycles	268.0	315.8	352.9	459.3	621.8	771.6	0.1	0.6	1.4	0.0	0.1	0.2
rail transport	91.9	50.8	46.3	48.2	58.2	75.0	0.0	0.0	0.2	0.0	0.0	0.3
aviation	11.2	14.0	16.8	26.5	43.9	62.1	0.1	-0.1	-0.4	0.2	-0.2	-0.6
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	0.1	0.2	0.5
travel per person (km per capita)	6489	6227	6662	8391	11295	14471	3	11	26	0.0	0.1	0.2
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**339.4**	**441.7**	**541.3**	**0.1**	**-0.5**	**0.1**	**0.0**	**-0.1**	**0.0**
trucks	118.4	119.0	155.5	223.9	319.2	412.1	0.0	-0.3	-0.4	0.0	-0.1	-0.1
rail transport	205.2	137.8	118.7	114.7	121.7	128.4	0.1	-0.2	0.4	0.0	-0.1	0.3
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	0.1	0.4	0.8
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	591	538	492	0	-1	0	0.0	-0.1	0.0
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**28.4**	**32.0**	**34.4**	**-1.6**	**-5.6**	**-7.6**	**-5.3**	**-14.8**	**-18.0**
public road transport	1.4	1.0	1.2	1.1	1.0	0.9	0.0	-0.1	-0.2	-2.5	-9.1	-16.1
private cars and motorcycles	7.9	9.5	11.6	14.0	15.6	16.0	-0.8	-2.1	-3.4	-5.5	-11.8	-17.4
trucks	7.0	6.7	7.5	10.9	13.0	15.0	-0.2	-2.1	-3.0	-1.7	-14.0	-16.8
rail transport	2.0	1.4	1.3	1.1	0.9	0.8	-0.1	-0.1	-0.2	-5.1	-14.0	-17.6
aviation	1.3	1.2	1.3	1.4	1.5	1.7	-0.5	-1.1	-0.8	-26.7	-43.0	-32.2
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-2.9	-5.5
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	27.5	22.9	18.9	-2.2	-4.2	-4.4	-7.5	-15.6	-18.9
freight transport (toe/Mtkm)	24.6	28.8	30.0	33.9	30.6	28.6	-0.6	-4.9	-5.9	-1.9	-13.8	-17.0

Source: PRIMES

EU25: EXTENDED POLICY OPTIONS CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**872.9**	**751.5**	**674.7**	**12.6**	**10.7**	**13.8**	**1.5**	**1.4**	**2.1**
Solids	350.8	264.7	203.4	124.4	69.6	49.5	-29.4	-56.8	-53.0	-19.1	-44.9	-51.7
Oil	120.3	162.2	163.5	121.3	99.7	84.9	-10.4	-2.4	-1.6	-7.9	-2.4	-1.8
Natural gas	139.6	174.0	196.6	191.6	148.4	118.8	-5.3	0.8	1.6	-2.7	0.6	1.4
Nuclear	196.9	215.3	237.7	223.1	191.7	160.8	-22.2	-21.9	-24.6	-9.0	-10.2	-13.2
Renewable energy sources	69.2	80.7	96.1	212.5	242.2	260.8	79.9	90.9	91.3	60.2	60.1	53.9
Hydro	23.4	26.3	29.0	30.6	32.5	33.9	0.5	0.8	1.7	1.7	2.5	5.1
Biomass	31.1	35.4	42.2	122.4	131.8	133.8	64.9	66.9	60.1	113.0	103.0	81.6
Waste	12.3	15.9	19.3	30.5	36.0	36.2	4.8	8.3	9.0	18.7	29.8	33.2
Wind	0.1	0.4	1.9	15.4	27.3	38.3	1.4	7.2	11.5	10.4	35.8	42.9
Solar and others	0.1	0.3	0.4	9.7	10.6	13.4	8.0	7.7	8.1	473.9	259.7	152.9
Geothermal	2.2	2.5	3.3	4.0	4.1	5.1	0.2	0.1	0.9	5.9	2.7	21.2
Net Imports	**711.6**	**701.7**	**799.3**	**791.4**	**919.4**	**1000.2**	**-183.0**	**-285.1**	**-361.7**	**-18.8**	**-23.7**	**-26.6**
Solids	75.2	73.8	91.4	66.5	48.7	47.6	-23.4	-77.6	-149.9	-26.0	-61.4	-75.9
Oil	510.8	491.8	519.6	462.2	449.6	466.9	-110.3	-176.3	-184.1	-19.3	-28.2	-28.3
Crude oil and Feedstocks	480.2	471.5	496.8	441.8	438.4	463.7	-108.0	-172.7	-181.2	-19.6	-28.3	-28.1
Oil products	30.6	20.3	22.8	20.4	11.3	3.1	-2.3	-3.7	-2.8	-10.0	-24.6	-47.4
Natural gas	123.5	134.8	186.2	260.7	419.0	483.3	-49.3	-31.2	-27.8	-15.9	-6.9	-5.4
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1615.4**	**1616.2**	**1613.7**	**-168.7**	**-272.7**	**-346.0**	**-9.5**	**-14.4**	**-17.7**
Solids	430.6	346.0	303.2	190.9	118.3	97.1	-52.8	-134.4	-202.8	-21.7	-53.2	-67.6
Oil	596.2	622.2	635.6	534.5	494.6	490.6	-119.0	-177.0	-183.8	-18.2	-26.4	-27.3
Natural gas	259.2	307.1	376.0	452.2	567.4	602.1	-54.7	-30.4	-26.1	-10.8	-5.1	-4.2
Nuclear	196.9	215.3	237.7	223.1	191.7	160.8	-22.2	-21.9	-24.6	-9.0	-10.2	-13.2
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	212.5	242.2	260.8	79.9	90.9	91.3	60.2	60.1	53.9
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	11.8	7.3	6.0	-1.8	-6.1	-9.3	-13.5	-45.3	-60.7
Oil	38.4	39.6	38.5	33.1	30.6	30.4	-3.5	-5.0	-4.0	-9.7	-13.9	-11.7
Natural gas	16.7	19.5	22.8	28.0	35.1	37.3	-0.4	3.5	5.3	-1.5	10.9	16.4
Nuclear	12.7	13.7	14.4	13.8	11.9	10.0	0.1	0.6	0.5	0.5	4.9	5.4
Renewable energy forms	4.5	5.1	5.8	13.2	15.0	16.2	5.7	7.0	7.5	77.0	87.1	86.9
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3171.1**	**3476.6**	**3656.7**	**-248.1**	**-472.1**	**-740.5**	**-7.3**	**-12.0**	**-16.8**
Nuclear	780.0	864.4	921.2	866.4	747.4	664.0	-86.0	-86.2	-102.5	-9.0	-10.3	-13.4
Hydro & wind	272.7	309.7	359.5	535.3	697.3	869.8	22.6	94.9	164.3	4.4	15.7	23.3
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1769.4	2031.9	2122.8	-184.7	-480.7	-802.3	-9.5	-19.1	-27.4
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**362.6**	**361.0**	**347.9**	**-50.7**	**-121.9**	**-193.0**	**-12.3**	**-25.2**	**-35.7**
Solids	248.2	221.1	210.1	129.7	66.9	49.4	-45.5	-125.4	-194.8	-26.0	-65.2	-79.8
Oil (including refinery gas)	53.7	53.9	41.5	12.6	9.9	8.2	-11.2	-3.6	-1.2	-47.0	-26.5	-13.1
Gas	50.4	70.0	112.6	149.7	203.2	203.2	-35.4	-42.6	-52.0	-19.1	-17.3	-20.4
Biomass - Waste	10.3	13.6	17.5	66.9	77.2	82.2	41.1	49.5	54.1	159.2	178.8	192.1
Geothermal heat	1.9	2.1	3.0	3.7	3.8	4.9	0.3	0.2	0.9	8.1	4.5	24.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**714.1**	**700.9**	**714.7**	**-93.0**	**-142.2**	**-157.0**	**-11.5**	**-16.9**	**-18.0**
Refineries	641.3	675.9	710.9	625.2	597.3	606.6	-108.1	-169.7	-181.8	-14.7	-22.1	-23.1
District heating	31.7	23.1	14.5	9.2	9.5	7.4	-1.6	0.6	-1.4	-14.5	6.9	-15.7
Biofuels and hydrogen production	0.0	0.2	0.6	30.5	49.6	57.6	20.3	31.4	30.2	198.7	173.2	109.9
Others	127.6	81.2	68.3	49.2	44.6	43.1	-3.6	-4.5	-3.9	-6.9	-9.1	-8.4
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**67.7**	**63.5**	**61.2**	**-9.4**	**-13.6**	**-15.9**	**-12.2**	**-17.7**	**-20.7**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.4**	**121.4**	**124.8**	**0.1**	**0.0**	**-0.1**	**0.1**	**0.0**	**-0.1**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1092.4**	**1145.2**	**1199.6**	**-116.6**	**-172.6**	**-194.5**	**-9.6**	**-13.1**	**-14.0**
by sector												
Industry (1)	327.2	303.3	309.1	326.9	346.2	371.3	-12.0	-21.2	-17.2	-3.5	-5.8	-4.4
energy intensive industries	212.9	198.9	202.0	207.8	211.6	216.3	-8.5	-14.6	-12.7	-3.9	-6.5	-5.6
other industrial sectors	114.3	104.4	107.0	119.1	134.5	155.0	-3.4	-6.6	-4.5	-2.8	-4.7	-2.8
Residential	268.1	277.2	279.1	292.2	296.7	294.4	-16.4	-32.4	-44.4	-5.3	-9.8	-13.1
Tertiary	140.2	147.5	154.2	153.6	167.4	180.0	-20.6	-27.0	-38.1	-11.8	-13.9	-17.5
Transport	273.7	295.6	332.0	319.6	335.0	353.9	-67.6	-92.0	-94.8	-17.5	-21.5	-21.1
by fuel (1)												
Solids	117.7	80.8	57.4	36.2	28.4	24.9	-6.1	-7.8	-7.2	-14.4	-21.5	-22.5
Oil	424.2	443.7	464.2	416.1	385.0	388.3	-87.4	-152.6	-166.4	-17.4	-28.4	-30.0
Gas	196.2	219.5	245.7	282.5	322.3	349.7	-17.4	-2.6	6.2	-5.8	-0.8	1.8
Electricity	176.5	187.9	211.3	234.8	262.0	279.5	-18.6	-35.1	-54.8	-7.3	-11.8	-16.4
Heat (from CHP and District Heating)	62.9	56.7	55.6	59.8	70.4	79.3	-5.2	-5.3	-4.4	-8.0	-7.1	-5.2
Other	32.1	35.3	40.3	63.0	77.2	78.0	18.0	30.8	32.1	40.1	66.3	69.9
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.9**	**3664.9**	**3065.2**	**2908.7**	**2890.4**	**-692.0**	**-1132.0**	**-1413.2**	**-18.4**	**-28.0**	**-32.8**
Electricity and Steam production	1341.0	1242.7	1228.3	932.2	790.4	712.5	-303.1	-612.6	-900.6	-24.5	-43.7	-55.8
Energy Branch	144.2	163.9	164.0	126.8	152.4	159.7	-19.0	9.4	20.7	-13.0	6.6	14.9
Industry	713.2	644.8	605.7	494.9	475.4	491.1	-49.5	-70.4	-60.8	-9.1	-12.9	-11.0
Residential	519.7	490.4	462.6	442.2	436.6	430.0	-39.4	-58.6	-57.1	-8.2	-11.8	-11.7
Tertiary	256.8	251.0	236.7	208.1	213.5	225.3	-31.5	-27.4	-29.5	-13.1	-11.4	-11.6
Transport	794.6	859.1	967.5	860.9	840.4	871.8	-249.5	-372.3	-385.9	-22.5	-30.7	-30.7
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**81.3**	**77.2**	**76.7**	**-18.4**	**-30.0**	**-37.5**	-18.4	-28.0	-32.8

See explanations on the last page of the Appendix

Source: PRIMES

EU25: EXTENDED POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	141.3	111.8	89.6	-14.8	-18.9	-19.2	-9.5	-14.4	-17.7
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.5	3.5	3.5	-0.4	-0.6	-0.8	-9.5	-14.4	-17.7
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	6875	7523	7981	-538	-1022	-1616	-7.3	-12.0	-16.8
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	1.90	1.80	1.79	-0.21	-0.34	-0.40	-9.9	-15.9	-18.4
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	6.6	6.3	6.3	-1.5	-2.4	-3.1	-18.4	-28.0	-32.8
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	268.1	201.1	160.4	-60.5	-78.3	-78.4	-18.4	-28.0	-32.8
Import Dependency %	44.8	43.6	47.2	47.6	55.0	59.7	-5.6	-6.9	-7.6	-10.5	-11.1	-11.3
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	68.5	57.0	49.1	-2.5	-3.5	-2.3	-3.5	-5.8	-4.4
Residential (Energy on Private Income)	100.0	98.1	85.8	70.5	56.9	45.8	-4.0	-6.2	-6.9	-5.3	-9.8	-13.1
Tertiary (Energy on Value added)	100.0	96.7	86.8	66.0	56.2	48.0	-8.9	-9.1	-10.2	-11.8	-13.9	-17.5
Transport (Energy on GDP)	100.0	101.1	99.3	74.7	61.9	52.5	-15.8	-17.0	-14.1	-17.5	-21.5	-21.1
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.24	0.18	0.15	-0.05	-0.11	-0.14	-18.4	-36.6	-48.2
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.84	1.72	1.68	-0.13	-0.18	-0.15	-6.6	-9.3	-8.1
Industry	2.18	2.13	1.96	1.51	1.37	1.32	-0.09	-0.11	-0.10	-5.8	-7.6	-6.9
Residential	1.94	1.77	1.66	1.51	1.47	1.46	-0.05	-0.03	0.02	-3.0	-2.2	1.6
Tertiary	1.83	1.70	1.54	1.35	1.28	1.25	-0.02	0.04	0.08	-1.5	2.9	7.1
Transport	2.90	2.91	2.91	2.69	2.51	2.46	-0.17	-0.33	-0.34	-6.1	-11.7	-12.1
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**763.2**	**877.1**	**988.3**	**-20.6**	**-69.6**	**-129.9**	**-2.6**	**-7.4**	**-11.6**
Nuclear		134.7	140.3	129.8	106.1	99.0	0.0	-1.9	-8.8	0.0	-1.7	-8.1
Hydro (pumping excluded)		93.3	96.2	108.8	116.1	119.1	4.2	6.8	7.0	4.0	6.2	6.2
Wind and solar		2.5	13.0	78.2	139.1	199.8	5.0	35.1	50.6	6.9	33.7	33.9
Thermal		386.9	406.7	446.4	515.8	570.3	-29.9	-109.6	-178.7	-6.3	-17.5	-23.9
of which cogeneration units		*87.3*	*103.4*	*161.6*	*205.3*	*222.2*	*31.9*	*37.2*	*23.5*	*24.6*	*22.1*	*11.8*
Open cycle(incl. biomass-waste)		343.8	335.6	283.1	176.9	129.2	12.6	1.6	-18.1	4.6	0.9	-12.3
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	3.6	13.1	31.1	2.6	-53.5	-118.8	269.1	-80.3	-79.3
Gas Turbines Combined Cycle		20.4	47.4	133.2	263.8	260.5	-36.4	-55.0	-124.0	-21.5	-17.2	-32.3
Small Gas Turbines		22.0	22.8	25.2	44.3	42.1	-8.7	-19.1	-23.7	-25.7	-30.1	-36.0
Fuel Cells		0.0	0.0	0.0	16.1	105.6	0.0	16.1	105.6			
Geothermal heat		0.7	1.0	1.3	1.5	1.8	0.1	0.2	0.3	8.5	16.7	24.9
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.2	44.3	51.1	55.9	1.7	4.3	7.2	4.0	9.1	14.8
Load factor for gross electric capacities (%)		48.2	50.4	47.4	45.2	42.2	-2.4	-2.4	-2.7	-4.7	-5.0	-5.9
CHP indicator (% of electricity from CHP)		11.5	12.6	22.3	23.3	25.8	7.8	7.8	9.5	54.4	50.4	58.1
Non fossil fuels in electricity generation (%)		46.8	46.4	53.5	51.6	52.7	8.1	12.9	17.1	17.8	33.3	48.0
nuclear		33.1	31.8	27.3	21.5	18.2	-0.5	0.4	0.7	-1.9	1.8	4.2
renewable energy forms		13.7	14.6	26.2	30.1	34.5	8.6	12.5	16.4	49.0	71.1	90.0
of which waste		*0.9*	*1.1*	*1.2*	*0.9*	*1.2*	*-0.1*	*-0.3*	*0.2*	*-9.4*	*-25.8*	*16.9*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6424.4**	**7498.5**	**8532.0**	**-8.4**	**-10.5**	**-6.8**	**-0.1**	**-0.1**	**-0.1**
public road transport	484.5	469.2	493.8	559.2	594.6	623.4	55.4	61.6	67.8	11.0	11.6	12.2
private cars and motorcycles	3593.6	3950.3	4291.6	4922.7	5684.3	6379.9	-102.9	-104.0	-94.6	-2.0	-1.8	-1.5
rail transport	408.3	371.7	402.3	500.2	578.3	650.7	85.3	98.9	113.1	20.6	20.6	21.0
aviation	168.5	215.5	298.3	403.0	595.6	824.8	-45.1	-66.0	-92.2	-10.1	-10.0	-10.1
inland navigation	28.9	31.9	33.6	39.3	45.8	53.3	-1.1	-1.0	-0.8	-2.7	-2.2	-1.5
travel per person (km per capita)	10618	11233	12174	13929	16227	18622	-18	-23	-15	-0.1	-0.1	-0.1
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2685.8**	**3331.6**	**4036.3**	**-4.0**	**-7.3**	**-6.5**	**-0.1**	**-0.2**	**-0.2**
trucks	1064.3	1233.6	1482.7	1851.1	2378.3	2975.2	-115.6	-138.5	-157.4	-5.9	-5.5	-5.0
rail transport	440.2	358.0	368.0	462.2	516.5	561.6	83.9	96.7	108.4	22.2	23.0	23.9
inland navigation	258.1	268.2	297.0	372.6	436.8	499.6	27.7	34.6	42.5	8.0	8.6	9.3
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	230	224	0	-1	0	-0.1	-0.2	-0.2
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**319.6**	**335.0**	**353.9**	**-67.6**	**-92.0**	**-94.8**	**-17.5**	**-21.5**	**-21.1**
public road transport	7.7	6.9	7.0	7.2	6.6	6.2	0.0	-0.3	-0.2	0.2	-5.0	-3.1
private cars and motorcycles	138.1	146.1	157.1	147.8	140.1	134.0	-21.1	-28.6	-27.6	-12.5	-16.9	-17.1
trucks	82.9	93.2	108.5	117.6	135.1	152.1	-26.2	-39.3	-43.4	-18.2	-22.5	-22.2
rail transport	8.8	8.9	9.0	7.7	6.5	6.6	-0.3	-0.1	0.4	-4.2	-0.8	5.8
aviation	29.1	33.8	45.1	33.1	39.6	47.2	-19.9	-23.6	-24.0	-37.5	-37.4	-33.7
inland navigation	7.0	6.7	5.4	6.2	7.0	7.8	-0.1	-0.1	0.0	-1.2	-1.0	-0.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	30.2	25.6	22.6	-6.4	-7.0	-6.0	-17.5	-21.4	-21.0
freight transport (toe/Mtkm)	51.7	54.4	53.8	46.7	43.0	39.8	-9.7	-11.7	-10.7	-17.2	-21.4	-21.1

Source: PRIMES

EU15: EXTENDED POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**764.3**	**666.8**	**604.8**	**21.3**	**31.3**	**31.9**	**2.9**	**4.9**	**5.6**
Solids	209.9	138.0	99.4	58.6	29.5	16.6	-11.7	-26.6	-26.5	-16.7	-47.4	-61.5
Oil	117.7	159.2	160.4	118.9	97.4	82.8	-10.3	-2.2	-1.4	-7.9	-2.2	-1.7
Natural gas	132.9	166.6	190.6	185.7	143.0	113.8	-5.3	0.9	1.6	-2.8	0.6	1.5
Nuclear	181.4	201.2	222.8	208.5	176.8	155.4	-21.8	-21.9	-24.6	-9.5	-11.0	-13.6
Renewable energy sources	66.3	74.4	88.1	192.6	220.1	236.3	70.5	81.1	82.7	57.7	58.4	53.9
Hydro	22.3	24.9	27.6	28.6	30.3	31.6	0.5	0.8	1.6	1.6	2.7	5.2
Biomass	29.7	30.8	36.1	108.3	117.3	119.1	57.1	58.8	53.3	111.6	100.4	81.1
Waste	11.9	15.6	18.7	28.0	33.3	33.5	3.6	7.1	8.1	14.9	27.0	31.9
Wind	0.1	0.4	1.9	14.7	25.5	34.9	1.4	7.2	11.3	10.3	39.7	47.7
Solar and others	0.1	0.2	0.3	9.1	9.6	12.1	7.7	7.1	7.6	540.4	291.6	168.6
Geothermal	2.2	2.5	3.3	4.0	4.1	5.1	0.2	0.1	0.9	5.9	2.7	21.2
Net Imports	**645.4**	**651.3**	**737.9**	**712.9**	**816.2**	**887.3**	**-169.4**	**-260.8**	**-320.9**	**-19.2**	**-24.2**	**-26.6**
Solids	89.9	94.4	107.2	74.4	54.1	52.2	-22.6	-69.3	-127.3	-23.3	-56.2	-70.9
Oil	460.9	446.7	472.4	414.8	401.5	416.9	-102.1	-161.3	-165.3	-19.7	-28.7	-28.4
Crude oil and Feedstocks	436.8	434.7	455.5	402.4	398.1	421.8	-101.2	-159.9	-164.9	-20.1	-28.7	-28.1
Oil products	24.1	12.0	16.9	12.4	3.4	-4.9	-0.9	-1.4	-0.5	-6.5	-29.4	10.1
Natural gas	92.3	108.6	154.7	220.4	357.3	415.0	-44.7	-30.2	-28.4	-16.9	-7.8	-6.4
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1429.3**	**1429.4**	**1432.2**	**-146.4**	**-227.8**	**-287.2**	**-9.3**	**-13.7**	**-16.7**
Solids	302.8	237.7	212.4	133.0	83.6	68.8	-34.4	-95.9	-153.8	-20.5	-53.4	-69.1
Oil	545.8	575.6	586.9	485.8	445.3	439.7	-110.7	-161.8	-164.9	-18.6	-26.6	-27.3
Natural gas	222.1	273.4	338.7	406.0	500.3	528.9	-50.0	-29.3	-26.7	-11.0	-5.5	-4.8
Nuclear	181.4	201.2	222.8	208.5	176.8	155.4	-21.8	-21.9	-24.6	-9.5	-11.0	-13.6
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	192.6	220.1	236.3	70.5	81.1	82.7	57.7	58.4	53.9
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	9.3	5.9	4.8	-1.3	-5.0	-8.1	-12.4	-46.0	-62.9
Oil	41.3	42.2	40.4	34.0	31.2	30.7	-3.9	-5.5	-4.5	-10.2	-15.0	-12.7
Natural gas	16.8	20.0	23.3	28.4	35.0	36.9	-0.5	3.0	4.6	-1.8	9.5	14.3
Nuclear	13.7	14.8	15.3	14.6	12.4	10.9	0.0	0.4	0.4	-0.2	3.1	3.7
Renewable energy forms	5.0	5.5	6.1	13.5	15.4	16.5	5.7	7.0	7.6	73.8	83.6	84.7
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**2815.9**	**3052.9**	**3226.1**	**-211.2**	**-397.6**	**-619.9**	**-7.0**	**-11.5**	**-16.1**
Nuclear	720.1	810.1	863.7	809.3	689.1	642.6	-84.6	-86.3	-102.5	-9.5	-11.1	-13.8
Hydro & wind	259.8	294.2	343.8	503.7	651.1	803.3	21.3	95.1	160.7	4.4	17.1	25.0
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1502.8	1712.8	1780.3	-147.8	-406.4	-678.1	-9.0	-19.2	-27.6
Fuel Inputs for Thermal Power Generation [1]	**291.8**	**295.1**	**318.3**	**299.8**	**302.2**	**291.0**	**-38.0**	**-94.8**	**-153.8**	**-11.3**	**-23.9**	**-34.6**
Solids	186.1	163.9	153.6	89.5	45.0	31.9	-28.1	-88.8	-147.3	-23.9	-66.4	-82.2
Oil (including refinery gas)	48.7	49.6	38.3	9.9	8.0	6.4	-10.4	-3.1	-0.4	-51.2	-27.9	-5.6
Gas	45.1	66.0	106.3	138.5	177.8	175.0	-33.9	-45.0	-54.6	-19.6	-20.2	-23.8
Biomass - Waste	10.0	13.5	17.1	58.1	67.6	72.8	34.1	42.0	47.5	142.2	164.0	187.5
Geothermal heat	1.9	2.1	3.0	3.7	3.8	4.9	0.3	0.2	0.9	8.1	4.5	24.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**653.2**	**640.7**	**652.0**	**-87.9**	**-131.1**	**-141.9**	**-11.9**	**-17.0**	**-17.9**
Refineries	594.6	635.8	665.7	581.2	551.9	559.2	-102.4	-158.0	-166.1	-15.0	-22.3	-22.9
District heating	12.4	11.0	6.0	5.1	6.7	5.3	-1.1	1.5	-0.6	-18.2	28.4	-10.9
Biofuels and hydrogen production	0.0	0.2	0.6	28.6	46.5	53.3	18.5	28.8	27.5	182.5	162.4	106.6
Others	97.1	58.1	50.6	38.3	35.6	34.2	-2.9	-3.3	-2.6	-7.2	-8.6	-7.2
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**59.2**	**55.4**	**53.7**	**-8.2**	**-11.9**	**-14.2**	**-12.2**	**-17.7**	**-20.9**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.4**	**108.5**	**110.5**	**0.1**	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**972.5**	**1016.0**	**1064.0**	**-104.2**	**-148.7**	**-165.0**	**-9.7**	**-12.8**	**-13.4**
by sector												
Industry [1]	262.2	255.6	268.7	288.8	306.9	329.7	-10.6	-18.4	-14.9	-3.5	-5.7	-4.3
energy intensive industries	180.4	170.9	175.8	183.1	187.1	191.2	-7.6	-12.6	-10.9	-4.0	-6.3	-5.4
other industrial sectors	81.9	84.7	92.9	105.7	119.8	138.5	-3.0	-5.8	-3.9	-2.7	-4.6	-2.8
Residential	228.1	236.0	244.7	256.8	258.4	255.0	-14.1	-26.0	-36.1	-5.2	-9.1	-12.4
Tertiary	115.3	127.9	132.7	132.0	143.9	156.1	-17.2	-21.8	-30.5	-11.5	-13.2	-16.3
Transport	253.8	275.7	309.1	294.9	306.9	323.1	-62.3	-82.5	-83.6	-17.4	-21.2	-20.6
by fuel [1]												
Solids	76.8	47.0	36.0	23.3	19.1	17.3	-5.1	-6.2	-5.8	-18.1	-24.4	-25.2
Oil	391.5	414.1	430.6	380.9	349.1	351.8	-81.3	-139.9	-150.0	-17.6	-28.6	-29.9
Gas	169.7	194.9	220.3	251.4	285.9	309.7	-15.2	0.9	8.9	-5.7	0.3	2.9
Electricity	156.0	169.4	191.6	212.2	233.9	249.9	-16.1	-29.9	-46.4	-7.0	-11.3	-15.7
Heat (from CHP and District Heating)	35.2	39.3	42.1	47.7	57.2	64.4	-4.2	-3.5	-2.2	-8.1	-5.7	-3.3
Other	30.3	30.6	34.5	57.0	70.8	70.8	17.7	29.8	30.5	44.9	72.8	75.6
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3052.0**	**3117.5**	**2621.4**	**2511.7**	**2503.9**	**-583.6**	**-932.3**	**-1164.8**	**-18.2**	**-27.1**	**-31.7**
Electricity and Steam production	997.6	947.7	948.3	725.4	630.4	566.4	-226.5	-469.5	-714.2	-23.8	-42.7	-55.8
Energy Branch	129.8	144.4	145.4	117.1	141.0	147.0	-18.1	9.4	19.4	-13.4	7.1	15.2
Industry	576.2	526.5	509.3	413.5	398.5	413.6	-44.9	-61.6	-52.7	-9.8	-13.4	-11.3
Residential	436.4	417.4	412.9	395.6	390.4	385.6	-36.7	-50.3	-48.6	-8.5	-11.4	-11.2
Tertiary	203.5	212.7	199.6	175.3	183.5	195.8	-27.3	-22.9	-24.0	-13.5	-11.1	-10.9
Transport	738.5	803.2	902.2	794.5	767.9	795.5	-230.0	-337.4	-344.7	-22.4	-30.5	-30.2
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**85.1**	**81.5**	**81.2**	**-18.9**	**-30.2**	**-37.8**	-18.2	-27.1	-31.7

See explanations on the last page of the Appendix

Source: PRIMES

EU15: EXTENDED POLICY OPTIONS CASE | **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	131.6	104.8	84.6	-13.5	-16.7	-17.0	-9.3	-13.7	-16.7
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	3.7	3.7	3.7	-0.4	-0.6	-0.7	-9.3	-13.7	-16.7
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7261	7819	8293	-545	-1018	-1594	-7.0	-11.5	-16.1
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	1.83	1.76	1.75	-0.20	-0.32	-0.39	-9.8	-15.4	-18.1
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	6.8	6.4	6.4	-1.5	-2.4	-3.0	-18.2	-27.1	-31.7
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.3	364.8	241.4	184.1	148.0	-53.7	-68.3	-68.8	-18.2	-27.1	-31.7
Import Dependency %	47.6	46.6	49.4	48.3	55.0	59.5	-6.0	-7.9	-8.4	-11.1	-12.5	-12.3
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	76.1	64.0	55.2	-2.8	-3.8	-2.5	-3.5	-5.7	-4.3
Residential (Energy on Private Income)	100.0	97.6	88.2	73.2	59.3	47.8	-4.0	-6.0	-6.8	-5.2	-9.1	-12.4
Tertiary (Energy on Value added)	100.0	101.8	90.9	69.4	59.5	51.6	-9.0	-9.0	-10.1	-11.5	-13.2	-16.3
Transport (Energy on GDP)	100.0	101.2	99.5	74.7	61.9	52.5	-15.8	-16.6	-13.6	-17.4	-21.2	-20.6
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.21	0.17	0.14	-0.05	-0.09	-0.13	-17.9	-36.0	-48.6
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.83	1.71	1.68	-0.14	-0.19	-0.16	-7.0	-9.8	-8.5
Industry	2.20	2.06	1.90	1.43	1.30	1.25	-0.10	-0.12	-0.10	-6.5	-8.2	-7.3
Residential	1.91	1.77	1.69	1.54	1.51	1.51	-0.06	-0.04	0.02	-3.5	-2.5	1.4
Tertiary	1.76	1.66	1.50	1.33	1.27	1.25	-0.03	0.03	0.08	-2.2	2.3	6.5
Transport	2.91	2.91	2.92	2.69	2.50	2.46	-0.17	-0.34	-0.34	-6.1	-11.8	-12.2
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**674.1**	**761.3**	**853.9**	**-14.6**	**-51.3**	**-97.1**	**-2.1**	**-6.3**	**-10.2**
Nuclear		126.2	131.0	121.9	98.2	96.2	0.0	-1.9	-8.8	0.0	-1.9	-8.4
Hydro (pumping excluded)		87.1	89.8	100.9	107.3	110.2	3.9	6.3	6.5	4.0	6.2	6.3
Wind and solar		2.5	12.9	75.1	129.4	183.2	4.7	34.0	49.0	6.7	35.7	36.5
Thermal		322.9	344.8	376.3	426.4	464.3	-23.2	-89.7	-143.8	-5.8	-17.4	-23.6
of which cogeneration units		*59.3*	*77.1*	*128.8*	*164.5*	*175.5*	*26.5*	*34.6*	*29.1*	*25.9*	*26.6*	*19.9*
Open cycle(incl. biomass-waste)		281.8	276.9	228.9	145.5	112.6	14.3	9.7	-0.7	6.6	7.2	-0.7
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	2.8	4.1	20.0	2.3	-47.5	-99.0	513.1	-92.0	-83.2
Gas Turbines Combined Cycle		20.0	46.0	123.2	225.8	209.0	-34.1	-53.4	-114.0	-21.7	-19.1	-35.3
Small Gas Turbines		20.3	21.0	20.0	35.1	34.4	-5.9	-13.1	-17.0	-22.6	-27.2	-33.1
Fuel Cells		0.0	0.0	0.0	14.4	86.6	0.0	14.4	86.6			
Geothermal heat		0.7	1.0	1.3	1.5	1.8	0.1	0.2	0.3	8.5	16.7	24.9
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.9	45.5	51.6	56.2	1.5	3.6	6.5	3.5	7.4	13.1
Load factor for gross electric capacities (%)		48.9	50.8	47.7	45.8	43.1	-2.5	-2.7	-3.0	-5.0	-5.6	-6.6
CHP indicator (% of electricity from CHP)		9.2	10.3	20.3	21.7	23.7	7.6	7.9	9.6	60.4	56.9	67.7
Non fossil fuels in electricity generation (%)		49.9	49.3	55.8	54.0	55.6	7.6	12.9	17.4	15.8	31.5	45.4
nuclear		35.1	33.6	28.7	22.6	19.9	-0.8	0.1	0.5	-2.7	0.4	2.8
renewable energy forms		14.8	15.8	27.1	31.4	35.7	8.4	12.8	16.8	45.0	69.0	89.2
of which waste		*1.0*	*1.2*	*1.1*	*0.8*	*1.1*	*-0.3*	*-0.5*	*0.0*	*-19.3*	*-37.9*	*3.2*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5809.0**	**6691.5**	**7534.3**	**-8.1**	**-8.9**	**-5.9**	**-0.1**	**-0.1**	**-0.1**
public road transport	368.8	382.2	412.6	479.8	511.7	534.5	57.2	63.3	69.3	13.5	14.1	14.9
private cars and motorcycles	3325.6	3634.5	3938.8	4471.9	5074.9	5624.1	-94.4	-92.3	-80.2	-2.1	-1.8	-1.4
rail transport	316.4	320.9	356.0	441.6	507.5	559.5	74.9	86.4	96.7	20.4	20.5	20.9
aviation	157.3	201.5	281.5	377.0	552.4	763.7	-44.7	-65.3	-90.9	-10.6	-10.6	-10.6
inland navigation	28.3	31.4	33.0	38.6	45.0	52.5	-1.1	-1.0	-0.8	-2.7	-2.2	-1.6
travel per person (km per capita)	11465	12240	13261	14978	17138	19367	-21	-23	-15	-0.1	-0.1	-0.1
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2347.8**	**2892.7**	**3497.8**	**-2.7**	**-4.1**	**-3.7**	**-0.1**	**-0.1**	**-0.1**
trucks	946.0	1114.6	1327.2	1654.0	2092.4	2600.9	-88.8	-105.0	-119.3	-5.1	-4.8	-4.4
rail transport	234.9	220.2	249.3	321.9	364.2	398.2	58.3	66.2	72.9	22.1	22.2	22.4
inland navigation	257.1	266.9	296.1	371.9	436.1	498.8	27.8	34.7	42.6	8.1	8.6	9.3
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	207	0	0	0	-0.1	-0.1	-0.1
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**294.9**	**306.9**	**323.1**	**-62.3**	**-82.5**	**-83.6**	**-17.4**	**-21.2**	**-20.6**
public road transport	6.3	5.9	5.8	6.0	5.6	5.3	0.0	-0.2	0.0	0.1	-3.9	0.1
private cars and motorcycles	130.2	136.6	145.5	135.3	126.3	119.9	-18.8	-24.6	-22.3	-12.2	-16.3	-15.7
trucks	76.0	86.5	101.0	108.8	124.2	138.9	-23.9	-35.2	-38.5	-18.0	-22.1	-21.7
rail transport	6.9	7.5	7.7	6.5	5.5	5.7	-0.3	0.0	0.4	-4.7	-0.1	7.4
aviation	27.8	32.5	43.8	32.0	38.2	45.6	-19.2	-22.4	-23.2	-37.5	-37.0	-33.7
inland navigation	6.7	6.7	5.3	6.2	7.0	7.7	-0.1	-0.1	0.0	-1.2	-1.0	-0.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	30.8	26.2	23.4	-6.6	-7.0	-6.0	-17.6	-21.1	-20.3
freight transport (toe/Mtkm)	57.8	58.5	57.3	49.4	45.5	42.0	-10.1	-12.1	-10.9	-17.0	-21.0	-20.7

Source: PRIMES

NMS: EXTENDED POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**108.6**	**84.8**	**69.9**	**-8.7**	**-20.6**	**-18.1**	**-7.5**	**-19.6**	**-20.6**
Solids	140.9	126.7	104.0	65.8	40.0	33.0	-17.6	-30.2	-26.5	-21.1	-43.0	-44.5
Oil	2.6	3.0	3.1	2.3	2.3	2.1	-0.2	-0.2	-0.2	-6.8	-7.7	-7.6
Natural gas	6.7	7.4	6.1	5.9	5.4	4.9	0.0	0.0	0.0	0.0	-0.5	-0.1
Nuclear	15.5	14.1	14.8	14.6	14.9	5.3	-0.4	0.0	0.0	-2.4	0.3	0.0
Renewable energy sources	3.0	6.3	8.0	19.9	22.2	24.5	9.4	9.8	8.6	89.8	79.4	54.0
Hydro	1.1	1.3	1.4	2.1	2.1	2.3	0.0	0.0	0.1	2.4	0.6	3.7
Biomass	1.4	4.6	6.1	14.1	14.5	14.8	7.8	8.1	6.8	124.8	127.6	85.9
Waste	0.5	0.3	0.5	2.5	2.7	2.7	1.2	1.2	0.9	86.7	78.9	51.5
Wind	0.0	0.0	0.0	0.7	1.8	3.4	0.1	0.0	0.2	11.5	-2.0	7.6
Solar and others	0.0	0.0	0.0	0.6	1.0	1.3	0.3	0.5	0.5	113.2	106.0	65.7
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-16.2	-20.4	-25.0
Net Imports	**66.3**	**50.4**	**61.4**	**78.5**	**103.2**	**112.8**	**-13.7**	**-24.4**	**-40.7**	**-14.8**	**-19.1**	**-26.5**
Solids	-14.6	-20.7	-15.9	-8.0	-5.4	-4.6	-0.8	-8.3	-22.6	10.9	-288.8	-125.9
Oil	49.9	45.0	47.3	47.4	48.2	50.0	-8.2	-15.1	-18.7	-14.8	-23.8	-27.3
Crude oil and Feedstocks	43.4	36.7	41.3	39.4	40.3	41.9	-6.8	-12.8	-16.4	-14.7	-24.1	-28.1
Oil products	6.5	8.3	6.0	8.0	7.9	8.1	-1.4	-2.3	-2.4	-15.0	-22.3	-22.8
Natural gas	31.2	26.2	31.5	40.3	61.6	68.3	-4.7	-1.0	0.6	-10.4	-1.6	0.9
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**186.1**	**186.8**	**181.5**	**-22.4**	**-44.9**	**-58.8**	**-10.7**	**-19.4**	**-24.5**
Solids	127.8	108.2	90.8	57.9	34.6	28.3	-18.4	-38.5	-49.1	-24.1	-52.7	-63.4
Oil	50.4	46.6	48.7	48.7	49.3	50.9	-8.3	-15.2	-18.9	-14.6	-23.6	-27.0
Natural gas	37.1	33.8	37.3	46.2	67.1	73.3	-4.7	-1.1	0.6	-9.2	-1.6	0.8
Nuclear	15.5	14.1	14.8	14.6	14.9	5.3	-0.4	0.0	0.0	-2.4	0.3	0.0
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	19.9	22.2	24.5	9.4	9.8	8.6	89.8	79.4	54.0
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	31.1	18.5	15.6	-5.5	-13.0	-16.6	-15.0	-41.3	-51.5
Oil	21.6	22.3	24.6	26.2	26.4	28.0	-1.2	-1.4	-1.0	-4.3	-5.2	-3.4
Natural gas	15.9	16.2	18.8	24.8	35.9	40.4	0.4	6.5	10.1	1.7	22.1	33.4
Nuclear	6.6	6.7	7.5	7.8	8.0	2.9	0.7	1.6	0.7	9.3	24.4	32.3
Renewable energy forms	1.3	3.0	4.1	10.7	11.9	13.5	5.7	6.5	6.9	112.6	122.5	103.9
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**355.2**	**423.7**	**430.5**	**-36.9**	**-74.5**	**-120.6**	**-9.4**	**-15.0**	**-21.9**
Nuclear	60.0	54.3	57.4	57.1	58.3	21.4	-1.4	0.1	0.0	-2.4	0.3	0.0
Hydro & wind	12.9	15.5	15.7	31.5	46.2	66.5	1.4	-0.3	3.6	4.5	-0.6	5.8
Thermal (incl. biomass)	243.7	230.7	250.6	266.5	319.2	342.6	-36.8	-74.4	-124.2	-12.1	-18.9	-26.6
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**62.8**	**58.8**	**56.9**	**-12.7**	**-27.1**	**-39.2**	**-16.8**	**-31.6**	**-40.8**
Solids	62.2	57.2	56.5	40.2	21.9	17.5	-17.3	-36.6	-47.5	-30.1	-62.5	-73.1
Oil	4.9	4.4	3.2	2.7	1.9	1.8	-0.8	-0.5	-0.9	-22.1	-20.0	-32.1
Gas	5.3	4.0	6.3	11.2	25.4	28.2	-1.5	2.5	2.5	-12.2	10.7	9.9
Biomass - Waste	0.3	0.1	0.4	8.8	9.6	9.4	7.0	7.5	6.6	384.1	362.2	233.4
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**60.9**	**60.2**	**62.7**	**-5.1**	**-11.1**	**-15.0**	**-7.7**	**-15.5**	**-19.3**
Refineries	46.7	40.1	45.2	44.0	45.3	47.5	-5.7	-11.7	-15.7	-11.5	-20.5	-24.9
District heating	19.3	12.1	8.5	4.1	2.8	2.1	-0.4	-0.9	-0.7	-9.3	-23.8	-25.8
Biofuels and hydrogen production	0.0	0.0	0.0	1.8	3.1	4.4	1.8	2.6	2.7	2696.9	627.6	160.4
Others	30.5	23.1	17.7	11.0	9.0	8.8	-0.7	-1.1	-1.3	-5.8	-11.2	-12.8
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**8.5**	**8.2**	**7.6**	**-1.2**	**-1.7**	**-1.8**	**-11.9**	**-17.5**	**-18.9**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**12.9**	**14.3**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**	**-0.1**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**119.9**	**129.2**	**135.6**	**-12.4**	**-23.9**	**-29.5**	**-9.4**	**-15.6**	**-17.9**
by sector												
Industry	65.0	47.7	40.4	38.1	39.3	41.6	-1.4	-2.8	-2.3	-3.6	-6.7	-5.3
energy intensive industries	32.5	27.9	26.2	24.7	24.5	25.1	-1.0	-2.0	-1.8	-3.8	-7.6	-6.6
other industrial sectors	32.4	19.7	14.2	13.4	14.8	16.5	-0.4	-0.8	-0.5	-3.1	-5.1	-3.2
Residential	40.0	41.2	34.4	35.4	38.4	39.4	-2.3	-6.4	-8.3	-6.1	-14.3	-17.5
Tertiary	24.9	19.6	21.5	21.6	23.4	23.9	-3.5	-5.2	-7.6	-13.8	-18.1	-24.1
Transport	19.9	19.8	22.9	24.8	28.1	30.7	-5.3	-9.5	-11.2	-17.6	-25.2	-26.7
by fuel												
Solids	40.9	33.8	21.4	12.9	9.3	7.6	-0.9	-1.6	-1.4	-6.7	-14.7	-15.7
Oil	32.7	29.6	33.6	35.2	35.9	36.5	-6.1	-12.7	-16.4	-14.7	-26.1	-31.0
Gas	26.5	24.6	25.4	31.1	36.3	40.0	-2.2	-3.5	-2.6	-6.7	-8.9	-6.2
Electricity	20.5	18.5	19.6	22.6	28.1	29.6	-2.5	-5.1	-8.5	-10.0	-15.5	-22.3
Heat (from CHP and District Heating)	27.7	17.4	13.5	12.1	13.1	14.8	-1.0	-1.9	-2.2	-7.8	-12.4	-12.8
Other	1.8	4.7	5.8	6.0	6.4	7.1	0.3	1.0	1.6	6.1	17.8	28.7
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**443.8**	**397.0**	**386.5**	**-108.4**	**-199.6**	**-248.4**	**-19.6**	**-33.5**	**-39.1**
Electricity and Steam production	343.4	295.0	280.1	206.8	160.0	146.1	-76.6	-143.1	-186.4	-27.0	-47.2	-56.1
Energy Branch	14.4	19.5	18.7	9.7	11.4	12.7	-0.9	0.1	1.3	-8.1	0.5	11.4
Industry	137.0	118.2	96.4	81.5	76.9	77.5	-4.5	-8.9	-8.1	-5.3	-10.3	-9.4
Residential	83.2	72.9	49.7	46.6	46.2	44.4	-2.7	-8.3	-8.6	-5.5	-15.3	-16.2
Tertiary	53.3	38.3	37.2	32.8	30.0	29.5	-4.2	-4.5	-5.5	-11.3	-13.0	-15.6
Transport	56.1	55.9	65.3	66.4	72.4	76.2	-19.5	-34.9	-41.2	-22.7	-32.5	-35.1
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**64.6**	**57.8**	**56.2**	**-15.8**	**-29.0**	**-36.1**	-19.6	-33.5	-39.17

See explanations on the last page of the Appendix

Source: PRIMES

NMS: EXTENDED POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	324.2	227.6	164.9	-39.0	-54.7	-53.4	-10.7	-19.4	-24.5
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.5	2.6	2.6	-0.3	-0.6	-0.9	-10.7	-19.4	-24.5
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	4839	5912	6227	-502	-1039	-1744	-9.4	-15.0	-21.9
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.39	2.13	2.13	-0.26	-0.45	-0.51	-10.0	-17.5	-19.4
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	6.0	5.5	5.6	-1.5	-2.8	-3.6	-19.6	-33.5	-39.1
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	773.4	483.6	351.3	-188.9	-243.2	-225.8	-19.6	-33.5	-39.1
Import Dependency %	28.3	24.1	30.8	42.0	54.9	61.7	-2.0	0.1	-1.8	-4.6	0.2	-2.9
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	34.8	25.6	21.6	-1.3	-1.8	-1.2	-3.6	-6.7	-5.3
Residential (Energy on Private Income)	100.0	106.5	74.2	52.6	38.9	29.7	-3.4	-6.5	-6.3	-6.1	-14.3	-17.5
Tertiary (Energy on Value added)	100.0	74.8	67.2	45.3	33.1	24.3	-7.2	-7.3	-7.7	-13.8	-18.1	-24.1
Transport (Energy on GDP)	100.0	102.9	97.4	72.2	57.4	46.8	-15.4	-19.3	-17.1	-17.6	-25.2	-26.7
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.40	0.27	0.24	-0.10	-0.17	-0.20	-19.2	-38.1	-45.6
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.90	1.75	1.68	-0.06	-0.10	-0.08	-2.9	-5.3	-4.7
Industry	2.11	2.48	2.38	2.14	1.96	1.86	-0.04	-0.08	-0.08	-1.8	-3.9	-4.4
Residential	2.08	1.77	1.44	1.31	1.20	1.13	0.01	-0.01	0.02	0.7	-1.1	1.6
Tertiary	2.14	1.95	1.73	1.52	1.28	1.24	0.04	0.07	0.12	2.9	6.1	11.2
Transport	2.82	2.82	2.85	2.68	2.57	2.48	-0.18	-0.28	-0.32	-6.3	-9.9	-11.4
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**89.1**	**115.8**	**134.4**	**-6.0**	**-18.3**	**-32.8**	**-6.3**	**-13.7**	**-19.6**
Nuclear		8.4	9.3	7.9	7.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Hydro (pumping excluded)		6.1	6.4	8.0	8.7	8.9	0.3	0.5	0.5	3.6	5.8	6.0
Wind and solar		0.0	0.0	3.1	9.8	16.6	0.3	1.1	1.7	12.1	12.1	11.1
Thermal		64.0	61.9	70.1	89.4	106.0	-6.6	-19.9	-35.0	-8.6	-18.2	-24.8
of which cogeneration units		*28.1*	*26.3*	*32.8*	*40.8*	*46.8*	*5.4*	*2.6*	*-5.5*	*19.8*	*6.8*	*-10.6*
Open cycle (incl. biomass-waste)		61.9	58.6	54.2	31.5	16.7	-1.7	-8.1	-17.4	-3.1	-20.5	-51.1
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.8	9.0	11.1	0.3	-6.0	-19.8	53.7	-39.9	-64.1
Gas Turbines Combined Cycle		0.4	1.4	9.9	38.0	51.5	-2.3	-1.5	-10.1	-19.1	-3.9	-16.3
Small Gas Turbines		1.7	1.8	5.2	9.2	7.7	-2.8	-6.0	-6.7	-35.4	-39.3	-46.4
Fuel Cells		0.0	0.0	0.0	1.7	19.0	0.0	1.7	19.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	38.5	48.8	54.4	2.1	7.4	10.4	5.7	17.8	23.7
Load factor for gross electric capacities (%)		43.6	47.6	45.5	41.8	36.6	-1.6	-0.6	-1.1	-3.3	-1.5	-2.8
CHP indicator (% of electricity from CHP)		29.4	30.4	38.3	35.4	41.6	9.9	8.1	10.0	35.1	29.7	31.5
Non fossil fuels in electricity generation (%)		23.4	23.1	35.4	34.6	30.8	11.2	12.1	13.5	46.3	54.0	78.5
nuclear		18.1	17.7	16.1	13.8	5.0	1.2	2.1	1.1	7.7	17.9	28.0
renewable energy forms		5.3	5.4	19.3	20.9	25.8	10.0	10.1	12.5	108.6	93.0	93.3
of which waste		*0.0*	*0.1*	*1.6*	*1.4*	*1.5*	*1.0*	*1.0*	*1.1*	*170.2*	*225.1*	*308.1*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**615.4**	**807.0**	**997.8**	**-0.3**	**-1.6**	**-0.9**	**0.0**	**-0.2**	**-0.1**
public road transport	115.7	87.0	81.2	79.4	82.9	88.9	-1.8	-1.7	-1.5	-2.2	-2.0	-1.7
private cars and motorcycles	268.0	315.8	352.9	450.7	609.4	755.8	-8.5	-11.8	-14.4	-1.8	-1.9	-1.9
rail transport	91.9	50.8	46.3	58.6	70.8	91.2	10.4	12.5	16.4	21.6	21.5	21.9
aviation	11.2	14.0	16.8	26.0	43.2	61.1	-0.4	-0.8	-1.4	-1.5	-1.7	-2.2
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	-0.9	-0.7	-0.5
travel per person (km per capita)	6489	6227	6662	8384	11261	14431	-4	-23	-13	0.0	-0.2	-0.1
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**338.1**	**439.0**	**538.5**	**-1.3**	**-3.2**	**-2.8**	**-0.4**	**-0.7**	**-0.5**
trucks	118.4	119.0	155.5	197.1	285.9	374.3	-26.8	-33.6	-38.2	-12.0	-10.5	-9.3
rail transport	205.2	137.8	118.7	140.3	152.3	163.4	25.6	30.5	35.4	22.3	25.0	27.7
inland navigation	1.0	1.3	0.8	0.7	0.7	0.8	-0.1	-0.1	-0.1	-16.7	-13.9	-11.9
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	589	535	489	-2	-4	-3	-0.4	-0.7	-0.5
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**24.8**	**28.1**	**30.7**	**-5.3**	**-9.5**	**-11.2**	**-17.6**	**-25.2**	**-26.7**
public road transport	1.4	1.0	1.2	1.2	1.0	0.9	0.0	-0.1	-0.2	0.8	-10.3	-19.6
private cars and motorcycles	7.9	9.5	11.6	12.5	13.7	14.1	-2.3	-4.0	-5.3	-15.4	-22.5	-27.3
trucks	7.0	6.7	7.5	8.8	11.0	13.2	-2.3	-4.1	-4.9	-20.8	-27.2	-26.9
rail transport	2.0	1.4	1.3	1.1	1.0	0.9	0.0	0.0	0.0	-0.7	-4.6	-3.0
aviation	1.3	1.2	1.3	1.2	1.4	1.7	-0.7	-1.2	-0.8	-36.8	-45.7	-33.6
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.1	-9.1	-11.9
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	24.9	20.6	17.1	-4.8	-6.5	-6.3	-16.2	-24.1	-26.9
freight transport (toe/Mtkm)	24.6	28.8	30.0	27.9	26.3	25.5	-6.7	-9.2	-8.9	-19.3	-25.8	-26.0

Source: PRIMES

EU25: FULL POLICY OPTIONS CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**872.3**	**800.3**	**783.8**	**11.9**	**59.5**	**122.9**	**1.4**	**8.0**	**18.6**
Solids	350.8	264.7	203.4	124.5	63.6	44.4	-29.3	-62.7	-58.1	-19.1	-49.7	-56.7
Oil	120.3	162.2	163.5	121.3	99.7	84.9	-10.4	-2.4	-1.6	-7.9	-2.4	-1.8
Natural gas	139.6	174.0	196.6	191.6	148.4	118.7	-5.3	0.8	1.6	-2.7	0.6	1.3
Nuclear	196.9	215.3	237.7	222.3	248.9	276.8	-23.0	35.4	91.5	-9.4	16.6	49.4
Renewable energy sources	69.2	80.7	96.1	212.7	239.7	259.0	80.0	88.4	89.5	60.3	58.4	52.8
Hydro	23.4	26.3	29.0	30.6	32.5	33.9	0.5	0.8	1.7	1.7	2.6	5.2
Biomass	31.1	35.4	42.2	122.4	130.4	132.6	65.0	65.5	58.9	113.0	100.9	79.9
Waste	12.3	15.9	19.3	30.6	35.2	36.2	4.9	7.5	9.0	19.2	26.9	33.2
Wind	0.1	0.4	1.9	15.3	27.0	37.8	1.4	6.9	11.0	10.3	34.2	40.9
Solar and others	0.1	0.3	0.4	9.7	10.6	13.3	8.0	7.7	8.0	473.9	260.0	151.8
Geothermal	2.2	2.5	3.3	4.0	4.1	5.1	0.2	0.1	0.9	5.9	2.7	21.2
Net Imports	**711.6**	**701.7**	**799.3**	**791.4**	**899.5**	**961.6**	**-183.0**	**-305.0**	**-400.2**	**-18.8**	**-25.3**	**-29.4**
Solids	75.2	73.8	91.4	66.5	46.7	36.4	-23.3	-79.6	-161.1	-26.0	-63.0	-81.6
Oil	510.8	491.8	519.6	462.2	449.6	466.8	-110.3	-176.4	-184.1	-19.3	-28.2	-28.3
Crude oil and Feedstocks	480.2	471.5	496.8	441.8	438.4	463.7	-108.0	-172.7	-181.3	-19.6	-28.3	-28.1
Oil products	30.6	20.3	22.8	20.4	11.2	3.1	-2.3	-3.7	-2.9	-10.0	-24.8	-48.2
Natural gas	123.5	134.8	186.2	260.5	403.3	458.8	-49.4	-46.9	-52.3	-16.0	-10.4	-10.2
Electricity	2.2	1.4	2.1	2.1	-0.1	-0.3	0.0	-2.2	-2.7	0.0	-107.2	-113.3
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1614.7**	**1645.1**	**1684.2**	**-169.4**	**-243.8**	**-275.5**	**-9.5**	**-12.9**	**-14.1**
Solids	430.6	346.0	303.2	191.0	110.4	80.7	-52.7	-142.3	-219.2	-21.6	-56.3	-73.1
Oil	596.2	622.2	635.6	534.5	494.5	490.5	-119.0	-177.0	-183.9	-18.2	-26.4	-27.3
Natural gas	259.2	307.1	376.0	452.1	551.7	577.5	-54.8	-46.0	-50.8	-10.8	-7.7	-8.1
Nuclear	196.9	215.3	237.7	222.3	248.9	276.8	-23.0	35.4	91.5	-9.4	16.6	49.4
Electricity	2.2	1.4	2.1	2.1	-0.1	-0.3	0.0	-2.2	-2.7	0.0	-107.2	-113.3
Renewable energy forms	69.2	80.7	96.1	212.7	239.7	259.0	80.0	88.4	89.5	60.3	58.4	52.8
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	11.8	6.7	4.8	-1.8	-6.7	-10.5	-13.4	-49.8	-68.7
Oil	38.4	39.6	38.5	33.1	30.1	29.1	-3.5	-5.5	-5.3	-9.6	-15.4	-15.4
Natural gas	16.7	19.5	22.8	28.0	33.5	34.3	-0.4	1.9	2.2	-1.4	6.0	7.0
Nuclear	12.7	13.7	14.4	13.8	15.1	16.4	0.0	3.8	7.0	0.1	33.8	73.8
Renewable energy forms	4.5	5.1	5.8	13.2	14.6	15.4	5.7	6.6	6.7	77.1	81.9	77.8
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3170.3**	**3508.5**	**3703.1**	**-248.8**	**-440.1**	**-694.1**	**-7.3**	**-11.1**	**-15.8**
Nuclear	780.0	864.4	921.2	865.1	960.9	1049.9	-87.3	127.4	283.4	-9.2	15.3	37.0
Hydro & wind	272.7	309.7	359.5	535.2	693.8	863.1	22.6	91.3	157.6	4.4	15.2	22.3
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1770.0	1853.8	1790.0	-184.1	-658.9	-1135.1	-9.4	-26.2	-38.8
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**362.7**	**335.4**	**303.8**	**-50.6**	**-147.5**	**-237.1**	**-12.2**	**-30.5**	**-43.8**
Solids	248.2	221.1	210.1	129.8	59.0	33.1	-45.4	-133.3	-211.1	-25.9	-69.3	-86.5
Oil (including refinery gas)	53.7	53.9	41.5	12.6	10.0	8.3	-11.2	-3.6	-1.2	-47.0	-26.4	-12.7
Gas	50.4	70.0	112.6	149.6	187.8	179.2	-35.5	-57.9	-76.1	-19.2	-23.6	-29.8
Biomass - Waste	10.3	13.6	17.5	67.1	74.8	78.5	41.2	47.1	50.3	159.8	170.2	178.8
Geothermal heat	1.9	2.1	3.0	3.7	3.8	4.9	0.3	0.2	0.9	8.1	4.5	24.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**713.8**	**701.2**	**714.7**	**-93.3**	**-141.9**	**-157.0**	**-11.6**	**-16.8**	**-18.0**
Refineries	641.3	675.9	710.9	625.2	597.2	606.6	-108.1	-169.8	-181.9	-14.7	-22.1	-23.1
District heating	31.7	23.1	14.5	9.1	10.2	7.9	-1.7	1.3	-0.9	-15.3	14.9	-9.8
Biofuels and hydrogen production	0.0	0.2	0.6	30.5	49.6	57.6	20.3	31.4	30.2	198.7	173.2	109.9
Others	127.6	81.2	68.3	49.0	44.2	42.5	-3.9	-4.9	-4.5	-7.3	-10.0	-9.5
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**67.8**	**63.6**	**61.4**	**-9.3**	**-13.6**	**-15.8**	**-12.0**	**-17.7**	**-20.5**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.4**	**121.4**	**124.8**	**0.1**	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1092.3**	**1145.5**	**1200.6**	**-116.6**	**-172.4**	**-193.5**	**-9.6**	**-13.1**	**-13.9**
by sector												
Industry (1)	327.2	303.3	309.1	326.9	346.2	372.0	-12.0	-21.2	-16.5	-3.5	-5.8	-4.3
energy intensive industries	212.9	198.9	202.0	207.8	211.6	216.8	-8.5	-14.6	-12.2	-4.0	-6.5	-5.3
other industrial sectors	114.3	104.4	107.0	119.1	134.6	155.2	-3.4	-6.6	-4.3	-2.8	-4.7	-2.7
Residential	268.1	277.2	279.1	292.2	296.8	294.6	-16.4	-32.3	-44.2	-5.3	-9.8	-13.1
Tertiary	140.2	147.5	154.2	153.6	167.4	180.2	-20.6	-26.9	-37.9	-11.8	-13.8	-17.4
Transport	273.7	295.6	332.0	319.6	335.0	353.9	-67.6	-92.0	-94.8	-17.5	-21.5	-21.1
by fuel (1)												
Solids	117.7	80.8	57.4	36.2	28.4	24.8	-6.1	-7.8	-7.3	-14.4	-21.5	-22.7
Oil	424.2	443.7	464.2	416.1	384.9	388.2	-87.4	-152.7	-166.5	-17.4	-28.4	-30.0
Gas	196.2	219.5	245.7	282.6	322.1	349.1	-17.4	-2.8	5.7	-5.8	-0.9	1.7
Electricity	176.5	187.9	211.3	234.7	262.5	280.6	-18.6	-34.6	-53.8	-7.4	-11.6	-16.1
Heat (from CHP and District Heating)	62.9	56.7	55.6	59.8	70.9	77.7	-5.2	-4.8	-5.9	-8.1	-6.4	-7.1
Other	32.1	35.3	40.3	62.9	76.7	80.2	18.0	30.2	34.3	40.0	65.1	74.8
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.9**	**3664.9**	**3064.7**	**2838.8**	**2766.7**	**-692.5**	**-1201.9**	**-1536.9**	**-18.4**	**-29.7**	**-35.7**
Electricity and Steam production	1341.0	1242.7	1228.3	931.4	721.4	590.9	-303.9	-681.6	-1022.2	-24.6	-48.6	-63.4
Energy Branch	144.2	163.9	164.0	127.0	152.2	159.5	-18.8	9.2	20.5	-12.9	6.4	14.7
Industry	713.2	644.8	605.7	494.9	475.1	490.0	-49.5	-70.7	-61.9	-9.1	-13.0	-11.2
Residential	519.7	490.4	462.6	442.3	436.5	430.1	-39.4	-58.7	-57.1	-8.2	-11.8	-11.7
Tertiary	256.8	251.0	236.7	208.1	213.2	224.5	-31.4	-27.8	-30.3	-13.1	-11.5	-11.9
Transport	794.6	859.1	967.5	860.9	840.4	871.7	-249.5	-372.3	-385.9	-22.5	-30.7	-30.7
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**81.3**	**75.3**	**73.4**	**-18.4**	**-31.9**	**-40.8**	-18.4	-29.7	-35.7

See explanations on the last page of the Appendix

Source: PRIMES

EU25: FULL POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	141.2	113.8	93.5	-14.8	-16.9	-15.3	-9.5	-12.9	-14.1
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.5	3.6	3.7	-0.4	-0.5	-0.6	-9.5	-12.9	-14.1
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	6874	7592	8083	-539	-952	-1515	-7.3	-11.1	-15.8
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	1.90	1.73	1.64	-0.21	-0.41	-0.55	-9.9	-19.3	-25.2
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	6.6	6.1	6.0	-1.5	-2.6	-3.4	-18.4	-29.7	-35.7
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	268.1	196.3	153.5	-60.6	-83.1	-85.3	-18.4	-29.7	-35.7
Import Dependency %	44.8	43.6	47.2	47.6	52.9	55.1	-5.5	-9.0	-12.2	-10.4	-14.5	-18.2
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	68.5	57.0	49.1	-2.5	-3.5	-2.2	-3.5	-5.8	-4.3
Residential (Energy on Private Income)	100.0	98.1	85.8	70.5	56.9	45.9	-4.0	-6.2	-6.9	-5.3	-9.8	-13.1
Tertiary (Energy on Value added)	100.0	96.7	86.8	66.0	56.2	48.1	-8.9	-9.0	-10.1	-11.8	-13.8	-17.4
Transport (Energy on GDP)	100.0	101.1	99.3	74.7	61.9	52.5	-15.8	-17.0	-14.1	-17.5	-21.5	-21.1
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.24	0.16	0.13	-0.05	-0.12	-0.17	-18.5	-42.7	-57.3
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.84	1.72	1.68	-0.13	-0.18	-0.15	-6.5	-9.4	-8.2
Industry	2.18	2.13	1.96	1.51	1.37	1.32	-0.09	-0.11	-0.10	-5.8	-7.6	-7.3
Residential	1.94	1.77	1.66	1.51	1.47	1.46	-0.05	-0.03	0.02	-3.0	-2.2	1.5
Tertiary	1.83	1.70	1.54	1.35	1.27	1.25	-0.02	0.03	0.08	-1.5	2.7	6.6
Transport	2.90	2.91	2.91	2.69	2.51	2.46	-0.17	-0.33	-0.34	-6.1	-11.7	-12.1
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**763.4**	**882.9**	**1007.4**	**-20.5**	**-63.8**	**-110.8**	**-2.6**	**-6.7**	**-9.9**
Nuclear		134.7	140.3	129.8	140.6	174.1	0.0	32.5	66.3	0.0	30.1	61.5
Hydro (pumping excluded)		93.3	96.2	108.8	116.0	119.1	4.2	6.7	7.0	4.0	6.2	6.2
Wind and solar		2.5	13.0	78.2	137.4	196.9	5.0	33.3	47.8	6.9	32.0	32.0
Thermal		386.9	406.7	446.5	489.0	517.2	-29.7	-136.3	-231.8	-6.2	-21.8	-30.9
of which cogeneration units		*87.3*	*103.4*	*161.7*	*206.4*	*220.7*	*32.1*	*38.3*	*22.0*	*24.7*	*22.8*	*11.1*
Open cycle(incl. biomass-waste)		343.8	335.6	283.1	175.3	128.8	12.5	0.0	-18.5	4.6	0.0	-12.6
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	3.6	12.9	19.0	2.6	-53.8	-130.9	271.3	-80.7	-87.3
Gas Turbines Combined Cycle		20.4	47.4	133.3	239.6	234.3	-36.3	-79.2	-150.3	-21.4	-24.8	-39.1
Small Gas Turbines		22.0	22.8	25.2	44.4	44.8	-8.7	-19.0	-21.0	-25.6	-30.0	-31.9
Fuel Cells		0.0	0.0	0.0	15.4	88.6	0.0	15.4	88.6			
Geothermal heat		0.7	1.0	1.3	1.5	1.8	0.1	0.2	0.3	8.5	16.7	24.9
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.2	44.3	50.3	54.3	1.7	3.5	5.7	4.0	7.5	11.6
Load factor for gross electric capacities (%)		48.2	50.4	47.4	45.4	42.0	-2.4	-2.3	-2.9	-4.8	-4.7	-6.5
CHP indicator (% of electricity from CHP)		11.5	12.6	22.3	22.6	24.3	7.9	7.1	8.0	54.5	45.9	49.0
Non fossil fuels in electricity generation (%)		46.8	46.4	53.5	56.8	61.7	8.1	18.1	26.1	17.8	46.6	73.3
nuclear		33.1	31.8	27.3	27.4	28.4	-0.6	6.3	10.9	-2.0	29.7	62.6
renewable energy forms		13.7	14.6	26.2	29.4	33.4	8.6	11.8	15.2	49.1	66.9	83.5
of which waste		*0.9*	*1.1*	*1.2*	*0.8*	*0.8*	*-0.1*	*-0.4*	*-0.2*	*-8.5*	*-30.4*	*-21.9*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6424.4**	**7498.6**	**8532.2**	**-8.4**	**-10.5**	**-6.7**	**-0.1**	**-0.1**	**-0.1**
public road transport	484.5	469.2	493.8	559.2	594.6	623.4	55.4	61.6	67.7	11.0	11.6	12.2
private cars and motorcycles	3593.6	3950.3	4291.6	4922.7	5684.2	6379.6	-102.9	-104.2	-95.0	-2.0	-1.8	-1.5
rail transport	408.3	371.7	402.3	500.2	578.5	651.2	85.3	99.2	113.6	20.6	20.7	21.1
aviation	168.5	215.5	298.3	403.0	595.6	824.8	-45.1	-66.0	-92.2	-10.1	-10.0	-10.1
inland navigation	28.9	31.9	33.6	39.3	45.7	53.3	-1.1	-1.0	-0.8	-2.7	-2.2	-1.5
travel per person (km per capita)	10618	11233	12174	13929	16227	18623	-18	-23	-15	-0.1	-0.1	-0.1
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2685.8**	**3331.7**	**4036.3**	**-4.0**	**-7.3**	**-6.5**	**-0.1**	**-0.2**	**-0.2**
trucks	1064.3	1233.6	1482.7	1851.1	2378.2	2974.8	-115.5	-138.7	-157.8	-5.9	-5.5	-5.0
rail transport	440.2	358.0	368.0	462.2	516.7	562.0	83.9	96.8	108.8	22.2	23.1	24.0
inland navigation	258.1	268.2	297.0	372.6	436.8	499.5	27.7	34.5	42.5	8.0	8.6	9.3
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	235	230	224	0	-1	0	-0.1	-0.2	-0.2
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**319.6**	**335.0**	**353.9**	**-67.6**	**-92.0**	**-94.8**	**-17.5**	**-21.5**	**-21.1**
public road transport	7.7	6.9	7.0	7.2	6.6	6.2	0.0	-0.3	-0.2	0.2	-5.0	-3.2
private cars and motorcycles	138.1	146.1	157.1	147.8	140.1	134.0	-21.1	-28.6	-27.6	-12.5	-16.9	-17.1
trucks	82.9	93.2	108.5	117.6	135.1	152.1	-26.2	-39.3	-43.4	-18.2	-22.5	-22.2
rail transport	8.8	8.9	9.0	7.7	6.5	6.6	-0.3	-0.1	0.4	-4.2	-0.8	5.9
aviation	29.1	33.8	45.1	33.1	39.6	47.2	-19.9	-23.6	-24.0	-37.5	-37.4	-33.7
inland navigation	7.0	6.7	5.4	6.2	7.1	7.8	-0.1	-0.1	0.0	-1.2	-0.8	-0.1
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	30.2	25.6	22.6	-6.4	-7.0	-6.0	-17.5	-21.4	-21.0
freight transport (toe/Mtkm)	51.7	54.4	53.8	46.7	43.0	39.8	-9.7	-11.7	-10.7	-17.2	-21.4	-21.1

Source: PRIMES

EU15: FULL POLICY OPTIONS CASE — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**764.0**	**713.4**	**703.7**	**21.0**	**77.9**	**130.8**	**2.8**	**12.3**	**22.8**
Solids	209.9	138.0	99.4	58.6	23.7	12.2	-11.7	-32.3	-30.8	-16.7	-57.7	-71.6
Oil	117.7	159.2	160.4	118.9	97.4	82.8	-10.3	-2.2	-1.4	-7.9	-2.2	-1.7
Natural gas	132.9	166.6	190.6	185.7	143.0	113.8	-5.3	0.9	1.6	-2.8	0.6	1.5
Nuclear	181.4	201.2	222.8	208.1	231.5	259.9	-22.3	32.8	79.9	-9.7	16.5	44.4
Renewable energy sources	66.3	74.4	88.1	192.8	217.7	235.0	70.6	78.8	81.4	57.8	56.7	53.0
Hydro	22.3	24.9	27.6	28.6	30.3	31.7	0.5	0.8	1.6	1.7	2.8	5.4
Biomass	29.7	30.8	36.1	108.3	116.0	118.2	57.1	57.4	52.4	111.6	98.0	79.7
Waste	11.9	15.6	18.7	28.1	32.6	33.6	3.7	6.4	8.2	15.4	24.4	32.3
Wind	0.1	0.4	1.9	14.7	25.1	34.4	1.4	6.9	10.8	10.2	37.9	45.6
Solar and others	0.1	0.2	0.3	9.1	9.6	12.0	7.7	7.1	7.5	540.4	291.9	167.3
Geothermal	2.2	2.5	3.3	4.0	4.1	5.1	0.2	0.1	0.9	5.9	2.7	21.2
Net Imports	**645.4**	**651.3**	**737.9**	**712.9**	**797.5**	**853.2**	**-169.4**	**-279.4**	**-355.0**	**-19.2**	**-25.9**	**-29.4**
Solids	89.9	94.4	107.2	74.5	52.1	40.7	-22.6	-71.3	-138.7	-23.2	-57.8	-77.3
Oil	460.9	446.7	472.4	414.8	401.4	416.7	-102.1	-161.3	-165.5	-19.7	-28.7	-28.4
Crude oil and Feedstocks	436.8	434.7	455.5	402.4	398.1	421.7	-101.2	-159.9	-165.0	-20.1	-28.7	-28.1
Oil products	24.1	12.0	16.9	12.4	3.3	-5.0	-0.9	-1.4	-0.5	-6.5	-30.1	10.9
Natural gas	92.3	108.6	154.7	220.3	342.9	395.0	-44.7	-44.6	-48.4	-16.9	-11.5	-10.9
Electricity	2.3	1.5	3.7	3.3	1.1	0.8	0.0	-2.2	-2.4	0.0	-67.5	-76.1
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1429.0**	**1457.4**	**1497.0**	**-146.7**	**-199.8**	**-222.5**	**-9.3**	**-12.1**	**-12.9**
Solids	302.8	237.7	212.4	133.1	75.9	53.0	-34.3	-103.6	-169.5	-20.5	-57.7	-76.2
Oil	545.8	575.6	586.9	485.8	445.3	439.6	-110.7	-161.8	-165.1	-18.6	-26.7	-27.3
Natural gas	222.1	273.4	338.7	405.9	485.9	508.8	-50.1	-43.7	-46.8	-11.0	-8.3	-8.4
Nuclear	181.4	201.2	222.8	208.1	231.5	259.9	-22.3	32.8	79.9	-9.7	16.5	44.4
Electricity	2.3	1.5	3.7	3.3	1.1	0.8	0.0	-2.2	-2.4	0.0	-67.5	-76.1
Renewable energy forms	66.3	74.4	88.1	192.8	217.7	235.0	70.6	78.8	81.4	57.8	56.7	53.0
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	9.3	5.2	3.5	-1.3	-5.6	-9.4	-12.3	-51.9	-72.7
Oil	41.3	42.2	40.4	34.0	30.6	29.4	-3.9	-6.1	-5.8	-10.2	-16.6	-16.5
Natural gas	16.8	20.0	23.3	28.4	33.3	34.0	-0.5	1.4	1.7	-1.8	4.3	5.2
Nuclear	13.7	14.8	15.3	14.6	15.9	17.4	-0.1	3.9	6.9	-0.4	32.5	65.9
Renewable energy forms	5.0	5.5	6.1	13.5	14.9	15.7	5.7	6.6	6.8	74.0	78.2	75.8
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**2815.8**	**3085.2**	**3268.1**	**-211.3**	**-365.3**	**-578.0**	**-7.0**	**-10.6**	**-15.0**
Nuclear	720.1	810.1	863.7	808.8	891.7	980.0	-85.1	116.4	234.9	-9.5	15.0	31.5
Hydro & wind	259.8	294.2	343.8	503.7	647.7	797.6	21.3	91.8	155.0	4.4	16.5	24.1
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1503.2	1545.7	1490.5	-147.5	-573.4	-967.9	-8.9	-27.1	-39.4
Fuel Inputs for Thermal Power Generation [1]	**291.8**	**295.1**	**318.3**	**299.9**	**278.2**	**252.6**	**-37.9**	**-118.8**	**-192.3**	**-11.2**	**-29.9**	**-43.2**
Solids	186.1	163.9	153.6	89.5	37.2	16.2	-28.1	-96.6	-163.0	-23.9	-72.2	-91.0
Oil (including refinery gas)	48.7	49.6	38.3	9.9	8.0	6.3	-10.4	-3.1	-0.4	-51.2	-27.9	-6.3
Gas	45.1	66.0	106.3	138.5	163.7	155.7	-33.9	-59.1	-73.9	-19.7	-26.5	-32.2
Biomass - Waste	10.0	13.5	17.1	58.3	65.5	69.5	34.3	39.8	44.2	142.8	155.5	174.4
Geothermal heat	1.9	2.1	3.0	3.7	3.8	4.9	0.3	0.2	0.9	8.1	4.5	24.0
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**652.9**	**641.0**	**651.7**	**-88.3**	**-130.8**	**-142.2**	**-11.9**	**-17.0**	**-17.9**
Refineries	594.6	635.8	665.7	581.2	551.9	559.1	-102.4	-158.1	-166.2	-15.0	-22.3	-22.9
District heating	12.4	11.0	6.0	5.0	7.4	5.6	-1.2	2.2	-0.3	-19.4	41.9	-5.4
Biofuels and hydrogen production	0.0	0.2	0.6	28.6	46.5	53.3	18.5	28.8	27.5	182.5	162.4	106.6
Others	97.1	58.1	50.6	38.0	35.2	33.7	-3.2	-3.7	-3.2	-7.8	-9.6	-8.6
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**59.3**	**55.4**	**53.8**	**-8.1**	**-11.9**	**-14.1**	**-12.0**	**-17.7**	**-20.8**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.4**	**108.5**	**110.5**	**0.1**	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**972.4**	**1016.2**	**1065.0**	**-104.2**	**-148.5**	**-164.0**	**-9.7**	**-12.8**	**-13.3**
by sector												
Industry [1]	262.2	255.6	268.7	288.8	306.9	330.4	-10.6	-18.4	-14.2	-3.5	-5.7	-4.1
energy intensive industries	180.4	170.9	175.8	183.1	187.1	191.7	-7.6	-12.6	-10.5	-4.0	-6.3	-5.2
other industrial sectors	81.9	84.7	92.9	105.7	119.8	138.7	-3.0	-5.8	-3.8	-2.8	-4.6	-2.6
Residential	228.1	236.0	244.7	256.8	258.5	255.2	-14.1	-25.9	-35.8	-5.2	-9.1	-12.3
Tertiary	115.3	127.9	132.7	132.0	144.0	156.3	-17.2	-21.7	-30.4	-11.5	-13.1	-16.3
Transport	253.8	275.7	309.1	294.9	306.9	323.1	-62.3	-82.5	-83.6	-17.4	-21.2	-20.6
by fuel [1]												
Solids	76.8	47.0	36.0	23.3	19.1	17.2	-5.1	-6.2	-5.9	-18.1	-24.5	-25.4
Oil	391.5	414.1	430.6	380.9	349.0	351.8	-81.3	-140.0	-150.1	-17.6	-28.6	-29.9
Gas	169.7	194.9	220.3	251.4	285.7	309.0	-15.2	0.7	8.2	-5.7	0.2	2.7
Electricity	156.0	169.4	191.6	212.2	234.4	250.9	-16.1	-29.4	-45.4	-7.0	-11.2	-15.3
Heat (from CHP and District Heating)	35.2	39.3	42.1	47.7	57.8	63.0	-4.2	-2.9	-3.6	-8.1	-4.8	-5.5
Other	30.3	30.6	34.5	57.0	70.2	73.0	17.7	29.3	32.7	44.9	71.4	81.1
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3052.0**	**3117.5**	**2620.8**	**2445.1**	**2392.7**	**-584.1**	**-998.9**	**-1275.9**	**-18.2**	**-29.0**	**-34.8**
Electricity and Steam production	997.6	947.7	948.3	724.7	564.8	457.3	-227.3	-535.1	-823.2	-23.9	-48.6	-64.3
Energy Branch	129.8	144.4	145.4	117.2	140.8	146.8	-17.9	9.2	19.2	-13.3	7.0	15.0
Industry	576.2	526.5	509.3	413.5	398.2	412.5	-44.9	-61.9	-53.8	-9.8	-13.4	-11.5
Residential	436.4	417.4	412.9	395.6	390.3	385.6	-36.7	-50.4	-48.6	-8.5	-11.4	-11.2
Tertiary	203.5	212.7	199.6	175.3	183.1	195.0	-27.3	-23.3	-24.7	-13.5	-11.3	-11.3
Transport	738.5	803.2	902.2	794.5	768.0	795.5	-230.0	-337.4	-344.7	-22.4	-30.5	-30.2
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**85.0**	**79.3**	**77.6**	**-19.0**	**-32.4**	**-41.4**	-18.2	-29.0	-34.8

See explanations on the last page of the Appendix

Source: PRIMES

EU15: FULL POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	131.6	106.8	88.5	-13.5	-14.6	-13.1	-9.3	-12.1	-12.9
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	3.7	3.7	3.8	-0.4	-0.5	-0.6	-9.3	-12.1	-12.9
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7260	7902	8401	-545	-936	-1486	-7.0	-10.6	-15.0
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	1.83	1.68	1.60	-0.20	-0.40	-0.54	-9.8	-19.3	-25.1
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	6.8	6.3	6.2	-1.5	-2.6	-3.3	-18.2	-29.0	-34.8
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.3	364.8	241.3	179.2	141.4	-53.8	-73.2	-75.4	-18.2	-29.0	-34.8
Import Dependency %	47.6	46.6	49.4	48.3	52.8	54.8	-6.0	-10.1	-13.0	-11.1	-16.1	-19.2
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	76.1	64.0	55.3	-2.8	-3.8	-2.4	-3.5	-5.7	-4.1
Residential (Energy on Private Income)	100.0	97.6	88.2	73.2	59.3	47.9	-4.0	-5.9	-6.7	-5.2	-9.1	-12.3
Tertiary (Energy on Value added)	100.0	101.8	90.9	69.4	59.6	51.6	-9.0	-9.0	-10.0	-11.5	-13.1	-16.3
Transport (Energy on GDP)	100.0	101.2	99.5	74.7	61.9	52.5	-15.8	-16.6	-13.6	-17.4	-21.2	-20.6
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.21	0.15	0.11	-0.05	-0.11	-0.16	-18.0	-43.2	-58.8
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.83	1.71	1.68	-0.14	-0.19	-0.16	-7.0	-9.9	-8.7
Industry	2.20	2.06	1.90	1.43	1.30	1.25	-0.10	-0.12	-0.10	-6.5	-8.3	-7.7
Residential	1.91	1.77	1.69	1.54	1.51	1.51	-0.06	-0.04	0.02	-3.5	-2.6	1.3
Tertiary	1.76	1.66	1.50	1.33	1.27	1.25	-0.03	0.03	0.07	-2.2	2.1	6.0
Transport	2.91	2.91	2.92	2.69	2.50	2.46	-0.17	-0.34	-0.34	-6.1	-11.8	-12.2
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**674.1**	**767.0**	**872.2**	**-14.6**	**-45.6**	**-78.8**	**-2.1**	**-5.6**	**-8.3**
Nuclear		126.2	131.0	121.9	130.9	163.9	0.0	30.8	58.9	0.0	30.8	56.2
Hydro (pumping excluded)		87.1	89.8	100.9	107.3	110.2	3.9	6.2	6.5	4.0	6.2	6.3
Wind and solar		2.5	12.9	75.1	127.6	180.4	4.7	32.3	46.2	6.7	33.9	34.4
Thermal		322.9	344.8	376.3	401.1	417.7	-23.2	-115.0	-190.4	-5.8	-22.3	-31.3
of which cogeneration units		*59.3*	*77.1*	*128.9*	*165.5*	*174.6*	*26.6*	*35.5*	*28.2*	*26.0*	*27.3*	*19.3*
Open cycle(incl. biomass-waste)		281.8	276.9	228.9	143.9	112.0	14.3	8.1	-1.3	6.6	6.0	-1.2
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	2.8	4.1	8.1	2.3	-47.5	-110.9	513.0	-92.0	-93.2
Gas Turbines Combined Cycle		20.0	46.0	123.3	203.1	187.3	-34.0	-76.2	-135.7	-21.6	-27.3	-42.0
Small Gas Turbines		20.3	21.0	20.0	34.9	37.0	-5.9	-13.2	-14.4	-22.6	-27.5	-28.0
Fuel Cells		0.0	0.0	0.0	13.6	71.5	0.0	13.6	71.5			
Geothermal heat		0.7	1.0	1.3	1.5	1.8	0.1	0.2	0.3	8.5	16.7	24.9
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.9	45.5	50.8	54.6	1.5	2.7	4.9	3.5	5.7	9.9
Load factor for gross electric capacities (%)		48.9	50.8	47.7	45.9	42.8	-2.5	-2.6	-3.4	-5.0	-5.3	-7.4
CHP indicator (% of electricity from CHP)		9.2	10.3	20.3	20.9	22.2	7.6	7.1	8.1	60.5	51.4	57.3
Non fossil fuels in electricity generation (%)		49.9	49.3	55.8	59.5	64.5	7.6	18.4	26.2	15.8	44.9	68.6
nuclear		35.1	33.6	28.7	28.9	30.0	-0.8	6.4	10.6	-2.7	28.6	54.8
renewable energy forms		14.8	15.8	27.1	30.6	34.5	8.4	12.0	15.6	45.1	64.6	82.8
of which waste		*1.0*	*1.2*	*1.2*	*0.8*	*0.7*	*-0.3*	*-0.5*	*-0.4*	*-18.3*	*-41.5*	*-35.8*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5809.0**	**6691.6**	**7534.4**	**-8.1**	**-8.8**	**-5.8**	**-0.1**	**-0.1**	**-0.1**
public road transport	368.8	382.2	412.6	479.8	511.7	534.5	57.2	63.2	69.3	13.5	14.1	14.9
private cars and motorcycles	3325.6	3634.5	3938.8	4471.9	5074.8	5623.8	-94.4	-92.4	-80.5	-2.1	-1.8	-1.4
rail transport	316.4	320.9	356.0	441.6	507.7	560.0	74.9	86.6	97.2	20.4	20.6	21.0
aviation	157.3	201.5	281.5	377.0	552.4	763.6	-44.7	-65.3	-90.9	-10.6	-10.6	-10.6
inland navigation	28.3	31.4	33.0	38.6	45.0	52.5	-1.1	-1.0	-0.8	-2.7	-2.2	-1.6
travel per person (km per capita)	11465	12240	13261	14978	17138	19368	-21	-23	-15	-0.1	-0.1	-0.1
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2347.8**	**2892.7**	**3497.9**	**-2.7**	**-4.1**	**-3.7**	**-0.1**	**-0.1**	**-0.1**
trucks	946.0	1114.6	1327.2	1654.0	2092.3	2600.6	-88.8	-105.1	-119.5	-5.1	-4.8	-4.4
rail transport	234.9	220.2	249.3	321.9	364.3	398.5	58.3	66.3	73.3	22.1	22.3	22.5
inland navigation	257.1	266.9	296.1	371.9	436.1	498.8	27.8	34.7	42.6	8.1	8.6	9.3
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	212	207	0	0	0	-0.1	-0.1	-0.1
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**294.9**	**306.9**	**323.1**	**-62.3**	**-82.5**	**-83.6**	**-17.4**	**-21.2**	**-20.6**
public road transport	6.3	5.9	5.8	6.0	5.6	5.3	0.0	-0.2	0.0	0.1	-3.9	0.1
private cars and motorcycles	130.2	136.6	145.5	135.3	126.3	119.9	-18.8	-24.6	-22.3	-12.2	-16.3	-15.7
trucks	76.0	86.5	101.0	108.8	124.2	138.9	-23.9	-35.2	-38.5	-18.0	-22.1	-21.7
rail transport	6.9	7.5	7.7	6.5	5.6	5.7	-0.3	0.0	0.4	-4.7	-0.1	7.6
aviation	27.8	32.5	43.8	32.0	38.2	45.6	-19.2	-22.4	-23.2	-37.5	-37.0	-33.7
inland navigation	6.7	6.7	5.3	6.2	7.0	7.7	-0.1	-0.1	0.0	-1.2	-0.8	-0.1
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	30.8	26.2	23.4	-6.6	-7.0	-6.0	-17.6	-21.1	-20.3
freight transport (toe/Mtkm)	57.8	58.5	57.3	49.4	45.5	42.0	-10.1	-12.1	-10.9	-17.0	-21.0	-20.7

Source: PRIMES

NMS: FULL POLICY OPTIONS CASE | **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**108.3**	**86.9**	**80.1**	**-9.1**	**-18.4**	**-7.9**	**-7.7**	**-17.5**	**-9.0**
Solids	140.9	126.7	104.0	65.9	39.9	32.1	-17.6	-30.4	-27.3	-21.1	-43.3	-46.0
Oil	2.6	3.0	3.1	2.3	2.3	2.1	-0.2	-0.2	-0.2	-6.8	-7.6	-6.9
Natural gas	6.7	7.4	6.1	5.9	5.4	4.9	0.0	0.0	-0.1	0.0	-0.5	-1.9
Nuclear	15.5	14.1	14.8	14.2	17.4	16.9	-0.7	2.5	11.6	-4.7	17.1	216.5
Renewable energy sources	3.0	6.3	8.0	19.9	22.0	24.0	9.4	9.6	8.1	89.8	78.0	51.0
Hydro	1.1	1.3	1.4	2.1	2.1	2.3	0.0	0.0	0.1	2.4	0.7	2.9
Biomass	1.4	4.6	6.1	14.1	14.4	14.5	7.8	8.1	6.5	124.8	126.7	82.0
Waste	0.5	0.3	0.5	2.5	2.6	2.6	1.2	1.1	0.8	86.7	72.2	47.2
Wind	0.0	0.0	0.0	0.7	1.8	3.4	0.1	-0.1	0.2	11.2	-2.8	5.4
Solar and others	0.0	0.0	0.0	0.6	1.0	1.3	0.3	0.5	0.5	113.3	106.1	65.8
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-16.2	-20.4	-24.8
Net Imports	**66.3**	**50.4**	**61.4**	**78.5**	**102.0**	**108.4**	**-13.7**	**-25.6**	**-45.2**	**-14.8**	**-20.1**	**-29.4**
Solids	-14.6	-20.7	-15.9	-8.0	-5.4	-4.4	-0.8	-8.3	-22.3	11.0	-288.1	-124.4
Oil	49.9	45.0	47.3	47.4	48.2	50.1	-8.2	-15.1	-18.7	-14.8	-23.8	-27.2
Crude oil and Feedstocks	43.4	36.7	41.3	39.4	40.3	42.0	-6.8	-12.8	-16.3	-14.7	-24.1	-27.9
Oil products	6.5	8.3	6.0	8.0	7.9	8.1	-1.4	-2.3	-2.4	-15.0	-22.3	-22.9
Natural gas	31.2	26.2	31.5	40.3	60.4	63.8	-4.7	-2.3	-3.9	-10.5	-3.6	-5.8
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-1.1	0.0	0.0	-0.3	0.0	0.0	30.5
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**185.7**	**187.8**	**187.2**	**-22.7**	**-44.0**	**-53.0**	**-10.9**	**-19.0**	**-22.1**
Solids	127.8	108.2	90.8	57.9	34.5	27.8	-18.4	-38.7	-49.7	-24.1	-52.9	-64.1
Oil	50.4	46.6	48.7	48.7	49.3	51.0	-8.3	-15.2	-18.8	-14.6	-23.6	-26.9
Natural gas	37.1	33.8	37.3	46.2	65.9	68.6	-4.7	-2.3	-4.0	-9.2	-3.4	-5.5
Nuclear	15.5	14.1	14.8	14.2	17.4	16.9	-0.7	2.5	11.6	-4.7	17.1	216.5
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-1.1	0.0	0.0	-0.3	0.0	0.0	30.5
Renewable energy forms	3.0	6.3	8.0	19.9	22.0	24.0	9.4	9.6	8.1	89.8	78.0	51.0
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	31.2	18.4	14.8	-5.4	-13.2	-17.4	-14.8	-41.8	-54.0
Oil	21.6	22.3	24.6	26.2	26.2	27.2	-1.1	-1.6	-1.8	-4.1	-5.7	-6.2
Natural gas	15.9	16.2	18.8	24.9	35.1	36.7	0.5	5.7	6.4	1.9	19.3	21.2
Nuclear	6.6	6.7	7.5	7.7	9.3	9.0	0.5	2.8	6.8	6.9	44.5	306.2
Renewable energy forms	1.3	3.0	4.1	10.7	11.7	12.8	5.7	6.4	6.2	113.0	119.7	93.8
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**354.5**	**423.3**	**435.0**	**-37.5**	**-74.9**	**-116.1**	**-9.6**	**-15.0**	**-21.1**
Nuclear	60.0	54.3	57.4	56.3	69.2	70.0	-2.2	11.1	48.5	-3.8	19.0	226.1
Hydro & wind	12.9	15.5	15.7	31.5	46.1	65.5	1.3	-0.4	2.6	4.4	-0.9	4.2
Thermal (incl. biomass)	243.7	230.7	250.6	266.8	308.0	299.5	-36.6	-85.5	-167.2	-12.1	-21.7	-35.8
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**62.8**	**57.2**	**51.3**	**-12.7**	**-28.7**	**-44.8**	**-16.8**	**-33.4**	**-46.6**
Solids	62.2	57.2	56.5	40.2	21.8	16.9	-17.3	-36.7	-48.1	-30.1	-62.7	-74.0
Oil	4.9	4.4	3.2	2.7	1.9	1.9	-0.8	-0.5	-0.8	-22.1	-19.3	-28.8
Gas	5.3	4.0	6.3	11.2	24.1	23.5	-1.6	1.2	-2.2	-12.4	5.2	-8.5
Biomass - Waste	0.3	0.1	0.4	8.8	9.4	9.0	7.0	7.3	6.2	384.2	353.5	218.5
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**60.9**	**60.2**	**63.0**	**-5.1**	**-11.0**	**-14.8**	**-7.7**	**-15.5**	**-19.0**
Refineries	46.7	40.1	45.2	44.0	45.3	47.5	-5.7	-11.7	-15.6	-11.5	-20.5	-24.8
District heating	19.3	12.1	8.5	4.1	2.8	2.3	-0.4	-0.9	-0.5	-9.7	-23.6	-19.2
Biofuels and hydrogen production	0.0	0.0	0.0	1.8	3.1	4.4	1.8	2.6	2.7	2696.9	627.5	160.4
Others	30.5	23.1	17.7	11.0	9.0	8.8	-0.7	-1.1	-1.3	-5.8	-11.2	-12.9
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**8.5**	**8.2**	**7.6**	**-1.2**	**-1.7**	**-1.7**	**-12.0**	**-17.6**	**-18.4**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**12.9**	**14.3**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**	**-0.1**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**119.9**	**129.2**	**135.6**	**-12.5**	**-23.9**	**-29.5**	**-9.4**	**-15.6**	**-17.9**
by sector												
Industry	65.0	47.7	40.4	38.1	39.3	41.6	-1.4	-2.8	-2.3	-3.6	-6.7	-5.3
energy intensive industries	32.5	27.9	26.2	24.7	24.5	25.1	-1.0	-2.0	-1.8	-3.8	-7.6	-6.6
other industrial sectors	32.4	19.7	14.2	13.4	14.8	16.5	-0.4	-0.8	-0.5	-3.1	-5.0	-3.2
Residential	40.0	41.2	34.4	35.4	38.3	39.4	-2.3	-6.4	-8.4	-6.1	-14.4	-17.5
Tertiary	24.9	19.6	21.5	21.6	23.4	23.9	-3.5	-5.2	-7.6	-13.8	-18.1	-24.1
Transport	19.9	19.8	22.9	24.8	28.1	30.7	-5.3	-9.5	-11.2	-17.6	-25.2	-26.7
by fuel												
Solids	40.9	33.8	21.4	12.9	9.3	7.6	-0.9	-1.6	-1.4	-6.8	-14.7	-15.8
Oil	32.7	29.6	33.6	35.2	35.9	36.4	-6.1	-12.7	-16.4	-14.7	-26.2	-31.1
Gas	26.5	24.6	25.4	31.1	36.4	40.0	-2.2	-3.5	-2.6	-6.6	-8.7	-6.0
Electricity	20.5	18.5	19.6	22.5	28.1	29.7	-2.6	-5.2	-8.4	-10.2	-15.6	-22.1
Heat (from CHP and District Heating)	27.7	17.4	13.5	12.1	13.1	14.7	-1.1	-1.9	-2.3	-8.0	-12.7	-13.5
Other	1.8	4.7	5.8	6.0	6.4	7.2	0.3	1.0	1.6	6.1	18.2	29.0
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**443.9**	**393.6**	**374.0**	**-108.4**	**-203.0**	**-261.0**	**-19.6**	**-34.0**	**-41.1**
Electricity and Steam production	343.4	295.0	280.1	206.7	156.6	133.6	-76.6	-146.5	-199.0	-27.0	-48.3	-59.8
Energy Branch	14.4	19.5	18.7	9.7	11.4	12.7	-0.9	0.1	1.3	-8.1	0.6	11.4
Industry	137.0	118.2	96.4	81.5	76.9	77.5	-4.6	-8.9	-8.1	-5.3	-10.4	-9.4
Residential	83.2	72.9	49.7	46.7	46.2	44.5	-2.6	-8.3	-8.5	-5.4	-15.2	-16.0
Tertiary	53.3	38.3	37.2	32.8	30.1	29.4	-4.1	-4.5	-5.6	-11.2	-12.9	-16.0
Transport	56.1	55.9	65.3	66.4	72.4	76.2	-19.5	-34.9	-41.2	-22.7	-32.5	-35.1
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**64.6**	**57.3**	**54.4**	**-15.8**	**-29.5**	**-38.0**	-19.6	-34.0	-41.1

See explanations on the last page of the Appendix

Source: PRIMES

NMS: FULL POLICY OPTIONS CASE — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	323.6	228.7	170.2	-39.6	-53.6	-48.2	-10.9	-19.0	-22.1
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.5	2.6	2.7	-0.3	-0.6	-0.8	-10.9	-19.0	-22.1
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	4830	5907	6292	-511	-1044	-1679	-9.6	-15.0	-21.1
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.39	2.10	2.00	-0.26	-0.48	-0.65	-9.8	-18.6	-24.4
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	6.0	5.5	5.4	-1.5	-2.8	-3.8	-19.6	-34.0	-41.1
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	773.5	479.5	339.8	-188.8	-247.3	-237.2	-19.6	-34.0	-41.1
Import Dependency %	28.3	24.1	30.8	42.0	54.0	57.5	-2.0	-0.8	-6.1	-4.5	-1.4	-9.5
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	34.8	25.6	21.6	-1.3	-1.8	-1.2	-3.6	-6.7	-5.3
Residential (Energy on Private Income)	100.0	106.5	74.2	52.5	38.8	29.7	-3.4	-6.5	-6.3	-6.1	-14.4	-17.5
Tertiary (Energy on Value added)	100.0	74.8	67.2	45.3	33.1	24.3	-7.3	-7.3	-7.7	-13.8	-18.1	-24.1
Transport (Energy on GDP)	100.0	102.9	97.4	72.2	57.4	46.8	-15.4	-19.3	-17.1	-17.6	-25.2	-26.7
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.40	0.26	0.21	-0.09	-0.17	-0.22	-19.1	-39.3	-50.5
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.90	1.75	1.68	-0.05	-0.10	-0.08	-2.8	-5.3	-4.8
Industry	2.11	2.48	2.38	2.14	1.96	1.86	-0.04	-0.08	-0.09	-1.8	-4.0	-4.4
Residential	2.08	1.77	1.44	1.32	1.21	1.13	0.01	-0.01	0.02	0.8	-1.0	1.8
Tertiary	2.14	1.95	1.73	1.52	1.28	1.23	0.05	0.08	0.12	3.1	6.3	10.7
Transport	2.82	2.82	2.85	2.68	2.57	2.48	-0.18	-0.28	-0.32	-6.3	-9.9	-11.4
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**89.2**	**115.9**	**135.2**	**-5.9**	**-18.2**	**-32.0**	**-6.2**	**-13.6**	**-19.1**
Nuclear		8.4	9.3	7.9	9.6	10.2	0.0	1.7	7.3	0.0	21.5	257.3
Hydro (pumping excluded)		6.1	6.4	8.0	8.7	8.9	0.3	0.5	0.5	3.6	5.8	6.0
Wind and solar		0.0	0.0	3.1	9.7	16.5	0.3	1.0	1.5	12.1	11.4	10.3
Thermal		64.0	61.9	70.2	87.9	99.6	-6.5	-21.3	-41.3	-8.5	-19.5	-29.3
of which cogeneration units		*28.1*	*26.3*	*32.8*	*40.9*	*46.1*	*5.5*	*2.7*	*-6.2*	*20.0*	*7.2*	*-11.8*
Open cycle (incl. biomass-waste)		61.9	58.6	54.2	31.5	16.8	-1.7	-8.1	-17.2	-3.1	-20.4	-50.5
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.8	8.7	10.9	0.3	-6.3	-20.0	58.0	-41.8	-64.7
Gas Turbines Combined Cycle		0.4	1.4	10.0	36.5	47.0	-2.3	-3.0	-14.6	-18.5	-7.6	-23.7
Small Gas Turbines		1.7	1.8	5.2	9.4	7.8	-2.8	-5.7	-6.6	-35.4	-37.9	-45.6
Fuel Cells		0.0	0.0	0.0	1.7	17.0	0.0	1.7	17.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	38.5	48.4	53.0	2.1	7.0	9.1	5.7	16.9	20.6
Load factor for gross electric capacities (%)		43.6	47.6	45.4	41.7	36.7	-1.7	-0.7	-0.9	-3.6	-1.7	-2.4
CHP indicator (% of electricity from CHP)		29.4	30.4	38.3	35.2	40.1	10.0	7.9	8.5	35.1	28.9	26.8
Non fossil fuels in electricity generation (%)		23.4	23.1	35.2	36.9	40.9	11.0	14.5	23.7	45.6	64.3	137.3
nuclear		18.1	17.7	15.9	16.3	16.1	1.0	4.7	12.2	6.4	40.1	313.1
renewable energy forms		5.3	5.4	19.3	20.6	24.8	10.1	9.8	11.5	109.0	90.4	86.0
of which waste		*0.0*	*0.1*	*1.6*	*1.3*	*1.4*	*1.0*	*0.9*	*1.0*	*170.6*	*201.4*	*281.6*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**615.4**	**807.0**	**997.8**	**-0.3**	**-1.7**	**-0.9**	**0.0**	**-0.2**	**-0.1**
public road transport	115.7	87.0	81.2	79.4	82.9	88.9	-1.8	-1.7	-1.5	-2.2	-2.0	-1.7
private cars and motorcycles	268.0	315.8	352.9	450.7	609.4	755.8	-8.5	-11.8	-14.4	-1.8	-1.9	-1.9
rail transport	91.9	50.8	46.3	58.6	70.8	91.2	10.4	12.5	16.5	21.6	21.5	22.0
aviation	11.2	14.0	16.8	26.0	43.2	61.1	-0.4	-0.8	-1.4	-1.5	-1.7	-2.2
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	-0.9	-0.7	-0.5
travel per person (km per capita)	6489	6227	6662	8384	11261	14431	-4	-23	-13	0.0	-0.2	-0.1
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**338.1**	**439.0**	**538.5**	**-1.3**	**-3.2**	**-2.8**	**-0.4**	**-0.7**	**-0.5**
trucks	118.4	119.0	155.5	197.1	285.9	374.2	-26.8	-33.6	-38.2	-12.0	-10.5	-9.3
rail transport	205.2	137.8	118.7	140.2	152.3	163.5	25.6	30.5	35.5	22.3	25.0	27.8
inland navigation	1.0	1.3	0.8	0.7	0.7	0.8	-0.1	-0.1	-0.1	-16.7	-13.9	-11.9
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	589	535	489	-2	-4	-3	-0.4	-0.7	-0.5
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**24.8**	**28.1**	**30.7**	**-5.3**	**-9.5**	**-11.2**	**-17.6**	**-25.2**	**-26.7**
public road transport	1.4	1.0	1.2	1.2	1.0	0.9	0.0	-0.1	-0.2	0.8	-10.3	-19.6
private cars and motorcycles	7.9	9.5	11.6	12.5	13.7	14.0	-2.3	-4.0	-5.3	-15.4	-22.5	-27.3
trucks	7.0	6.7	7.5	8.8	11.0	13.2	-2.3	-4.1	-4.9	-20.8	-27.2	-26.9
rail transport	2.0	1.4	1.3	1.1	1.0	0.9	0.0	0.0	0.0	-0.7	-4.6	-2.9
aviation	1.3	1.2	1.3	1.2	1.4	1.7	-0.7	-1.2	-0.8	-36.8	-45.7	-33.6
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.1	-9.1	-11.9
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	24.9	20.6	17.1	-4.8	-6.5	-6.3	-16.2	-24.1	-26.9
freight transport (toe/Mtkm)	24.6	28.8	30.0	27.9	26.3	25.5	-6.7	-9.2	-8.9	-19.3	-25.8	-26.0

Source: PRIMES

(1) EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

APPENDIX 8

Summary energy balances and indicators by group of countries (EU-25, EU-15, new Member states (NMS)) – comparison to baseline

- "Kyoto forever" at the EU-25 level case
- "Gothenburg type" targets with domestic action at the EU-25 level case

EU25: "KYOTO FOREVER" AT THE EU25 LEVEL — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**849.2**	**721.0**	**683.7**	**-11.2**	**-19.9**	**22.8**	**-1.3**	**-2.7**	**3.5**
Solids	350.8	264.7	203.4	132.8	77.4	57.3	-21.1	-48.9	-45.2	-13.7	-38.7	-44.1
Oil	120.3	162.2	163.5	131.5	102.0	86.2	-0.2	-0.1	-0.3	-0.1	-0.1	-0.3
Natural gas	139.6	174.0	196.6	196.6	147.6	117.1	-0.2	0.0	0.0	-0.1	0.0	0.0
Nuclear	196.9	215.3	237.7	245.3	209.5	201.9	0.0	-4.0	16.6	0.0	-1.9	8.9
Renewable energy sources	69.2	80.7	96.1	142.9	184.5	221.2	10.3	33.2	51.8	7.7	21.9	30.6
Hydro	23.4	26.3	29.0	30.3	31.9	33.0	0.2	0.2	0.8	0.7	0.7	2.4
Biomass	31.1	35.4	42.2	63.0	87.2	106.0	5.5	22.3	32.3	9.6	34.3	43.9
Waste	12.3	15.9	19.3	28.8	33.2	33.0	3.1	5.5	5.9	12.1	19.8	21.5
Wind	0.1	0.4	1.9	15.3	25.0	38.2	1.3	4.9	11.3	9.7	24.2	42.2
Solar and others	0.1	0.3	0.4	1.7	3.0	6.2	0.0	0.1	0.9	-1.0	2.6	17.4
Geothermal	2.2	2.5	3.3	3.8	4.2	4.8	0.1	0.2	0.6	2.1	6.1	13.3
Net Imports	**711.6**	**701.7**	**799.3**	**941.8**	**1136.5**	**1226.7**	**-32.7**	**-68.0**	**-135.1**	**-3.4**	**-5.6**	**-9.9**
Solids	75.2	73.8	91.4	76.8	61.5	64.0	-13.1	-64.8	-133.5	-14.5	-51.3	-67.6
Oil	510.8	491.8	519.6	558.0	603.9	618.1	-14.4	-22.1	-32.8	-2.5	-3.5	-5.0
Crude oil and Feedstocks	480.2	471.5	496.8	535.3	589.4	612.8	-14.5	-21.6	-32.1	-2.6	-3.5	-5.0
Oil products	30.6	20.3	22.8	22.7	14.5	5.3	0.0	-0.5	-0.7	0.2	-3.1	-11.8
Natural gas	123.5	134.8	186.2	304.8	469.1	542.3	-5.2	18.9	31.2	-1.7	4.2	6.1
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1740.3**	**1801.0**	**1847.4**	**-43.8**	**-87.9**	**-112.3**	**-2.5**	**-4.7**	**-5.7**
Solids	430.6	346.0	303.2	209.6	138.9	121.3	-34.1	-113.7	-178.7	-14.0	-45.0	-59.6
Oil	596.2	622.2	635.6	638.9	649.4	641.3	-14.6	-22.2	-33.1	-2.2	-3.3	-4.9
Natural gas	259.2	307.1	376.0	501.5	616.6	659.4	-5.4	18.9	31.2	-1.1	3.2	5.0
Nuclear	196.9	215.3	237.7	245.3	209.5	201.9	0.0	-4.0	16.6	0.0	-1.9	8.9
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	142.9	184.5	221.2	10.3	33.2	51.8	7.7	21.9	30.6
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	12.0	7.7	6.6	-1.6	-5.7	-8.7	-11.8	-42.3	-57.1
Oil	38.4	39.6	38.5	36.7	36.1	34.7	0.1	0.5	0.3	0.2	1.4	0.9
Natural gas	16.7	19.5	22.8	28.8	34.2	35.7	0.4	2.6	3.6	1.4	8.2	11.3
Nuclear	12.7	13.7	14.4	14.1	11.6	10.9	0.3	0.3	1.5	2.5	2.9	15.6
Renewable energy forms	4.5	5.1	5.8	8.2	10.2	12.0	0.8	2.2	3.3	10.5	27.9	38.5
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3395.1**	**3873.9**	**4295.3**	**-24.0**	**-74.7**	**-101.8**	**-0.7**	**-1.9**	**-2.3**
Nuclear	780.0	864.4	921.2	952.5	819.5	836.2	0.0	-14.0	69.6	0.0	-1.7	9.1
Hydro & wind	272.7	309.7	359.5	530.6	662.1	855.5	17.9	59.7	150.0	3.5	9.9	21.3
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1912.1	2392.3	2603.6	-42.0	-120.4	-321.5	-2.1	-4.8	-11.0
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**396.5**	**441.6**	**464.0**	**-16.7**	**-41.3**	**-76.9**	**-4.0**	**-8.6**	**-14.2**
Solids	248.2	221.1	210.1	146.4	87.1	76.0	-28.8	-105.2	-168.1	-16.5	-54.7	-68.9
Oil (including refinery gas)	53.7	53.9	41.5	20.2	13.3	8.0	-3.6	-0.3	-1.4	-15.0	-2.0	-15.1
Gas	50.4	70.0	112.6	193.0	282.2	309.3	7.9	36.5	54.0	4.3	14.9	21.2
Biomass - Waste	10.3	13.6	17.5	33.5	55.1	66.2	7.7	27.5	38.0	29.9	99.2	135.0
Geothermal heat	1.9	2.1	3.0	3.5	3.9	4.5	0.1	0.2	0.6	2.7	6.8	14.4
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**789.4**	**817.1**	**831.6**	**-17.7**	**-26.0**	**-40.1**	**-2.2**	**-3.1**	**-4.6**
Refineries	641.3	675.9	710.9	718.2	744.3	754.4	-15.0	-22.7	-34.1	-2.1	-3.0	-4.3
District heating	31.7	23.1	14.5	11.5	10.2	10.6	0.7	1.3	1.8	6.4	14.9	20.6
Biofuels and hydrogen production	0.0	0.2	0.6	10.2	17.8	26.4	0.0	-0.3	-1.0	-0.4	-1.7	-3.7
Others	127.6	81.2	68.3	49.6	44.8	40.2	-3.3	-4.4	-6.8	-6.2	-8.9	-14.4
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**75.8**	**74.7**	**73.4**	**-1.3**	**-2.5**	**-3.7**	**-1.7**	**-3.2**	**-4.8**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.7**	**121.7**	**125.0**	**0.3**	**0.2**	**0.1**	**0.3**	**0.2**	**0.1**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1179.8**	**1266.0**	**1324.6**	**-29.1**	**-51.9**	**-69.5**	**-2.4**	**-3.9**	**-5.0**
by sector												
Industry (1)	327.2	303.3	309.1	332.0	354.2	373.4	-6.9	-13.2	-15.1	-2.0	-3.6	-3.9
energy intensive industries	212.9	198.9	202.0	211.0	216.7	217.2	-5.3	-9.6	-11.8	-2.5	-4.2	-5.1
other industrial sectors	114.3	104.4	107.0	121.0	137.5	156.2	-1.6	-3.6	-3.3	-1.3	-2.6	-2.1
Residential	268.1	277.2	279.1	301.7	316.3	322.9	-6.9	-12.8	-15.9	-2.2	-3.9	-4.7
Tertiary	140.2	147.5	154.2	165.8	183.8	203.2	-8.4	-10.5	-14.9	-4.8	-5.4	-6.8
Transport	273.7	295.6	332.0	380.3	411.7	425.1	-6.9	-15.3	-23.6	-1.8	-3.6	-5.3
by fuel (1)												
Solids	117.7	80.8	57.4	36.5	28.2	22.3	-5.8	-8.0	-9.8	-13.6	-22.1	-30.4
Oil	424.2	443.7	464.2	492.9	516.4	523.7	-10.6	-21.2	-31.1	-2.1	-3.9	-5.6
Gas	196.2	219.5	245.7	286.9	305.4	318.4	-13.1	-19.5	-25.0	-4.4	-6.0	-7.3
Electricity	176.5	187.9	211.3	251.9	292.3	328.0	-1.5	-4.8	-6.4	-0.6	-1.6	-1.9
Heat (from CHP and District Heating)	62.9	56.7	55.6	65.8	76.6	85.3	0.8	0.9	1.7	1.2	1.1	2.0
Other	32.1	35.3	40.3	45.9	47.1	47.0	0.9	0.7	1.1	2.1	1.5	2.3
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.6**	**3664.9**	**3561.2**	**3562.2**	**3563.4**	**-196.0**	**-478.4**	**-740.2**	**-5.2**	**-11.8**	**-17.2**
Electricity and Steam production	1341.0	1242.7	1228.3	1128.3	1070.0	1069.5	-107.0	-333.0	-543.6	-8.7	-23.7	-33.7
Energy Branch	144.2	163.9	164.0	143.2	139.9	134.1	-2.5	-3.1	-4.9	-1.7	-2.2	-3.5
Industry	713.2	644.8	605.7	514.6	500.1	492.6	-29.8	-45.7	-59.3	-5.5	-8.4	-10.7
Residential	519.7	490.4	462.6	463.1	463.2	449.9	-18.5	-32.0	-37.3	-3.8	-6.5	-7.6
Tertiary	256.8	251.0	236.7	221.1	220.3	226.8	-18.5	-20.7	-28.0	-7.7	-8.6	-11.0
Transport	794.6	858.8	967.5	1090.8	1168.8	1190.5	-19.7	-43.9	-67.1	-1.8	-3.6	-5.3
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**94.5**	**94.5**	**94.5**	**-5.2**	**-12.7**	**-19.6**	-5.2	-11.8	-17.2

See explanations on the last page of the Appendix

Source: PRIMES

EU25: "KYOTO FOREVER" AT THE EU25 LEVEL — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	152.2	124.5	102.5	-3.8	-6.1	-6.2	-2.5	-4.7	-5.7
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.8	3.9	4.0	-0.1	-0.2	-0.2	-2.5	-4.7	-5.7
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	7361	8383	9375	-52	-162	-222	-0.7	-1.9	-2.3
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.05	1.98	1.93	-0.06	-0.16	-0.27	-2.8	-7.5	-12.2
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	7.7	7.7	7.8	-0.4	-1.0	-1.6	-5.2	-11.8	-17.2
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	311.5	246.3	197.7	-17.1	-33.1	-41.1	-5.2	-11.8	-17.2
Import Dependency %	44.8	43.6	47.2	52.6	61.2	64.2	-0.5	-0.7	-3.1	-1.0	-1.2	-4.6
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	69.5	58.3	49.3	-1.4	-2.2	-2.0	-2.0	-3.6	-3.9
Residential (Energy on Private Income)	100.0	98.1	85.8	72.8	60.6	50.3	-1.7	-2.5	-2.5	-2.2	-3.9	-4.7
Tertiary (Energy on Value added)	100.0	96.7	86.8	71.2	61.7	54.2	-3.6	-3.5	-4.0	-4.8	-5.4	-6.8
Transport (Energy on GDP)	100.0	101.1	99.3	88.9	76.1	63.0	-1.6	-2.8	-3.5	-1.8	-3.6	-5.3
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.27	0.22	0.20	-0.02	-0.07	-0.10	-8.3	-22.7	-32.7
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.94	1.86	1.78	-0.02	-0.03	-0.05	-1.3	-1.8	-2.7
Industry	2.18	2.13	1.96	1.55	1.41	1.32	-0.06	-0.07	-0.10	-3.5	-4.9	-7.1
Residential	1.94	1.77	1.66	1.53	1.46	1.39	-0.03	-0.04	-0.04	-1.7	-2.7	-3.1
Tertiary	1.83	1.70	1.54	1.33	1.20	1.12	-0.04	-0.04	-0.05	-3.0	-3.3	-4.4
Transport	2.90	2.91	2.91	2.87	2.84	2.80	0.00	0.00	0.00	0.0	0.0	-0.1
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**790.8**	**954.5**	**1143.9**	**7.0**	**7.8**	**25.7**	**0.9**	**0.8**	**2.3**
Nuclear		134.7	140.3	129.8	112.9	126.4	0.0	4.9	18.6	0.0	4.6	17.2
Hydro (pumping excluded)		93.3	96.2	105.4	112.4	116.0	0.8	3.2	3.8	0.8	2.9	3.4
Wind and solar		2.5	13.0	80.2	130.2	205.8	7.1	26.1	56.6	9.6	25.1	37.9
Thermal		386.9	406.7	475.4	599.0	695.8	-0.9	-26.3	-53.3	-0.2	-4.2	-7.1
of which cogeneration units		*87.3*	*103.4*	*132.7*	*165.5*	*213.7*	*3.0*	*-2.6*	*15.0*	*2.3*	*-1.6*	*7.5*
Open cycle(incl. biomass-waste)		343.8	335.6	265.1	163.9	126.7	-5.5	-11.4	-20.7	-2.0	-6.5	-14.0
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	3.2	32.1	75.6	2.2	-34.5	-74.4	229.5	-51.8	-49.6
Gas Turbines Combined Cycle		20.4	47.4	175.1	349.2	438.7	5.6	30.5	54.1	3.3	9.6	14.1
Small Gas Turbines		22.0	22.8	30.8	52.2	52.4	-3.2	-11.1	-13.4	-9.3	-17.6	-20.4
Fuel Cells		0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.6			
Geothermal heat		0.7	1.0	1.2	1.5	1.8	0.0	0.2	0.4	2.7	19.1	27.8
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.1	43.4	48.8	50.7	0.8	2.0	2.1	2.0	4.2	4.2
Load factor for gross electric capacities (%)		48.2	50.4	49.0	46.3	42.9	-0.8	-1.3	-2.0	-1.6	-2.7	-4.5
CHP indicator (% of electricity from CHP)		11.5	12.6	14.3	15.1	16.9	-0.2	-0.4	0.6	-1.2	-2.6	3.4
Non fossil fuels in electricity generation (%)		46.8	46.4	47.1	43.3	44.9	1.7	4.5	9.3	3.7	11.7	26.1
nuclear		33.1	31.8	28.1	21.2	19.5	0.2	0.0	2.0	0.7	0.2	11.7
renewable energy forms		13.7	14.6	19.1	22.1	25.4	1.5	4.5	7.3	8.4	25.5	39.9
of which waste		*0.9*	*1.1*	*1.6*	*1.7*	*1.5*	*0.3*	*0.5*	*0.5*	*23.1*	*45.2*	*50.1*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6415.1**	**7474.4**	**8485.0**	**-17.7**	**-34.7**	**-53.9**	**-0.3**	**-0.5**	**-0.6**
public road transport	484.5	469.2	493.8	501.7	531.6	555.7	-2.1	-1.4	0.1	-0.4	-0.3	0.0
private cars and motorcycles	3593.6	3950.3	4291.6	5016.5	5773.0	6453.8	-9.1	-15.4	-20.7	-0.2	-0.3	-0.3
rail transport	408.3	371.7	402.3	411.9	473.6	530.6	-2.9	-5.7	-7.0	-0.7	-1.2	-1.3
aviation	168.5	215.5	298.3	444.8	649.6	890.6	-3.4	-12.1	-26.4	-0.7	-1.8	-2.9
inland navigation	28.9	31.9	33.6	40.3	46.7	54.2	-0.1	-0.1	0.1	-0.3	-0.1	0.1
travel per person (km per capita)	10618	11233	12174	13909	16174	18520	-38	-75	-118	-0.3	-0.5	-0.6
Freight transport activity (Gtkm)	**1762.6**	**1859.8**	**2147.6**	**2679.3**	**3316.1**	**4005.8**	**-10.5**	**-22.9**	**-37.1**	**-0.4**	**-0.7**	**-0.9**
trucks	1064.3	1233.6	1482.7	1960.7	2501.7	3104.6	-6.0	-15.2	-27.9	-0.3	-0.6	-0.9
rail transport	440.2	358.0	368.0	375.4	414.1	446.0	-2.9	-5.7	-7.2	-0.8	-1.4	-1.6
inland navigation	258.1	268.2	297.0	343.2	400.3	455.2	-1.6	-2.0	-1.9	-0.5	-0.5	-0.4
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	234	229	222	-1	-2	-2	-0.4	-0.7	-0.9
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**380.3**	**411.7**	**425.1**	**-6.9**	**-15.3**	**-23.6**	**-1.8**	**-3.6**	**-5.3**
public road transport	7.7	6.9	7.0	7.1	6.8	6.1	-0.1	-0.1	-0.2	-1.0	-2.1	-3.6
private cars and motorcycles	138.1	146.1	157.1	168.3	167.1	157.6	-0.7	-1.6	-3.9	-0.4	-0.9	-2.4
trucks	82.9	93.2	108.5	143.2	169.5	186.5	-0.6	-5.0	-9.0	-0.5	-2.8	-4.6
rail transport	8.8	8.9	9.0	7.7	6.1	5.9	-0.3	-0.4	-0.3	-3.8	-6.2	-5.5
aviation	29.1	33.8	45.1	47.9	55.1	61.3	-5.1	-8.1	-9.9	-9.7	-12.8	-13.9
inland navigation	7.0	6.7	5.4	6.2	7.0	7.6	0.0	-0.1	-0.1	-0.7	-1.3	-1.9
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	35.8	31.4	27.1	-0.9	-1.2	-1.5	-2.3	-3.7	-5.3
freight transport (toe/Mtkm)	51.7	54.4	53.8	56.3	53.5	48.6	-0.1	-1.2	-1.8	-0.1	-2.1	-3.7

Source: PRIMES

EU15: "KYOTO FOREVER" AT THE EU25 LEVEL — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**737.5**	**630.4**	**594.9**	**-5.5**	**-5.1**	**21.9**	**-0.7**	**-0.8**	**3.8**
Solids	209.9	138.0	99.4	57.5	27.1	14.3	-12.8	-29.0	-28.7	-18.3	-51.7	-66.7
Oil	117.7	159.2	160.4	129.1	99.5	83.9	-0.1	-0.1	-0.3	-0.1	-0.1	-0.3
Natural gas	132.9	166.6	190.6	190.7	142.1	112.2	-0.2	0.0	0.0	-0.1	0.0	0.0
Nuclear	181.4	201.2	222.8	230.3	193.2	184.9	0.0	-5.5	4.9	0.0	-2.8	2.7
Renewable energy sources	66.3	74.4	88.1	129.8	168.5	199.6	7.7	29.5	46.0	6.3	21.2	30.0
Hydro	22.3	24.9	27.6	28.3	29.7	30.7	0.1	0.1	0.7	0.5	0.5	2.3
Biomass	29.7	30.8	36.1	56.0	79.3	94.2	4.8	20.8	28.5	9.4	35.5	43.3
Waste	11.9	15.6	18.7	25.7	29.9	29.9	1.4	3.7	4.5	5.6	13.9	17.7
Wind	0.1	0.4	1.9	14.6	22.9	34.5	1.3	4.6	10.9	9.7	25.5	46.1
Solar and others	0.1	0.2	0.3	1.4	2.5	5.4	0.0	0.1	0.9	-1.3	2.2	19.7
Geothermal	2.2	2.5	3.3	3.8	4.2	4.8	0.1	0.2	0.6	2.1	6.1	13.3
Net Imports	**645.4**	**651.3**	**737.9**	**850.7**	**1010.2**	**1088.7**	**-31.5**	**-66.7**	**-119.6**	**-3.6**	**-6.2**	**-9.9**
Solids	89.9	94.4	107.2	85.1	67.5	69.6	-11.9	-55.9	-109.9	-12.3	-45.3	-61.2
Oil	460.9	446.7	472.4	502.7	542.2	552.1	-14.2	-20.6	-30.1	-2.7	-3.7	-5.2
Crude oil and Feedstocks	436.8	434.7	455.5	489.1	537.4	556.8	-14.4	-20.6	-29.9	-2.9	-3.7	-5.1
Oil products	24.1	12.0	16.9	13.6	4.8	-4.7	0.3	0.0	-0.2	2.0	0.4	4.9
Natural gas	92.3	108.6	154.7	259.6	397.3	463.8	-5.4	9.8	20.5	-2.0	2.5	4.6
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1538.6**	**1585.3**	**1621.8**	**-37.1**	**-71.8**	**-97.6**	**-2.4**	**-4.3**	**-5.7**
Solids	302.8	237.7	212.4	142.6	94.6	83.9	-24.8	-84.9	-138.6	-14.8	-47.3	-62.3
Oil	545.8	575.6	586.9	582.2	586.4	574.3	-14.3	-20.7	-30.4	-2.4	-3.4	-5.0
Natural gas	222.1	273.4	338.7	450.3	539.4	576.0	-5.7	9.8	20.5	-1.2	1.8	3.7
Nuclear	181.4	201.2	222.8	230.3	193.2	184.9	0.0	-5.5	4.9	0.0	-2.8	2.7
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	129.8	168.5	199.6	7.7	29.5	46.0	6.3	21.2	30.0
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	9.3	6.0	5.2	-1.4	-4.9	-7.8	-12.7	-44.9	-60.0
Oil	41.3	42.2	40.4	37.8	37.0	35.4	0.0	0.4	0.2	0.0	1.0	0.7
Natural gas	16.8	20.0	23.3	29.3	34.0	35.5	0.3	2.1	3.2	1.1	6.5	9.9
Nuclear	13.7	14.8	15.3	15.0	12.2	11.4	0.4	0.2	0.9	2.4	1.6	8.9
Renewable energy forms	5.0	5.5	6.1	8.4	10.6	12.3	0.7	2.2	3.4	8.9	26.7	37.8
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**3007.3**	**3385.8**	**3755.0**	**-19.7**	**-64.7**	**-91.0**	**-0.7**	**-1.9**	**-2.4**
Nuclear	720.1	810.1	863.7	894.0	755.3	766.0	0.0	-20.1	20.9	0.0	-2.6	2.8
Hydro & wind	259.8	294.2	343.8	499.1	612.0	786.6	16.6	56.1	144.0	3.4	10.1	22.4
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1614.3	2018.5	2202.4	-36.4	-100.7	-256.0	-2.2	-4.8	-10.4
Fuel Inputs for Thermal Power Generation [1]	**291.8**	**295.1**	**318.3**	**325.4**	**368.1**	**387.9**	**-12.3**	**-28.8**	**-57.0**	**-3.7**	**-7.3**	**-12.8**
Solids	186.1	163.9	153.6	97.4	55.5	49.1	-20.3	-78.3	-130.1	-17.2	-58.5	-72.6
Oil (including refinery gas)	48.7	49.6	38.3	16.7	10.7	5.2	-3.7	-0.4	-1.6	-18.0	-3.9	-23.9
Gas	45.1	66.0	106.3	178.4	248.4	271.0	6.0	25.5	41.5	3.5	11.5	18.1
Biomass - Waste	10.0	13.5	17.1	29.5	49.8	58.1	5.5	24.1	32.8	22.8	94.2	129.4
Geothermal heat	1.9	2.1	3.0	3.5	3.9	4.5	0.1	0.2	0.6	2.7	6.8	14.4
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**724.0**	**746.8**	**756.5**	**-17.1**	**-25.0**	**-37.4**	**-2.3**	**-3.2**	**-4.7**
Refineries	594.6	635.8	665.7	668.6	688.3	693.5	-15.0	-21.6	-31.7	-2.2	-3.0	-4.4
District heating	12.4	11.0	6.0	6.8	5.8	6.7	0.6	0.6	0.7	10.1	10.8	12.4
Biofuels and hydrogen production	0.0	0.2	0.6	10.1	17.4	24.8	0.0	-0.3	-1.0	-0.4	-1.7	-3.7
Others	97.1	58.1	50.6	38.5	35.3	31.5	-2.7	-3.6	-5.4	-6.5	-9.3	-14.7
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**66.2**	**65.2**	**64.4**	**-1.2**	**-2.1**	**-3.4**	**-1.8**	**-3.1**	**-5.1**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.6**	**108.7**	**110.7**	**0.3**	**0.2**	**0.1**	**0.3**	**0.2**	**0.1**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1050.4**	**1119.3**	**1167.9**	**-26.2**	**-45.5**	**-61.1**	**-2.4**	**-3.9**	**-5.0**
by sector												
Industry [1]	262.2	255.6	268.7	293.3	313.6	331.5	-6.1	-11.6	-13.1	-2.0	-3.6	-3.8
energy intensive industries	180.4	170.9	175.8	186.0	191.4	192.0	-4.7	-8.4	-10.2	-2.5	-4.2	-5.0
other industrial sectors	81.9	84.7	92.9	107.3	122.3	139.6	-1.4	-3.3	-2.9	-1.3	-2.6	-2.0
Residential	228.1	236.0	244.7	264.9	273.6	277.8	-5.9	-10.7	-13.3	-2.2	-3.8	-4.6
Tertiary	115.3	127.9	132.7	141.7	156.8	173.7	-7.5	-8.9	-13.0	-5.0	-5.4	-6.9
Transport	253.8	275.7	309.1	350.5	375.2	384.9	-6.7	-14.2	-21.8	-1.9	-3.7	-5.4
by fuel [1]												
Solids	76.8	47.0	36.0	24.1	19.1	15.3	-4.3	-6.1	-7.8	-15.3	-24.2	-33.8
Oil	391.5	414.1	430.6	452.1	469.4	473.7	-10.1	-19.6	-28.2	-2.2	-4.0	-5.6
Gas	169.7	194.9	220.3	254.4	268.5	279.1	-12.2	-16.5	-21.7	-4.6	-5.8	-7.2
Electricity	156.0	169.4	191.6	227.0	259.5	290.5	-1.3	-4.3	-5.8	-0.6	-1.6	-2.0
Heat (from CHP and District Heating)	35.2	39.3	42.1	52.8	61.1	68.0	1.0	0.4	1.4	1.9	0.6	2.1
Other	30.3	30.6	34.5	40.1	41.6	41.3	0.7	0.6	1.0	1.9	1.5	2.5
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.7**	**3117.5**	**3046.6**	**3063.5**	**3070.9**	**-158.4**	**-380.5**	**-597.7**	**-4.9**	**-11.0**	**-16.3**
Electricity and Steam production	997.6	947.7	948.3	873.3	845.5	854.8	-78.6	-254.4	-425.7	-8.3	-23.1	-33.2
Energy Branch	129.8	144.4	145.4	132.6	128.5	122.7	-2.6	-3.2	-4.8	-1.9	-2.4	-3.8
Industry	576.2	526.5	509.3	432.4	422.6	417.0	-26.0	-37.4	-49.4	-5.7	-8.1	-10.6
Residential	436.4	417.4	412.9	416.7	413.4	402.4	-15.6	-27.2	-31.8	-3.6	-6.2	-7.3
Tertiary	203.5	212.7	199.6	186.2	189.0	195.8	-16.4	-17.4	-24.0	-8.1	-8.4	-10.9
Transport	738.5	802.9	902.2	1005.3	1064.4	1078.2	-19.2	-40.9	-62.0	-1.9	-3.7	-5.4
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**98.8**	**99.4**	**99.6**	**-5.1**	**-12.3**	**-19.4**	-4.9	-11.0	-16.3

See explanations on the last page of the Appendix

Source: PRIMES

EU15: "KYOTO FOREVER" AT THE EU25 LEVEL — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	141.7	116.2	95.9	-3.4	-5.3	-5.8	-2.4	-4.3	-5.7
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	4.0	4.1	4.2	-0.1	-0.2	-0.3	-2.4	-4.3	-5.7
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7754	8672	9653	-51	-166	-234	-0.7	-1.9	-2.4
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	1.98	1.93	1.89	-0.05	-0.15	-0.24	-2.7	-7.0	-11.3
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	7.9	7.8	7.9	-0.4	-1.0	-1.5	-4.9	-11.0	-16.3
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	280.6	224.6	181.5	-14.6	-27.9	-35.3	-4.9	-11.0	-16.3
Import Dependency %	47.6	46.6	49.4	53.6	61.6	64.7	-0.7	-1.3	-3.2	-1.3	-2.1	-4.7
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	77.3	65.4	55.5	-1.6	-2.4	-2.2	-2.0	-3.6	-3.8
Residential (Energy on Private Income)	100.0	97.6	88.2	75.6	62.8	52.1	-1.7	-2.5	-2.5	-2.2	-3.8	-4.6
Tertiary (Energy on Value added)	100.0	101.8	90.9	74.4	64.9	57.4	-3.9	-3.7	-4.3	-5.0	-5.4	-6.9
Transport (Energy on GDP)	100.0	101.2	99.5	88.8	75.6	62.6	-1.7	-2.9	-3.5	-1.9	-3.7	-5.4
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.24	0.21	0.19	-0.02	-0.06	-0.09	-8.0	-22.0	-32.1
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.94	1.87	1.79	-0.02	-0.03	-0.05	-1.2	-1.7	-2.6
Industry	2.20	2.06	1.90	1.47	1.35	1.26	-0.06	-0.07	-0.10	-3.7	-4.7	-7.1
Residential	1.91	1.77	1.69	1.57	1.51	1.45	-0.02	-0.04	-0.04	-1.5	-2.5	-2.9
Tertiary	1.76	1.66	1.50	1.31	1.21	1.13	-0.04	-0.04	-0.05	-3.2	-3.2	-4.3
Transport	2.91	2.91	2.92	2.87	2.84	2.80	0.00	0.00	0.00	0.0	0.0	-0.1
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**695.8**	**821.3**	**976.9**	**7.1**	**8.7**	**25.9**	**1.0**	**1.1**	**2.7**
Nuclear		126.2	131.0	121.9	104.3	117.0	0.0	4.2	12.0	0.0	4.2	11.4
Hydro (pumping excluded)		87.1	89.8	97.5	103.8	107.1	0.6	2.7	3.4	0.6	2.7	3.3
Wind and solar		2.5	12.9	77.2	120.3	188.1	6.8	24.9	53.8	9.6	26.1	40.1
Thermal		322.9	344.8	399.3	493.0	564.7	-0.3	-23.1	-43.4	-0.1	-4.5	-7.1
of which cogeneration units		*59.3*	*77.1*	*105.9*	*129.9*	*166.1*	*3.6*	*0.0*	*19.7*	*3.5*	*0.0*	*13.5*
Open cycle(incl. biomass-waste)		281.8	276.9	214.5	135.9	111.5	-0.2	0.1	-1.8	-0.1	0.1	-1.6
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.3	16.7	49.1	-0.2	-34.9	-69.9	-40.8	-67.6	-58.7
Gas Turbines Combined Cycle		20.0	46.0	160.5	301.1	362.9	3.2	21.9	39.9	2.0	7.8	12.3
Small Gas Turbines		20.3	21.0	22.8	37.7	38.8	-3.1	-10.5	-12.6	-12.0	-21.7	-24.5
Fuel Cells		0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.6			
Geothermal heat		0.7	1.0	1.2	1.5	1.8	0.0	0.2	0.4	2.7	19.1	27.8
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.8	44.6	49.4	51.3	0.7	1.4	1.6	1.5	2.9	3.3
Load factor for gross electric capacities (%)		48.9	50.8	49.3	47.1	43.9	-0.8	-1.4	-2.3	-1.7	-2.9	-5.0
CHP indicator (% of electricity from CHP)		9.2	10.3	12.5	13.6	14.9	-0.2	-0.2	0.8	-1.2	-1.8	5.8
Non fossil fuels in electricity generation (%)		49.9	49.3	49.8	45.6	46.9	1.6	4.5	8.6	3.3	11.0	22.6
nuclear		35.1	33.6	29.7	22.3	20.4	0.2	-0.2	1.0	0.7	-0.7	5.3
renewable energy forms		14.8	15.8	20.0	23.3	26.5	1.4	4.7	7.6	7.4	25.2	40.3
of which waste		*1.0*	*1.2*	*1.6*	*1.7*	*1.5*	*0.2*	*0.4*	*0.4*	*11.8*	*33.9*	*40.7*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5800.7**	**6668.2**	**7489.8**	**-16.4**	**-32.2**	**-50.4**	**-0.3**	**-0.5**	**-0.7**
public road transport	368.8	382.2	412.6	420.8	447.1	465.1	-1.8	-1.3	-0.1	-0.4	-0.3	0.0
private cars and motorcycles	3325.6	3634.5	3938.8	4557.6	5152.6	5684.6	-8.7	-14.6	-19.8	-0.2	-0.3	-0.3
rail transport	316.4	320.9	356.0	364.1	415.9	456.5	-2.6	-5.1	-6.3	-0.7	-1.2	-1.4
aviation	157.3	201.5	281.5	418.6	606.5	830.1	-3.1	-11.1	-24.4	-0.7	-1.8	-2.9
inland navigation	28.3	31.4	33.0	39.6	46.0	53.4	-0.1	-0.1	0.1	-0.3	-0.1	0.1
travel per person (km per capita)	11465	12240	13261	14957	17078	19253	-42	-82	-130	-0.3	-0.5	-0.7
Freight transport activity (Gtkm)	**1438.0**	**1601.7**	**1872.6**	**2341.4**	**2876.9**	**3468.1**	**-9.0**	**-19.9**	**-33.5**	**-0.4**	**-0.7**	**-1.0**
trucks	946.0	1114.6	1327.2	1737.1	2183.3	2694.1	-5.6	-14.0	-26.0	-0.3	-0.6	-1.0
rail transport	234.9	220.2	249.3	261.9	294.1	319.7	-1.7	-3.9	-5.6	-0.7	-1.3	-1.7
inland navigation	257.1	266.9	296.1	342.4	399.4	454.3	-1.6	-2.0	-1.9	-0.5	-0.5	-0.4
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	211	205	-1	-1	-2	-0.4	-0.7	-1.0
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**350.5**	**375.2**	**384.9**	**-6.7**	**-14.2**	**-21.8**	**-1.9**	**-3.7**	**-5.4**
public road transport	6.3	5.9	5.8	5.9	5.7	5.1	-0.1	-0.1	-0.2	-1.1	-2.2	-3.5
private cars and motorcycles	130.2	136.6	145.5	153.5	149.5	138.8	-0.7	-1.4	-3.4	-0.4	-0.9	-2.4
trucks	76.0	86.5	101.0	132.1	154.8	169.2	-0.6	-4.6	-8.2	-0.5	-2.9	-4.6
rail transport	6.9	7.5	7.7	6.6	5.2	5.0	-0.3	-0.4	-0.3	-4.1	-6.5	-5.5
aviation	27.8	32.5	43.8	46.1	52.9	59.2	-5.0	-7.7	-9.5	-9.8	-12.7	-13.8
inland navigation	6.7	6.7	5.3	6.2	7.0	7.6	0.0	-0.1	-0.1	-0.7	-1.3	-1.9
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	36.4	32.0	27.8	-0.9	-1.3	-1.6	-2.5	-3.8	-5.4
freight transport (toe/Mtkm)	57.8	58.5	57.3	59.4	56.3	51.0	-0.1	-1.2	-1.9	-0.1	-2.2	-3.6

Source: PRIMES

NMS: "KYOTO FOREVER" AT THE EU25 LEVEL — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**111.7**	**90.6**	**88.9**	**-5.6**	**-14.8**	**0.9**	**-4.8**	**-14.0**	**1.0**
Solids	140.9	126.7	104.0	75.3	50.4	43.0	-8.2	-19.9	-16.5	-9.8	-28.3	-27.7
Oil	2.6	3.0	3.1	2.5	2.4	2.3	0.0	0.0	0.0	-0.4	-0.2	-1.4
Natural gas	6.7	7.4	6.1	5.9	5.5	4.9	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	15.5	14.1	14.8	14.9	16.3	17.0	0.0	1.5	11.6	0.0	9.9	217.6
Renewable energy sources	3.0	6.3	8.0	13.1	16.1	21.7	2.6	3.7	5.8	24.6	29.8	36.2
Hydro	1.1	1.3	1.4	2.1	2.2	2.3	0.1	0.1	0.1	3.1	4.2	4.0
Biomass	1.4	4.6	6.1	7.0	7.9	11.8	0.7	1.5	3.9	11.4	23.7	48.6
Waste	0.5	0.3	0.5	3.1	3.3	3.1	1.7	1.8	1.4	128.8	124.1	76.4
Wind	0.0	0.0	0.0	0.6	2.1	3.6	0.1	0.2	0.4	8.9	11.7	13.3
Solar and others	0.0	0.0	0.0	0.3	0.5	0.8	0.0	0.0	0.0	1.0	4.7	4.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.0	-4.8	-5.8
Net Imports	**66.3**	**50.4**	**61.4**	**91.0**	**126.3**	**138.0**	**-1.1**	**-1.3**	**-15.5**	**-1.2**	**-1.0**	**-10.1**
Solids	-14.6	-20.7	-15.9	-8.3	-6.0	-5.6	-1.1	-8.9	-23.5	15.7	-310.6	-131.2
Oil	49.9	45.0	47.3	55.3	61.7	66.0	-0.3	-1.5	-2.7	-0.5	-2.4	-4.0
Crude oil and Feedstocks	43.4	36.7	41.3	46.2	52.1	56.0	0.0	-1.0	-2.2	-0.1	-1.9	-3.8
Oil products	6.5	8.3	6.0	9.2	9.7	10.0	-0.2	-0.5	-0.5	-2.5	-4.7	-4.6
Natural gas	31.2	26.2	31.5	45.2	71.8	78.4	0.2	9.1	10.7	0.5	14.5	15.8
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**201.6**	**215.7**	**225.6**	**-6.8**	**-16.1**	**-14.7**	**-3.3**	**-6.9**	**-6.1**
Solids	127.8	108.2	90.8	67.0	44.3	37.4	-9.3	-28.8	-40.0	-12.2	-39.4	-51.7
Oil	50.4	46.6	48.7	56.7	63.0	67.0	-0.3	-1.5	-2.8	-0.5	-2.3	-3.9
Natural gas	37.1	33.8	37.3	51.1	77.2	83.4	0.2	9.1	10.7	0.5	13.4	14.7
Nuclear	15.5	14.1	14.8	14.9	16.3	17.0	0.0	1.5	11.6	0.0	9.9	217.6
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	13.1	16.1	21.7	2.6	3.7	5.8	24.6	29.8	36.2
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	33.2	20.6	16.6	-3.4	-11.0	-15.6	-9.3	-34.9	-48.6
Oil	21.6	22.3	24.6	28.1	29.2	29.7	0.8	1.4	0.7	2.9	4.9	2.3
Natural gas	15.9	16.2	18.8	25.4	35.8	37.0	0.9	6.4	6.7	3.9	21.8	22.2
Nuclear	6.6	6.7	7.5	7.4	7.6	7.5	0.2	1.2	5.3	3.4	18.1	238.3
Renewable energy forms	1.3	3.0	4.1	6.5	7.4	9.6	1.4	2.1	3.0	28.8	39.5	45.1
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**387.8**	**488.1**	**540.3**	**-4.2**	**-10.1**	**-10.8**	**-1.1**	**-2.0**	**-2.0**
Nuclear	60.0	54.3	57.4	58.5	64.2	70.2	0.0	6.1	48.7	0.0	10.5	227.1
Hydro & wind	12.9	15.5	15.7	31.5	50.1	68.9	1.3	3.6	6.0	4.4	7.7	9.5
Thermal (incl. biomass)	243.7	230.7	250.6	297.8	373.8	401.3	-5.6	-19.7	-65.5	-1.8	-5.0	-14.0
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**71.1**	**73.4**	**76.1**	**-4.4**	**-12.5**	**-20.0**	**-5.8**	**-14.5**	**-20.8**
Solids	62.2	57.2	56.5	49.0	31.6	26.9	-8.6	-26.9	-38.0	-14.9	-46.0	-58.5
Oil	4.9	4.4	3.2	3.5	2.6	2.9	0.1	0.2	0.2	2.7	6.9	7.1
Gas	5.3	4.0	6.3	14.6	33.9	38.2	1.8	11.0	12.6	14.4	47.8	49.1
Biomass - Waste	0.3	0.1	0.4	4.1	5.4	8.1	2.3	3.3	5.2	124.4	160.7	185.1
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**65.4**	**70.2**	**75.1**	**-0.6**	**-1.1**	**-2.7**	**-0.9**	**-1.5**	**-3.5**
Refineries	46.7	40.1	45.2	49.7	56.0	60.8	0.0	-1.1	-2.4	-0.1	-1.9	-3.7
District heating	19.3	12.1	8.5	4.6	4.4	3.9	0.1	0.8	1.1	1.4	20.8	38.2
Biofuels and hydrogen production	0.0	0.0	0.0	0.1	0.4	1.6	0.0	0.0	0.0	-0.1	-1.3	-2.7
Others	30.5	23.1	17.7	11.0	9.4	8.8	-0.6	-0.7	-1.4	-5.1	-7.3	-13.4
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.5**	**9.5**	**9.0**	**-0.1**	**-0.4**	**-0.3**	**-1.4**	**-3.6**	**-3.1**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**13.0**	**14.4**	**0.0**	**0.0**	**0.0**	**0.3**	**0.3**	**0.0**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**129.4**	**146.7**	**156.7**	**-3.0**	**-6.4**	**-8.4**	**-2.2**	**-4.2**	**-5.1**
by sector												
Industry	65.0	47.7	40.4	38.6	40.5	41.9	-0.8	-1.6	-2.0	-2.1	-3.8	-4.6
energy intensive industries	32.5	27.9	26.2	25.0	25.3	25.3	-0.7	-1.2	-1.6	-2.6	-4.6	-6.0
other industrial sectors	32.4	19.7	14.2	13.7	15.2	16.6	-0.1	-0.4	-0.4	-1.1	-2.5	-2.3
Residential	40.0	41.2	34.4	36.8	42.7	45.1	-1.0	-2.1	-2.6	-2.6	-4.7	-5.5
Tertiary	24.9	19.6	21.5	24.1	27.0	29.6	-1.0	-1.6	-1.9	-3.9	-5.7	-6.1
Transport	19.9	19.8	22.9	29.8	36.5	40.2	-0.2	-1.0	-1.8	-0.6	-2.8	-4.3
by fuel												
Solids	40.9	33.8	21.4	12.4	9.1	7.0	-1.4	-1.9	-2.0	-10.2	-17.2	-21.9
Oil	32.7	29.6	33.6	40.8	46.9	49.9	-0.5	-1.6	-2.9	-1.2	-3.4	-5.5
Gas	26.5	24.6	25.4	32.4	36.9	39.3	-0.9	-2.9	-3.3	-2.7	-7.4	-7.7
Electricity	20.5	18.5	19.6	24.9	32.8	37.5	-0.2	-0.5	-0.6	-0.8	-1.4	-1.5
Heat (from CHP and District Heating)	27.7	17.4	13.5	13.0	15.5	17.3	-0.2	0.5	0.3	-1.2	3.3	1.9
Other	1.8	4.7	5.8	5.8	5.5	5.6	0.2	0.1	0.1	3.6	1.1	1.1
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**514.6**	**498.7**	**492.5**	**-37.6**	**-97.9**	**-142.4**	**-6.8**	**-16.4**	**-22.4**
Electricity and Steam production	343.4	295.0	280.1	255.0	224.4	214.7	-28.4	-78.6	-117.9	-10.0	-25.9	-35.5
Energy Branch	14.4	19.5	18.7	10.6	11.4	11.4	0.0	0.0	-0.1	0.4	0.3	-0.7
Industry	137.0	118.2	96.4	82.2	77.5	75.6	-3.8	-8.3	-9.9	-4.4	-9.7	-11.6
Residential	83.2	72.9	49.7	46.4	49.8	47.5	-2.9	-4.8	-5.5	-5.9	-8.7	-10.3
Tertiary	53.3	38.3	37.2	34.8	31.2	31.0	-2.1	-3.3	-4.0	-5.7	-9.6	-11.4
Transport	56.1	55.9	65.3	85.5	104.4	112.3	-0.5	-3.0	-5.1	-0.6	-2.8	-4.3
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**74.9**	**72.6**	**71.6**	**-5.5**	**-14.2**	**-20.7**	-6.8	-16.4	-22.4

See explanations on the last page of the Appendix

Source: PRIMES

NMS: "KYOTO FOREVER" AT THE EU25 LEVEL — SUMMARY ENERGY BALANCE AND INDICATORS (B)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	351.4	262.7	205.0	-11.8	-19.6	-13.3	-3.3	-6.9	-6.1
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.7	3.0	3.3	-0.1	-0.2	-0.2	-3.3	-6.9	-6.1
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	5283	6811	7815	-58	-140	-156	-1.1	-2.0	-2.0
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.55	2.31	2.18	-0.10	-0.26	-0.46	-3.7	-10.2	-17.4
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.0	7.0	7.1	-0.5	-1.4	-2.1	-6.8	-16.4	-22.4
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	896.7	607.5	447.6	-65.6	-119.3	-129.4	-6.8	-16.4	-22.4
Import Dependency %	28.3	24.1	30.8	44.9	58.2	60.8	0.9	3.5	-2.7	2.1	6.3	-4.3
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	35.4	26.4	21.7	-0.8	-1.0	-1.0	-2.1	-3.8	-4.6
Residential (Energy on Private Income)	100.0	106.5	74.2	54.5	43.2	34.1	-1.4	-2.1	-2.0	-2.6	-4.7	-5.5
Tertiary (Energy on Value added)	100.0	74.8	67.2	50.5	38.1	30.0	-2.0	-2.3	-2.0	-3.9	-5.7	-6.1
Transport (Energy on GDP)	100.0	102.9	97.4	87.0	74.5	61.1	-0.6	-2.1	-2.7	-0.6	-2.8	-4.3
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.45	0.32	0.28	-0.04	-0.11	-0.15	-9.0	-25.4	-34.9
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.92	1.79	1.70	-0.03	-0.05	-0.06	-1.4	-2.8	-3.5
Industry	2.11	2.48	2.38	2.13	1.91	1.81	-0.05	-0.12	-0.14	-2.4	-6.1	-7.4
Residential	2.08	1.77	1.44	1.26	1.17	1.05	-0.04	-0.05	-0.06	-3.4	-4.2	-5.1
Tertiary	2.14	1.95	1.73	1.44	1.16	1.05	-0.03	-0.05	-0.06	-1.9	-4.1	-5.6
Transport	2.82	2.82	2.85	2.86	2.86	2.80	0.00	0.00	0.00	0.0	0.0	-0.1
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**95.0**	**133.3**	**167.0**	**-0.1**	**-0.8**	**-0.2**	**-0.1**	**-0.6**	**-0.1**
Nuclear		8.4	9.3	7.9	8.7	9.4	0.0	0.8	6.6	0.0	9.6	230.9
Hydro (pumping excluded)		6.1	6.4	7.9	8.7	8.9	0.2	0.4	0.4	3.1	5.0	5.3
Wind and solar		0.0	0.0	3.1	9.9	17.7	0.3	1.2	2.7	9.6	13.5	18.2
Thermal		64.0	61.9	76.1	106.0	131.0	-0.6	-3.2	-9.9	-0.8	-2.9	-7.0
of which cogeneration units		*28.1*	*26.3*	*26.8*	*35.6*	*47.5*	*-0.6*	*-2.6*	*-4.8*	*-2.0*	*-6.8*	*-9.1*
Open cycle (incl. biomass-waste)		61.9	58.6	50.6	28.1	15.2	-5.4	-11.5	-18.8	-9.6	-29.0	-55.4
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	2.9	15.4	26.4	2.4	0.4	-4.5	468.1	2.5	-14.5
Gas Turbines Combined Cycle		0.4	1.4	14.7	48.1	75.8	2.4	8.6	14.2	19.3	21.7	23.1
Small Gas Turbines		1.7	1.8	8.0	14.5	13.6	-0.1	-0.7	-0.8	-0.8	-4.3	-5.8
Fuel Cells		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	37.9	45.7	47.7	1.5	4.3	3.7	4.1	10.4	8.4
Load factor for gross electric capacities (%)		43.6	47.6	46.6	41.8	36.9	-0.4	-0.6	-0.7	-0.9	-1.4	-1.9
CHP indicator (% of electricity from CHP)		29.4	30.4	28.0	25.8	30.4	-0.3	-1.5	-1.3	-1.0	-5.5	-4.0
Non fossil fuels in electricity generation (%)		23.4	23.1	26.6	27.2	31.1	2.4	4.7	13.9	9.9	20.9	80.6
nuclear		18.1	17.7	15.1	13.2	13.0	0.2	1.5	9.1	1.1	12.8	233.6
renewable energy forms		5.3	5.4	11.5	14.0	18.2	2.2	3.2	4.8	24.1	29.6	36.0
of which waste		*0.0*	*0.1*	*2.0*	*1.6*	*1.2*	*1.4*	*1.2*	*0.9*	*227.2*	*273.9*	*247.2*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**614.4**	**806.2**	**995.2**	**-1.3**	**-2.5**	**-3.5**	**-0.2**	**-0.3**	**-0.4**
public road transport	115.7	87.0	81.2	80.9	84.5	90.6	-0.3	-0.1	0.1	-0.4	-0.1	0.1
private cars and motorcycles	268.0	315.8	352.9	458.8	620.4	769.3	-0.4	-0.8	-0.9	-0.1	-0.1	-0.1
rail transport	91.9	50.8	46.3	47.8	57.6	74.1	-0.4	-0.6	-0.7	-0.8	-1.0	-0.9
aviation	11.2	14.0	16.8	26.2	43.0	60.5	-0.2	-0.9	-2.0	-0.8	-2.1	-3.2
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	-0.1	0.0	0.2
travel per person (km per capita)	6489	6227	6662	8370	11250	14393	-18	-34	-51	-0.2	-0.3	-0.4
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**337.9**	**439.2**	**537.7**	**-1.5**	**-3.0**	**-3.6**	**-0.4**	**-0.7**	**-0.7**
trucks	118.4	119.0	155.5	223.6	318.4	410.5	-0.3	-1.1	-1.9	-0.1	-0.4	-0.5
rail transport	205.2	137.8	118.7	113.5	120.0	126.3	-1.1	-1.8	-1.7	-1.0	-1.5	-1.3
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	-0.4	-0.2	0.1
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	589	535	489	-3	-4	-3	-0.4	-0.7	-0.7
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**29.8**	**36.5**	**40.2**	**-0.2**	**-1.0**	**-1.8**	**-0.6**	**-2.8**	**-4.3**
public road transport	1.4	1.0	1.2	1.1	1.1	1.0	0.0	0.0	0.0	-0.6	-1.4	-4.2
private cars and motorcycles	7.9	9.5	11.6	14.7	17.5	18.9	0.0	-0.2	-0.5	-0.3	-1.0	-2.4
trucks	7.0	6.7	7.5	11.0	14.7	17.3	0.0	-0.4	-0.8	-0.2	-2.5	-4.5
rail transport	2.0	1.4	1.3	1.1	1.0	0.9	0.0	0.0	-0.1	-2.2	-4.5	-5.5
aviation	1.3	1.2	1.3	1.8	2.2	2.1	-0.1	-0.4	-0.4	-4.9	-15.9	-16.5
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.6	-1.1
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	29.6	26.4	22.5	-0.2	-0.7	-0.9	-0.6	-2.6	-3.7
freight transport (toe/Mtkm)	24.6	28.8	30.0	34.5	34.8	33.1	0.0	-0.7	-1.3	0.1	-1.9	-3.9

Source: PRIMES

EU25: "GOTHENBURG TYPE" TARGETS (DOMESTIC ACTION) AT EU25 LEVEL — SUMMARY ENERGY BALANCE AND INDICATORS (A)

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**876.8**	**896.9**	**897.3**	**849.2**	**724.0**	**709.1**	**-11.2**	**-16.9**	**48.2**	**-1.3**	**-2.3**	**7.3**
Solids	350.8	264.7	203.4	132.8	52.6	27.5	-21.1	-73.7	-75.1	-13.7	-58.3	-73.2
Oil	120.3	162.2	163.5	131.5	101.6	85.8	-0.2	-0.5	-0.7	-0.1	-0.4	-0.8
Natural gas	139.6	174.0	196.6	196.6	147.5	114.9	-0.2	0.0	-2.3	-0.1	0.0	-1.9
Nuclear	196.9	215.3	237.7	245.3	210.6	214.2	0.0	-2.9	28.9	0.0	-1.4	15.6
Renewable energy sources	69.2	80.7	96.1	142.9	211.6	266.8	10.3	60.3	97.4	7.7	39.8	57.5
Hydro	23.4	26.3	29.0	30.3	32.0	33.3	0.2	0.4	1.1	0.7	1.2	3.3
Biomass	31.1	35.4	42.2	63.0	109.2	138.9	5.5	44.3	65.3	9.6	68.2	88.5
Waste	12.3	15.9	19.3	28.8	35.1	36.5	3.1	7.4	9.4	12.1	26.7	34.5
Wind	0.1	0.4	1.9	15.3	27.6	44.5	1.3	7.5	17.7	9.7	37.3	66.0
Solar and others	0.1	0.3	0.4	1.7	3.2	8.2	0.0	0.3	2.9	-1.0	9.5	53.8
Geothermal	2.2	2.5	3.3	3.8	4.4	5.4	0.1	0.5	1.1	2.1	11.7	27.1
Net Imports	**711.6**	**701.7**	**799.3**	**941.8**	**1080.7**	**1070.0**	**-32.7**	**-123.8**	**-291.8**	**-3.4**	**-10.3**	**-21.4**
Solids	75.2	73.8	91.4	76.8	43.5	23.1	-13.1	-82.8	-174.3	-14.5	-65.5	-88.3
Oil	510.8	491.8	519.6	558.0	581.9	575.2	-14.4	-44.1	-75.7	-2.5	-7.0	-11.6
Crude oil and Feedstocks	480.2	471.5	496.8	535.3	568.4	570.9	-14.5	-42.6	-74.0	-2.6	-7.0	-11.5
Oil products	30.6	20.3	22.8	22.7	13.4	4.3	0.0	-1.5	-1.7	0.2	-10.0	-27.8
Natural gas	123.5	134.8	186.2	304.8	453.3	469.3	-5.2	3.1	-41.8	-1.7	0.7	-8.2
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1554.3**	**1572.7**	**1650.7**	**1740.3**	**1748.2**	**1716.2**	**-43.8**	**-140.7**	**-243.6**	**-2.5**	**-7.4**	**-12.4**
Solids	430.6	346.0	303.2	209.6	96.2	50.6	-34.1	-156.5	-249.4	-14.0	-61.9	-83.1
Oil	596.2	622.2	635.6	638.9	627.0	598.0	-14.6	-44.6	-76.4	-2.2	-6.6	-11.3
Natural gas	259.2	307.1	376.0	501.5	600.8	584.2	-5.4	3.0	-44.0	-1.1	0.5	-7.0
Nuclear	196.9	215.3	237.7	245.3	210.6	214.2	0.0	-2.9	28.9	0.0	-1.4	15.6
Electricity	2.2	1.4	2.1	2.1	2.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	69.2	80.7	96.1	142.9	211.6	266.8	10.3	60.3	97.4	7.7	39.8	57.5
as % in Gross Inland Consumption												
Solids	27.7	22.0	18.4	12.0	5.5	2.9	-1.6	-7.9	-12.4	-11.8	-58.9	-80.8
Oil	38.4	39.6	38.5	36.7	35.9	34.8	0.1	0.3	0.4	0.2	0.9	1.3
Natural gas	16.7	19.5	22.8	28.8	34.4	34.0	0.4	2.7	2.0	1.4	8.6	6.2
Nuclear	12.7	13.7	14.4	14.1	12.0	12.5	0.3	0.7	3.0	2.5	6.6	32.0
Renewable energy forms	4.5	5.1	5.8	8.2	12.1	15.5	0.8	4.1	6.9	10.5	51.1	79.8
Electricity Generation in TWh_e	**2455.6**	**2608.7**	**2897.9**	**3395.1**	**3827.8**	**4048.9**	**-24.0**	**-120.9**	**-348.3**	**-0.7**	**-3.1**	**-7.9**
Nuclear	780.0	864.4	921.2	952.5	824.0	883.9	0.0	-9.5	117.4	0.0	-1.1	15.3
Hydro & wind	272.7	309.7	359.5	530.6	696.0	952.6	17.9	93.5	247.2	3.5	15.5	35.0
Thermal (incl. biomass)	1402.9	1434.7	1617.2	1912.1	2307.8	2212.4	-42.0	-204.9	-712.8	-2.1	-8.2	-24.4
Fuel Inputs for Thermal Power Generation (1)	**364.4**	**360.8**	**384.6**	**396.5**	**424.0**	**402.3**	**-16.7**	**-58.9**	**-138.6**	**-4.0**	**-12.2**	**-25.6**
Solids	248.2	221.1	210.1	146.4	50.9	16.7	-28.8	-141.4	-227.5	-16.5	-73.5	-93.2
Oil (including refinery gas)	53.7	53.9	41.5	20.2	9.4	8.1	-3.6	-4.1	-1.4	-15.0	-30.4	-14.7
Gas	50.4	70.0	112.6	193.0	281.6	271.6	7.9	35.9	16.4	4.3	14.6	6.4
Biomass - Waste	10.3	13.6	17.5	33.5	78.0	100.9	7.7	50.3	72.7	29.9	181.5	258.4
Geothermal heat	1.9	2.1	3.0	3.5	4.1	5.1	0.1	0.5	1.1	2.7	12.9	28.8
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**800.6**	**780.4**	**794.2**	**789.4**	**789.4**	**776.7**	**-17.7**	**-53.8**	**-95.0**	**-2.2**	**-6.4**	**-10.9**
Refineries	641.3	675.9	710.9	718.2	722.0	709.7	-15.0	-45.0	-78.7	-2.1	-5.9	-10.0
District heating	31.7	23.1	14.5	11.5	10.1	11.0	0.7	1.2	2.2	6.4	14.0	25.6
Biofuels and hydrogen production	0.0	0.2	0.6	10.2	17.6	25.0	0.0	-0.5	-2.4	-0.4	-3.0	-8.8
Others	127.6	81.2	68.3	49.6	39.6	30.9	-3.3	-9.5	-16.1	-6.2	-19.3	-34.2
Energy Branch Consumption	**76.0**	**81.3**	**82.3**	**75.8**	**72.8**	**68.7**	**-1.3**	**-4.4**	**-8.5**	**-1.7**	**-5.7**	**-11.0**
Non-Energy Uses	**94.0**	**103.0**	**105.6**	**114.7**	**121.8**	**125.0**	**0.3**	**0.3**	**0.1**	**0.3**	**0.3**	**0.1**
Final Energy Demand	**1009.2**	**1023.5**	**1074.4**	**1179.8**	**1222.8**	**1218.0**	**-29.1**	**-95.1**	**-176.2**	**-2.4**	**-7.2**	**-12.6**
by sector												
Industry (1)	327.2	303.3	309.1	332.0	344.9	354.7	-6.9	-22.5	-33.7	-2.0	-6.1	-8.7
energy intensive industries	212.9	198.9	202.0	211.0	208.8	201.6	-5.3	-17.4	-27.4	-2.5	-7.7	-12.0
other industrial sectors	114.3	104.4	107.0	121.0	136.0	153.1	-1.6	-5.1	-6.4	-1.3	-3.6	-4.0
Residential	268.1	277.2	279.1	301.7	303.5	290.5	-6.9	-25.7	-48.3	-2.2	-7.8	-14.3
Tertiary	140.2	147.5	154.2	165.8	174.3	178.2	-8.4	-20.0	-39.9	-4.8	-10.3	-18.3
Transport	273.7	295.6	332.0	380.3	400.1	394.6	-6.9	-26.9	-54.1	-1.8	-6.3	-12.1
by fuel (1)												
Solids	117.7	80.8	57.4	36.5	22.6	13.9	-5.8	-13.5	-18.2	-13.6	-37.4	-56.7
Oil	424.2	443.7	464.2	492.9	499.0	481.9	-10.6	-38.6	-72.8	-2.1	-7.2	-13.1
Gas	196.2	219.5	245.7	286.9	289.4	278.4	-13.1	-35.4	-65.0	-4.4	-10.9	-18.9
Electricity	176.5	187.9	211.3	251.9	289.0	309.6	-1.5	-8.1	-24.7	-0.6	-2.7	-7.4
Heat (from CHP and District Heating)	62.9	56.7	55.6	65.8	74.2	83.7	0.8	-1.5	0.0	1.2	-2.0	0.0
Other	32.1	35.3	40.3	45.9	48.5	50.5	0.9	2.1	4.6	2.1	4.5	10.0
CO_2 Emissions (Mt of CO_2)	**3769.5**	**3651.6**	**3664.9**	**3561.2**	**3286.6**	**2980.0**	**-196.0**	**-754.1**	**-1323.7**	**-5.2**	**-18.7**	**-30.8**
Electricity and Steam production	1341.0	1242.7	1228.3	1128.3	912.1	749.4	-107.0	-490.9	-863.7	-8.7	-35.0	-53.5
Energy Branch	144.2	163.9	164.0	143.2	136.1	126.1	-2.5	-7.0	-12.9	-1.7	-4.9	-9.3
Industry	713.2	644.8	605.7	514.6	469.0	429.3	-29.8	-76.8	-122.6	-5.5	-14.1	-22.2
Residential	519.7	490.4	462.6	463.1	433.4	386.5	-18.5	-61.7	-100.6	-3.8	-12.5	-20.7
Tertiary	256.8	251.0	236.7	221.1	201.1	185.8	-18.5	-39.8	-69.0	-7.7	-16.5	-27.1
Transport	794.6	858.8	967.5	1090.8	1134.9	1102.8	-19.7	-77.8	-154.8	-1.8	-6.4	-12.3
CO_2 Emissions Index (1990=100)	**100.0**	**96.9**	**97.2**	**94.5**	**87.2**	**79.1**	**-5.2**	**-20.0**	**-35.1**	-5.2	-18.7	-30.8

See explanations on the last page of the Appendix

Source: PRIMES

EU25: "GOTHENBURG TYPE" TARGETS (DOMESTIC ACTION) AT EU25 LEVEL — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	441.1	448.6	453.4	461.2	462.1	458.2	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	7315	7817	8939	11433	14462	18020	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	212.5	201.2	184.7	152.2	120.9	95.2	-3.8	-9.7	-13.5	-2.5	-7.4	-12.4
Gross Inl. Cons./Capita (toe/inhabitant)	3.5	3.5	3.6	3.8	3.8	3.7	-0.1	-0.3	-0.5	-2.5	-7.4	-12.4
Electricity Generated/Capita (kWh/inhabitant)	5567	5816	6391	7361	8283	8837	-52	-262	-760	-0.7	-3.1	-7.9
Carbon intensity (t of CO_2/toe of GIC)	2.43	2.32	2.22	2.05	1.88	1.74	-0.06	-0.26	-0.46	-2.8	-12.1	-20.9
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.5	8.1	8.1	7.7	7.1	6.5	-0.4	-1.6	-2.9	-5.2	-18.7	-30.8
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	515.3	467.2	410.0	311.5	227.3	165.4	-17.1	-52.1	-73.5	-5.2	-18.7	-30.8
Import Dependency %	44.8	43.6	47.2	52.6	59.9	60.1	-0.5	-2.0	-7.2	-1.0	-3.3	-10.7
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	91.1	82.7	69.5	56.8	46.9	-1.4	-3.7	-4.5	-2.0	-6.1	-8.7
Residential (Energy on Private Income)	100.0	98.1	85.8	72.8	58.2	45.2	-1.7	-4.9	-7.5	-2.2	-7.8	-14.3
Tertiary (Energy on Value added)	100.0	96.7	86.8	71.2	58.5	47.6	-3.6	-6.7	-10.7	-4.8	-10.3	-18.3
Transport (Energy on GDP)	100.0	101.1	99.3	88.9	73.9	58.5	-1.6	-5.0	-8.0	-1.8	-6.3	-12.1
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.44	0.40	0.37	0.27	0.19	0.15	-0.02	-0.09	-0.15	-8.3	-33.0	-50.3
Final energy demand (t of CO_2/toe)	2.26	2.19	2.12	1.94	1.83	1.73	-0.02	-0.06	-0.10	-1.3	-3.3	-5.6
Industry	2.18	2.13	1.96	1.55	1.36	1.21	-0.06	-0.13	-0.21	-3.5	-8.5	-14.8
Residential	1.94	1.77	1.66	1.53	1.43	1.33	-0.03	-0.08	-0.11	-1.7	-5.1	-7.5
Tertiary	1.83	1.70	1.54	1.33	1.15	1.04	-0.04	-0.09	-0.13	-3.0	-7.0	-10.8
Transport	2.90	2.91	2.91	2.87	2.84	2.80	0.00	0.00	-0.01	0.0	-0.1	-0.3
Electricity and steam generation												
Generation Capacity in GW_e		**617.4**	**656.2**	**790.8**	**972.1**	**1137.5**	**7.0**	**25.4**	**19.3**	**0.9**	**2.7**	**1.7**
Nuclear		134.7	140.3	129.8	115.5	137.4	0.0	7.5	29.6	0.0	7.0	27.5
Hydro (pumping excluded)		93.3	96.2	105.4	114.4	118.9	0.8	5.1	6.7	0.8	4.7	6.0
Wind and solar		2.5	13.0	80.2	146.7	245.0	7.1	42.7	95.8	9.6	41.0	64.2
Thermal		386.9	406.7	475.4	595.5	636.2	-0.9	-29.9	-112.9	-0.2	-4.8	-15.1
of which cogeneration units		*87.3*	*103.4*	*132.7*	*177.9*	*212.3*	*3.0*	*9.7*	*13.6*	*2.3*	*5.8*	*6.8*
Open cycle(incl. biomass-waste)		343.8	335.6	265.1	174.8	137.2	-5.5	-0.5	-10.1	-2.0	-0.3	-6.9
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	3.2	18.6	32.0	2.2	-48.1	-118.0	229.5	-72.1	-78.7
Gas Turbines Combined Cycle		20.4	47.4	175.1	351.6	383.6	5.6	32.9	-1.0	3.3	10.3	-0.3
Small Gas Turbines		22.0	22.8	30.8	48.8	47.0	-3.2	-14.5	-18.8	-9.3	-22.9	-28.5
Fuel Cells		0.0	0.0	0.0	0.0	34.3	0.0	0.0	34.3			
Geothermal heat		0.7	1.0	1.2	1.6	2.1	0.0	0.3	0.7	2.7	25.7	50.6
Indicators												
Efficiency for thermal electricity production (%)		35.8	37.1	43.4	49.2	50.2	0.8	2.3	1.5	2.0	5.0	3.1
Load factor for gross electric capacities (%)		48.2	50.4	49.0	45.0	40.6	-0.8	-2.7	-4.3	-1.6	-5.6	-9.5
CHP indicator (% of electricity from CHP)		11.5	12.6	14.3	15.7	17.5	-0.2	0.2	1.2	-1.2	1.4	7.4
Non fossil fuels in electricity generation (%)		46.8	46.4	47.1	47.2	55.1	1.7	8.5	19.5	3.7	21.9	54.8
nuclear		33.1	31.8	28.1	21.5	21.8	0.2	0.4	4.4	0.7	2.0	25.2
renewable energy forms		13.7	14.6	19.1	25.7	33.3	1.5	8.1	15.1	8.4	45.9	83.2
of which waste		*0.9*	*1.1*	*1.6*	*1.9*	*1.9*	*0.3*	*0.7*	*1.0*	*23.1*	*61.6*	*96.9*
Transport sector												
Passenger transport activity (Gpkm)	**4683.8**	**5038.7**	**5519.7**	**6415.1**	**7442.9**	**8375.0**	**-17.7**	**-66.2**	**-163.9**	**-0.3**	**-0.9**	**-1.9**
public road transport	484.5	469.2	493.8	501.7	530.9	553.5	-2.1	-2.1	-2.1	-0.4	-0.4	-0.4
private cars and motorcycles	3593.6	3950.3	4291.6	5016.5	5758.1	6399.4	-9.1	-30.2	-75.2	-0.2	-0.5	-1.2
rail transport	408.3	371.7	402.3	411.9	470.5	522.8	-2.9	-8.8	-14.7	-0.7	-1.8	-2.7
aviation	168.5	215.5	298.3	444.8	636.7	845.2	-3.4	-25.0	-71.8	-0.7	-3.8	-7.8
inland navigation	28.9	31.9	33.6	40.3	46.7	54.0	-0.1	-0.1	0.0	-0.3	-0.2	-0.1
travel per person (km per capita)	10618	11233	12174	13909	16106	18280	-38	-143	-358	-0.3	-0.9	-1.9
Freight transport activity (Gpkm)	**1762.6**	**1859.8**	**2147.6**	**2679.3**	**3296.4**	**3934.1**	**-10.5**	**-42.6**	**-108.7**	**-0.4**	**-1.3**	**-2.7**
trucks	1064.3	1233.6	1482.7	1960.7	2486.3	3045.5	-6.0	-30.5	-87.1	-0.3	-1.2	-2.8
rail transport	440.2	358.0	368.0	375.4	411.3	438.5	-2.9	-8.6	-14.7	-0.8	-2.0	-3.2
inland navigation	258.1	268.2	297.0	343.2	398.8	450.1	-1.6	-3.5	-6.9	-0.5	-0.9	-1.5
freight activity per unit of GDP (tkm/000 Euro'00)	241	238	240	234	228	218	-1	-3	-6	-0.4	-1.3	-2.7
Energy demand in transport (Mtoe)	**273.7**	**295.6**	**332.0**	**380.3**	**400.1**	**394.6**	**-6.9**	**-26.9**	**-54.1**	**-1.8**	**-6.3**	**-12.1**
public road transport	7.7	6.9	7.0	7.1	6.7	5.8	-0.1	-0.2	-0.6	-1.0	-3.5	-8.7
private cars and motorcycles	138.1	146.1	157.1	168.3	166.0	153.9	-0.7	-2.6	-7.7	-0.4	-1.6	-4.7
trucks	82.9	93.2	108.5	143.2	165.2	173.0	-0.6	-9.3	-22.6	-0.5	-5.3	-11.5
rail transport	8.8	8.9	9.0	7.7	6.0	5.6	-0.3	-0.5	-0.6	-3.8	-8.1	-10.1
aviation	29.1	33.8	45.1	47.9	49.3	48.9	-5.1	-14.0	-22.3	-9.7	-22.1	-31.3
inland navigation	7.0	6.7	5.4	6.2	7.0	7.4	0.0	-0.2	-0.4	-0.7	-2.2	-5.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	39.0	38.6	39.2	35.8	30.5	25.5	-0.9	-2.0	-3.1	-2.3	-6.2	-11.0
freight transport (toe/Mtkm)	51.7	54.4	53.8	56.3	52.5	46.0	-0.1	-2.2	-4.5	-0.1	-4.0	-8.9

Source: PRIMES

EU15: "GOTHENBURG TYPE" TARGETS (DOMESTIC ACTION) AT EU25 LEVEL — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**708.1**	**739.5**	**761.3**	**737.5**	**644.5**	**635.0**	**-5.5**	**9.1**	**62.1**	**-0.7**	**1.4**	**10.8**
Solids	209.9	138.0	99.4	57.5	18.3	8.5	-12.8	-37.7	-34.5	-18.3	-67.3	-80.2
Oil	117.7	159.2	160.4	129.1	99.2	83.5	-0.1	-0.4	-0.6	-0.1	-0.4	-0.7
Natural gas	132.9	166.6	190.6	190.7	142.1	110.0	-0.2	0.0	-2.2	-0.1	0.0	-2.0
Nuclear	181.4	201.2	222.8	230.3	194.0	194.5	0.0	-4.7	14.6	0.0	-2.4	8.1
Renewable energy sources	66.3	74.4	88.1	129.8	190.9	238.4	7.7	52.0	84.9	6.3	37.4	55.3
Hydro	22.3	24.9	27.6	28.3	29.9	31.0	0.1	0.4	1.0	0.5	1.3	3.2
Biomass	29.7	30.8	36.1	56.0	96.7	121.0	4.8	38.2	55.3	9.4	65.2	84.1
Waste	11.9	15.6	18.7	25.7	31.5	32.8	1.4	5.3	7.4	5.6	20.0	29.3
Wind	0.1	0.4	1.9	14.6	25.7	40.9	1.3	7.5	17.3	9.7	41.1	73.1
Solar and others	0.1	0.2	0.3	1.4	2.7	7.3	0.0	0.2	2.8	-1.3	9.4	61.5
Geothermal	2.2	2.5	3.3	3.8	4.4	5.4	0.1	0.5	1.1	2.1	11.7	27.1
Net Imports	**645.4**	**651.3**	**737.9**	**850.7**	**951.0**	**933.5**	**-31.5**	**-126.0**	**-274.7**	**-3.6**	**-11.7**	**-22.7**
Solids	89.9	94.4	107.2	85.1	47.6	25.0	-11.9	-75.9	-154.4	-12.3	-61.5	-86.1
Oil	460.9	446.7	472.4	502.7	521.5	513.8	-14.2	-41.2	-68.4	-2.7	-7.3	-11.7
Crude oil and Feedstocks	436.8	434.7	455.5	489.1	517.5	518.6	-14.4	-40.5	-68.0	-2.9	-7.3	-11.6
Oil products	24.1	12.0	16.9	13.6	4.1	-4.9	0.3	-0.7	-0.4	2.0	-14.8	8.2
Natural gas	92.3	108.6	154.7	259.6	378.6	391.5	-5.4	-8.9	-51.9	-2.0	-2.3	-11.7
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**1320.6**	**1363.8**	**1452.5**	**1538.6**	**1540.2**	**1506.8**	**-37.1**	**-116.9**	**-212.6**	**-2.4**	**-7.1**	**-12.4**
Solids	302.8	237.7	212.4	142.6	65.9	33.6	-24.8	-113.6	-189.0	-14.8	-63.3	-84.9
Oil	545.8	575.6	586.9	582.2	565.5	535.7	-14.3	-41.7	-69.0	-2.4	-6.9	-11.4
Natural gas	222.1	273.4	338.7	450.3	520.7	501.5	-5.7	-8.9	-54.1	-1.2	-1.7	-9.7
Nuclear	181.4	201.2	222.8	230.3	194.0	194.5	0.0	-4.7	14.6	0.0	-2.4	8.1
Electricity	2.3	1.5	3.7	3.3	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	66.3	74.4	88.1	129.8	190.9	238.4	7.7	52.0	84.9	6.3	37.4	55.3
as % in Gross Inland Consumption												
Solids	22.9	17.4	14.6	9.3	4.3	2.2	-1.4	-6.6	-10.7	-12.7	-60.5	-82.8
Oil	41.3	42.2	40.4	37.8	36.7	35.5	0.0	0.1	0.4	0.0	0.2	1.1
Natural gas	16.8	20.0	23.3	29.3	33.8	33.3	0.3	1.8	1.0	1.1	5.8	3.0
Nuclear	13.7	14.8	15.3	15.0	12.6	12.9	0.4	0.6	2.4	2.4	5.0	23.4
Renewable energy forms	5.0	5.5	6.1	8.4	12.4	15.8	0.7	4.0	6.9	8.9	47.8	77.2
Electricity Generation in TWh_e	**2139.1**	**2308.3**	**2574.1**	**3007.3**	**3343.5**	**3529.9**	**-19.7**	**-107.0**	**-316.2**	**-0.7**	**-3.1**	**-8.2**
Nuclear	720.1	810.1	863.7	894.0	758.4	802.6	0.0	-17.0	57.5	0.0	-2.2	7.7
Hydro & wind	259.8	294.2	343.8	499.1	649.3	883.6	16.6	93.4	241.0	3.4	16.8	37.5
Thermal (incl. biomass)	1159.2	1204.0	1366.5	1614.3	1935.7	1843.8	-36.4	-183.4	-614.6	-2.2	-8.7	-25.0
Fuel Inputs for Thermal Power Generation (1)	**291.8**	**295.1**	**318.3**	**325.4**	**353.5**	**333.8**	**-12.3**	**-43.4**	**-111.0**	**-3.7**	**-10.9**	**-25.0**
Solids	186.1	163.9	153.6	97.4	31.7	7.8	-20.3	-102.1	-171.4	-17.2	-76.3	-95.6
Oil (including refinery gas)	48.7	49.6	38.3	16.7	7.0	5.6	-3.7	-4.2	-1.2	-18.0	-37.5	-17.1
Gas	45.1	66.0	106.3	178.4	243.1	229.1	6.0	20.3	-0.5	3.5	9.1	-0.2
Biomass - Waste	10.0	13.5	17.1	29.5	67.7	86.3	5.5	42.1	60.9	22.8	164.2	240.6
Geothermal heat	1.9	2.1	3.0	3.5	4.1	5.1	0.1	0.5	1.1	2.7	12.9	28.8
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**704.2**	**705.1**	**722.9**	**724.0**	**721.8**	**707.3**	**-17.1**	**-50.1**	**-86.6**	**-2.3**	**-6.5**	**-10.9**
Refineries	594.6	635.8	665.7	668.6	667.2	652.9	-15.0	-42.8	-72.4	-2.2	-6.0	-10.0
District heating	12.4	11.0	6.0	6.8	5.8	6.6	0.6	0.6	0.6	10.1	11.3	10.2
Biofuels and hydrogen production	0.0	0.2	0.6	10.1	17.2	23.5	0.0	-0.5	-2.3	-0.4	-3.1	-8.8
Others	97.1	58.1	50.6	38.5	31.6	24.4	-2.7	-7.4	-12.5	-6.5	-18.9	-33.9
Energy Branch Consumption	**63.2**	**68.4**	**69.5**	**66.2**	**63.4**	**60.0**	**-1.2**	**-3.9**	**-7.8**	**-1.8**	**-5.8**	**-11.6**
Non-Energy Uses	**84.0**	**93.6**	**95.1**	**103.6**	**108.8**	**110.6**	**0.3**	**0.3**	**0.1**	**0.3**	**0.3**	**0.1**
Final Energy Demand	**859.5**	**895.2**	**955.1**	**1050.4**	**1081.7**	**1074.2**	**-26.2**	**-83.1**	**-154.8**	**-2.4**	**-7.1**	**-12.6**
by sector												
Industry (1)	262.2	255.6	268.7	293.3	305.8	315.5	-6.1	-19.4	-29.1	-2.0	-6.0	-8.4
energy intensive industries	180.4	170.9	175.8	186.0	184.8	178.7	-4.7	-14.9	-23.5	-2.5	-7.4	-11.6
other industrial sectors	81.9	84.7	92.9	107.3	121.0	136.8	-1.4	-4.6	-5.6	-1.3	-3.6	-3.9
Residential	228.1	236.0	244.7	264.9	262.9	249.3	-5.9	-21.4	-41.8	-2.2	-7.5	-14.4
Tertiary	115.3	127.9	132.7	141.7	148.6	152.1	-7.5	-17.1	-34.5	-5.0	-10.3	-18.5
Transport	253.8	275.7	309.1	350.5	364.3	357.3	-6.7	-25.1	-49.4	-1.9	-6.4	-12.1
by fuel (1)												
Solids	76.8	47.0	36.0	24.1	14.9	8.6	-4.3	-10.3	-14.5	-15.3	-41.0	-62.9
Oil	391.5	414.1	430.6	452.1	453.4	436.1	-10.1	-35.6	-65.8	-2.2	-7.3	-13.1
Gas	169.7	194.9	220.3	254.4	254.8	245.3	-12.2	-30.3	-55.5	-4.6	-10.6	-18.5
Electricity	156.0	169.4	191.6	227.0	256.4	273.6	-1.3	-7.4	-22.7	-0.6	-2.8	-7.7
Heat (from CHP and District Heating)	35.2	39.3	42.1	52.8	59.3	66.1	1.0	-1.4	-0.5	1.9	-2.4	-0.8
Other	30.3	30.6	34.5	40.1	43.0	44.6	0.7	2.0	4.3	1.9	4.9	10.6
CO_2 Emissions (Mt of CO_2)	**3082.1**	**3051.7**	**3117.5**	**3046.6**	**2841.3**	**2583.0**	**-158.4**	**-602.6**	**-1085.7**	**-4.9**	**-17.5**	**-29.6**
Electricity and Steam production	997.6	947.7	948.3	873.3	726.6	595.8	-78.6	-373.4	-684.8	-8.3	-33.9	-53.5
Energy Branch	129.8	144.4	145.4	132.6	124.5	115.0	-2.6	-7.1	-12.5	-1.9	-5.4	-9.8
Industry	576.2	526.5	509.3	432.4	397.0	363.6	-26.0	-63.0	-102.7	-5.7	-13.7	-22.0
Residential	436.4	417.4	412.9	416.7	388.0	348.7	-15.6	-52.7	-85.5	-3.6	-12.0	-19.7
Tertiary	203.5	212.7	199.6	186.2	172.6	160.9	-16.4	-33.7	-58.9	-8.1	-16.4	-26.8
Transport	738.5	802.9	902.2	1005.3	1032.6	998.9	-19.2	-72.7	-141.3	-1.9	-6.6	-12.4
CO_2 Emissions Index (1990=100)	**100.0**	**99.0**	**101.2**	**98.8**	**92.2**	**83.8**	**-5.1**	**-19.6**	**-35.2**	-4.9	-17.5	-29.6

See explanations on the last page of the Appendix

Source: PRIMES

EU15: "GOTHENBURG TYPE" TARGETS (DOMESTIC ACTION) AT EU25 LEVEL — **SUMMARY ENERGY BALANCE AND INDICATORS (B)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Main Energy System Indicators												
Population (Million)	366.0	373.4	378.7	387.8	390.4	389.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	6982	7494	8545	10859	13641	16920	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	189.1	182.0	170.0	141.7	112.9	89.1	-3.4	-8.6	-12.6	-2.4	-7.1	-12.4
Gross Inl. Cons./Capita (toe/inhabitant)	3.6	3.7	3.8	4.0	3.9	3.9	-0.1	-0.3	-0.5	-2.4	-7.1	-12.4
Electricity Generated/Capita (kWh/inhabitant)	5844	6182	6797	7754	8563	9074	-51	-274	-813	-0.7	-3.1	-8.2
Carbon intensity (t of CO_2/toe of GIC)	2.33	2.24	2.15	1.98	1.84	1.71	-0.05	-0.23	-0.42	-2.7	-11.2	-19.7
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8.4	8.2	8.2	7.9	7.3	6.6	-0.4	-1.5	-2.8	-4.9	-17.5	-29.6
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	441.4	407.2	364.8	280.6	208.3	152.7	-14.6	-44.2	-64.2	-4.9	-17.5	-29.6
Import Dependency %	47.6	46.6	49.4	53.6	59.6	59.5	-0.7	-3.3	-8.3	-1.3	-5.2	-12.3
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	95.0	89.6	77.3	63.8	52.8	-1.6	-4.1	-4.9	-2.0	-6.0	-8.4
Residential (Energy on Private Income)	100.0	97.6	88.2	75.6	60.3	46.8	-1.7	-4.9	-7.8	-2.2	-7.5	-14.4
Tertiary (Energy on Value added)	100.0	101.8	90.9	74.4	61.5	50.3	-3.9	-7.1	-11.4	-5.0	-10.3	-18.5
Transport (Energy on GDP)	100.0	101.2	99.5	88.8	73.5	58.1	-1.7	-5.1	-8.0	-1.9	-6.4	-12.1
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.42	0.37	0.34	0.24	0.18	0.14	-0.02	-0.08	-0.14	-8.0	-31.9	-50.0
Final energy demand (t of CO_2/toe)	2.27	2.19	2.12	1.94	1.84	1.74	-0.02	-0.06	-0.10	-1.2	-3.1	-5.2
Industry	2.20	2.06	1.90	1.47	1.30	1.15	-0.06	-0.12	-0.20	-3.7	-8.2	-14.8
Residential	1.91	1.77	1.69	1.57	1.48	1.40	-0.02	-0.07	-0.09	-1.5	-4.8	-6.2
Tertiary	1.76	1.66	1.50	1.31	1.16	1.06	-0.04	-0.08	-0.12	-3.2	-6.7	-10.2
Transport	2.91	2.91	2.92	2.87	2.83	2.80	0.00	0.00	-0.01	0.0	-0.1	-0.3
Electricity and steam generation												
Generation Capacity in GW_e		**538.8**	**578.6**	**695.8**	**839.3**	**975.0**	**7.1**	**26.7**	**24.0**	**1.0**	**3.3**	**2.5**
Nuclear		126.2	131.0	121.9	106.7	126.3	0.0	6.6	21.3	0.0	6.6	20.3
Hydro (pumping excluded)		87.1	89.8	97.5	105.7	110.0	0.6	4.6	6.3	0.6	4.6	6.0
Wind and solar		2.5	12.9	77.2	136.3	226.5	6.8	40.9	92.2	9.6	42.9	68.7
Thermal		322.9	344.8	399.3	490.7	512.3	-0.3	-25.4	-95.8	-0.1	-4.9	-15.8
of which cogeneration units		*59.3*	*77.1*	*105.9*	*143.2*	*166.2*	*3.6*	*13.2*	*19.9*	*3.5*	*10.2*	*13.6*
Open cycle(incl. biomass-waste)		281.8	276.9	214.5	144.9	119.4	-0.2	9.1	6.0	-0.1	6.7	5.3
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	0.3	5.5	14.4	-0.2	-46.1	-104.6	-40.8	-89.4	-87.9
Gas Turbines Combined Cycle		20.0	46.0	160.5	301.6	314.4	3.2	22.3	-8.6	2.0	8.0	-2.7
Small Gas Turbines		20.3	21.0	22.8	37.1	36.7	-3.1	-11.1	-14.7	-12.0	-23.0	-28.6
Fuel Cells		0.0	0.0	0.0	0.0	25.4	0.0	0.0	25.4			
Geothermal heat		0.7	1.0	1.2	1.6	2.1	0.0	0.3	0.7	2.7	25.7	50.6
Indicators												
Efficiency for thermal electricity production (%)		36.6	37.8	44.6	49.5	50.4	0.7	1.5	0.8	1.5	3.2	1.6
Load factor for gross electric capacities (%)		48.9	50.8	49.3	45.5	41.3	-0.8	-3.0	-4.8	-1.7	-6.2	-10.5
CHP indicator (% of electricity from CHP)		9.2	10.3	12.5	14.4	15.5	-0.2	0.5	1.4	-1.2	3.9	9.9
Non fossil fuels in electricity generation (%)		49.9	49.3	49.8	49.5	57.3	1.6	8.4	19.1	3.3	20.5	49.8
nuclear		35.1	33.6	29.7	22.7	22.7	0.2	0.2	3.4	0.7	0.9	17.4
renewable energy forms		14.8	15.8	20.0	26.8	34.6	1.4	8.2	15.7	7.4	44.2	83.1
of which waste		*1.0*	*1.2*	*1.6*	*1.9*	*2.0*	*0.2*	*0.6*	*0.9*	*11.8*	*48.7*	*82.8*
Transport sector												
Passenger transport activity (Gpkm)	**4196.4**	**4570.6**	**5021.9**	**5800.7**	**6639.3**	**7388.8**	**-16.4**	**-61.1**	**-151.3**	**-0.3**	**-0.9**	**-2.0**
public road transport	368.8	382.2	412.6	420.8	446.6	463.3	-1.8	-1.8	-1.9	-0.4	-0.4	-0.4
private cars and motorcycles	3325.6	3634.5	3938.8	4557.6	5139.0	5634.6	-8.7	-28.2	-69.7	-0.2	-0.5	-1.2
rail transport	316.4	320.9	356.0	364.1	413.1	449.5	-2.6	-8.0	-13.3	-0.7	-1.9	-2.9
aviation	157.3	201.5	281.5	418.6	594.6	788.1	-3.1	-23.1	-66.4	-0.7	-3.7	-7.8
inland navigation	28.3	31.4	33.0	39.6	45.9	53.3	-0.1	-0.1	0.0	-0.3	-0.2	-0.1
travel per person (km per capita)	11465	12240	13261	14957	17004	18993	-42	-157	-389	-0.3	-0.9	-2.0
Freight transport activity (Gpkm)	**1438.0**	**1601.7**	**1872.6**	**2341.4**	**2859.0**	**3403.3**	**-9.0**	**-37.8**	**-98.3**	**-0.4**	**-1.3**	**-2.8**
trucks	946.0	1114.6	1327.2	1737.1	2169.0	2640.0	-5.6	-28.3	-80.2	-0.3	-1.3	-2.9
rail transport	234.9	220.2	249.3	261.9	292.0	314.1	-1.7	-6.0	-11.2	-0.7	-2.0	-3.4
inland navigation	257.1	266.9	296.1	342.4	397.9	449.3	-1.6	-3.5	-6.9	-0.5	-0.9	-1.5
freight activity per unit of GDP (tkm/000 Euro'00)	206	214	219	216	210	201	-1	-3	-6	-0.4	-1.3	-2.8
Energy demand in transport (Mtoe)	**253.8**	**275.7**	**309.1**	**350.5**	**364.3**	**357.3**	**-6.7**	**-25.1**	**-49.4**	**-1.9**	**-6.4**	**-12.1**
public road transport	6.3	5.9	5.8	5.9	5.6	4.9	-0.1	-0.2	-0.4	-1.1	-3.6	-8.1
private cars and motorcycles	130.2	136.6	145.5	153.5	148.6	136.1	-0.7	-2.3	-6.1	-0.4	-1.5	-4.3
trucks	76.0	86.5	101.0	132.1	150.8	157.0	-0.6	-8.6	-20.4	-0.5	-5.4	-11.5
rail transport	6.9	7.5	7.7	6.6	5.1	4.7	-0.3	-0.5	-0.5	-4.1	-8.4	-10.1
aviation	27.8	32.5	43.8	46.1	47.3	47.2	-5.0	-13.4	-21.5	-9.8	-22.0	-31.3
inland navigation	6.7	6.7	5.3	6.2	6.9	7.3	0.0	-0.2	-0.4	-0.7	-2.2	-5.2
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	40.7	39.8	40.2	36.4	31.1	26.1	-0.9	-2.1	-3.3	-2.5	-6.5	-11.1
freight transport (toe/Mtkm)	57.8	58.5	57.3	59.4	55.3	48.3	-0.1	-2.3	-4.6	-0.1	-4.0	-8.7

Source: PRIMES

NMS: "GOTHENBURG TYPE" TARGETS (DOMESTIC ACTION) AT EU25 LEVEL — **SUMMARY ENERGY BALANCE AND INDICATORS (A)**

Mtoe	1990	1995	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
							Difference from Baseline			% diff. from Baseline		
Primary Production	**168.7**	**157.4**	**136.0**	**111.7**	**79.5**	**74.1**	**-5.6**	**-25.9**	**-13.9**	**-4.8**	**-24.6**	**-15.8**
Solids	140.9	126.7	104.0	75.3	34.3	18.9	-8.2	-36.0	-40.6	-9.8	-51.2	-68.2
Oil	2.6	3.0	3.1	2.5	2.4	2.2	0.0	0.0	-0.1	-0.4	-0.4	-3.8
Natural gas	6.7	7.4	6.1	5.9	5.4	4.9	0.0	0.0	-0.1	0.0	-0.7	-1.2
Nuclear	15.5	14.1	14.8	14.9	16.6	19.7	0.0	1.8	14.3	0.0	12.1	267.5
Renewable energy sources	3.0	6.3	8.0	13.1	20.7	28.4	2.6	8.3	12.5	24.6	67.1	78.8
Hydro	1.1	1.3	1.4	2.1	2.1	2.3	0.1	0.0	0.1	3.1	0.0	4.3
Biomass	1.4	4.6	6.1	7.0	12.5	17.9	0.7	6.1	10.0	11.4	95.8	125.7
Waste	0.5	0.3	0.5	3.1	3.6	3.7	1.7	2.1	1.9	128.8	143.8	109.4
Wind	0.0	0.0	0.0	0.6	1.9	3.6	0.1	0.0	0.4	8.9	0.5	13.3
Solar and others	0.0	0.0	0.0	0.3	0.6	0.9	0.0	0.1	0.1	1.0	10.4	11.3
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.0	-9.0	-15.2
Net Imports	**66.3**	**50.4**	**61.4**	**91.0**	**129.7**	**136.5**	**-1.1**	**2.2**	**-17.1**	**-1.2**	**1.7**	**-11.1**
Solids	-14.6	-20.7	-15.9	-8.3	-4.0	-1.9	-1.1	-6.9	-19.9	15.7	-240.8	-110.8
Oil	49.9	45.0	47.3	55.3	60.3	61.5	-0.3	-2.9	-7.3	-0.5	-4.6	-10.6
Crude oil and Feedstocks	43.4	36.7	41.3	46.2	50.9	52.3	0.0	-2.1	-6.0	-0.1	-4.0	-10.3
Oil products	6.5	8.3	6.0	9.2	9.4	9.2	-0.2	-0.8	-1.3	-2.5	-7.7	-12.3
Natural gas	31.2	26.2	31.5	45.2	74.7	77.8	0.2	12.0	10.1	0.5	19.1	14.9
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Consumption	**233.7**	**208.9**	**198.1**	**201.6**	**208.0**	**209.3**	**-6.8**	**-23.8**	**-30.9**	**-3.3**	**-10.3**	**-12.9**
Solids	127.8	108.2	90.8	67.0	30.3	17.0	-9.3	-42.9	-60.4	-12.2	-58.6	-78.0
Oil	50.4	46.6	48.7	56.7	61.5	62.4	-0.3	-2.9	-7.4	-0.5	-4.5	-10.6
Natural gas	37.1	33.8	37.3	51.1	80.1	82.7	0.2	11.9	10.0	0.5	17.5	13.8
Nuclear	15.5	14.1	14.8	14.9	16.6	19.7	0.0	1.8	14.3	0.0	12.1	267.5
Electricity	-0.2	-0.1	-1.5	-1.2	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy forms	3.0	6.3	8.0	13.1	20.7	28.4	2.6	8.3	12.5	24.6	67.1	78.8
as % in Gross Inland Consumption												
Solids	54.7	51.8	45.8	33.2	14.6	8.1	-3.4	-17.0	-24.1	-9.3	-53.9	-74.8
Oil	21.6	22.3	24.6	28.1	29.6	29.8	0.8	1.8	0.8	2.9	6.4	2.6
Natural gas	15.9	16.2	18.8	25.4	38.5	39.5	0.9	9.1	9.3	3.9	31.0	30.6
Nuclear	6.6	6.7	7.5	7.4	8.0	9.4	0.2	1.6	7.2	3.4	24.9	321.8
Renewable energy forms	1.3	3.0	4.1	6.5	9.9	13.6	1.4	4.6	7.0	28.8	86.2	105.2
Electricity Generation in TWh_e	**316.6**	**300.5**	**323.8**	**387.8**	**484.3**	**519.0**	**-4.2**	**-13.9**	**-32.1**	**-1.1**	**-2.8**	**-5.8**
Nuclear	60.0	54.3	57.4	58.5	65.6	81.3	0.0	7.4	59.9	0.0	12.8	279.1
Hydro & wind	12.9	15.5	15.7	31.5	46.6	69.1	1.3	0.1	6.2	4.4	0.2	9.8
Thermal (incl. biomass)	243.7	230.7	250.6	297.8	372.1	368.6	-5.6	-21.5	-98.1	-1.8	-5.5	-21.0
Fuel Inputs for Thermal Power Generation	**72.7**	**65.7**	**66.3**	**71.1**	**70.5**	**68.5**	**-4.4**	**-15.4**	**-27.6**	**-5.8**	**-18.0**	**-28.7**
Solids	62.2	57.2	56.5	49.0	19.2	8.9	-8.6	-39.3	-56.0	-14.9	-67.2	-86.3
Oil	4.9	4.4	3.2	3.5	2.5	2.5	0.1	0.1	-0.2	2.7	2.6	-8.4
Gas	5.3	4.0	6.3	14.6	38.6	42.5	1.8	15.6	16.9	14.4	68.2	65.8
Biomass - Waste	0.3	0.1	0.4	4.1	10.3	14.6	2.3	8.2	11.8	124.4	396.6	418.1
Geothermal heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Hydrogen - Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fuel Input in other transformation proc.	**96.5**	**75.3**	**71.3**	**65.4**	**67.6**	**69.4**	**-0.6**	**-3.7**	**-8.4**	**-0.9**	**-5.2**	**-10.8**
Refineries	46.7	40.1	45.2	49.7	54.8	56.8	0.0	-2.2	-6.3	-0.1	-3.9	-10.0
District heating	19.3	12.1	8.5	4.6	4.3	4.4	0.1	0.7	1.6	1.4	17.9	58.1
Biofuels and hydrogen production	0.0	0.0	0.0	0.1	0.4	1.5	0.0	0.0	-0.1	-0.1	-1.8	-8.3
Others	30.5	23.1	17.7	11.0	8.1	6.6	-0.6	-2.1	-3.6	-5.1	-20.8	-35.1
Energy Branch Consumption	**12.8**	**12.9**	**12.8**	**9.5**	**9.4**	**8.7**	**-0.1**	**-0.5**	**-0.6**	**-1.4**	**-4.9**	**-6.8**
Non-Energy Uses	**10.0**	**9.4**	**10.5**	**11.0**	**13.0**	**14.4**	**0.0**	**0.1**	**0.0**	**0.3**	**0.4**	**0.1**
Final Energy Demand	**149.8**	**128.3**	**119.3**	**129.4**	**141.1**	**143.7**	**-3.0**	**-12.0**	**-21.4**	**-2.2**	**-7.8**	**-12.9**
by sector												
Industry	65.0	47.7	40.4	38.6	39.0	39.2	-0.8	-3.1	-4.6	-2.1	-7.3	-10.6
energy intensive industries	32.5	27.9	26.2	25.0	24.0	23.0	-0.7	-2.5	-3.9	-2.6	-9.5	-14.5
other industrial sectors	32.4	19.7	14.2	13.7	15.0	16.3	-0.1	-0.6	-0.7	-1.1	-3.6	-4.3
Residential	40.0	41.2	34.4	36.8	40.6	41.2	-1.0	-4.2	-6.6	-2.6	-9.4	-13.7
Tertiary	24.9	19.6	21.5	24.1	25.7	26.1	-1.0	-2.9	-5.4	-3.9	-10.2	-17.2
Transport	19.9	19.8	22.9	29.8	35.8	37.2	-0.2	-1.8	-4.7	-0.6	-4.7	-11.3
by fuel												
Solids	40.9	33.8	21.4	12.4	7.8	5.3	-1.4	-3.2	-3.7	-10.2	-29.0	-40.8
Oil	32.7	29.6	33.6	40.8	45.7	45.8	-0.5	-2.9	-7.0	-1.2	-6.0	-13.3
Gas	26.5	24.6	25.4	32.4	34.7	33.1	-0.9	-5.2	-9.5	-2.7	-13.0	-22.2
Electricity	20.5	18.5	19.6	24.9	32.6	36.0	-0.2	-0.7	-2.0	-0.8	-2.1	-5.3
Heat (from CHP and District Heating)	27.7	17.4	13.5	13.0	14.9	17.5	-0.2	-0.1	0.5	-1.2	-0.6	3.1
Other	1.8	4.7	5.8	5.8	5.5	5.9	0.2	0.1	0.3	3.6	1.9	5.9
CO_2 Emissions (Mt of CO_2)	**687.4**	**599.8**	**547.3**	**514.6**	**445.2**	**397.0**	**-37.6**	**-151.4**	**-238.0**	**-6.8**	**-25.4**	**-37.5**
Electricity and Steam production	343.4	295.0	280.1	255.0	185.6	153.6	-28.4	-117.5	-178.9	-10.0	-38.8	-53.8
Energy Branch	14.4	19.5	18.7	10.6	11.5	11.1	0.0	0.2	-0.4	0.4	1.5	-3.2
Industry	137.0	118.2	96.4	82.2	71.9	65.7	-3.8	-13.8	-19.8	-4.4	-16.1	-23.2
Residential	83.2	72.9	49.7	46.4	45.5	37.8	-2.9	-9.1	-15.2	-5.9	-16.6	-28.7
Tertiary	53.3	38.3	37.2	34.8	28.4	24.9	-2.1	-6.1	-10.1	-5.7	-17.7	-28.9
Transport	56.1	55.9	65.3	85.5	102.3	103.9	-0.5	-5.1	-13.5	-0.6	-4.7	-11.5
CO_2 Emissions Index (1990=100)	**100.0**	**87.3**	**79.6**	**74.9**	**64.8**	**57.8**	**-5.5**	**-22.0**	**-34.6**	-6.8	-25.4	-37.5

See explanations on the last page of the Appendix

Source: PRIMES

NMS: "GOTHENBURG TYPE" TARGETS (DOMESTIC ACTION) AT THE EU25 LEVEL							SUMMARY ENERGY BALANCE AND INDICATORS (B)					
Mtoe	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
							Difference from Baseline			**% diff. from Baseline**		
Main Energy System Indicators												
Population (Million)	75.1	75.2	74.7	73.4	71.7	69.1	0.0	0.0	0.0	0.0	0.0	0.0
GDP (in 000 MEuro'00)	333	323	394	574	821	1100	0	0	0	0.0	0.0	0.0
Gross Inl. Cons./GDP (toe/MEuro'00)	701.6	647.4	502.5	351.4	253.3	190.2	-11.8	-29.0	-28.1	-3.3	-10.3	-12.9
Gross Inl. Cons./Capita (toe/inhabitant)	3.1	2.8	2.7	2.7	2.9	3.0	-0.1	-0.3	-0.4	-3.3	-10.3	-12.9
Electricity Generated/Capita (kWh/inhabitant)	4214	3997	4332	5283	6757	7506	-58	-194	-464	-1.1	-2.8	-5.8
Carbon intensity (t of CO_2/toe of GIC)	2.94	2.87	2.76	2.55	2.14	1.90	-0.10	-0.43	-0.75	-3.7	-16.8	-28.2
CO_2 Emissions/Capita (t of CO_2/inhabitant)	9.2	8.0	7.3	7.0	6.2	5.7	-0.5	-2.1	-3.4	-6.8	-25.4	-37.5
CO_2 Emissions to GDP (t of CO_2/MEuro'00)	2063.9	1859.2	1388.0	896.7	542.3	360.8	-65.6	-184.4	-216.3	-6.8	-25.4	-37.5
Import Dependency %	28.3	24.1	30.8	44.9	62.0	64.8	0.9	7.3	1.2	2.1	13.2	1.9
Energy intensity indicators (1990=100)												
Industry (Energy on Value added)	100.0	83.6	55.1	35.4	25.4	20.4	-0.8	-2.0	-2.4	-2.1	-7.3	-10.6
Residential (Energy on Private Income)	100.0	106.5	74.2	54.5	41.1	31.1	-1.4	-4.3	-4.9	-2.6	-9.4	-13.7
Tertiary (Energy on Value added)	100.0	74.8	67.2	50.5	36.3	26.5	-2.0	-4.1	-5.5	-3.9	-10.2	-17.2
Transport (Energy on GDP)	100.0	102.9	97.4	87.0	73.1	56.6	-0.6	-3.6	-7.2	-0.6	-4.7	-11.3
Carbon Intensity indicators												
Electricity and Steam production (t of CO_2/MWh)	0.50	0.55	0.54	0.45	0.27	0.21	-0.04	-0.16	-0.23	-9.0	-37.2	-52.2
Final energy demand (t of CO_2/toe)	2.20	2.22	2.08	1.92	1.76	1.62	-0.03	-0.09	-0.15	-1.4	-4.6	-8.3
Industry	2.11	2.48	2.38	2.13	1.84	1.67	-0.05	-0.19	-0.28	-2.4	-9.5	-14.1
Residential	2.08	1.77	1.44	1.26	1.12	0.92	-0.04	-0.10	-0.19	-3.4	-8.0	-17.3
Tertiary	2.14	1.95	1.73	1.44	1.11	0.95	-0.03	-0.10	-0.16	-1.9	-8.3	-14.2
Transport	2.82	2.82	2.85	2.86	2.86	2.79	0.00	0.00	-0.01	0.0	0.0	-0.2
Electricity and steam generation												
Generation Capacity in GW_e		**78.6**	**77.6**	**95.0**	**132.8**	**162.4**	**-0.1**	**-1.3**	**-4.7**	**-0.1**	**-1.0**	**-2.8**
Nuclear		8.4	9.3	7.9	8.8	11.1	0.0	0.9	8.3	0.0	11.9	291.6
Hydro (pumping excluded)		6.1	6.4	7.9	8.7	8.9	0.2	0.4	0.5	3.1	5.3	5.6
Wind and solar		0.0	0.0	3.1	10.5	18.5	0.3	1.7	3.5	9.6	19.9	23.7
Thermal		64.0	61.9	76.1	104.8	123.9	-0.6	-4.4	-17.0	-0.8	-4.0	-12.1
of which cogeneration units		*28.1*	*26.3*	*26.8*	*34.7*	*46.0*	*-0.6*	*-3.5*	*-6.3*	*-2.0*	*-9.1*	*-12.0*
Open cycle (incl. biomass-waste)		61.9	58.6	50.6	29.9	17.9	-5.4	-9.7	-16.2	-9.6	-24.5	-47.5
Supercritical Polyvalent/Clean Coal and Lignite		0.0	0.0	2.9	13.1	17.6	2.4	-1.9	-13.4	468.1	-12.8	-43.2
Gas Turbines Combined Cycle		0.4	1.4	14.7	50.1	69.2	2.4	10.6	7.6	19.3	26.8	12.4
Small Gas Turbines		1.7	1.8	8.0	11.8	10.3	-0.1	-3.4	-4.1	-0.8	-22.4	-28.3
Fuel Cells		0.0	0.0	0.0	0.0	8.9	0.0	0.0	8.9			
Geothermal heat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Indicators												
Efficiency for thermal electricity production (%)		32.0	34.3	37.9	47.4	48.9	1.5	6.0	4.9	4.1	14.6	11.1
Load factor for gross electric capacities (%)		43.6	47.6	46.6	41.6	36.5	-0.4	-0.8	-1.2	-0.9	-1.8	-3.1
CHP indicator (% of electricity from CHP)		29.4	30.4	28.0	25.3	31.1	-0.3	-2.0	-0.5	-1.0	-7.4	-1.7
Non fossil fuels in electricity generation (%)		23.4	23.1	26.6	31.5	40.5	2.4	9.0	23.2	9.9	40.0	134.6
nuclear		18.1	17.7	15.1	13.5	15.7	0.2	1.9	11.8	1.1	16.0	302.6
renewable energy forms		5.3	5.4	11.5	17.9	24.8	2.2	7.1	11.4	24.1	65.9	85.7
of which waste		*0.0*	*0.1*	*2.0*	*1.9*	*1.8*	*1.4*	*1.4*	*1.4*	*227.2*	*325.2*	*392.9*
Transport sector												
Passenger transport activity (Gpkm)	**487.4**	**468.1**	**497.8**	**614.4**	**803.6**	**986.1**	**-1.3**	**-5.1**	**-12.6**	**-0.2**	**-0.6**	**-1.3**
public road transport	115.7	87.0	81.2	80.9	84.3	90.2	-0.3	-0.2	-0.3	-0.4	-0.3	-0.3
private cars and motorcycles	268.0	315.8	352.9	458.8	619.1	764.8	-0.4	-2.1	-5.4	-0.1	-0.3	-0.7
rail transport	91.9	50.8	46.3	47.8	57.4	73.3	-0.4	-0.9	-1.5	-0.8	-1.5	-2.0
aviation	11.2	14.0	16.8	26.2	42.1	57.1	-0.2	-1.9	-5.4	-0.8	-4.3	-8.7
inland navigation	0.6	0.5	0.6	0.7	0.7	0.8	0.0	0.0	0.0	-0.1	-0.1	0.0
travel per person (km per capita)	6489	6227	6662	8370	11213	14262	-18	-71	-182	-0.2	-0.6	-1.3
Freight transport activity (Gtkm)	**324.7**	**258.1**	**275.0**	**337.9**	**437.4**	**530.9**	**-1.5**	**-4.8**	**-10.4**	**-0.4**	**-1.1**	**-1.9**
trucks	118.4	119.0	155.5	223.6	317.3	405.5	-0.3	-2.2	-6.9	-0.1	-0.7	-1.7
rail transport	205.2	137.8	118.7	113.5	119.2	124.4	-1.1	-2.6	-3.5	-1.0	-2.1	-2.8
inland navigation	1.0	1.3	0.8	0.8	0.8	0.9	0.0	0.0	0.0	-0.4	-0.5	-0.9
freight activity per unit of GDP (tkm/000 Euro'00)	975	800	697	589	533	482	-3	-6	-9	-0.4	-1.1	-1.9
Energy demand in transport (Mtoe)	**19.9**	**19.8**	**22.9**	**29.8**	**35.8**	**37.2**	**-0.2**	**-1.8**	**-4.7**	**-0.6**	**-4.7**	**-11.3**
public road transport	1.4	1.0	1.2	1.1	1.1	0.9	0.0	0.0	-0.1	-0.6	-2.5	-12.2
private cars and motorcycles	7.9	9.5	11.6	14.7	17.4	17.8	0.0	-0.3	-1.5	-0.3	-1.8	-8.0
trucks	7.0	6.7	7.5	11.0	14.4	15.9	0.0	-0.7	-2.1	-0.2	-4.8	-11.8
rail transport	2.0	1.4	1.3	1.1	0.9	0.9	0.0	-0.1	-0.1	-2.2	-6.1	-10.1
aviation	1.3	1.2	1.3	1.8	2.0	1.7	-0.1	-0.6	-0.8	-4.9	-24.4	-33.6
inland navigation	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-1.2	-3.8
Efficiency indicator (activity related)												
passenger transport (toe/Mpkm)	24.4	26.5	29.5	29.6	26.0	21.1	-0.2	-1.1	-2.3	-0.6	-4.0	-9.8
freight transport (toe/Mtkm)	24.6	28.8	30.0	34.5	34.1	31.0	0.0	-1.3	-3.5	0.1	-3.8	-10.1

Source: PRIMES

(1) EUROSTAT Energy Balances do not take into account non-marketed steam, i.e. steam generated - either in boilers or in CHP plants - and used on site by industrial consumers.
Using statistical information provided by EUROSTAT on CHP, the non-marketed steam generated in CHP units as well as the corresponding fuel input have been estimated for this study. In the PRIMES model, steam has been attributed to the demand side and the fuel input to the supply side. This approach ensures a better comparability of historical figures with the projections. However, slight differences exist for certain figures related to steam generation - both in terms of final energy demand and transformation input - in this report compared to EUROSTAT energy balances.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions

EU15: EU15 Member States
EU25: EU15 Member States + New Member States
Europe-30: EU15 Member States + New Member States + EU Candidate Countries (Bulgaria, Romania, Turkey) + Norway + Switzerland
NMS: New Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

Units

toe: tonne of oil equivalent, or 10^7 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 10^9 watt
MWh: megawatt-hour or 10^6 watt-hour
TWh: Terawatt-hour or 10^{12} watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 10^9 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 10^9 tonne-kilometre

European Commission

European energy and transport — Scenarios on key drivers

Luxembourg: Office for Official Publications of the European Communities

2004 — 262 pp. — 21 x 29.7 cm

ISBN 92-894-6684-7

Price (excluding VAT) in Luxembourg: EUR 45.00