



The EU Reference Scenario 2016

Energy, transport and GHG emissions – Trends to 2050



European Commission

**Directorate-Generals for Energy, Climate Action,
and Mobility and Transport**



Projecting energy, transport and greenhouse gas emission trends based on adopted policies

- The time horizon of projections covers the period up to 2050
- It is not a forecast, but a simulation given certain market conditions and policies adopted until end of 2014
- It assumes relevant binding 2020 targets are met
- It uses a range of economic/energy/environment models
- Results are available for the EU and individual Member States
- European Commission develops the Reference Scenario in collaboration with EU countries and a European modelling consortium
- It provides a benchmark against which expected impacts of new policies could be analysed (such as for Impact Assessments)



The Reference Scenario projects the state of play on progress towards Energy Union objectives

1. Security of energy supply
2. Internal energy market
3. Moderation of energy demand
4. Decarbonisation
5. Research and innovation and competitiveness

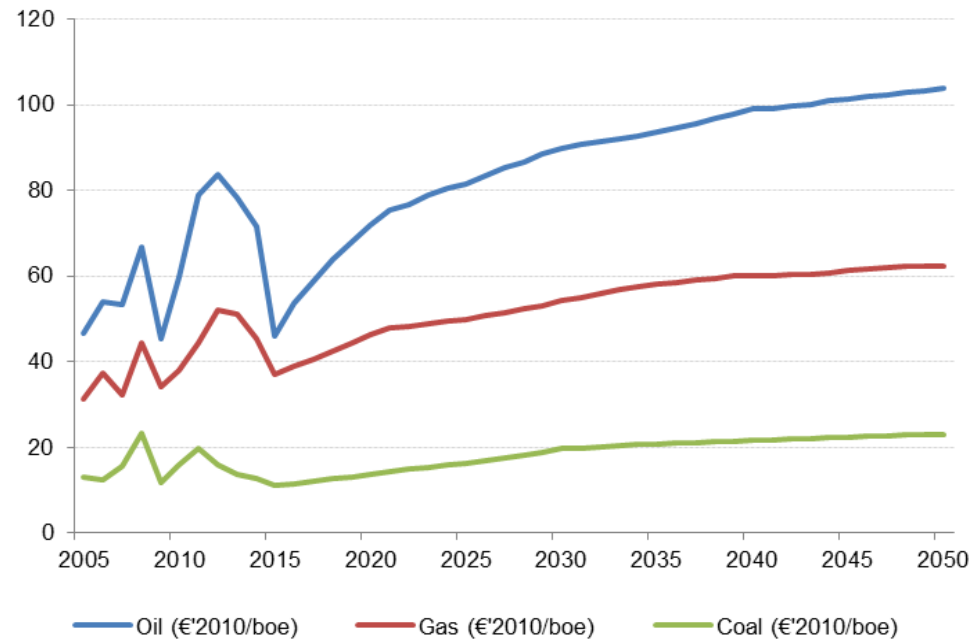
1. Energy security



Fossil fuel prices projected to increase moderately over the coming decades

- Current oversupply leads to lower hydrocarbon prices than recent past until 2020
- Declining resource to production ratios drive increases in oil and gas prices after 2020
- Deceleration in global demand combined with vast amounts of cheap coal resources mean that coal prices will not exceed recent peaks before 2030

Fossil Fuel Price: historical evolution and projections



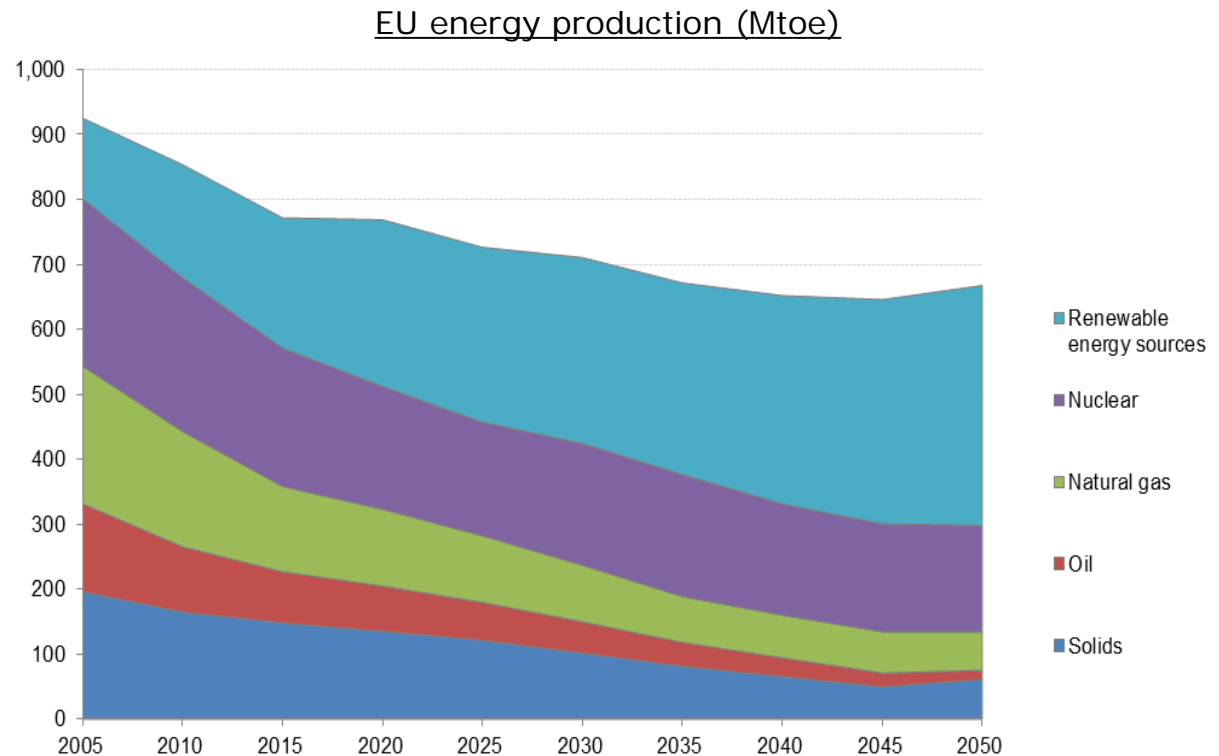
Source: PROMETHEUS modelling, NTUA, E3M-Lab

1. Energy security



EU energy production continues to decrease...

- Strong decline in domestic EU fossil fuel production
- Increase in renewable energy production: still dominated by biomass, although the share of wind and solar will gradually increase



Source: PRIMES modelling, NTUA, E3M-Lab

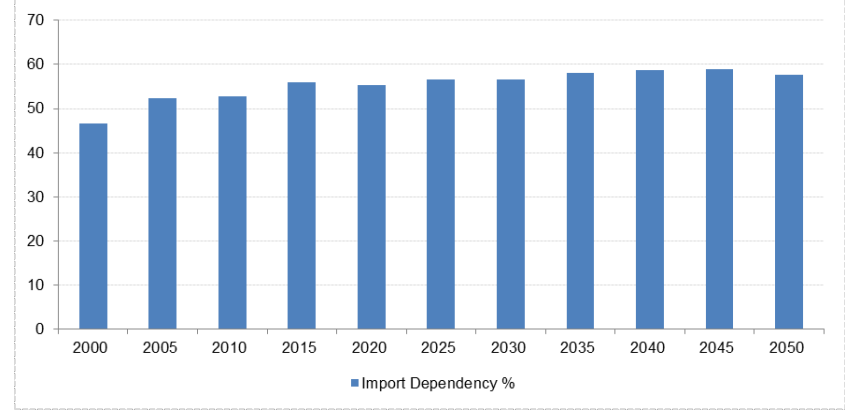
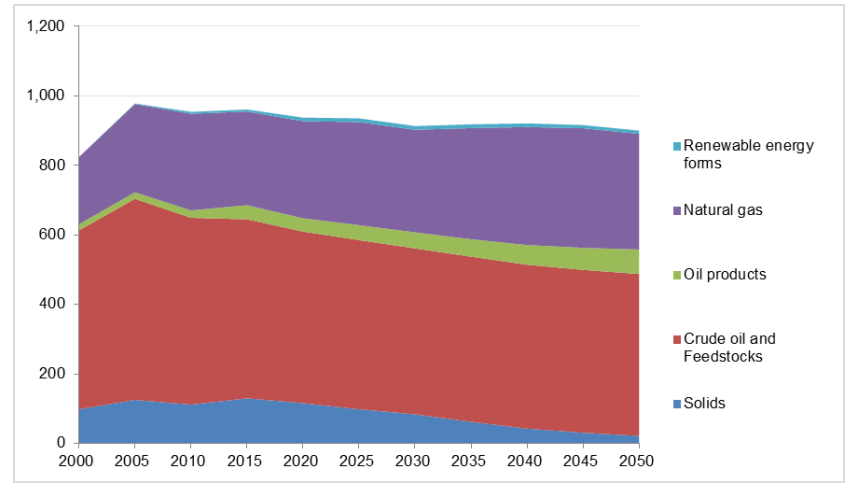
1. Energy security



... which only leads to a small increase in import dependence

- RES deployment, combined with energy efficiency improvements and nuclear production, partly compensates the shortfall in EU production of fossil fuels
- Import dependency projected to continue to hover around 50% of overall EU energy demand

EU energy net imports (Mtoe)

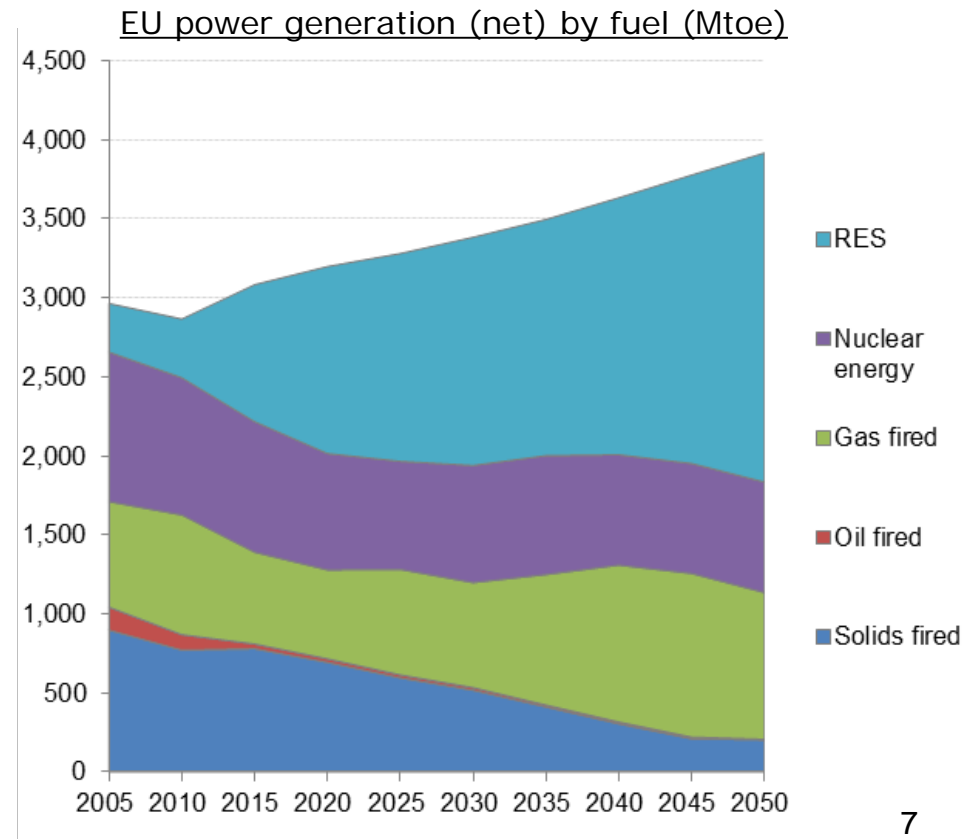


Source: PRIMES modelling, NTUA, E3M-Lab



The EU power generation mix changes, in favour of renewables

- Significant development of renewable energy (mostly solar and wind onshore)
- Biomass remains stable over the period
- Decline of electricity generation from solid fuels (mostly coal)
- Gas-fired generation decreases until 2020, but increases thereafter
- Nuclear energy decreases slightly



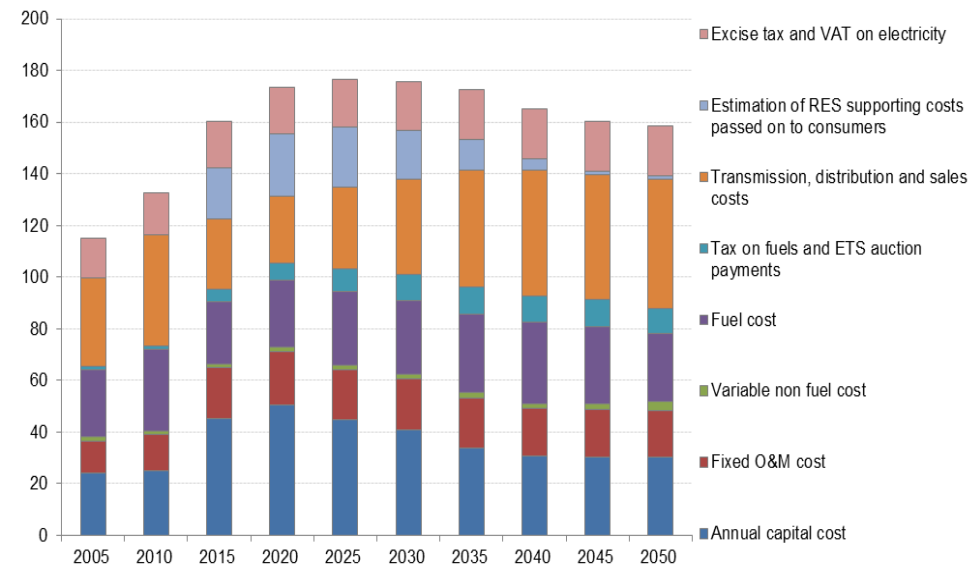
2. Internal market



Electricity prices increase slightly and the structure of generation costs changes

- In the short term, significant increase in capital costs; more than compensates decrease in fuel costs
- In the medium term, grid costs, carbon pricing and taxes on fuel continue to increase, while capital costs stabilize
- From 2030, the fuel cost component remains stable despite the increase in fuel prices
- Carbon price is projected to increase with limited impact on electricity prices, as the share of carbon-intensive power generation decreases

Decomposition of electricity generation costs and prices
(€'2013 / MWh)



Source: PRIMES modelling, NTUA, E3M-Lab

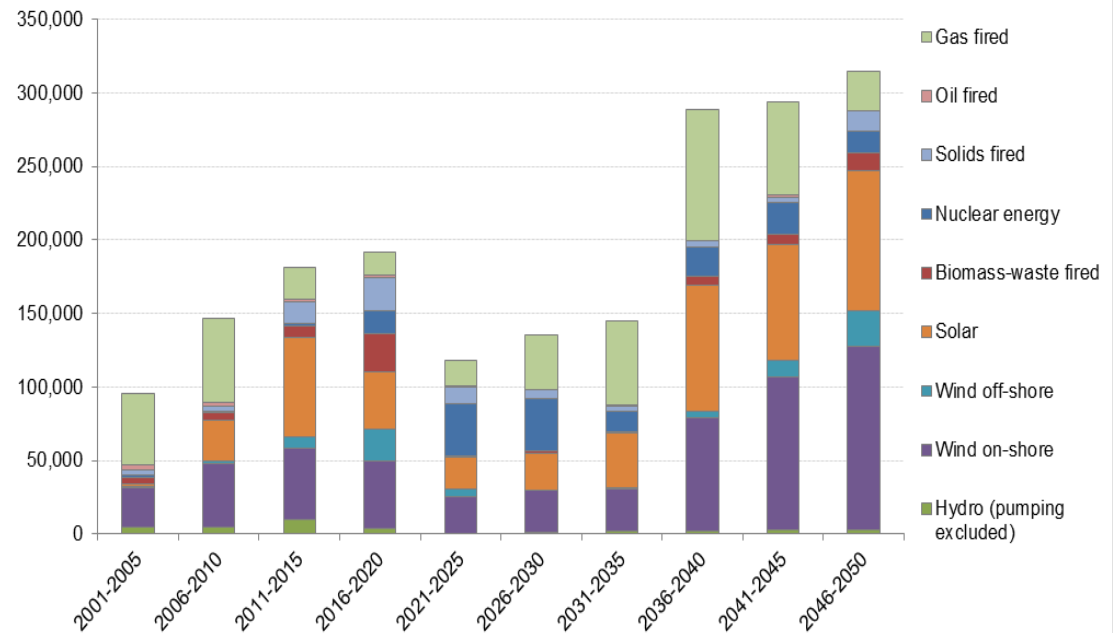
2. Internal market



Electricity power investments dominated by renewable energy

- New plant investment is dominated by renewable energy
- New thermal plant investment is mainly for gas (Combined Cycle Gas Turbine and Combined Heat and Power plants)
- New nuclear investment takes place mainly after 2030
- Retrofitting of old plants concerns solid fuel plants in the short/medium term - nuclear and renewables replaced on the same site

Net power capacity investments by plant type
(MWh – for five year period)



Source: PRIMES modelling, NTUA, E3M-Lab

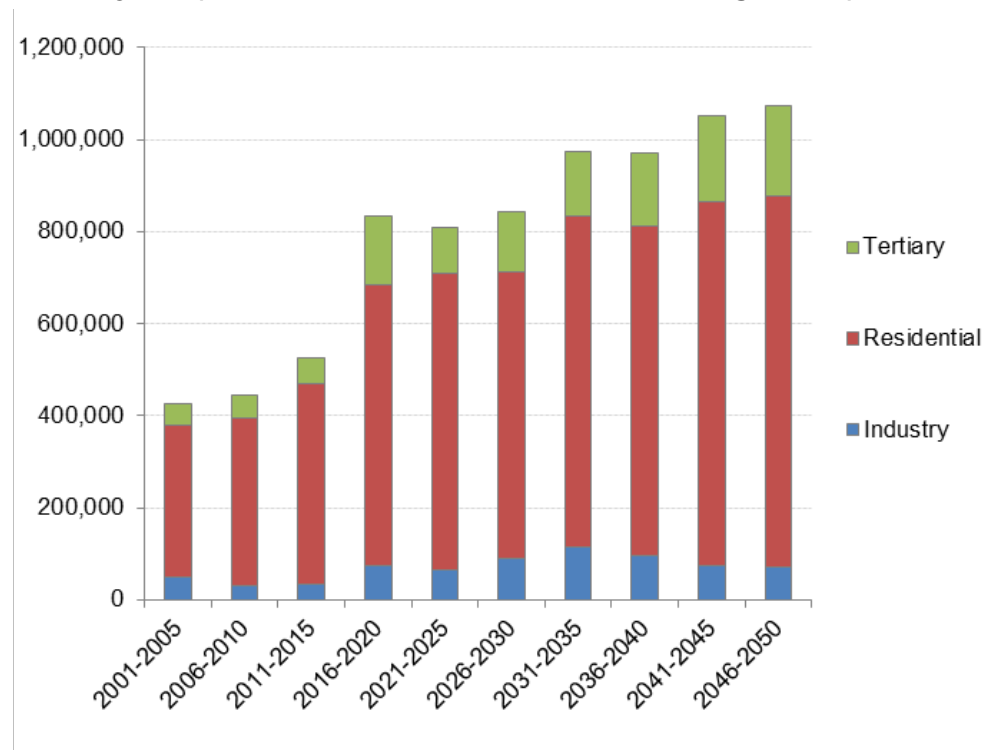
2. Internal market



Investments in energy demand sectors increase, as a result of energy efficiency policies

- Investment in demand sectors peak in the short term, as a result of energy efficiency policies
- Energy-related spending in households' expenditures increases by 2020, before stabilising in 2020s and eventually decreasing to historical levels
- Transport investments also increase over time, in line with GDP growth

Investment expenditures demand side
(5-year period - million €'2013 - excluding transport)



Source: PRIMES modelling, NTUA, E3M-Lab

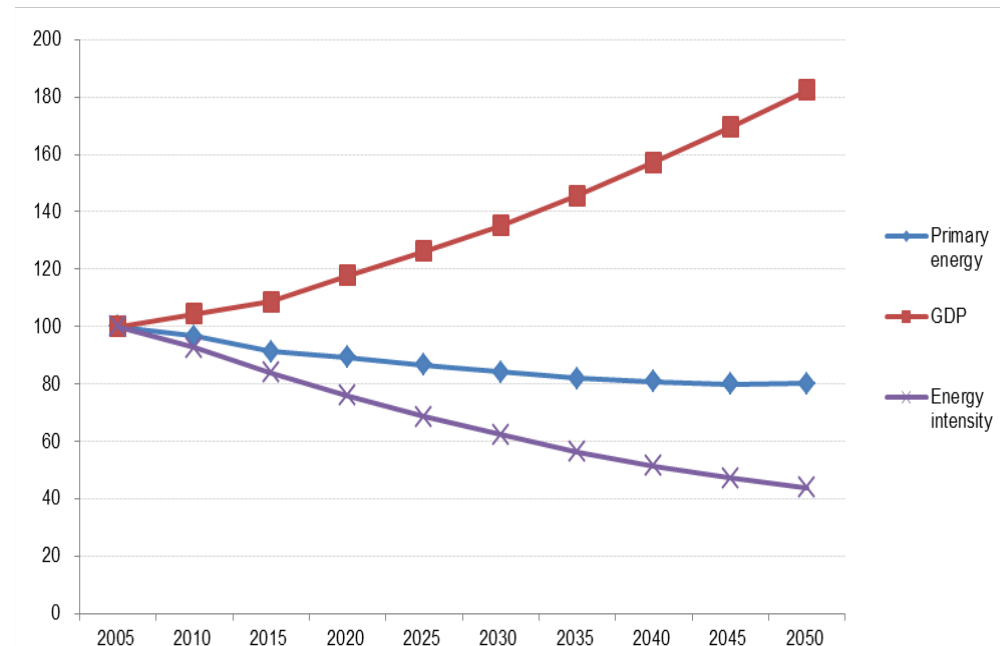
3. Energy demand



Primary energy demand and GDP further decouple, continuing trends observed over past decades

- Total energy requirements remain steadily below 2015 level
- Energy efficiency improvements are supported by policy up to 2020 and by market/technology trends after 2020
- Deceleration of energy efficiency progress occurs post-2020

EU primary energy demand, GDP and energy intensity (2005=100)



Source: PRIMES modelling, NTUA, E3M-Lab

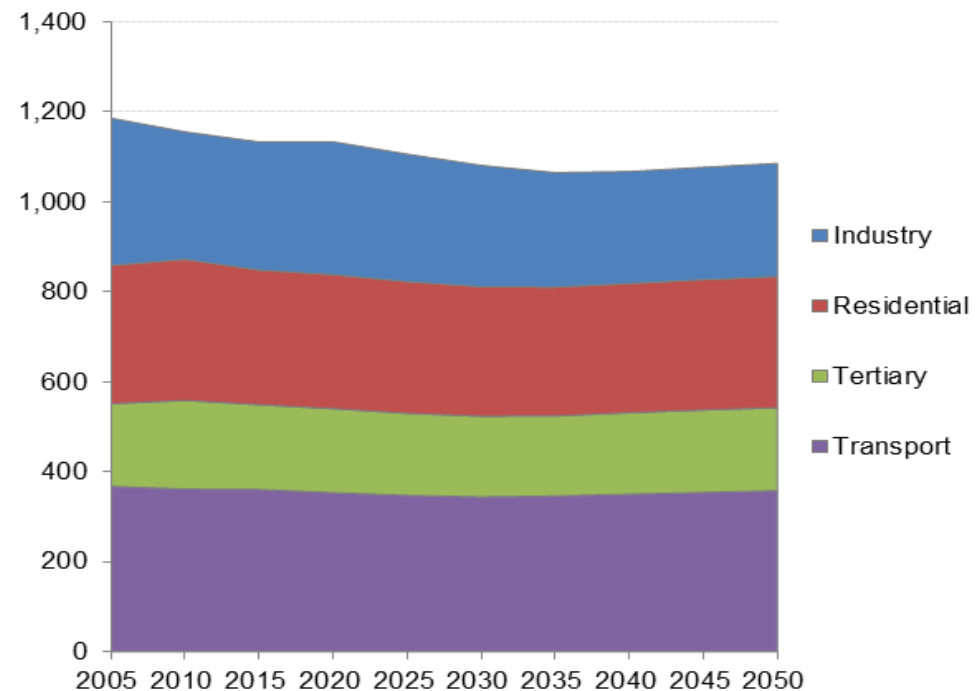
3. Energy demand



Demand by sector remains broadly the same

- Transport and residential sectors represent the lion's share of final energy demand
- Slightly decreasing share for industry, mostly due to energy efficiency improvements in non-energy intensive industries
- Stable share for services and agriculture (tertiary) sector

Final energy demand by sector (Mtoe)

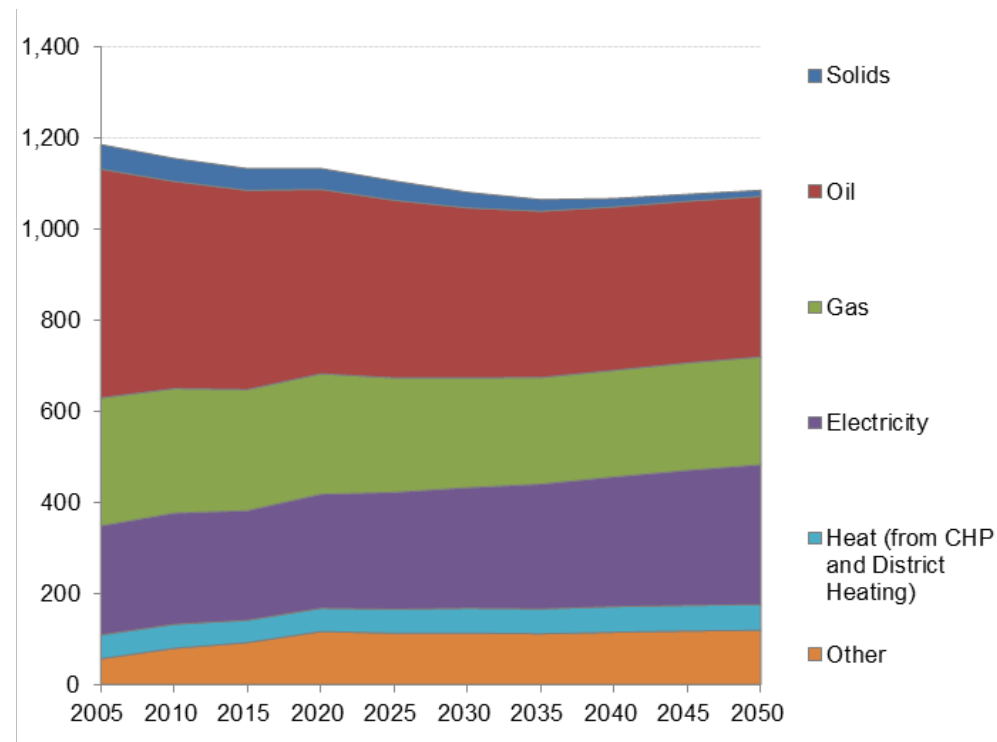




Gradual penetration of electricity in fuel mix

- Growing electricity demand vis-à-vis other final energy usages
- Some electrification of heating (heat pumps) and of transport (passenger cars and trains)
- Uncoupling between appliance stock and energy consumption due to the technological progress facilitated by Ecodesign Regulations

Final energy demand by fuel (Mtoe)



Source: PRIMES modelling, NTUA, E3M-Lab

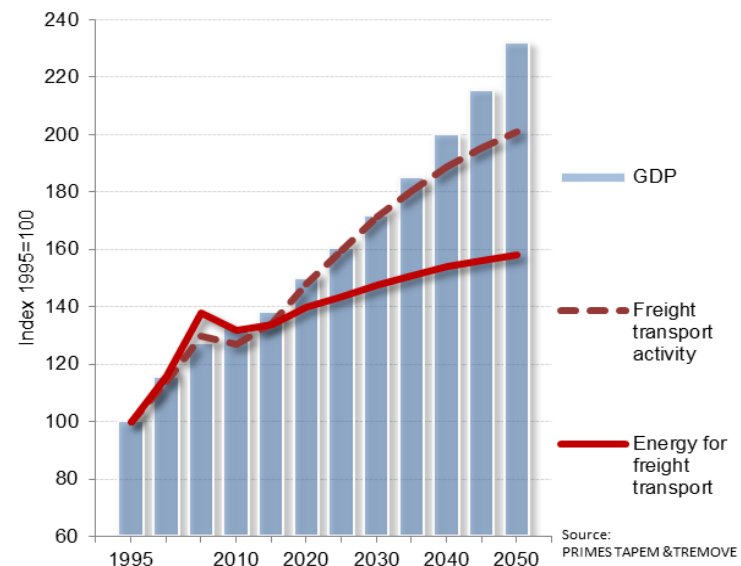
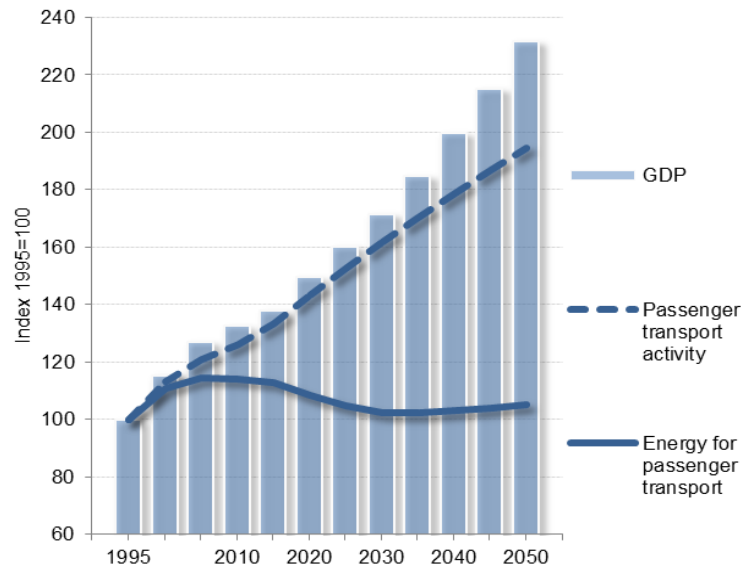
3. Energy demand



Decoupling of transport energy consumption and transport activity intensifies

- Transport activity for passenger (including international intra and extra-EU aviation) and freight increases, but less than GDP, especially in the long term
- Energy intensity of transport activity significantly improves over time, as a result of policies and technological progress

Trends in transport activity and energy consumption (index 1995=100)



Source: PRIMES TAPEM & TREMOVE

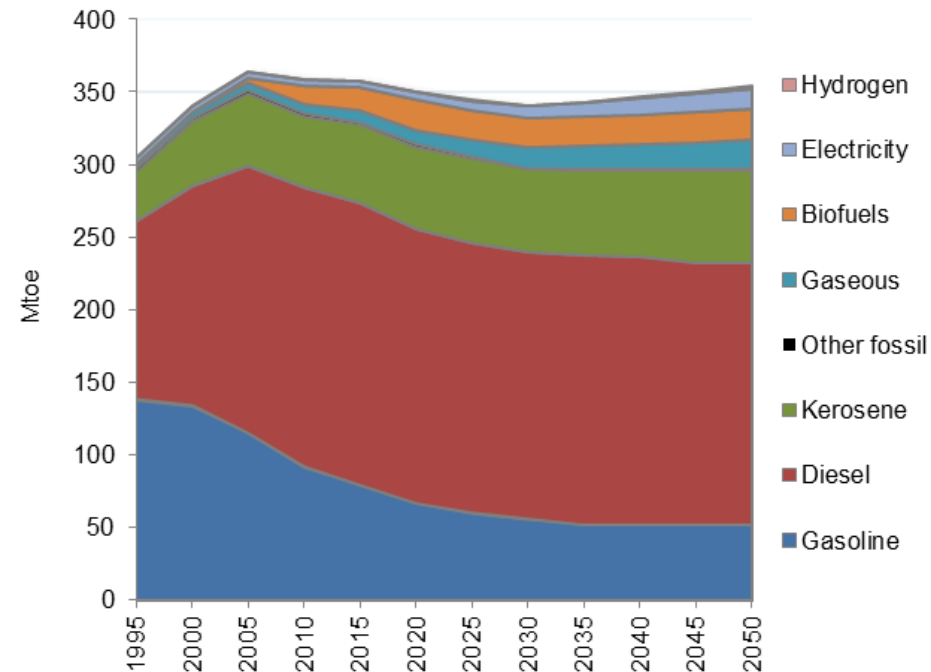
3. Energy demand



Oil products still supply vast majority of EU transport needs

- Diesel maintains its share in the medium term while gasoline's share significantly decreases
- Biofuel use increases by 2020, in line with policies, and then stabilises
- Electricity and hydrogen consumption steadily increase
- LNG becomes a candidate energy carrier for road freight and waterborne transport but its potential does not fully materialise

Final energy demand in transport by fuel type (Mtoe)



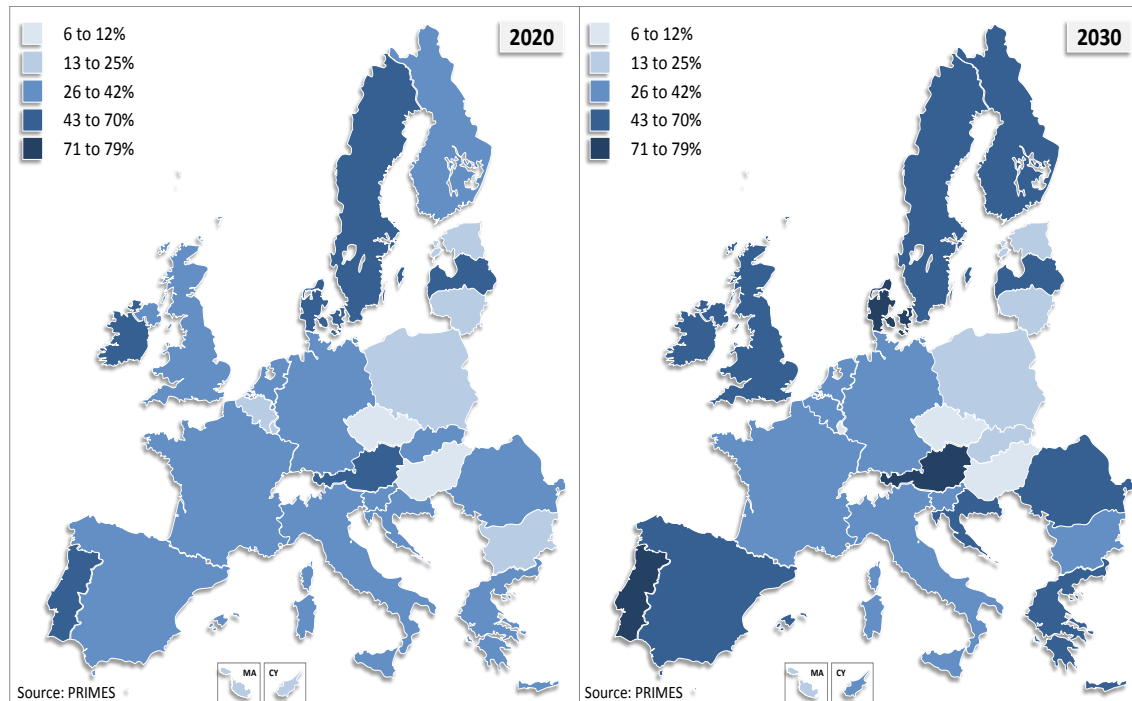
4. Decarbonisation



Renewable energy increases, driven by policy in the short term, and then by market trends

- Acceleration of renewables deployment in the short term, driven by current and additional policies needed to reach binding 2020 targets
- Slower increase post-2020, driven by market forces - within the Emissions Trading Scheme and via technical-economic improvements

Renewable electricity shares in EU Member States in 2020 and 2030

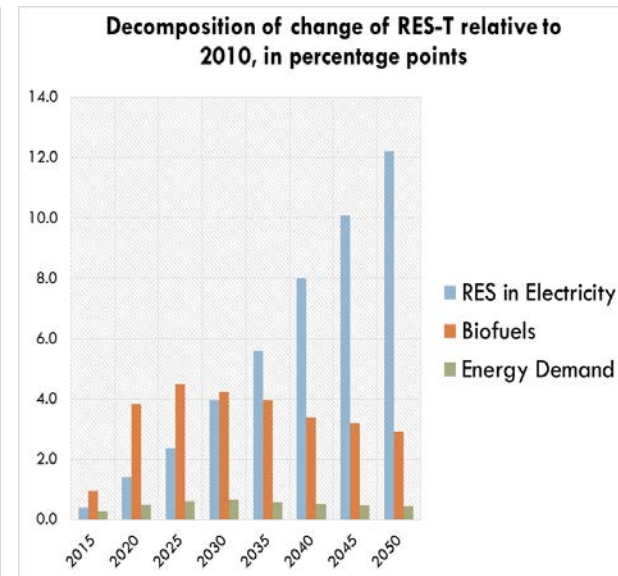
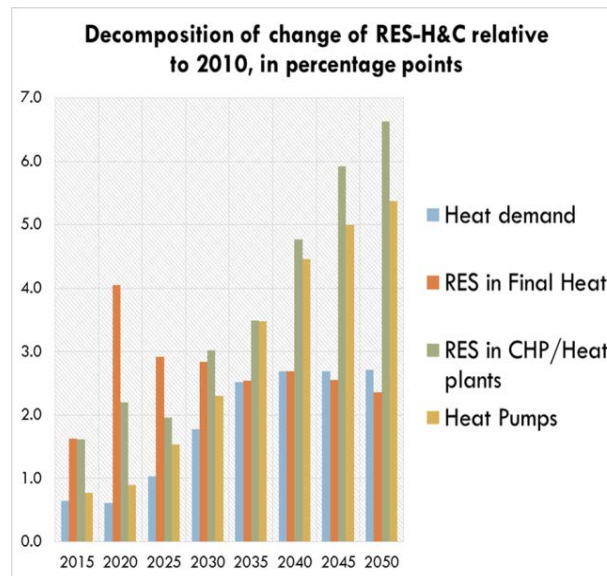
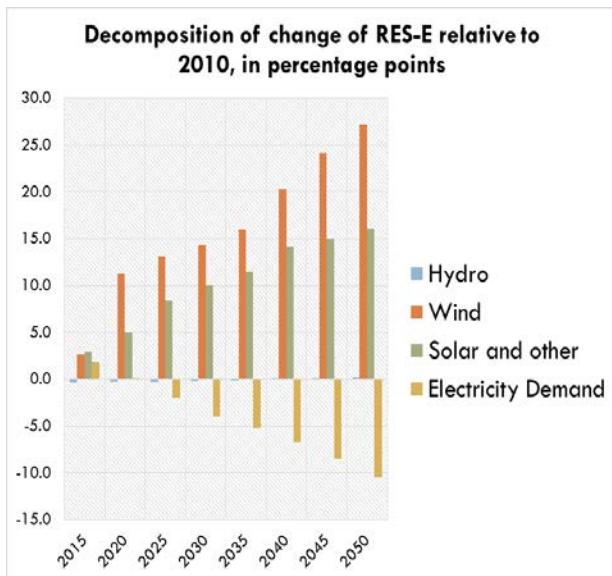


4. Decarbonisation



Decomposing the increase in renewables across sectors

- Wind and solar play a key role in power generation
- Renewables in heating and cooling increase gradually
- Biofuels are the main driver of renewable increase in the transport sector till 2030



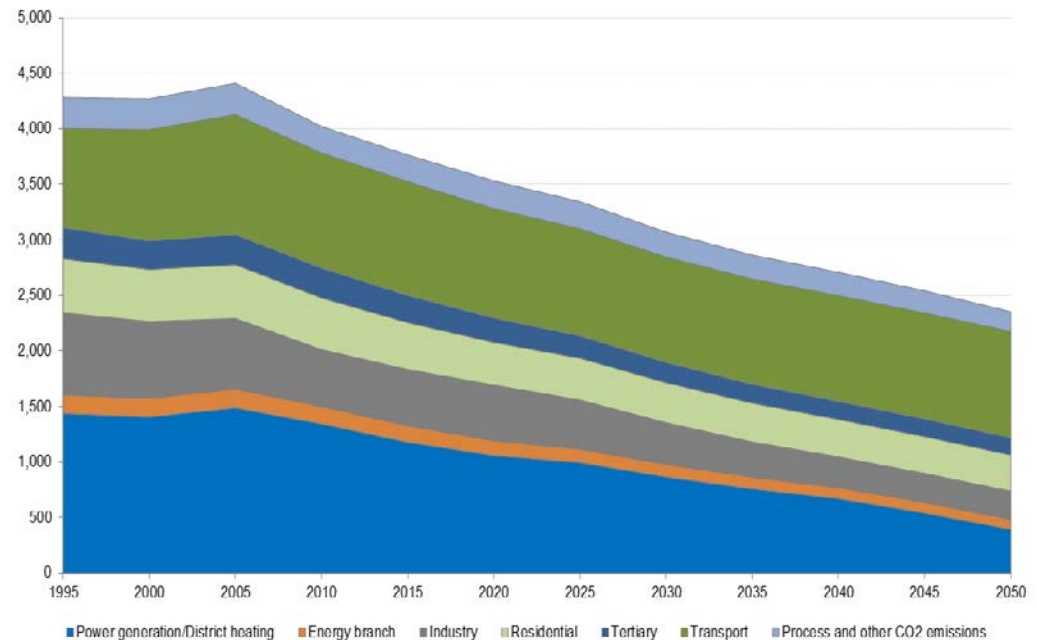
4. Decarbonisation



Reduction of CO₂ emissions occurs mainly in the power and heat production sectors

- Renewables and carbon pricing enable restructuring in power and heat sectors
- In industry, reductions take place in energy related emissions, while process emissions remain somewhat stable
- Energy efficiency is the main driver of emission reductions in end-uses of energy.
- Transport overtakes power as largest CO₂ emitting sector by 2030

CO₂ emissions (Mt) by sector



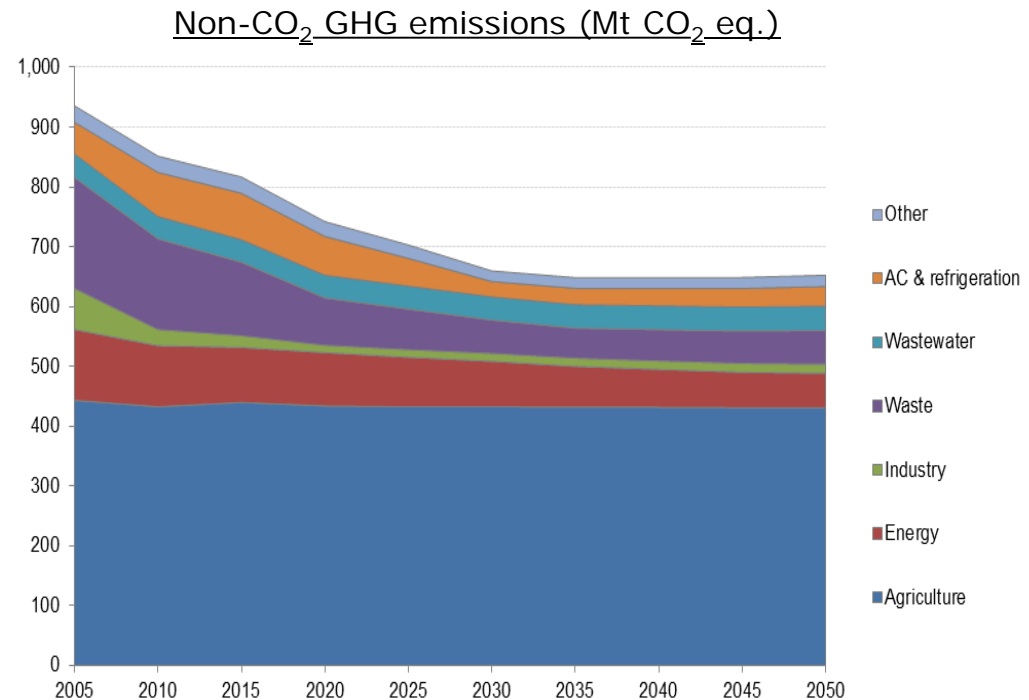
Source: Modelling suite for EU Reference Scenario 2016

4. Decarbonisation



Non-CO₂ GHG emissions reduce strongly until 2030, driven by policies

- Agriculture emissions remain relatively stable; share in total non-CO₂ increases from around half to two thirds
- Waste emissions reduce strongly driven by policies
- Significant trend shift in A&C refrigeration, reflecting revised F-gas regulation of 2014
- Decreases of industrial emissions reflect ETS inclusion



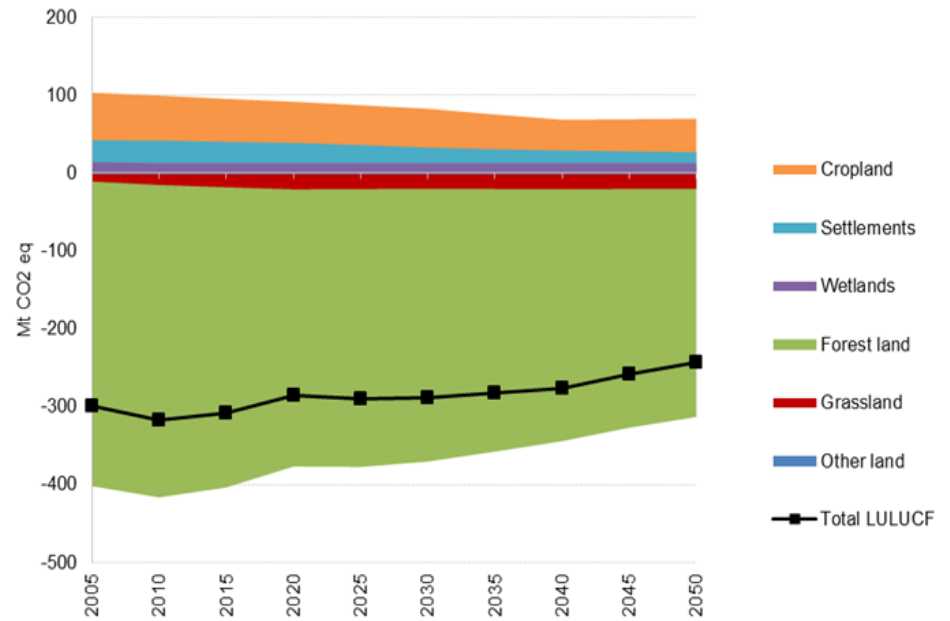
4. Decarbonisation



Land Use, Land Use Change and Forestry remains a net carbon sink, but contribution is declining

- Decline of sink is driven partly by increase in timber demand (fostered by increase in bioenergy demand)
- Forest land: decline in the managed forests carbon sink is partially compensated by a rising carbon sink from afforestation and decreasing emissions from deforestation
- Agriculture plays a smaller part: cropland emissions decrease and grassland sink increases

EU28 emissions/removals in the LULUCF sector
(Mt CO₂ eq.)



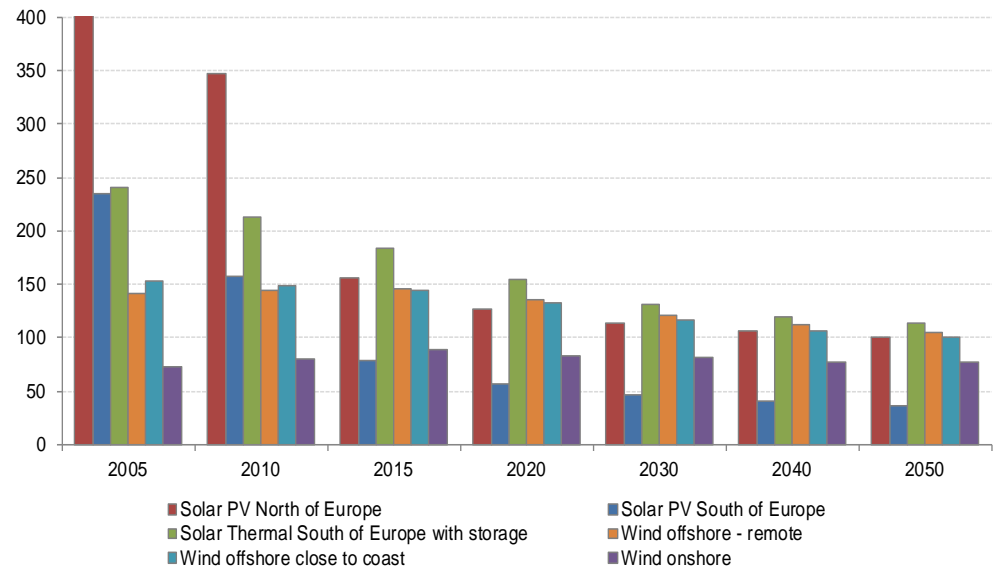
Source: Modelling suite for EU Reference Scenario 2016



Some renewable energy technologies are beginning to be fully competitive

- Solar photovoltaic technologies become competitive over coming years, especially within southern Europe
- Onshore wind is already close to being competitive, with limited potential for additional cost reductions
- More modest cost decreases for offshore wind (especially remote stations)

Illustrative levelized cost of electricity for selected RES technologies (€'2013/MWh-net)



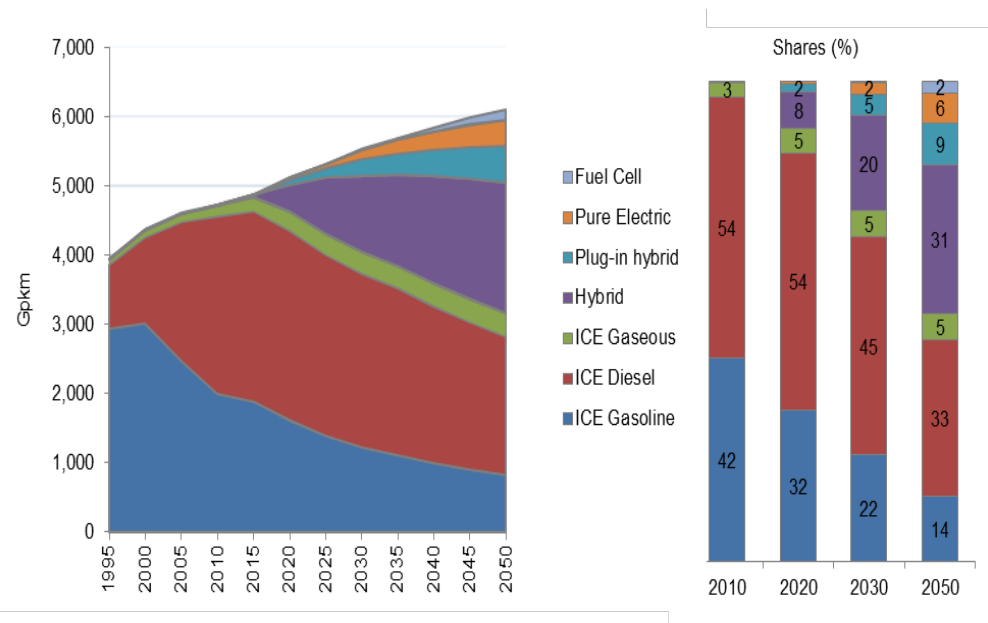
Source: Modelling suite for EU Reference Scenario 2016



Electrically chargeable vehicles slowly penetrate the market from 2020 onwards

- Car manufacturers are expected to comply with the CO₂ standards by marketing vehicles equipped with hybrid systems
- Electrically chargeable vehicles are kick-started by existing EU and national policies, as well as by incentive schemes
- Other energy forms such as liquefied petroleum gas and natural gas maintain a rather limited share

Evolution of activity of light duty vehicles by type and fuel

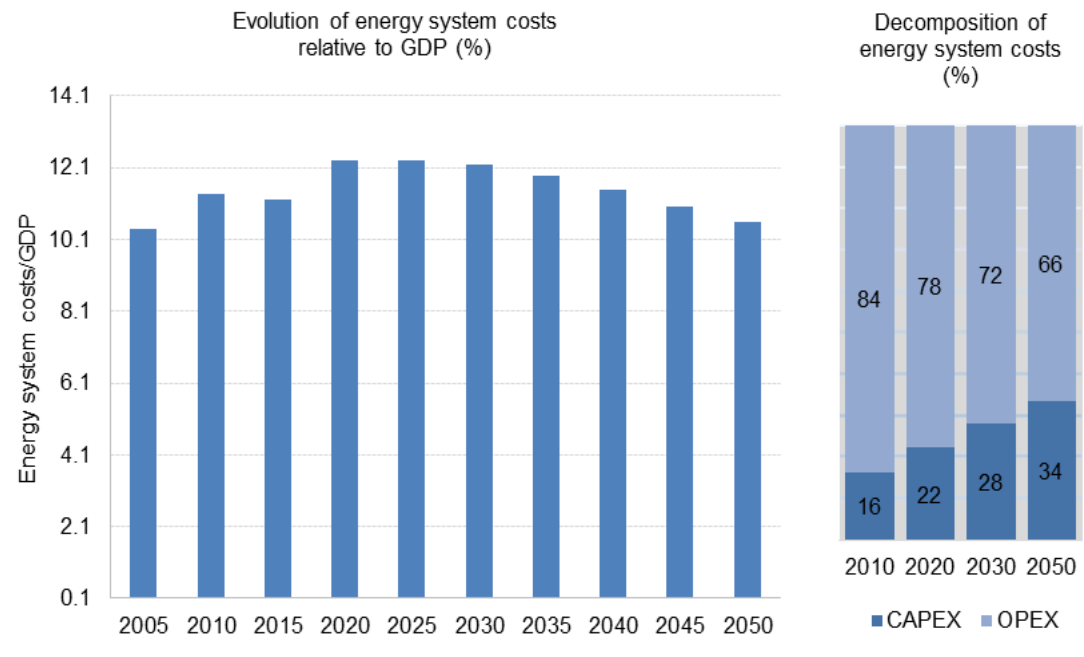


Source: PRIMES-TREMOVE model, NTUA, E3M-Lab



Energy System Costs slightly increase by 2020, then stabilize and decrease after 2030

- The increase of costs by 2020 is due to rising fuel prices, electricity costs and capital costs related to energy efficiency investments
- In the long term, technology improvements drive cost reductions which over-compensate the effect of increasing fossil fuel prices
- Capital expenditures increase their share in overall system costs, as energy technologies become capital intensive but require less fuel

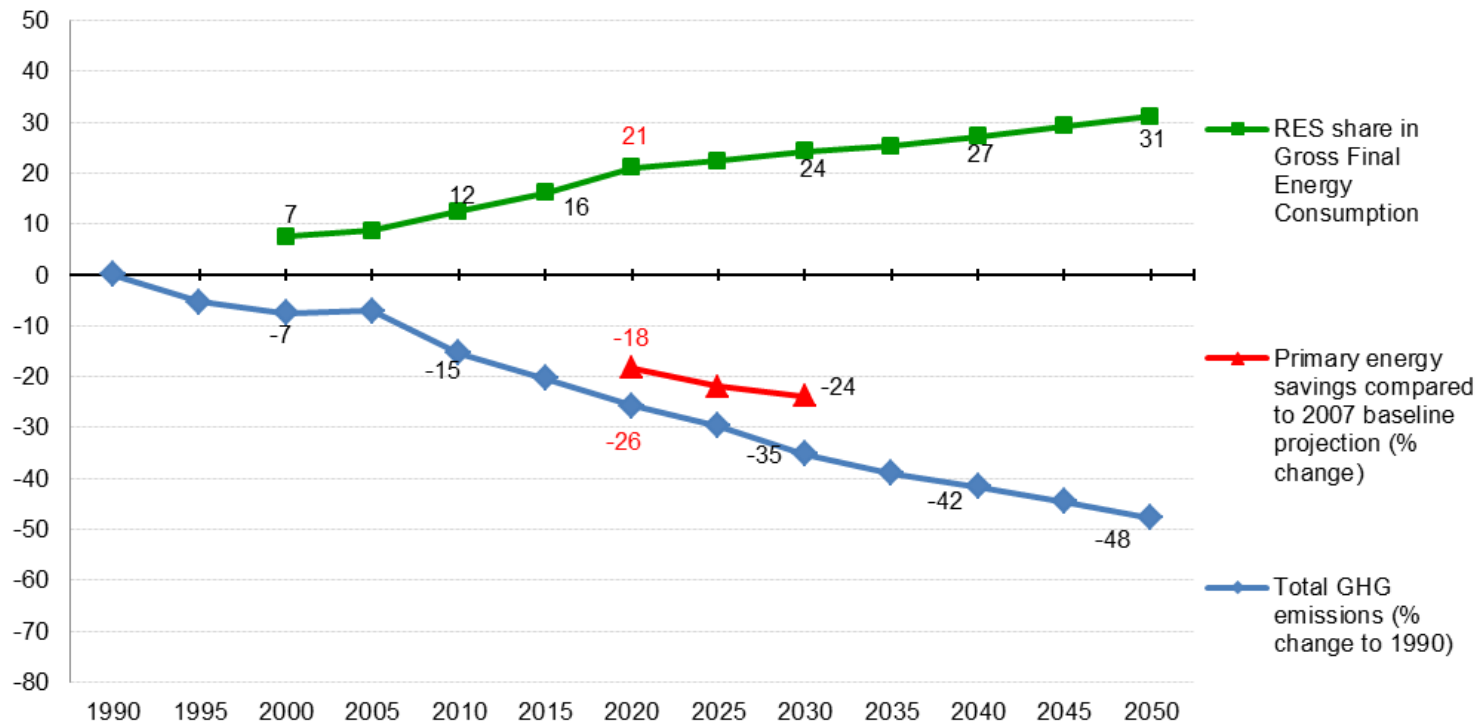


Source: PRIMES modelling, NTUA, E3M-Lab



EU energy trends show good progress, but more effort is needed to meet medium to long term targets and objectives

Projection of key policy indicators: GHG emissions, renewables share and energy efficiency





- Projected decrease in EU fossil fuel production, but net fuel imports will decrease. EU's **import dependency** will only slowly increase - mainly due to more renewable energy sources and significant energy efficiency improvements. Nuclear energy remains stable.
- EU **power generation mix** will change in favour of renewables. Gas maintains its role in the power generation mix in 2030, but other fossil fuels will see their share decrease.
- Significant **energy efficiency** improvements driven mainly by policy up to 2020 and then by market/technology trends post-2020. Primary energy demand and GDP will continue to decouple.
- Significant growth in **transport activity**, but decoupling between energy consumption and activity will continue and even intensify in the future.
- **Greenhouse gas emissions** decrease beyond 20% in 2020; further decreases thereafter but below agreed 2030 and 2050 objectives.
- **Non-CO₂ emissions decrease** until 2030 even more strongly than CO₂ emissions. The net sink provided by the land use, land use change and forestry sector declines, mainly with the sink in existing forests decreasing, but partly compensated by other activities such as afforestation.
- **Energy-related investment** expenditures increase substantially until 2020 driven by renewable energy and energy efficiency developments. Overall energy system costs increase in 2020, also driven by projected rising fossil fuel prices, before stabilising and eventually decreasing in the longer term, reaping the benefits of the investments made.

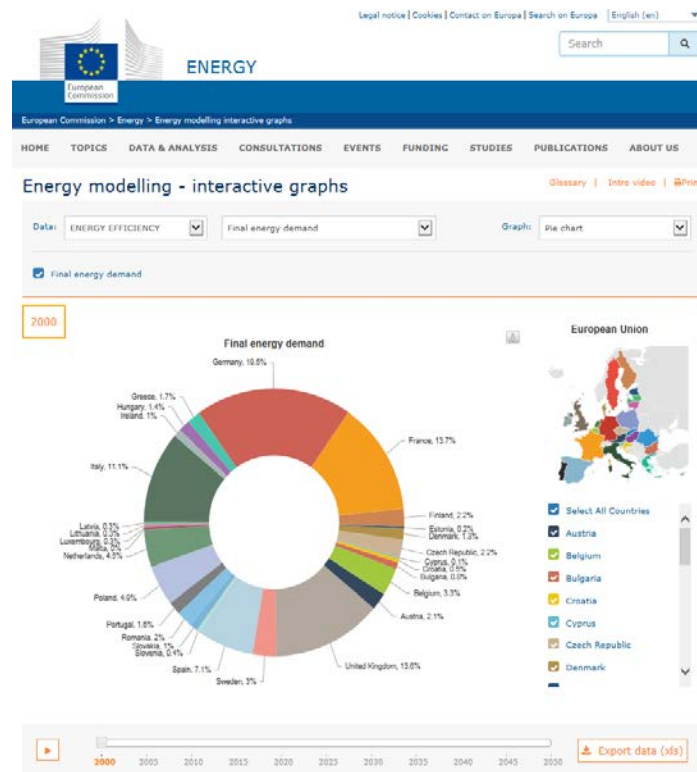
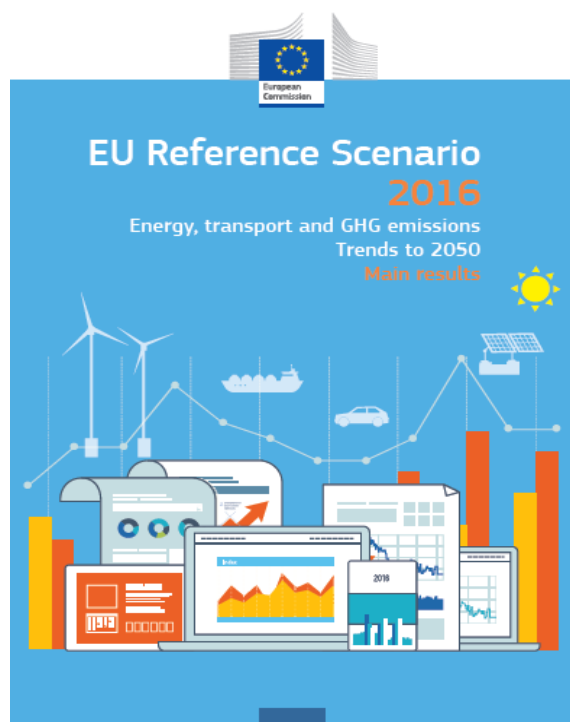
For more information



Website: <https://ec.europa.eu/energy/en/data-analysis/energy-modelling>

Methodology, assumptions and detailed results are presented in the EU Reference Scenario 2016 publication

A visualisation tool helps explore the results in a user-friendly way



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