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COMMISSION STAFF WORKING DOCUMENT

In-depth study of European Energy Security

Accompanying the document

Communication from the Commission to the Council and the European Parliament:

European energy security strategy

{COM(2014) 330 final}

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Executive summary

Introduction

As energy has come to be a vital part of Europe's economy and of modern lifestyles, we have come to expect *secure* energy supplies: uninterrupted access to energy sources at an affordable price. We expect to find petrol at the pumps, gas for heating and non-stop electricity, with blackouts too disruptive to countenance. To meet such expectations, for several years, Europe's energy policies have had a security of supply "pillar". Policies have been introduced to create electricity and gas markets, increase competition, diversify sources and supplies, to cut consumption and emissions. These policies not only aim to increase competitiveness and keep affordable prices as well as move towards a more sustainable energy system, but –the EU being a major energy importer- they are equally important for energy security. Thus, with the EU's 2020 energy and climate policies, energy efficiency and renewables polices and the planned 2030 policies, a range of measures exist to also address security of supply concerns.

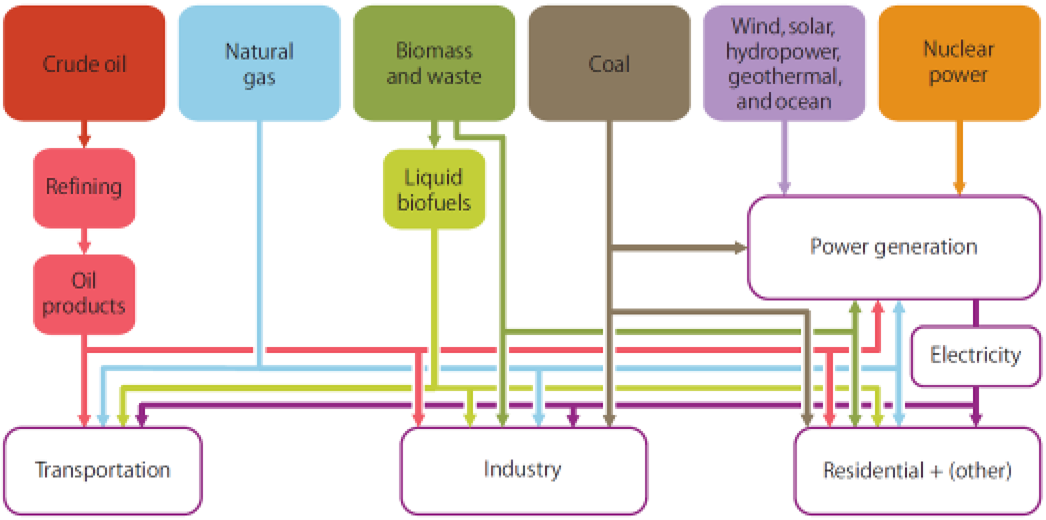
Despite the national and European measures and laws in place, current events on the EU's Eastern border have raised concerns regarding both the continuity of energy supplies and regarding the price of energy. This has provoked apprehension regarding **short term** access to energy, in particular access to affordable gas supplies in the coming months. It has also raised questions about the adequacy of the measures taken for the **medium term**.

To help address and better understand all the issues surrounding the security of energy supply, the March European Council called on the Commission to conduct an in-depth study of EU energy security and to present by June a comprehensive plan for the reduction of EU energy dependence. The study - this report - provides an extensive range of information and analysis regarding the sources, diversity, dependency and cost of energy in each Member State and for the EU as a whole. In this way, it aims to provide Member States, the European Parliament and stakeholders a deeper understanding of the energy system from a security perspective. It also provides a basis, underlying data and evidence for the comprehensive plan for the reduction of EU energy dependence, presented by the Commission together with this document.

Risks and resilience

The energy system is a complex structure, where aspects of "security" differ according to the actors involved at each point in the chain. Schematically, the system consists of fuels, transformation and consumption:

Figure S 1. Energy system



(Source: IEA MOSES working paper 2011)

For each tier, the risks to security differ, as does the element's resilience[1].

The risk of disruptions or significant price spikes to <u>fuel supply</u> depends on the number and diversity of suppliers, transport modes, regulatory framework and supply points, and the commercial and political stability in the countries of origin. The resilience of energy providers or consumers to respond to any disruptions by substituting other supplies, suppliers, fuel routes or fuels depends on stock levels, diversity of suppliers and

[1] IEA MOSES working paper 2011

supply points (infrastructure, ports, pipelines). These are the elements which are the common focus of energy security discussions, focussing both on events which require short term responses (to short term "crises") and medium responses to reduce risks and improve resilience.

The energy transformation tier, including refining and power generation, also faces risks. Refining risks are associated with having access to sufficient capacity for refining of different fuel sources. In the electricity sector, in addition to the above fuel risks, there are risks of volatility of supply, of system stability and generation adequacy, and risks related to operation and development of networks, including interconnection capacities. Resilience in this sector also depends on the number and diversity of fuels, refineries and power plants, as well as imports from third countries in the case of petroleum products.

The third element of the energy system is the composition of the consumers: amongst the variety of different households and industries, the costs of supply disruptions differ, as does the resilience of different groups and their flexibility to shift or reduce energy consumption.

For each of these three components of the energy system, of Europe's energy mix, the degree of risk or of insecurity can be assessed. And for each component there are a variety of measures that can be adopted, both at national and at European level.

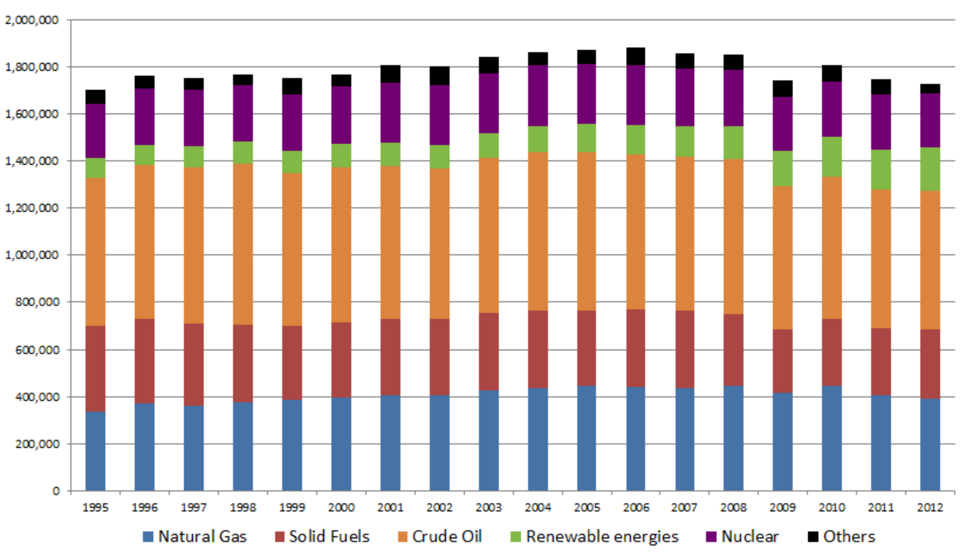
It needs to be stressed that the EU's energy system is increasingly integrated, while at the same time Member States are importing from the same supplier countries. It is therefore important to consider energy security from an EU perspective, an issue that is reflected in the new Energy Article of the Lisbon Treaty. Choices taken on the level of fuel supply, infrastructure development, energy transformation or consumption lead to spill-over effects on other Member States. Next to providing key information on the energy security situation of each Member State, this assessment aims to consider energy security aspects also from a regional and EU perspective.

Current European energy security

Total demand for energy slowly declining

Total demand[2] for energy has been increasing slowly in the period 1995-2006, but since then has been gradually falling, it is now more than 8% below its 2006 peak due to a combination of factors, including the economic crisis and structural changes in the economy of the EU, and efficiency improvements. Such changes and improvements have been linked to concrete polices implemented in the last 10 years, as well as to the significant increase of fossil fuel prices, most notably oil.

Figure S 2. Total energy demand, EU28, ktoe

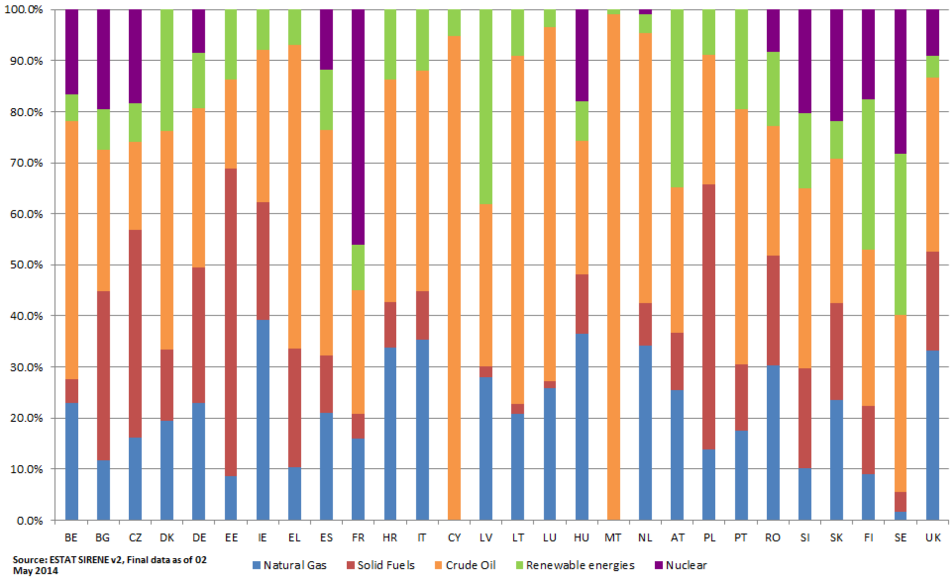


Source: Eurostat, energy. Calculations of the European Commission.

The composition of consumption has shown a slow but persistent change over time with the share of gas going up from around 20% to 23% of gross inland consumption between the mid-1990s and 2012 and the share of renewables more than doubling to almost 11% in 2012. In contrast, the shares of solid fuels declined from around 21% to 17%, oil from 37% to 34%, whilst nuclear remained stable in relative terms at 13%.

[2] Calculated as Gross Inland Consumption + Bunkers.

Figure S 3 Total energy demand, shares by fuel (%) in each Member State, 2012



Source: Eurostat, energy. Calculations of the European Commission. Note: In the case of Cyprus, Estonia, Latvia, Luxembourg Malta and Slovenia values refer to petroleum products, not crude oil.

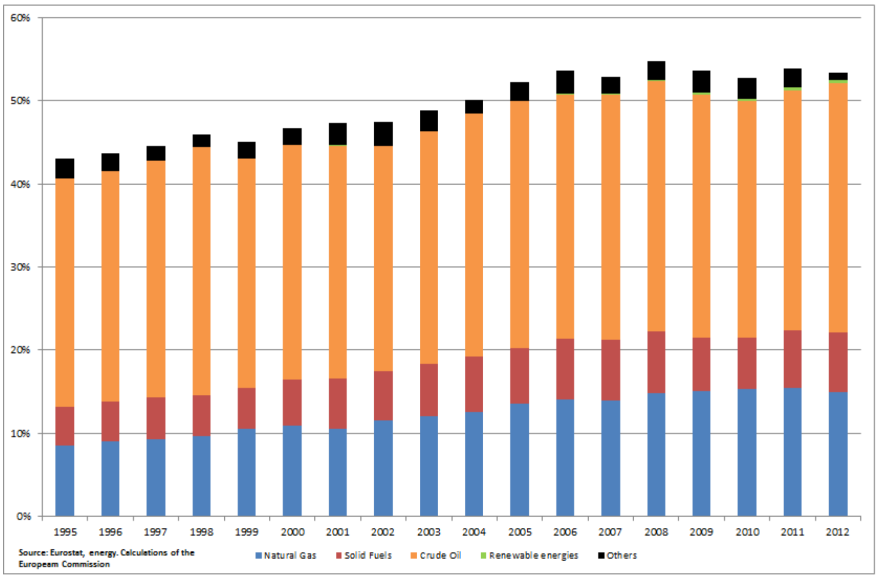
A trend of increasing import dependency, reaching more than 50% in recent years

rt dependency has increased by almost a quarter (10 percentage points), especially in the first decade. Two factors are at the origin: (1) a significant decline of EU production of oil, gas and coal, linked to a gradual depletion of EU reserves and the closure of uncompetitive sources, and (2) growing amounts of imported oil, gas, and coal to compensate for declining domestic production.

However, since 2006, the increasing share of renewables as well as the reduction of overall demand seems to have contributed to a stabilisation of import dependency.

The result is that for 2012, oil still constitutes the largest quantity of imports and at almost 90% still one of the highest shares of import dependency. The 66% import dependency of gas is the next greatest quantity, and the 62% of hard coal the third. Whilst import dependency for uranium is 95%, it constitutes a relatively small quantity. And the lowest import dependency of 4% occurs for renewable energy (chiefly biomass).

Figure S 4. Share of net imports in total demand by energy product, EU28, in %[3]

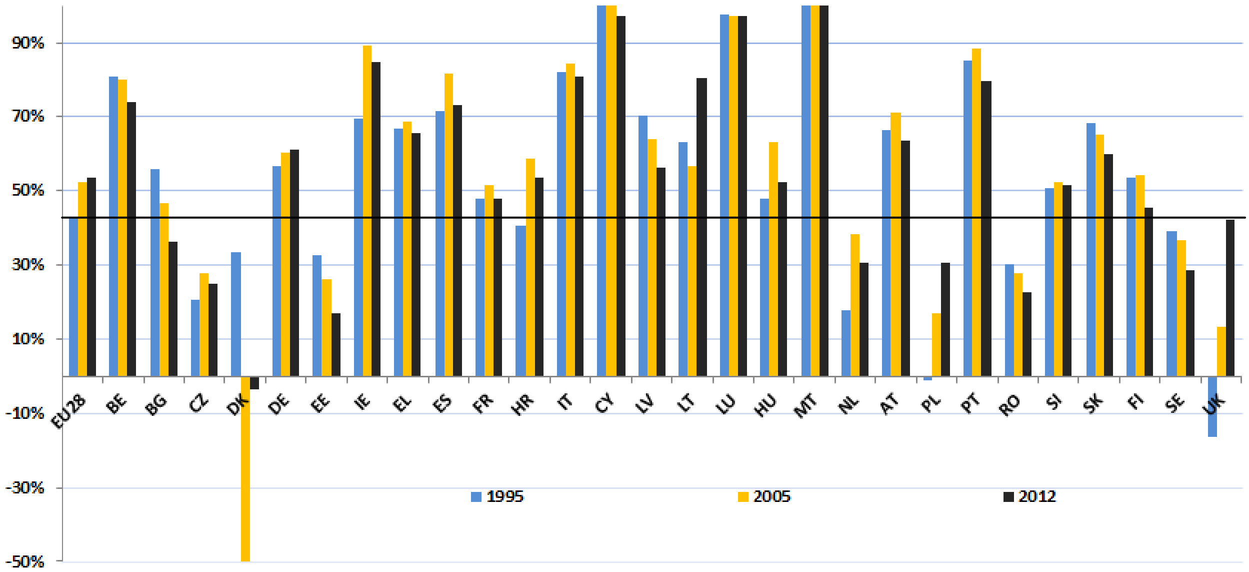


[3] The graph shows the contribution of different energy sources to total energy import dependency, which for all energy sources adds up to 53% in 2012. The sum of the relative shares of the net imports in total demand represents the import dependency for all energy products. Net imports of crude oil (the import dependency of which is 88%) represent 30% of total energy demand; net imports of natural gas (the import dependency of which is 66%) account for 15% of total energy demand; net imports of solid fuels (with an import dependency of 42%) constitute 7% of total demand and so on.
N.B. Uranium imports are not accounted in this context; Eurostat energy treats nuclear electricity as a domestic resource.

Major differences among Member States, but nearly all are heavily import dependent

The aggregated EU-level numbers hide a great deal of differences between Member States. In Member States with indigenous energy production, import dependency has changed considerably: two Member States have gone from having an energy surplus to a significant deficit, another has changed from deficit to slight surplus; 18 member States import more than 50% of their energy. Whilst the deficit of some countries has decreased, this is mostly due to falling energy demand rather than increased domestic supply.

Figure S 5. Energy import dependency, all products



Source: Eurostat, energy

France, Spain and Italy have all seen energy deficits peak in 2005, the subsequent decrease driven by a combination of weak demand and increased renewable energy. The deficit of the largest energy consumers in the EU – Germany – has unsurprisingly been the largest in energy terms and since its peak in 2001 has shown fluctuations in both directions, without a stable trend.

Crude oil: risks of supply disruption mitigated by liquid global oil markets and regulated stocks, but a tight supply/demand balance, the concentration of suppliers and high import dependency can lead to price shocks with significant economic consequences in case of supply disruption events

Oil continues to be the largest single primary energy source used in the EU. It is mainly fuelling transport where it has limited viable alternatives (providing 95% of transport fuel). Of all energy sources, it has one of the highest shares of imports (almost 90%), leaving the EU exposed to the global oil market where the EU is a price taker. Because of the structural unbalances in European refining, the EU is also reliant on international product trade. Oil is traded in a liquid global market, but suppliers are quite concentrated, hindering diversification efforts. However, since it is mostly imported by sea, from a logistical point of view, it is relatively easy to switch from one supplier. Refineries reliant on Russia's Druzhba pipeline constitute an exception. The concerned Member States[4] would require improved alternative supply routes in order to ensure effective diversification.

Given oil's history of supply and price shocks, significant steps have been taken to diversify supplies and to prepare for short term shocks. EU Member States are legally required to hold emergency oil stocks equivalent to 90 days of net imports[5]. In addition, other measures including demand restraint can contribute to addressing longer lasting disruptions. Transport's dependence on oil still has to be addressed. Whilst efficiency levels

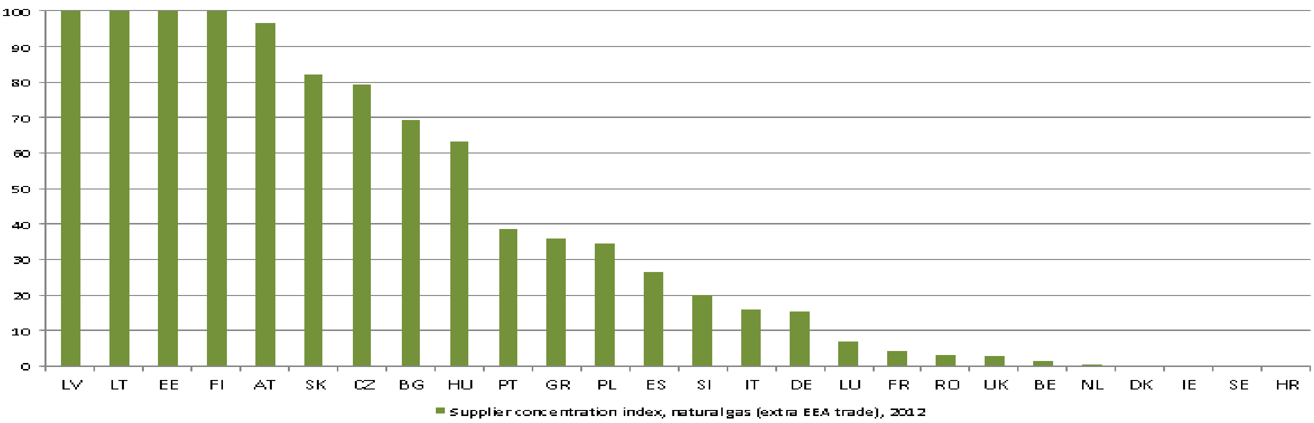
[4] Poland, Germany, Slovakia, Czech Republic, Hungary
[5] 90 days of net imports or 61 days of consumption, whichever is higher

have improved significantly in the last decade, progress towards substitutes and alternative supplies (e.g. biofuels, electricity) continues to be limited.

Gas: development of markets and gas infrastructure (interconnectors, reverse flows and storage) are improving resilience, but a short term winter supply disruption through Ukraine transit routes poses significant challenges, in particular for Bulgaria, Romania, Hungary and Greece.

The EU's increasing dependency on **gas** imports has posed a challenge and increased the risks to security of supply. A reliable, transparent and interconnected market has the potential to mitigate these risks. The EU imports over 60% of its gas, with two thirds of these imports coming from countries outside of the EEA. The Baltic States, Finland, Slovakia and Bulgaria are dependent on a single supplier for their entire gas imports. The Czech Republic and Austria also have very concentrated imported gas supplies.

Figure S 6. Supplier concentration, natural gas, 2012

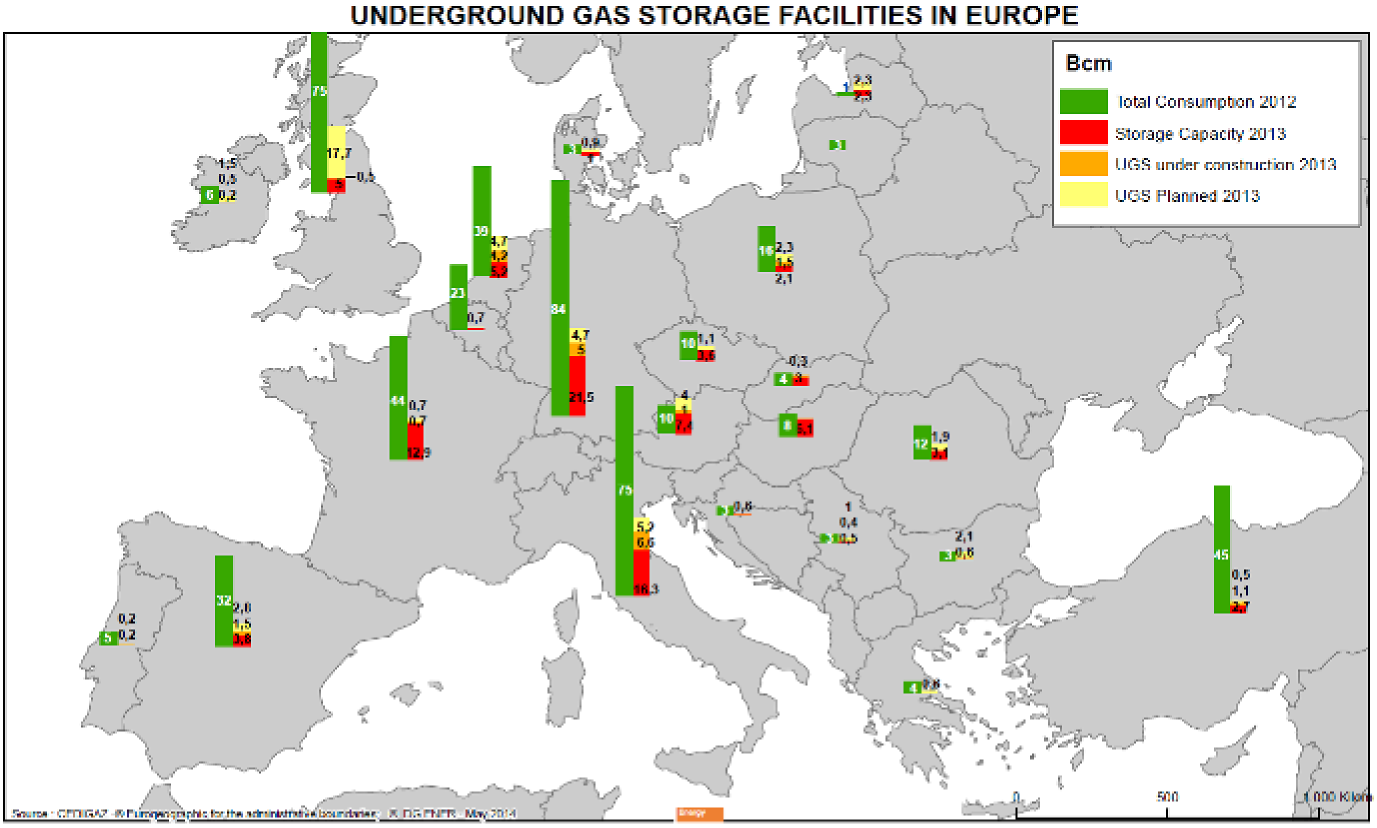


Source: Eurostat, European Commission calculations on gas imports from outside the European Economic Area

Note: The supplier concentration index takes into account both the diversity of suppliers and the exposure of a country to external suppliers: Large values indicate limited diversification with imports forming a large part of consumption

The flexibility of transport infrastructure in terms of location, number and available capacity of pipelines and LNG terminals, underground storage and the way infrastructure is operated all play an important role in shaping the resilience of the gas sector. The potential to operate pipelines in two directions increases the resilience in case of a supply disruption. Further investment in physical reverse flows is therefore important.

Figure S 7. Underground gas storage facilities in Europe



Source: CEDIGAZ.

The flexibility of supply in the short term and availability of alternative external sources depend on competition on the world markets, most notably for LNG, and on the degree to which such sources are already reserved by long-term contracts or other commitments (e.g. intergovernmental agreements). In the EU the long term[6] contracts of pipeline gas are estimated to cover 17-30% of market demand, nearly entirely from Russia.

EU import pipeline capacity is 8776 GWh/day, roughly comparable to the capacity of LNG terminals (6170 GWh/day). The scope for using more of the LNG capacity differs among terminals, largely depending on their location and infrastructure. There is more scope on the Iberian Peninsula and less for supplies in Eastern Europe. The role of LNG as a ready tool to increase resilience in the short term is undermined by high global LNG prices on Asian markets and long term contracts for pipeline gas deliveries. The EU's gas storage, together with increased scope for reverse flows, can play a mitigating role in the event of supply disruption. A well-functioning market sending correct price signals will also help steer gas flows and boost storage levels in the event of restrictions to supplies. So EU internal market, reverse flow and gas storage rules all help to boost EU gas supply resilience and ensure that missing gas is being delivered.

The estimates of ENTSO-G[7] show, depending on the duration and on the level of the demand (e.g. high demand in winter), potential disruptions will affect a majority of EU Member States directly (except for France, Spain and Portugal). Indirect effects will include increases in LNG gas prices for the entire EU. The state of infrastructure, levels of interconnections and market development expose some Member States in the east to greater disruption than those in the west. According to various analysis of ENTSO-G, in the case of disruption of transit through Ukraine, those countries exposed to likely disruption of deliveries are Bulgaria, Romania, Hungary and Greece, as well as Energy Community Members FYROM, Serbia and Bosnia and Herzegovina. In the case of disruption of all supplies from Russia over winter (October to March), in addition to the above countries, Finland, Poland, the Czech Republic, Slovakia, Croatia, Slovenia, and the three Baltic

[6] Some even beyond 2030
[7] (European Network Transmission System Operator – Gas)

States - Lithuania, Latvia and Estonia - are also exposed to disruption. Interruption of supply to Lithuania may also impact on the level of supply in Kaliningrad.

Solid fuels: increasing import dependence, liquid markets, but low level of modernisation, ageing power plants, low efficiency and lack of diversification lead to high carbon intensity in some countries

Solid fuel (including hard coal, sub-bituminous coal, lignite/brown coal and peat[8]) provides 17% of the EU's energy, with Germany, Poland, the UK and Greece being the top four consumers. The largest part of solid fuels serves as transformation input to electricity, CHP and district heating plants, with smaller amounts going to coke ovens, blast furnaces and final energy demand.

Between 1995-2012 demand declined by almost 20%, falling in nearly all Member States. The import dependency for solid fuels has been increasing also due to the closure of uncompetitive mines in a number of EU countries, and currently stands at 42%. However, for hard coal on its own, this figure increases to more than 60%, with Russia being the main source (26% of all imports to the EU). Most recently, demand for coal has rebounded as a result of favourable prices compared to gas, leading to gas to coal switch in electricity generation[9].

The global market for hard coal is liquid, with multiple suppliers and broadly well-functioning transport infrastructure. Given coal's high carbon intensity, (higher carbon content and relatively low generation efficiency), its viability and potential contribution to energy security in the medium to long term is subject to modernisation in terms of increasing conversion efficiencies and further technological improvements, notably the development and application of carbon capture and storage.

Nuclear: diversified supply of uranium, but final fuel assemblies are not, notably for Russian reactors in Bulgaria, Czech Republic, Finland, Hungary and Slovakia

Nuclear powered electricity constitutes 13% of the EU's energy consumption, and 27% of its electricity generation. 95% of the fuel, uranium, is imported, from a variety of supplying countries (including Kazakhstan, Canada, Russia, Niger and Australia), for the EU's 131 nuclear power plants (in 16 Member States, led by France, the UK, Sweden, Germany, Belgium and Spain). The Euratom Treaty set up a common supply system for nuclear materials, in particular nuclear fuel, established the Euratom Supply Agency to guarantee reliability of supplies and equal access of all EU users to sources of supply.

Uranium must undergo several processing steps (milling, conversion, enrichment) before being fabricated into tailor-made, reactor type-specific "fuel assemblies". And whilst the uranium itself can be purchased from multiple suppliers and easily stored, the final fuel assembly process is managed by a limited number of companies. For western designed reactors, this process can be split, and diversification of providers achieved. For Russian designed reactors, the process is "bundled" and managed by one Russian company, TVEL, currently with insufficient competition, diversification of supplier or back up. Thus, EU fuel assemblies are approximately 40% dependant on non EU suppliers[10].

Renewable energy: the most indigenous resource with greatest fuel diversity, but with concerns regarding the variable nature of wind and solar power, creating challenges in terms of reliability, requiring adaptation of the grid

Renewable energy, promoted by the EU in particular for energy security and sustainability/decarbonisation reasons for almost two decades, constitutes the most indigenous form of energy, with imports (of biomass) constituting only 4% of total renewable energy production. In 2012 the production of renewable electricity

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[8] Different international organisations apply different definitions and classifications of solid fuels. See Eurostat classification of solid fuels at http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/nrg_quant_esms_an1.pdf .

[9] Strongest growth 2011-2012 seen in Portugal, UK, Spain, France, Ireland and the Netherlands, driven by falling coal and rising gas prices.

[10] Russian reactors in Finland, Bulgaria, Czech Republic, Hungary and Slovakia depend on Russian fabrication services, while the reactor in Slovenia depends on US-fabricated fuel.

reached 799 TWh. Hydro power is the most important renewable electricity source and accounts for 46% of renewable electricity generation in the EU, biomass 18%, and wind and solar power 35% (or 7% of gross electricity production). As the share of wind and solar power grows, however, further modernisation of the grid and system operations will be necessary to ensure the electricity supply continues to be reliable.

Refining

Regarding **energy transformation**, the **refining** industry has a crucial role in transforming crude oil into oil products which can be used for final consumption. While the EU has ample refining capacity to cover the overall demand for petroleum products, it is a net *exporter* of certain products (in particular gasoline and, to a smaller extent, fuel oil) but a net *importer* of others (gasoil/diesel, jet fuel, naphtha and LPG). As with Uranium, the reliance on non EU processing can add commercial or supply constraints if the global market is not competitive.

Electricity: an increasingly diverse fuel mix with high system reliability, but more integrated and smart infrastructure is needed to enhance market functioning, improve efficiency and the integration of renewable and distributed generation

The transformation of fuel into **electricity** is a critical element of the EU's energy sector. Unlike other final energy sources, electricity constitutes the most fuel-diverse form of energy available. In addition, diversity in terms of fuels and generation technologies is expected to increase further in the future. To a degree, fuel switching is feasible, in response to price signals or supply constraints, with the range of commercially available electricity generating technologies continuing to grow, increasing the potential to combine energy security, sustainability and GHG emission reduction objectives. Nevertheless, this overall EU picture conceals large differences between Member States.

The storage capabilities for electricity are very limited, which means that production and consumption need to match almost instantly, posing particular challenges to the transmission and distribution network infrastructure. Nevertheless, system reliability of the electricity system is very high compared to other regions of the world. The resilience of the EU's energy system is being improved through the growing use of electricity, notably with improvements to the integration of the European electricity grid and completion of key inter-connectors. Import dependency is being reduced through the growth of the use of renewable energy sources. As well as improving the EU's overall energy resilience, such measures are also tackling the vulnerability of isolated electricity systems, (notably the energy islands of the Baltic Member States); improving their scope for developing competitive markets and reducing the negative security and economic impacts of market concentration.

The difficulties of building and maintaining such a network create bottlenecks which constrain competition and market development. Electricity infrastructure constraints can also undermine the reliability or security of electricity supply, since infrastructure, power plant or fuel supply failures in relatively isolated systems (e.g. "energy islands") will have less scope for market responses and more negative impacts than in well interconnected areas.

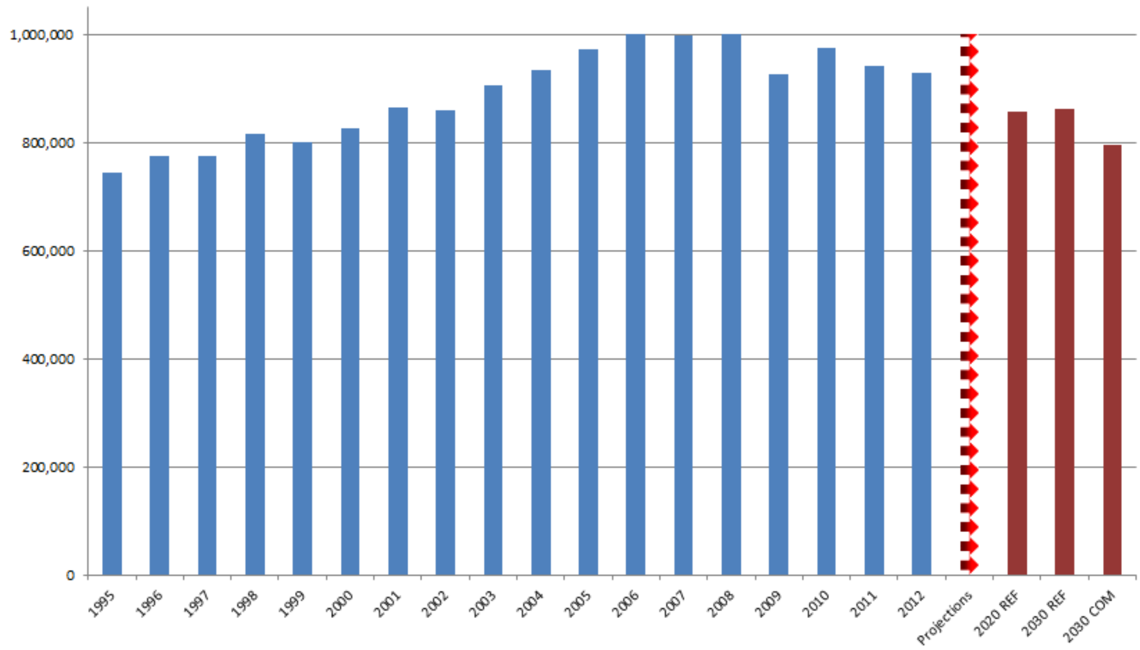
In conclusion, in the case of electricity, security of supply issues are different from those of fossil fuels, and in most of the EU countries the resilience of the power system is good enough to cope with problems of usual magnitude. However, simultaneous occurrence of unusual or extreme events (e.g.: an ongoing cold and dry winter coupled with a major external gas supply disruption) might cause perceivable disturbances in the functioning of the European electricity system and internal market. In order to avoid such disturbances, member states need to coordinate their electricity generation adequacy assessments at least with their direct neighbours or with other countries in the EU as well. In the case of the electricity security of supply issues are rather related to the stability of the grid, however, supply issues of fuel feedstock have repercussions on the electricity market. Therefore, exchanges of information on negotiations with external fossil suppliers among the EU member states could also contribute to assuring the security of generation feedstock supply.

Expected European energy security in 2030

In a medium-term perspective, the **2030 Framework for energy and climate policies** will generate substantial energy security benefits. In particular, the increase of indigenous energy sources via the proposed renewable energy target, as well as the reduction of energy consumption via a new energy efficiency framework will contribute to lowering the Union's energy dependence. As part of the 2030 Framework, the Commission proposed a governance scheme based on national plans for competitive, secure and sustainable energy which aims to increase enhance regional coordination and coherence between EU and national energy policies. It also proposed 3 energy security indicators: diversification of energy imports and the share of indigenous energy sources used in energy consumption; deployment of smart grids and interconnections between Member States; and technological innovation. As with this in-depth study, monitoring of these indicators over time can help track the benefits of EU energy security policy.
Under a regime of more coordinated European energy policies, common climate policy objectives and a growing single market, the resilience of Europe's energy sector should improve. The figure below combines the historic trends on energy deficit until 2012, with the projected energy deficit under 2 scenarios: the Reference scenario reflecting the full implementation of the 2020 policies and a '2030' scenario reflecting, the implementation of the proposed 2030 Climate and Energy policy framework. It illustrates that despite continued reduction in the production of indigenous fossil fuels, the net imports are decreasing significantly, as a result of efficiency as well as fuel diversification.

The importance of energy efficiency for attaining the energy policy objectives of sustainability, competitiveness and energy security in the medium term has been underlined by the 2030 Framework. In the proposed governance scheme, national plans for competitive, secure and sustainable energy would include Member States' contributions to EU energy efficiency improvements.

Figure S 8. EU net imports, ktoe, 1995-2012 and Commission projections



Source: Eurostat and European Commission projections based on the PRIMES model

The table below gives a more detailed overview per fuel for both these scenarios, and compares it with the IEA 'new policies' scenario, which broadly serves as the IEA's baseline scenario. Import dependency will keep increasing over time in order to compensate for the declining domestic production. At the same time though, a considerable reduction in total demand for the various fossil fuels in 2020, and also in 2030 with the implementation of the proposed 2030 policy framework, is projected. The projected reduction in total demand is important from an energy security perspective, but also from an economic perspective to reduce the total import bill, which already increases due to the projected increase in fossil fuel prices.

Table S 1. Total Demand and Import Dependency per fossil fuel for different scenarios

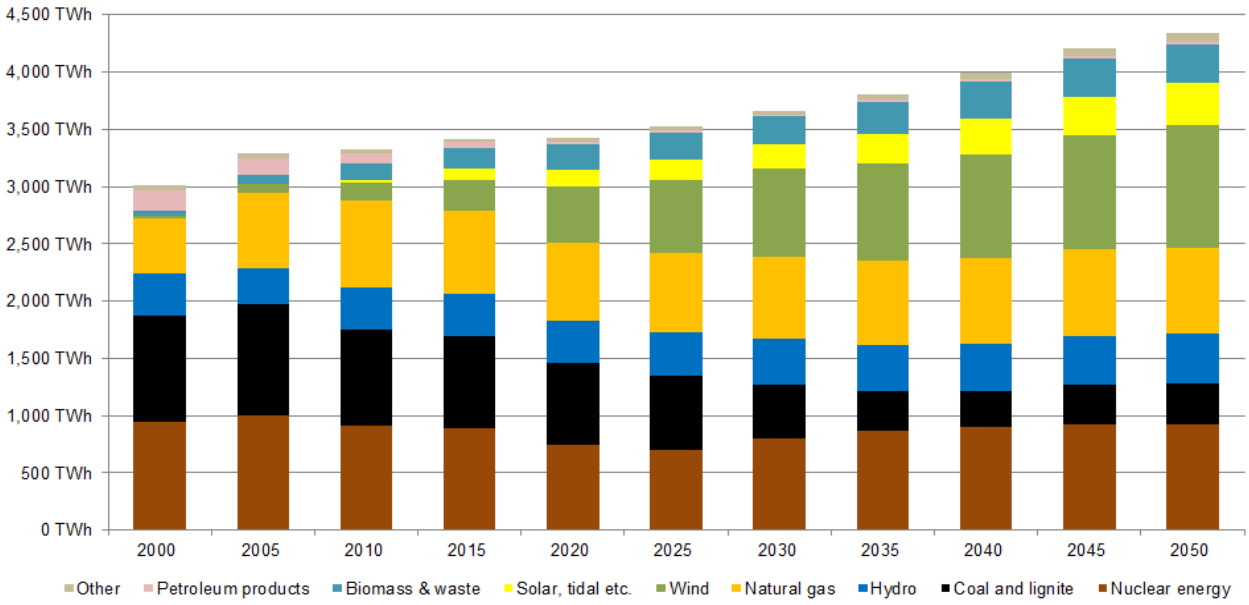
			2010	2020	2030
projection for EU28 (Reference Scenario)	Oil	Total Demand (Mtoe)	669	606	578
		Import Dependency (%)	**84%**	**87%**	**90%**
	Natural gas	Total Demand (Mtoe)	444	407	400
		Import Dependency (%)	**62%**	**65%**	**73%**
	Coal	Total Demand (Mtoe)	281	236	174
		Import Dependency (%)	**40%**	**41%**	**49%**
projection for EU28 (2030 policy framework)	Oil	Total Demand (Mtoe)	669	604	559
		Import Dependency (%)	**84%**	**87%**	**90%**
	Natural gas	Total Demand (Mtoe)	444	404	347
		Import Dependency (%)	**62%**	**65%**	**72%**
	Coal	Total Demand (Mtoe)	281	231	155
		Import Dependency (%)	**40%**	**40%**	**48%**
			2010	**2020**	**2030**
IEA projection for EU28 (WEO2013 new policies scenario)	Oil	Total Demand (Mtoe)	683	569	481
		Import Dependency (%)	**83%**	**85%**	**89%**
	Natural gas	Total Demand (Mtoe)	446	407	442
		Import Dependency (%)	**62%**	**73%**	**79%**
	Coal	Total Demand (Mtoe)	280	248	174
		Import Dependency (%)	**40%**	**43%**	**48%**

Source: European Commission projections based on the PRIMES model, IEA World Energy Outlook 2013

Finally, while electricity consumption itself is expected to grow, continuous fuels and technology diversification is expected, notably with higher shares of renewable energy, which from a supply perspective will improve security. The changing diversity of fuels, notably the growth of wind and solar power, together with the building of the internal electricity market, will however also require significant infrastructure investment, to ensure that power generation adequacy is maintained.

A sufficiently ambitious renewable energy target for 2030 at the EU level will contribute to increase the share of indigenous renewable energy sources in the Union's energy mix, thereby reducing EU energy dependency. The proposed governance scheme proposed in the 2030 Framework based on national plans for competitive, secure and sustainable energy will ensure an effective implementation of the target.

Figure S 9. Power generation from different sources in the 2013 PRIMES Reference Scenario



Assessment of energy capacity, transport and storage

Having reviewed the risks and resilience of the different fuel sectors in Europe, and the changes expected over the coming decades, it is important to take stock of existing measures regarding the management of energy capacity, transport and storage both in the short and medium term.

Short term

For oil, following IEA practice, the EU has oil stock storage rules and demand restraint (short term energy efficiency) action plans that can help improve short term market resilience and partly sustain the European economy in the event of a price or supply shock. Moreover new entrants to the global oil market also reduce risks of any such shocks. In the gas sector, EU rules for responding to shocks are weaker, with some rules covering back up, adequacy requirements and demand side, efficiency measures. Recent EU infrastructure policy measures improving reverse gas flow options have also reduced the weakness of the EU's resilience in this area. Adequate inventories make a shortage of nuclear fuel highly unlikely.

The IEA has analysed a scenario of interruption of transit of Russian gas to Europe via Ukraine. This explores how alternative supply routes (LNG, Norway, Nordstream etc…) and supplies, EU production and storage and demand response/curtailment measures could attempt to replace Russian gas flows through Ukraine.

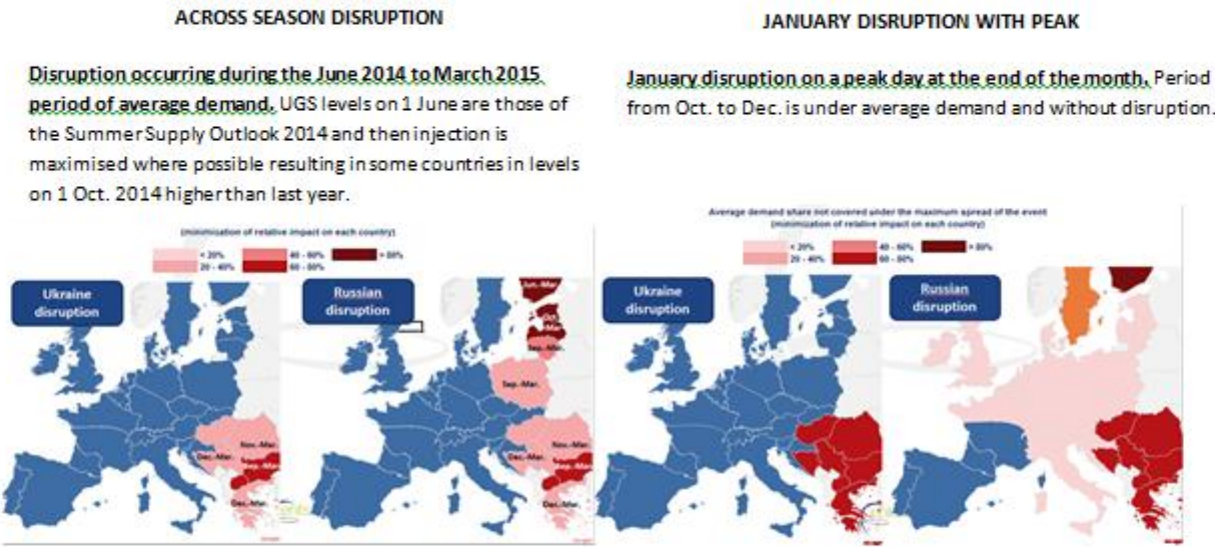
ENTSO-G recently estimated the impact of a possible disruption crisis by analysing the response of gas infrastructure in the EU (pipelines, LNG, storages) in the case of disruption of gas supplies from Russia or transit from Ukraine.[11] Assuming maximum solidarity between Member States, the summer outlook and the estimate for winter confirm the vulnerability of Member States in the South-East of the EU and the Balkans. If disruptions of Russian deliveries occur during daily peak demand in January, almost the entire EU, except the Iberian Peninsula and the south of France would be likely to be directly affected. The effects are likely to be less severe in the case of disruption from Ukraine, however South-East Europe could face a situation where more 60-80% of supply is not covered.

Disruption of Russian supplies across season (June 2014 to March 2015) could result in shortages (based on average demand) in states in the East of Europe. Bulgaria and FYROM might face a disruption of 60-80% of

[11] See ENTSOG presentation of 7/5/2014. ENTSOG underlines that the estimation should not be understood as an actual forecast neither in term of demand disruption nor supply mix.

demand from September to March, Poland 20-40% and Lithuania 40-60%. Latvia and Estonia might face difficulties from October to March with more than 80% of demand not covered; Finland would face similar disruption from January to March. A 20-40% disruption might also occur in Romania, Croatia, Serbia and Greece for the late 2014/early 2015. Cross seasonal disruption to supplies transiting Ukraine would also create shortages in South East Europe, with Bulgaria and FYROM affected from September onwards.

Figure S 10. Disruption crisis: estimate of affected countries

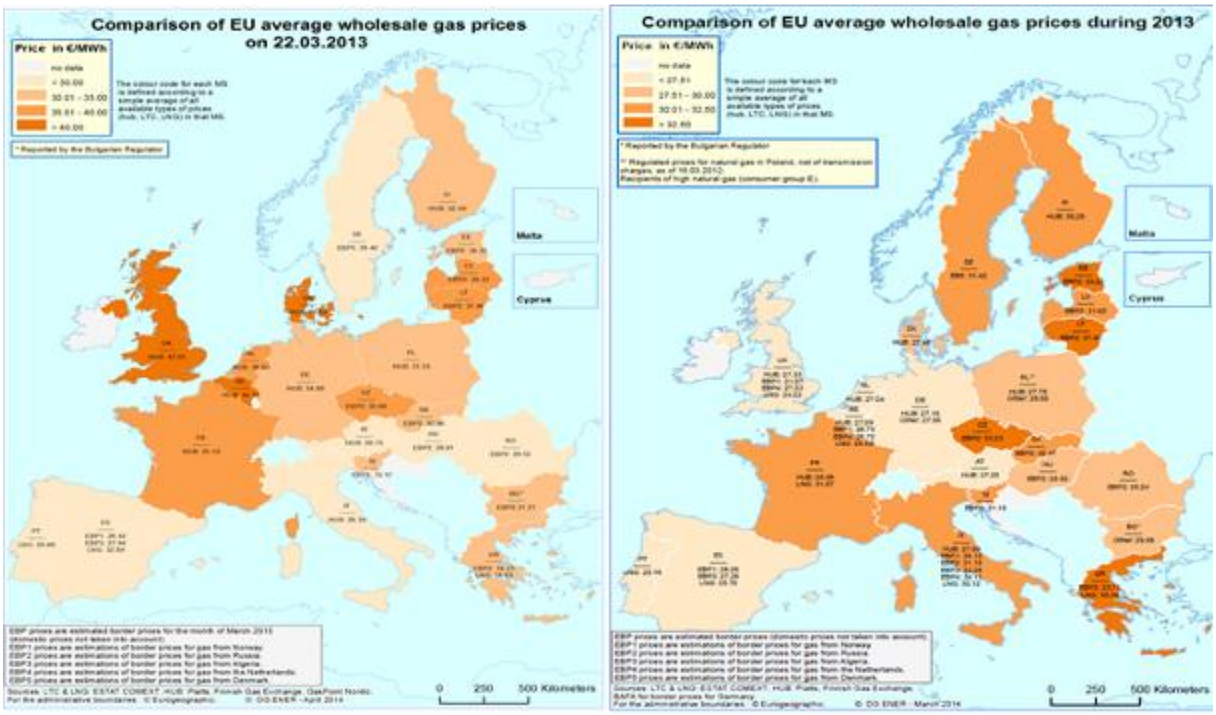


Source: ENTSO-G

The extent of disruption also depends on the reliability of infrastructure bringing alternative fuels, the scope for demand response measures and on gas market price signals attracting supplies. Regarding this last point, in March 2013 (a cold spell), high demand in Member States with diverse sources, good infrastructure connections and established markets saw significant price rises which attracted increased supplies[12]. In contrast, prices did not react greatly in Member States in the East and South-East of the EU. So whilst eastern Member States are the most vulnerable to supply disruptions, the limited markets and/or price regulation in the east resulted in the market instead delivering increased supplies to *Western* Europe. Thus more liquid markets (with more supply options) are more able to respond to disruptions.

[12] For example the prices in the UK and in Belgium increased to the level close to € 40/MWh in comparison to average prices of between € 25 and € 30/MWh. The price increases at the hubs in the EU were also following this trend. See analysis of the European Commission at http://ec.europa.eu/energy/observatory/gas/doc/20130611_q1_quarterly_report_on_european_gas_markets.pdf

Figure S 11. Market resilience: the cold spell of March 2013



For electricity, Europe's growing interconnectedness and the growing trade in electricity between Member States has already proved the security benefits that come from growing diversity: at different times in recent years, short term surpluses of one form of electricity in one Member State (e.g. nuclear power in France or wind and solar in Demark and Germany) have flowed to counter deficits in another Member State.

Medium term

Core EU policies already in place steer the EU's energy sector towards a more secure and resilient form in the medium term. Regarding **internal energy reserve capacities**, the promotion of the development of a wide range of indigenous low carbon fuels can clearly increase the diversity of fuel supplies and thus reduce the risk of both supply and price shocks. Some Member States are also exploring the scope for expanding non-conventional fossil fuel production, such as shale gas, which may also diversify supply. More broadly, building up the flexibility of Europe's infrastructure, both for gas and electricity, facilitates the more efficient use of existing reserves. And the greater competition resulting from more integrated markets reduces individual suppliers' scope for supply disruptions or anti-competitive pricing.

Improving the integration of Europe's energy sector can also improve the diversity of **external energy reserve capacities**. This is because the bottlenecks, monopoly suppliers and supply risks of currently isolated Member States dissolve when the alternative infrastructure, ports, pipelines, etc. of other Member States become available. Member State access to global energy reserves are also improved when European purchasing power is coordinated; where measures are taken against product bundling (either directly in the form of nuclear fuel processing, or indirectly through compliance with EU single market rules), the scope for supplier control of uncompetitive oil, gas, coal, uranium and electricity markets is reduced, and the diversity of fuel reserves and suppliers increased.

1. Introduction

As energy has come to be a vital part of Europe's economy and of modern lifestyles, we have come to expect *secure* energy supplies: uninterrupted availability of energy sources at an affordable price. We expect to find petrol at the pumps, gas for heating and, in this computerised era, non-stop electricity, with blackouts too disruptive to countenance. We also expect supplies to be "affordable". Whilst energy as a part of household consumption is only around 6% in the EU, almost 11% of EU households feel unable to keep their homes warm[13]. In addition, several European energy intensive industries warn of the negative impact of energy costs on their competitiveness.

To meet such expectations, for several years, Europe's energy (and climate) policies have had a security of supply "pillar". Policies have been introduced to create electricity and gas markets, increase competition, diversify sources and supplies, to cut consumption and emissions. And these same policies also reduce the risk of loss of supply and, through increasing competition, can help keep prices in check and affordable.

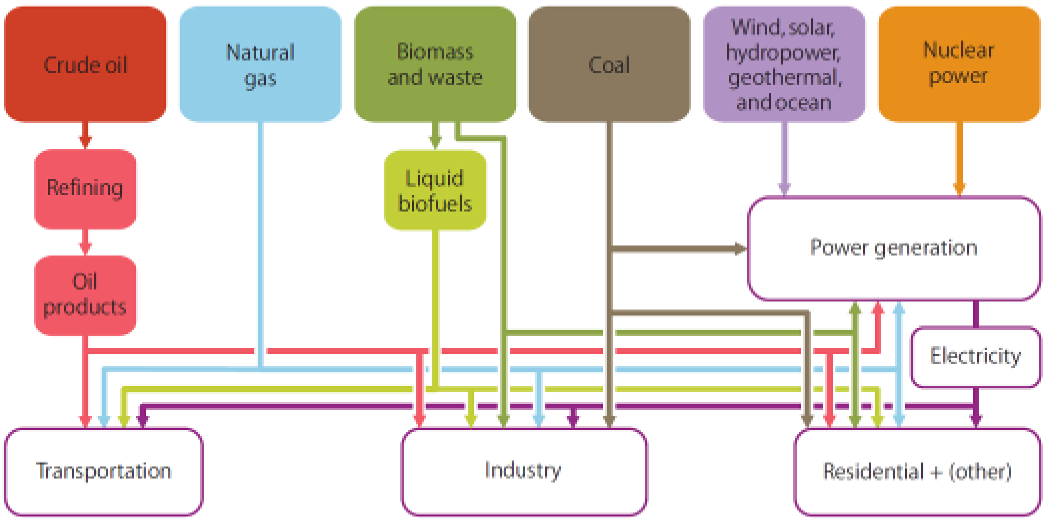
Despite the national and European measures and laws in place, current events on the EU's eastern border have raised concerns regarding both the continuity of energy supplies and regarding the price of energy. This has provoked apprehension regarding both short term access to energy; in particular access to affordable gas supplies in the coming months. It has also raised questions about the adequacy of the measures taken for the medium term.

To help address and better understand all the issues surrounding the security of energy supply, the March European Council called on the Commission to conduct an in-depth study of EU energy security and to present by June a comprehensive plan for the reduction of EU energy dependence. The study - this report - provides an extensive range of information and data regarding the sources, diversity, dependency and cost of energy in each Member State and for the EU as a whole.

1.1 Risks and resilience

The energy system is a complex structure, where aspects of "security" differ according to the actors involved at each point in the chain. Schematically, the system consists of fuels, transformation and consumption:

Figure 1. Energy system



Source: IEA MOSES working paper 2011

For each tier, the risks to security differ, as does the element's resilience[14].

[13] Eurostat Income and Living Conditions (ILIC) questionnaire 2012.

[14] IEA MOSES working paper 2011

The risk of disruptions or significant price spikes to fuel supply depends on the number and diversity of suppliers, transport modes, market structure and regulatory framework and supply points, and the commercial stability in the countries of origin. The resilience of energy providers or consumers to respond to any disruptions by substituting other supplies, suppliers, fuel routes or fuels depends on stock levels, diversity of suppliers and supply points (infrastructure, ports, pipelines). These are the elements which are the common focus of energy security discussions, focussing both on events which require short term responses (to short term "crises") and medium responses to reduce risks and improve resilience.

The energy transformation tier, including refining and power generation, also faces risks. Refining risks are associated with having access to sufficient capacity for refining of different fuel sources to meet consumer needs to refined products. In the electricity sector, in addition to the above fuel risks, there are risks of volatility of supply (including weather patterns (rain, wind, sun), unplanned power plant outages, age profile of power plants), risks to ensure system stability and generation adequacy and risks related to operation and development of networks, including interconnection capacities. Resilience in this sector also depends on the number and diversity of fuels, refineries and power plants, as well as imports from third countries in the case of petroleum products.

The third element of the energy system is the composition of the consumers: amongst the variety of different households and industries, the costs of supply disruptions differ, as does the resilience of different groups and their flexibility to shift or reduce energy consumption.

For each of these three components of the energy system, of Europe's energy mix, the degree of risk or of insecurity can be assessed. And for each component there are a variety of measures that can be adopted, both at national and at European level.

It needs to be stressed that the national energy mix choices of each of the Member States affect others. Choices taken on the level of fuel supply, infrastructure development, energy transformation or consumption may lead to higher negative spill-overs on other Member States and therefore also on the level of the EU. It seems inevitable that assessment of necessary measures to mitigate risks has to include an assessment of risks and negative effects linked to particular fuel choices. The below analysis shows that when formulating policy options for closer cooperation and solidarity among the Member States in improving various aspects of security, mechanisms need to be developed to avoid that risky choices are taken in the first place.

2 Current European energy security

2.1 Energy sources in the EU

2.1.1 All energy products

2.1.1.1 Gross inland consumption of energy in the EU

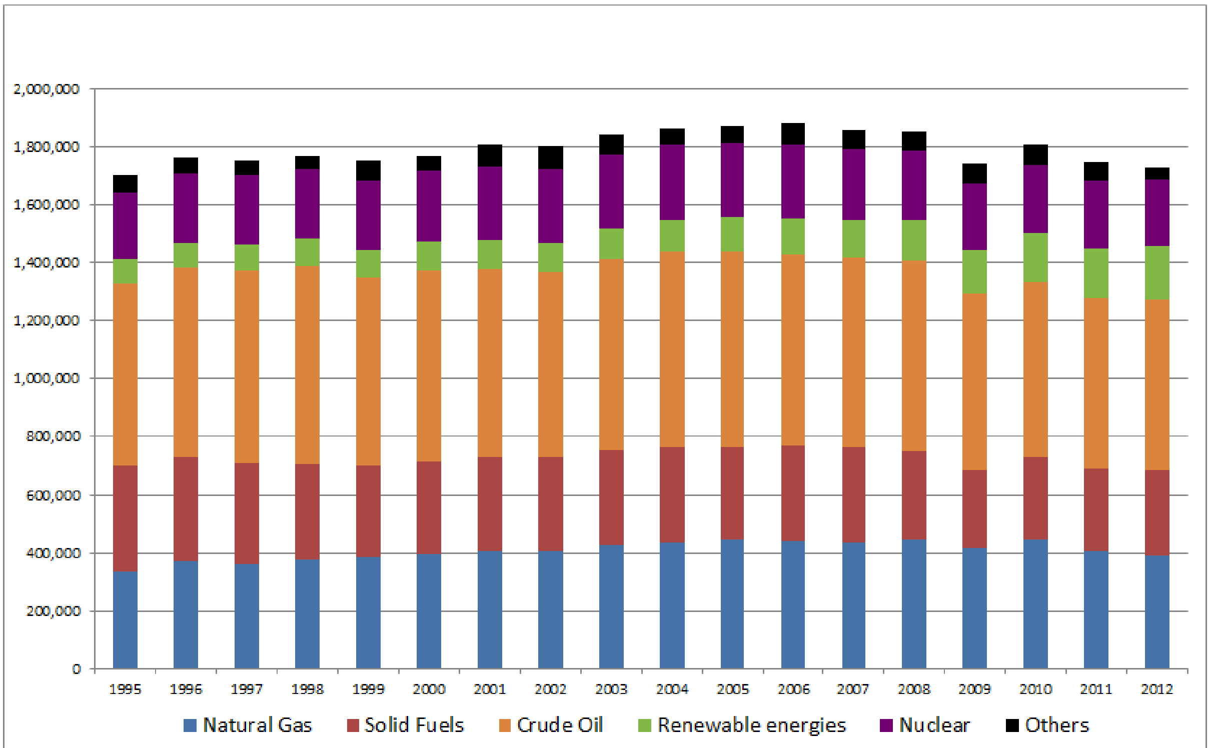
The way energy flows through the system before reaching the final consumer in the form of electricity, heat or transport fuels has profound implications on energy security. Crude oil and petroleum products, along with natural gas, dominate the energy mix on the supply side, while industry and households have largest shares on the demand side (see Figure 2 and Figure 4).

Changes in the energy system in general, and changes related to the energy mix in particular, are slow and underpinned by significant investment capital needs. Total demand for energy in 2012 was roughly at the same level as it was in the mid-90s, but is more than 8% below its peak in 2006 due to a combination of factors, including structural changes in the economy of the EU, the economic crisis and efficiency improvements.

Most Member States have seen their gross consumption peak towards the middle of the first decade of this century – mostly in the period 2005-2008 – and subsequently contract[15].

[15] Some MS that joined the EU in 2004 and 2007 – including BG, RO, PL and LT - witnessed a steep drop in consumption at the end of the 90s with the collapse of inefficient heavy industry

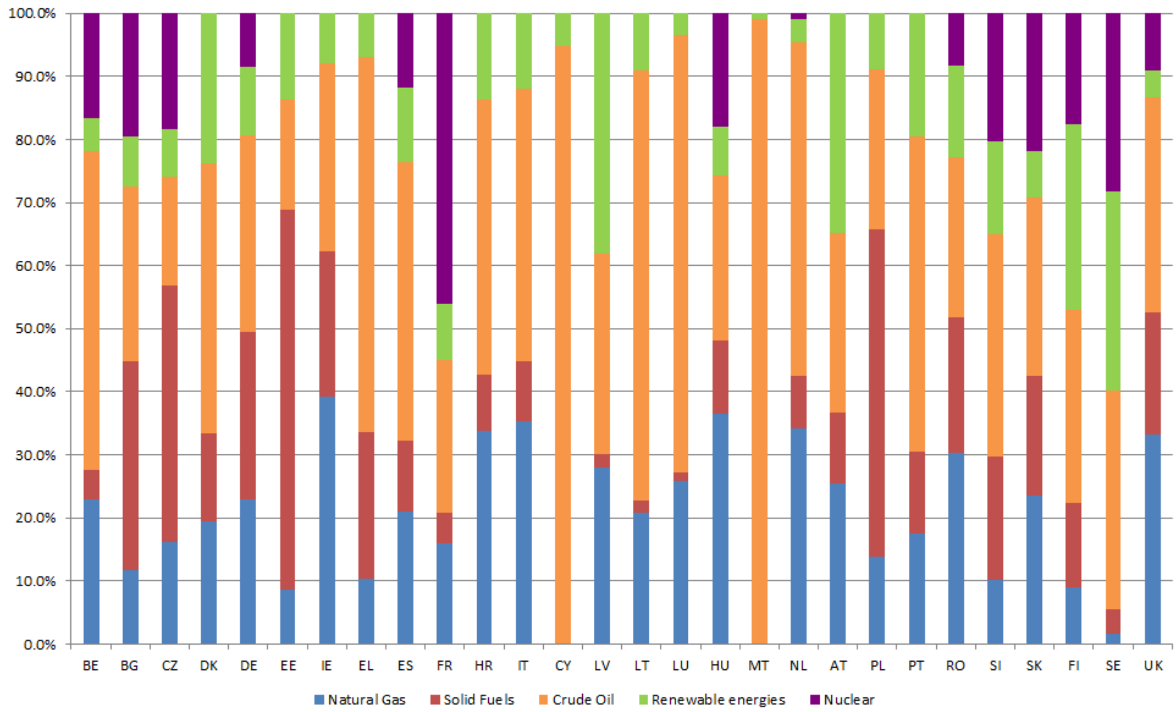
Figure 2. Total energy demand 1995-2012, EU28, ktoe



Source: Eurostat, energy. Calculations of the European Commission.

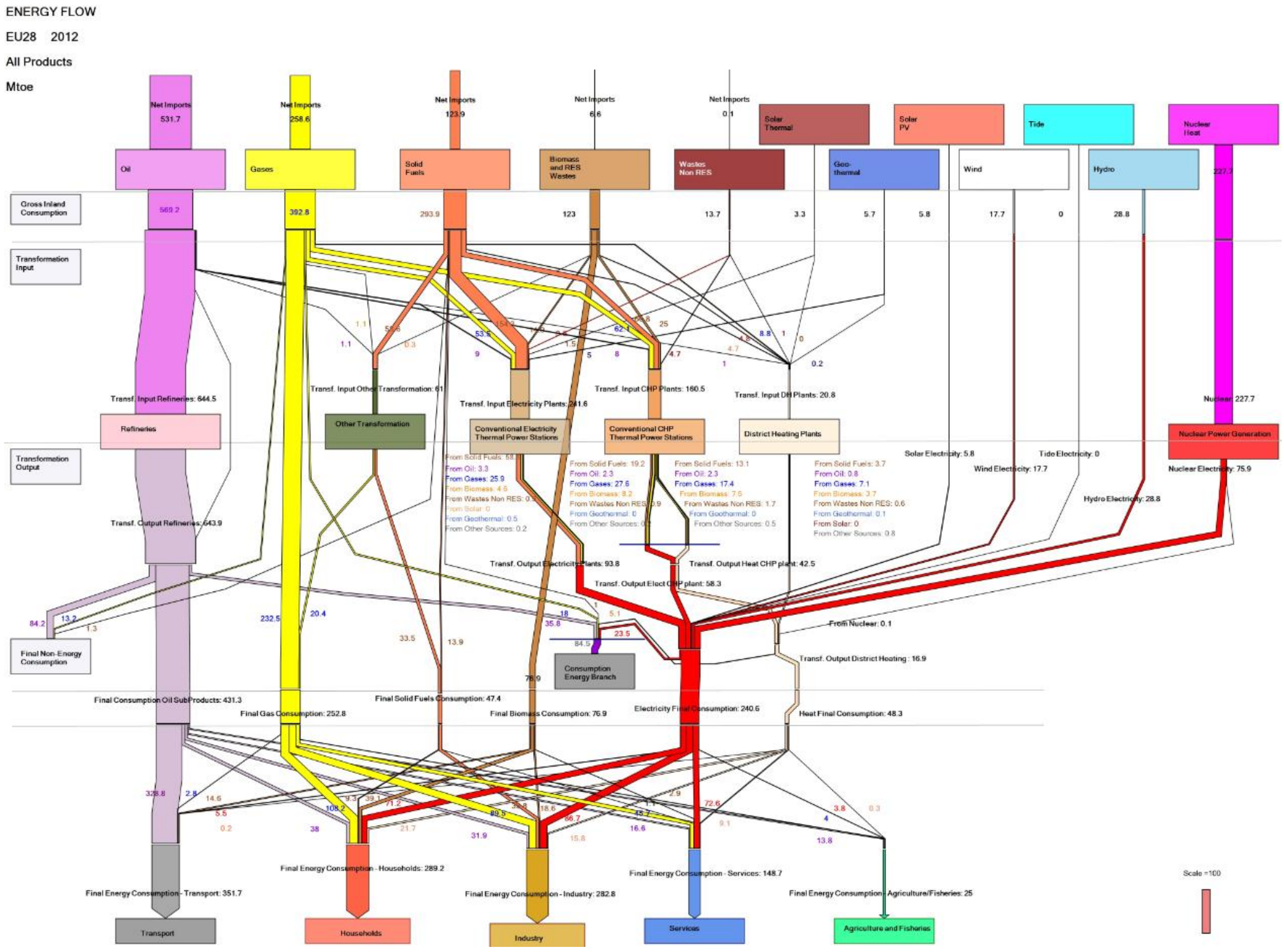
The composition of consumption has shown a slow but persistent change over time with the share of gas going up from around 20% to 23% of gross inland consumption between the mid-1990s and 2012 and the share of renewables more than doubling to almost 11% in 2012. In contrast, the shares of solid fuels declined from around 21% to 17%, oil from 37% to 34%. Nuclear remained relatively stable in relative terms at 13%.

Figure 3 Total energy demand, shares by fuel (%) in each Member State, 2012



Source: Eurostat, energy.Calculations of the European Commission. Note: In the case of Cyprus, Estonia, Latvia, Luxembourg Malta and Slovenia values refer to petroleum products, not crude oil.

Figure 4. Energy flow in the EU, all products, 2012
Source: Eurostat, energy. Calculations of the European Commission



2.1.1.2 EU primary energy production

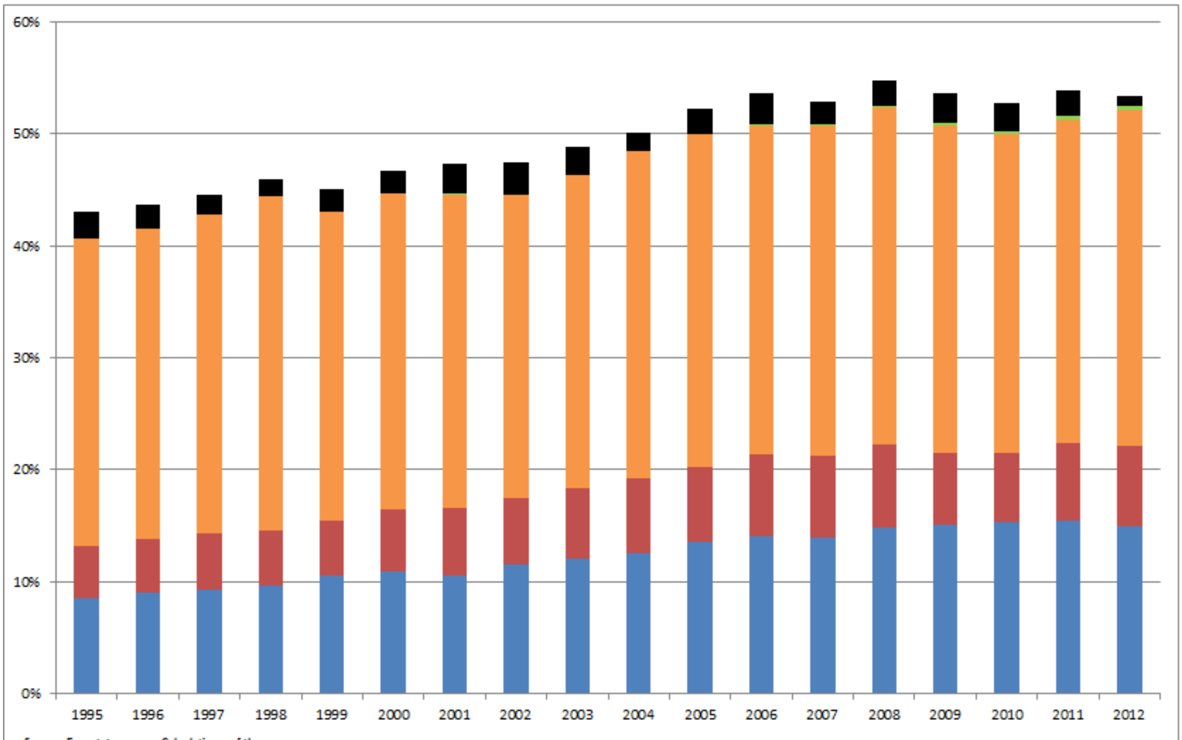
EU primary energy production decreased by almost a fifth between 1995 and 2012. In this period natural gas production dropped by 30%, production of crude oil and petroleum went down by 56% and of solid fuels (including coal) by 40%. On the other hand renewable energy production registered a remarkable growth – 9% only over the period 2010-2012 – and has reached a 22% share of primary energy production.

Netherlands and the UK are the largest producers of natural gas in the EU and in 2012 respectively accounted for 43% and 26% of gas production in the EU; the third and fourth producers - Germany and Romania – have a 7% and 6.5% share of natural gas production in the EU. The UK is the largest producer of crude oil in the EU with a 61% share of EU production in 2012; Denmark is the second largest producer with a 14% share.

2.1.1.3 Imports and energy deficit of the EU

The EU has been importing growing amounts of energy to compensate for declining domestic production and meet demand that until 2006 was steadily growing. Overall EU import dependency has increased, mostly driven by growth in import dependency of natural gas (+6 p.p in the period 1995-2012) and crude oil (+3 p.p. in the same period). Import dependency is a function of net imports and total demand. Therefore a drop in production would result in an increase in imports if demand is stable, growing or decreasing by less than the drop in production. If the drop in production is faster and/or larger than the decrease in demand, this would result in increasing import dependency against falling demand.

Figure 5. Share of net imports in total demand by energy product, EU28, in %[16]

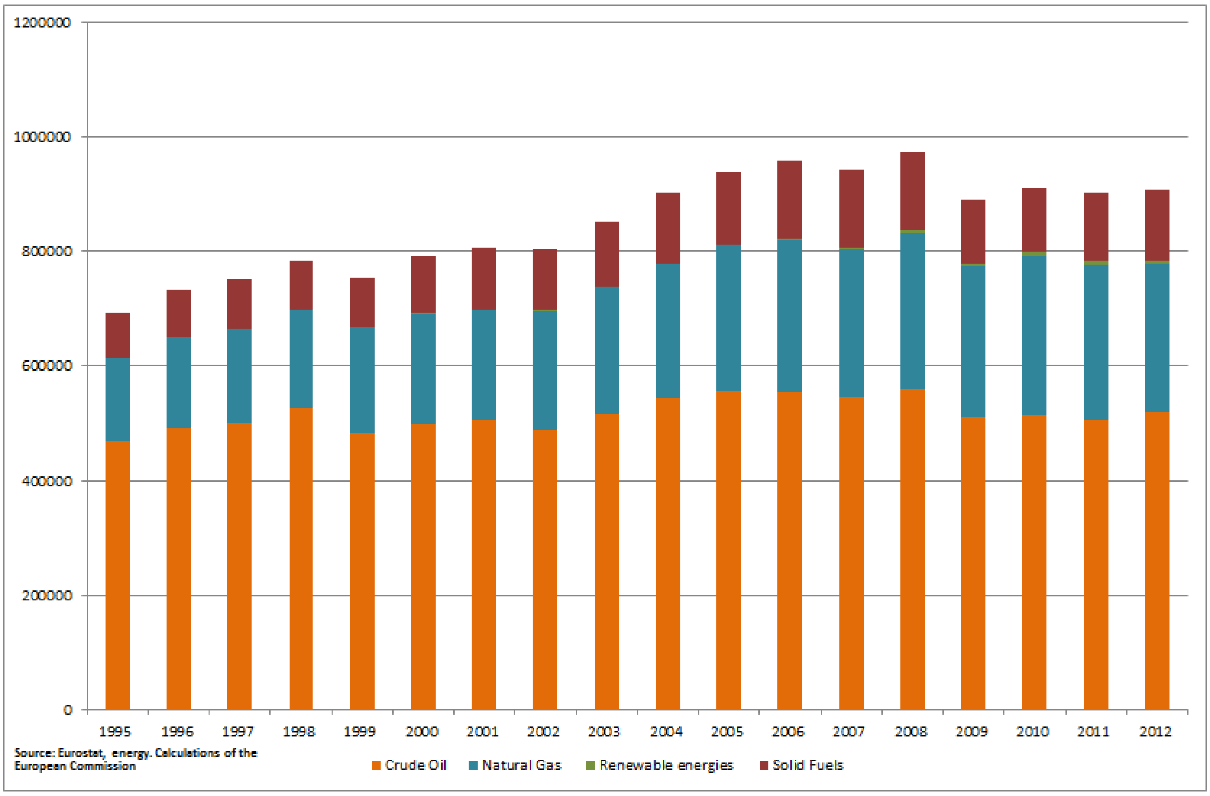


Source: Eurostat, energy. Calculations of the Europeam Commission

[16] The graph shows the contribution of different energy sources to total energy import dependency, which for all energy sources adds up to 53% in 2012. The sum of the relative shares of the net imports in total demand represents the import dependency for all energy products. Net imports of crude oil (the import dependency of which is 88%) represent 30% of total energy demand; net imports of natural gas (the import dependency of

While import dependency points to the relative share of imports in demand (in %), the net imports – showing the total energy deficit - denotes the absolute volumes of energy that the European economy needs to import (in energy terms, e.g. ktoe), that is the difference between total demand and total production. Since the peak in 2006-2008, the net imports have decreased – largely driven by fall and shift of consumption; still net imports in 2012 were at 25% above its 1995 levels.

Figure 6. EU net imports by fuel, ktoe, 1995-2012



2.1.1.4 Great differences among Member States

The aggregated EU-level numbers hide a great deal of differences between Member States. In Member States with indigenous energy production, the share of production to total demand has decreased – in the case of the UK by half from its peak, in the case of Denmark and Poland by 30-40% and in the case of the NL by more than 15%. EE is the only Member State that has seen a stable and significant increase in the share of domestic production in total energy demand against a stable growth in demand[17].

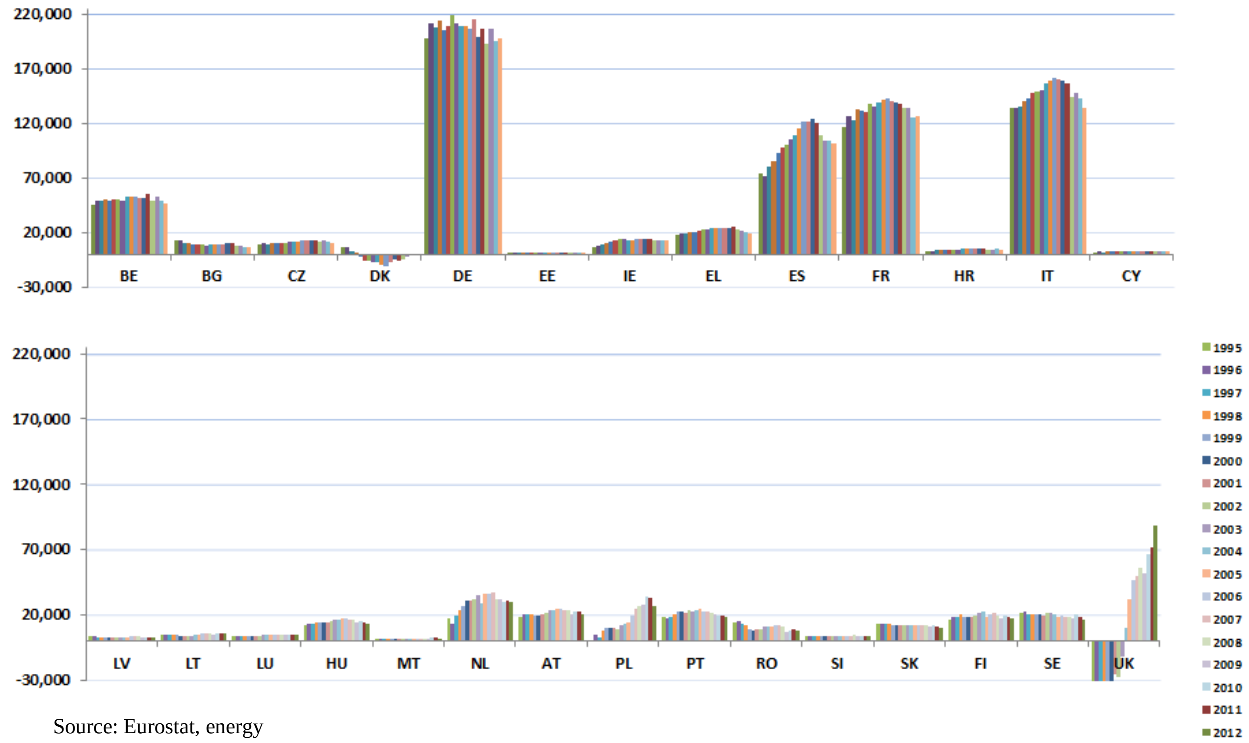
As a result, the net imports of most Member States have increased. Nowhere is this more visible than in the UK, which had an energy surplus until 2003 and a steeply growing deficit ever since. France, Spain and Italy have all seen energy deficits peak in 2005 and go down ever since, likely driven by a combination of weak demand and increased renewables share. The deficit of the largest energy

which is 66%) account for 15% of total energy demand; net imports of solid fuels (with an import dependency of 42%) constitute 7% of total demand and so on.
N.B. Uranium imports are not accounted in this context; Eurostat energy treats nuclear electricity as a domestic resource.

[17] Bulgaria has also seen a significant increase, but mostly due to drop in demand rather than increase in production.

consumers in the EU – Germany – has unsurprisingly been the largest in energy terms and since its peak in 2001 has shown fluctuations in both directions, without a stable trend.

Figure 7. Net imports of all energy products, by Member State, 1995-2012, ktoe

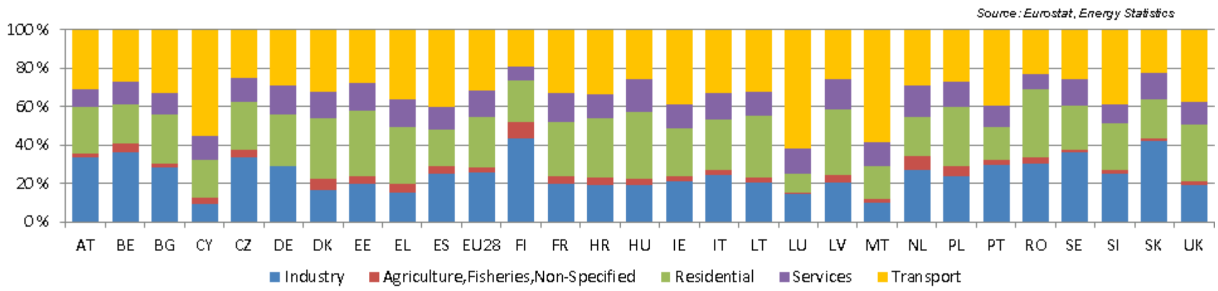


Source: Eurostat, energy

2.1.1.5 Energy consumption and the role of energy efficiency

At the level of the EU, transport is the largest energy consumers and accounts for almost a third of final energy consumption. Industry and the residential sector account for about a quarter each. In 7 Member States industry accounts for a third or more of final energy consumption; the share of the residential sector varies between 17% of total final energy consumption in Portugal and Malta and 36% in Romania[18].

Figure 8. Final energy consumption by end-use sector, all energy products, 2012

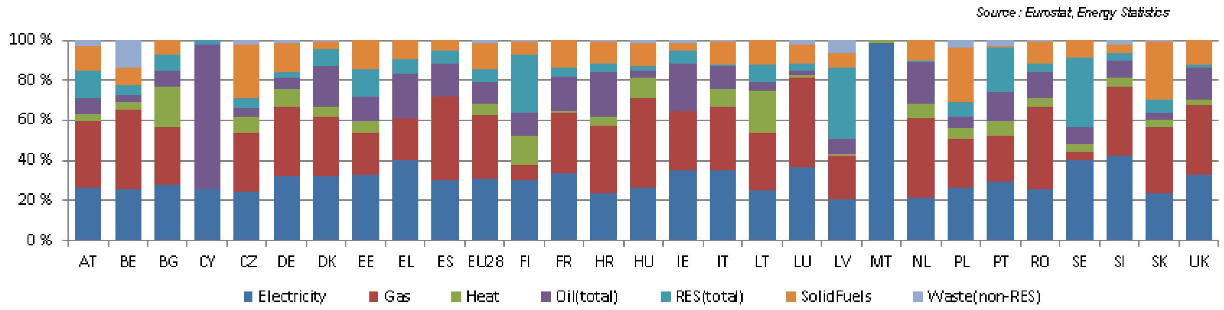


Looking at sectoral level, electricity and gas each account for around 30% of final energy consumption of the industrial sector in the large majority of Member States, followed by oil (mostly below 20% of final energy consumption of industry, apart from Cyprus, Denmark, Greece, Croatia, Ireland and the

[18] The share of the residential sector in Luxembourg is only 10%, but this number is likely influenced by the very high share of the transport sector due to transit and 'fuel tourism' from neighbouring countries.

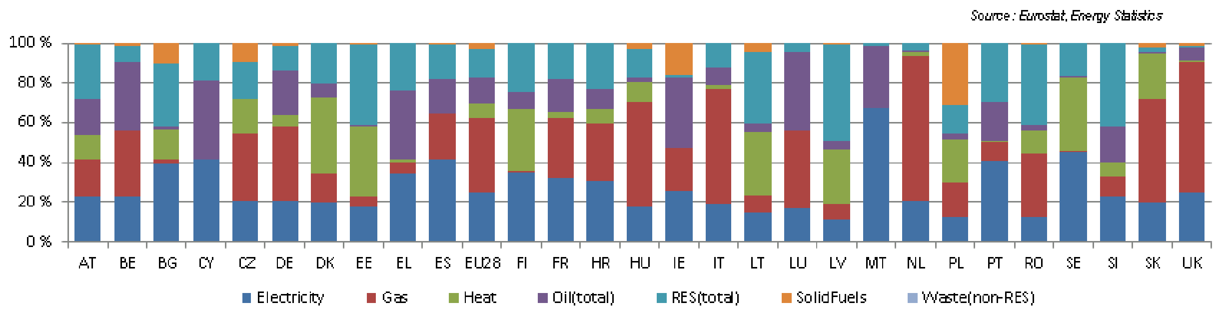
Netherlands) and solid fuels (mostly below 15% except for the Czech republic, Estonia, Poland and Slovakia).Gas accounts for 40% or more of final energy consumption of industry in Belgium, Spain, Hungary, Luxembourg and Romania.

Figure 9. Final energy consumption in the industrial sector, relative shares of energy products, 2012



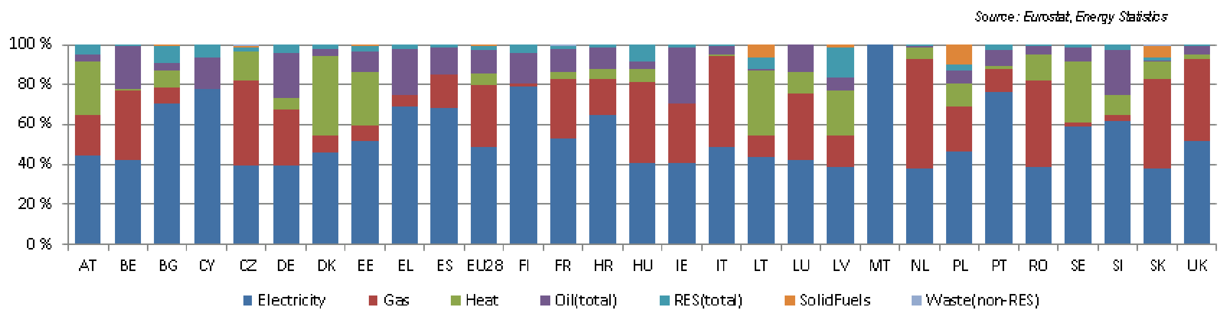
In the residential sector electricity accounts for about a quarter of final energy consumption and gas for almost 40%. In Germany, Hungary, Italy, Luxembourg, the Netherlands, Slovakia and the UK more than 40% of residential energy consumption depends on gas. Heat has an important share (above 15%) in the final energy consumption of the residential sector of most Member States that joined the EU in 2004 and 2007, and in Scandinavian countries (Bulgaria, the Czech republic, Denmark, Estonia, Finland, Lithuania, Latvia, Poland, Sweden, Slovakia).

Figure 10. Final energy consumption in the residential sector, relative share of energy products, 2012



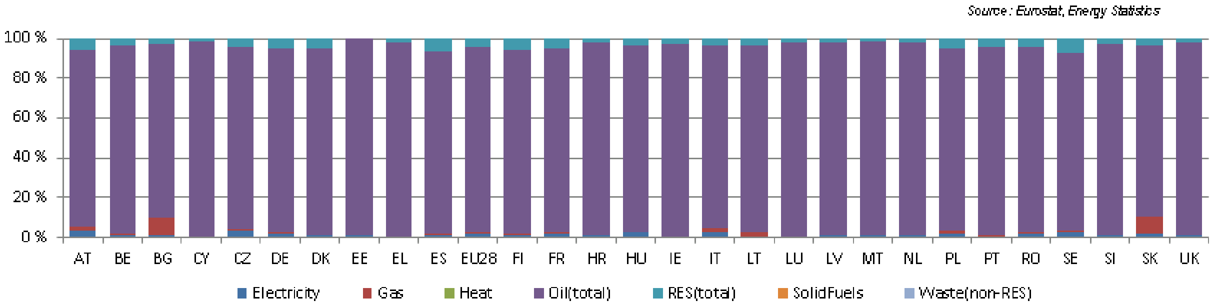
In the services sector electricity accounts for 40% or more in almost all Member States. Gas has a relatively high share in the service sector of the Czech republic, Hungary, Italy, Luxembourg, the Netherlands, Romania, Slovakia and the UK.

Figure 11. Final energy consumption in the service sector, relative share of energy products, 2012



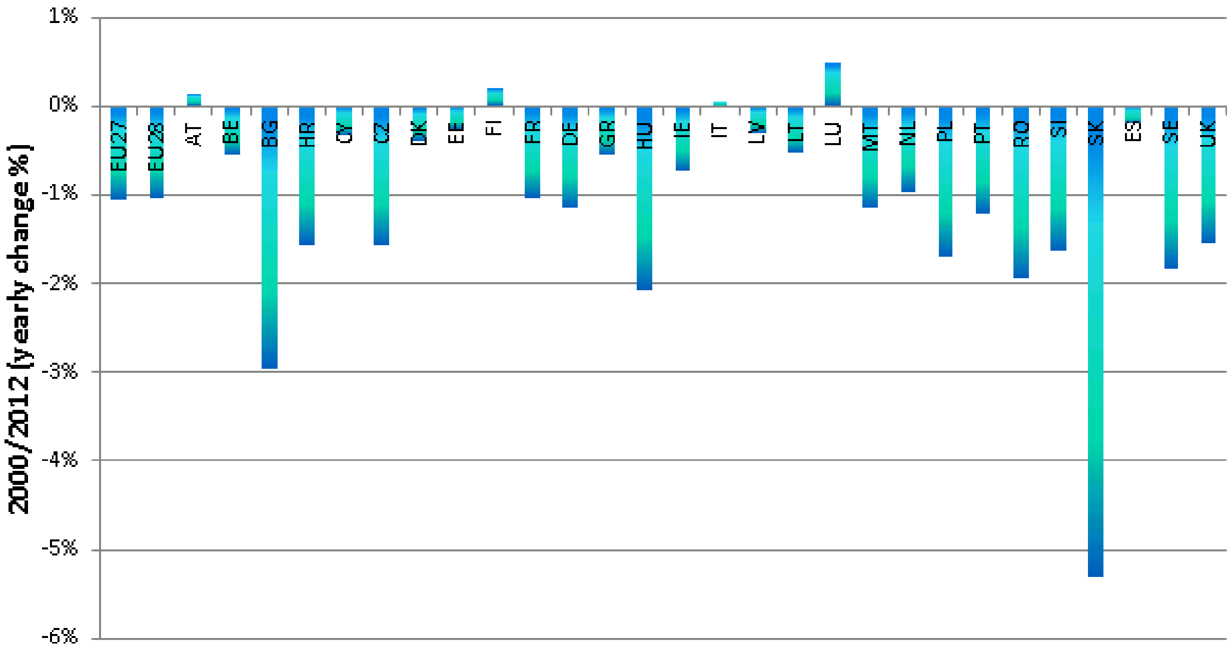
Finally, transport is almost entirely reliant on oil. Gas accounts for about 9% of final energy consumption of transport in Bulgaria and Slovakia. The share of renewable energy sources in the transport sector is to rise to a minimum 10% in every Member State by 2020 (Directive 2009/28/EC).

Figure 12. Final energy consumption in transport, relative share of energy products, 2012



Energy efficiency measures have the potential to reduce energy consumption and imports. Energy efficiency gains can be evaluated after removing the impact of factors such as climate conditions, activity levels, social changes, etc. from the evolution of energy consumption. In the period 2000-2012 energy efficiency has contributed to a reduction of energy consumption in almost all Member States. In this period energy efficiency has contributed to a 1% annual reduction in energy consumption in the EU. For countries like Slovakia and Bulgaria the efficiency driven decrease in consumption was around 5% and 3% per year, respectively. Other Member States highly exposed to a disruption of Russian gas supply have also achieved important savings through energy efficiency, in particular Hungary (-2%/y), Poland (-1.7%/y) or the Czech Republic (-1.6%/y).

Figure 13. The role of energy efficiency in reducing final energy consumption (2000-2012)



Source: Fraunhofer Institute. Study evaluating the current energy efficiency policy framework in the EU and providing orientation on policy options for realising the cost-effective energy-efficiency/saving potential until 2020 and beyond. Work in progress.

Summary all energy products

Changes in the energy system are slow and underpinned by significant investment capital needs. Total demand for energy in 2012 was roughly at the same level as it was in the mid-90s, but is more than 8% below its peak in 2006. Structural changes in the economy of the EU, the economic crisis and efficiency improvements all played a role in this decline.

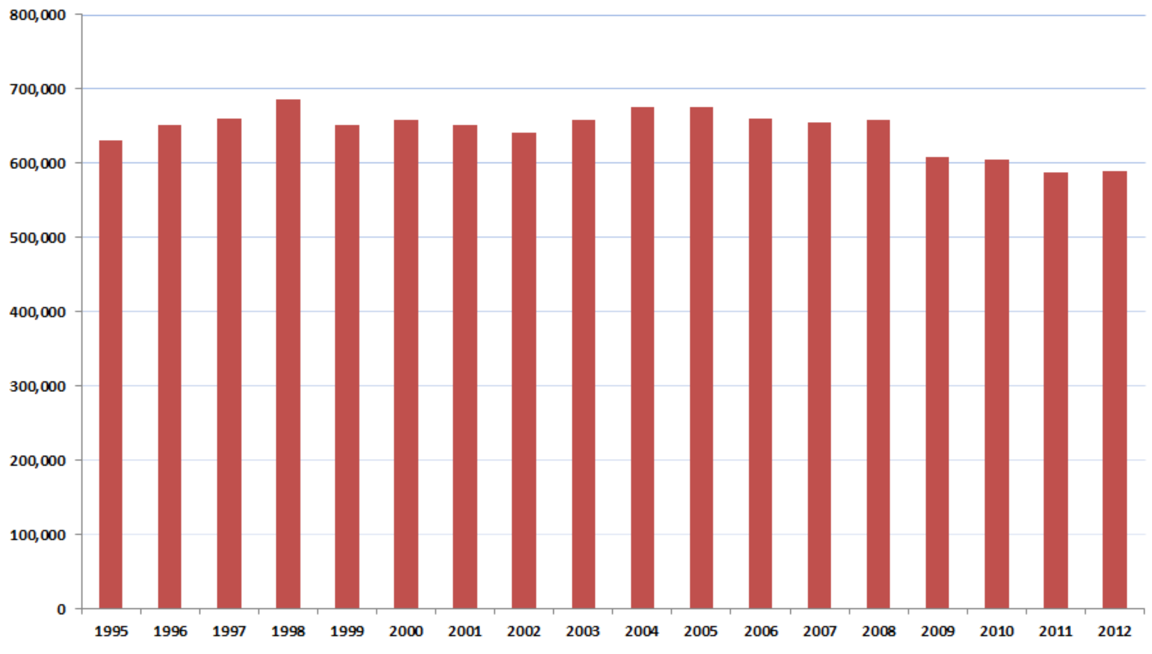
Against falling domestic production, overall energy dependency in the EU has been increasing since the mid-90s, mostly driven by growing import dependency in natural gas and crude oil (together +9 p.p. in the period 1995-2012). The aggregated EU-level numbers hide a great deal of differences among Member States and across fuels. This is why it is important to examine recent trends fuel by fuel.

2.1.2 Oil

2.1.2.1 Consumption, production and imports

Oil continues to be the main fuel in the EU energy mix, representing about 34% of gross inland consumption. Transport is by far the biggest user of oil in the EU, followed by the petrochemical industry; it has been largely phased out from power generation and its role is decreasing in heating. Oil has a dominant role in Cyprus and Malta where, in addition to fuelling transport, it remains the main fuel for power generation. In 2012, the EU was the second largest consumer in the world after the US, representing about 15% of global consumption.[19]

Figure 14. Gross inland consumption of crude oil in the EU, 1995-2012, ktoe



Source: Eurostat, energy

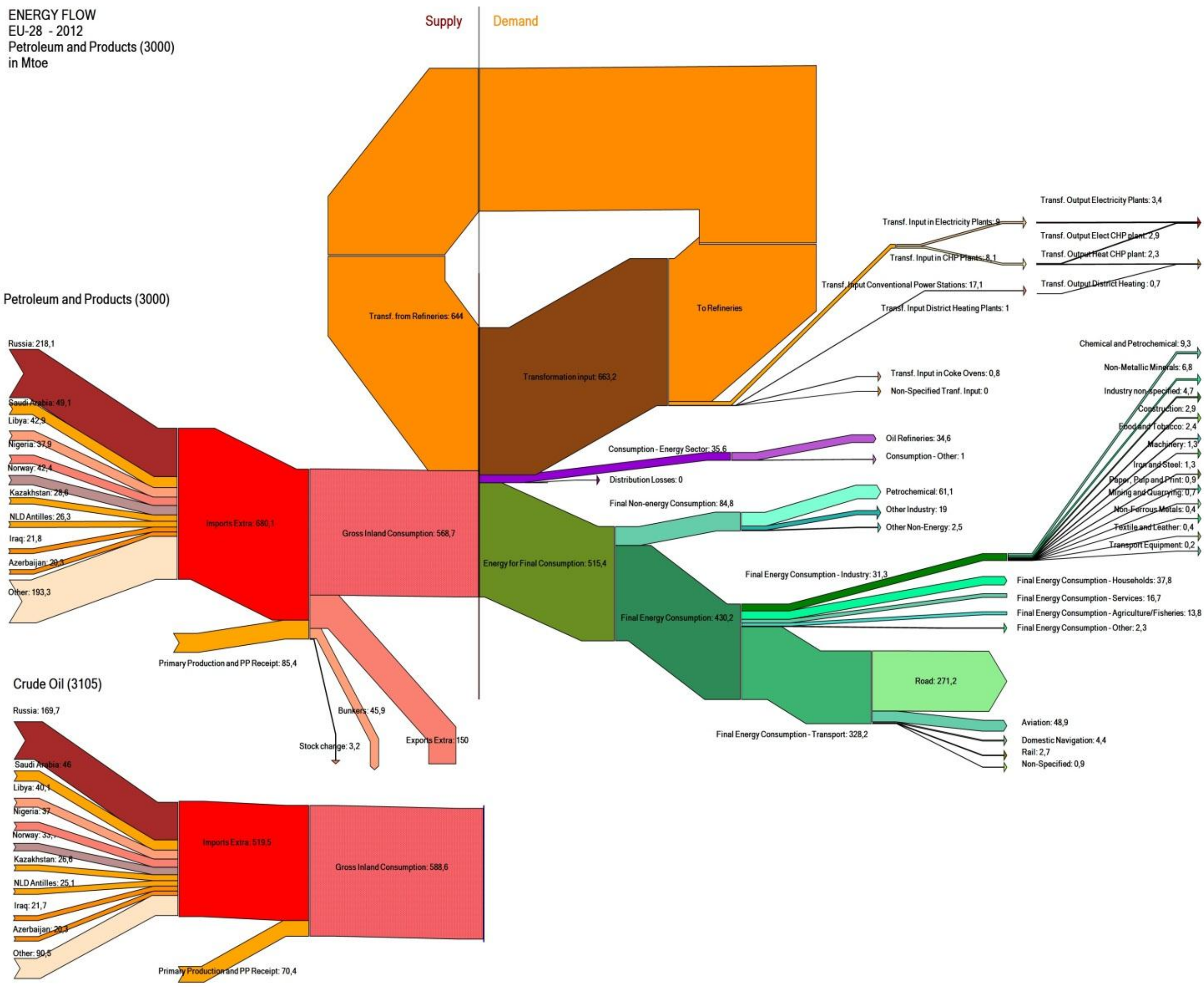
EU crude oil consumption has been fluctuating in the study period but since 2005 it has shown a marked decreasing tendency which accelerated after the economic crisis of 2008. Consumption decreased by 12.9% since 2005 (average -2.0%/year) and by 10.5% since 2008 (average -2.7%/year).

[19] BP Statistical Review of World Energy 2013

In addition to the impact of the crisis, the decline is at least partly driven by structural factors (e.g. by the improving fuel economy of vehicles) which is helped by relevant EU policies (see chapter 4.2.1.2). Compared to 1995, the decrease of gross inland consumption is only 6.6%.

As practically all crude oil is processed in refineries, the gross inland consumption of crude oil basically shows the quantity of crude oil refined in EU refineries and is not necessarily reflecting the final consumption of oil products (part of the refinery output is exported while part of the consumed products are imported). Therefore, crude oil consumption of Member States without refineries is zero.

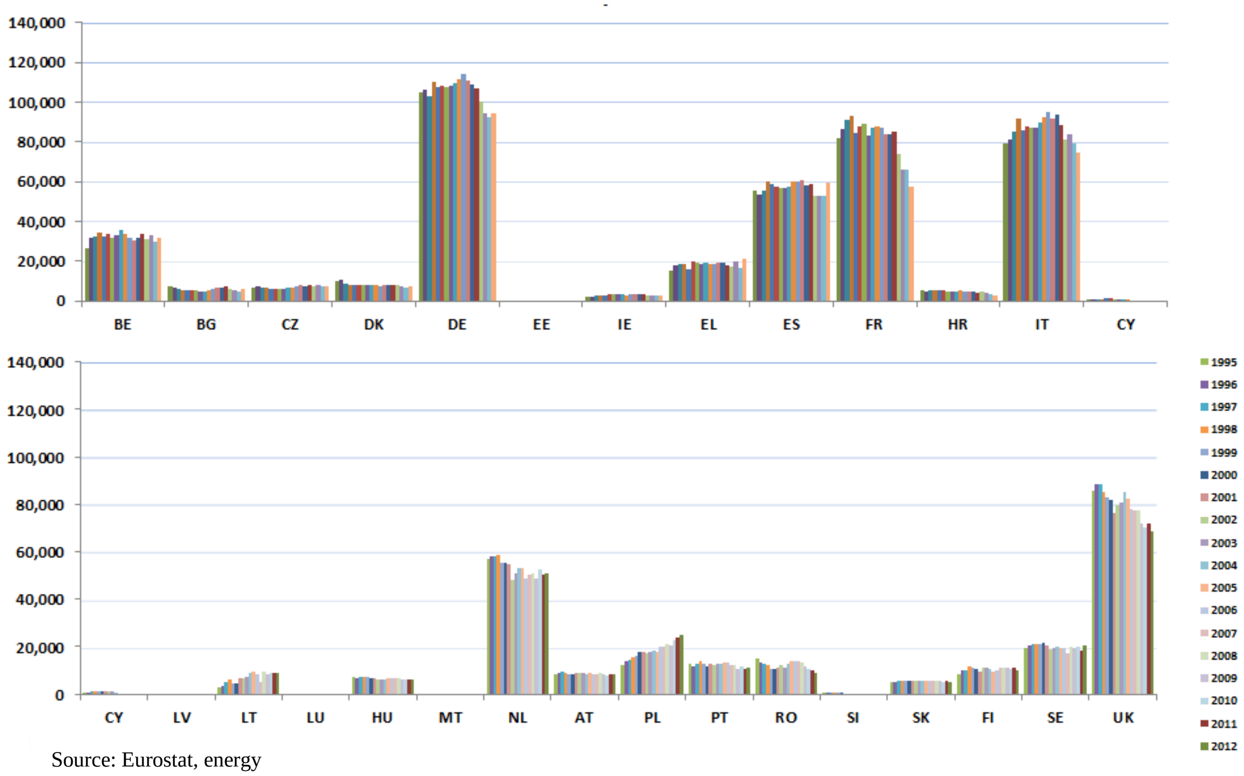
Figure 15. Energy flow of petroleum and products in the EU, 2012



Source: Eurostat, energy. Calculations of the European Commission

A decline in crude oil consumption has been observed across most of Europe after 2005. Only four Member States (Finland, Greece, Poland and Sweden) have seen an increase of crude oil consumption in the period 2005-2012 but Poland is the only country with a consistent and significant rise. The decline was particularly steep in Croatia, France and Romania where crude oil consumption decreased by more than 30% between 2005 and 2012. In France, several refineries have been closed in the last few years. Germany, Italy, Portugal and the UK have also seen above-average declines in oil consumption, at least partly driven by refinery closures.

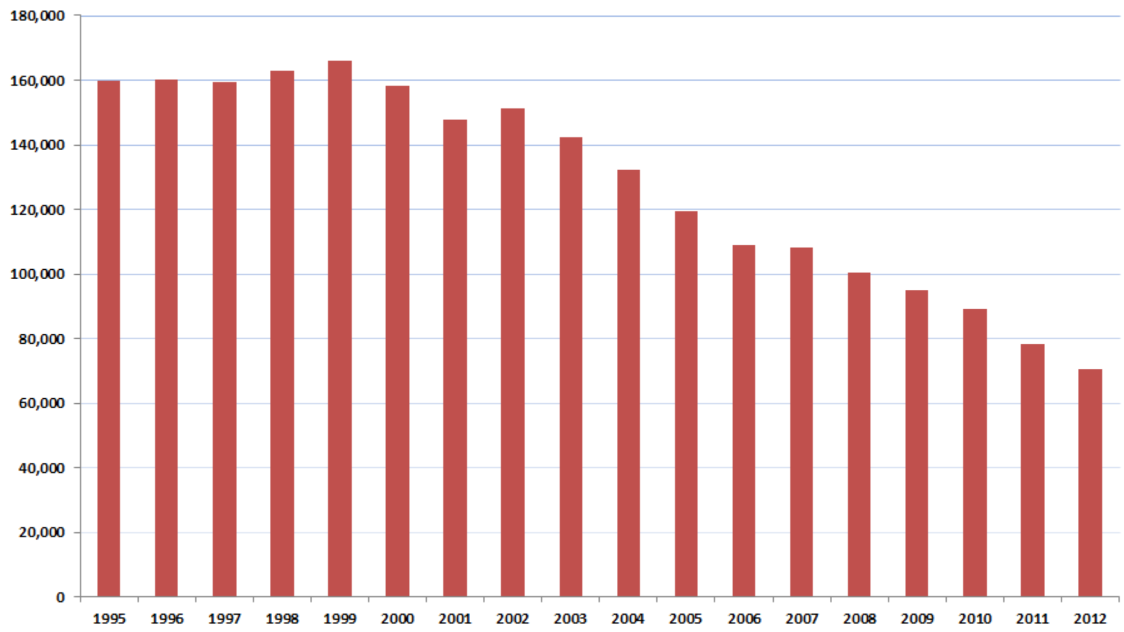
Figure 16. Gross inland consumption of crude oil by Member State, 1995-2012, ktoe



Source: Eurostat, energy

Between 1995 and 2012, indigenous crude oil production decreased from 160 million tons to 71 Mtoe, reflecting the fact that the North Sea, the main producing region, is a mature area. Since its peak in 1999, production decreased by around 56% (average -6.4%/y). The UK remains by far the largest producer, although its share from the EU-28 has decreased from 78% in the second part of the 1990s to 61% in 2012.

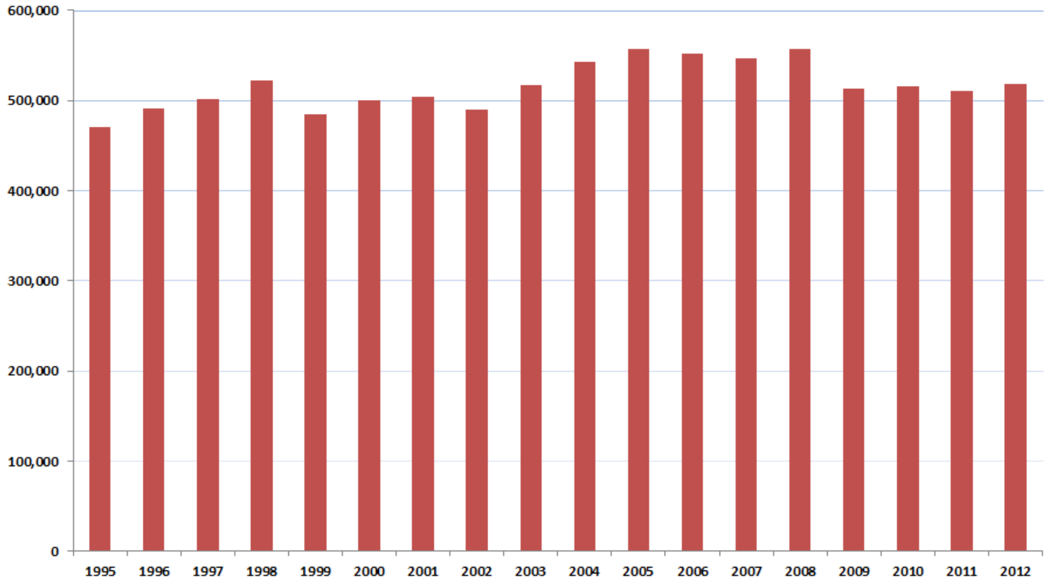
Figure 17. Indigenous production of crude oil in the EU, 1995-2012, ktoe



Source: Eurostat, energy

While net imports of crude oil (including both external and internal) have fallen after 2008, in 2012 they were still 11% higher than in 1995. Over the last few years the decrease of consumption and the decrease of production have more or less offset each other and net imports have stabilized at around 510 million tons.

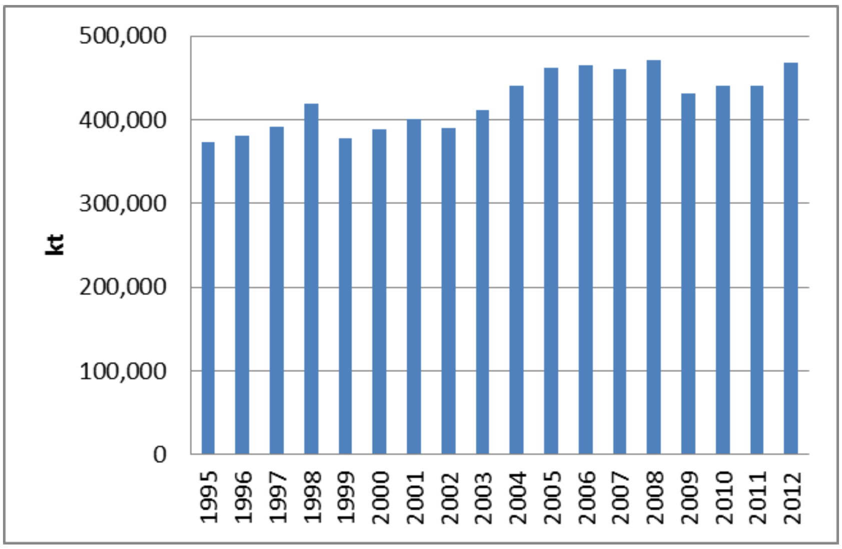
Figure 18. Net imports of crude oil in the EU, 1995-2012, ktoe



Source: Eurostat, energy

If only extra-EEA trade is considered, net imports increased even faster: in 2012 they were 25% higher than in 1995 because of the decline in imports from Norway. While Norwegian supplies exceeded 100 million tons in the period 1995-2004, they fell below 70 million tons in 2011. Over the last few years net extra-EEA imports have averaged at around 440 million tons.

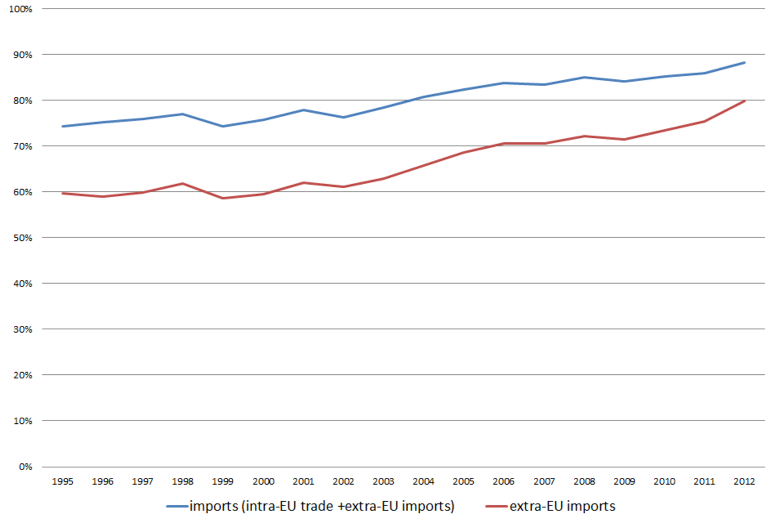
Figure 19. Net imports of crude oil in the EU (extra-EEA), kt



Source: Eurostat, energy

Import dependence of crude oil, expressed as a percentage of consumption, continued to increase and in 2012 reached 88% which is the highest level among fossil fuels. Extra-EEA import dependence (i.e. when Norwegian supplies are not counted as imports) is slightly lower, in 2012 it was 80%. Chapter 4.9 offers another metric of diversification – referred to as supplier concentration index – which takes into account both the diversity of suppliers and the exposure of a country to external suppliers looking at net imports by fuel partner in the context of gross inland consumption of each fuel.

Figure 20. Import dependency of crude oil, 1995-2012



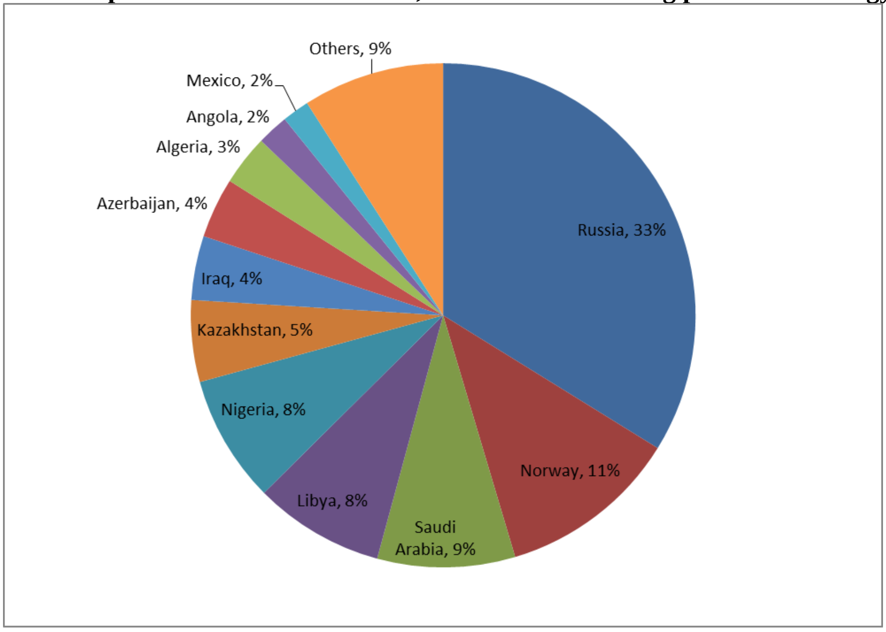
Source: Eurostat, energy. Calculations of the European Commission

The UK, the largest oil producer in the EU, became a net importer in 2005, leaving Denmark as the only net exporter. However, Danish oil production is also falling (by almost 50% since its peak in 2004) and in some years Denmark is likely to become a net importer. Germany, Italy, Spain, France and the Netherlands remain the largest net importers of crude oil although – with the exception of Spain – the absolute value of net imports decreased in these countries between 1995 and 2012.

In 2012, a third of extra-EU imports of crude oil and NGL came from Russia, followed by Norway (11%) and Saudi Arabia (9%). In terms of monetary value, the total value of extra-EU imports of crude oil and NGLs[20] was 302.3 billion Euro. Russian accounted for the largest share of imports in monetary terms (33%), followed by Norway (11%), Nigeria (9%) and Saudi Arabia (8%).

[20] Product codes 27090090 (petroleum oils and oils obtained from bituminous minerals, crude) and 27090010 (petroleum oils from natural gas and condensates)

Figure 21. Extra-EU imports of crude oil and NGL, share of main trading partners in energy terms, 2012



Source: Eurostat, energy

Table 1. Extra-EU imports of petroleum oil, crude and NGL, share of main trading partners in monetary value and energy terms, 2013

Partner	VALUE (Share %)	NET MASS (Share %)
Russia	33%	34%
Norway	11%	11%
Nigeria	9%	8%
Saudi Arabia	8%	8%
Kazakhstan	7%	6%
Libya	6%	6%
Algeria	5%	5%
Azerbaijan	5%	4%
Iraq	3%	4%
Angola	3%	3%
Mexico	2%	2%
Equatorial Guinea	1%	1%
Egypt	1%	1%
Kuwait	1%	1%

Source: Eurostat, Comext database

2.1.2.2 Infrastructure and supply routes

Nearly 90% of crude oil imported to the EU arrives by sea, giving considerable flexibility with respect to supply sources and routes. While transport costs can be volatile, they represent a low share of the value of crude oil, facilitating imports from distant regions like the Middle East or Latin America.

Most refineries are located on the coast and therefore have direct access to oil coming from producing countries of the world. Inland refineries on the other hand are typically supplied by the pipelines coming from the major ports, the most important of which are the Rotterdam-Rhein Pipeline (RRP) from Rotterdam, the South European Pipeline (SPSE) from Marseille and the Transalpine Pipeline (TAL) from Trieste.

Refineries in Central Eastern Europe (Poland, the Eastern part of Germany, Slovakia, the Czech Republic and Hungary) constitute a notable exception as they are typically supplied by the Druzhba pipeline with oil coming directly from Russia (with the Czech refiners partly supplied through the TAL and IKL pipelines). This pipeline delivers about 50 million tons of oil a year, approximately 30% of total Russian imports to the EU. Main oil ports in the EU according to inwards tonnages of crude oil in 2012 are indicated in the map below.

Considering the decreasing oil consumption in Europe, the majority of existing infrastructure (ports and pipelines) are unlikely to constitute a serious bottleneck. However, in 2012 the TAL pipeline became saturated as the Karlsruhe refinery redirected all imports to this route (previously, about half of its crude oil arrived through the SPSE pipeline) while Czech refineries tried to compensate the falling Druzhba volumes by increased imports on the TAL pipeline.

Figure 22. Main oil ports in the EU

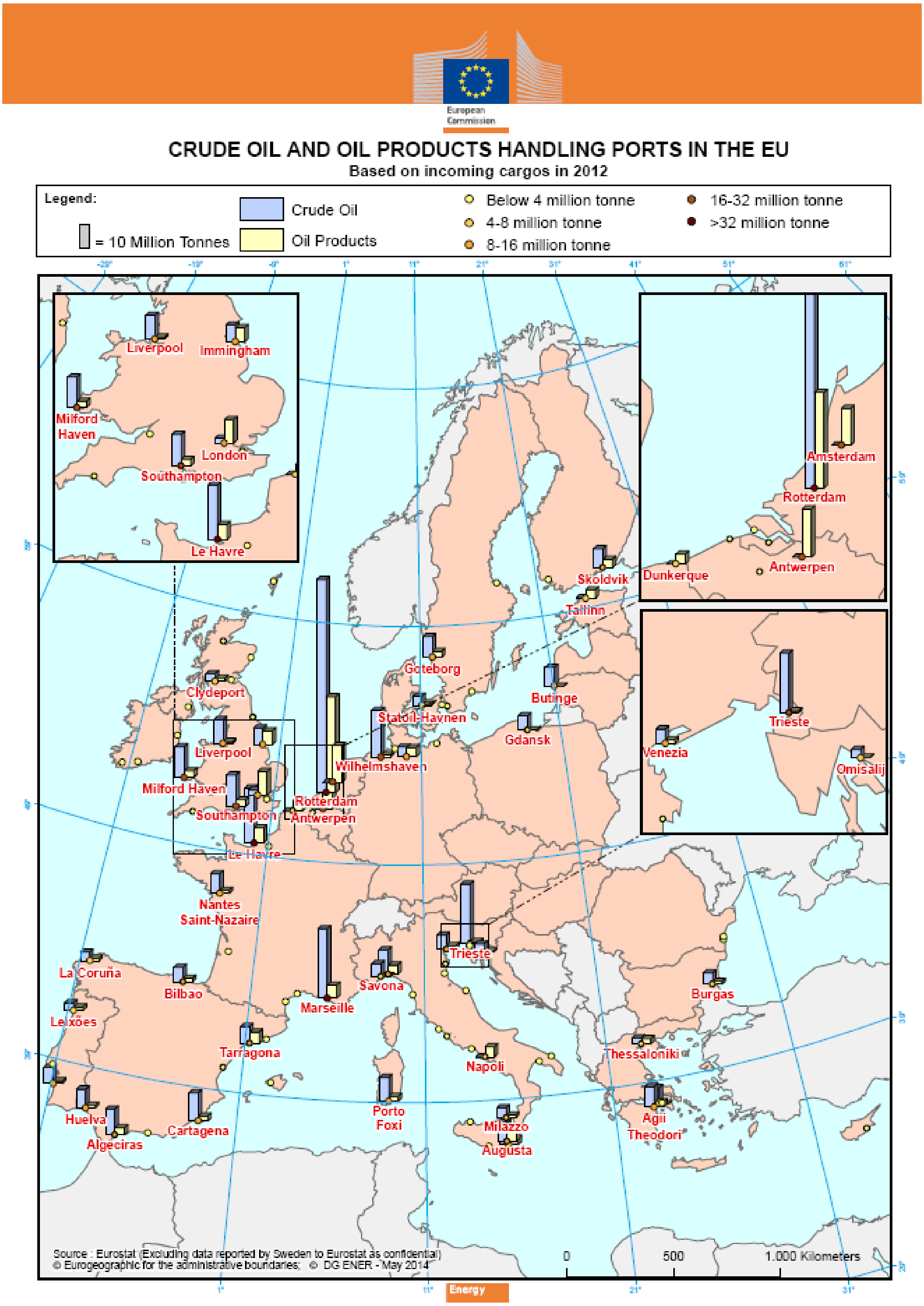


Figure 23. Refineries and oil pipelines in Europe
Source: Europia

Summary oil

While the consumption of oil has been decreasing since 2005 (by 13% in the period 2005-2012), it continues to be the main primary energy source used in the EU, representing 34% of the energy mix. Oil is mainly fuelling transport (64% of final consumption of oil and oil products) where it has limited viable alternatives.

Of all energy sources, oil has the highest import dependency, 88% (80% if only imports from outside the European Economic Area are taken into consideration), contributing to a significant import bill (EUR 302 billion in 2012) and making the EU exposed to the global oil market where the EU is a price taker.

Oil is traded in a liquid global market, which is however characterized by a concentration of suppliers, hindering diversification efforts. As many suppliers are exposed to geopolitical risks, the market is prone to supply disruptions and volatility of prices but market forces generally ensure the continuity of supplies to consumers.

Oil is imported to the EU mostly by sea (nearly 90% of total imports), at relatively low transportation cost. Therefore, from a logistic point of view, it is relatively easy to switch from one supplier to another. On the other hand, refiners are often configured to process a particular type of oil so the quality of crude oil can be a constraint.

Refineries supplied by the Druzhba pipeline are in turn highly vulnerable to a risk of disruption of this route. The concerned Member States require improved alternative supply routes in order to ensure effective diversification of supplies; there are a couple of "projects of common interest" which would bring an improvement in this respect.

Overall, there is ample EU refining capacity (about 15 million barrels/day) to cover the demand for oil products. However – when individual products are considered – there is a mismatch of supply and demand, making the EU reliant on international product trade: it is a net exporter of gasoline (49 million tons in 2012) and a net importer of middle distillates (31 million tons).

The decline of consumption in recent years has led to an overcapacity of refining which is exacerbated by the increasing competition from other regions. The ensuing rationalisation of the sector (1.7 million barrels/day capacity closed since 2008) means that in the future the EU is likely to become more dependent on product imports.

Having equipped with emergency oil stocks equivalent to about 100 days of net imports, the EU is well prepared to cope with temporary disruptions. In addition to the release of stocks, other measures including demand restraint can contribute to addressing a lasting disruption.

In the longer run, transport's dependence on oil has to be addressed in order to decrease the EU's exposure to imports. Whilst efficiency levels have improved significantly in the last decade, generating a significant reduction in energy intensity, substitutes and alternative supplies (e.g. biofuels, electricity) continue to be elusive.

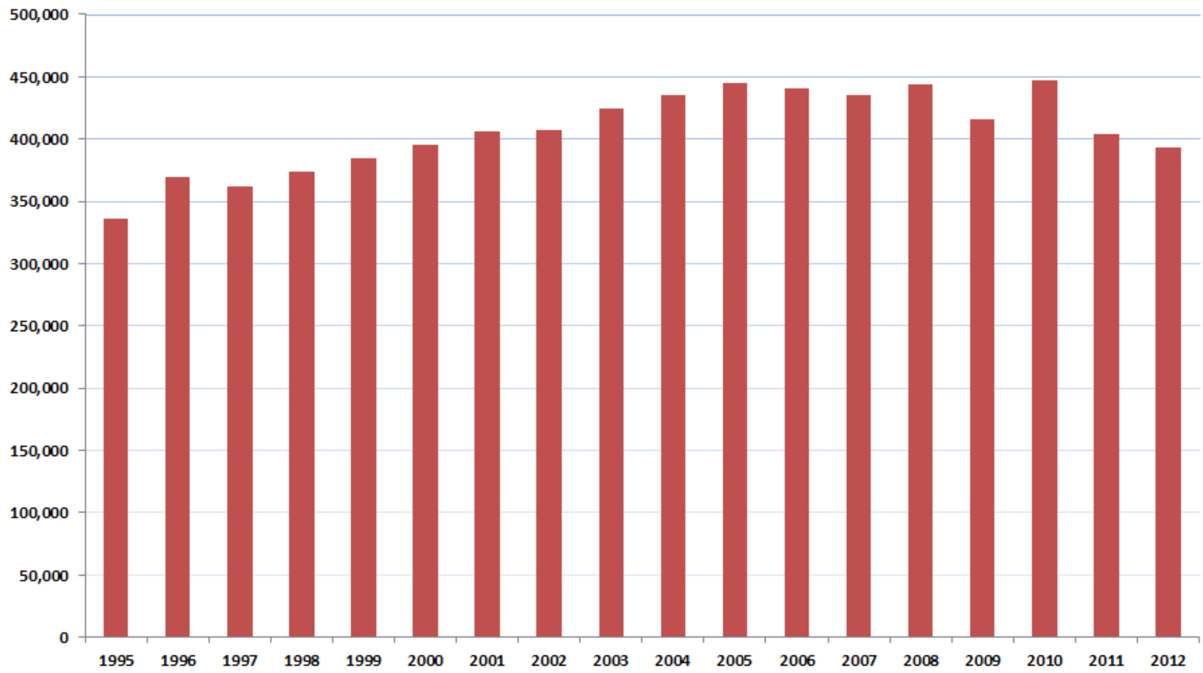
2.1.3 Natural gas

Given its limited and decreasing reserves of natural gas, the EU is a net importer of gas. The increasing dependency on gas imports has posed challenges and increased the risks to security of supply. A reliable, transparent and interconnected market has the potential to mitigate some of these risks. Gas is transported by pipelines to the final consumer, making the operation of pipelines and the availability of capacity crucial factors. Finally, in case of the crisis supply of gas requires mechanisms in order to mobilise reserves on time and replace them with supply or demand measures to cover missing amounts of gas.

2.1.3.1 Consumption, production and imports

The pre-crisis gas demand in the EU was close to 450 Mtoe. The gas consumption in 2012 dropped below 400 Mtoe – its lowest levels since the turn of the century. The economic crisis, subdued demand for electricity and changes in electricity production sector with growing role of solid fuels (mainly coal) and renewables are all factors behind this drop.

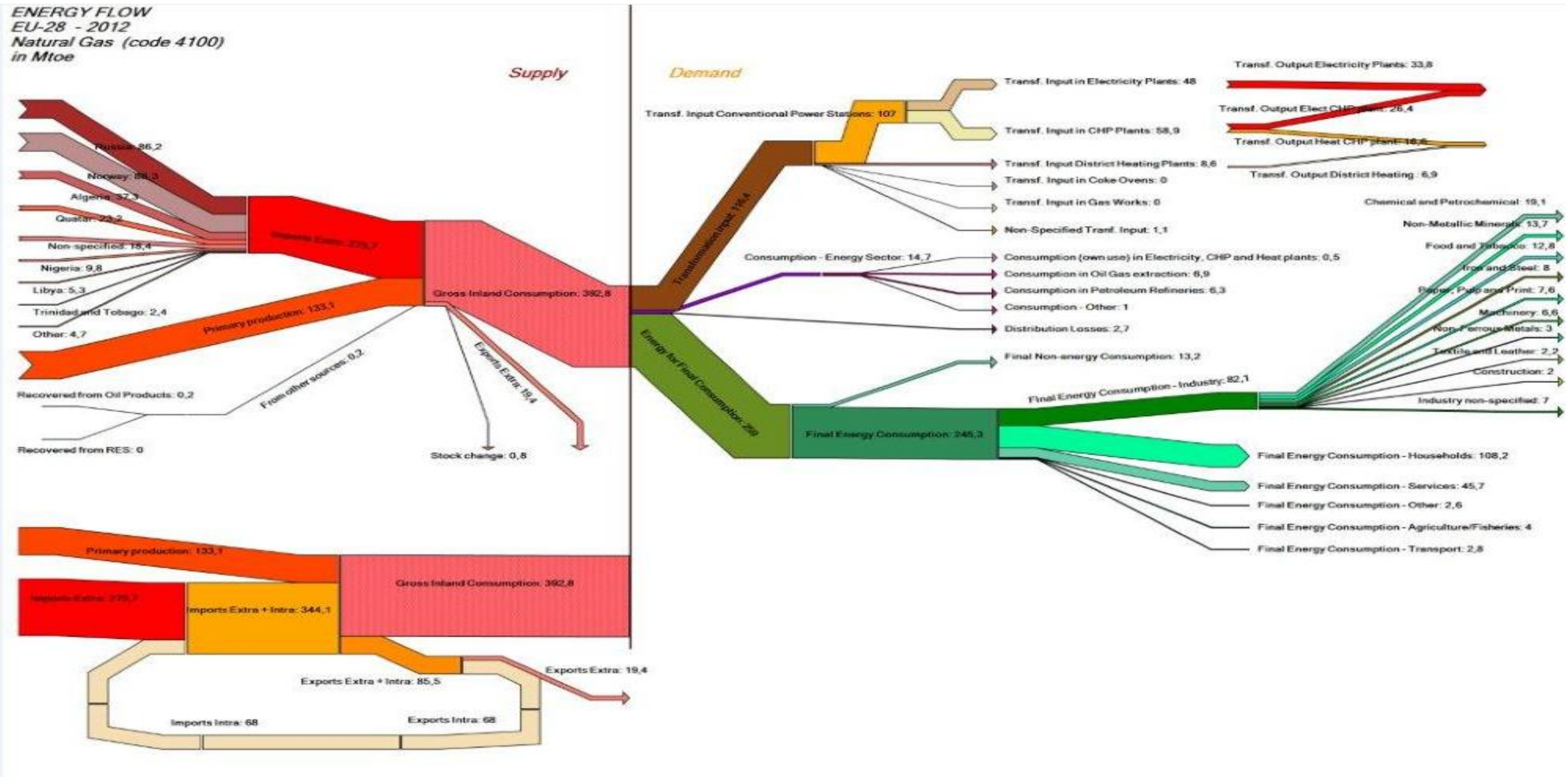
Figure 24. Total energy demand for gas in the EU, 1995-2012, ktoe



Source: Eurostat, energy

As shown in the energy flow chart majority of gas is being consumed in households (108 Mtoe) and in electricity production (107 Mtoe) of which more than half (59 Mtoe) is used as input in CHP plants. Almost 19% of the electricity generated in the EU comes from gas and for some Member States the share of gas in electricity generation is significant (in 2012 above 40% in Italy, Ireland, Lithuania, Luxembourg and the Netherlands). As regards non-household consumers, services consume 45.3 Mtoe whereas the biggest industrial consumers are sectors of chemical and petrochemical industries, production of non-metallic minerals and food and tobacco production.

Figure 25. Energy flow of natural gas in the EU, 2012



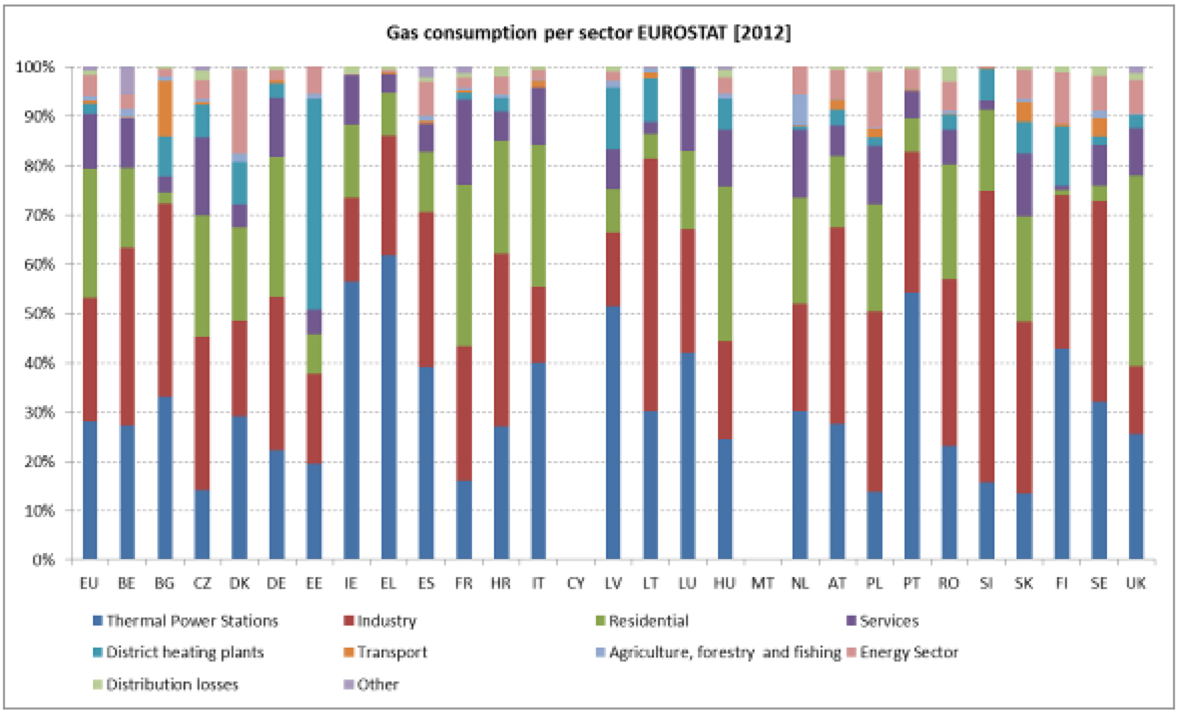
Source: Eurostat, energy. Calculations of the European Commission

Electricity production, heating for households and services (including district heating) and industry consume more than 90% of the natural gas in the EU.

Industry accounts for approximately 25% of gross inland consumption of gas. This includes both natural gas uses for heat generation for industrial consumption as well as gas used as raw material. The residential and tertiary sectors account for approximately 40% of gross inland consumption of gas. This consists mainly of direct use for heating and domestic hot water preparation for households and commercial buildings (using individual or central boilers) also with very important variations among Member States, in France the share of these sectors goes up to 50% while in Bulgaria it is only 5%.

In 2012 the transformation sector accounted for about 30% of gross inland gas consumption, mostly as input in electricity and CHP plants. The share of natural gas in power generation varies between Member States (see details in Table 7 in the electricity section of chapter 2). The use of electricity for heating and domestic hot water preparation also has an impact on gas use, depending on the electricity mix of the Member State. For instance, Bulgaria has a highly electrified heating sector and more than a third of gas consumption is used for electricity production. Thus, measures reducing heating demand or increasing the efficiency of electric appliances will also have an important impact on gas consumption.

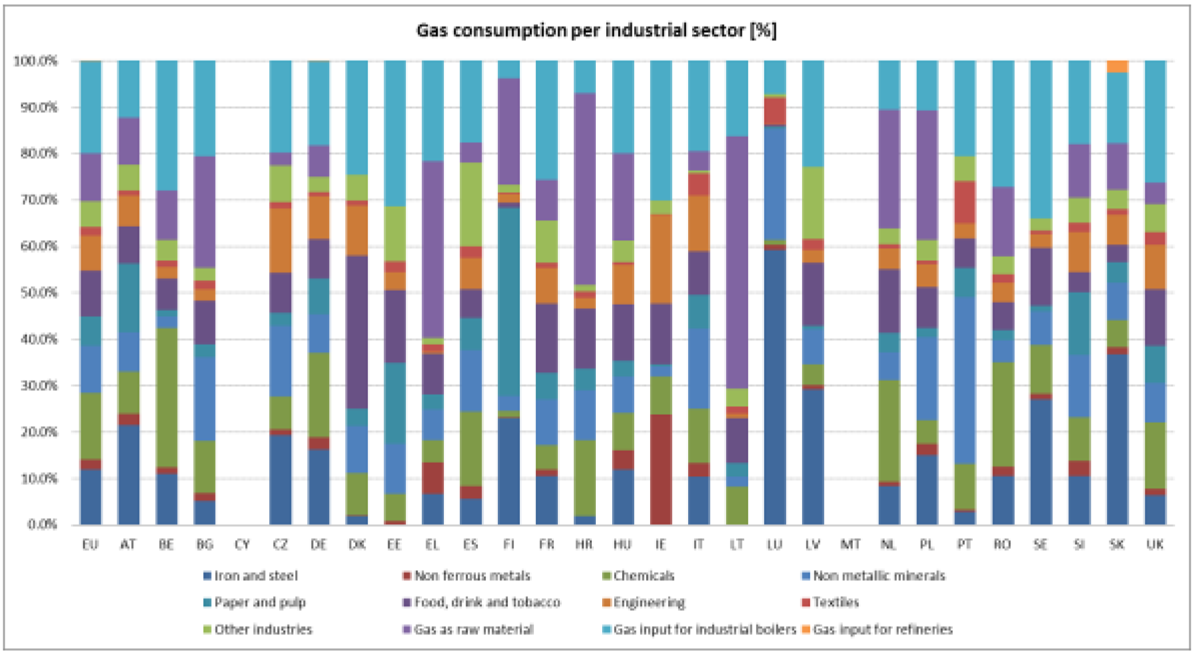
Figure 26. Natural gas consumption by sector, 2012



Source: Eurostat, energy

The relative importance of the gas used in industry per Member State varies from percentage values above 35% in Austria, Belgium, Bulgaria, Croatia, Poland, Lithuania and Slovenia to much lower values in Member States such as Ireland or the United Kingdom. Nevertheless the distribution of gas use per different industry sector presents important variations per Member State so it is to be understood that “one fits all” solution is not possible for the industrial sector and Member States should focus their efforts on the sectors were they have a highest relative consumption and a highest improvement potential.

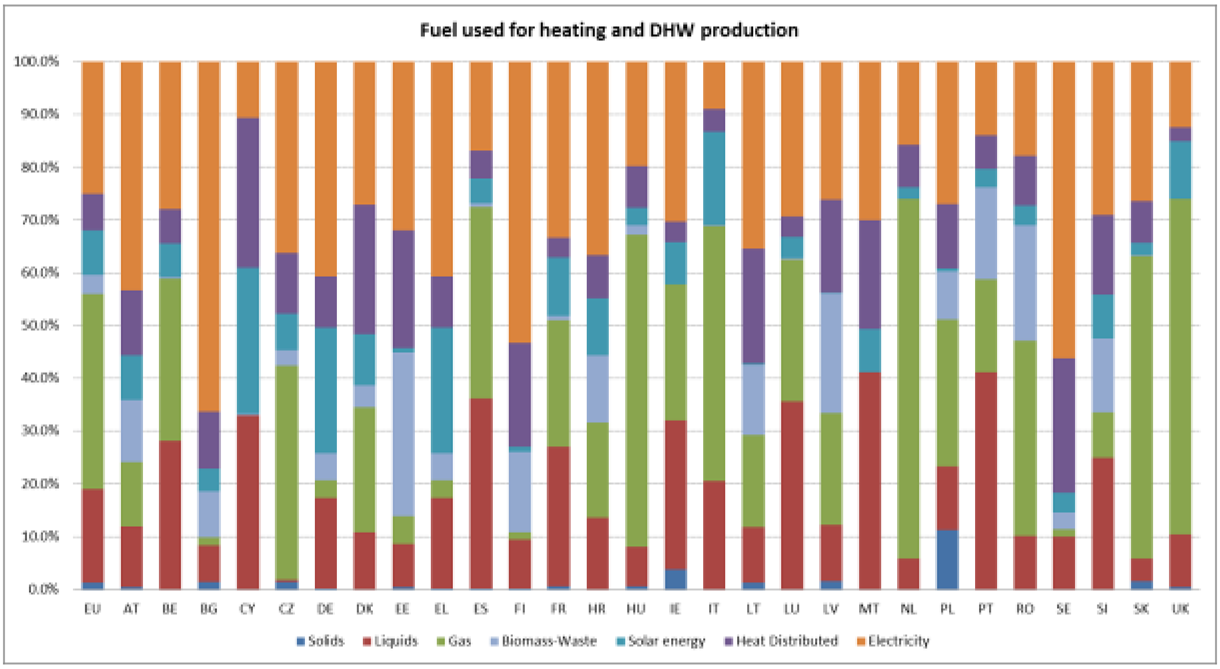
Figure 27. Natural gas consumption per industrial sector, 2012



Source: Eurostat, energy

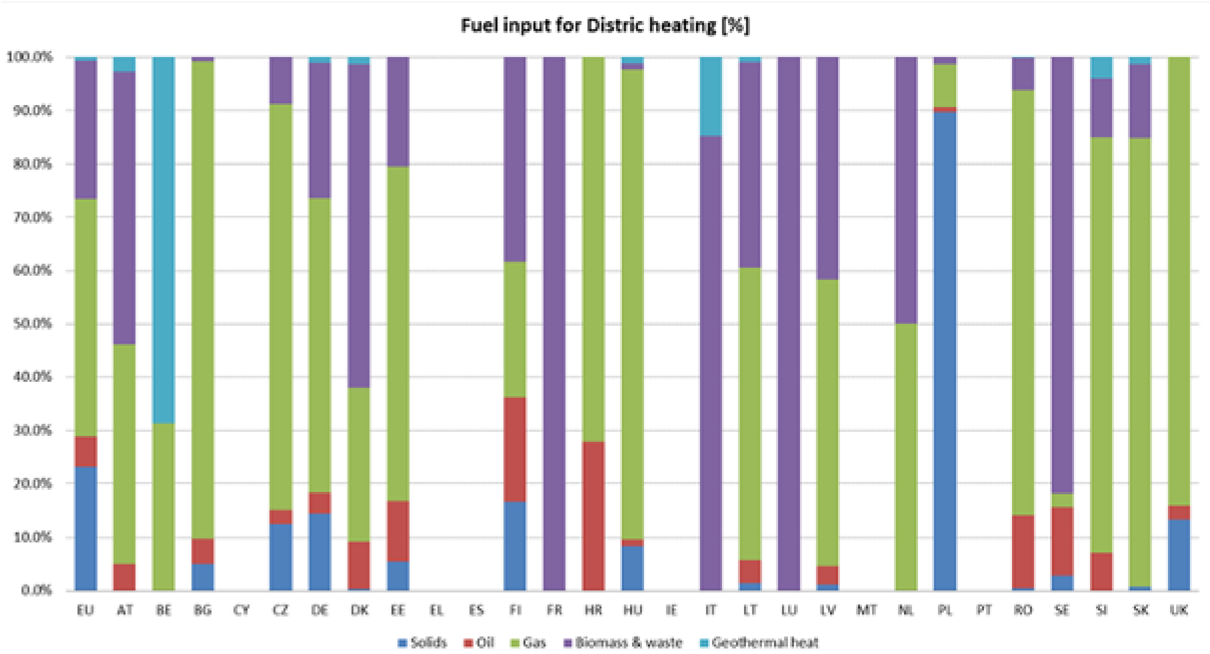
The overall gas use in district heating installations is 2% for the whole EU. District heating accounts for a relatively small part of final gas consumption at European level, but it has a significant share in the Eastern European countries. Gas consumption in district heating in Estonia, Latvia, Lithuania and Finland represents more than 10% of the total gas consumption and around 7% in Slovakia and the Czech Republic.

Figure 28. Heating and domestic hot water: production by fuel



Source: PRIMES 2013

Figure 29. Fuel input for district heating (%)

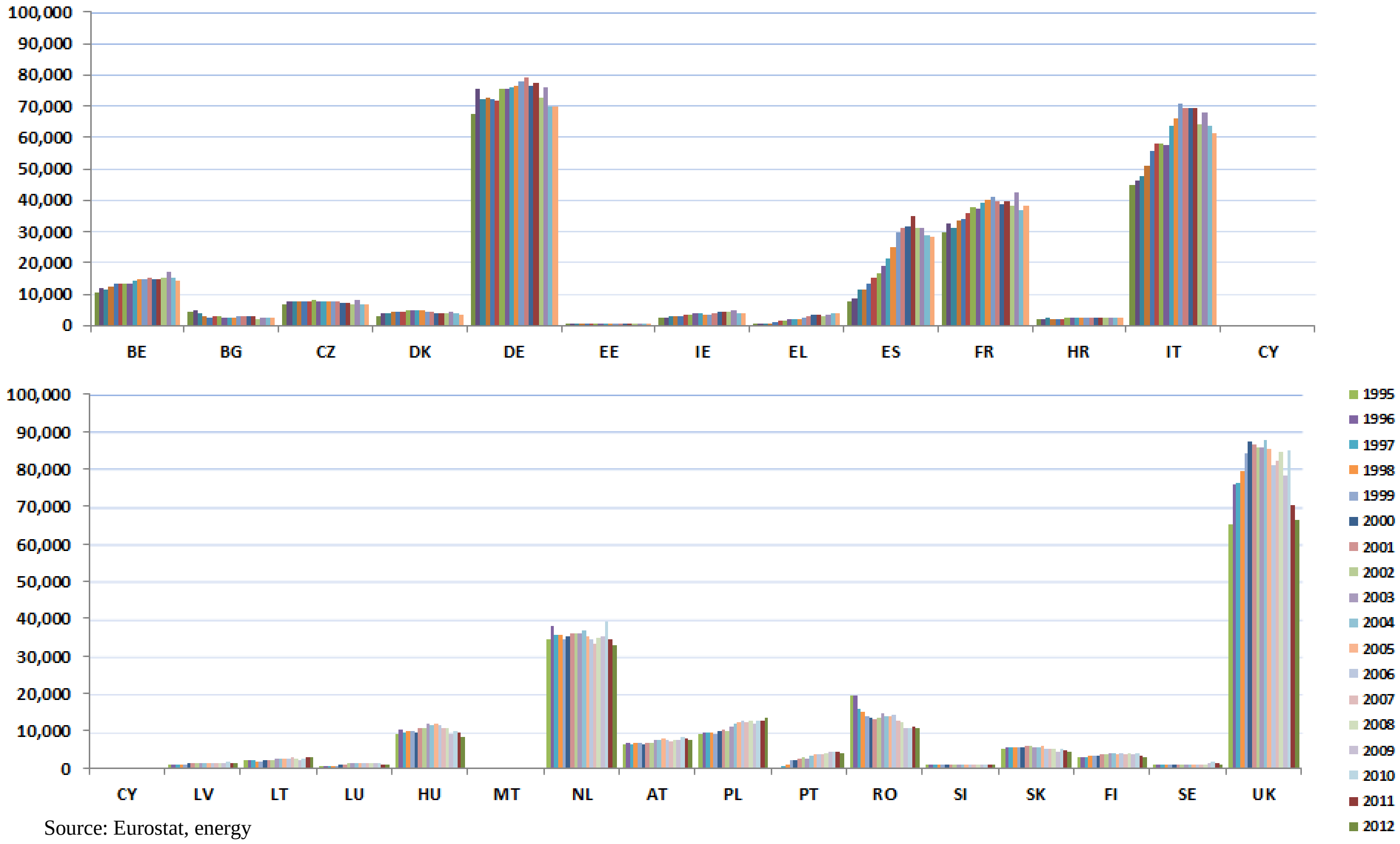


Source: PRIMES 2013

Germany and the UK are the largest consumers of gas, with drop in the UK in the year 2012 below 70 Mtoe. Other significant consumers of gas include Italy, France, the Netherlands and Spain. In the eastern part of the EU consumption of gas in Poland increased in 2012 above 10 Mtoe whereas in Romania dropped to similar level from 20 Mtoe in the late 90ties.

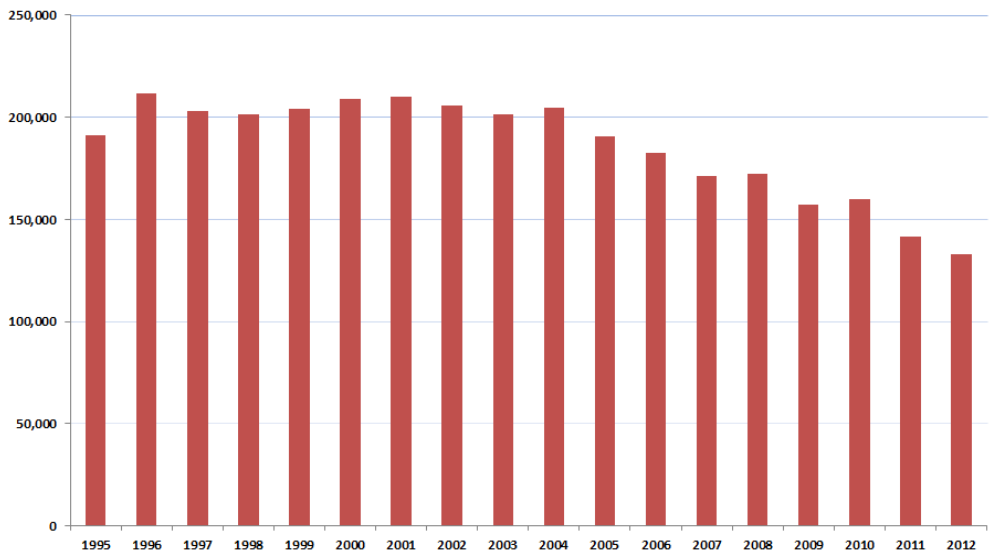
The EU production decreased over last 10 years from the level of 200 Mtoe in the late 90ties to the level of below 150 Mtoe in 2012 marking the lowest level since 1995. The biggest producer of gas in 2012 the EU are the Netherlands with production close to 60 Mtoe. Production of the UK dropped to the level of 35 Mtoe in 2012 from a level of above 90 Mtoe in the beginning of the decade. The EU exports 19.4 Mtoe to non-EU states, mostly transits to Switzerland, the southern Balkans and Turkey.

Figure 30. Total energy demand for gas in the Member States, 1995-2012, ktoe



Source: Eurostat, energy

Figure 31. Total production of natural gas in the EU, 1995-2012, ktoe



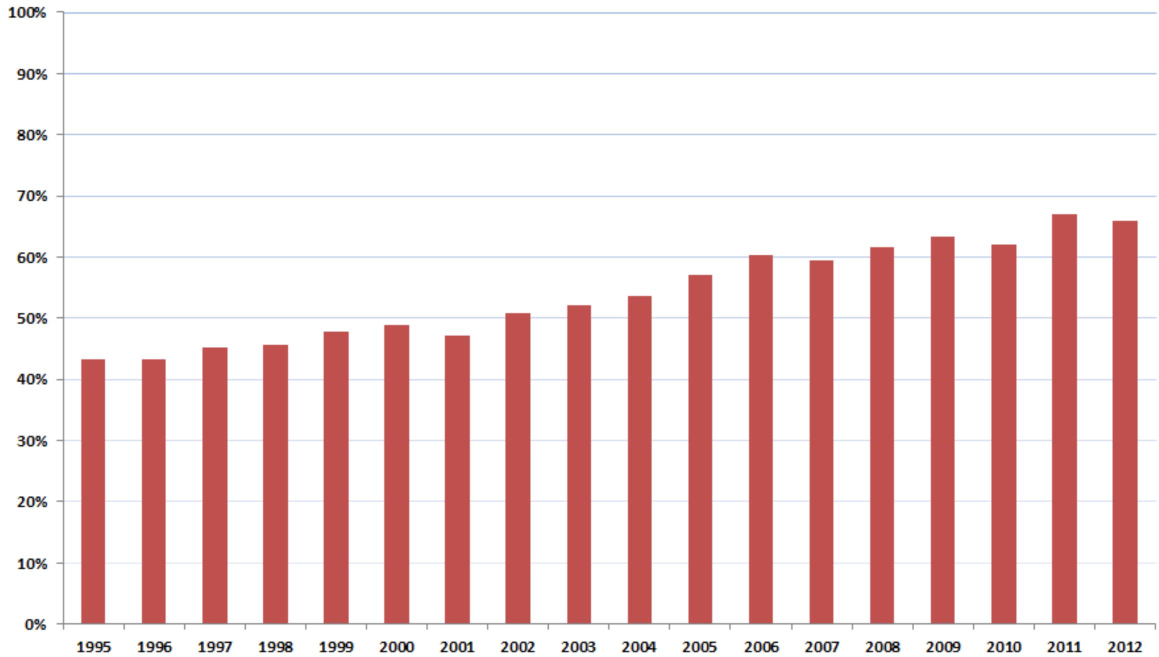
Source: Eurostat, energy

The conventional gas proved reserves of the EU for the end of 2012 have been estimated on the level of 1412 Mtoe (1700 bcm)[21] i.e. less than four years of total EU consumption (see Figure 82 in chapter 4.1. for reserves-to-production ratios). Germany, Italy, Poland and Romania hold ca 83 Mtoe each, UK 166 Mtoe and Netherlands 830 Mtoe. As regards remaining EEA Member States Norway holds 1744 Mtoe.

Natural gas production from shale formations seems to have higher potential in Europe compared to other unconventional hydrocarbons: shale gas technically recoverable resources are estimated to amount to 13289 Mtoe. However, only a part of these resources is likely to be economically recoverable and there is high uncertainty as to the extent of those until more exploration projects have been undertaken[22].

Since domestic production of gas covers only 30% of consumption, the gap between demand and supply reaches currently 250 Mtoe and Member States rely on imports of gas from non-EU states. The import dependency for gas peaked in 2011 before falling by 1.3 p.p. in 2012 to 65.8%. This dynamics was underpinned by a fast decrease in gross inland consumption of gas (-12% between 2010 and 2012) and a more moderate drop in import volumes (-5% between 2010 and 2012).

Figure 32. Natural gas import dependence in the EU, 1995-2012, %



Source: Eurostat, energy

The biggest net importers of gas are the biggest EU economies with Germany and Italy importing most in 2012. UK and Italy increased their imports of gas in absolute values most. The Netherlands and Denmark are net exporters of natural gas.

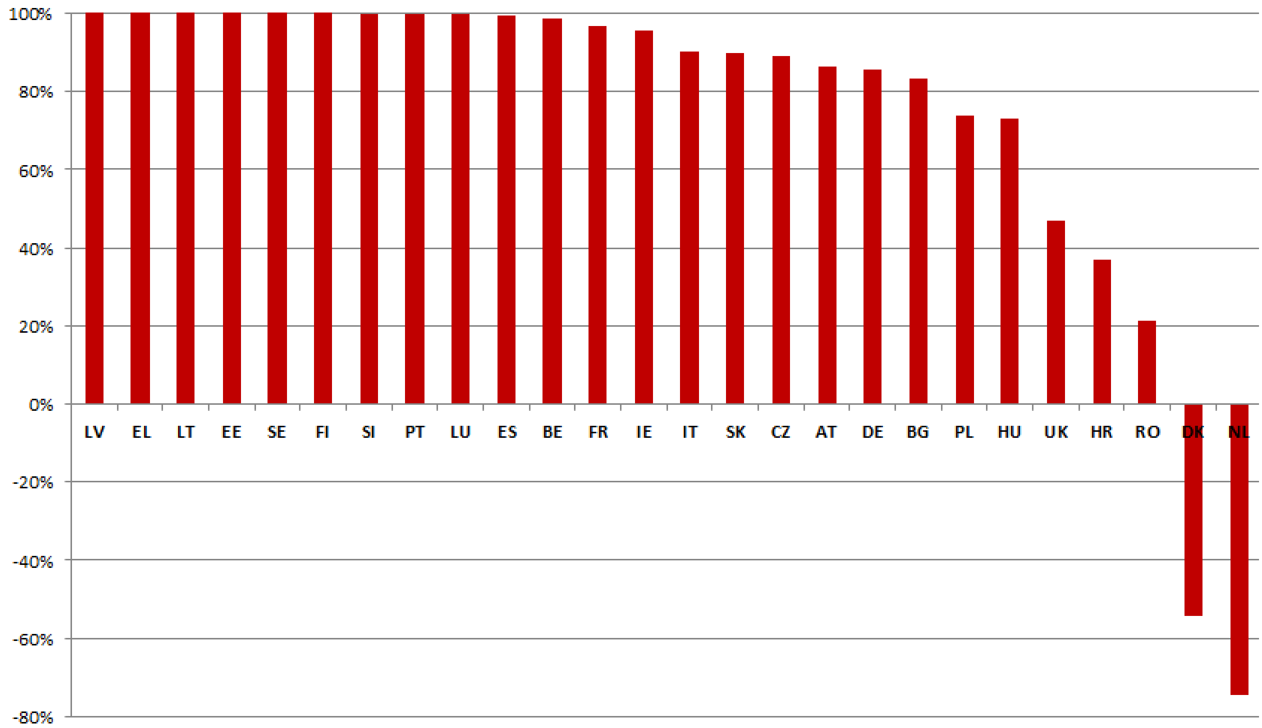
Net imports to Germany and Italy have been relatively stable in the last decade (in 2012 down by 8% and 12% respectively from the peak in 2006). In 2004 the UK became a net importer with import volumes growing thirty-fold in less than a decade to reach 31 mtoe in 2012.

[21] http://www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf
[22] COM/2014/023 final/2 : http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014DC0023R(01)

Among EU Member States, the level of dependency and diversifications of suppliers and supply routes varies greatly. Some northern and eastern Member States depend on a single supplier, and often on one supply route, for their entire natural gas consumption, while others have a more diversified portfolio of suppliers.

Due to the size of their economies, Member States with similar import dependencies (measuring the relative share of imports in consumption) have rather different energy deficits (measuring in absolute terms the difference between demand and production, i.e. the net import volumes). The dynamics of import dependency over time is also important and driven by the relative changes in consumption and production. For example countries like Germany and France decreased their gas import dependency between 1995 and 2012 (in percentage terms), but their energy deficits increased (in absolute terms).

Figure 33. Natural gas import dependency by Member State (intra+extra-EU imports), 2012, %



Source: Eurostat, energy. European Commission calculations

The supplier concentration indices in chapter 4.9 offer another metric of diversification which takes into account both the diversity of suppliers and the exposure of a country to external suppliers, looking at net imports by fuel partner in the context of gross inland consumption of each fuel.

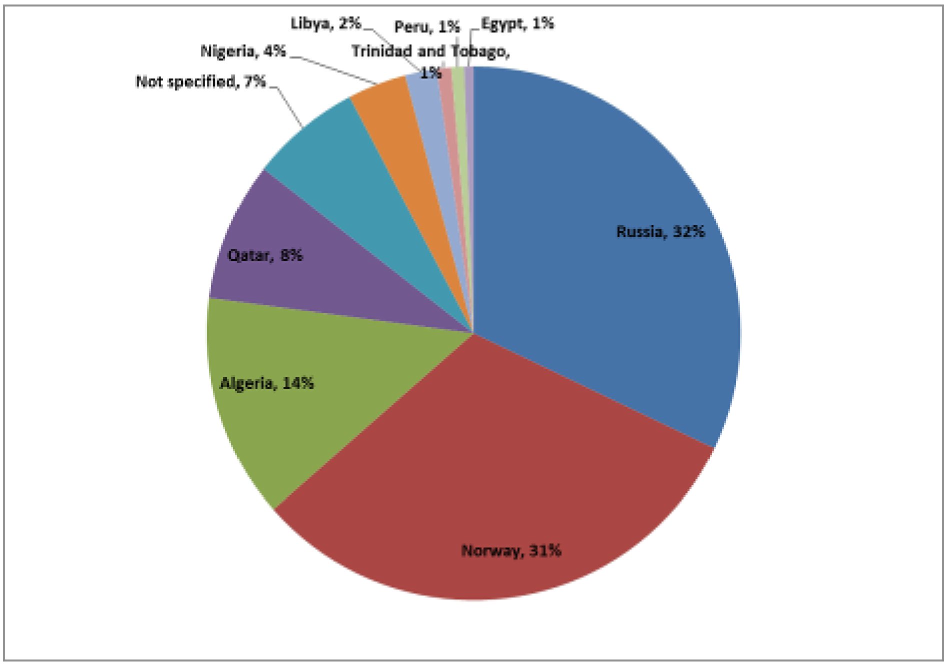
In 2012 imports from Russia accounted for 32% of total extra-EU imports to the EU in energy terms, followed by imports from Norway (31%) and Algeria (14%). According to data from the COMEXT database of Eurostat, in 2013 the extra-EU import bill for natural gas was at 87 billion Euro. Looking at natural gas imports from outside of the EU, Russia holds the biggest share of total imports in value terms (41%), followed by Norway (32%), Algeria (14%) and Libya (7%).

Table 2. Extra-EU imports of natural gas, by main trading partners (share in monetary value and in mass in 2013)

Partner	VALUE (Share %)	NET MASS (Share %)
Russia	41%	39%
Norway	32%	34%
Algeria	14%	13%
Qatar	7%	7%
Libya	2%	2%
Nigeria	2%	2%

Source: Eurostat, Comext

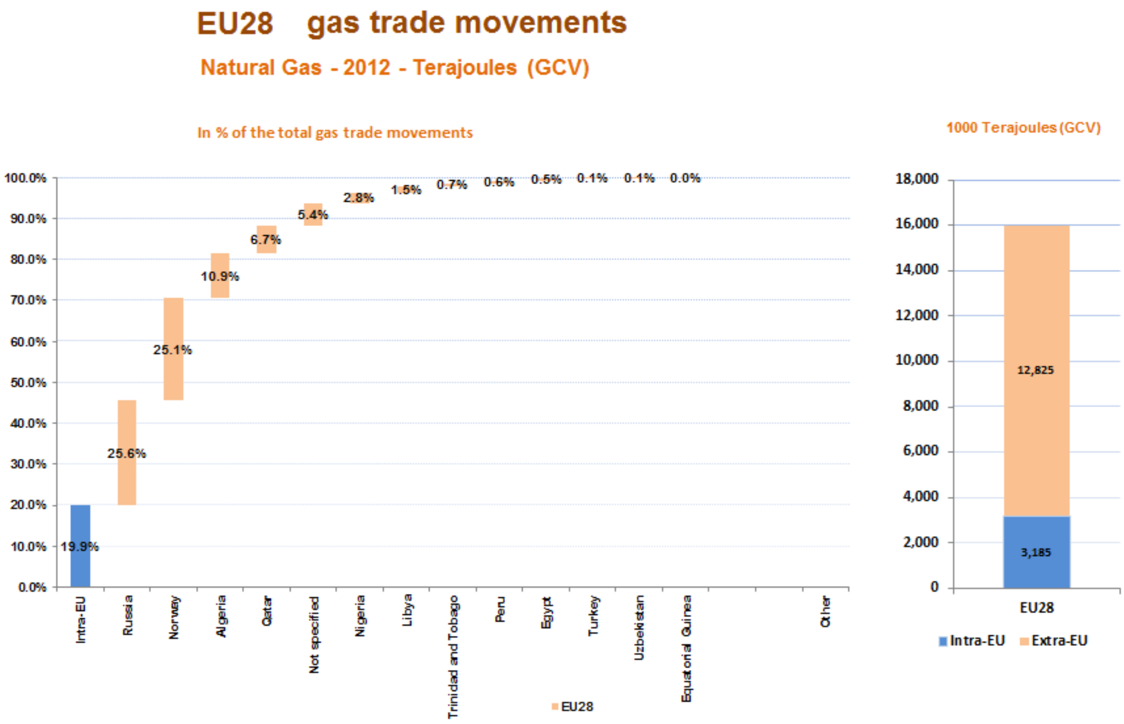
Figure 34. Extra-EU imports of natural gas, by main trading partners (share in energy terms in 2012)



Source: Eurostat, energy

When looking at the total trade movements of gas – both gas entering the EU from outside (extra-EU) and the internal trade movements of gas across the EU (intra-EU), one can see that about 20% of all trade movements are within the EU. Russian gas is estimated to account for one quarter of these internal trade movements, chiefly due to transit through Germany, Austria, the Czech Republic, Slovakia, Italy and Hungary.

Figure 35. Gas trade movements: intra-EU and extra-EU, 2012



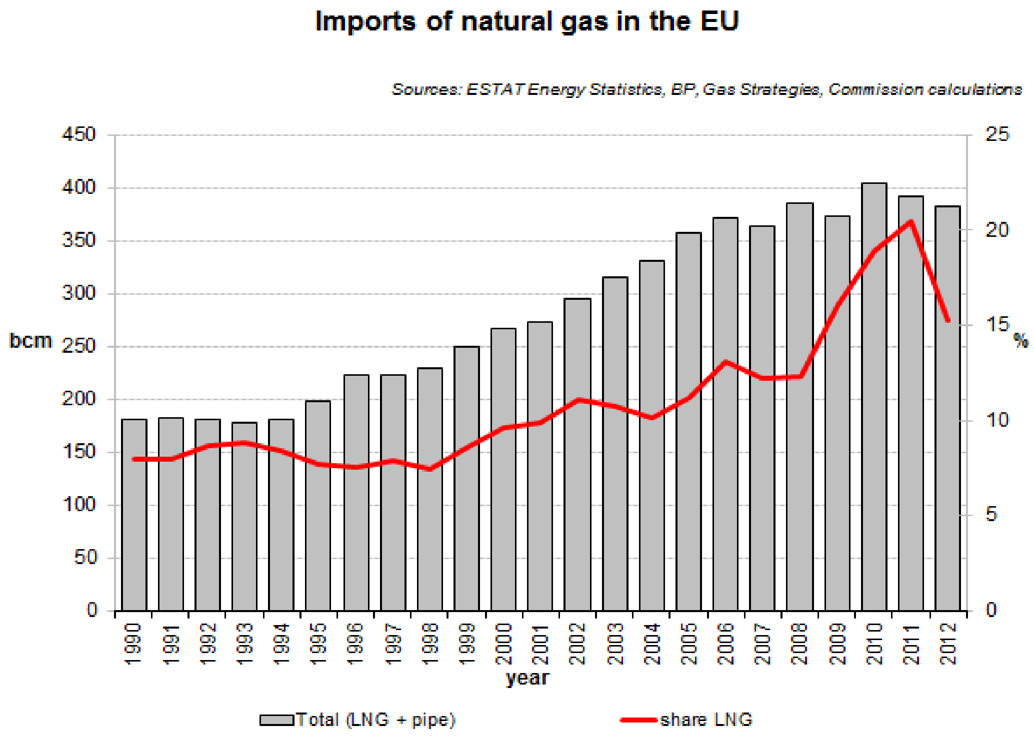
Source: Eurostat, energy. Calculations of the European Commission

2.1.3.2 Transport infrastructure

An important factor influencing the use of gas is the flexibility of transport infrastructure and the way it is being operated. Geographical location, the number and available capacity of pipelines, LNG terminals and underground storage are key factors in considering the flexibility with which the infrastructure allows to react to supply disruptions and periods of high demand.

The majority of the gas imported to the EU comes through pipelines. While in 2011 LNG imports exceeded 20% of total imports, in 2012 the share of LNG in total imports went down by more than 5 p.p. – a significant drop, even if LNG share has doubled in a decade. In 2012, against falling demand for natural gas, the strong decrease of LNG deliveries (more than 22 bcm/ year) was only partially compensated by an increase of imports of natural gas delivered by pipelines (12 bcm/ year).

Figure 36. Share of LNG in EU natural gas imports



The 2013/14 Winter supply Outlook of ENTSOG pointed out that there is no big variation in the Norwegian, Algerian and Libyan supplies, but there are important decrease in the LNG imports (-32%). The drop in imports of LNG was due to the divergence of gas prices between Europe and Asia, which lead to cargo redirection and re-exports to Asia and caused a decrease in the arrival of spot cargos. This drop was replaced with a relevant increase withdraws from storages (+40%) and of Russian imports (+7.5%, mostly Nord Stream flows).

2.1.3.2.1 Pipeline deliveries

The total capacity of pipelines directed to the EU from supplier countries is 397 bcm/year. The major entry points of the pipelines are on the Eastern borders of the EU and in the north. New projects under construction include the pipelines of the Southern Gas Corridor which will allow by 2020 supplies to the EU markets of 10 bcm per year gas from Azerbaijan. The currently envisaged infrastructure in Turkey could transport up to 25 bcm per year for the European market and is thus able to absorb further gas volumes from Azerbaijan as well as volumes from Northern Iraq[23].

Reverse flows that provide a possibility to operate the pipelines in two directions are a crucial element in mitigating security of supply risks and allowing gas flowing freely. The security of gas supply Regulation 994/2010 made implementation of such investments obligatory where the costs and benefits analysis showed positive spillovers of such projects[24]. On this basis three projects have been

[23] Arguably robust growth of domestic demand in Turkey might constrain the volumes transited.
[24] Three reverse flow investments are under implementation: from Germany to Poland, from Greece to Bulgaria and from Romania to Hungary

implemented. Since 1st of April 2014 Poland has implemented physical reverse flows on the Yamal pipeline[25] . This allows Poland to cover almost half (7.15 bcm) of its consumption through imports from Germany and the Czech Republic. This is indeed an important step in diversification of supply routes by which Poland (which relies on imports for some 74% of its gross inland consumption) will be able to replace the 72% of Russian imports (9.8 bcm) by internal flows from the EU. The allocation of capacity procedure for firm capacity from Germany started on the 29 of April 2014[26]. Since 2009 a number of projects have been completed with the aid from the European Energy Programme for Recovery (EEPR)[27].

In Austria, reverse flow modifications on the connections between Baumgarten and the pipelines HAG and TAG were completed in 2011. This allows countries adjacent to Austria to use the Italian LNG terminals as a point of entry, in particular in case of a disruption of the supply of gas entering EU at the Ukraine and Slovak border. In addition, it also eliminates bottlenecks in transport of gas to Croatia, Italy and Slovenia and vice versa. The Austrian transmission grid is making progress to become an easily accessible and integrated system, and further steps should be taken to ensure integration of the TSOs. The Austrian market plays a key role in connecting the liquid northwest European markets to the Southeast European markets. The Baumgarten hub can play an important role but it needs to ensure that gas from different sources is traded there, that it is reliable, and that gas can be transported to and from the hub easily and flexibly.

Projects of the interconnector in Cieszyn between Poland and Czech Republic as well as establishing reverse flow connections in Hungary[28] and Czech Republic enable bidirectional transmission between West and East and were completed in 2011 and 2012. Further projects with support of EEPR are on-going between Lithuania and Latvia, Portugal and Spain.

The maps below show major investment made in infrastructure developments in Central and South-East Europe since 2009. Physical reverse flows in pipelines require investments which have not been made yet on all interconnector points within the EU. When implementing the Regulation 994/2010 the Regulatory authorities agreed in most of the cases to grant exemptions to the system operators from the obligation of conducting such investments.

Thus, reverse flows are an important factor of flexibility as they provide alternative supply routes and connect gas systems to additional entry points, including indirect access to LNG terminals. In addition, the alternative supply routes provide more opportunity to trade and increase hub liquidity. As indicated in **Figure 35**, despite a high dependency of the EU on external suppliers, the equivalent of a fifth of the EU gas imports is already being traded within the EU.

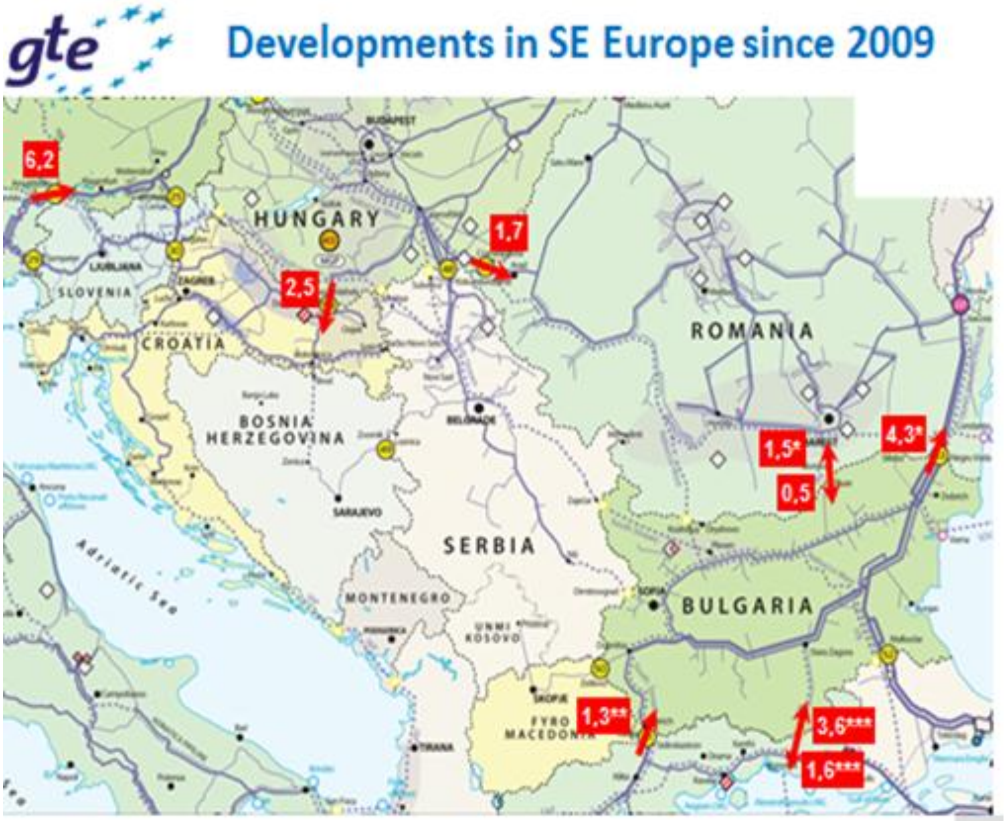
[25] http://en.gaz-system.pl/en/press-centre/news/information-for-the-media/artykul/201826/

[26] http://en.gaz-system.pl/en/press-centre/news/information-for-the-media/artykul/201838/

[27] SWD(2013) 458 final

[28] Romania-Hungary is currently one-directional and delivers Russian gas to Romania. Croatia-Hungary is bidirectional, but in the absence of an LNG terminal quantities would be relatively limited.

Figure 37. Infrastructure developments in Central and South-East Europe since 2009



Source: GIE, Presentation at the 25th Madrid Forum 6/5/2014

Congestion of interconnector points in the EU (physical and contractual) poses an important challenge to free flow of gas and a factor that needs to be addressed as part of efforts to mitigate security of supply risks. In their report ACER concluded that out of over 350 interconnection points at least 118 are congested[29]. Most of the congestion points were found in the Central Western Europe[30].Congestion at the Austrian border and the German-Polish border is critical as these are connecting the liquid northwest European markets to the Central and Southeast European markets. Congestion appears also on the borders of Bulgaria, Poland and Hungary. Based on their preliminary findings[31], ACER recommends greater transparency and coherence in reporting of data.

It needs to be emphasised that the existing main transport pipeline that transports gas from Russia through Ukraine, Moldova, Romania, to Bulgaria, Greece and Turkey, is not operated in line with EU legislation (no TpA, no unbundling, no reverse flows) and therefore separates markets and undermines security of supply instead of being an interconnection that can be flexibly used to transport gas between vulnerable markets.

[29] http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER%20Gas%20Contractual%20Congestion%20Report%202014.pdf

[30] However this was the region were most of the data were reported.

[31] See paragraphs 54-56 of the Report regarding the limitations of the data collected and therefore preliminary character of the findings

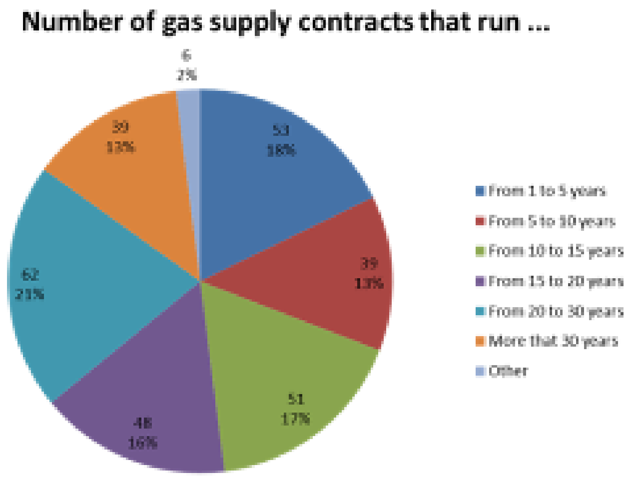
Figure 38. **Indicative map of contractually congested interconnection points in Europe**

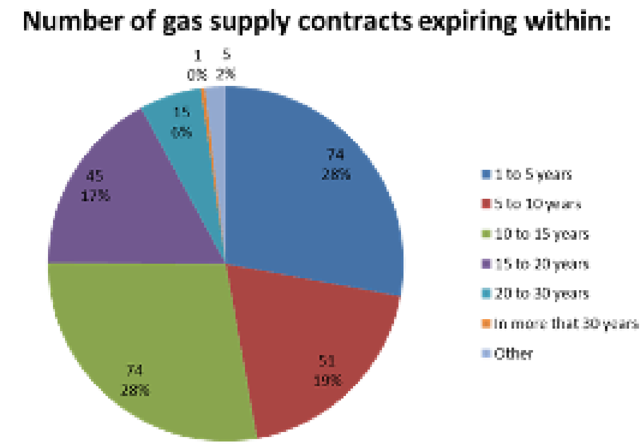
Source: 2014 ACER annual report on congestion at interconnection points in Q4/2013, TSO responses to the ACER survey on CMP implementation and analysis of TSOs' data and ENTSOG Transparency Platform

2.1.3.2.2 Contractual obligations

Diversification of supply via pipelines requires construction of new infrastructure outside of the EU, which is normally underpinned by longer term commitments. The long term contracts of pipeline gas are estimated to cover 17-30% of EU market demand i.e. nearly entire import from Russia, with different duration periods[32]. From the reports by Member States to the Commission made on the basis of security of supply Regulation 994/2010 is appears that there are close to 300 contracts with duration above one year, for supply of gas from third countries. They are evenly distributed regarding their duration 31% of these contracts has duration between 1-10 years, 33% duration between 10-20 years, 36% duration of more than 20 years. Six Member States have less than 5 gas supply contracts (BG, FI, EL, LV, PT, SI) while five Member States have more than 30 contracts each (BE, FR, IT, ES, DE). As regards expiry dates 47% will expire within 10 years, 45% within 10-20 years and 8% above 20 years. For 4 Member States all their contracts will expire within 10 years. These contracts are sometimes covered by the intergovernmental agreements and cover nearly entire deliveries of the Member States concerned.

Figure 39. Gas supply contracts in the EU





[32] http://ec.europa.eu/energy/gas_electricity/studies/doc/gas/lt-st_final_report_06092013final.pdf

Long term commitments and geography of pipelines in the EU (lack of North-South connections) lead to congestions in the network and are reasons why some of the Member States are more dependent than others from single upstream suppliers.

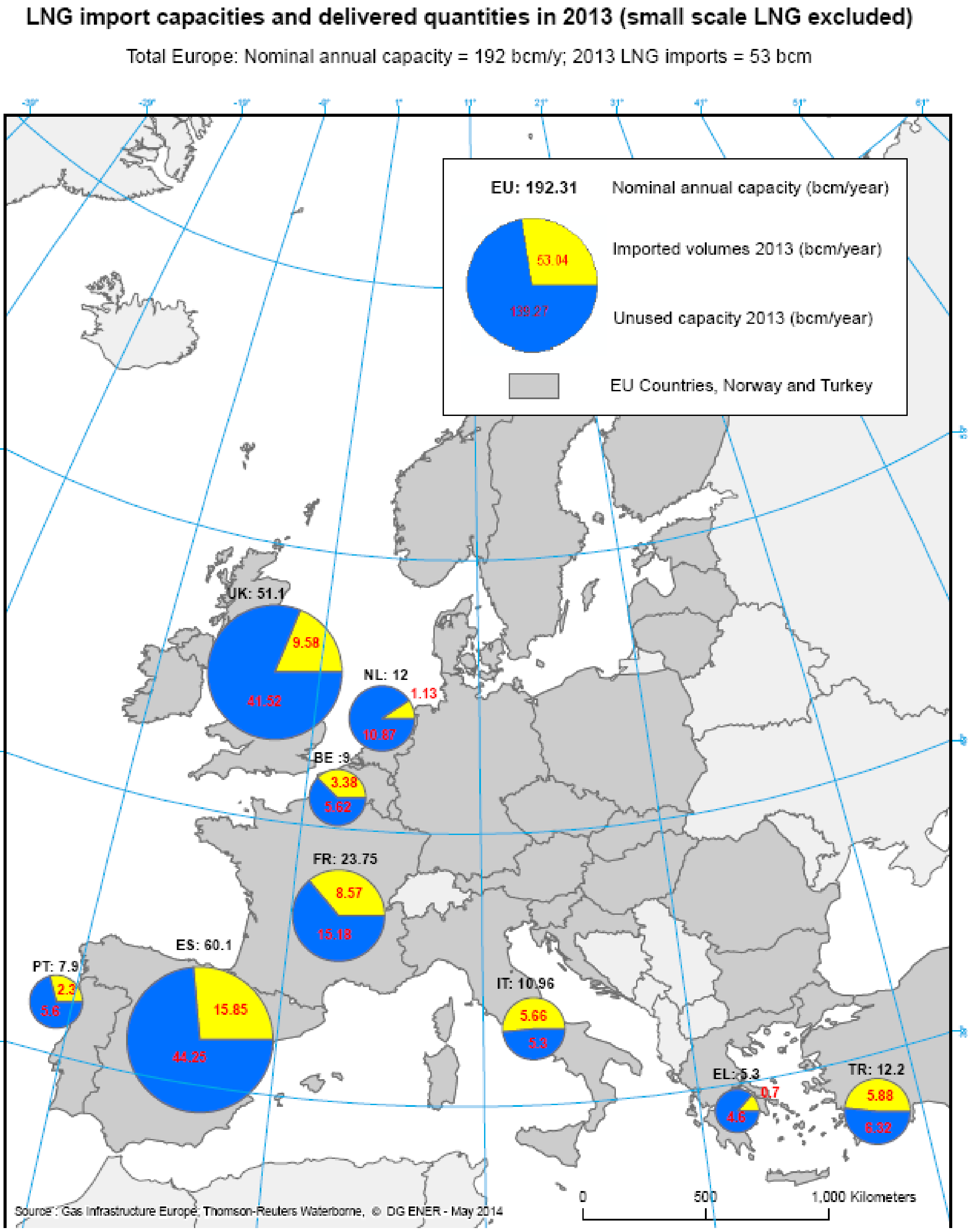
2.1.3.2.3 LNG terminals

The total regasification capacity of LNG terminals in the Europe (excluding small scale LNG) is around 200 bcm/year. Further terminals are planned and their total capacity is planned to reach 275 bcm/year in 2022. The map below shows capacities of terminals that are operating as of 2013. The map shows that main LNG capacities are in the west of the EU.

Whereas the pipeline capacities are almost fully utilised, the utilisation of LNG terminals is much lower. Data from Thompson/Reuters shows that utilisation rate of LNG terminals is about 25%. The Council of European Energy Regulators (CEER) estimates that 137 bcm of regasification capacity (73% technical capacity) in the EU was not used in 2013. In terms of volume 58 bcm of capacity was not used in Spain and 44 bcm in the UK, 15 bcm in France, 11 bcm in Netherlands, 8 bcm in Belgium, 6 bcm in Italy and 5 bcm in Greece.

This latest development characterizes well the variables with the major impact on the supply in the gas market and its potential in the future. The supplies of the LNG can in principle provide a certain degree of flexibility due to free capacities. Additional factors at play in evaluating the role of LNG include tightness of global LNG markets and competition for spot cargos between Europe, Asia and Latin America, very high prices with Asian LNG deliveries at significant price premium over European ones and a time lag before a cargo arrives. CEER points also out that the number of countries importing LNG is growing (29 in 2013), whereas the number of exporting is rather stable and the LNG market is supply constrained at present. The relative inflexibility of some European market participants who are bound by long-term contracts for pipeline gas with take-or-pay obligations may be another reason of the decreasing relative share of LNG in total imports in the EU and the low level of utilisation of LNG terminals.

Figure 40. LNG import capacities and delivered quantities in the EU, 2013

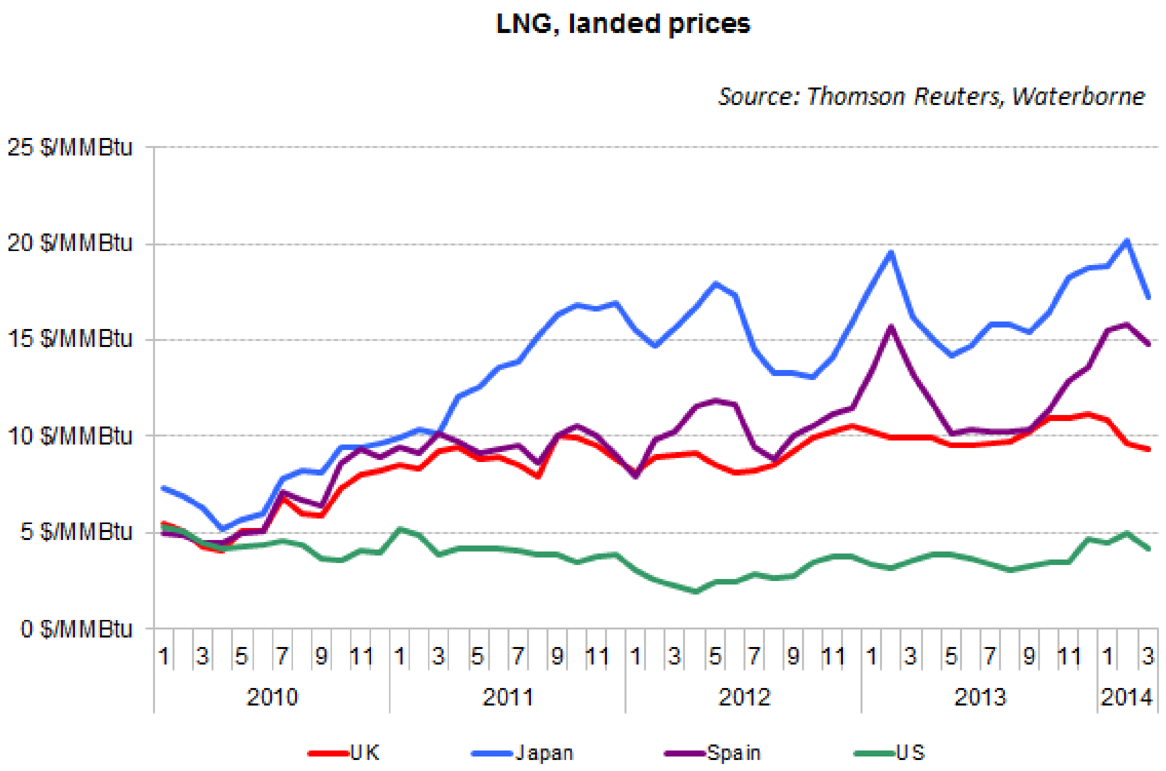


The diversion of LNG cargoes to the Pacific basin in the aftermath of Fukushima is well documented[33] and the figure below provides further evidence for the more attractive pricing conditions in Japan (similar price levels were also observed in South Korea and China). The EU – Asia price differential is greater than the shipping cost difference so in the case of LNG destination clauses have served to lock supplies, which in a genuine spot market would probably have been delivered to Asia.

[33] Check for example the regular publications of the Market observatory for energy here: http://ec.europa.eu/energy/observatory/gas/gas_en.htm

Against a background of falling demand a new LNG trade feature has expanded – re-exports, whereby LNG importers can take advantage of arbitrage opportunities by selling LNG to a higher-priced market, but have to meet the contractual obligation of unloading the LNG tanker at the initial destination as described in the contract with their LNG supplier. The IEA estimates that in 2012 Spain re-exported 1.7 bcm, Belgium 1.6 bcm, France 0.2 bcm and Portugal 0.1 bcm[34].

Figure 41. LNG price developments, selected countries

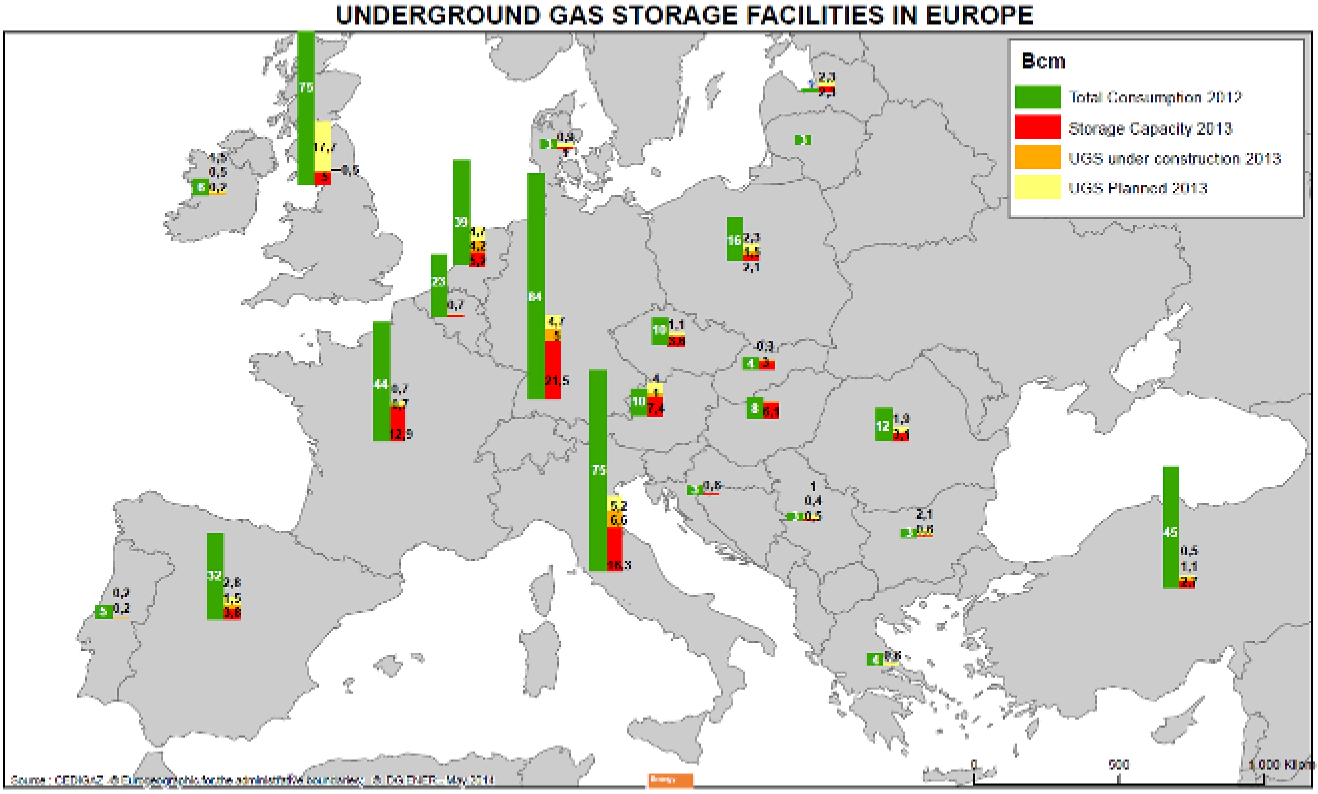


2.1.3.2.4 <u>Gas storage</u>

Gas storage can act as a buffer in case of a disruption of gas deliveries, but its availability depends on storage levels and the speed with which gas can be delivered to the consumers. According to CEDIGAZ there are 130 UGS facilities in Europe, including non EU countries such as Turkey, comprising a combined capacity exceeding 90 bcm. As the map shows there are more storage capacities in the West of the EU. However the ratio gas consumption/storage capacity is similarly spread across the EU with some exceptions such as Austria and Latvia whose storage capacity exceeds consumption.

[34] A precondition for re-exports is that the receiving regasification terminal is technically capable of loading the initially unloaded LNG back into the tanker, a feature many regasification terminals lack. Source: IEA. 2013. Mid-term gas market report. OECD/IEA.

Figure 42 Underground storage facilities in Europe

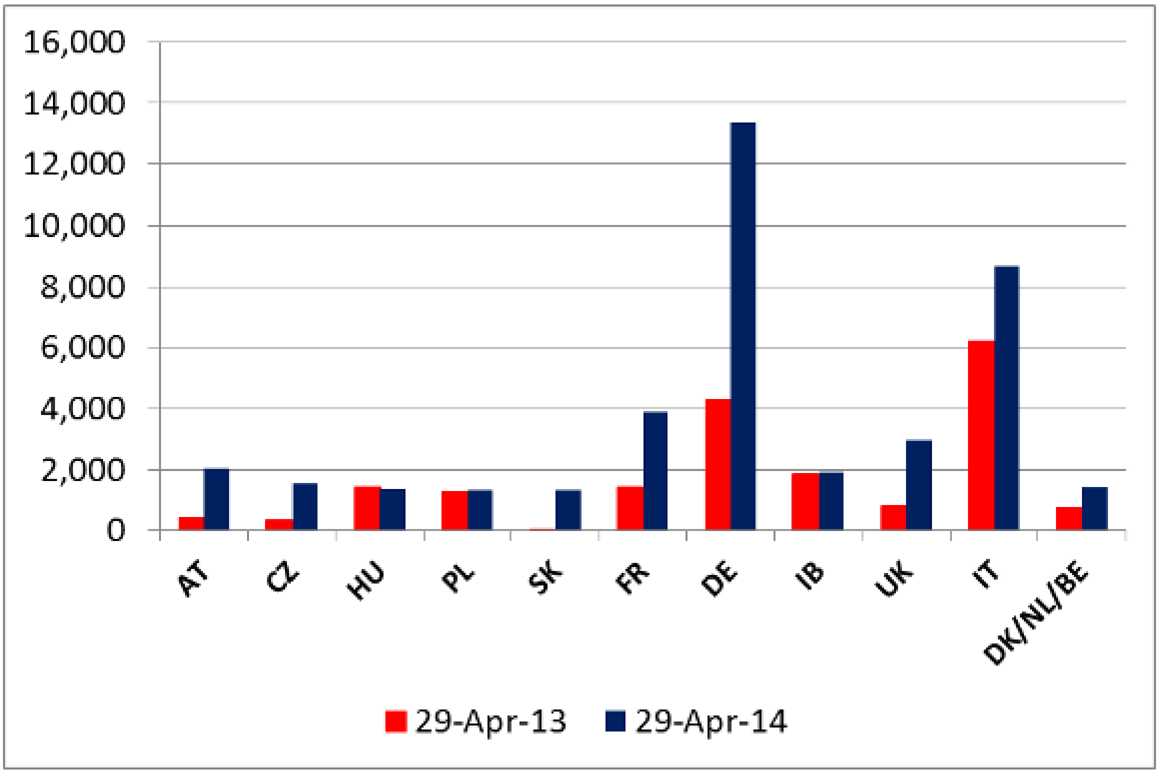


Source: CEDIGAZ.

As pointed out by Gas Storage Europe (GSE) and CEER the current storage levels are above the level normally observed around this time of the year. This is because of the mild winter 2013/2014. The storages are also filling quickly and ENTSO-G forecasts that 90% level can be reached by the end of this summer.

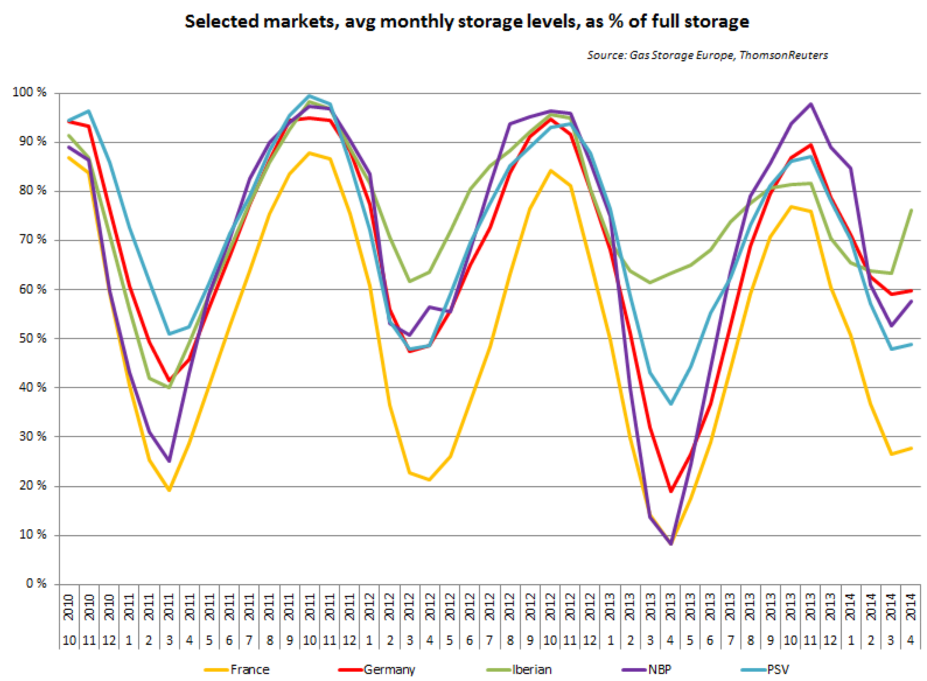
As of mid-May 2014, the underground gas storages of the 8 EU hub regions (Baumgarten, France, Germany, Iberian, NBP, PSV, TTF and Zeebrugge) contained 44 bcm of natural gas and were full at 55%. The maximum storage withdrawal rate is estimated at 1.4 bcm/day (data from Thomson-Reuters and Gas Storage Europe). However, the business model for filling gas storages is not necessarily setting incentives to store gas to prevent crisis situations. Gas storages are being filled in on the basis of spreads between summer and winter time. Analysis of such spreads, based on historic events does not predict unexpected events. Moreover the price spread between winter time and summer time decreases over years. The decreasing spreads and volatility - due to a combination of factors such as excess of supply in Europe and competition from other sources of flexibility (LNG, interconnectors and spot gas) and increasing storage-to-storage competition – have undermined the value of storage.

Figure 43. Storage Levels 29 April – 2013 vs. 2014 (million m^3)



Source: GSE: Data from the Aggregated Gas Stock Inventory which delivers online daily data representing approximately 78 BCM, i.e. 87 % of EU technical storage capacity. Data per country and for 8 defined hub areas on the volume in stock as well as the daily injection and withdrawals.

Figure 44. Gas storage in Europe (% of full storage)



2.1.3.3 Resilience of infrastructure today and ahead

The availability and location of pipelines and management of their congestion, available LNG terminals and storages give a view how gas can be supplied in case of disruptions from main sources of supply.

The 2013 Ten Years Network Development Plan (TYNDP) of the European Network Transmission System Operators for Gas (ENTSO-G) identifies zones whose balance relies strongly on dependency on Russian gas and LNG gas, with different ranges depending on the minimum supply share of the predominant supply[35].

The study concludes that supply dependence on Russian gas will increase when considering only TYNDP projects where final investment decision has been taken (FID-Projects). ENTSO-G is of the view that this is due to the lack of appropriate infrastructure being available to bring other sources to compensate for the increase of gas demand and the decrease of national production in the eastern part of Europe. ENSTO-G argues that dependence can be strongly reduced with the commissioning of projects where final investment decisions have not been yet made (Non-FID Projects foreseen for 2017 and 2022) and especially if new sources of gas can be supplied to the South-East of Europe. ENTSO-G notes that the dependence on LNG is more local and of a lower degree. It concentrates on the Iberian Peninsula and South of France. It has been also underlined that LNG is by nature diversified in its potential origins. Further investments in FID projects will diminish by 2017 and 2022 the dependence on LNG deliveries.

In addition, ENTSO-G analyses the resilience level of the EU Member States infrastructure and its flexibility i.e. the ability of infrastructure to respond to situations of particularly high demand or supply disruptions. In the 2013 TYNDP the simulation shows the flexibility of infrastructure by comparing the normal situation of demand and supply (the Reference Case) and of two scenarios: in a single day of highest transported gas quantity and in a day at the end of a 14 day period of high demand. Further the gas system infrastructure has been assessed in respect of situations of supply disruptions: disruptions of transit via Belarus and Ukraine. The map below shows the outcome for the scenario in day 14 of high demand and disruptions in Belarus and Ukraine transits. The case shows lack of infrastructure resilience of South-East Europe, Sweden, Denmark and Finland in case of an interruption of Russian gas transit through Ukraine.

[35] Page 95 of the 2013 TYNDP: *This dependency is measured as the minimum share of a given supply source required to balance the annual demand and exit flow of a Zone. This assessment is based on full supply minimisation modelling seeking for cases where a Zone will require a supply share of more than 20% from the minimized source".*

Figure 45. Supply Source Dependence on annual basis (red colours indicate high dependence)

Note: FID projects - projects with final investment decision. Non-FID projects – projects where final investment decisions have not been yet made

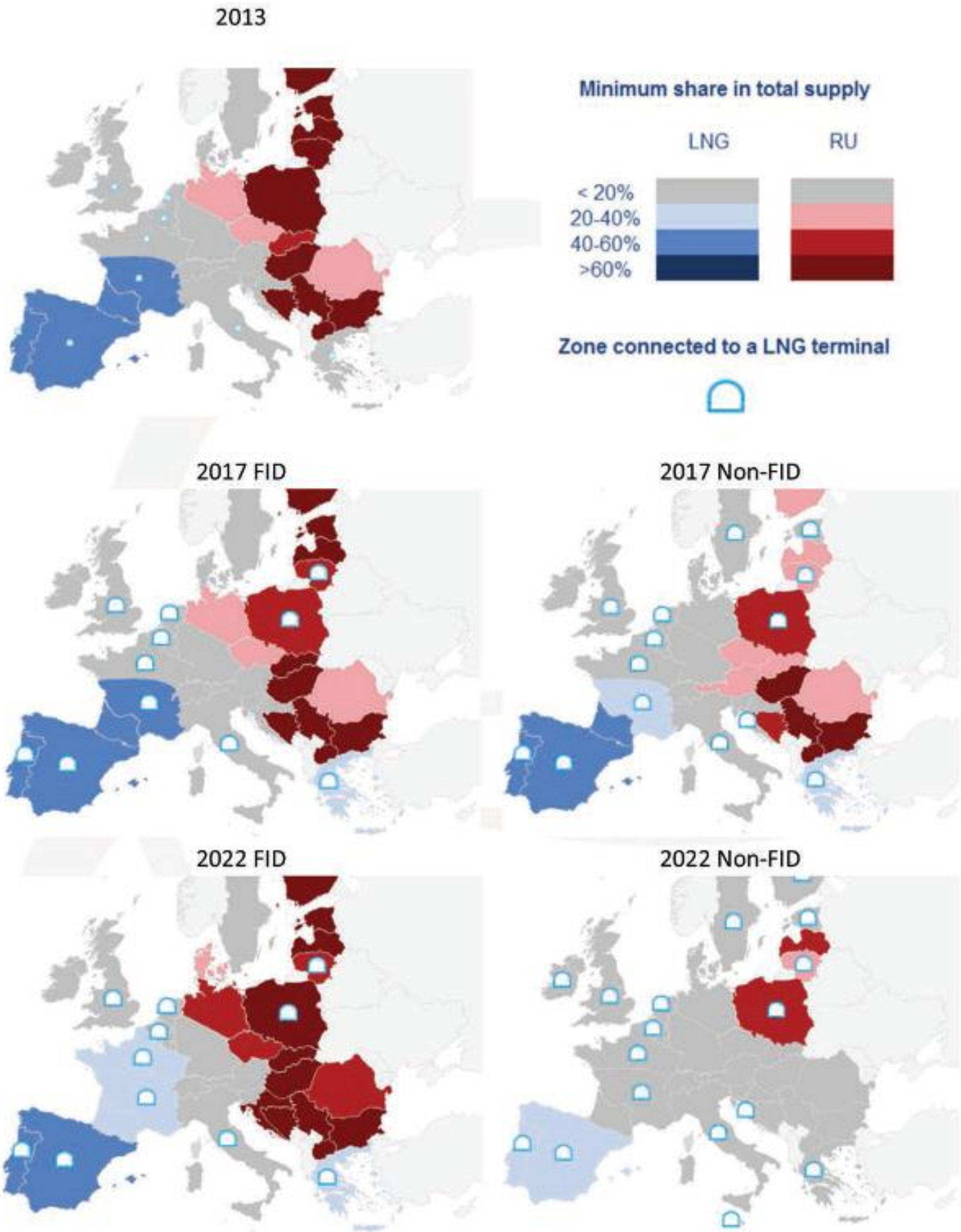
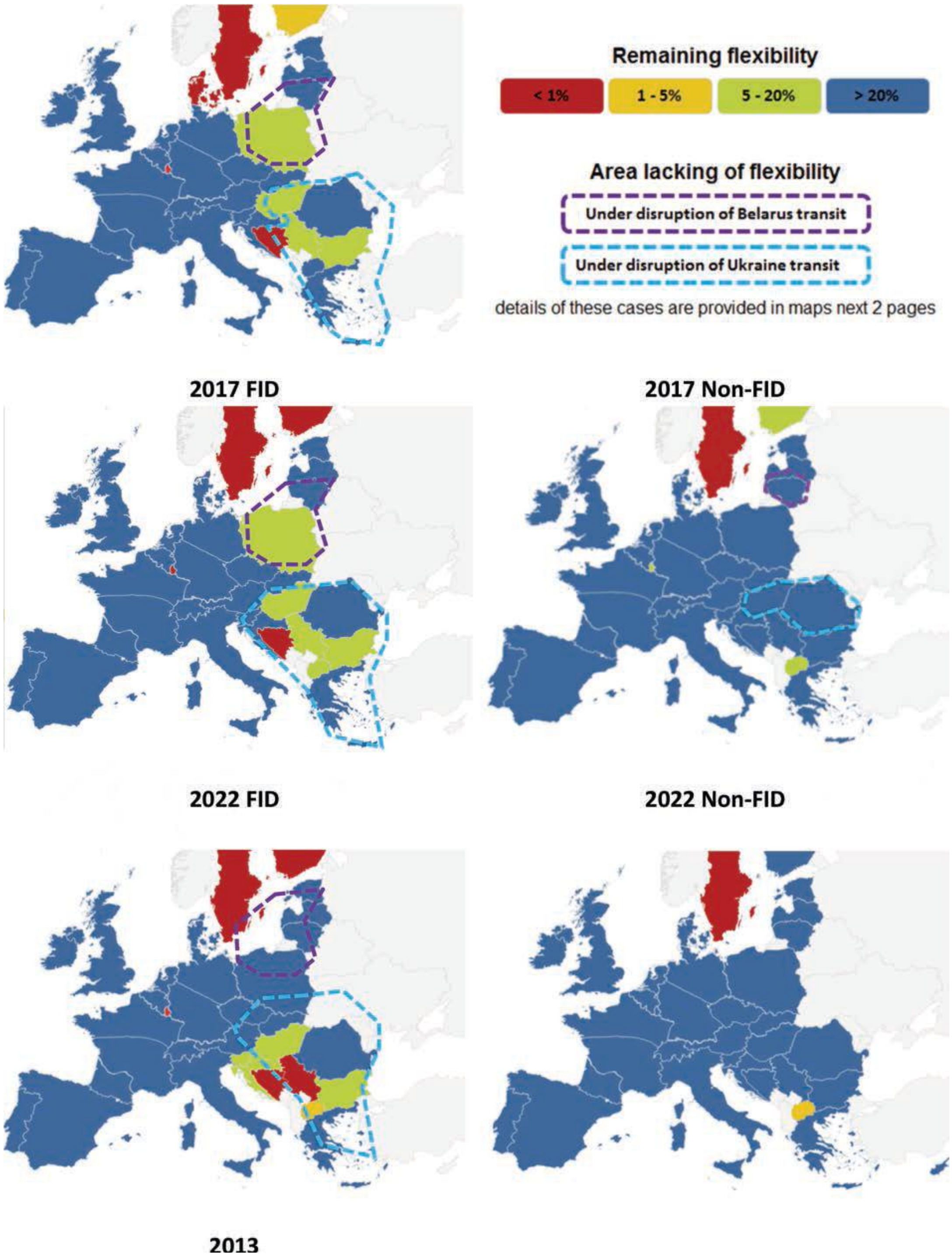


Figure 46. Infrastructure Resilience under 14-day Uniform Risk Situation

Note: FID projects - projects with final investment decision. Non-FID projects – projects where final investment decisions have not been yet made



Summary

- Gas import dependency of the EU exceeds 60% of total demand, with two thirds of imports coming from countries outside of the EEA. The Baltics and Finland are dependent on a single supplier for their entire gas consumption.
- The flexibility of transport infrastructure in terms of geographical location, the number and available capacity of pipelines and LNG terminals, underground storage and the way infrastructure is operated all play an important role in shaping the resilience of the gas sector.
- The potential to operate pipelines in two directions increases the resilience in case of a supply disruption. It is thus important to ensure investment in physical reverse flows and prevent physical and contractual congestion at interconnectors.
- The flexibility of supply in short term and availability of alternative external sources depends on competition on the world markets and on the degree to which such sources are already reserved by long-term contracts or other commitments (e.g. intergovernmental agreements). In the EU the long term contracts of pipeline gas are estimated to cover 17-30% of EU market demand i.e. nearly entire import from Russia, with different duration periods. These volumes are sometimes covered by the intergovernmental agreements and some reach beyond the year 2030.
- The capacity of the pipes to the EU is 8776 GWh/day, roughly comparable to the capacity of LNG terminals (6170 GWh/day). The possibility of the existing under-utilised LNG capacity to contribute to improved resilience differs among terminals, largely depending on their geographical location and the infrastructure allowing the transport of gas (mostly on the Iberian Peninsula with less importance for supplies in the eastern part of Europe). The role of LNG as a tool to increase resilience is undermined by ongoing tightness in global LNG markets and high prices on Asian markets, as well as the relative inflexibility of some market participants bound to pipeline volumes by long-term contracts with take-or-pay obligations.
- In case of disruption of gas the deliverability of gas from underground storages is a mitigating factor but its availability depends on storage level and the speed with which gas can be delivered to the consumers. It needs to be pointed that the large majority of storage is designed for a rigid winter-summer cycle, so the contribution to a sustained disruption may be more limited than what capacity numbers suggest.

2.1.4 Coal

2.1.4.1 Consumption, production and imports

Coal is a generic term used for a range of solid fuels with varying composition and energy content, including hard coal, sub-bituminous coal, lignite/brown coal and peat[36].

The EU is the third largest coal-consuming region globally, after China and North America; the gross inland consumption of solid fuels in 2012 stood at 294 mtoe. In the period 1995-2012 the total demand for solid fuels in the EU went down by almost 20%, falling down in virtually all Member States. Following the slump in consumption in 2009, demand started recovering and 2012 was the fourth consecutive year of growth in solid fuel consumption. Yet, consumption is still below pre-crisis levels and indeed about 15% below the levels in the mid-90s. By far the largest part of solid fuels serves as transformation input to electricity, CHP and district heating plants, with smaller amounts going to coke ovens, blast furnaces and final energy demand.

Hard coal accounts for about 70% of gross inland consumption, but the EU produces about one third of the hard coal consumed and is dependent on imports for about 63%. About 70% of hard coal is used in power plants, the rest almost equally distributed between steel mills/coking plants and the heating market. In the period 2011-2012 the weakened steel business and the reduction in pig iron and crude steel production at the mills witnessed a drop in demand for hard coal. This was more than overcompensated with the growing use of steam coal for power generation. Lignite production and consumption also increased at a faster rate[37].

At the level of **all solid fuels**, EU production meets more than half of EU demand. Germany, Poland and the UK remain the largest consumers of solid fuels with consumption in 2012 up by 4% on annual basis in Germany, up by 27% in the UK and down by 4% in Poland. A number of Member States have seen a double-digit growth in consumption between 2011 and 2012, in particular Portugal (+33%), Spain (+23%), France (+12%), Ireland (+16%) and the Netherlands (+10%), though consumption remains below pre-crisis levels. The decline in coal and CO_2 prices and the high gas prices provided coal with a strong competitive advantage to gas in power generation.

Directive 2001/80 on the limitation of emissions of certain pollutants into the air from large combustion plants limited an even higher increase. It allowed a fixed number of operating hours for opted out plants, which have been utilised at a high speed; thus the upswing in the last two years in effect may lead to accelerated decommissioning.

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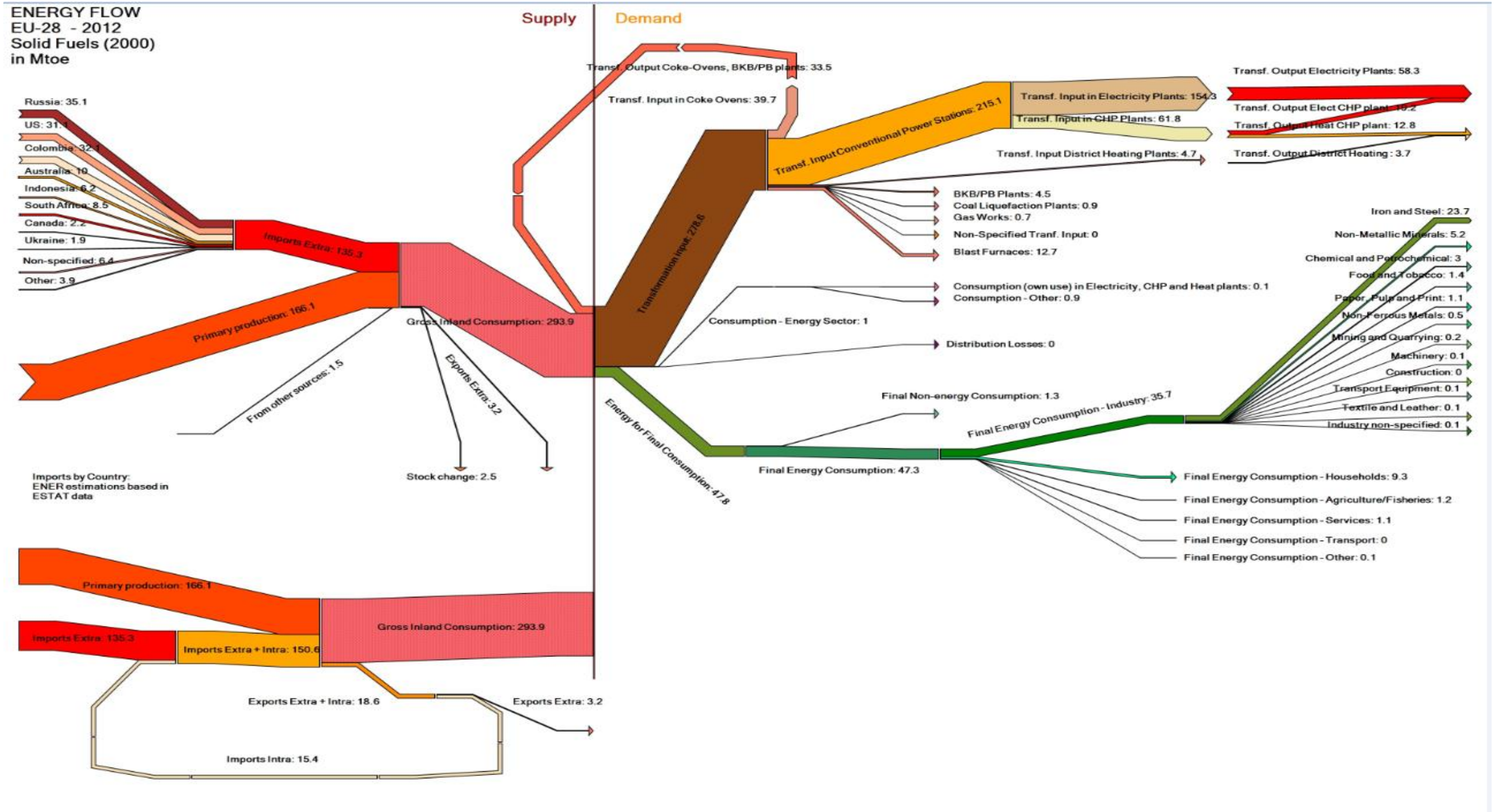
[36] Different international organisations apply different definitions and classifications of solid fuels. See Eurostat classification of solid fuels at http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/nrg_quant_esms_an1.pdf

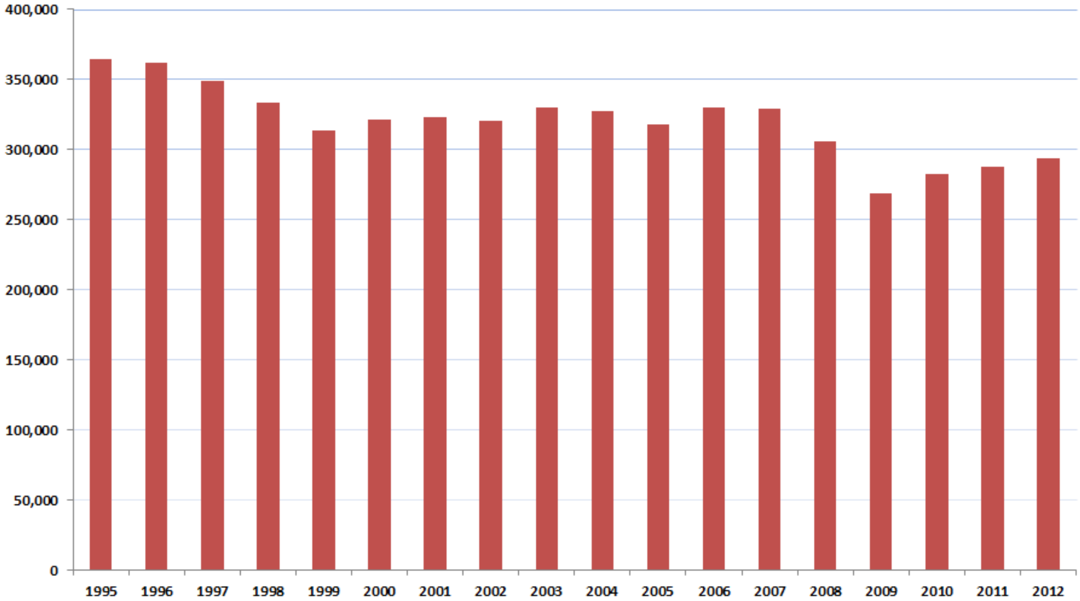
[37] Verein der Kohlenimporteure. 2013. Annual Report 2013. Facts and Trends 2012/2013

Figure 47. Energy flow of solid fuels in the EU, 2012



Source: Eurostat, energy. Calculations of the European Commission

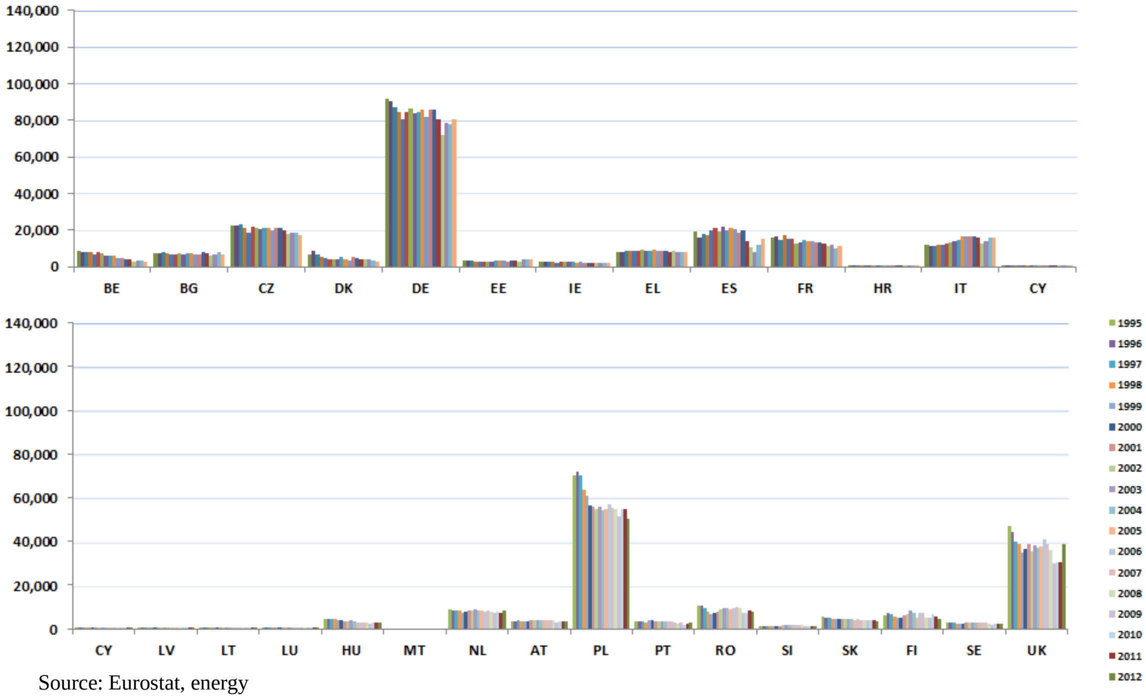
Figure 48. Gross inland consumption of solid fuels in the EU, 1995-2012, ktoe



Source: Eurostat, energy

Note: Solid fuels includes the following categories:hard coal and derivatives; lignite, peat and derivatives; oil shale and oil sands.

Figure 49. Gross inland consumption of solid fuels by MS, 1995-2012, ktoe

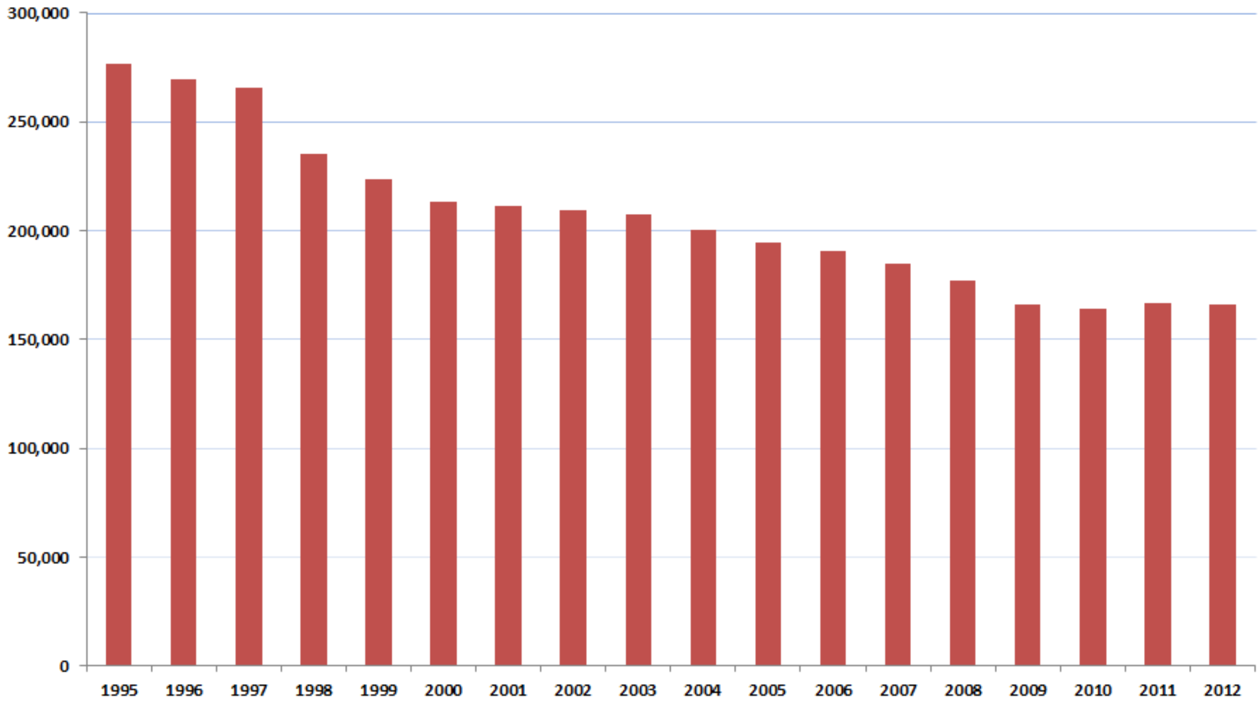


Source: Eurostat, energy

The EU remains a large coal producer. In 2012 it produced 167,533 ktoe of solid fuels, a relatively stable output on annual basis, but down by 40% in comparison to the mid-1990s and well below pre-crisis levels. Since the mid-1990s the production of solid fuels in the largest producers in the EU –

Poland, Germany and the Czech Republic – went down by 37%, 40% and 25%, respectively, but has been stable over the last 2 years.

Figure 50. Total energy production of solid fuels in the EU (1995-2012), ktoe

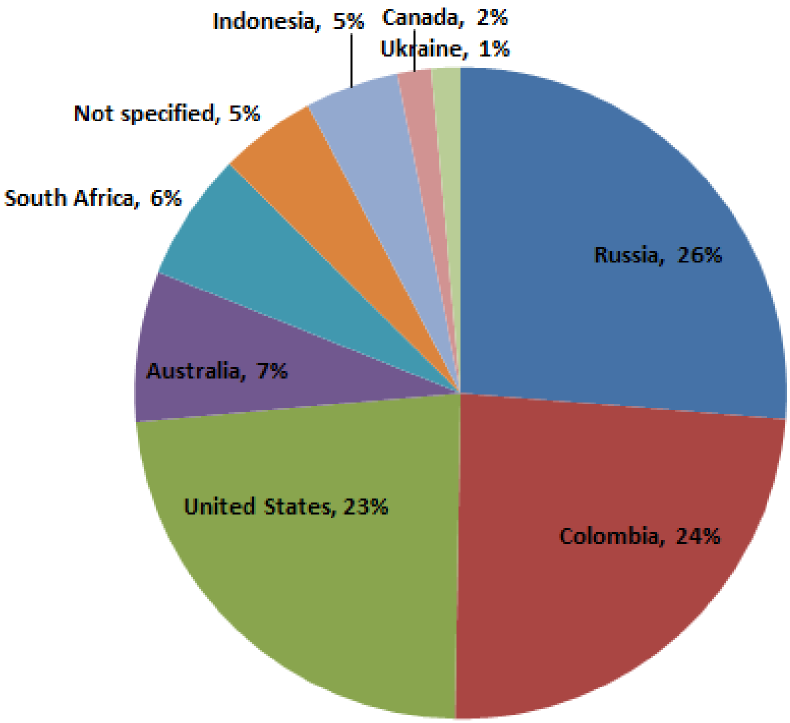


Source: Eurostat, energy

Hard coal imports to the EU are rising to compensate for the decline in domestic coal production and meet the recent increase in demand by power utilities driven by the fall in coal import prices and the competitive position of coal in the power sector. Total imports on 2012 increased faster than consumption (+3.3% on annual basis), pointing to high stockpiles of coal at major ports and power plants.

Russia remains the largest exporter of solid fuels to the EU (26% of imports to the EU), followed by Columbia (24%) and the US (23%). The United States has gained a higher share of the European market. Declining steam coal exports from Indonesia and South Africa have been replaced by greater supplies from Colombia and the United States. Australian imports have declined against competition from North American exporters.

Figure 51. Extra-EU imports of solid fuels, by main trading partners (share in energy terms in 2012)



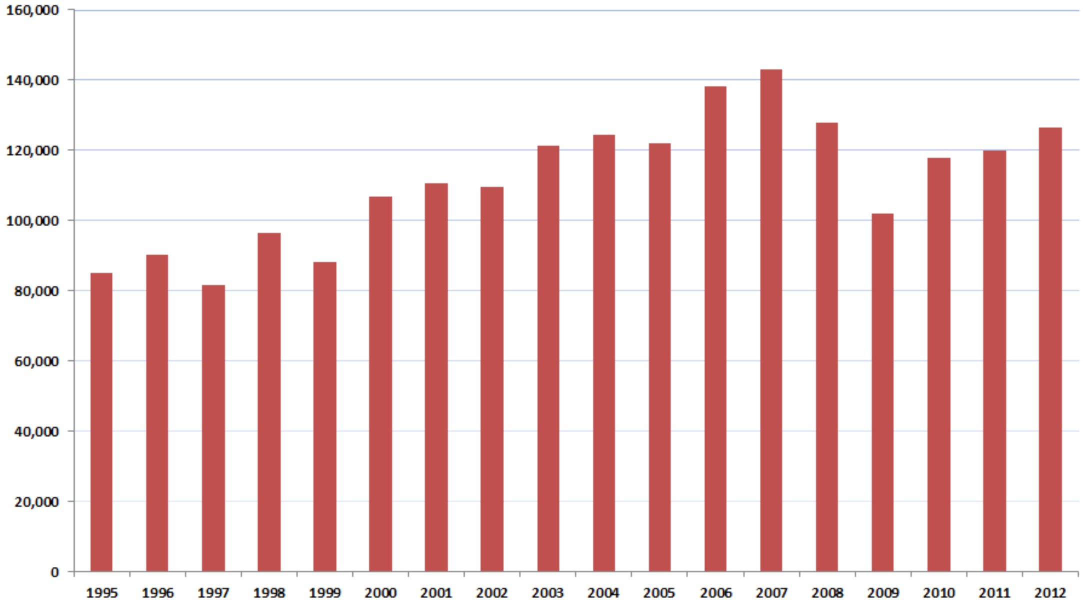
Source: Eurostat, energy

The largest importers of coal in the EU are Germany, the UK, Italy and Spain. Between 2011 and 2012 there has been a decrease in hard coal net imports to Germany as higher consumption was absorbed by growing domestic production and less stock building. Demand for steam coal surged in the UK due to increased coal-fired generation, driving up net imports of hard coal (including steam coal)[38].

The fall in production, along with the increase in consumption of solid fuels, have been driving up the energy deficit of solid fuels – calculated as the difference between total demand and total production. While the deficit is below the 2007 peak levels, it has grown up by 5% in 2012 compared to 2011 (and by 25% since 2009, the lowest value since the turn of the century).

[38] IEA. 2013. Mid-term coal market report.

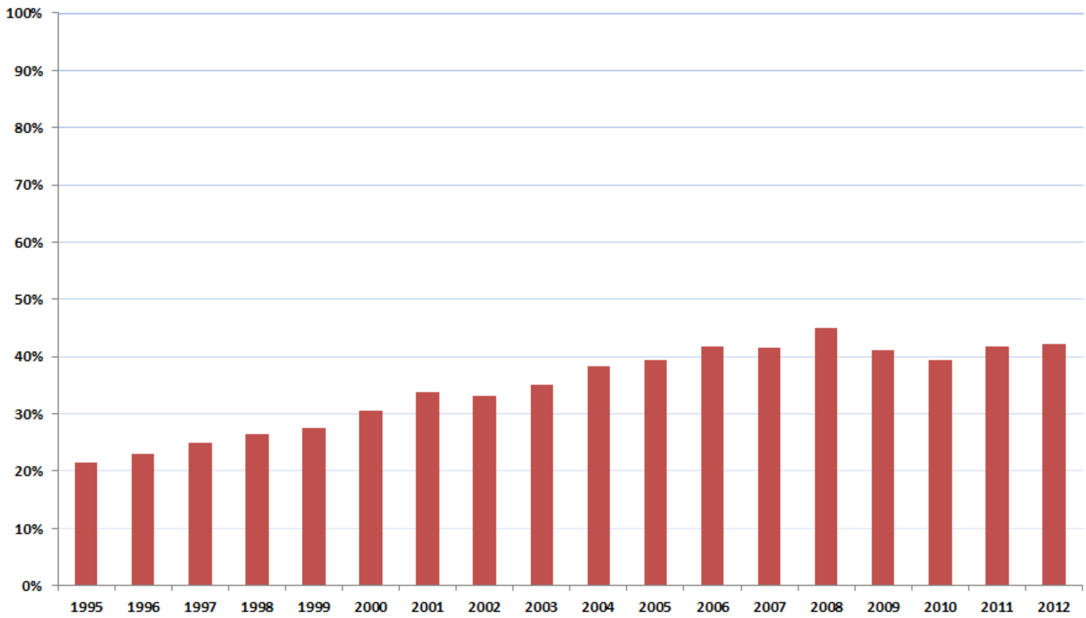
Figure 52. Energy deficit of solid fuels to the EU28, 1995-2012, ktoe



Source: Eurostat, energy

The net import dependence of the EU on solid fuels from countries outside the EEA remains low in comparison to other fossil fuels, but has almost doubled since the mid-90s and has been above 40%in recent years, after peaking at 45% in 2008. Hard coal accounts for virtually the entire solid fuel imports to the EU. Chapter 4.9 offers another metric of diversification (supplier concentration index) that takes into account both the diversity of suppliers and the exposure of a country to external suppliers and looks at net imports by fuel partner in the context of gross inland consumption of each fuel.

Figure 53. Import dependence of solid fuels, EU28 from countries outside the European Economic Area



Source: Eurostat, energy

2.1.4.2 Coal infrastructure

Coal mining, transport, processing, storage and blending infrastructure come at play before coal reaches the final user.

The way that coal is transported to where it will be used depends on the distance to be covered – in general coal can be moved directly by railroad, truck, pipeline, barge or ship[39]. Over relatively short distances coal transportation can be carried out by conveyor or truck. Trains and barges are used for longer distances within domestic markets, or alternatively coal can be mixed with water to form a coal slurry and transported through a pipeline. International transportation commonly relies on ships in different sizes (BGR 2013)[40]. The use of barges on inland waterways and as an interconnecting link between land- and sea-freight is also locally important. The share of transport costs in the delivered price of coal varies widely depending on the type of coal purchased and location of the consumer.

Coal enters the EU predominantly by sea and to a smaller extent by land (rail) and is transported overland or on major rivers. The main trans-loading ports for coal imports into Europe are in the Netherlands (Rotterdam and Amsterdam), which along with Antwerp in Belgium, constitute the ARA trading area – the most important for imported coking coal and steam coal in north-west Europe, with Rotterdam alone handling 60% of seaborne coal to Europe.

Besides seaborne imports, Europe is also supplied by overland transport volumes. The main entry points by rail are coal imports to Poland from Ukraine and Russia. Coal is also transported by land within the EU by railway or truck, e.g. from Poland to Germany or from Scotland to England.

[39] Energy obtained from coal can be transported as a liquid or gaseous fuel.
[40] Handysize - 40-45,000 DWT, Panamax - about 60-80,000 DWT, Capesize vessels - about 80,000 DWT

Efficient transport infrastructure therefore is of utmost importance with cross-border rail links and links to ports. For example, in 2012 about 50% of German hard coal imports entered on domestic ships from ARA ports, 30% are transported through German seaports and the remaining 20% overland by rail[41]. About half of the hard coal exports from Poland are transported by land to neighbouring countries, with the remaining volumes trans - shipped via the Baltic ports.

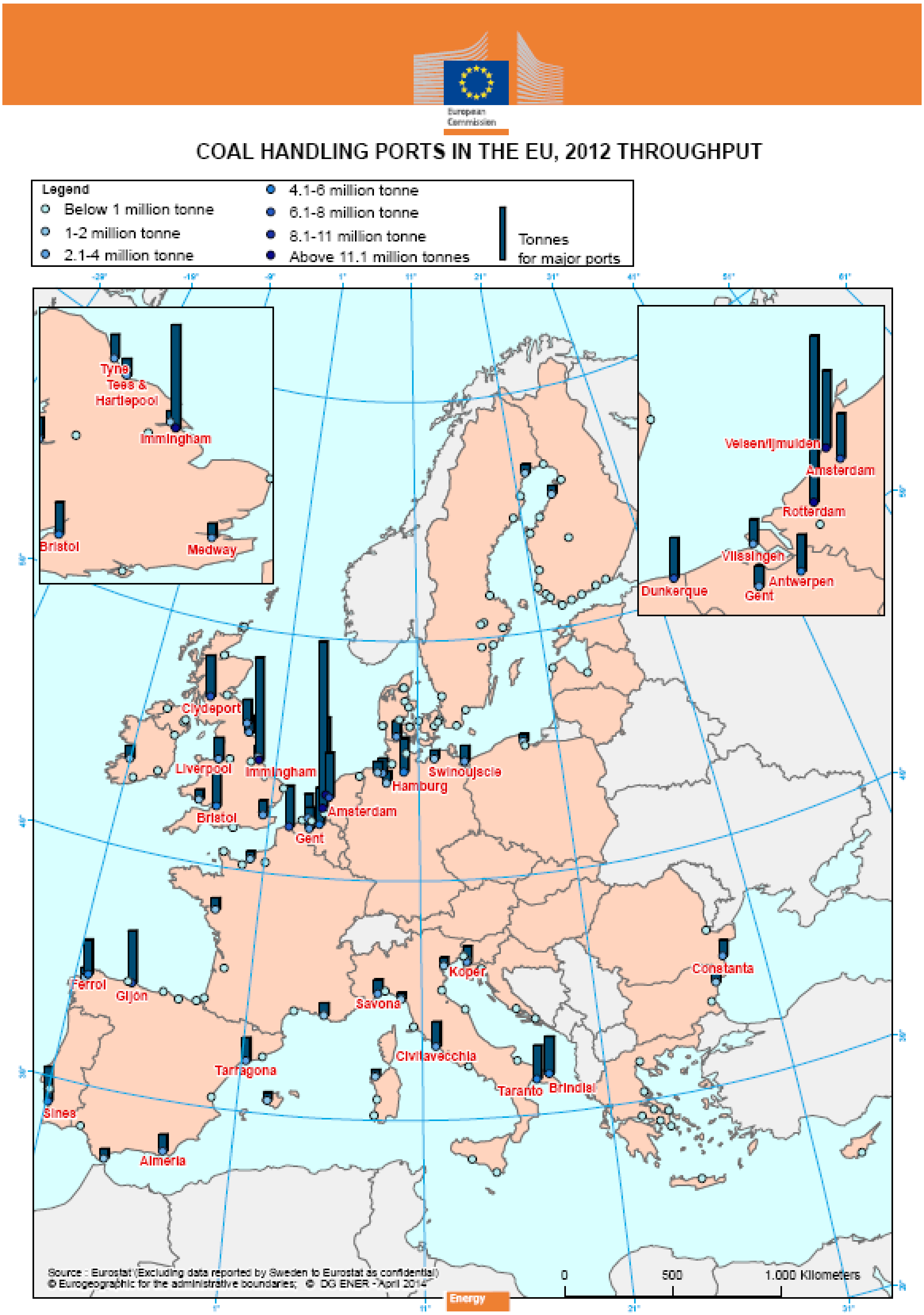
Volume is one of the crucial aspects of measuring performance of ports, indicating the throughput or a port's output (see Figure 54).

Coal stockyards act as storage capacity – either as a buffer or for the longer term – and also have an important role in helping to achieve the most appropriate blend of coals for particular end uses. Various stacking and reclaiming methods exist. In principle stocks are held by producers (mines), importers (e.g. at ports), energy transformation industries (power plants) and large consumers. The coal stored in European ports is the property of coal traders and consumers (e.g. power companies). Unlike in the case of oil, there is no minimum stock requirement in terms of coal inventories and stock changes almost daily. The total storage capacity of Europe's largest transhipment hub – the EMO in Rotterdam – has a stock of 7 million tons of hard coal. Apart from EMO, there are other larger cargo-handling companies with sizeable daily transhipment in the Netherlands (Rotterdam EBS and RBT; Amsterdam OBA), in Germany (Hamburg Hansa port; Wilhelmshaven and Nordenham Rhenus Midgard), in Belgium (Antwerp Seainvest), in UK (Immingham)[42]. All these ports have an estimated 2 to 4 million tonnes of storage capacity related to the handling capacities .

[41] Verein der Kohlenimporteure. 2013. Annual Report 2013. Facts and Trends 2012/2013

[42] Numbers provided by Euracoal. No information on transhipment of coal ports in Spain (Gijon) or France (Dunkirk).

Figure 54. Major coal handling ports in the EU, 2012 throughput



International coal trade has grown over the past three decades, but still accounts for less than a fifth of hard coal production[43]. The collapse in maritime freight rates since the economic and financial crisis has reduced costs associated with international transportation of coal. Different geographic markets are generally well integrated, as seaborne transport costs are much lower than, for example, for LNG.

Historically steam coal was produced domestically in Member States close to the place of consumption of steam coal – mine-mouth thermal power plants. The production costs of domestic steam coal exceeded increasingly the import costs of steam coal plus the associated transport costs and gradually Member States have been downsizing domestic production of steam coal[44].

Internationally traded steam coal is split into two major markets: the Atlantic basin (focussed on the Amsterdam-Rotterdam-Antwerp, ARA hub) and the Pacific basin (focussed on the Newcastle hub in Australia). The Atlantic market for steam coal – that has gradually come to replace domestic steam coal production – is made up of the major utilities in Western Europe and the utilities located near the US coast, with major suppliers being South Africa, Colombia, Russia and Poland; the share of US coal in total coal imports to the EU has increased from 12% in 2008 to 17% in 2012. The Richards Bay port in South Africa plays an important role in constraining price divergence across the two basins.. The intercontinental maritime coal market is well integrated with extensive spot and derivative trading.

Europe is increasingly an import led coal market and international prices act as leverage to negotiate price contracts with domestic coal producers[45]. At the same time, global coal markets are very competitive, well diversified and operate with minimal geopolitical risk.

Coal prices can differ due to differences in coal quality and transportation costs. In recent years the spreads between the major coal benchmarks for internationally traded coal to the Atlantic market have been edging ever lower. China became a significant net importer of coal in 2009. Since then prices of Chinese coal imports have risen above those in Europe and have remained at a price premium of up to 50%.

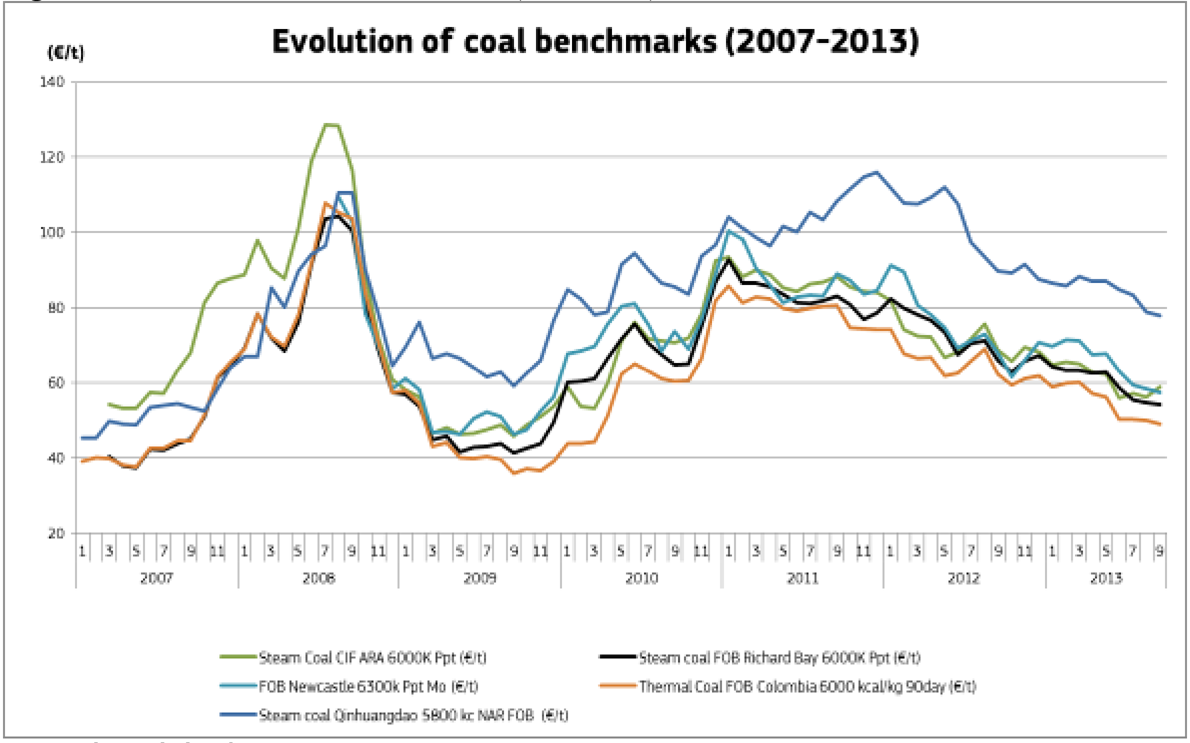
The demand-driven doubling of global hard coal production capacities since the turn of the century and the continuing expansion of existing mines and the opening up of new mines, have given rise to today‘s excess capacities and oversupply in the global hard coal market[46]. The current increase in US exports due to the shale gas boom that depressed the domestic coal market also plays a role in the oversupply.

This excess global supply of hard coal has already led to the closure of mines in the USA, Australia and China, as well as the announcement of planned closures in Europe. Against this oversupply situation, prices of coal have gone down.

[43] The intercontinental maritime coal market is proportionally small because of the vast domestic coal market in China.
[44] KEMA 2013
[45] Unlike for hard coal, there is no free - market price formation for lignite used in power generation and very little international trade. This is because its low energy density makes transport uneconomic over longer distances. For this reason, it is common to build lignite - fired power plants adjacent to lignite mines such that producer and consumer co–exist in a captive market and form a single economic entity. Lignite is then most economically transported by dedicated infrastructure – typically a conveyor belt – delivered directly to nearby power plants under, for example, 50 - year contracts (Euracoal 2013).

[46] Verein der Kohlenimporteure. 2013. Annual Report 2013. Facts and Trends 2012/2013

Figure 55 Evolution of coal benchmarks (2007-2013)



Sources: Platts and Bloomberg

Summary coal

The EU is the third largest coal-consuming region globally. Demand for solid fuels in the EU went down by almost 20% since the mid-90. Following the slump in consumption in 2009, demand started recovering and 2012 was the fourth consecutive year of growth in solid fuel consumption. A number of Member States have seen a double-digit growth in consumption between 2011 and 2012, in particular Portugal (+32%), Spain (+20%), France (+13%), Ireland (+12%) and the Netherlands (+10%). The decline in coal and CO_2 prices and the high gas prices provided coal with a strong competitive advantage to gas in power generation.

The EU is dependent on imports of hard coal (used in power plants, steel mills/coking plants and the heating market). Hard coal accounts for about 70% of gross inland consumption of solid fuels, but the EU meets only about one third of its needs for hard coal with idnigenous production.

The EU has a diversified portfolio of coal suppliers, with Russian, Colombian and US imports accounting for each for apprximately a quarter of hard coal import quantities.

Raising production costs of domestic hard coal and depressed prices on global coal markets have made imports an economically attractive option; international prices increasingly act as leverage to negotiate price contracts with domestic coal producers.

Efficient transport infrastructure is of utmost importance for coal trade with cross-border rail links and links to ports.

Global hard coal markets are very competitive and well diversified. Different geographic markets are generally well integrated, as seaborne transport costs are much lower than, for example, for LNG. Global markets have not experienced spikes or disruptions as the ones observed in the crude oil market or in some regional markets for natural gas. Thus, there is no minimum stock requirement in terms of coal inventories and stock changes almost daily.

Just like with other energy commodities, coal deliveries run physical, including weather-related, risks to security of supply. Weather conditions, such as floods, may impact mine production. In addition, weather can cause delays in seaborne imports and domestic river transport (low river levels or freezing conditions). Congestion of transport infrastructure can lead to disruption of supplies. Yet, one could reasonably expect such disruptions to be short-lived, with inventories offering a short-term buffer and the continuing oversupply in global coal markets giving scope for reaction.

2.1.5 Uranium and nuclear fuel

Nuclear fuel differs from fossil fuels in the sense that the raw material (uranium) must undergo several processing steps (milling, conversion, enrichment) before being fabricated into fuel assemblies which in turn must be tailor-made for each reactor type.

Nuclear materials and fuel cycle services are bought and sold by industrial companies (reactor operators and fuel producers), not directly under government-to-government agreements, although in many cases bilateral state-level agreements set the framework for commercial contracts. Many but not all reactor operators and fuel producers are partly or even fully state-owned.

In the EU, there are two distinct nuclear fuel procurement approaches: utilities operating western design reactors usually enter into separate contracts with uranium mining companies, conversion service providers (which convert solid U_3O_8 into a gaseous form, UF_6), enrichment service providers and finally fuel assembly manufacturers. This approach allows for diversification of all steps of the front end of the fuel cycle, and for bigger utilities it offers the possibility to maintain several suppliers at all stages.

In contrast, utilities operating Russian design reactors in most cases purchase their fuel as integrated packages of fuel assemblies, including the uranium and related services, from the same supplier, the Russian company TVEL. In this approach, there is no diversification, nor backup in case of supply problems (whether for technical or political reasons). Ideally, diversification of fuel assembly manufacturing should also take place, but this would require some technological efforts because of the different reactor designs (VVER 440 and 1000).

On the supply side, EU industry is active in all parts of the nuclear fuel supply chain. While uranium production in the EU is limited, EU companies have mining operations in several major producer countries. EU industry also has significant capacities in conversion, enrichment, fuel fabrication and spent fuel reprocessing, making it a global technology leader.

Since the 1990's, EU dependency on imported uranium has remained constant, while domestic mining production and reprocessing cover roughly 5 % of the EU needs for uranium. In conversion and enrichment, external dependence in the 1990's was around 20 %, the rest being covered by domestic supplies. However, with the EU enlargements of 2004 and 2007 and the enrichment technology transition in France, this share has increased to around 40 % in 2012, although the latest data from 2013 points to a slight decrease in this dependency rate. Likewise, for fuel fabrication, in the 1990's, only 2 Russian design reactors in Finland were dependent on Russian fabricated fuel, but today reactors also in Bulgaria, Czech Republic, Hungary and Slovakia depend on Russian fabrication services, while the reactor in Slovenia depends on US-fabricated fuel.

Demand for **natural uranium** in the EU represents approximately one third of global uranium requirements.

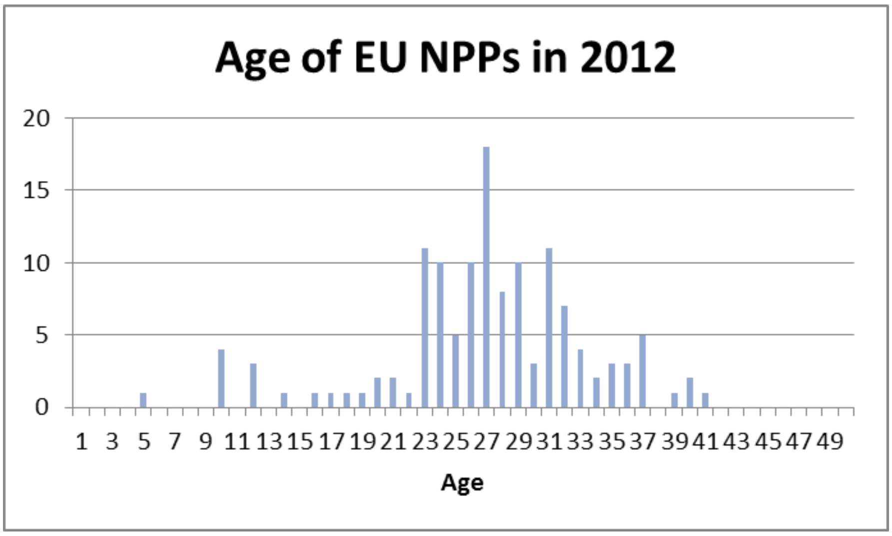
Table 3. Commercial nuclear power reactors in the EU, 2013

Belgium	7
Bulgaria	2
Czech Republic	6
Finland	4 (1)
France	58 (1)
Germany	9
Hungary	4
Netherlands	1
Romania	2
Slovakia	4 (2)
Slovenia/Croatia*	1
Spain	7
Sweden	10
United Kingdom	16
Total	**131 (4)**

* Croatia's power company HEP owns a 50% stake in the Krsko nuclear power plant in Slovenia
Source: ESA

At the end of 2013, there were 131 commercial nuclear power reactors operating in the EU, located in 14 EU Member States and managed by 18 nuclear utilities. There were four reactors under construction in France, Slovakia and Finland. EU gross electricity generation amounted to 3295 TWh in 2012 and nuclear gross electricity generation accounted for 26.8 % of total EU production. A significant share of nuclear power plants in the EU is 20 or more years old.

Figure 56 Average age of nuclear power plants in the EU

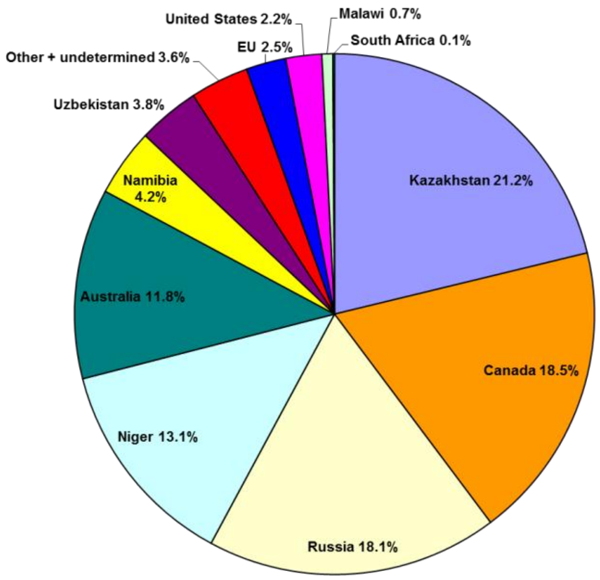


Source: European Commission

In 2013, fresh fuel containing the equivalent of 2 343 tonnes uranium (tU) was loaded into commercial reactors in the EU-28. It was produced using 17 175 tU of natural uranium and 1 024 tU of reprocessed uranium as feed, enriched with 12 617 thousand Separative Work Units (tSWU).

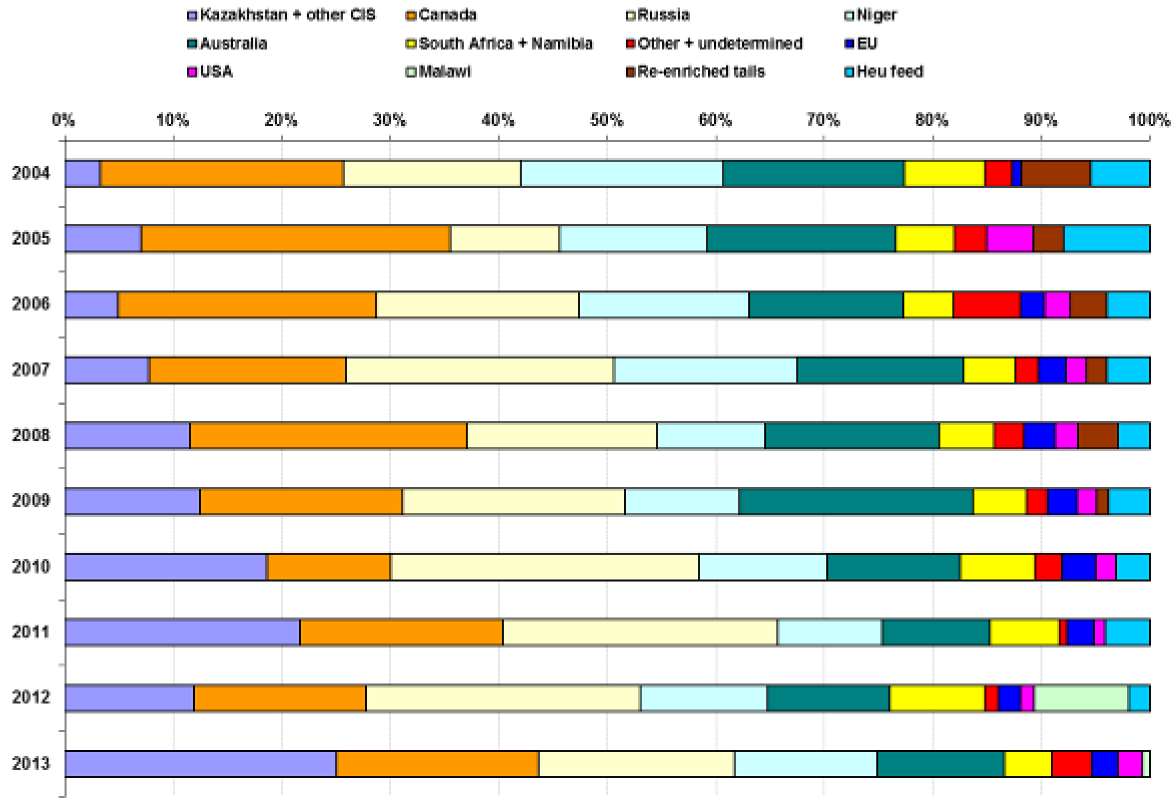
Deliveries of natural uranium to EU utilities occur mostly under long-term contracts, the spot market representing less than 10 % of total deliveries.

Figure 57 Origins of uranium delivered to EU utilities in 2013 (% share)



Source: ESA

Figure 58 Purchases of natural uranium by EU utilities by origin, 2004–13 (tU) (%)



Source: ESA

Natural uranium supplies to the EU come from well-diversified sources, with the main uranium-producing regions being the CIS, North America, Africa and Australia.

Kazakhstan and Canada are currently the top two countries delivering natural uranium to the EU in 2013, providing 40 % of the total. In 2013 uranium originating in Kazakhstan represented the largest proportion, with 3 612 tU or 21 % of total deliveries. In third place, uranium mined in Russia (including purchases of natural uranium contained in enriched uranium product, EUP) amounted to 18 %. Niger and Australia account for 13 % and 12 %, respectively.

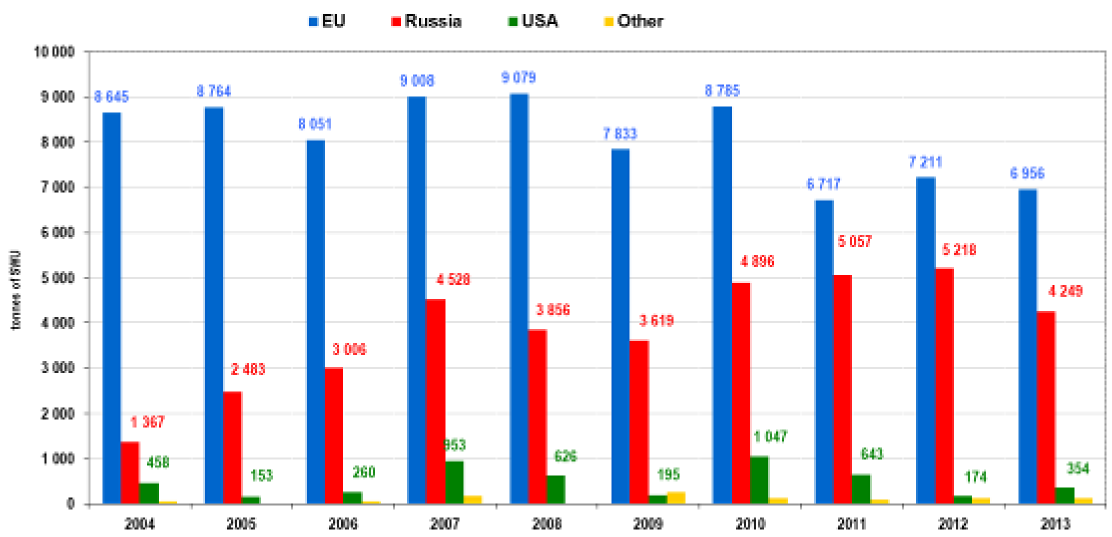
Table 4. Providers of enrichment services delivered to EU utilities

Enricher	Quantities in 2013 (tSWU)	Share in 2013 (%)	Quantities in 2012 (tSWU)	Share in 2012 (%)	Change over 2012 (%)
AREVA/Eurodif and Urenco (EU)	6 956	60%	7 211	57%	-4%
Tenex/TVEL (Russia)	4 249	36%	5 218	41%	-19%
USEC (USA)	354	3%	174	1%	104%
Others ([1])	119	1%	122	1%	-2%
TOTAL	11 678	100%	12 724	100%	-8%

([1]) including enriched reprocessed uranium. Source: ESA

In 2013, the **enrichment services** (separative work) supplied to EU utilities totalled 11 678 tSW. Some 60 % of the EU requirements were supplied by the two European enrichers (AREVA and Urenco). Deliveries of separative work from Russia (Tenex and TVEL) to EU utilities accounted for 36% of EU requirements, while 3 % were provided by the US company USEC.

Figure 59 Supply of enrichment to EU utilities by provider, 2004–13 (tSWU)



Source: ESA

In terms of mining volume, European uranium produced in the Czech Republic and Romania covers approximately 2 % of the EU utilities' total requirements.

When it comes to **conversion**: The current EU capacity operated by the French AREVA, 14 000 tU/y would be more than sufficient to cover most of EU needs, if run at full capacity and if no exports were taking place. This plant is being replaced by a more modern COMURHEX II facility of similar capacity with progressive starting of the units planned by 2015.

Likewise for **enrichment**, the EU-based capacities operated by AREVA and Urenco would be sufficient to cover all EU needs if no exports were taking place. It has to be underlined that these EU companies are major suppliers for worldwide customers (in the USA, Asia, South Africa, Latin America).

In fuel **fabrication**, EU industry – with facilities in Germany, Spain, France, Sweden and the UK – would be able to cover all EU needs for western design reactors, and in principle could also establish the production capacity needed for VVER fuel (for Russian design reactors). However, developing and licensing fuel assemblies for Russian design reactors would take a few years in normal circumstances, provided that a sufficient market is available to make the investment attractive for the industry.

Currently roughly 20% of EU nuclear power plant requirements for **natural uranium** and 36% of the requirements for uranium enrichment services are covered by supplies from Russia. A small portion of EU requirements are fulfilled by imports from the USA.

In addition Russia supplies **fuel assembly manufacturing services** for the Russian design reactors in Bulgaria (2 reactors) Czech Republic (6), Finland (2), Hungary (4), Slovakia (4).

While Finland also operates non-Russian design reactors with western fuel supplies, BG, CZ, HU and SK are 100 % dependent on Russian nuclear fuels (uranium, conversion, enrichment and fuel fabrication) with the exception of CZ which has domestic uranium mining and partly diversified enrichment supplies). In order to estimate the risk of this dependency for overall energy supplies, the share of nuclear in the energy mix needs to be taken into account.

In addition, also many western EU utilities have substantial supplies of enriched uranium from Russia (20-40 % of their needs). However, nuclear materials and other fuel cycle services than fabrication may be substituted by other sources, in particular in current market conditions which are rather favourable for buyers (as long as reactors in Japan remain shut down the market for uranium and fuel cycle services is in oversupply and prices have been declining since the Fukushima accident in 2011).

The situation of Romania deserves a special mention. Although the two reactors operating in Romania are based on the Canadian CANDU technology, Romania is self-sufficient for its fuel needs as it produces uranium and masters the fuel fabrication process, because the uranium used in this type of reactors does not need to be enriched.

One important development is the success of non-EU reactor vendors (Russian and to some extent US-Japanese and possibly Korean in the future) to win orders for new build in the EU, often based on attractive financing arrangements. In the case of the Russian vendor, reactor construction is linked to long term fuel supplies due to the lack of alternative fuel fabricator.

At the same time, the Russian industry is developing fuel assemblies for western type pressurised water reactors and could enter this commercial market in the 2020 horizon. These two developments together could increase the EU dependency on Russian nuclear fuel supplies, if mitigating measures are not taken.

2.1.5.1 Risk and resilience

While the EU is highly dependent on uranium imports, uranium can be and is sourced from a large number of countries, and some of the major producers such as Australia and Canada are long standing close EU partners. Even in countries such as Kazakhstan and Niger, EU industry has large ownership interests in uranium mining operations.

On the risk side, there is certainly some political uncertainty with uranium coming from CIS countries (Russia, Kazakhstan and Uzbekistan) and Africa. In recent years, Kazakhstan has become by far the world's largest producer, with still further potential to increase its production. It is thus the equivalent of Saudi-Arabia in oil production. Serious political unrest in Kazakhstan or Niger could certainly impact uranium prices, but considering the significant inventories held by EU utilities, a real shortage appears highly unlikely in the medium term. Other countries, e.g. Canada, Australia or Namibia could increase their production in response. During the commodity boom around 2004–2008, a lot of exploration was carried out and identified uranium reserves have increased but are not being developed due to currently depressed prices. The market is thus working according to price signals.

When global demand recovers or in case of a supply problem somewhere, other producers could fill the gap. More widespread reprocessing of spent fuel and re-enrichment of depleted uranium could also provide additional supplies if needed and could be performed by EU industry.

For other parts of the fuel cycle, EU industry can cover most or all of the EU utilities' needs. The main element there is to ensure the continued viability of the EU industry so that this capacity remains at least at the current level and does not disappear as a result of short term economic considerations.

While the EU uranium conversion capacity is concentrated in France, enrichment plants operate in France, Germany, the Netherlands and the UK. Likewise, fabrication plants are located in many Member States, albeit not all can produce fuel for different types of reactors, without major investments.

In general, transport and storage capacity do not constitute major issues for the nuclear fuel cycle.

- **Market resilience: European price levels versus major benchmarks**

The market for uranium and fuel cycle services is a global market and prices are very similar in different regions. Compared to oil and gas markets, the nuclear fuel market is much smaller and less liquid, meaning that prices could spike up rapidly in case of supply problems. However, the cost of uranium and even of the whole nuclear fuel is only a small part of the operating costs of nuclear power plant (5–10%), so that even a sharp increase in fuel prices would not lead to a big change in the final electricity price.

- **Risks to the viability of the EU industry**

The Russian potential in enrichment services is very strong. The installed capacity of Russian uranium enrichment facilities accounts for about 28 500 tSWU, which covers roughly half of the world's total capacity and over twice the EU annual requirements. Therefore, as happened in the 1990's, the risk remains that over abundant imports from Russia could jeopardize the viability of the EU enrichment industry, leading to less secure supplies in the future if European capacities were to be reduced.

At the moment, the traditional US enricher (USEC) is able to supply only very limited quantities of enrichment services. It is possible that in the early 2020's one or two American companies and possibly the Chinese may be exporting some enrichment services but will most likely not be significant players outside their domestic markets. Longer term, more competition to EU suppliers can be expected.

- **The problem of fuel fabrication**

While all parts of the fuel cycle are indispensable, before fuel fabrication takes place, nuclear materials can be substituted with equivalent materials from other sources. However, fuel assemblies are reactor-specific and fuel fabrication is a critical part for security of supply.

For western design reactors, alternative fabricators are available and licenced but replacing the Russian-made fuel assemblies for Russian design reactors by a non-Russian supplier could take 2–3 years in a best-case scenario, likely even more, due to extensive licensing and testing requirements before commercial use. **Many of the Russian reactor operators in the EU have stocks of fuel for only a few months and would be wise to consider increasing their inventories of fabricated fuel.**

While there is previous experience of fuel fabricated by the US-Japanese company Westinghouse (with production facilities in Spain and Sweden) used for the Russian design reactors of VVER-440 and VVER-1000 type, the new proposed Russian reactors, to be built in Finland, Hungary, Turkey and possibly in the UK, would be of a new type VVER-1200 and it is uncertain whether Westinghouse or another producer would develop this type of fuel assemblies without a reasonable assurance of having a market.

The Westinghouse production capacity for the VVER-440 fuel, which used to be produced in Spain, has been dismantled due to lack of orders in the face of aggressive pricing by the Russian competitor. For the VVER-1000 fuel, production capacity exists in Sweden and is currently used to supply some reactors in Ukraine. This capacity might be expanded in case of sufficient demand from EU utilities. The mere existence of a competing alternative would be a strong incentive for Russia to not use nuclear fuel as political leverage and to not raise prices unilaterally.

With a view to mitigating dependence from Russian supply, in some cases utilities operating Russian design reactors have diversified part of the supply chain and have sent uranium enriched in the EU to Russia for fuel fabrication (no alternative fabricator due to reactor type). Such an option is technically possible, but allegedly increases costs and entails delays and risks due to increased transport requirements, and Russian custom practices and taxes. In fact, this option is discouraged by the Russian side, **as the fuel fabrication company TVEL (which is also a part of ROSATOM) usually delivers its customers a ready, all-inclusive package and is not keen to decrease its sales**.

Summary nuclear

While the EU is highly dependent on uranium imports, uranium can be and is sourced from a large number of countries, and some of the major producers such as Australia and Canada are long standing close EU partners.

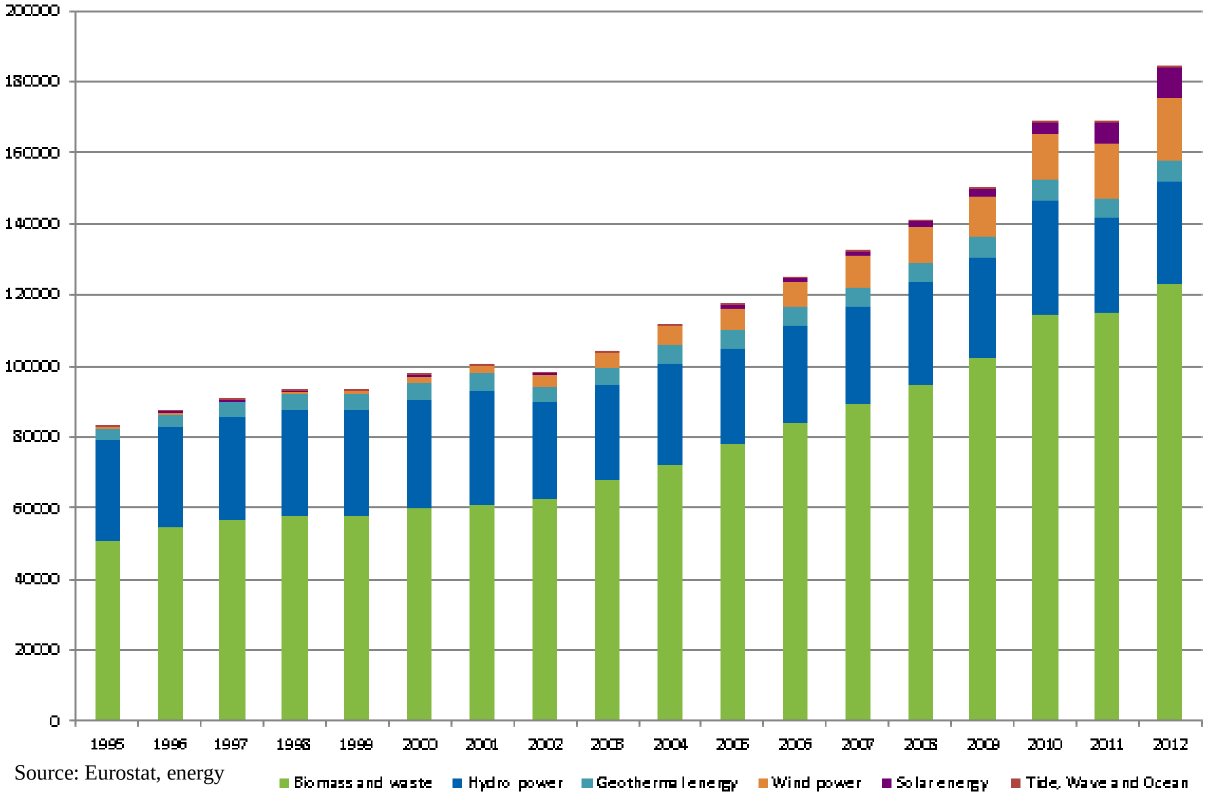
EU industry has large ownership interests in uranium mining operations in countries such as Kazakhstan and Niger.

EU utilities hold significant inventories, making a real shortage highly unlikely.

2.1.6 Renewable energy

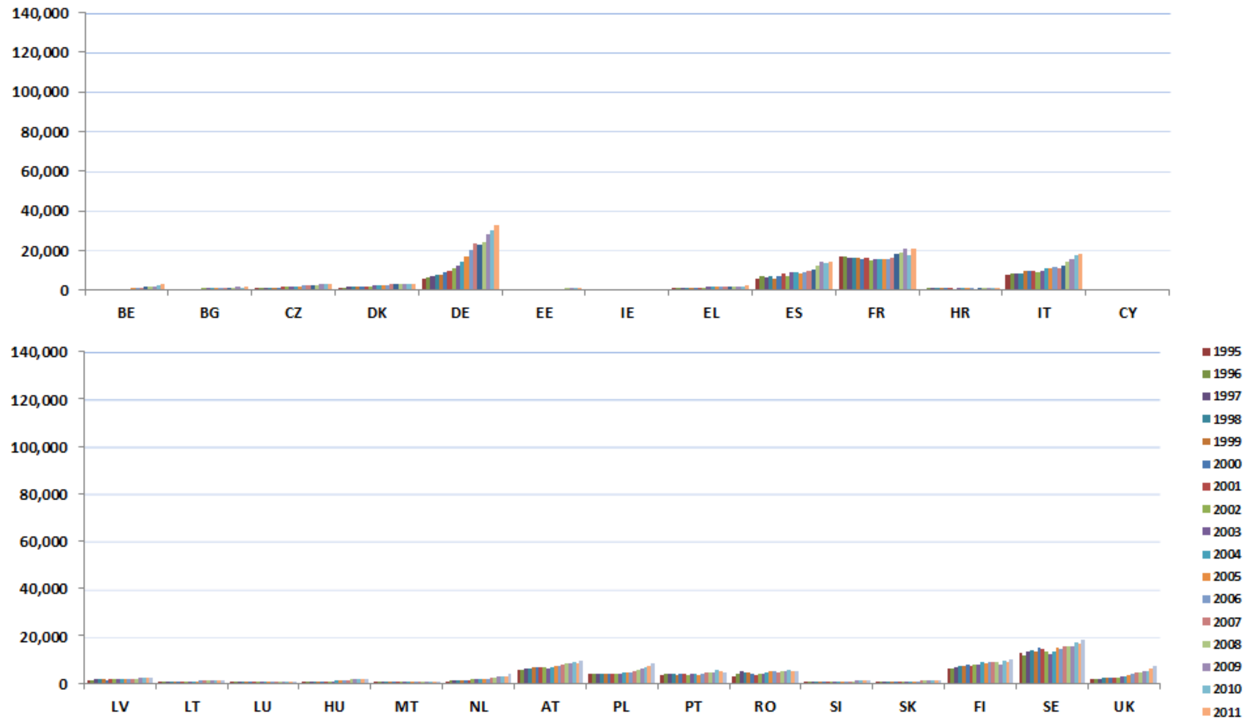
The total demand for renewables in the EU has almost doubled in a decade with steep growth in a number of Member States, including Germany, Spain and Italy. Import dependency in renewables is negligible (below 4% overall, though much higher for all biomass uses) and often conferred to intra-EU trade movements.

Figure 60. Gross inland consumption of renewable energy sources in the EU, 1995-2012, ktoe



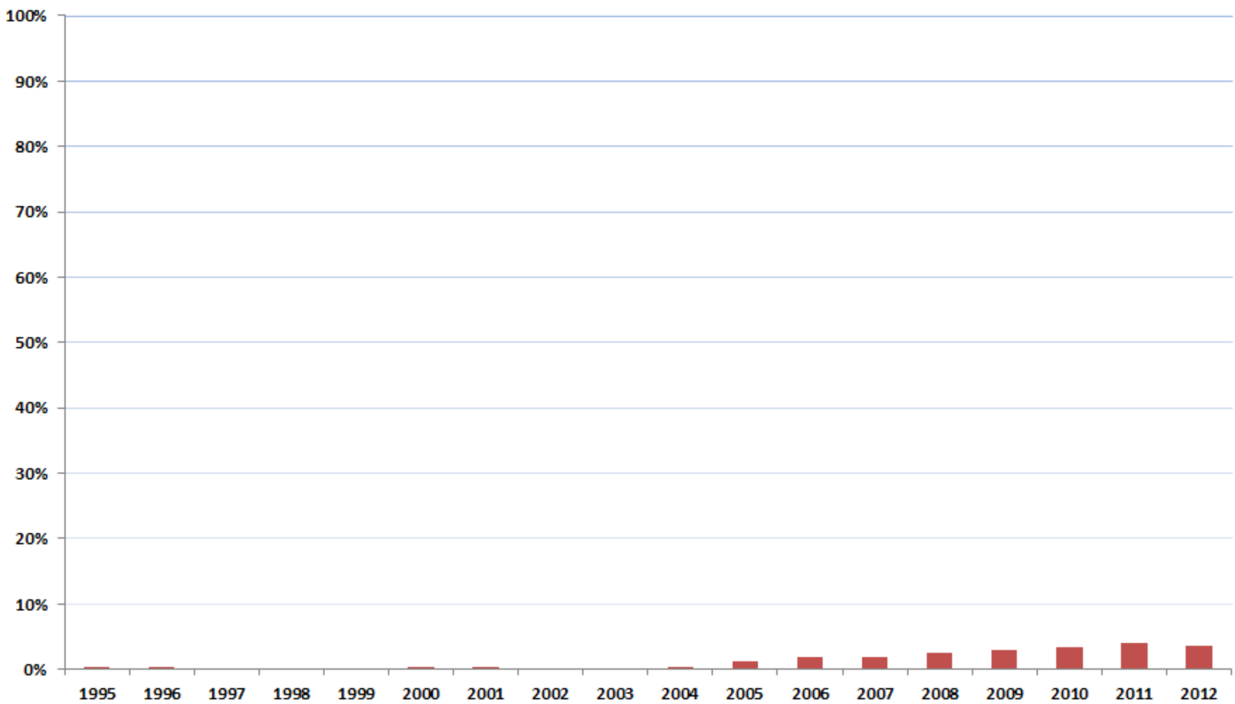
Source: Eurostat, energy

Figure 61. Total production of renewable energy sources by MS, 1995-2012, ktoe



Source: Eurostat, energy

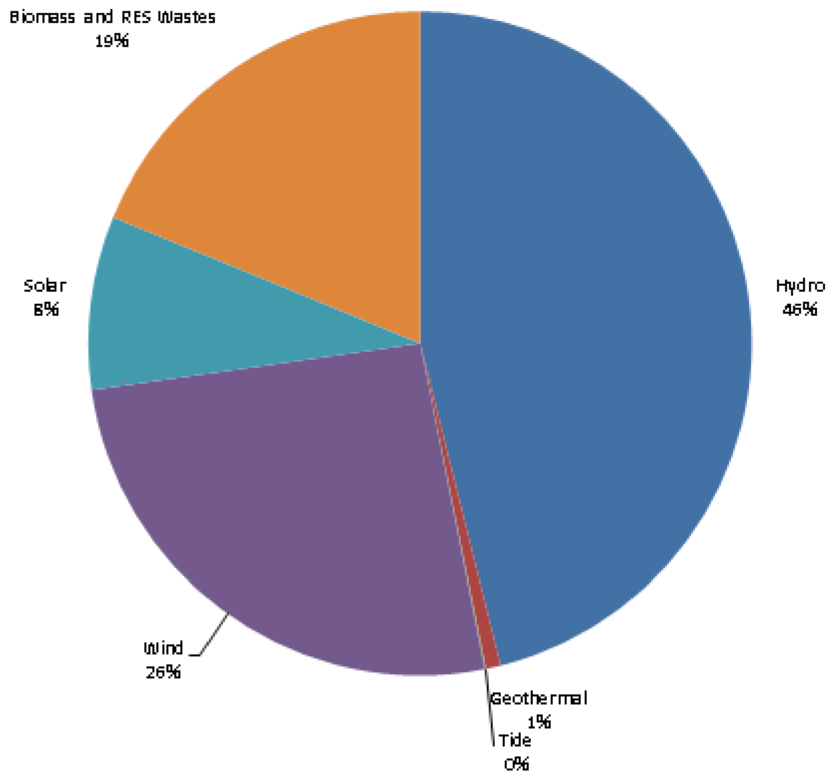
Figure 62. Import dependence of renewable energy sources, 1995-2012, %



Source: Eurostat, energy

In 2012 the production of renewable electricity reached 799 TWh, an increase of more than 13% compared to 2011. It now accounts for 24% of gross electricity generated. Hydro power is the most important renewable electricity source and accounts for 46% of renewable electricity generation in the EU, followed by wind (26%), biomass and RES wastes (19%) and solar (8%). Between 2011 and 2012 electricity from solar energy saw an impressive growth of more than 50%, with its share in renewable electricity generation reaching 9%. Electricity from wind registered a growth of about 14% and electricity from biomass and waste of about 12%.

Figure 63. EU gross electricity generation of renewables by source, 2012



Source: Eurostat, energy

In 2012 the EU had installed about 44% of the world's renewable electricity (excluding hydro). The average RES share is highest in the electricity sector – 24%, and this sectors has also witnessed major increase in renewable energy based capacity. The RES share in heating sector stands at about 16% and in transport – 5%.

2.2 Energy transformation

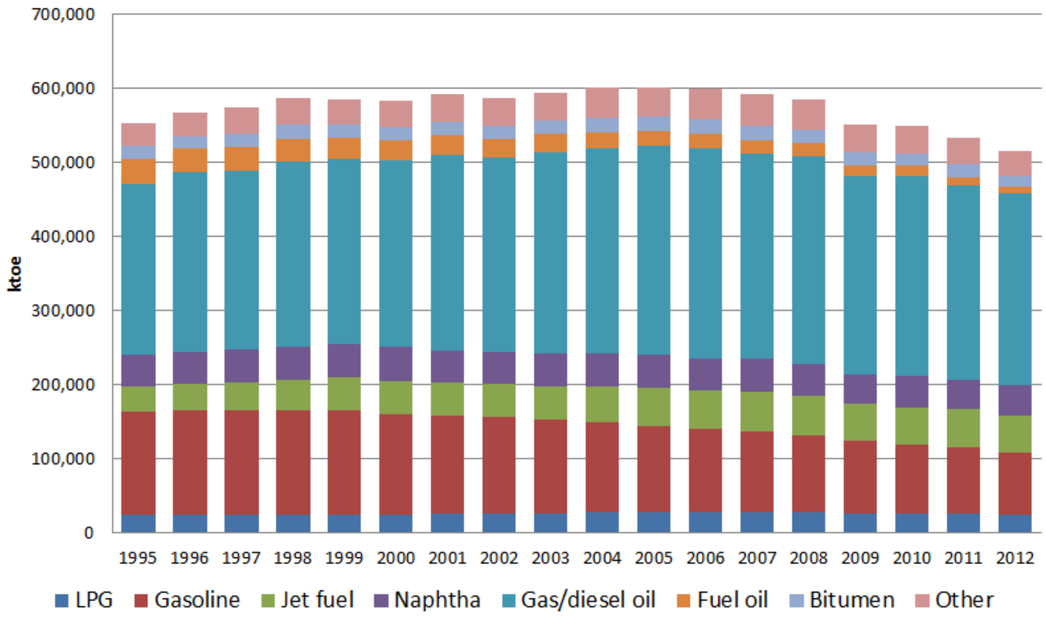
2.2.1 Refining

The refining industry has a crucial role in transforming crude oil and other feedstock into oil products which can be used for final consumption. From the final consumption of oil and oil products, transport has a dominant role, representing 64% in 2012. Within the transport sector, road transport makes up 83% and aviation 15%. Industry, including both non-energy and energy consumption, uses 22% (from which the chemical and petrochemical industry 14%) while the share of other sectors (mainly residential, services and agriculture) is 14%.

The EU is the second largest producer of oil products after the United States, with a production capacity of some 15 million barrels per day in 2012, about 16% of global refining capacity. According to Europia, the association of European petroleum industry, 83 mainstream refineries (those with an annual capacity of at least 2.5 million tons/year) operated in the EU in 2012.

Overall, EU refining capacity is well above EU demand for oil products. In fact, the decline in the demand for refined products since 2005, which accelerated after the financial crisis, has led to a significant excess refining capacity. Falling demand (by 14% between 2005 and 2012), coupled with excess capacity, decreasing utilization and increased competition from non-EU refineries have depressed margins. Projections for future oil product demand point towards continuing decline, with the exception of middle distillates which may continue to grow for a few more years.

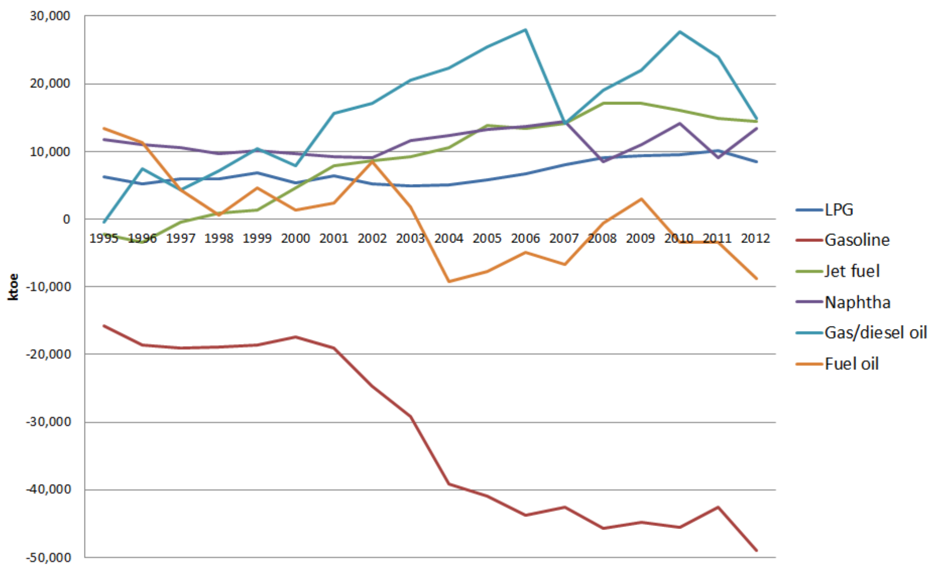
Figure 64. Final consumption of oil products in the EU, ktoe



Source: Eurostat, energy

While the EU has ample refining capacity to cover the overall demand for petroleum products, there is a **mismatch of supply and demand when individual products** are concerned. As a result, the EU is a net exporter of certain products (in particular gasoline and, to a smaller extent, fuel oil) but a net importer of others (mainly gasoil/diesel, jet fuel, naphtha and LPG).

Figure 65. Net imports of main petroleum products in the EU, 1995-2012, ktoe

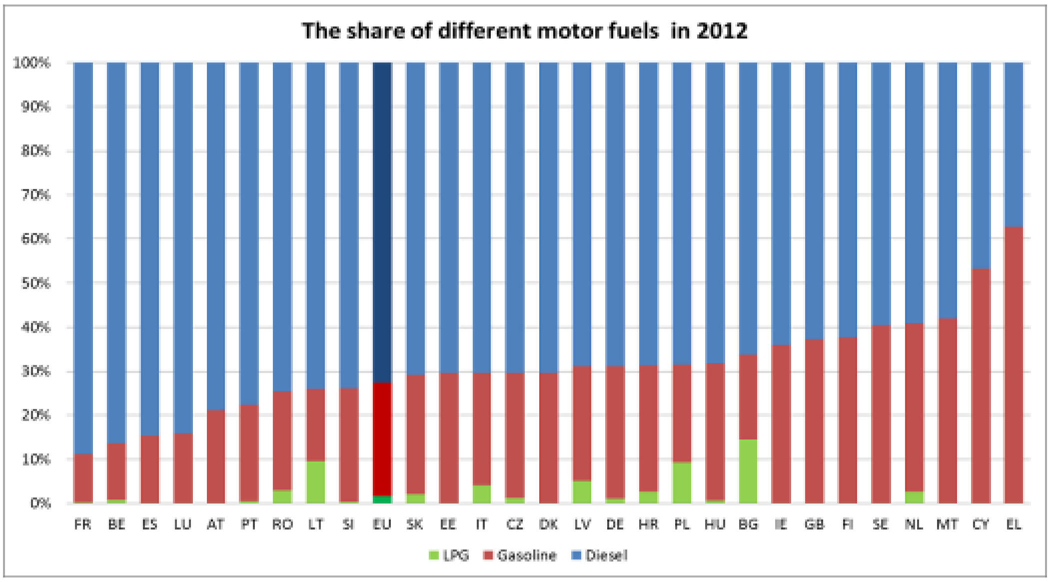


Source: Eurostat, energy

Overall, exports and imports are more or less in balance (with a net product export of 7.5 mtoe in 2012). In 2012, net exports of gasoline amounted to 49 mtoe, close to 40% of EU refinery total gasoline output of 127 mtoe. Net imports of middle distillates (gasoil/diesel, jet fuel and other kerosene) totalled 31 mtoe, equivalent to about 10% of the consumption of these products.

This is a result of the "dieselisation" whereby gasoline-fuelled vehicles are replaced by those equipped with diesel engines. At least partly, this development has in the past been driven by taxation policy across the EU which has generally imposed a lower duty on diesel fuel than on gasoline.

Figure 66. Gasoline and diesel in motor fuel consumption



Source: European Commission, DG Energy

In 2012, the consumption of gasoline represented only 26% of total consumption of motor fuels in the EU. Greece – where diesel cars have been banned from the main cities – and Cyprus were the only countries where the consumption of gasoline exceeded that of diesel. The share of LPG among motor fuels is less than 2% in the EU although in some Member States (especially Bulgaria, Lithuania and Poland) its share can reach up to 9-15%.

The response of a number of EU refining companies to the current market situation and future prospects has been to put refineries up for sale or to halt operations, sometimes for indefinite periods of time, and/or converting sites to terminals. However, complete closures of refineries is often hindered by high clean-up costs which owners would have to incur.

According to the IEA, there has been a reduction in capacity of 1.8 million barrels/day in Europe since 2008, in terms either of refinery closures, transformation of refineries into import terminals or capacity reductions. Despite these reductions, it is considered that the region is still suffering from overcapacity and that more refineries, especially the less sophisticated ones, remain at risk of closure in the coming years.

Capacity reductions have an impact on security of supply because every refinery produces a certain amount of products which are indispensable from a security of supply standpoint (such as middle distillates and naphtha, of which the EU is a net importer). Therefore, refinery closures are making the EU more dependent on product imports and increasing the reliance on related infrastructure (import terminals and product storage facilities).

In addition to shut-downs, many refineries have changed hands since the beginning of the crisis. Many of the sellers have been vertically integrated oil companies, while not all recent buyers have significant experience in refining. Indeed, it is far from evident that all recent buyers of refineries in the EU either have long-term interests or the financial strength to keep refineries open. Furthermore, most of the EU refining capacity that has been sold since the crisis has been to non-EU companies.

In sharp contrast to EU demand, non-EU petroleum product demand especially for products such as diesel, gasoil and naphtha is projected to grow significantly. Expectations are therefore of growing global competition - and, therefore, growing prices - for supplies of such products, which happen to be also the petroleum products which the EU consumes more than it produces. The EU has in fact been experiencing a growing trend in net imports of middle distillates and naphtha in the last few years. Major refining investments in the Middle East and Asia are expected to stabilise refining capacity globally.

On the other hand, the EU produces much more gasoline than it consumes and exports the rest. The US has been the main outlet for this excess gasoline over the last few years, but it has been significantly reducing its imports of gasoline. Finding new outlets for gasoline exports has become an increasingly difficult challenge.

Going forward, and even taking into account falling EU demand, it therefore appears very likely that the EU's import dependence on certain products such as gasoil/diesel will increase, unless the industry is able to invest in further conversion capacity to produce more middle distillates. Such investments are also necessary (but technically more difficult) to decrease the high gasoline yield of the EU refining industry, which would reduce the EU refining industry's 'export dependence' in that fuel[47].

[47] Most refinery upgrade projects increase middle distillate yield by decreasing fuel oil yield; eliminating the gasoline surplus is not straightforward.

2.2.2 Electricity

Electricity is the most widely used energy source in the EU and its existence is indispensable for almost all domains of everyday life and economic operations. Electricity can be generated from various sources (fossil fuels, nuclear, renewable energy sources, etc.). There is a great deal of variety in the composition of power generation mixes and the source of feedstock used for electricity generation.

2.2.2.1 Electricity consumption, generation and imports

As Table 5 shows the share of solid fuels in the EU-28 power mix was 27.4% in 2012, and the import dependency of solid fuels was 26%, being lower than for other fossil fuels, mainly due to abundant domestic brown coal and lignite endowments. 53% of all solid fuels in the EU-28 were used in conventional electricity generation power plants and 21% were used in conventional thermal power stations.

Table 5. Import dependency and solid fuel consumption in the electricity generation in 2012

			Share of solid fuels gross inland consumption	
2012	Import dependency	Share of solid fuels in power generation	In electricity plants	In CHP plants
EU-28	25.6%	27.4%	52.5%	20.7%
BE	100.0%	4.1%	26.0%	0.9%
BG	5.2%	48.3%	78.2%	16.1%
CZ	-11.5%	50.8%	46.9%	28.6%
DK	100.0%	34.4%	0.0%	98.3%
DE	20.4%	44.0%	70.8%	8.6%
EE	-6.6%	81.9%	62.1%	4.0%
IE	78.0%	29.4%	72.4%	0.3%
EL	-1.1%	51.0%	68.1%	29.2%
ES	78.4%	18.5%	82.9%	0.3%
FR	98.4%	3.4%	35.8%	2.7%
HR	100.0%	21.2%	78.9%	0.5%
IT	99.7%	16.4%	67.7%	0.3%
CY	100.0%	0.0%	0.0%	0.0%
LV	93.9%	0.0%	0.0%	12.9%
LT	86.2%	0.0%	0.0%	0.0%
LU	100.0%	0.0%	0.0%	0.0%
HU	16.0%	18.3%	58.6%	2.3%
MT	-	0.0%	-	-
NL	100.0%	23.6%	44.4%	17.2%
AT	100.0%	6.1%	24.6%	3.5%
PL	-8.1%	83.0%	0.0%	66.0%
PT	100.0%	28.1%	99.1%	0.0%
RO	5.4%	38.8%	53.6%	31.9%
SI	14.2%	32.7%	9.8%	85.5%
SK	67.2%	11.9%	0.0%	32.3%
FI	63.9%	15.3%	16.7%	47.8%
SE	87.1%	0.5%	0.0%	19.6%
UK	73.4%	39.4%	81.0%	0.4%

Source: Eurostat, energy

Across different Member States there were significant differences regarding import dependency, the share of coal in power generation, and the importance of electricity and heat generation in the annual coal consumption. Countries like Denmark, Ireland, Croatia, the Netherlands, Portugal and the UK are characterised by a significant share of coal in their power mix (at least 20%), a high level of import dependency (at least 70%), and the majority of their solid fuel consumption being taken up by the electricity and heat sector. The power sector in these member states is therefore sensitive to changes in import volumes of solid fuels, mainly steam coal, otherwise saying an import supply disruption would primarily impact electricity and heat generation.

Table 6 shows similar data for gas. Import dependency of gas (66%) was much higher than that of solid fuels in the EU-28 in 2012. The share of gas in the EU-28 power mix was 18.7%. The share of electricity generation was 14% in the annual EU gas consumption, while another 16% was used in combined heat and power plants. In the case of natural gas sectors besides power generation (e.g.: residential heating, industry, transport) are also important consumers.

Table 6. Import dependency and gas consumption in the electricity generation in 2012

			Share of gas gross inland consumption	
2012	Import dependency	Share of gas in power generation	In electricity plants	In CHP plants
EU-28	65,8%	18,7%	13,6%	15,8%
BE	98,6%	30,9%	25,4%	3,5%
BG	83,3%	5,0%	0,1%	32,3%
CZ	89,0%	4,4%	0,1%	16,6%
DK	-54,2%	13,6%	0,0%	29,1%
DE	85,7%	13,9%	8,4%	16,0%
EE	100,0%	5,3%	13,3%	11,8%
IE	95,6%	49,8%	49,6%	6,8%
EL	100,3%	21,9%	56,2%	4,3%
ES	99,6%	24,9%	27,3%	12,9%
FR	96,6%	4,3%	5,5%	10,9%
HR	37,1%	23,8%	0,5%	24,7%
IT	90,2%	44,8%	14,9%	26,0%
CY	-	0,0%	-	-
LV	113,8%	33,3%	0,0%	51,5%
LT	100,1%	57,1%	0,0%	30,2%
LU	99,7%	62,6%	0,0%	41,9%
HU	72,9%	27,5%	9,5%	15,7%
MT	-	0,0%	-	-
NL	-74,5%	57,4%	9,0%	22,2%
AT	86,3%	15,9%	12,2%	19,2%
PL	73,8%	5,0%	0,0%	15,7%
PT	99,7%	22,9%	23,7%	30,1%
RO	21,2%	14,8%	4,7%	18,6%
SI	99,8%	3,4%	0,3%	15,3%
SK	89,8%	11,7%	3,5%	12,0%
FI	100,0%	10,3%	5,1%	44,8%
SE	100,0%	0,8%	0,0%	48,2%
UK	47,0%	27,8%	21,8%	4,3%

Source: Eurostat, energy

Again, Member States showed significant differences regarding gas import dependency and its use in the electricity and heat sector. Countries like Belgium, Ireland, Greece, Spain, Italy, Latvia, Lithuania, Luxembourg, Hungary and Portugal were all common in having significant share of natural gas in their power mixes (at least 20%) and in high gas import dependency rates (at least 70%) in 2012. The electricity and heat generation sector in these countries are sensitive to import supply disruptions. Nevertheless, the share of the power sector is lower in the overall gas consumption than that in the solid fuel consumption in the countries highlighted in the table above. In case of supply shortages gas volumes might be put to the disposal of the power sector, though other important consumers (e.g. residential heating) may limit the flexibility of redirection of gas among different consumer segments.

It is important to note that from a security of supply point of view electricity generation is more sensitive to natural gas than to solid fuels. Import dependency is lower for solid fuels in the EU than for natural gas and coal import sources are more diversified globally, meaning that power generation in the EU is more resilient to external coal supply disruptions than to natural gas shortages. Additional measures to promote short-term flexibility of sources of electricity production are needed.

Crude and petroleum products only had significant shares in the power generation mix of Malta (with a share of 99%), Cyprus (94%), and, to a lesser extent, Greece (10%). These countries had full external dependency on oil and petroleum products. Malta used 78% of its gross inland petroleum product consumption in the electricity and heat sector, while in the case of Cyprus this ratio was 54%, and in Greece 9% in 2012. This makes the power sector in Malta and Cyprus sensitive to import oil supply disruptions.

Biomass and wastes accounted for 4.5% of power generation in the EU-28 in 2012. Around 12% of the annual biomass consumption in the EU was used in electricity plants and another 20% in combined heat and power generation. In the case of biomass and wastes import dependency is not significant in the EU, but biomass imports represent a significant share of the increase in biomass use in the EU.

The three main economic sectors consuming electricity were industry (with a share of 36% of the EU-28 electricity final consumption – 2,796 TWh in 2012), services (31%) and households (30%).

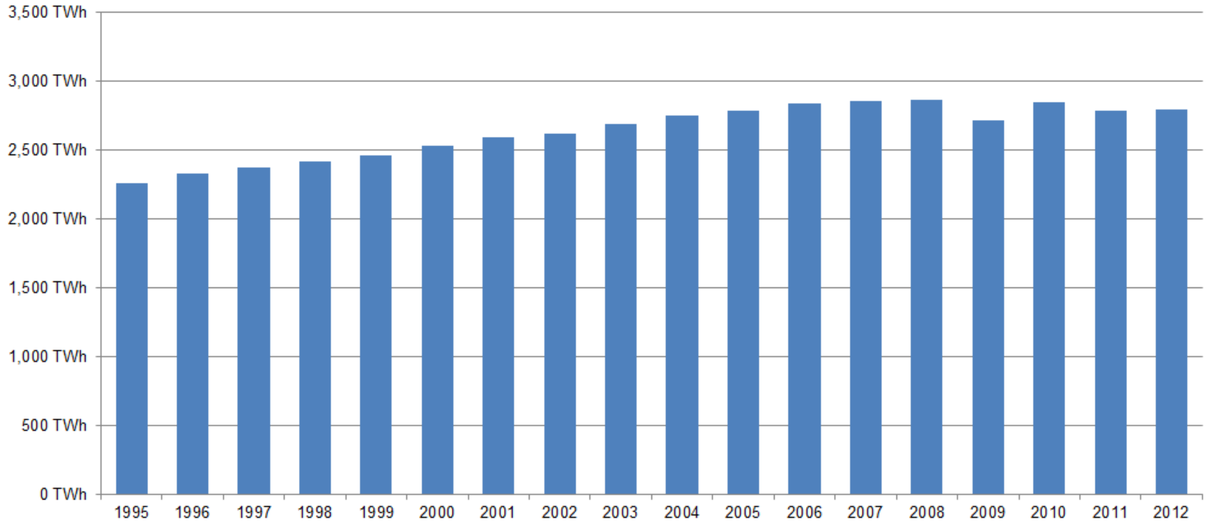
Electricity consumption in the EU-28 was steadily growing between 1995 and 2008, increasing by more than 26% during this time period. This growth was mainly due to the general increase in economic activities across the EU resulting in growing demand for power.

With the outbreak of the economic crisis in 2008 electricity consumption fell back in 2009 in most of the EU member states and was 2.4% lower in 2012 compared to 2008 on EU average, mainly due to the sluggish economic recovery, especially in those member states, which were the mostly affected by the economic downturn. During the whole 1995-2012 period the EU-28 electricity consumption went up by 23.5%, from 2,264 TWh measured in 1995 to 2,796 TWh in 2012.

The average EU growth hides significant differences among different member states. Bulgaria was the only member state where electricity consumption decreased during this period (-2.8%), while in Denmark it remained practically unchanged (+0.5%). There were four member states where the increase in electricity consumption remained below 10% (Sweden: 2.2%; Romania: 6.6%; United Kingdom: 7.8% and Slovakia: 8.8%) while on the other hand there were four countries where it exceeded 60% (Portugal: 60.5%; Ireland: 63.7%; Spain: 69.9%; Cyprus: 97.8%).

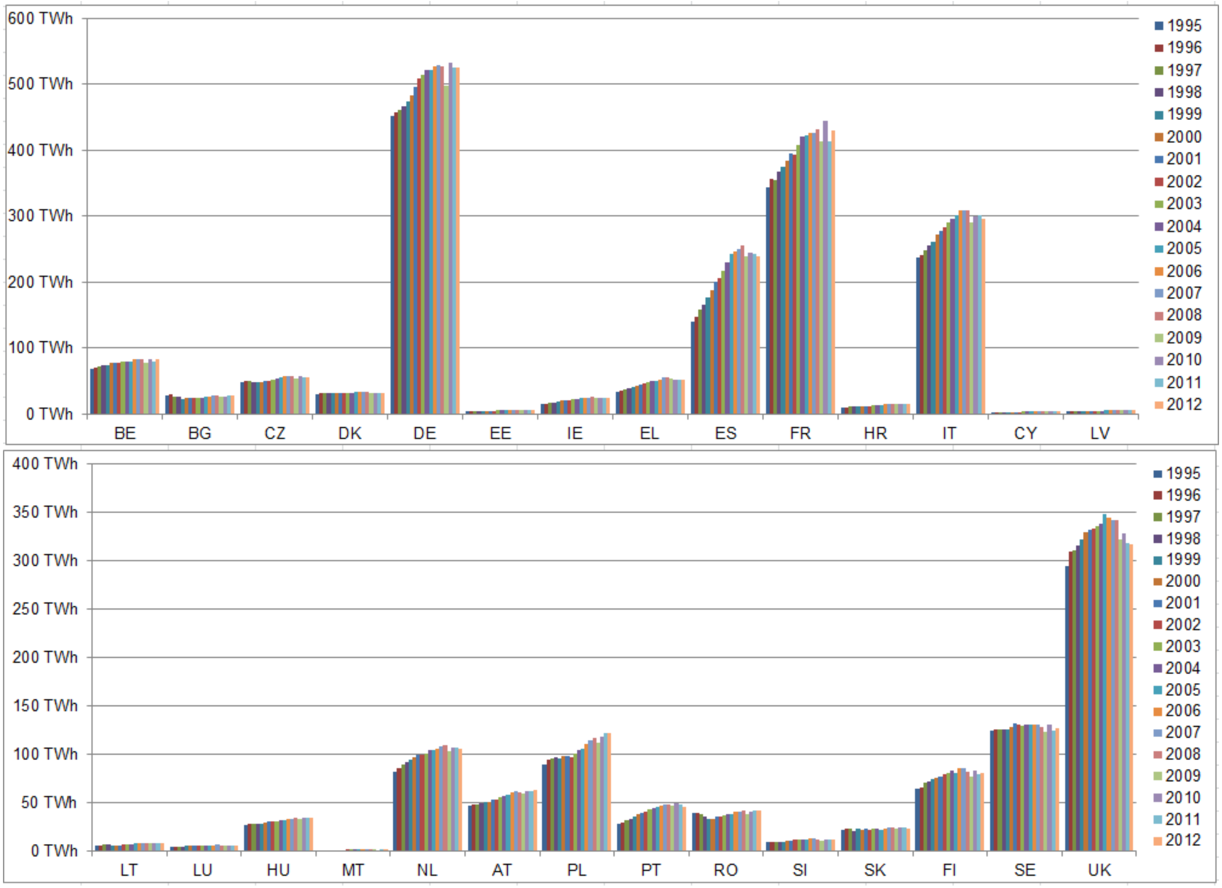
Electricity demand has been influenced besides the economic growth by the changes in the structure of the economy, energy efficiency measures and the role of electricity in overall energy consumption. For example, in many countries in Central and Eastern Europe restructuring of the economy, resulting in decreasing electricity intensity, helped to mitigate electricity consumption, though many countries in the region showed impressive economic performance during the 1995-2012 period.

Figure 67 Electricity available for final consumption in the EU-28 (1995-2012)



Source: Eurostat, energy

Figure 68 Electricity available for final consumption in the EU member states (1995-2012)

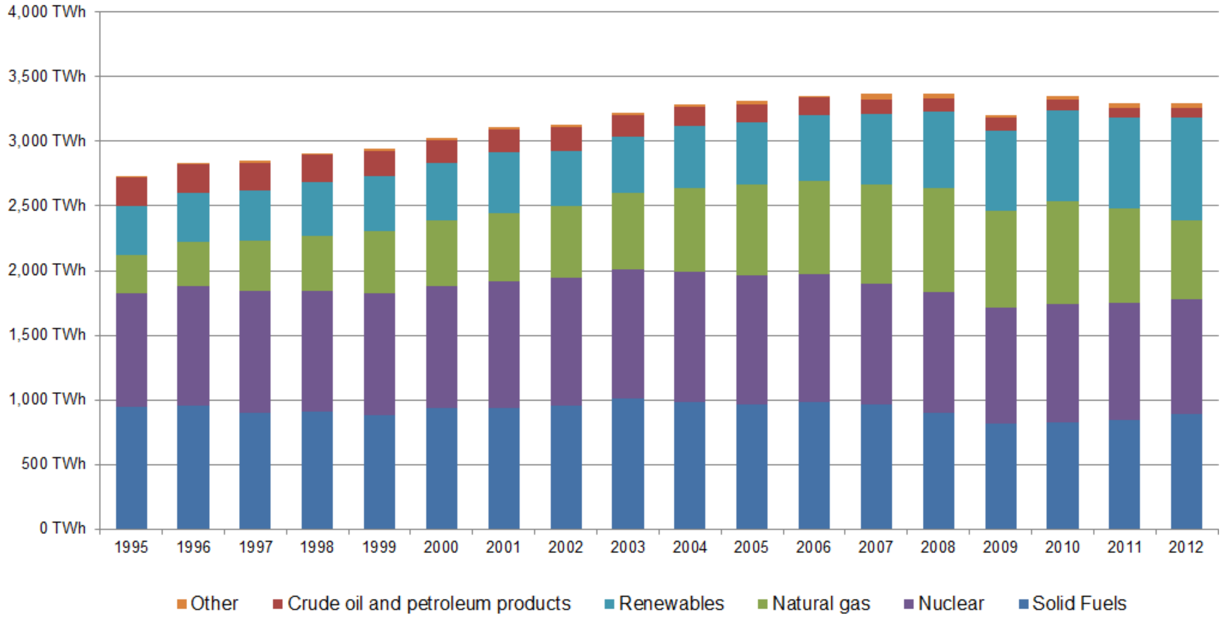


Source: Eurostat, energy

Not surprisingly, electricity consumption in a given country shows strong correlation with the size of the economy. In the EU the biggest electricity consumers are Germany, France, the UK, Italy and Spain, which countries accounted for 65% of the EU electricity consumption in 2012 (18.8%, 15.4%, 11.4%, 10.6% and 8.6%, respectively). On the other hand, the combined electricity consumption of Malta, Cyprus, Latvia, Lithuania and Luxembourg was 1% of the total EU consumption in 2012.

Figure 69 shows the evolution of power generation in the EU between 1995 and 2012. 27.1% of the EU-28 power generation was based on solid fuels (mainly coal and lignite) in 2012, followed by nuclear (26.8%), renewable energy sources (24.1%) and natural gas (18.7%). Since the mid-90s the share of solid fuels and nuclear went down by 8 and 5 percentage points, respectively, while the share of gas went up by almost 9 percentage points and of renewables by 10 percentage points. The increase in the share of renewables was mainly due to the rapidly growing wind and solar based power generation in the last decade, while the share of hydro remained practically stable.

Figure 69 Total gross domestic power generation in the EU-28, TWh



Source: Eurostat, energy

The share of nuclear power generation followed a downward trend in the EU power mix in this period, as in many member states the broader public opinion was not favourable of using nuclear as power source, especially after the two most serious nuclear power plant incidents ever (Chernobyl, 1986 and Fukushima, 2011). Countries like Germany or Belgium have decided to gradually phase out existing nuclear generation capacities, while Italy halted the nuclear plants after the Chernobyl accident and Austria has always been unfavourable towards nuclear power. In France however, though energy policies reckon with decreasing share of nuclear, this generation source will continue playing an important role even on the longer run. New nuclear power plant projects are in the phase of implementation in Finland, the UK and some Central and Eastern European countries.

Within renewable energies the share of wind energy has been rapidly growing; from the almost negligible share of 0.1% in 1995 to 6.7% in 2012 in the EU. Solar power generation has also started to gain importance, though its share was only 2.2% in the same year. These two generation sources have emerged as alternatives to conventional fossil fuels and nuclear, however, it is important to note that due to their intermittent nature back-up generation capacities need to be assured to maintain an adequate power supply to the grid. In the case of hydro generation the impact of intermittency can be mitigated by increasing the storage capacities.

The competition between coal and gas fired generation has always been influenced by the relative price ratio of these two fuels, and recently the price of carbon emission allowances has begun to play an important role. Greenhouse gas emissions (GHG) for each unit of generated power are higher in the case of coal than gas. However, during the last two-three years the decreasing trend of the share of coal-fired power generation in the mix and the increasing trend of gas is being reversed. Between 2010 and 2012 the share of gas went down from 23%.6 to 18.7%, while that of coal went up from 24.5% to 27.1%. This was mainly due to the rapidly decreasing import steam coal prices in Europe since the beginning of 2011, coupled with steadily high gas prices, and to the permanently low level of carbon prices, being favourable to coal and unable to give incentives to switch to gas-fired generation.

Figure 70 shows the profitability of coal-fired (clean dark spreads) and the gas-fired (clean spark spreads) power generation in the UK and Germany. It is obvious that coal-fired generation assured better profitability than gas-fired generation both in the UK and Germany in 2012 and 2013. In the last two years gas-fired generation became highly uncompetitive in Germany and in other parts of the continental Europe as well, squeezing out gas from the European power mix. Coal-fired generation became highly competitive in the UK, though the emission limits imposed by the Large Combustion Plants Directive[48] have put a limit on the use of coal and as consequence significant coal-fired capacities had to be taken offline in the last two years. In the EU power mix coal could only partially replace the missing gas and nuclear generation; the remaining gap was filled by renewable energy sources during the last couple of years.

Consequently, the deterioration of the competitiveness of gas-fired generation resulted in the decrease of the load factor of gas power plants in most of the EU member states. The already low load factor of gas-fired generation reduces the scope for the power sector to react in a gas curtailment situation.

[48] DIRECTIVE 2001/80/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants

Figure 70 Evolution of monthly average clean dark spreads and clean spark spreads in the UK and Germany

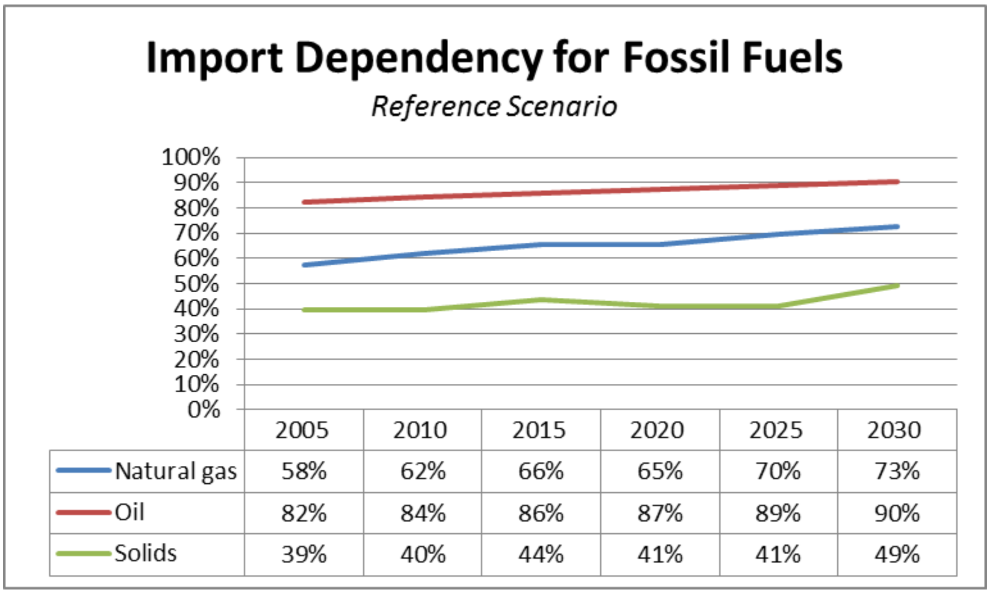
Source: Platts

3 Expected European energy security in 2030

The EU Reference Scenario 2013[49] (Reference Scenario) projections indicate that even if adopted policies (both in EU and national level) are fully implemented, EU's import dependence increasing trend will not change. Reliance on fossil fuel imports will keep increasing in the coming years in order to compensate for the declining domestic production, despite the parallel reduction in energy demand for these resources (Figure 71).

Most interestingly, this import dependency trend remains persistent until 2030 even in the case of the 2030 policy framework, despite the strong energy and climate policies assumed leading to decarbonisation in 2050[50]. What changes though in these projections are the diminishing net imports volumes, which combined with the projected increases in fossil fuel prices, lead to significant fuel savings. This holds especially true for the scenarios with concrete energy efficiency policies and RES targets, highlighting their importance in an energy security context. For example, while the average yearly fuel savings of the preferred scenario in the 2030 framework Communication (i.e. GHG40) amounts to 25.7 bn Euro, the savings double when concrete energy efficiency policies are present, even in the scenario without a RES target.

Figure 71. Import Dependency for Fossil Fuels (Reference Scenario)

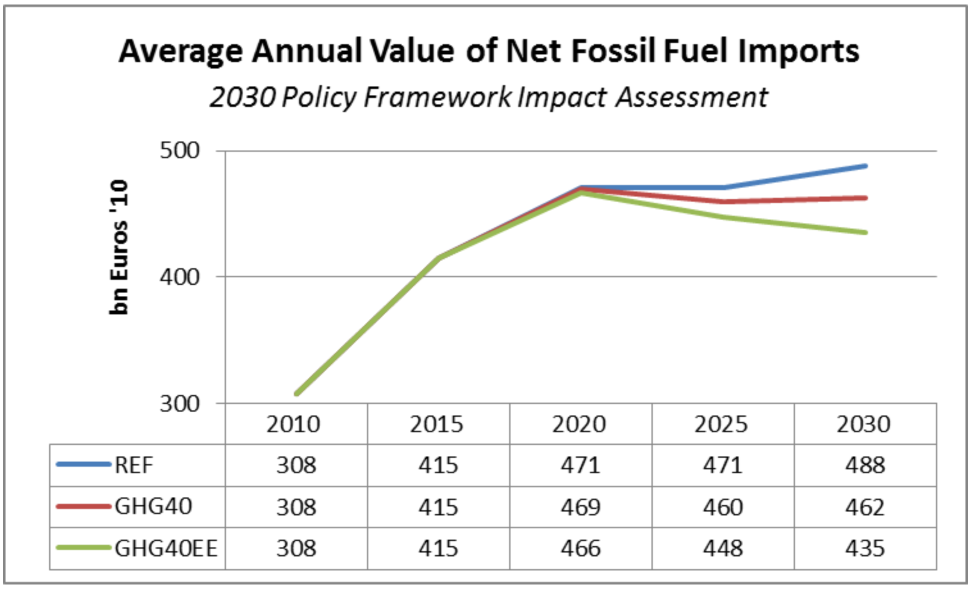


	2005	2010	2015	2020	2025	2030
Natural gas	58%	62%	66%	65%	70%	73%
Oil	82%	84%	86%	87%	89%	90%
Solids	39%	40%	44%	41%	41%	49%

Source: PRIMES 2013[51]

[49] The EU Reference Scenario 2013, elaborated using the PRIMES model for energy and CO2 emission projections, assumes that the legally binding GHG and RES targets for 2020 will be achieved and that the policies agreed at EU level by spring 2012 as well as relevant adopted national policies (but no additional ones) will be fully implemented in the Member States.
[50] The trend changes after 2030, when the positive effects of these policies materialize.
[51] Note that Oil figures for PRIMES are not restricted to crude oil, but also include oil products and feedstock.

Figure 72. Average Annual Value of Net Fossil Fuel Imports (2030 Policy Framework Impact Assessment)



Source: PRIMES 2014[52,53]

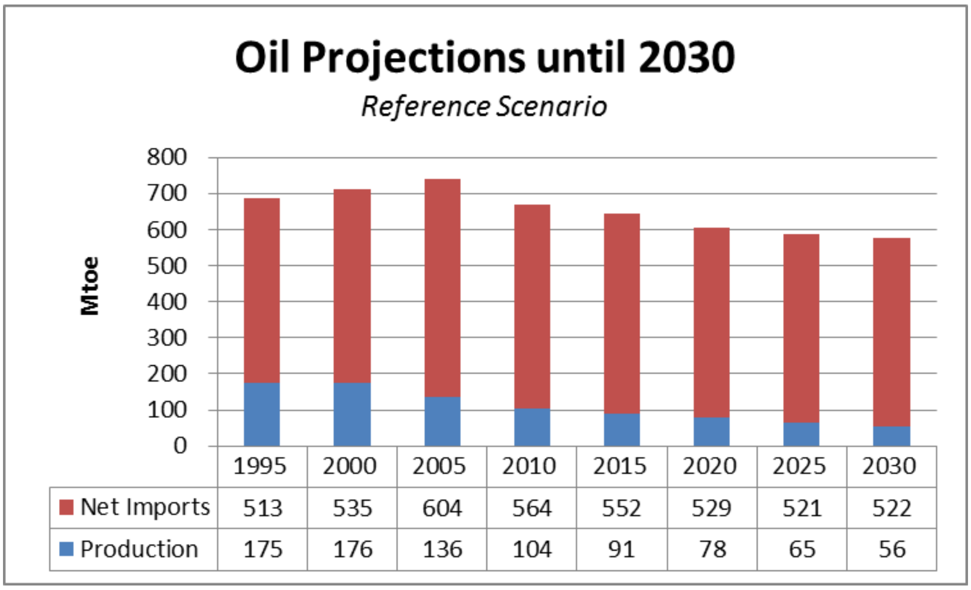
3.1 Oil

Oil imports decline steadily over the Reference Scenario projection period, but at a smaller rate compared to the reductions in production. As a result the import dependency for oil increases. The main reductions in the final consumption of oil and its liquid products between 2010 and 2030 lie within the Transport sector, where oil consumption drops by around 35 Mtoe (from 345 Mtoe to 310 Mtoe), and the Residential sector, with a similar drop of around 30 Mtoe (from 78 Mtoe to 48 Mtoe).

[52] Scenario GHG40 corresponds to the 2030 Policy Framework Communication (used subsequently in this section).

[53] Figures have been calculated approximately based on modelling simplifications. Each value corresponds to the previous 5yr period (i.e. 2005 corresponds to average yearly value for 2001-2005).

Figure 73. Oil Projections until 2030 (Reference Scenario)

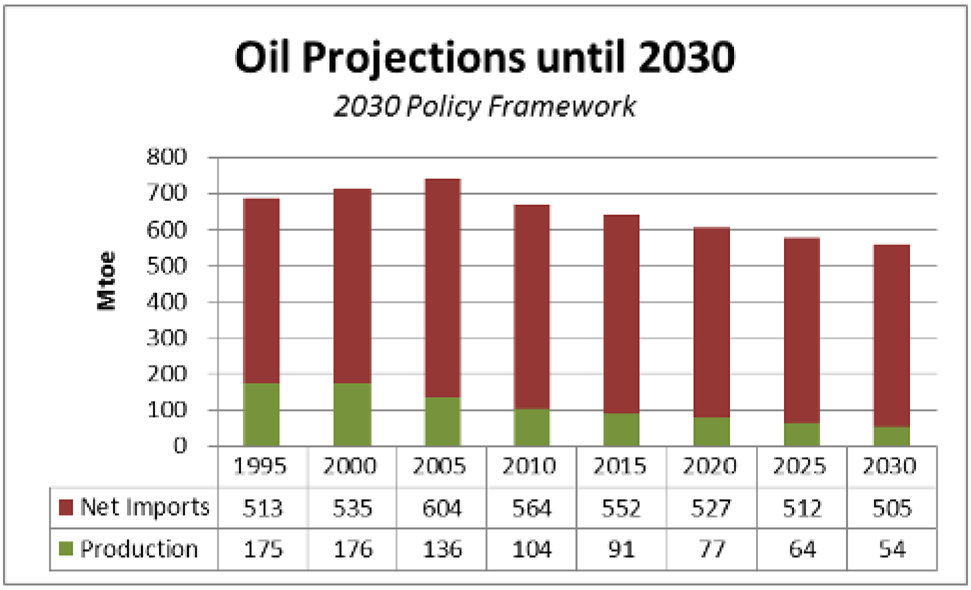


	1995	2000	2005	2010	2015	2020	2025	2030
Net Imports	513	535	604	564	552	529	521	522
Production	175	176	136	104	91	78	65	56

Source: PRIMES 2013

The declining trend of oil imports appears stronger in the 2030 Policy Framework, slowly starting to diverge from the Reference Scenario as of 2020. The effects of the modelled climate and energy policies start showing in 2030, when net imports are lower by 17 Mtoe compared to the Reference Scenario, although the trend becomes much more pronounced in the later projection years and closer to 2050 (Figure 74).

Figure 74. Oil Projections until 2030 (2030 Policy Framework)



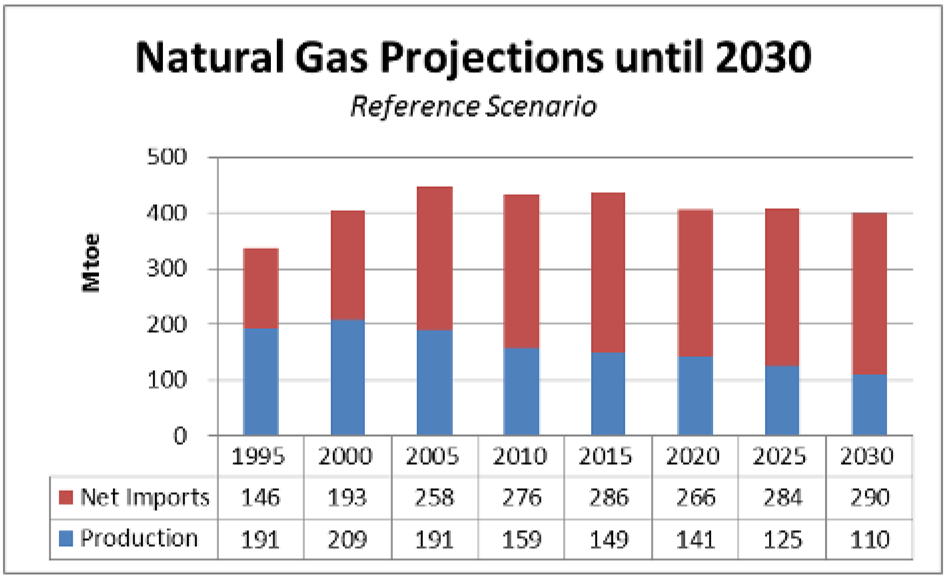
	1995	2000	2005	2010	2015	2020	2025	2030
Net Imports	513	535	604	564	552	527	512	505
Production	175	176	136	104	91	77	64	54

Source: PRIMES 2014

3.2 Natural gas

Contrary to the other fossil fuels, the consumption of natural gas is projected to only slightly decrease until 2030, remaining proportional to the respective use of natural gas in power generation and households. Therefore, in combination with the decline in production, net imports of natural gas are projected to increase until 2030.

Figure 75. Natural Gas Projections until 2030 (Reference Scenario)

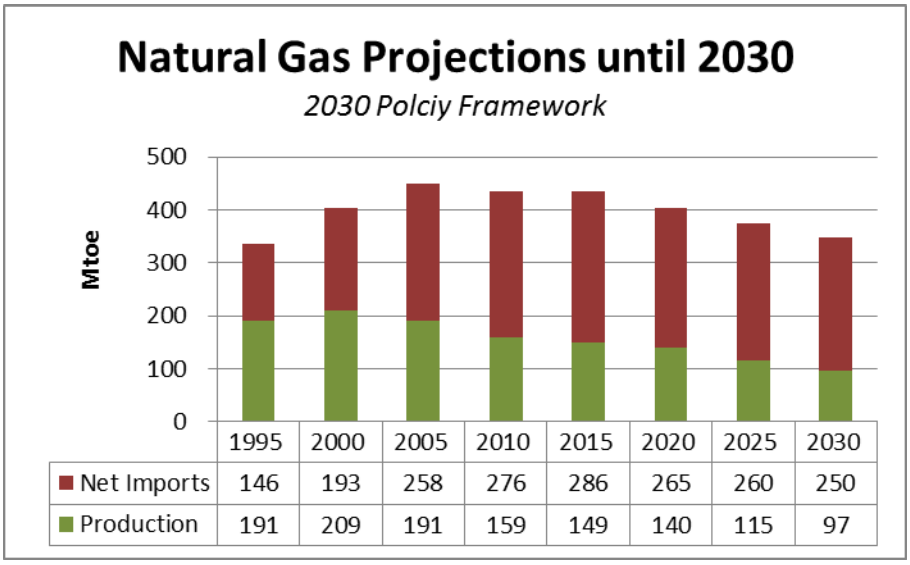


	1995	2000	2005	2010	2015	2020	2025	2030
Net Imports	146	193	258	276	286	266	284	290
Production	191	209	191	159	149	141	125	110

Source: PRIMES 2013

In the presence of the 2030 framework energy and climate policies, final consumption in gas decreases further, most notably in households and power generation, thus leading to a slight decrease of natural gas imports. Despite this tendency though, the decreasing production of natural gas retains the increasing trend in its import dependency.

Figure 76. Natural Gas Projections until 2030 (2030 Policy Framework)



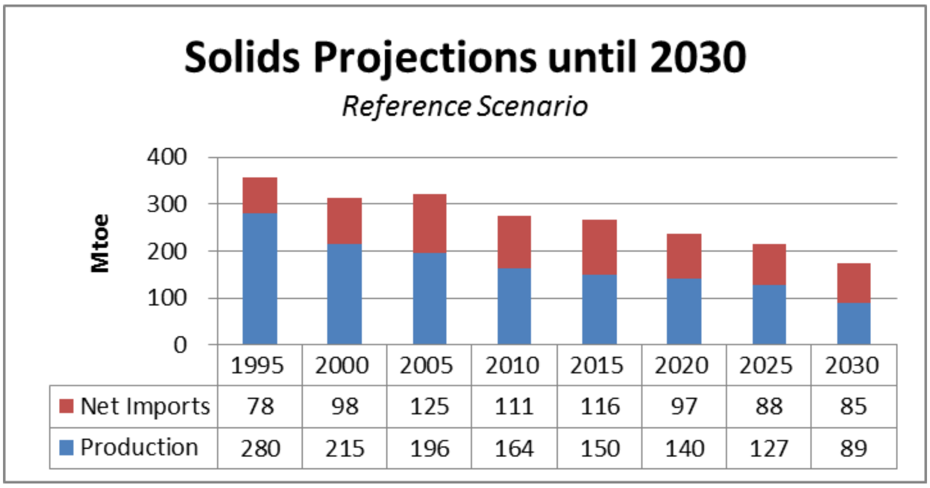
	1995	2000	2005	2010	2015	2020	2025	2030
Net Imports	146	193	258	276	286	265	260	250
Production	191	209	191	159	149	140	115	97

Source: PRIMES 2014

3.3 Solid Fuels

Similar to oil, solids imports decline steadily over the Reference Scenario projection period, but again at a smaller rate compared to production. As a result import dependency for solids also increases, despite the significant reduction in the consumption of solids (mainly in power generation, where their use as an input fuel is halved).

Figure 77. Solids Projections until 2030 (Reference Scenario)

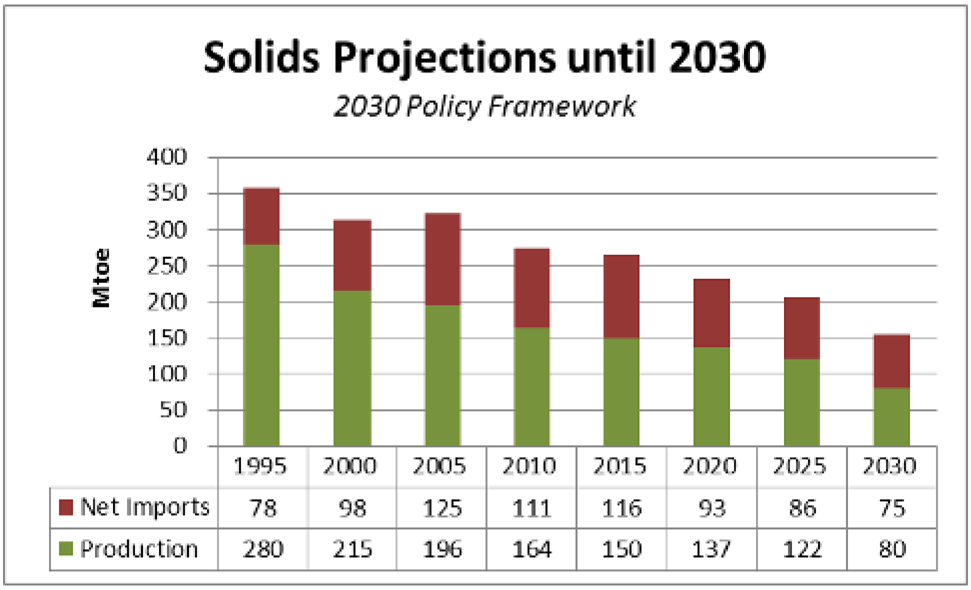


	1995	2000	2005	2010	2015	2020	2025	2030
Net Imports	78	98	125	111	116	97	88	85
Production	280	215	196	164	150	140	127	89

Source: PRIMES 2013

The 2030 Policy Framework is projected to have similar effects to solids as in oil, further strengthening the declining rate of solid imports. The trend is much more pronounced in the later projection years.

Figure 78. Solids Projections until 2030 (2030 Policy Framework)



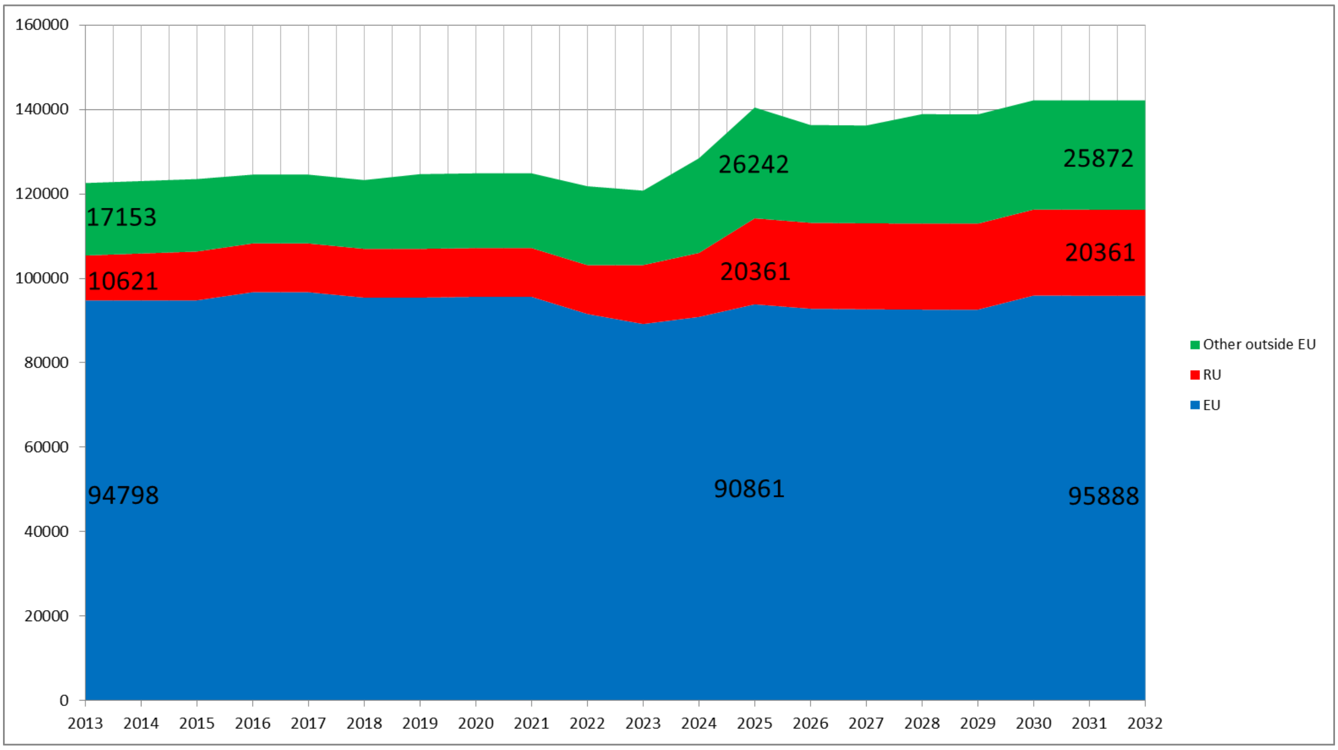
	1995	2000	2005	2010	2015	2020	2025	2030
Net Imports	78	98	125	111	116	93	86	75
Production	280	215	196	164	150	137	122	80

Source: PRIMES 2014

3.4 Uranium

The supply and demand situation for nuclear fuels is not expected to change radically by 2030. Under current assumptions, nuclear generating capacity in the EU may somewhat decrease in that time frame due to ageing reactors and political decisions in some Member States (Figure 79). However, most existing reactors are expected to undergo a licence renewal leading to a lifetime extension or be replaced by new reactors of similar capacity.

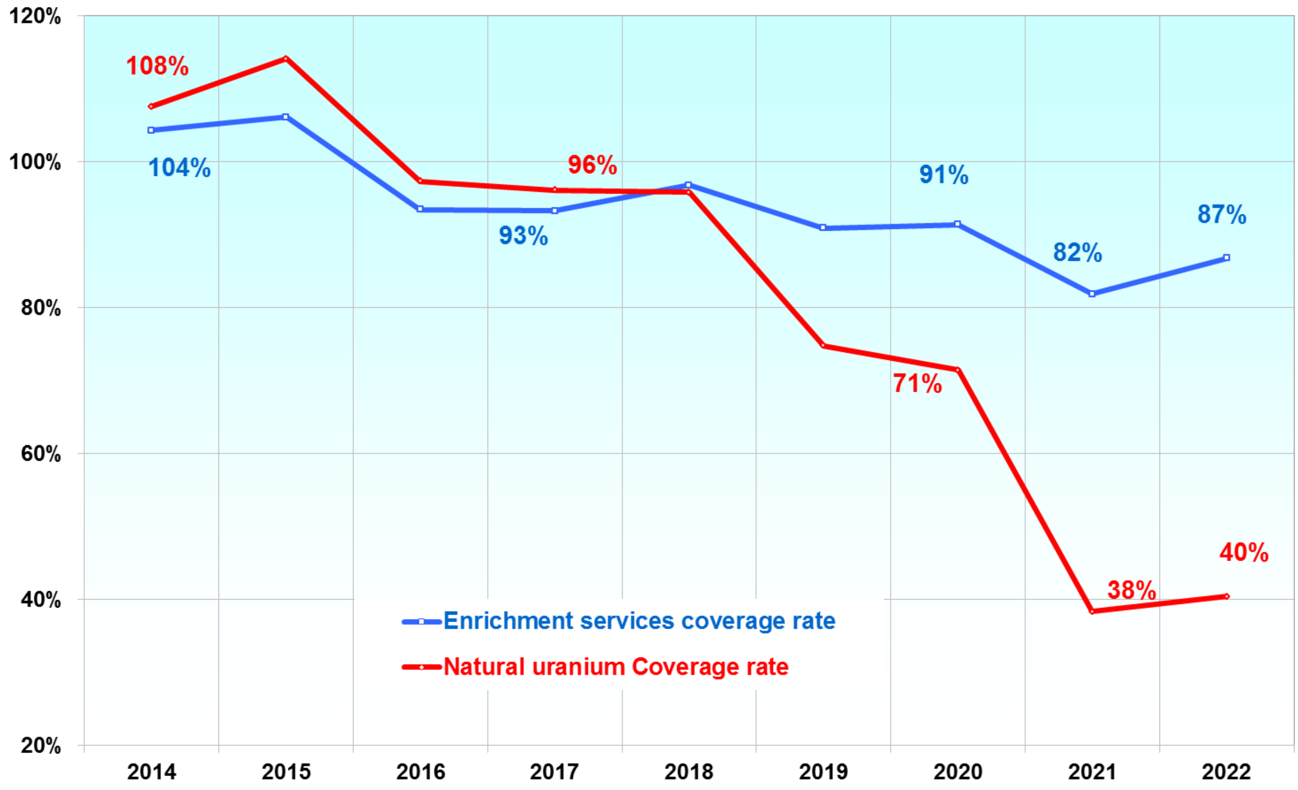
Figure 79. Net generating capacity forecast in the EU by type of reactor – 2013-2032



Source: ESA

Taking into account EU utilities' contractual coverage for the coming years and their inventories, EU reactor requirements for both natural uranium and enrichment services are sufficiently covered in the short and medium term (Figure 80).

Figure 80 Coverage rate for natural uranium and enrichment services, 2014–22 (%)



Source: ESA

3.5 Electricity

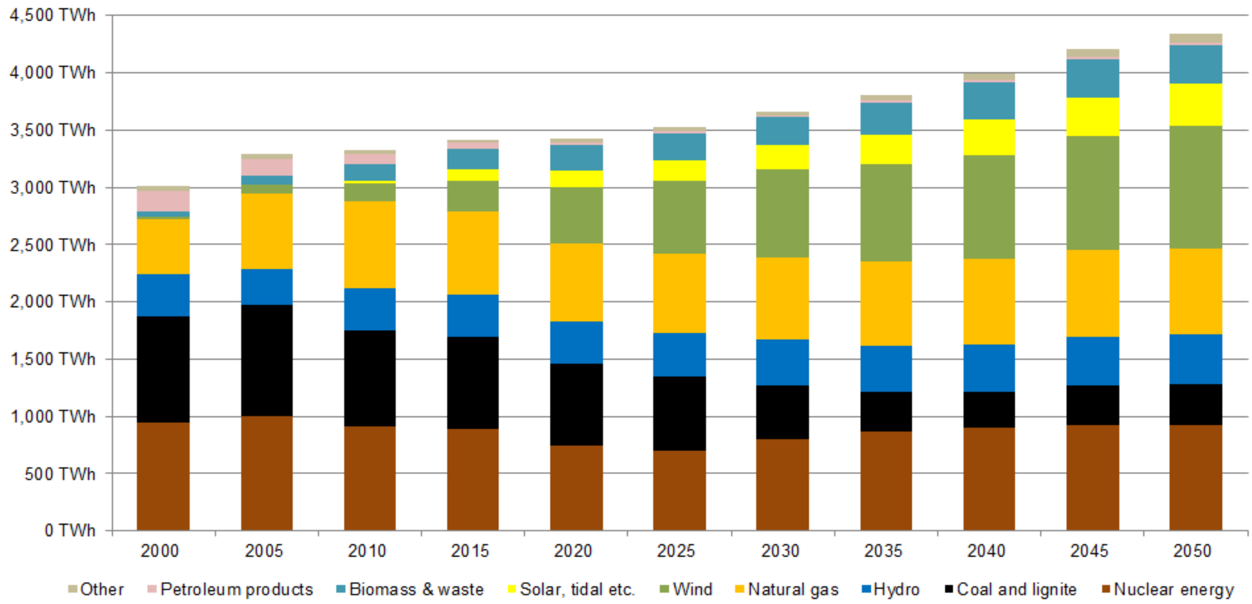
The 2013 PRIMES energy reference scenario, taking into account all energy and climate policy measures being already in force, shows a gradual increase in electricity generation and consumption until 2050 in the EU-28 (see Figure 81). According to this scenario the share of solid fuels will drop to 8% until 2050 from their current share of more than one quarter in the power mix. The share of nuclear generation will also go down to 21%, while that of natural gas will also decrease (to 17% in 2050). Wind power will gain a large share compared to the current 6%, as it will assure almost 25% of the power generation in 2050. The share of solar power will also grow significantly and it will assure 8% of the power mix in 2050, similarly to biomass whose share will double from the current 4%.

The evaluation of the 27 National Renewable Energy Action Plans shows that the share of renewables in the EU final energy consumption would reach 20.6% in 2020. Renewable energy production is projected to increase from 99 million tonnes of oil equivalent (Mtoe) in 2005 to 245 Mtoe in 2020 (an average annual growth rate of 6% per year).

Based on Member State projections for renewable energy use and their sectoral targets, the combined EU renewable energy share in electricity will grow form 19.4% in 2010 to 34% in 2020, in heating and cooling respectively - from 12.5% to 21.5% and in transport from 5% to 11%. Renewable energy industry expectations for the renewable energy shares in the three sectors are higher – EU Industry roadmap[54] estimates that 2020 renewable energy share in the electricity sector could reach even 42%, in the heating and cooling – 23.5% and in the transport 12%. According to NREAP analysis, in the next decade the strongest growth will occur in wind power (from 2% to 14,1% of the total electricity consumption) and solar electricity (from 0% to 3% of the total electricity consumption).

In the electricity sector, according to NREAP technology projections by 2020 wind would become the most important renewable energy source providing 40% of all renewable electricity compared to 25% in 2010, the contribution of photovoltaic and solar thermal electricity would also grow from current 3% to 9%, the contribution of biomass is expected remain almost unchanged (18% in 2010 compared to 19% in 2020), while the role of hydro would decrease from 50% in 2010 to 30% in 2020. The role of geothermal and wave and tidal are still expected to remain marginal in 2020 with respectively 1% and 0.5%.

Figure 81 Power generation from different sources in the 2013 PRIMES Reference Scenario



Source: PRIMES

In the heating sector the analysis of Member State projections in NREAPs indicate that biomass would maintain its dominance (80% of all renewable heating in 2020, down from 90% in 2010), solar energy based heating would increase to 6% compared to 2% in 2010 and geothermal is expected to contribute 2% in 2020 compared to the current 1%. The use of heat pumps would also increase from 6% in 2010 to 11% in 2020.

Concerning the transport sector, in 2020 the first generation biofuels (biodiesel and bioethanol) are still expected to maintain their predominance with 66% and 22% share of the total RES use in transport compared to the current 71% and 19%. The contribution of lignocellulosic biofuels and biofuels made from wastes and residues and the renewable electricity is expected to make up the rest of contribution - 12% - towards the renewable energy share in transport in 2020.

[54] Mapping Renewable Energy Pathways towards 2020, EU Industry Roadmap, European Renewable Energy Council (EREC) (2011)

3.6 Comparison to IEA projections

In order to provide a more complete picture on the projections for the fossil fuel import dependency until 2030, PRIMES projections are compared to the ones of the IEA World Energy Outlook 2013.

Despite their different assumptions, modelling techniques, statistical definitions, etc. and the diverging projections for various energy system figures, both projections seem to indicate a similarly increasing trend in EU import dependency[55], independently of the chosen scenario[56]. At the same time though, if adopted or announced policies are fully implemented, then a considerable reduction in the volume of fossil fuel imports should be expected.

For a more complete set of projections per fuel and per scenario, see Table 8 below. By comparing the IEA projections with the PRIMES ones, the most notable difference is that although the general direction of the various trends is similar (increase of gas imports, decrease of oil and gas) they differ in their intensity, with the IEA ones showing much stronger tendencies than the PRIMES ones, which tend to be more conservative (except for solids, where projections are similar).

Table 7. Net Imports and Import Dependency for all Fossil Fuels for different scenarios

		2010	2020	2030
PRIMES projection for EU28 (Reference Scenario)	Total Imports (Mtoe)	950.9	891.8	897.4
	Import Dependency (%)	**68.19%**	**71.36%**	**77.96%**
PRIMES projection for EU28 (2030 policy framework)	Total Imports (Mtoe)	950.9	884.9	828.7
	Import Dependency (%)	**68.19%**	**71.39%**	**78.08%**
IEA projection for EU28 (WEO2013 new policies scenario)[57]	Total Imports (Mtoe)	951.0	884.6	860.1
	Import Dependency (%)	**67.51%**	**72.30%**	**78.39%**

[55] Differences in the import dependency shares for oil in 2010 are due to different statistical definitions and calculations of the energy balances.
[56] In general the two most comparable scenarios are the Reference Scenario with the New Policies Scenario, which both assume full implementation of adopted policies (although New Policies assumes additionally implementation even of announced policies).
[57] Developed over the spring and summer of 2013

Table 8. Total Demand[58] and Import Dependency per fossil fuel for different scenarios

			2010	2020	2030
PRIMES projection for EU28 (Reference Scenario)	Oil	Total Demand (Mtoe)	669	606	578
		Import Dependency (%)	**84.25%**	**87.21%**	**90.38%**
	Natural gas	Total Demand (Mtoe)	444	407	400
		Import Dependency (%)	**62.10%**	**65.43%**	**72.58%**
	Coal	Total Demand (Mtoe)	281	236	174
		Import Dependency (%)	**39.52%**	**40.93%**	**49.08%**
PRIMES projection for EU28 (2030 policy framework)	Oil	Total Demand (Mtoe)	669	604	559
		Import Dependency (%)	**84.25%**	**87.22%**	**90.29%**
	Natural gas	Total Demand (Mtoe)	444	404	347
		Import Dependency (%)	**62.10%**	**65.40%**	**71.68%**
	Coal	Total Demand (Mtoe)	281	231	155
		Import Dependency (%)	**39.52%**	**40.45%**	**48.41%**
			2010	**2020**	**2030**
IEA projection for EU28 (WEO2013 new policies scenario)	Oil	Total Demand (Mtoe)	683	569	481
		Import Dependency (%)	**82.5%**	**84.6%**	**89.0%**
	Natural gas	Total Demand (Mtoe)	446	407	442
		Import Dependency (%)	**62.1%**	**72.7%**	**78.8%**
	Coal	Total Demand (Mtoe)	280	248	174
		Import Dependency (%)	**39.6%**	**43.4%**	**48.1%**

[58] Calculated as Gross Inland Consumption + Bunkers.

4 Assessment of energy capacity, transport and storage

The ever growing complexity and interdependencies of energy systems calls for understanding of a wider range of factors that define the energy security profile of a country or a region, including resource availability and diversification of suppliers, infrastructure or end-use sectors.

The risk of disruptions or significant price spikes to **fuel supply** depends on the number and diversity of suppliers, transport modes, regulatory framework and supply points, and the commercial stability in the countries of origin. The resilience of energy providers or consumers to respond to any disruptions by substituting other supplies, suppliers, fuel routes or fuels depends on stock levels, diversity of suppliers and supply points (infrastructure, ports, pipelines).

The **energy transformation** tier, including refining and power generation, also faces risks. Refining risks are associated with having access to sufficient capacity for refining of different fuel sources. In the electricity sector, in addition to the above fuel risks, there are risks of volatility of supply (including weather patterns (rain, wind, sun), unplanned power plant outages, age profile of power plants), risks to ensure system stability and generation adequacy and risks related to operation and development of networks, including interconnection capacities. Resilience in this sector also depends on the number and diversity of fuels, refineries and power plants, as well as imports from third countries in the case of petroleum products.

Finally, the resilience and cost of supply disruptions differ amongst the variety of households and industries, as does their flexibility to shift or reduce energy **consumption**.

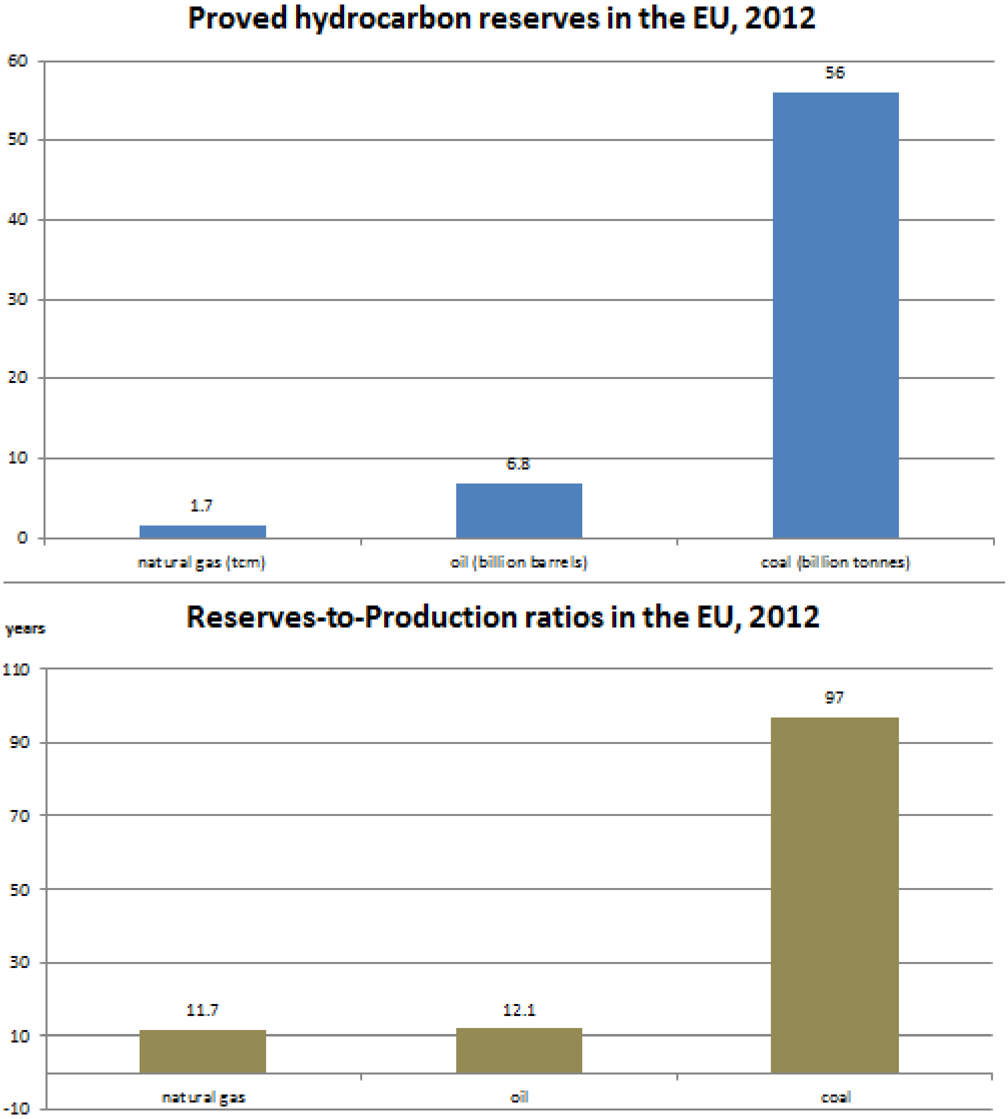
The energy mix of a country has by tradition been a national responsibility. Before functioning energy markets were established, governments managed the energy sector and were held directly responsible for energy supplies. As energy markets have been established, both nationally and at European level, the market is being harnessed to ply and manage the energy sector: multiple entrants at each point of energy supply increase the reliability of supplies as well as increasing competition which induces lower costs. However the market does not always capture the costs of disruptions to energy supplies. Where there are direct commercial arrangements which may suffer, broader and indirect sectoral and macroeconomic costs of disruption are not necessarily captured by contracts or insurance arrangements made by the market. In light of such market failures, governments have also regulated the market, to insist on a secure energy supply under most circumstances. And as the European energy market is established, it functions more smoothly and with fewer distortions when regulated at the European level or when national or regional regulatory measures are well coordinated.

The previous chapter looked at energy security as projected for the year 2030, given that the EU reduces its consumption of fossil fuels. The below text introduces first an overview over the energy dependence of the EU as it is the case currently. Finally it analyses the available external and internal reserves as well as infrastructural and contractual constraints to tap them.

4.1 Hydrocarbon reserves

The EU is poorly endowed with indigenous hydrocarbon energy resources in comparison to other world regions. At the end of 2012, proved oil reserves amounted to 6.8 billion barrels, only 0.4% of global reserves and equivalent to about 12 years of 2012 production levels. In the case of natural gas, at the end of 2012, proved reserves amounted to 1.7 trillion cubic meters, 0.9% of global reserves and equivalent to about 12 years of 2012 production levels (BP Statistical Review of World Energy). **In the case of coal, proved reserves at the end of 2012 were at 56 billion tonnes, or 6.5% of global reserves, equivalent to 97 years of 2012 production levels**.

Figure 82. Proved hydrocarbon reserves in the EU at the end of 2012



Source: BP, Statistical review of world energy, June 2013

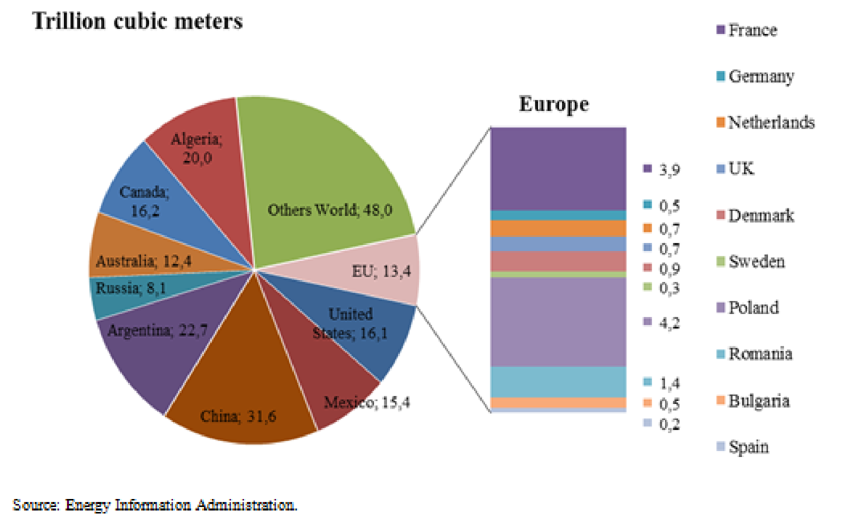
Producing oil from unconventional sources might slow down this trend but there is limited information on the potential of such resources. Current exploration efforts are focusing on shale gas but hampered by geological and public acceptance issues.

Information on EU shale gas reservoirs is limited and uncertain, due to early stages of exploration. It appears nonetheless that potential shale gas producers in the EU may not achieve similar production volumes and costs as their US counterparts. The main reason is that shale gas resources in the EU appear to be significantly smaller than the US. In addition, the EU potential reserves are dispersed across several countries, which may entail lower economies of scale in their exploitation[59].

[59] Between one third and half of the potential US reserves are located in one basin (Haynesville, 10% of total, around 2 tcm); other US basins are also sizeable.

Figure 83. Unproved technically recoverable shale gas resources

Unproved technically recoverable shale gas resources



Unproved shale gas Technically Recoverable Reserves[2]		
Tcm	2011	2013
Total EU	15,8	13.3
Of which		
France	5,1	3,9
Germany	0,2	0,5
Netherlands	0,5	0,7
Norway	2,4	0
UK	0,6	0,7
Denmark	0,7	0,9
Sweden	1,2	0,3
Poland	5,3	4,2
Bulgaria	/	0,5
Spain	/	0,2
Romania	/	1,4
Total US	24,4	16,1
Of which		
Marcellus	11,0	5.3
Total World	187,5	203,9

Source: "Energy Economic Developments in Europe, DG ECFIN, European Commission, 2014

The recently adopted Commission Recommendation 2014/70/EU sets minimum principles for the exploration and production of hydrocarbons using high-volume hydraulic fracturing, aiming to ensure that proper environmental and climate safeguards are in place.

4.2 Oil

4.2.1 Infrastructure and supply routes

While the refineries supplied by the Druzhba pipeline have **alternative supply routes**, some of these are not immediately available and/or have insufficient capacity to wholly replace the Druzhba pipeline. The dependence of these refineries on the Druzhba pipeline underlines the need for infrastructure projects facilitating the diversification of supply sources and routes.

The list of "projects of common interest" (PCI) unveiled by the Commission in October 2013 contains a number of projects which, if realised, would help the countries of Central Eastern Europe in this respect (see Figure 84):

- Bratislava-Schwechat-Pipeline: pipeline linking Schwechat (Austria) and Bratislava (Slovak Republic)
- TAL Plus: capacity expansion of the TAL Pipeline between Trieste (Italy) and Ingolstadt (Germany)
- JANAF-Adria pipelines: reconstruction, upgrading, maintenance and capacity increase of the existing JANAF and Adria pipelines linking the Croatian Omisalj seaport to the Southern Druzhba (Croatia, Hungary, Slovak Republic)
- Litvinov (Czech Republic)-Spergau (Germany) pipeline: the extension project of the Druzhba crude oil pipeline to the refinery TRM Spergau

- Adamowo-Brody pipeline: pipeline connecting the JSC Uktransnafta’s Handling Site in Brody (Ukraine) and Adamowo Tank Farm (Poland)
- Construction of Oil Terminal in Gdańsk
- Expansion of the Pomeranian Pipeline: loopings and second line on the Pomeranian pipeline linking Plebanka Tank Farm (near Płock) and Gdańsk Handling Terminal

Figure 84. Projects of common interest - Oil Supply Connections in Central Eastern Europe

Dependence on Russian oil and impacts of a possible (full) disruption of Russian oil supplies

Russia is by far the main supplier of crude oil to the EU with about 35% of extra-EU imports (the share of the second supplier, Norway, is only 10%), and also supplies considerable amount of petroleum products. To compare, EU imports from Iran before imposing the sanctions in mid-2012 amounted less than 6% of total oil imports. Almost all Member States having refineries import crude oil from Russia. The high dependence on Russian oil is not restricted to the countries supplied by the Druzhba pipeline: in 2012, 12 Member States imported more than a third of their crude oil from Russia.

Only about 30% of Russian oil (about 50 Mt) is arriving to Europe by pipeline, through the Druzhba pipeline system; most of the rest is transported by sea from the Russian ports in the Baltic Sea (Primorsk and Ust-Luga) and the Black Sea (mainly Novorossiysk).

About 2/3 of Russian exports of crude oil and oil products is directed to Europe, with the rest going to Asia (mainly China and Japan), the FSU (mainly Belarus) and to a lesser extent to the Americas. While Russian oil production has been rather stable in the past few years, there is a tendency of decreasing crude oil exports as more oil is directed to domestic refineries. This is helped by the system of export duties which favours product exports (lower export duty).

Considering the huge volumes, a disruption of Russian oil supplies to the EU is likely to have a marked impact on oil prices. Even without an actual disruption of oil flows, the escalating/easing of tensions over the Ukraine-Russia crisis have been a major force behind oil price movements since early March 2014. While these movements have so far been limited, leaving the Brent price in the

$105-110 range, an actual disruption would undoubtedly trigger a bigger price rise, potentially having a detrimental impact on the European and global economy.

While a disruption of this size may be temporarily covered by releasing stocks (emergency stocks held by EU Member States are equivalent to about 7 months of crude oil and product imports from Russia) and production increases from other countries (in April 2014, OPEC's effective spare capacity was 3.4 million barrels per day[60]), oil prices would probably see a lasting rise unless Russia can redirect exports to other regions. In that case, the price hike could be moderated in the longer run.

EU refineries would have to find new suppliers which is made difficult by the Iranian sanctions (EU import ban still in force), ongoing supply disruptions across the world (Libya, Yemen, Syria, Sudan etc.) and the US oil export ban. Furthermore, several EU refineries are configured to process Russian oil and may find it difficult to procure crude oil of comparable quality, leading to suboptimal operation. (Russia's main export grade, the Urals blend is a sour and medium heavy oil[61] and it accounts for more than 80% of the country's oil exports.) This would squeeze the already fragile EU refining sector, suffering from low margins and decreasing demand. Some of the products imported from Russia are used as feedstock and processed further in EU refineries. These would also have to be replaced from other sources.

Some of the Russian oil imports may be replaced by increased product imports, in particular from the US which, helped by the increasing indigenous oil production, has become a major net exporter of products. Again, this would hurt the EU refining sector by further reducing capacity utilization.

The refineries supplied by the Druzhba pipeline would be in a particularly difficult situation: in addition to finding new suppliers, they would need to resort to alternative supply routes. However, in some cases these are not immediately available and/or have insufficient capacity to wholly replace the Druzhba pipeline. Therefore, some or all of the concerned countries (Germany, Poland, Czech Republic, Slovakia, Hungary) would have to release emergency stocks in order to ensure the continuous supply of the refineries before alternative supply routes become operational.

As Russia has a massive crude oil export capacity surplus (oil export capacity of over 6 mb/d compared to about 4.5 mb/d available for exports), most of the oil flows going to Europe (including those carried by Druzhba) could be redirected to other export routes, including the Baltic Sea, the Black Sea and, to a lesser extent, the Far East and, in principle, sold on the global market. Accordingly, in the longer run Russian oil output would not necessarily have to decrease but would have to find new buyers. The feasibility of finding new customers will largely depend on the attitude of other consuming countries. (NB In case of Iran, the US was putting pressure on the Asian buyers of Iranian oil to reduce their purchases).

In case of redirecting Russian exports to new buyers, oil trade patterns would have to change significantly, with supply routes (from new suppliers to Europe and from Russia to new customers) becoming longer, putting pressure on the tanker market and increasing freight rates. Such a readjustment of supply routes would take time.

Provided that Russia cannot swiftly and fully redirect exports, there may be a significant impact on the Russian federal budget, but this may be partly offset by the increase of crude prices.

[60] IEA Oil Market Report, 15 May 2014

[61] Sulphur content of about 1.3%, API gravity of approximately 32

4.2.2 Internal energy reserve capacity

The EU has put a range of policies and legislation in place aiming to reduce CO2 emissions and improve energy efficiency, many of which will also moderate oil demand, either directly or indirectly. These include:

- A strategy is in place to reduce emissions from light-duty vehicles (cars and vans), including binding emissions targets for new fleets by 2020. As the automotive industry works towards meeting these targets, average consumption of vehicles is falling each year.

- A target is in place to reduce the greenhouse gas intensity of vehicle fuels (calculated on a life-cycle basis) by up to 10% from 2010 to 2020.

- To help drivers choose new cars with low fuel consumption, EU legislation requires Member States to ensure that relevant information is provided to consumers, including a label showing a car's fuel efficiency and CO2 emissions.

- Rolling resistance limits and tyre labelling requirements have been introduced and tyre pressure monitoring systems made mandatory on new vehicles.

- Since the beginning of 2012, aviation has been included in the EU Emissions Trading System (ETS). Currently this applies to flights within the European Economic Area.

- Public authorities are required to take account of life time energy use and CO2 emissions when procuring vehicles.

- The EU is aiming for a 20% cut in Europe's annual primary energy consumption by 2020. The Commission has proposed several measures to increase efficiency at all stages of the energy chain: generation, transformation, distribution and final consumption. In particular, the measures focusing on the building sector has a potential for reducing oil use in Member States where heating oil or kerosene is widely used in the residential sector (e.g. Austria, Belgium, Germany, Greece, Ireland). The Energy Performance of Buildings Directive 2010/31/EU (EPBD) is the main legislative instrument to reduce the energy consumption of buildings. Under this Directive, Member States must establish and apply minimum energy performance requirements for new and existing buildings. The Directive also requires Member States to ensure that by 2021 all new buildings are so-called 'nearly zero-energy buildings'.

- Under Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, the EU established the goal of reaching a 5.75% share of renewable energy in the transport sector by 2010. Under Directive 2009/28/EC on the promotion of the use of energy from renewable sources, this share rises to a minimum 10% in every Member State by 2020, thereby reducing the demand for oil-based fuels.

There is still significant potential for reducing the consumption of heavy-duty vehicles. In this area, the Commission is currently working on a comprehensive strategy to reduce CO2 emissions in both freight and passenger transport.

4.2.3 External energy reserve capacity

Oil is traded in a global market and most of the oil traded internationally is shipped by sea. Accordingly, most European refiners have an access to oil across the world. Refiners are free to select their suppliers; the choice is primarily governed by economics, i.e. price, transportation costs and crude oil quality. As it is relatively easy to switch from one supplier to another, security of supply is not the main consideration but many consumers prefer to establish a diversified supplier portfolio.

While increasing the diversification of oil supplies is certainly desirable, there are constraints which limit the potential for such diversification.

First, oil supply is rather concentrated: 6 countries cover 50% of global production and 14 countries cover 75%[62].

Second, crude oil comes in different grades, represented by variable properties, e.g. in terms of gravity and sulphur content. Refineries are typically configured to process a particular type of oil and switching to alternative supply grades may lead to suboptimal operation. For example, during the 2011 civil war in Libya, some refiners had difficulties to replace the sweet (low sulphur) and light Libyan crude while the Iran sanctions introduced in 2012 caused supply problems for some refineries specialised in bitumen production. Heavier and sourer (high sulphur content) crudes typically require additional processing to produce lighter products; therefore, complex, more sophisticated refineries are better equipped to process such feedstock.

Third, the choice of suppliers is often restricted by disruptions and other unplanned outages in producing countries. For example, in 2011, practically the total Libyan oil production came to a standstill due to the civil war. As a result, buyers of Libyan oil (which represented 10% of EU imports) had to find new suppliers. In a liquid global market this was possible but often at higher cost and/or different quality. In recent years the size of such unplanned outages has significantly increased: according to the US Energy Information Administration, they increased from 0.4 million barrels/day in January 2011 to 3.2 million barrels/day in March 2014[63]. In some cases, decisions by the EU limit the scope of suppliers. For example, the Iran sanctions introduced in 2012 banned EU oil imports from the country (which previously supplied 6% of EU imports), forcing refiners to find alternative suppliers.

Forth, some countries are restricting oil exports. For example, while the US oil output is quickly increasing thanks to the expanding tight oil production, existing legislation does not allow the export of oil.

For the Member States supplied by the Druzhba pipeline it is essential that, in case of need, they can quickly switch to alternative supply routes which have adequate spare capacities.

4.2.4 Emergency response tools

Member States have various emergency response tools at their disposal, many of which are underpinned by EU legislation.

Emergency stocks constitute the easiest and fastest way of making large volumes of additional oil and/or petroleum products available to an undersupplied market, thereby alleviating market shortage. The release of stocks can replace disrupted volumes and thereby it might be possible to avoid physical shortage and to dampen or eliminate potential price hikes. As a result, negative impacts of a disruption on the economy can be mitigated. The release of emergency stocks is now generally considered as the main emergency response tool to address an oil supply disruption (with other measures considered as supplementary to stock releases).

EU Member States have to hold oil stocks for emergency purposes since 1968. The currently applicable Council Directive 2009/119/EC requires Member States to hold emergency stocks of crude oil and/or petroleum products equivalent to 90 days of net imports or 61 days of consumption, whichever is higher. At the end of 2013, emergency stocks held by Member states pursuant to this

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[62] BP Statistical Review of World Energy 2013, data for 2012

[63] Source: EIA, http://www.eia.gov/forecasts/steo/xls/Fig35.xlsx and http://www.eia.gov/forecasts/steo/xls/Fig36.xlsx

legislation amounted to 131 million tons (60 million tons of crude oil and 71 million tons of products), equivalent to 102 days of net imports. The Directive also specifies the emergency procedures under which emergency stocks can be released.

In a recent study[64] the IEA examined the cost and benefits of holding public stocks for emergency purposes. Annual costs were found to be in the range of USD 7-10 per barrel; the actual figure will depend on the size and type of storage facilities, the composition of stocks and the interest rate. Considering recent oil price levels, the acquisition of stocks represents the biggest share of costs (up to 85%). The benefits of stockholding were assessed focusing on global crude oil disruptions and consist of reduced GDP losses and reduced import costs. Economic benefits were found to be quite significant, amounting to about USD 50 per barrel on a yearly basis, resulting in annual net benefits of some USD 40 per barrel.

Another important emergency response tool is ***demand restraint***. By reducing oil use in a sector in the short term, oil can be "freed up", thereby alleviating market shortage. Considering that most oil is used in transport, demand restraint measures typically target this sector. Such measures can range from light-handed measures like information campaigns encouraging people to use public transport to heavy-handed measures such as driving bans based on odd/even number plates. Most of these measures can be introduced at relatively low cost and at short notice but do require public acceptance (which may sometimes be difficult to obtain) and administrative control. In addition, extensive demand restraint may hamper economic activity and mobility. Demand restraint measures often have a limited impact (e.g. speed limit reductions) and/or take some time to have an impact on consumption (e.g. encouraging ecodriving).

In a serious and prolonged disruption it will be necessary to ensure that certain groups of users (e.g. emergency services) are adequately supplied with petroleum products which might require the introduction of ***rationing/allocation*** schemes.

According to EU legislation, Member States have to be able to reduce demand and allocate oil products in case of a disruption: Council Directive 2009/119/EC requires them to have procedures in place "to impose general or specific restrictions on consumption in line with the estimated shortages, inter alia, by allocating petroleum products to certain groups of users on a priority basis" (Article 19(1)).

Fuel switching means the temporary replacement of oil by other fuels in certain sectors/uses. For example, oil used for electricity generation or for heating purposes may be replaced by other fuels, provided that technical systems are in place to allow the switch to the alternative fuel (e.g. natural gas). However, the actual potential to use fuel switching in a crisis is limited in most Member States. The majority of oil is now used in transport and in the petrochemical sector, where it is difficult or almost impossible to replace significant amounts of oil in the short term.

In principle, a temporary ***increase of indigenous oil production*** can make additional oil available to the market. However, for technical and economic reasons, it is difficult to increase oil production at short notice. Only a handful of Member States produce oil in the EU and most of them have little or no spare capacity.

By ***relaxing fuel specifications***, the supply of certain petroleum products can be increased which, in principle, could contribute to alleviating a shortage. Under Directive 98/70/EC (fuel quality directive), the Commission may authorize higher limit values on the request of a Member State in case of “exceptional events, a sudden change in the supply of crude oils or petroleum products” (Article 7).

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[64] Focus on Energy Security - Costs, Benefits and Financing of Holding Emergency Oil Stocks, http://www.iea.org/publications/insights/FocusOnEnergySecurity_FINAL.pdf

The IEA's founding treaty, the International Energy Program (IEP) also foresees the ***(re)allocation*** of oil in case of a severe supply disruption, drawing oil from countries that are less negatively affected to those which are more severely affected. This tool has never been applied in practice.

In case of the disruption of supplies on a particular route, it may be possible to ***switch to alternative supply routes***. This is particularly relevant for Member States and refineries supplied by pipelines. For example, the countries supplied by the Druzhba pipeline have the following alternative supply routes at their disposal: the Rostock-Schwedt pipeline (Germany), the Pomeranian Pipeline (Poland), the Ingolstadt-Kralupy (IKL) pipeline (Czech Republic) and the Adria pipeline (Hungary and Slovakia). However, some of these are not immediately available and/or have insufficient capacity to wholly replace the Druzhba pipeline. The oil-related "projects of common interest" (PCI) announced by the Commission in October 2013 would increase the capacity of these routes and/or would establish additional routes.

Producing hydrogen using electricity generated from renewables, and using fuel cells that convert it back into electricity more efficiently than conventional technologies, can provide a solution. In this context, the Fuel Cells and Hydrogen 2 Joint Undertaking under Horizon 2020 (the EU Framework Programme for Research and Innovation) will aim at increasing energy efficiency of the production of hydrogen from water electrolysis and renewable sources whilst reducing operational and capital costs so that the combination of the hydrogen and the fuel cell system is competitive with the alternatives available in the marketplace and demonstrating on a large scale the feasibility of using hydrogen to support the integration of renewable energy sources into energy systems including through its use as a competitive energy storage medium for electricity produced from renewable energy sources.

Annex II provides a comprehensive overview by Member State of emergency response tools to address an oil supply disruption.

In addition to IEA-based plans, many signatories of the EU's Covenant of Mayors foresee actions to limit urban traffic and generate energy savings in the transport sector.

4.3 Natural gas

4.3.1 Internal energy reserve capacity

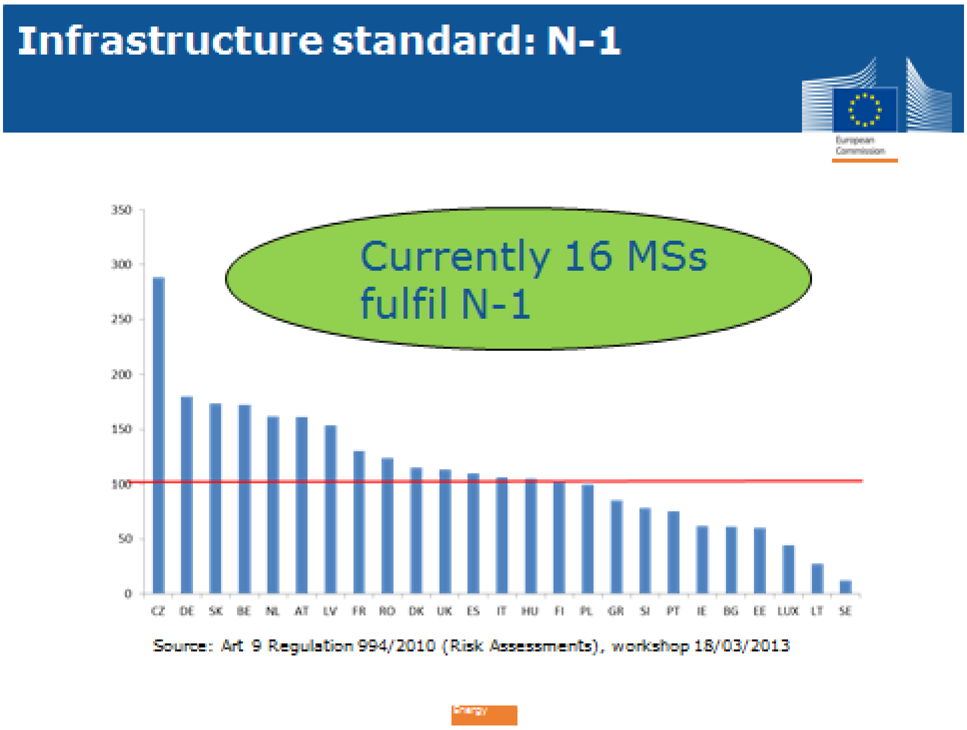
Today, **Regulation 994/2010** concerning measures to safeguard security of **gas supply** establishes market-based security of supply measures, non-market based measures in exceptional circumstances and defines "*responsibilities among natural gas undertakings, the Member States and the Union regarding both preventive action and the reaction to concrete disruptions of supply".* The Regulation names main factors on which security of supply will depend in the future:

- *evolution of the fuel mix,*
- *the development of production in the Union and in third countries supplying the Union,*
- *investment in storage facilities and in the diversification of gas routes and of sources of supply within and outside the Union including Liquefied Natural Gas (LNG) facilities.*

The obligations imposed by the Regulation require gas undertakings to ensure supplies to protected customers in three climatic conditions[65], however does not set a uniform supply standard i.e. there is no storage obligation in natural gas, it is rather up to national Competent Authorities to decide what proof they accept from undertakings to demonstrate their ability to satisfy demand. Further, the

[65] In extreme temperatures during a 7-day peak period occurring with a statistical probability of once in 20 years; any period of at least 30 days of exceptionally high gas demand occurring with a statistical probability of once in 20 years; for a period of at least 30 days in case of the disruption of the single largest gas infrastructure under average winter conditions.

Regulation requires Member States to ensure until end of 2014 that in case of a disruption of the single largest gas infrastructure, the capacity of the remaining infrastructure is able to satisfy the total exceptionally high gas demand in a MSs (N-1 standard)[66]. It also requires developing physical reverse flow capacity, following a procedure examining the potential benefits and costs[67]. In May 2013 only 16 Member States meet the N-1 standard.



Annex II of the Regulation lists measures the authorities of the Member States shall take into account when developing the Preventive Action Plan and the Emergency Plan established by the Regulation. The authorities are called upon to give preference, as far as possible, to those measures which have the least impact on the environment while taking into account security of supply aspects.

The Regulation points to the following <u>supply-side market based measures</u>:

- increased production flexibility,
- increased import flexibility,
- facilitating the integration of gas from renewable energy sources into the gas network infrastructure,
- commercial gas storage — withdrawal capacity and volume of gas in storage,
- LNG terminal capacity and maximal send-out capacity,
- diversification of gas supplies and gas routes,
- reverse flows,
- coordinated dispatching by transmission system operators,
- use of long-term and short-term contracts,
- investments in infrastructure, including bi-directional capacity,
- contractual arrangements to ensure security of gas supply.

Further, it points to a set of <u>demand-side market based measures</u>, in particular:

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[66] Currently 18 MSs fulfil, 5 MSs have exemptions
[67] See section 2

- use of interruptible contracts,
- fuel switch possibilities including use of alternative back-up fuels in industrial and power generation plants,
- voluntary firm load shedding,
- increased efficiency,
- increased use of renewable energy sources.

Only in the event of emergency the authorities can consider the contribution of the following indicative and non-exhaustive list of measures to re-establish security of supply:

- use of strategic gas storage,
- enforced use of stocks of alternative fuels (e.g. in accordance with Council Directive 2009/119/EC of 14 September 2009 imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products),
- enforced use of electricity generated from sources other than gas,
- enforced increase of gas production levels,
- enforced storage withdrawal.

Finally, demand-side non-market emergency measures include:

- various steps of compulsory demand reduction including:
- enforced fuel switching,
- enforced utilisation of interruptible contracts, where not fully utilised as part of market measures,
- enforced firm load shedding.

In addition, Commission Decision of 10 November 2010 amending Chapter 3 of Annex I to **Regulation 715/2009** on conditions for access to the natural gas transmission networks imposes obligation on TSOs to publish data on gas flows, nominations, storage levels etc.

In terms of **demand moderation** Member States have the possibility to introduce package of measures as defined in the Regulation 994/2010. The measures need to take into account longer periods of supply disruptions impacting also on winter supplies. In particular Member States relying on district heating can plan more strongly on fuel switch possibilities. Market measures such as increased use of interruptible contracts and fuel switch possibilities can be incentivised in Member States with high share of gas in industrial production. Awareness programmes and incentive for more efficient use of energy (including in CHPs) are a possible way forward to increase energy efficiency and lower consumption of gas in households, power production. Increase of production of power from renewables has a high potential to reduce EU demand for gas, however it is a medium term measure.

On the demand-side, the potential of the power sector to switch to coal is relatively limited due to the current drop in gas use for power generation driven by relatively low coal and CO_2 prices. Wind and solar generation could potentially contribute to a reduction of demand for fossil fuels in the power sector though their impact on gas use would depend on the merit order in each power market.

A large part of European gas demand comes from heating in the residential sector, making weather conditions critical to gas demand.

In terms of **increase of production** from the area of EEA, such increase is possible in Norway and the Netherlands and could be incentivised by the increase in gas prices if shortage of supply takes place. However it is necessary to warn/coordinate with the supplying states that demand increase is expected.

Production of shale gas is also possible in the medium term; in some countries of the EEA exploration is already on-going.

4.3.2 External energy reserve capacity

Another medium term measure is to aim at higher diversification of suppliers, such as increase of imports form the US and from Arab states. An obstacle to broader commitments is the ability of the EU Member States to enter into commitments while being bound with long term contracts with Russia. In such situation an opportunity is to use the supplies from non-Russian sources to increase gas storage. On the other hand measures can be taken that allow in the future to rely on the short term markets and do not bind Member States in the long term commitments i.e. such as introduction of obligatory sales of imported gas via exchanges.

Triggered by the recent events, IEA has analysed a scenario of interruption of transit of Russian gas to Europe via Ukraine, exploring the following options to replace Russian gas flows through Ukraine that were at 82 bcm in 2013, or about half of Russian imports to Europe:

- **Alternative supply routes**, i.e. re-routing of Russian imports (Nord Stream, Yamal and Blue Stream)

The analysis points that when it comes to alternative supply routes in a short-term disruption, there is very limited capacity on Yamal and Blue Stream, leaving Nord Stream as the only route providing re-routing opportunities for Russian gas.

- **Additional and/or alternative supplies**, including additional volumes from Norway, additional LNG, North Africa, Azerbaijan, Iran

The IEA does not expect alternative supplies from North Africa to provide incremental supply due to growing demand in Algeria, uncertainties with Libyan supplies that could come through the Green Stream pipeline and Iran's exports to Turkey dependent on Iranian domestic demand; Azerbaijan could provide some limited volumes through the South Caucasus pipeline.

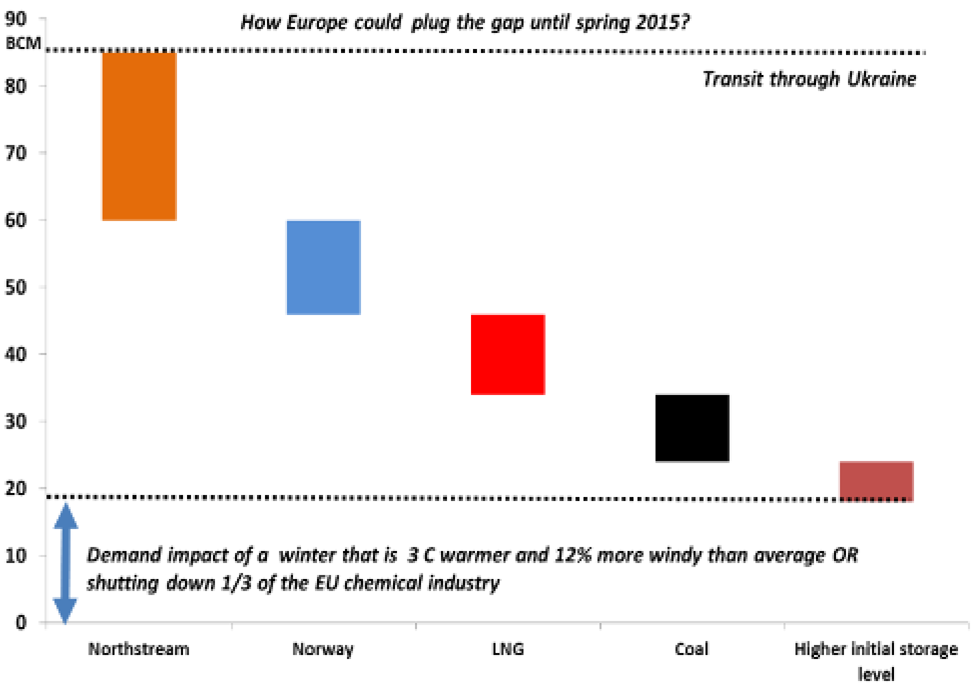
Global LNG markets remain tight and there is competition for cargos between Europe, Asia and Latin America. The IEA estimates that an increase of 1 USD/mbtu in Asia leads to a loss of 0.4 bcm of LNG to Europe.

- **production and seasonal storage**

The IEA expects that **Norway** could provide some additional volumes, but its impact is limited due to pipeline capacity to north-west Europe.

A short-lived disruption could imply limiting the injection into seasonal storage facilities. After a relatively warm winter season 2013-2014, storages across Europe are well filled. The IEA points to the fact that flexibility in storage injection is lower than in storage withdrawal, so lower injection into storages may push forward the consequences of a possible disruption to the next winter season.

Figure 85. Replacing gas imports through Ukraine



Source: IEA, presentation at the Governing Board

Recent research on the costs of reducing Russian gas dependence in Europe estimates that approximately 57 bcm of demand could be saved through six short-term measures at a cost of around 100 USD per capita or a total of 33 billion USD per year[68]. The top three short-term measures presented below include drawing down gas inventories, outbidding Asia on LNG and switching gas power to oil power[69].

When it comes to **drawing down gas inventories**, to bridge between supply today and future supply sources, Bernstein Energy estimates a potential reduction of 9 bcm/year. Since inventories need to be subsequently rebuilt, this is not a sustainable solution. There is a correlation between storage levels and gas prices decline in inventories putting pressure on spot prices; on the basis of this, Bernstein Energy estimates that the 9 bcm/year drawing down on inventories would equate 41 billion USD annual cost increase for gas consumers and 41 billion USD annual before-tax windfall to gas producers.

When it comes to **outbidding Asia on LNG cargoes**, the estimate points to potential to replace 18 bcm/year of Russian imports at annual monetary cost of 5 billion USD, assuming half of the LNG previously diverted to Japan can be attracted back into Europe for a price in the range of 17 USD/mmbtu (see Figure 41 for recent evolution of LNG landed prices). The diversion of LNG cargoes to the Pacific basin in the aftermath of Fukushima is well documented and the figure below provides further evidence for the more attractive pricing conditions in Japan (similar price levels were also observed in South Korea and China). The EU – Asia price differential is greater than the shipping

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[68] Bernstein Research/Bernstein Energy. 2014. Twelve steps to Russian gas independence in Europe: is the cure worse than the disease?

[69]Bernstein Energy also looks at three other short-term measures, namely closing loss-making refineries, rationing gas-intensive manufacturing industries and rationing residential gas usage.

cost difference so in the case of LNG destination clauses have served to lock supplies, which in a genuine spot market would probably have been delivered to Asia.

Against a background of falling demand a new LNG trade feature has expanded – re-exports, whereby LNG importers can take advantage of arbitrage opportunities by selling LNG to a higher-priced market, but have to meet the contractual obligation of unloading the LNG tanker at the initial destination as described in the contract with their LNG supplier. The IEA estimates that in 2012 Spain re-exported 1.7 bcm, Belgium 1.6 bcm, France 0.2 bcm and Portugal 0.1 bcm.

The third short-term measure outlined is the **switch of gas power to diesel power**, doubling the share of electricity generated from diesel in total electricity and doubling the utilisation rate. Taking into consideration that diesel is priced higher than gas, this could save 15 bcm of gas per year but would entitle additional costs of around 11 billion USD/year, which would need to be absorbed by electricity users.

4.3.3 Improving the internal market and infrastructure

The key measure in the medium term is the development of infrastructure granting priority to projects that allow higher diversification of suppliers of each of the Member States. Rapid introduction of internal market rules in particular allocation and congestion management and gas balancing network codes will allow the gas to flow more freely and solve congestion problems where such still occurs. Full abolishment of regulated prices for gas on wholesale and retail level is the only possibility to allow market signals transpire and allow energy efficiency measures to fully develop their potential.

4.3.3.1 Infrastructure development

The ENTSOG presented an estimation of the impact of a possible disruption crisis by analysing the response of the gas infrastructure in the EU for summer 2014 and preliminary estimations for winter 2014/2015 taking into account available options (pipelines, LNG, storage).[70] Assuming maximum solidarity between Member States, the Summer Supply Outlook and the estimation for winter confirm the vulnerability of Member States in the South East EU to disruptions in transit thorough Ukraine and disruption of deliveries of Russian gas. If disruptions occur at times of daily peak demand in January and under maximum solidarity between Member States, almost the entire EU, except for the Iberian Peninsula and south of France would be affected, in particular in case of disruption of gas supplies from Russia. The effects will be severe but only regional in case of disruption from Ukraine.

With regard to the Summer Supply Outlook 2014, disruption of transit through Ukraine over the summer months will result in a disruption in Bulgaria and FYROM (average 21 GWh/day), and failure to fill storages at 90% on 30th of September in preparation for winter demand. The storage levels in Bulgaria would be empty (0%), in Hungary and Serbia the share in comparison to the 90%

[70] See ENTSOG presentation of 7/5/2014 at the Madrid Regulatory Forum. ENTSOG underlines that the estimation should not be understood as an actual forecast neither in term of demand disruption nor supply mix. ENTSOG has prepared this preliminary Winter Risk Assessment on European Commission invitation in good faith and has endeavoured to prepare this document in a manner which is, as far as reasonably possible, objective, using information collected and compiled by ENTSOG from its members and from stakeholders together with its own assumptions on the usage of the gas transmission system. The scenarios included in this assessment do not represent any forecast but a view of what could happen in case of critical events. While ENTSOG has not sought to mislead any person as to the contents of this document, readers should rely on their own information (and not on the information contained in this document) when determining their respective commercial positions. The information is non-exhaustive and non-contractual in nature. ENTSOG shall not be liable for any costs, damages and/or any other losses incurred or suffered by any third party as a result of relying upon or using the information contained in this document. The estimations do not take into account the introduction of physical reverse flow on Yamal from Germany to Poland

level would be very low (20%). In Poland (82%) and Romania (75%) the 90% levels would not be reached either. In case of Russian supply disruption the impact on Bulgaria and FYROM would be the same as in case of disruption of Ukrainian transit but also other Member States would face demand disruptions: Poland (average 94 GWh/day) Finland (average 77 GWh/day) and Baltic States (average 64 GWh/day). The 90% level of storages would not be reached in number of states: Bulgaria, Latvia and Poland (0%), Hungary and Serbia (17%), Austria (59%), Germany, Czech Republic and Slovakia (84%) and Croatia (88%). Low storage levels at the end of September will have consequences for the resilience of the system in winter 2014/2015.

If disruptions occur at times of daily peak demand in January and under maximum solidarity between Member States, almost the entire EU, except for the Iberian Peninsula and south of France could be affected in case of disruption of gas supplies from Russia. The effects are likely to be less severe in case of disruption from Ukraine, however South-East Europe could face a situation where more 60-80% of supply is not covered. In case disruptions of supply from Russia take place during a cold spell time in March the impacts might spread across Europe, but in the case of South-East Europe of smaller magnitude in comparison to a January disruption.

In case of average demand, with disruptions of supply from Russia occurring during the June 2014 to March 2015 period, demand of states in the east of EU and neigbouring countries might not be covered over longer periods of time. Bulgaria and FYROM might face a disruption of 60-80% of demand from September to March, while Poland for the same period might not cover 20-40% of demand and Lithuania 40-60%. Latvia and Estonia might face difficulties from October to March with more than 80% of demand not covered and also Finland would face similar demand disruption from January to March. 20-40% disruption might also occur in Romania, Croatia, Serbia and Greece for the late 2014/early 2015.

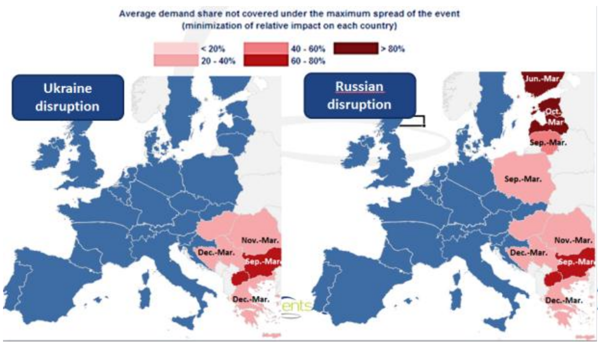
In this context it is worth mentioning that combination of factors other than infrastructure might affect the level of resilience and response in case of a crisis. Analysis by the IEA points out[71] that Italy is not able to transfer import disruption into an export reduction as it does not export natural gas. The only possibility is therefore to import form other sources, be it pipelines or LNG deliveries. However, the later might not always materialise: in February 2012 the cold weather affected the LNG deliveries in Italy and to a lesser extent in France. The sea conditions prevented scheduled LNG cargoes from docking and unloading in the Italian terminals of Rovigo and Panigaglia limiting the flexibility provided by LNG. LNG had a major role in Greece to compensate the temporarily reduced Russian volumes and the missing deliveries from Turkey, however, the financial position of the Greek companies made difficult to afford prompt spot cargoes.

[71] IEA-EMS Report 24/04/2014

Figure 86. Impact of gas disruption

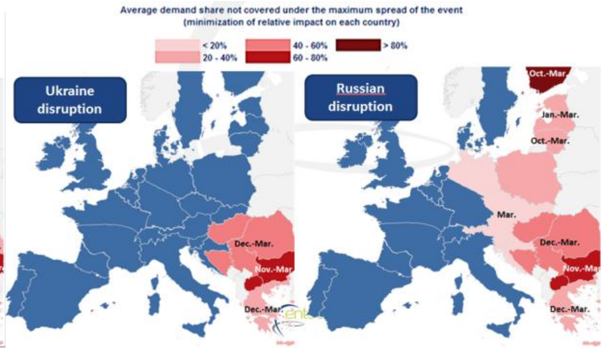
ACROSS SEASON DISRUPTION

Disruption occurring during the June 2014 to March 2015 period of average demand. UGS levels on 1 June are those of the Summer Supply Outlook 2014 and then injection is maximised where possible resulting in some countries in levels on 1 Oct. 2014 higher than last year.



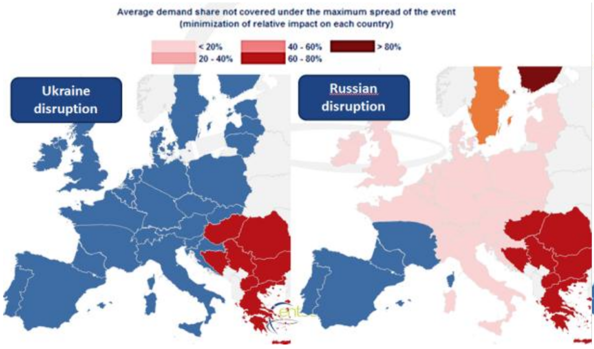
WINTER 2014/15 DISRUPTION

Events lasting from October 2014 to March 2015 under average demand with UGS level on 1 October as observed in 2013



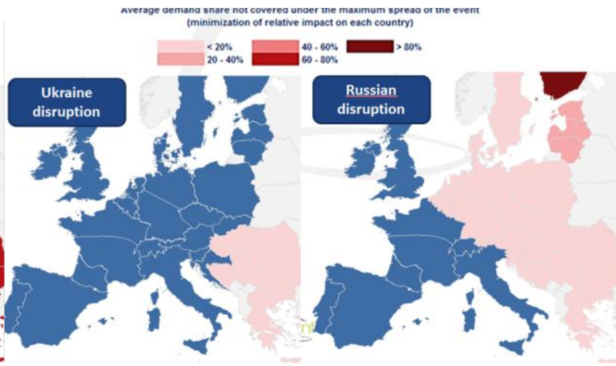
JANUARY DISRUPTION WITH PEAK

January disruption on a peak day at the end of the month. Period from Oct. to Dec. is under average demand and without disruption.



MARCH DISRUPTION WITH COLD SPELL

March disruption with a cold spell in the second half of the month. Period from Oct. to Feb. is under average demand and without disruption.



Source: ENTSO-G

A key measure in the medium term is the development of infrastructure granting priority to projects that allow higher diversification of suppliers of each of the Member States. According to ENTSOG it is not sufficient to develop projects where financial investment decision have been taken but decide projects among those already identified in the latest TYNDP edition.

4.3.3.2 Internal market and price signals

An important aspect to consider when analysing short term resilience to disruption of gas supplies is the reaction of prices of gas on the markets. In case of disruption and high demand prices will increase attracting new supplies. With adequate infrastructure in place, supplies could come from different sources and directions and the overall impact of price increase could be mitigated. As a rule, the prices at hubs give a fair representation of the supply and demand conditions in different trading areas. The operation of the gas markets improved significantly in the last couple of years, as shown by the decrease of flow against price differential (FAPD) events[72] that measure irrational adverse flows.

Table 9. Flows against price differential: events in selected adjacent areas

	2011	2012	2013
# observations / year	251	248	251
BE-NL	25	6	13
BE-UK	4	17	7
NL-UK	83	28	28
FR PEG Nord – FR PEG Sud	2	1	0
AT-IT	0	0	0
AT-DE	133	112	6
Average FAPD events selected	**41**	**27**	**9**

Sources. (1) Price data: Platts; (2) Flow nomination data: Fluxys, BBL, ENTSO-G TP

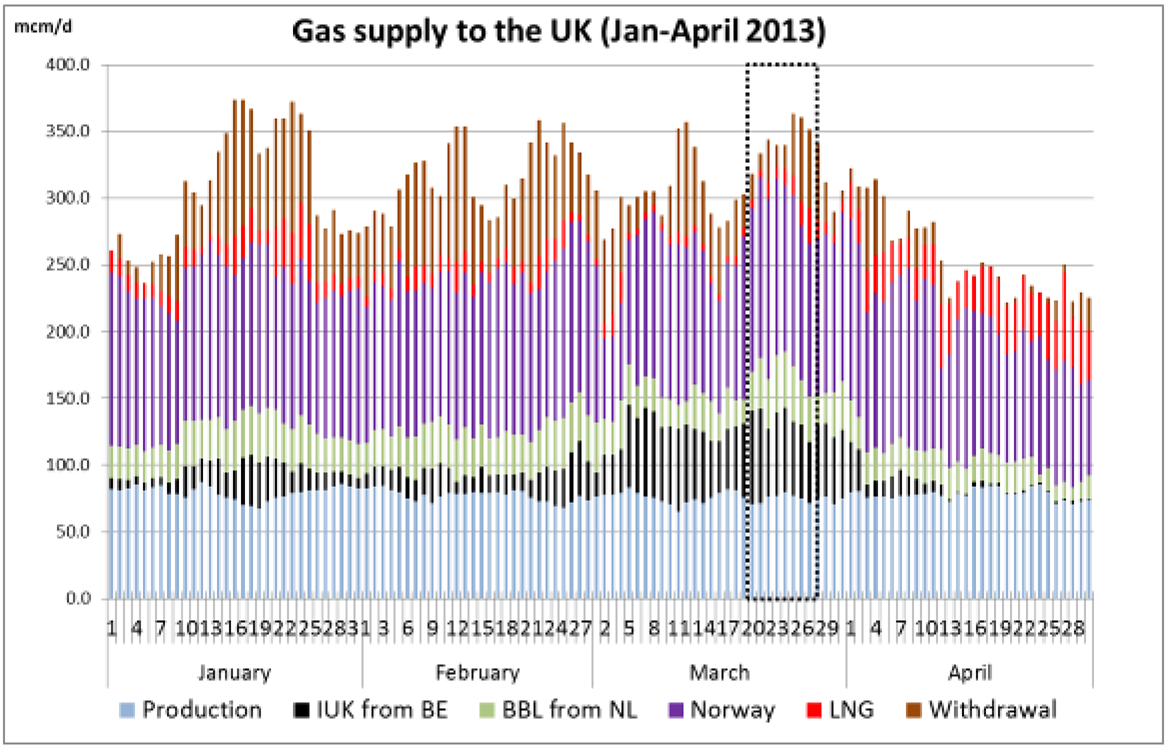
The 2013 cold spell events that hit the Northern part of Europe at the end of the heating season in March were another period of significant price swings as reaction in increasing demand and adjusting supply. The majority of countries in North and North-Western Europe experienced harsher than usual meteorological conditions throughout the 2012 – 2013 winter season. The March 2013 temperatures were well below the long term average, with some Member States recording more than 100 heating degree days (HDDs[73]) above the long term average. In two separate events during the second and third week of the month, the temperatures across the UK were 6 ^{0}C – 8^{0} C lower than the long term average for several days. This event can be a model how markets react when demand increases and supply reacts.

Prior to March 2013, market operators were withdrawing gas from storages at a faster-than normal rate. The March cold spell events accelerated further the withdrawal and as the winter season was coming to an end, a new minimum level of 2.71% was reached on 13.04.2013 in the NBP area. French storage levels were also extremely low and the minimum was reached on 10.04.201 (6.23%). With a decline in LNG and beach supply as well as low storage levels, the Interconnector between UK and Belgium was flexible in covering much reduced supply from other sources, setting an import record in March 2013 of 18,000 GWh (approx. 1670 mcm), breaking the previous flow record (Aug 2003). On 22 March, when the daily flow record might have otherwise have been broken again, there was a mechanical failure causing a full shutdown of the Bacton terminal in the UK. Within a few hours of

[72] Flow against price differentials (FAPDs): By combining daily price and flow data, Flow Against Price Differentials (FAPDs) are designed to give a measure of the consistency of economic decisions of market participants in the context of close to real time operation of natural gas systems.
With the closure of the day-ahead markets (D-1), the price for delivering gas in a given hub on day D is known by market participants. Based on price information for adjacent areas, market participants can establish price differentials. Later in D-1, market participants also nominate commercial schedules for day D.
An event labelled as an FAPD occurs when commercial nominations for cross border capacities are such that gas is set to flow from a higher price area to a lower price area. The FAPD event is defined by the minimum threshold of price difference under which no FAPD is recorded. The minimum threshold for gas is set at 0.5 €/MWh.
After the day ahead market closes, market participants still have the opportunity to level off their positions on the balancing market. That is why a high level of FAPD does not necessarily equate to irrational behaviour. In addition, it should be noted that close-to real time transactions represent only a fractional amount of the total trade on gas contracts.
[73] Heating degree days (HDDs) express the severity of a meteorological condition for a given area and in a specific time period. HDDs are defined relative to the outdoor temperature and to what is considered as comfortable room temperature. The colder is the weather, the higher is the number of HDDs. These quantitative indices are designed to reflect the demand for energy needed for heating purposes. Data from the Joint Research Centre of the European Commission.

the failure, IUK was back to maximum capacity, but for the first time failed to meet nominations in full. The below chart shows the increase of withdrawal from storages, imports from Norway, Netherlands and Belgium and stronger relying on LNG supplies also after the cold spell when the withdrawal form gas storages decreased.

Figure 87. The cold spell of March 2013: gas supply to the UK

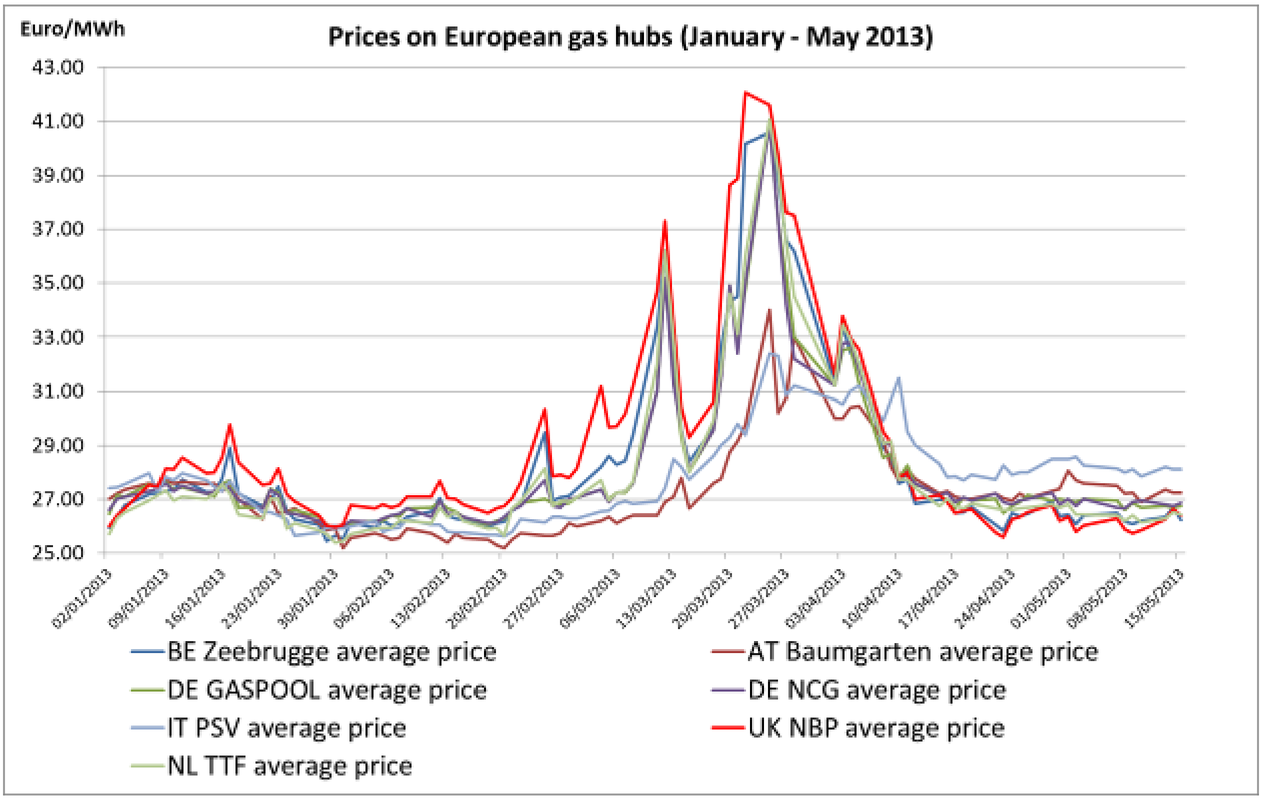


Source: Platts, Bentek

During periods of high demand markets with high degree of diversification, good infrastructure connections and established and liquid markets the prices increase significantly above the usual levels. For example the prices in the UK and in Belgium increased to the level close to € 40/MWh in comparison to average prices of between € 25 and € 30/MWh. The price increase at the hubs in the EU were also following this trend.

Similar developments took place during the February cold spell in 2012. Market signals worked well and wholesale prices reacted with a sharp increase enhancing gas and electricity flows to where it was most valued and bringing all available generation capacities online. In electricity, the increased demand pushed up prices reaching maximum level on 8 February. In France prices went up from 50€/MWh to 350€/MWh and in Germany from 50€/MWh to 100€/MWh. Wholesale day-ahead gas prices raised by more than 50% on the European hubs compared to levels registered before the cold weather. Notably in Italy prices reached 65€/MWh from 38€/MWh, while in UK, Germany and Austria prices kept aligned and reached 38€/MWh from levels of 23€/MWh.

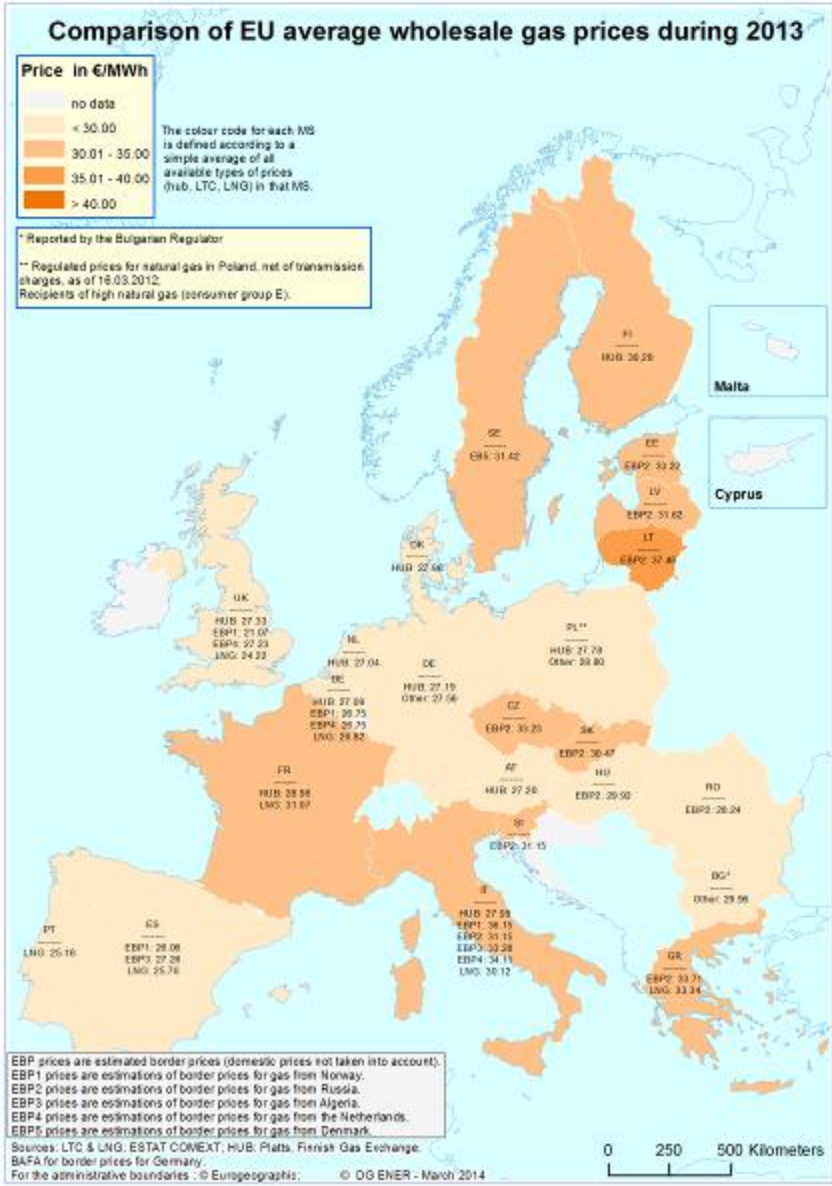
Figure 88. The cold spell of March 2013: prices on European hubs



Source: Platts

Member States in the East and South-East EU are most vulnerable to supply disruptions. In addition, they tend to regulate gas wholesale prices (e.g. Poland and Romania) and/or no liquid gas markets are established in these Member States. In times of unforeseen short-term disruption those Member States are likely to be least attractive to the potential alternative gas suppliers. Therefore any additional deliveries in times of supply disruptions would likely go first to the most liquid markets where shortage would be indicated by increasing prices.

Comparison of EU average wholesale gas prices on 22.03.2013
Price in €/MWh
no data
< 30.00
30.01 - 35.00
35.01 - 40.00
> 40.00
The colour code for each MS is defined according to a simple average of all available types of prices (hub, LTC, LNG) in that MS.
* Reported by the Bulgarian Regulator.
Malta
Cyprus
EBP prices are estimated border prices for the month of March 2013 (domestic prices not taken into account).
EBP1 prices are estimations of border prices for gas from Norway.
EBP2 prices are estimations of border prices for gas from Russia.
EBP3 prices are estimations of border prices for gas from Algeria.
EBP4 prices are estimations of border prices for gas from the Netherlands.
EBP5 prices are estimations of border prices for gas from Denmark.
Sources: LTC & LNG: ESTAT COMEXT; HUB: Platts, Finnish Gas Exchange, GasPoint Nordic;
For the administrative boundaries : © Eurogeographic © DG ENER - April 2014
0 250 500 Kilometers



Comparison of EU average wholesale gas prices during 2013
Price in €/MWh
no data
< 30.00
30.01 - 35.00
35.01 - 40.00
> 40.00
The colour code for each MS is defined according to a simple average of all available types of prices (hub, LTC, LNG) in that MS.
* Reported by the Bulgarian Regulator
** Regulated prices for natural gas in Poland, net of transmission charges, as of 16.03.2012; Recipients of high natural gas (consumer group E).
Malta
Cyprus
EBP prices are estimated border prices (domestic prices not taken into account).
EBP1 prices are estimations of border prices for gas from Norway.
EBP2 prices are estimations of border prices for gas from Russia.
EBP3 prices are estimations of border prices for gas from Algeria.
EBP4 prices are estimations of border prices for gas from the Netherlands.
EBP5 prices are estimations of border prices for gas from Denmark.
Sources: LTC & LNG: ESTAT COMEXT; HUB: Platts, Finnish Gas Exchange.
BAFA for border prices for Germany.
For the administrative boundaries : © Eurogeographis; © DG ENER - March 2014
0 250 500 Kilometers

4.3.3.3 Energy efficiency

Short term reduction of energy demand

Energy efficiency can play a significant role by reducing gas demand and imports in industry and in the residential and service sectors, in particular for heating and domestic hot water production and district heating.

Studies[74] analysing the effect of information campaigns on energy consumption indicate that the savings that can be achieved through information campaigns can go up to 10% reduction of energy consumption in the short term. Nevertheless, in most cases the energy savings achieved are lower, with the savings in the short term in the range of 3%-4%. The impact of any campaign will depend on a series of factors including its design, the target public, the level of public acceptance of the importance of energy savings (that will increase in a situation of energy supply disruptions).

The 3% savings that could be achieved in the short term in the households and services sector through information campaigns would represent a reduction on gas consumption of 4.6 Mtoe.

Long term data is scarcer and its results not conclusive, but evidence shows that these savings tend to be reduced if the campaign is not supported by further measures that have an impact in the long run.

Taking into account that a reduction on gas supply can put pressure in the very short term, information campaigns are well placed in order to have an immediate impact on the European gas demand especially taking into account that their impact might be increased during a crisis situation.

Information to consumers about the importance of reducing gas demand can also help to smooth the introduction of measures causing discomfort such as the reduction in the availability of heat from central or district heating installations or the reduction of available gas for industrial processes.

The Covenant of Mayors

After the adoption, in 2008, of the EU Climate and Energy Package, the European Commission launched the Covenant of Mayors programme which became the mainstream European movement involving local and regional authorities in the fight against climate change. It is based on a voluntary commitment by signatories to meet and exceed the 20% CO_2 reduction objective through increased energy efficiency and development of renewable energy sources. Indeed, local governments play a crucial role in mitigating the effects of climate change, all the more so when considering that 80% of energy consumption and CO_2 emissions is associated with urban activity.

In order to translate their political commitment into concrete measures and projects, Covenant signatories prepare Sustainable Energy Action Plans outlining the key actions they plan to undertake. These plans concentrate on decentralised measures to improve energy efficiency in buildings reduce emissions in urban traffic, communicate energy saving behaviour, increase efficiency in energy related infrastructure such as district heating and electricity networks, plan low energy developments, etc. The average expected reduction of emissions, mostly to be achieved through energy efficiency, is 28%. The implementation of most plans

[74] A review of intervention studies aimed at household energy conservation. Wokje Abrahamse, Linda Steg, Charles Vlek, Talib Rothengatter. Department of Pyschology, University of Groningen. Energy efficiency in buildings through information – Swedish perspective. Jessica Henryson, Teresa Håkansson, Jurek Pyrko. Lund Institute of Technology, Department of Heat and Power Eng. Innovative Communication Campaign Packages on Energy Efficiency. WEC-ADEME Case Study on Energy Efficiency Measures and Policies. Irmeli Mikkonen, Lea Gynther, Kari Hämekoski, Sirpa Mustonen, Susanna Silvonen.

could be accelerated, resulting in significant short-term energy savings benefits with high visibility and a relevant emulation effect.

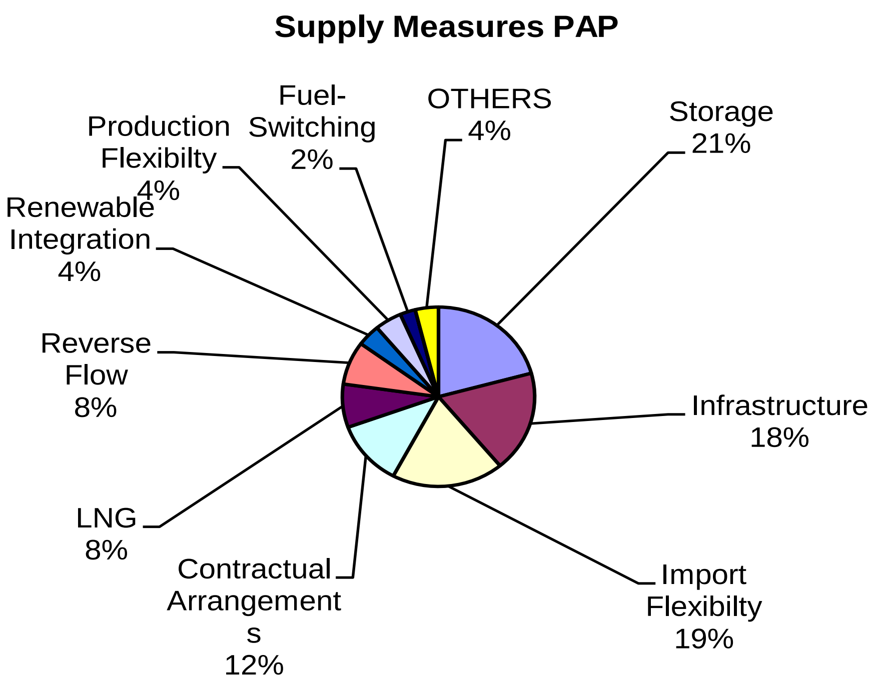
4.3.3.4 Short term disruption of supply in most exposed Member States

The state of the preparedness of the Member States in case of a disruption of supply is reflected in the measures developed in the scope of implementation of the Regulation 994/2010[75] i.e. the Preventive Action Plans (PAPs) and the Emergency Plans based of Risks Assessments. The Commission will present its detailed assessment of the Plans in its report required under the Regulation 994/2010 in December 2014.

Most of the measures in the Plans are related to infrastructure in general, storage facilities, import flexibility, LNG and production flexibility. Thus, 78% of the preventive measures proposed by the Member States are related to enhancement of infrastructure. The preliminary results reveal[76], firstly, that most of the preventive actions taken by Member States are market-based supply-side measures. Non-market-based initiatives make up just over 10% of the total, while demand-side measures constitute 14% of those discussed in PAPs.

Increased storage capacity is the most commonly adopted risk-reducing measure, followed by the increase of import flexibility either through pipeline interconnectors or LNG terminals. Domestic upgrades to the transmission system and revised contractual arrangements are also frequently employed tools. The latter includes regulatory measures such as ensuring proper monitoring and accurate forecasting of demand or implementing bilateral agreements to ensure stand-by capacity/flows in contingency situations. Production flexibility and fuel switching options are less common and in some countries the latter has been phased out by new market rules**.** The Plans submitted to the Commission show a high level of methodological and substantive heterogeneity. Often the link between risk scenarios and preventive measures seem to be lacking or risk scenarios are not even considered.

Figure 89: Classification of Supply Measures proposed in the Preventive Action Plans (PAPs)



Source: Preventive and Emergency Plans Review in accordance with Regulation 994/2010, JRC 2013

[75] http://ec.europa.eu/energy/gas_electricity/secure_supply/doc/national_plan_emergency_list.pdf
[76] Preventive and Emergency Plans Review in accordance with Regulation 994/2010, JRC 2013

As shown in the estimations of ENTSO-G depending on the duration of the disruptions and on the level of the demand (e.g. high demand in winter), the disruptions could affect the majority of the EU countries directly (except for France, Spain and Portugal) and indirectly e.g. by increase in LNG gas prices. However the state of infrastructure, existing level of interconnections and the stage of development of the markets expose some the European states in the East to higher extend than those in the West. Various analysis of ENTSO-G shows that in case of disruption of transit through Ukraine exposed to disruption of deliveries are likely to be Bulgaria, Romania, Hungary and Greece, as well as the Energy Community Members FYROM, Serbia and Bosnia and Herzegovina. In case of disruption of all supplies from Russia over entire winter period (October to March), in addition to the stated above, the exposed to disruption are also Finland, Poland, Czech Republic, Slovakia, Croatia, Slovenia, and the three Baltic States; Lithuania, Latvia and Estonia. Interruption of supply to Lithuania may also impact on the level of supply in Kaliningrad since gas to Kaliningrad is transported via Lithuania.

Assessed from today's perspective on the basis of data regarding gas consumption, supply and state of development of infrastructure the **Baltic States and Finland** may not have much alternative instruments at their hands to counteract gas supplies disruptions from Russia. All four states are in 100% dependent on deliveries from Russia. Finland is able to use their line-pack and fuel switching options to provide gas to protected customers to satisfy the 30 day obligation of the supply standard. Latvia can rely on storage capacities which are higher than its annual demand. Estonia would be able to use fuel switching to and rely partially on gas storage from Latvia. Lithuania is advancing construction of the LNG terminal. In the perspective of the next 5 years together with the interconnector to Poland and the regional terminal i.e. the implementation of the commitments under the Baltic Energy Market Interconnection Plan (BEMIP), the new infrastructure will be able to ensure full diversification of gas sources. Therefore each of the Member States has some options at hand, however only when put together, they allow for a strong regional strategy. Elements which can be used to benefit security of supply of the region are full utilisation of storage capacities in Latvia, rapid development of LNG terminals and interconnectors. Moreover the region could benefit from the development of contingency plans. An example of such plans is the one developed in Finland.

In terms of consumption, out of 3 Mtoe of gas, Finland uses 1.3 in CHP plants and 0.4 in district heating plants. The reminder is consumed by industry (0.8 Mtoe). Consumption in Latvia follows similar pattern as in Finland. Out of the 1.4 Mtoe of imported gas in 2012, 0.6 was consumed in CHP plant, 0.2 in district heating and 0.2 Mtoe in industry. Households and services consumed 0.1 Mtoe each. In Lithuania, out of the 2.7 Mtoe of gas consumed in 2012, 1.1 Mtoe was attributed to final non-energy consumption and 0.8 Mtoe to CHP plants. The reminder was attributed in similar shares to households (0.1Mtoe), industry (0.3 Mtoe) and services (0.1 Mtoe). In Estonia almost the entire gas import of 0.5 Mtoe in 2012 was consumed in district heating plant (0.4 Mtoe) and 0.1 was consumed by industry, households and services.

Poland depends in 2/3 of demand on Russian imports. In 2012, out of the 13.6 Mtoe of gas (of which 10 Mtoe was imported) households consumed 3.4 Mtoe, industry 3.7 Mtoe and services 1.6 Mtoe. Gas plays marginal role in electricity and heat production. Due to the physical reverse flow on Yamal pipeline introduced in April 2014, in case of disruption of deliveries and availability of gas in the West of the EU Poland will be able to cover up to 30% of domestic consumption and together with LNG terminal in Swinoujscie and use of Lasow and Cieszyn interconnectors Poland has the infrastructure to be able to replace deliveries from Russia by deliveries from other directions.

In 2012 Slovakia consumed 4.4 Mtoe of gas of which 3.9 was imported from Russia. Similarly to Poland, Slovakia is able to cover missing supplies from Russia by the use of reverse flow capacities from the Czech Republic and Austria. The response to a disruption from Russia will depend on the availability of the gas in the west of the EU and the ability to transport it to those two states. Furthermore, connections with Slovakia are important to ensure additional supplies to Hungary. In terms of consumption households consumed almost ¼ of the gas in Slovakia in 2012. Industry consumes 1.4 Mtoe and Services 0.6 Mtoe. Gas is also used in CHP plants (0.5 Mtoe and District heating 0.3 Mtoe).

Gas is the most important fuel in energy mix in Hungary. The imports are up to 98% of Russian origin. Hungary fulfils the N-1 supply standard in 2012. However despite high storage capacities (almost 2/3 of consumption) Hungary might not be able to fully replace Russian imports relying on the connection to Austria. In general there are five interconnections in Hungary, with Romania, Serbia, Austria, Croatia and Ukraine. Only the connection with Croatia is bidirectional. In order to facilitate the bidirectional operation between Hungary and Romania, a compressor station on the Romanian side is necessary to be constructed. New investments are needed on Austrian and Hungarian side in order to establish reverse flow. The interconnection with Slovakia is scheduled to be on stream in 2015 and will be capable of reverse flow transmission. The use of gas in Hungary is very spread. In 2012 out of 8.3 Mtoe, 2.7 Mtoe were consumed in households, 1 Mtoe by the industry, 1.4 Mtoe by services, 1.3 in CHP power plants, 0.8 in producing electricity in conventional power plants as well as 0.6 Mtoe in district heating. Development of connection with Slovakia and completion of the North-South gas connection and application of demand side measures is important for diversification of supply in Hungary.

Investments undertaken in Hungary and Austria are important to ensure that also Romania is able to respond to supply disruption from Russia. In Romania which relies in high extend on its domestic production the Russian imports cover only 10% of consumption. Imports from Hungary or Bulgaria are therefore key to fully replace disruption of deliveries from Russia. In terms of consumption the pattern is similar as in Hungary: Households and industry consume with almost equal shares above half of the 10.8 Mtoe of total demand. 2 Mtoe is consumed in CHP plants, 0.5 mtoe in conventional plants and o.5 Mtoe in district heating plants. Since the imports amount to 2.3 Mtoe demand response measures can play an important role in replacing imports in case of disruption.

Bulgaria is fully dependent on Russian gas and did not fulfil the N-1 standard in 2012. Bulgaria identifies the disruption of gas from Russia (its only gas supplier) as the one and most severe risk. The measures proposed in the Preventive Action Plans to address this situation are the development of new interconnectors with Greece, Serbia and Turkey. Promising short term source of diversification for Bulgaria is the LNG terminal in Greece which capacity exceeds the needs of Greece by the amount necessary to cover missing volumes in Bulgaria. With the construction of the interconnector BG-RO it would be possible to have flow in both directions. However works on interconnectors (planned and existing) need to be extended in order to cover for the disruption of Russian gas deliveries. In the energy mix of Bulgaria gas is less important than oil and nuclear. Majority of gas - 1.2 Mtoe out of 2.5 Mtoe in 2012 - is being consumed by the industry e.g. aluminium production. Production of electricity and heat in CHP consumed in 2012 another 0.8 Mtoe, whereas district heating 0.2 Mtoe. These consumption patterns allow Bulgaria to identify ways to target most protected consumers and reduce consumption of gas.

Gas accounts for 10% of the gross inland consumption of Greece. Half of it is being imported from Russia. Greece did not fulfil the N-1 standard in 2012. In terms of risks Greece noted among others the unavailability of power stations with dual fuel capability, 800 MWe unavailable out of 2000 MWe. In terms of infrastructure capacities, the LNG terminal in Revithousa is able to cover shortages of deliveries from Russia. Although fulfilment of N-1 standard will only be possible in Greece by the construction of a new LNG terminal, UGS or new interconnection and is not achievable before 2016, Greece emphasized in the Preventive Action Plans that the demand side measures would contribute significantly to raise the N-1 index. Indeed in terms of demand out of 0.5 Mtoe of gas consumed in Greece 0.3 is consumed by district heating plants which has a potential of consumption reduction by fuel switching and deployment of more efficient appliances.

Annex I provides energy flow charts and assessment of alternatives in case of gas disruption for the Baltic States, Finland, Bulgaria, Romania, the Czech Republic, Slovakia, Romania and Greece, along with country charts for each Member State of the EU on total energy demand by product, import dependency by product and imports of natural gas and crude oil by country of origin (including intra-EU flows)

Emergency response measures in Finland

As identified by the IEA in their report of 2012 Finland developed precise plan of reaction to fuel switching and demand side measures in case of disruption of gas from Russia.

First market measures are implemented aiming to increase price of gas. The TSO increases the price for excess gas and implement a buy back system through the Gas Exchange. This system proved successful in 2010 to shave the peaks of gas demand.

If these measures are not sufficient, the TSO in second step reduces the volumes of all its customers on a pro rata basis, except for protected customers (detached houses and other residential properties that directly use natural gas). A secondary market system applies in which the consumers can reduce their own consumption more than required by the TSO, and sell their quota to other customers.

In case of total disruption of deliveries National Emergency Supply Agency (NESA) can give permission to release compulsory stocks of alternative fuels. Over 40% of natural gas consumption can be switched by light fuel oil within 8 hours after fuel switching starts.

To satisfy the demand of protected customers an air propane mixing plant has been built in Porvoo to provide protected customers with air mixed propane gas which is activated only in case of disruptions (the pressure in the transfer pipelines has fallen below 7 bars). The gas mixture capacity of the plant is equivalent to 350 MW (or some 0.84 mcm/d at net caloric value), by which gas demand of protected customers (200 MW or 0.48 mcm/d) can be covered.

Dedicated measures have also been prepared to address the deliveries for the biggest gas consumers. In addition to protected customers, LPG stocks are planned to be used in the Porvoo refinery of Neste Oil Oy which is one of the largest consumers of natural gas.

Domestically liquefied LNG in Porvoo can also be available during a gas disruption. However, LNG can only be delivered by trucks and fed into the network through mobile LNG vaporisers.

Summary natural gas

- The 2014 Summer Outlook and the estimation for Winter 2014/2015 of ENTSO-G concludes that the resilience of the European gas system is satisfactory when facing a one moth event (in May) in terms of ensuring proper storage levels to prepare for winter 2014/15. However in case of an event lasting the whole summer the storages of the Member States would be seriously affected.
- As demonstrated in the past (cold snap of March 2013), in a well-functioning integrated internal market for gas, markets can be instrumental in times of crisis, sending signals to where gas is needed. Lack of infrastructure or regulatory failures such as lack of liquid gas markets and wholesale price regulation can seriously undermine market resilience.
- Member States in the East and South-East EU are most vulnerable to supply disruptions. Due to lack of liquid gas markets these Member States might be least attractive for alternative suppliers to deliver the missing gas supplies.

4.4 Coal

Coal is an indigenous resource with buoyant intra-EU trade: most coal is produced and used in the vicinity of deposits. Globally coal is predominantly supplied by domestic production with internationally traded coal accounting for a relatively small part of the market (less than 20% in 2012), the large part of which was transported by sea.

Just like with other energy commodities, coal deliveries run physical, including weather-related, risks to security of supply. Weather conditions, such as floods, may impact mine production. In addition, weather can cause delays in seaborne imports and domestic river transport (low river levels or freezing conditions). Congestion of transport infrastructure can lead to disruption of supplies[77]. Yet, one could reasonably expect such disruptions to be short-lived, with inventories offering a short-term buffer and the continuing oversupply in global coal markets giving scope for reaction.

Diversifying import sources and exploiting indigenous reserves are two ways of reducing security of supply risks related to coal.

4.4.1 Internal energy reserve capacity

In the EU, hard coal and lignite together account for more than 80% of non-renewable reserves[78]. While overall the production of solid fuels currently meets more than 60% of demand (more than 70% if intra-EU trade movements are considered), hard coal is more heavily dependent on imports with production meeting less than 40% of demand. The abundance of coal reserves and the fact that many Member States meet their coal demands domestically or through movements on the internal market (intra-EU trade), makes coal more resilient from security of supply point of view.

At the same time, international coal prices have sustained low levels due to oversupply and European hard coal producers are indeed struggling to survive against competition from internationally traded coal[79].

Some Member States have resorted to measures such as priority dispatch for electricity generated from domestic coal or peat, including Spain, Slovakia, Ireland and Estonia. This may lead to distortions of the markets, go against climate objectives and pose challenges with state aid rules.

4.4.2 External energy reserve capacity

Diversifying suppliers would spread the price-related and supply-related risks associated with importing. The EU does have its own coal reserves, so global supply and demand can only affect the country's energy security up to a point. If international prices were to rise or supplies were to fall to the point where importing coal became uneconomic or impractical, it is likely that mining these indigenous reserves would become more cost-effective.

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[77] Earnst&Young points to the top risks in the mining and metals industry with infrastructure access only scoring 9 out of 10, mostly in the context of companies turning to new deposits in frontier countries, where the lack of infrastructure can be a substantial hurdle. Source: Earnst&Young, Business risks in mining and metals 2013-2014

[78] Bundesanstalt für Geowissenschaften und Rohstoffe. 2013. Reserves, Resources and Availability of Energy Resources, Berlin.

[79] IEA. 2013. Medium-term market report on coal.

4.5 Uranium and nuclear fuel

The Euratom Treaty has set up a common supply system for nuclear materials, in particular nuclear fuel. It also established the Euratom Supply Agency (ESA) and conferred it the task to guarantee reliability of supplies of the materials in question, as well as equal access of all EU users to sources of supply.

For that purpose, pursuant to Chapter 6 of the Treaty, ESA has the exclusive right to conclude contracts for the supply of nuclear materials (ores, source material and special fissile materials) from inside or outside the Community. The Agency appears as a "single buyer", whose task is to balance demand and supply and to guarantee the best possible conditions for the EU utilities.

In practice, in normal circumstances of supply, the "*simplified procedure*" (introduced by Art. 5 bis of the Agency's Rules) is used, by which commercial partners – inside or outside the EU – may negotiate their transactions between themselves with the obligation to subsequently submit their draft contracts to ESA for consideration and conclusion. In any case, even within the framework of the simplified procedure, the Agency maintains the right to object to (and refuse to sign) a contract likely to jeopardise the achievement of the objectives of the Treaty. For that reason, all supply contracts, submitted to ESA for conclusion, undergo a thorough analysis, in the light also of the EU common policy.

The role of ESA is many-fold:

- ESA is actively promoting diversification of sources of nuclear fuel supply, with a view to preventing excessive dependence of EU users from any single, third-country source of supply.
- ESA warns individual users of potential excessive dependence from a single, external source of supply. ESA endeavours to propose alternatives and / or remedial measures to the user concerned.
- In its market-monitoring role, ESA has responsibility for early identification of market trends likely to affect medium- and long-term security of supply of nuclear materials and services in the EU market. In the event such trends were detected, the Agency will communicate, as appropriate, and consider relevant remedial action.
- In the event of a sudden deterioration of the situation in the market requiring a quick reaction (in particular, if external dependence increases significantly in a short period of time or if imports risk to distort competition within the EU internal market), as well as in case a user fails to diversify its sources of supply or to implement remedial measures, ESA shall make use of its powers under Chapter 6 of the Treaty.

Uranium resources exist in many EU MS; although the ore grades do not always compare to those in some other locations, there is some potential to increase uranium production in the EU over a 5–10 year horizon, perhaps to 1000–2000 tU, equivalent to 5–10 % of EU requirements, admittedly still a small part of the total consumption. In the longer term, the EU could even cover its needs to a large extent.

In addition, there is considerable potential to increase the use of reprocessed uranium and plutonium, should natural uranium prices rise. The recovery of uranium and plutonium through reprocessing of spent fuel is nowadays done in France and Russia. As an additional reserve, significant quantities of depleted uranium are stockpiled in the EU and could be either re-enriched or mixed with plutonium (MOX) in case of a shortage.

Conversion and Enrichment

The current EU capacities in uranium conversion would be sufficient to cover most of EU needs, if no exports were taking place. As the technology is mastered by EU industry, it is also possible to expand capacity according to demand, albeit not very suddenly.

For enrichment, the EU-based capacities operated by AREVA and Urenco would be more than sufficient to cover all EU needs if no exports were taking place. Since these EU companies are major suppliers for worldwide customers, a significant part of their production capacity is not immediately available for EU utilities' requirements.

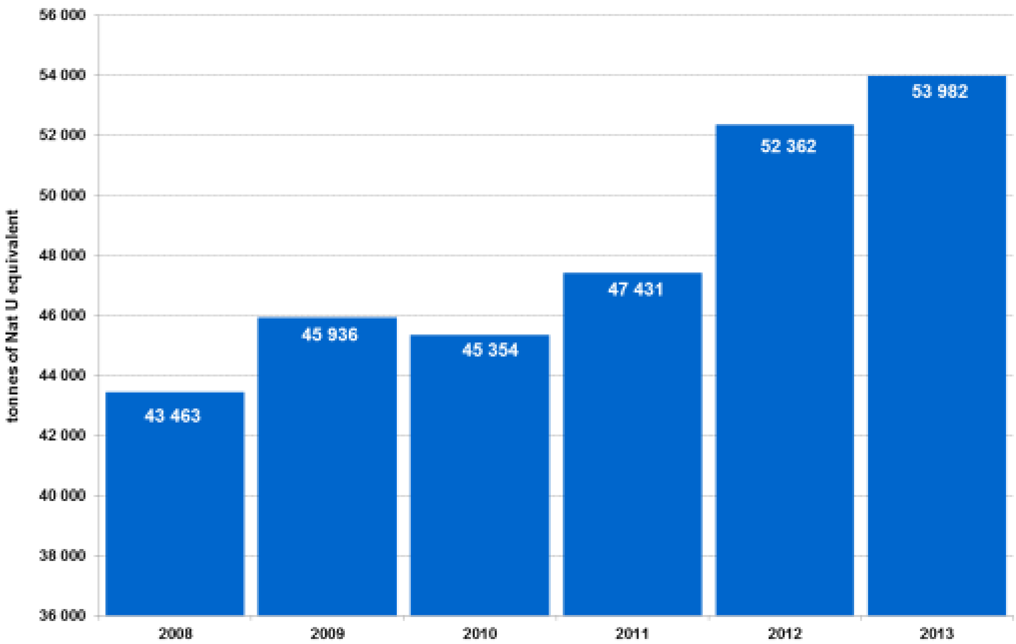
In particular for enrichment, maintaining idle reserve capacity is not practical, since the used centrifuges must be kept continuously in operation, which also requires energy. Therefore, centrifuge enrichment plants are operating at full capacity, although part of the capacity may be used for below optimum activities, such as re-enrichment of depleted uranium, depending on market conditions. This provides some margin of flexibility for increasing output.

Inventories

Uranium inventories owned by EU utilities at the end of 2013 totalled 53 982 tU, an increase of 3 % from the end of 2012 and 24 % from the end of 2008. The inventories represent uranium at different stages of the nuclear fuel cycle (natural uranium, in-process for conversion, enrichment or fuel fabrication), stored at EU or foreign nuclear facilities.

Based on average annual EU gross uranium reactor requirements (approximately 17 000 tU/year), uranium inventories can fuel EU utilities' nuclear power reactors, on average, for 3 years. Most EU utilities have inventories for 1–2 years' operation in different forms (natural or enriched uranium, fabricated fuel assemblies). Some utilities are covered for 4–6 years but others only for some months. In the current situation, most vulnerable in terms of security of supply are those utilities that depend on Russian fabricated fuel assemblies (VVER reactors), which cannot be quickly replaced by fuel assemblies from another manufacturer.

Figure 90. Total uranium inventories owned by EU utilities at the end of the year, 2008–13 (tonnes)



Source: ESA

4.5.1 External energy reserve capacity

Transport is not a major issue in nuclear fuel supply, although the limited number of ships and harbours that can handle nuclear materials is sometimes seen as a factor of vulnerability, in particular due to a geographic unbalance between conversion and enrichment services. Two thirds of the western conversion capacity is located in North America, whereas two thirds of the western enrichment capacity is in the EU. Likewise, transport arrangements may have to be changed in case of transit problems but usually an alternative can be found.

Storage as such is not problematic; dedicated storage facilities are subject to very strict safety and security requirements.

Whereas the uranium itself can be purchased from multiple suppliers and easily stored, the final fuel assembly process is managed by a limited number of companies. For western designed reactors, this process can be split, and diversification of providers achieved. For Russian designed reactors, the process is "bundled" and managed by one Russian company, TVEL, currently with insufficient competition, diversification of supplier or back up. Thus, particular attention should be paid to new nuclear power plants to be built in the EU using non-EU technology. While the aim is not to discriminate against non-EU suppliers, the operators of such plants should ensure that fuel supply diversification is possible and should present a credible diversification plan, comprising all stages of the fuel cycle.

4.5.2 Improving the internal market

For bundled sales of fuel assemblies (i.e. sales including nuclear material, enrichment and fuel fabrication), in particular for new reactors, the supplier of fuel assemblies must allow the plant operator to acquire enriched uranium from other sources as well. Likewise, the reactor constructor must enable the use of fuel assemblies produced by various fabricators (e.g. by disclosing fuel design specifications and allowing testing fuel assemblies of various origins). In the current circumstances regarding Russian designed reactors, this option seems unlikely.

4.6 Renewable energy

4.6.1 Internal energy reserve capacity

The share of renewable energy has increased to 14.1% in 2012 as a proportion of final energy consumed (compared to 8.7% in 2005), thus increasing the EU's local energy production and gradually reducing the dependency on energy imports[80]. This is particularly the case in the electricity sector, where the share of EU produced renewable electricity increase from 15% in 2005 to 24% in 2012. Reliance on imported fossil fuels is still high in the heating and transport in most Member States, where the use of renewables since 2005 has only increased little. The RES share in heating sector in 2012 was about 16%. In transport, the current 5% of renewable energy share is mainly based (above 95%) on first generation biofuel use, on average 70% of which are produced in the EU, while remaining share of their imports are mainly sourced from Brazil, US and South East Asian countries[81].

The key instrument for increasing renewable energy production has been the Renewable Energy Directive[82] and the national measures implementing it. The share of renewable energy has increased in every Member State since 2005. The Directive established national legally binding targets which have provided the incentives to national governments to undertake a range of measures to improve the uptake of renewable energy. These include improvements to national planning and equipment/installation authorisation processes and electricity grid operations (connection regimes etc.), some of which are explicitly required by the Directive. Financial support has also been used by Member States to increase uptake, compensating for the various market failures that result in suboptimal levels of renewable energy.

On aggregate, the EU has met its interim target for 2011/2012, driven by Member States efforts to make progress towards the national targets in the Renewable Energy Directive. 3 Member States (Sweden, Estonia and Bulgaria), had already reached their national 2020 RES targets in 2012, and a few others were close to meeting them in 2013 and 2014. Other Member States were well on track. However, as the trajectory grows steeper, more efforts will still be needed from Member States in order to reach it[83] Many Member States need however to make additional efforts to meet their respective 2020 national targets, and recent evolutions such as for instance retroactive changes to support schemes is causing concern as to whether the overall EU target will be met[84]. In order to allow an overall cost-efficient achievement of targets the Directive envisages cooperation mechanisms allowing Member States to fulfil a part of their target by using potentially less costly RES potential abroad. In order to assist Member States in addressing these challenges, the Commission issued Guidance[85] on support schemes and cooperation mechanisms in November 2013, which if fully adhered to is expected to have a significantly positive impact on cost-efficiency, flexibility, market integration, and further sustainable development of renewable energy in the EU.

[80] Calculations based on the Directive 28/2009/EC
[81] Renewable Energy Progress report, COM (2013) 175.
[82] Directive 28/2009/EC.
[83] See the Commission Renewables Progress Report.
[84] Other reasons for concern include the failure to address barriers to the uptake of renewable energy: administrative burdens and delays still cause problems and raise project risk for renewable energy projects; slow infrastructure development, delays in connection, and grid operational rules that disadvantage renewable energy producers all continue and all need to be addressed by Member States in the implementation of the Renewable Energy Directive. Many Member States therefore need to make additional efforts to meet their respective national targets under the Renewable Energy Directive. More information in the Commission's "Renewable energy progress report", COM(2013) 175 final
[85] Communication 'Delivering the internal electricity market and making the most of public intervention', C(2013) 7243 final

Much increased renewable energy consumption in the EU has been achieved through developments in EU renewable energy production, which has the potential to contribute to lower energy import dependence and, therefore, a lower energy import bill. EU production in renewable energy has increased significantly in recent years (by 231% between 1990 and 2011). At the same time, the production of non-renewable energy sources has fallen (by -27%). Over the same period (1990 to 2011), the EU's net energy imports increased by 24%. Without the contribution of (increasing) domestically produced renewable energy, the EU's net energy imports would have possibly increased by more.

While the exact contribution of renewables to reduced import dependency cannot precisely be estimated, it should be noted that 90 Mtoe is the difference between renewable energy produced domestically in the EU in 2011 and 1990. Increased renewable energy production may also have reduced energy demand, and will to some extent also have displaced production of domestic non-renewable sources. Altogether, the avoided costs of imported fuel saved thanks to the use of renewable energy are conservatively estimated to amount to around €30 billion in the EU in 2010 compared to an external trade deficit in energy products that year of €304 billion[86].

Increased deployment can be made further cost effective by flanking and supporting policies that help Member States increase their energy security and independence by increasing the share of renewable energy in a cost competitive manner. Such policies would focus on removing market failures, which persistently reduces the rate of deployment of renewable energy. The Commission will analyse the whole possible range of such options, and propose action, including legislation wherever appropriate[87].

In addition to the Commission's evaluation of the NREAPs, various stakeholders have analysed the Member State renewable energy plans and have expressed their views on the Member State technology choices and the adequacy of measures planned to achieve the renewable energy targets[88]. The REPAP 2020 project provided an independent assessment of the NREAPs evaluating the quality of measures included in the action plans for tackling the administrative barriers to renewable energy development, improvement of energy infrastructure development and electricity network operation and support measures in each of the 3 energy consuming sectors. It found that the biggest weaknesses still existed in the field of administrative procedures and spatial planning followed by still rather weak support measures for renewable energy heating and cooling. It also found that further improvements were still required in many Member States in the area of support measures in the electricity sector. This assessment is also largely echoed in European Renewable Energy Council's (EREC) EU industry roadmap.

Since the adoption of the Renewable Energy Directive, the scientific evidence base regarding the GHG emission impacts associated with indirect land use change (ILUC) has grown. In response to the ILUC issue, the Commission proposed to limit the amount of food-based (1st generation) biofuels that can contribute to the relevant targets (including the 10 % renewables target for transport) and has indicated that first generation biofuels with high estimated indirect land-use change emissions should not continue to receive public support after 2020[89]. However, as projections indicate that Europe will need considerable amounts of biofuels towards 2050, the Commission's proposal includes increased incentives for advanced biofuels that do not need land for their production, such as biofuels made from residues, algae and wastes. In order for the transport sector to decarbonise in a cost-effective and sustainable manner, technology developments of relatively small quantities of advanced renewable fuels going beyond R&D are necessary, in line with the Commission's proposal for limiting emissions from indirect land-use change.

[86] Report on economic aspects of energy and climate policies, 2013, European Commission, DG ECFIN
[87] Report on economic aspects of energy and climate policies, 2013, European Commission, DG ECFIN
[88] REPAP 2020 project report (2011), Mapping Renewable Energy Pathways towards 2020, EU Industry Roadmap, EREC (2011), EREC ECN/EEA report on Renewable Energy Action Plans (2011)
[89] Proposal for a directive amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable source, COM(2012)595

The Commission is currently analysing the sustainability issues associated with increased use of solid and gaseous biomass for electricity, heating and cooling in the EU, to consider whether additional EU action is needed and appropriate. While imports of wood pellets will increase up to 2030, most of the biomass for heating and power production is planned to be sourced domestically[90] and therefore it is subject to national and EU environmental and forest policies and regulations. According to existing scientific understanding, most of the biomass supply chains currently used in the EU provide significant carbon emission reductions compared to fossil fuels. Only a limited number of biomass feedstock may have uncertain or potentially negative climate benefits. However, the comparisons depend partly on the methodological assumptions made in the relevant studies. The Commission is currently reviewing the scientific basis and possible safeguards and will take this into account in the above mentioned analysis.

[90] Commission own calculations on the basis of data from National Renewable Energy Action Plans (NREAPs), Eurostat and IEA 2010 (Global Wood Pellet Industry Market and Trade Study)

4.7 Electricity

The electricity sector is in the midst of a deep transformation, which can pose new electricity security challenges. Some of these challenges can only be solved by having electricity markets that are more flexible and better integrated across borders. Traditional forms of power generation – such as coal, natural gas and nuclear – allow for central dispatch. The rapid deployment of renewables – mostly wind and solar power – contributes to sustainability, but the integration of variable renewable production creates a new set of challenges in system operation, mostly at distribution level (except for large offshore wind parks or large-scale solar parks connected at high-voltage). In addition, renewables have marginal production costs that are close to zero and, through the merit order, have an impact of the economics of other generation capacities.

In a decarbonised system, the single market will be even more important leading to a shift from intra-EU flows of fossil fuels to increasing reliance on electricity. Electricity imports from neighbouring countries often serve to replace fossil fuel imports and increase security of supply. Thus, electricity security assessments may need to be done at the level of the interconnected system in the future rather than at the level of individual systems. In addition, different geographical patterns of renewable energy power production offer efficiency gains in balancing, also implying large and expanding electricity trade. The completion of the internal energy market, including the integration of balancing markets, as well as the mobilisation of demand-side response, are pre-requisites for the smoother integration of renewables into the electricity system.

4.7.1 Internal energy reserve capacity

Directive 2005/89/EC establishes measures aimed at safeguarding security of electricity supply so as to ensure the proper functioning of the internal market for electricity and to ensure an adequate level of generation capacity, balance between supply and demand and level of interconnection between Member States for the development of the internal market.

The Electricity Coordination Group established in 2013 that security standards differ between Member States and no single definition what security of supply mean can be identified. In the scope of the discussion regarding the necessity of **generation adequacy** measures, DG ENER undertook steps to ensure that the assessment of security of supply becomes more quantifiable and transparent. This overview shows that although there is no clear definition at the EU level of what security of supply means, there is a clear focus on measures to establish security of supply. Depending on the fuel the complexity of the measures increases. On oil mandatory stocks are an obligation, on gas National Plans and measures need to be undertaken in the framework of the internal market with an important role of infrastructure. On electricity measures involve in addition secure system operation.

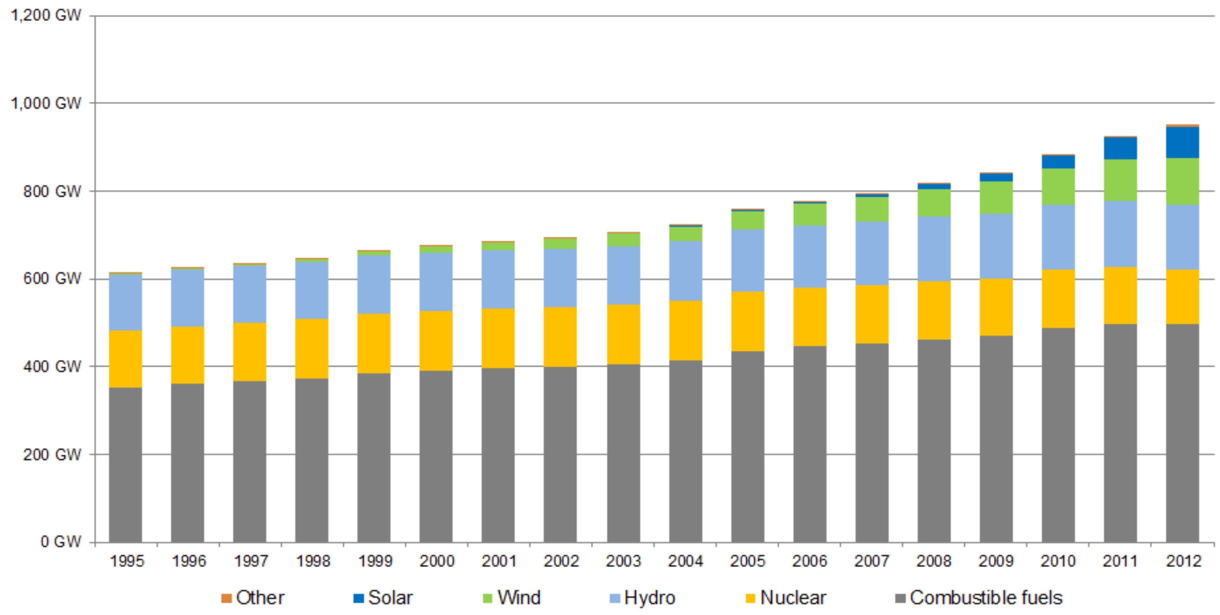
All the measures above focus rather on short term situations to react in times of crisis or supply disruption. However there is also a time dimension to security of supply. In longer term, pursuing policies of changing fuel mix away from fossil fuels, by investments in infrastructure and stronger integration of the energy markets the EU is able to achieve higher energy independency from external suppliers. Therefore ensuring security of supply and lowering energy dependence is a matter of interplay between trade flows of the fuels, infrastructure that is need and contractual obligations set in market terms as well as long term policies lowering consumption of fuels and their more efficient use.

4.7.1.1 Generation capacity

Security of electricity supply in a given country depends on a number of factors. First of all, it depends on the supply and demand relation: how big share of the country's annual electricity consumption is produced domestically and how much does it need to import, or in other case how big electricity surplus does to country possess, which can be exported? Security of supply also depends on the power infrastructure in the country and the interconnection capacities to its neighbours. The resilience of its power generation system (how it can react to sudden increases in power demand), the capability of rapidly substituting power generation feedstock is also important. In its import structure the number of supplier countries also impacts the concentration of imports and thus security of supply. Finally, on the long term security of electricity supply may depend on the effectiveness of the energy policies (e.g.: energy efficiency measures, decisions on energy mixes, climate policy goals, etc.)

Figure 91 shows the evolution of installed electricity generation capacities between 1995 and 2012 in the EU-28. From security of supply point of view it is important to compare the evolution of power generation/consumption with that of the installed capacities. Between 1995 and 2012 power generation in the EU-28 went up by 20.5% and final electricity consumption increased by 23.5%, while during the same period the amount of installed capacities were up by 55%. Decrease was only registered in the case of nuclear capacities in the EU (-4.1%). Combustible fuel capacities grew by more than 40%. Wind and solar installations[91] showed the most dynamic picture within this period, as the former ones registered a forty-three fold increase while the latter ones recorded a hundred-and-forty-five fold increase between 1995 and 2012.

Figure 91 Installed power generation capacities in the EU-28 (1995 - 2012)



Source: Eurostat, energy

The growth in installed generation capacities exceeded both the increase in power generation and consumption, suggesting an improvement in security of electricity supply from domestic generation point of view. The growth in renewable capacities brought diversity of generation sources.

Besides generation technologies the **availability** of the existing capacities can exert influence on the security of electricity supply. Table 10 shows the composition of the capacities, according to generation technologies (fuel) and provides information on their availability in the December reference points in 2010, 2011 and 2012 for the transmission system operators of the ENTSO-E[92].

[91] Given the elimination of conversion losses of thermal power generation, a growing share of renewable electricity itself reduces primary energy consumption, so its contribution is indeed sizeable. Due to conversion efficiency, conventional energy statistics tends to underestimate the contribution of renewables.

[92] ENTSO-E provides data for 34 countries, out of the 28 EU member states Malta is not included, but Norway, Switzerland, Iceland and the Balkan countries with the exception of Albania and Kosovo are included

By comparing data of the same month in different years (reference point) the seasonality of non-available capacities (e.g.: planned maintenance works) can be eliminated.

As we can see, the share of the unavailable capacities compared to the total net generation capacities varied between 26-33% during the observed period, of which the highest part could be attributed to non-usable capacities[93] (17-23% of the total net generation capacities). Maintenance and plant overhaul was responsible for the non-availability of 3-3.5% of all capacities, as December is not a typical maintenance period of the year. Outages, primarily meaning unscheduled non-availability of generation capacities, had a share of 2.1-2.8% between December 2010 and 2012. **Outages** pose a threat to the security of electricity supply, especially combined with other non-planned events (e.g.: weather conditions, supply disruptions of fuel feedstock, etc.), however, during the observed period system service reserves were higher than capacities being unavailable due to outages.

Table 10. The availability of generation capacities in ENTSO-E member TSOs, December 2010-2012

GW	2010	2011	2012	Change 2012 to 2011	
				Absolute value (GW)	%
Net Generating Capacity	910.7	935.5	981.1	45.5	4.9
Fossil fuels power	451.3	454.8	463.5	8.7	1.9
Nuclear power	133.9	125.7	125.4	-0.4	-0.3
Renewable energy sources (incl. renewable hydro)	253.4	303.7	354.8	51.2	16.8
Non-renewable hydro power	66.5	46.8	36.5	-10.3	-22.0
Not clearly identifiable energy sources power	5.7	4.5	0.9	-3.6	-80.4
Unavailable capacity	237.1	270.6	329.0	58.4	21.6
Non-usable capacity	155.7	189.4	232.5	43.2	22.8
Maintenance & overhauls	26.3	30.2	36.0	5.9	19.4
Outages	22.9	20.0	27.6	7.6	38.1
System service reserve	32.2	31.1	32.9	1.8	5.8
Reliable Available Capacity	658.5	664.9	652.1	-12.9	-1.9
Load	521.2	473.5	481.3	7.8	1.7
Remaining capacity	137.3	191.4	170.7	-20.7	-10.8
Exchanges	-0.6	-2.2	-1.1	1.2	-52.2
Imports	40.1	51.2	46.1	-5.1	-10
Exports	40.7	53.4	47.2	-6.3	-11.7

Source: ENTSO-E

It is also important to examine the ratio of domestic production and consumption in each country in order to assess the local exposure to external electricity supply shocks. Countries like Lithuania, Luxembourg, Hungary or Croatia produced in 2012 significantly less electricity than their annual national consumption, meaning that they needed to import power to satisfy all domestic demand. In contrast, Estonia, Czech Republic, Bulgaria and France produced more than their domestic needs, and export a part of their production[94]. Here it is worth mentioning that net power flow positions in a given country can change significantly from one year to the other, for example, if the availability of domestic generating capacities are

[93] Due to various reasons, for example: temporary limitation due to constraints, like power stations in mothball or test operation, heat extraction for CHP's; limitation due to fuel constraints management; power stations with output power limitation due to environmental and ambient constraints, etc.

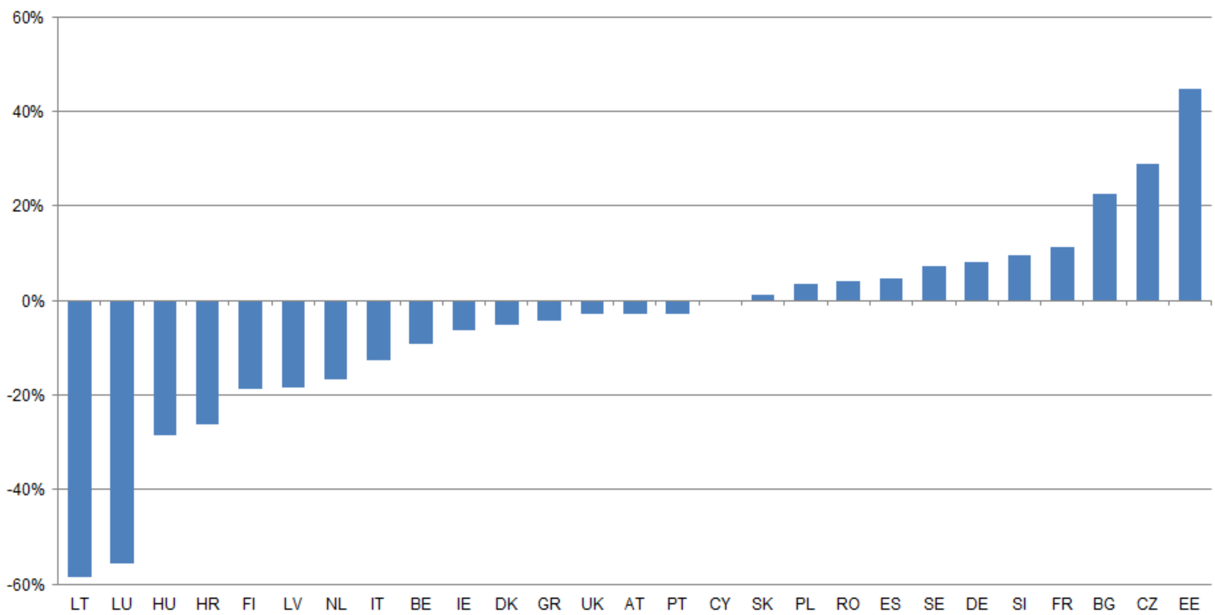
[94] Besides relative shares of imports to consumption it is important to examine the absolute volumes of power flows. France (net electricity exporter) and Italy (net electricity importer) do not show outstanding values in terms of relative numbers of electricity generation gaps or surpluses, though cross border flows in these two countries have major impact on the power flows in the EU as a whole.

affected by planned or unplanned maintenance works or due to weather conditions the availability of hydro generation changes significantly.

In the context of security of supply for electricity it needs to be emphasised that intra-community electricity trade can have a positive impact on reducing the external dependency on fossil fuels and thus the vulnerability of a given country and thus should be clearly distinguished from extra-EU imports. Increasing intra-EU electricity imports does not necessarily result in higher external energy dependency and could even reduce the overall energy exposure to third countries in some member states. For example, as gas-fired electricity generation became uncompetitive in Hungary, the country imports more electricity from the Czech Republic generated from domestic coal. In other words, instead of burning Russian gas, the country relies on foreign (though intra-EU) coal-fired generation, which is a better situation from the aspect of external fossil fuel dependency. Recently the Netherlands tends to import more electricity from Germany (based on coal-fired and renewables generation), replacing domestic gas-fired generation, though in this case the competitiveness of imports weighs more than the security of supply aspect.

These two cases give a perfect example on why the issue of electricity security of supply should be tackled at EU level and why not only national aspects should be taken into consideration. The accomplishment of the EU internal electricity market in itself could contribute to decreasing external fossil fuel dependency in the EU.

Figure 92 Difference between power generation and annual power consumption in 2013 in the EU countries (compared with annual consumption)

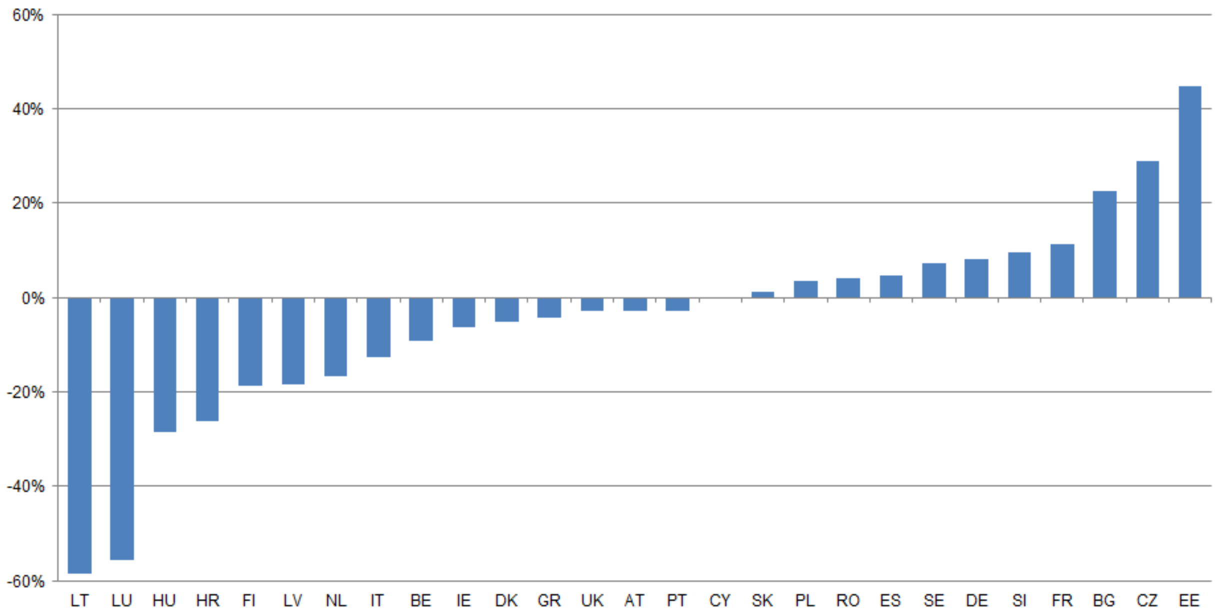


Source: ENTSO-E, calculations of the European Commission. Malta is missing

4.7.1.2 Short term disruption of supply in most exposed Member States

Another important aspect is the quality of electricity infrastructure, as security of supply risks may stem from disruptions (non-availability of an interconnector or cables). In the case of extra-EU imports it is important to see the number of interconnections and the changes in the availability of capacities.

Figure 93 Difference between power generation and annual power consumption in 2013



Source: ENTSO-E, calculations of the European Commission. Malta is missing

According to the data of Eurostat, in 2012 the **Netherlands** imported 5.3% of its annual electricity consumption from Norway using the NorNed high voltage direct current (DC) link. **Denmark** also imported power from Norway (17.5% of its annual consumption), similarly to **Sweden** (5.5% of its annual consumption). In the case of the Netherlands and Denmark, being net power importers, imports from Norway had higher importance than in the case of Sweden (which is a net power exporter). Both the Netherlands and Denmark are well connected with other neighbours. Norway is an EEA country, applying the community acquis.

Finland imported 5.5% of its annual electricity consumption from Russia in 2012, and given that the country is a net power importer and less connected with EU countries having cheap power sources (e.g.: Norway), a supply disruption of the Russian imports would possibly result in wholesale price hikes or higher use of domestic resources or increased imports from other sources.

Among the Baltic States **Estonia** has sufficient level of domestic generation capacities and the country does not need imports. During the most recent years cable links were also established with Finland (Estlink 1 and Estlink 2 – DC links). Latvia and Lithuania are in a quite different situation. **Latvia** imported 18% of its domestic electricity need from Russia in 2012, and the country is also connected with Estonia, Lithuania thorough 300-330 kV AC transmission power links. After the Ignalina nuclear power plant was shut down at the end of 2009, **Lithuania** heavily relies on power imports. In 2012 the country imported 29% of its annual power need from Russia via a 750 kV transmission line and 25% from Belarus (through several transmission lines of 300-330 kV voltage).

Poland, the Czech Republic and Slovakia are all net power exporter countries and are exposed less than 2% of their annual electricity consumption to extra-EU import sources, meaning that in their cases external supply disruptions are highly unlikely to have significant impacts. Furthermore, these countries are well connected to their neighbours, increasing the probability of finding alternative supply routes in case of a disruption.

Hungary imported 11% of its annual power need from the neighbouring Ukraine in 2012 (via a 750 kV high voltage transmission line), which share is high enough for supply problems in the case of a potential Ukrainian import disruption. The country is also sensitive for imports from the Balkan countries, being affected by hydro availability. As Hungary imports more than a quarter of its annual power need, these features make the country sensitive to extra-EU electricity supply shocks.

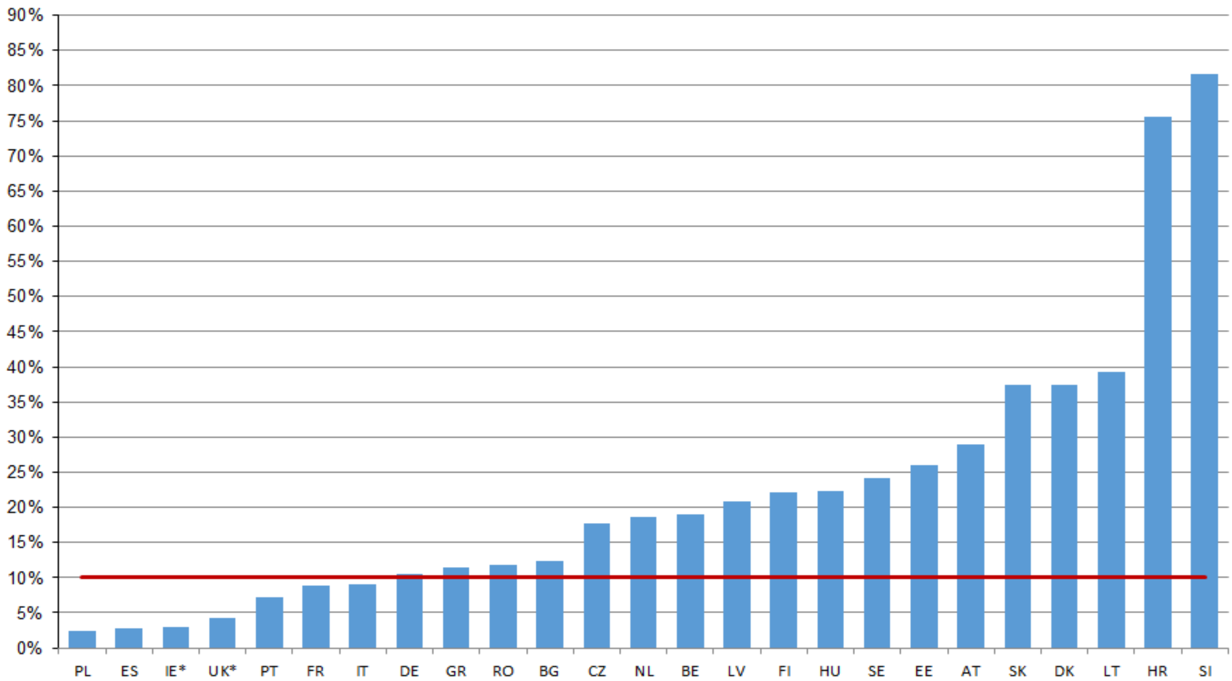
Croatia is also a net importer of electricity and imported 12.6% of its annual power need from Bosnia and 3.4% from Serbia in 2012. The country is well connected with its neighbours but the electricity market is sensitive to changes in power supply in the Balkans.

Romania is a net power exporter; it imported only 8% of its electricity needs in 2012. The country has a high voltage (750 kV) transmission line link towards Ukraine and is well connected with its neighbours. **Bulgaria** is in a net electricity exporter position and is not really sensitive to external import supply disruptions.

Greece is a net power importer and imported 3.3% of its electricity need from Turkey and 3.1% from the Former Yugoslav Republic of Macedonia (FYROM). The country is connected to all of its neighbours, including Italy (with a high voltage sub-sea DC link).

In the previous section electricity import sources and the import dependency of the EU member states having electricity supplies from countries outside the EU have been presented. Each member state should have enough interconnector capacities in order to be able to import electricity from (or alternatively, export to) neighbouring countries. The next chart (Figure 94) shows ratio of the available electricity interconnectors and domestic power generation capacities in each member state of the EU, with the exception of Cyprus and Malta, which are not connected to any other country, and Luxembourg, which has more than twice as high import capacities than domestic generation.

Figure 94 Ratio of available cross-border electricity interconnector capacities compared to domestic installed power generation capacities



Source: Ten Year Electricity Network Development (TYNDP) Plan, 2012 Malta and Cyprus are missing. The Irish power system includes Northern Ireland as well (and it is consequently not included in the UK)

In contrast to significant import dependencies in electricity, some member states might heavily be affected by domestic supply disruptions in the lack of the option of importing power. In July 2011 an explosion in Cyprus heavily impacted the power plant, which generated almost the half of the island's electricity need, resulting in several blackouts. As Cyprus is not connected to any other countries ('a true energy island'), it could not mitigate the impact of the disruption by substituting domestic production by imports. Furthermore, as the country's power mix is extremely dominated by oil-fired generation, alternative fuels could not assure a sufficient power supply either.

In general, most EU Member States perform well in terms of quality of electricity supply. A ranking of 144 countries undertaken by the World Economic Forum on quality of electricity supply, 5 of the top 10 positions are occupied by EU Member States. There remain differences between Member States, with 15 EU Member States in the top 30[95], while the remaining 13 rank lower down the list with Romania and Bulgaria in positions 88 and 95 respectively.

Extreme weather conditions, natural disasters, force major events and planned or unplanned plant, interconnector or power link maintenance works can affect the electricity security of supply in each country, especially in those cases, when several events occur simultaneously. For example, in March 2011, in the aftermath of the Fukushima nuclear power plant incident in Japan, the public acceptance of nuclear power generation rapidly diminished in many EU member states; and some of them decided to take nuclear capacities off the grid immediately. This had only a short-lived impact on spot electricity prices, as increasing renewable and coal-fired generation could substitute the missing capacities and thus eliminating the security of supply risks.

In contrast, the cold spell that affected most of Europe in February 2012 put a higher risk of security of electricity supply. Natural gas prices suddenly hiked in the consequence of low temperatures, affecting electricity prices. Electricity prices in North Western Europe were further influenced by increasing heating related demand in France, where most of the heating needs are satisfied by electricity. The cold weather also had an impact on hydro and other conventional generation in some countries as river waters could not be used either for power generation or for cooling purposes in power plants because of the freezing temperatures. And nuclear capacities were reduced in the previous year. Although no severe supply disruptions occurred, the whole European power system was under heavily strain.

In the case of electricity security of supply issues are different from those of fossil fuels, and in most of the EU countries the resilience of the power system is good enough to cope with problems of usual magnitude. However, simultaneous occurrence of unusual or extreme events (e.g.: an ongoing cold and dry winter coupled with a major external gas supply disruption) might cause perceivable disturbances in the functioning of the European electricity system and internal market.

In order to avoid such disturbances, Member States need to coordinate their policies regarding the electricity generation adequacy and in negotiating with external suppliers. In the case of the electricity security of supply issues are rather related to the stability of the grid, however, supply issues of fuel feedstock have repercussions on the electricity market.

Contrarily to fossil fuels, the storability of electricity is limited. Besides fuel cells the most commonly known form for storing electricity is hydro reserves. At EU level electricity security of supply can also be reinforced by hydro reservoirs in some European countries, having significant hydro generation capacities (Austria, Norway, Switzerland, etc.). A good example for this is the cheap electricity generation during off-peak hours in Germany, which is exported to Norway in order to pump the water back to reservoirs, being used for power generation during the peak hours and this generated electricity is re-imported to Germany.

At EU level imports can be deemed to be marginal compared to the electricity consumption, and thus external import electricity dependency is of secondary nature; mainly manifesting in feedstock import dependency used for power generation. As fossil fuel feedstock is also used in economic sectors other than electricity

[95] The Netherlands, Denmark, Austria, the UK, France, Finland, Sweden, Belgium, Luxembourg, the Czech republic, Ireland, Germany, Slovakia, Portugal, Slovenia and Spain

generation (e.g.: transport), electrification of the whole economy could substantially contribute to reducing energy import dependency if electricity can substitute other energy sources.

4.7.2 Improving the internal market

In 2002 EU member states agreed in the presidency conclusions of the Barcelona European Council[96] on a target for the level of electricity interconnections equivalent to at least 10% of their installed production capacities by 2005.

Although this deadline has long passed, there are still nine member states that do not meet this target according to the data of the 2012 TYNDP. Bottlenecks in interconnections may pose risks to the security of electricity supply in the case of unplanned domestic generation capacity outages, or in the case of interconnector maintenance works (or unplanned disruptions). In order to avoid these events these member states should develop sufficient level of interconnector capacities.

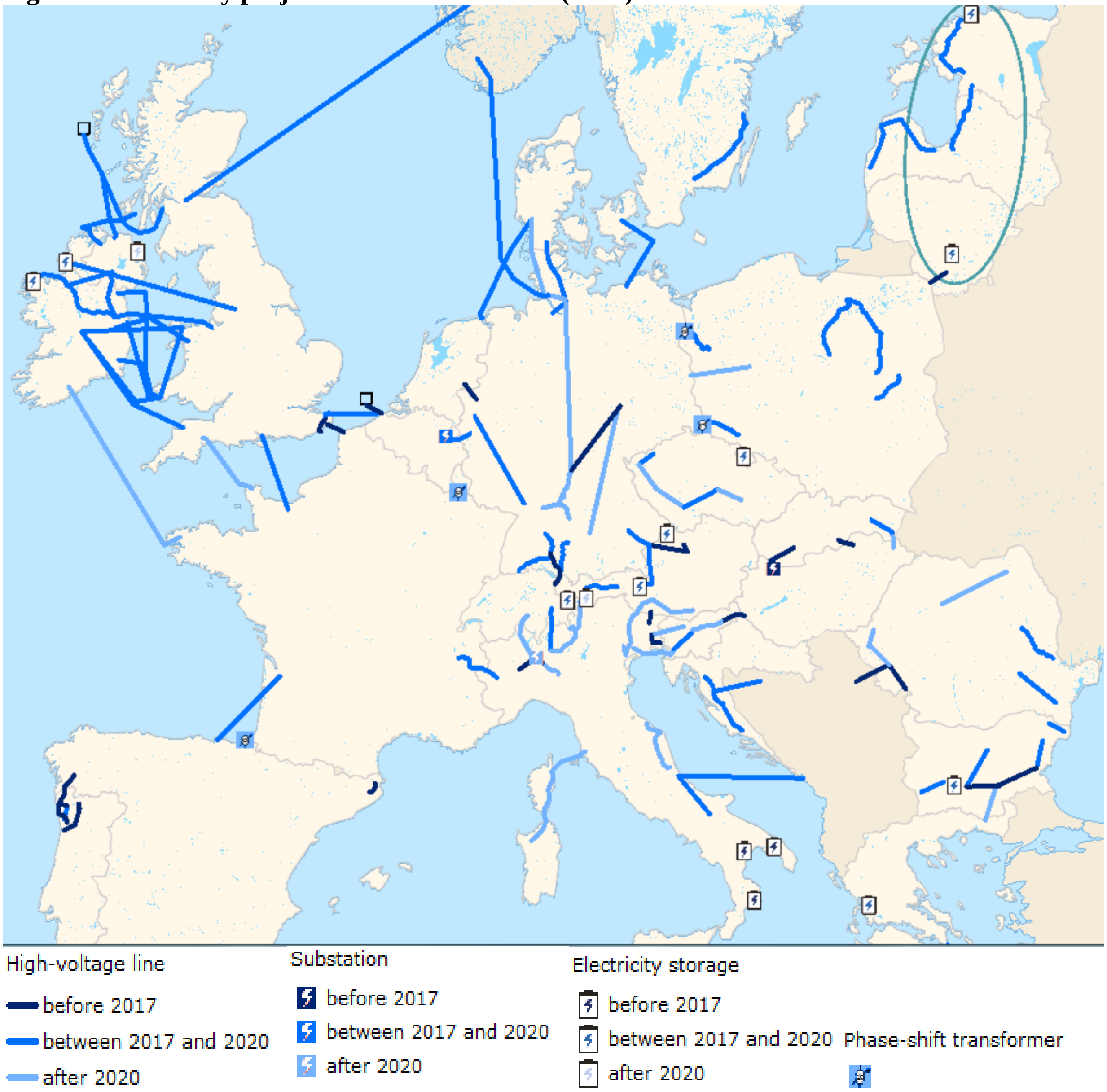
In order to tackle infrastructure bottlenecks, the European Commission and the member states aim at implementing a number of development projects. Figure 95 shows the electricity projects of common interests (PCI) in the EU. The first list of the PCIs was established in 2013, containing 248 projects, of which 132 in the electricity domain. The projects are contributing to the realisation of a pan-European integrated grid; to the ending of the isolation and removing bottlenecks in national grids and to the achievement of the 10% electricity interconnection target.

These projects aim at constructing new high voltage lines, substations, electricity storage capacities and phase shift transformers in order to enhance electricity security of supply in the EU internal energy market and to improve the functioning of the market by tackling the problems deriving from unplanned cross-border power flows.

However, progress with interconnectors in the onshore looped system has not been fast enough during the last couple of years; on some critical borders such as Germany – France available transmission capacity actually declined. This points to the need for the development of the transmission systems to be accelerated.

[96] http://ec.europa.eu/invest-in-research/pdf/download_en/barcelona_european_council.pdf

Figure 95 Electricity projects of common interest (PCIs) in the EU



Source: European Commission

Besides infrastructure developments a solid legal framework assuring the functioning of electricity cross-border trade can also contribute to enhancing the electricity security of supply. The Third energy package foresees the development of a harmonized legal framework at European level. Binding European rules (Network Codes), are being developed, adopted and increasingly applied in the day-to-day practical functioning of the electricity wholesale markets. Their impacts may not be as immediately tangible as those of a new interconnector, but they are true progress that is fundamental to foster cross-border trade. Regional initiatives are also proving concrete value in the (early) implementation of network codes.

Day-ahead price coupling has been tested and successfully implemented first amongst the countries of the Pentalateral Forum (Germany, France, Belgium, the Netherlands and Luxembourg) and Austria. In a second step, in February 2014, that region was coupled with the UK and Ireland and the Nordic region (Norway, Sweden, Denmark, Finland and the Baltic States). In May 2014, Spain and Portugal joined, resulting in one of the largest power market areas in the world. Hungary, Slovakia and the Czech Republic have implemented as a first step the mutual coupling of their markets, with the ambition to couple that market too with the larger market in the west. Hence, market integration is developing from the North to the South and from the West to the East, based on concrete projects initiated at regional level.

Day-ahead market price couplings contribute to increasing cross-border electricity trade through implicit transaction allocations. They substantially contribute to reducing the number of hours, when electricity flows from more expensive markets to the cheaper ones (referred as adverse power flows as this is the opposite way of economically justifiable market functioning, resulting in welfare losses in cross-border power trade). Couplings usually reduce price differentials between neighbouring markets, contributing to more homogenous price levels across the coupled region, however, this does not hold true for each trading hour after the coupling takes place, as price divergences may exist, even on longer run.

Government interventions in the energy market may still be needed for investing in generation, as well as for infrastructure investment, establishment of system operation rules and market coupling. The Commission's Communication and guidance of November 2013 "Delivering the internal electricity market and making the most of public intervention" explained in detail the conditions under which such intervention may be justified. It also explained the criteria under which the interventions are legitimate, whether related to the transformation of the energy sector into a low carbon regime or to ensuring the security of energy supply.

4.8 Research and innovation

Research and innovation actions already make an important contribution to EU energy security. This is notably the aim of the SET-Plan Integrated Roadmap currently in preparation, which will identify the changes required for the transformation of the energy system in the medium to long run, the key drivers for innovation, and the necessary research and innovation actions. On the supply side, the Roadmap will support the development of new and innovative energy technologies that are at the same time more efficient, cleaner, more reliable and more cost-competitive. In terms of network infrastructure, the aim will be to ensure energy system integration by developing the tools to manage variability in the energy supply, storage and distribution, to accommodate increasing renewable production and to allow more decentralized power generation from variable sources. Last but not least, the Roadmap will support significant improvement in energy efficiency, notably in the building sector, for industrial applications and for cities. However, the political direction of the emerging version of the SET-Plan and its associated Roadmap and Action Plan should be clearly set against the opportunities that emerge from the realities of energy security.

There are a few key areas where energy research and innovation has the potential to make an important contribution to energy security.

Coal-powered generation with carbon capture and storage: the coal sector already contributes to Europe's security of energy supply and this is expected to remain the case in the long run. Research and innovation efforts are however needed to reduce the environmental impact of increasing coal use and ensure compatibility with the EU climate change goals.

Renewables: EU research on renewables will continue to seek maximization of the vast untapped EU potential for domestic energy resources, with a particular emphasis on actions supporting the decreasing of costs and pushing for the market deployment of new innovative technologies. This will be done having in mind the need to avoid creating new economic, material or feedstock dependencies.

Nuclear fission research: a number of EU Member States are currently operating pressurized water reactors of Russian design (VVERs) on fuel imported from Russia. Recent attempts were made to diversify the fuel supply for this type of reactor but experiments were not all conclusive, which have raised safety concerns. There is a need to promote research cooperation at EU level in order to tackle these issues, which were so far addressed at national level only. An amendment to the Euratom Work Programme will be proposed to allow such research and innovation action to be launched in 2014, alongside a broader assessment through recourse to external expertise.

Power to Gas (P2G): P2G has the decisive advantage to convert excess electricity from renewables (e.g. solar, wind) into storable gas and, when electricity shortage arises, to convert it back into electricity (e.g. using fuel cells) in order to balance the grid. Research and innovation actions are required to optimise the process as well as reduce the price of fuel cell technologies.

Unconventional gas: unconventional gas, in particular shale gas, is gaining interest as a new possible source in the energy mix, which could also contribute to Europe's security of energy supply. However an important research and innovation effort would be needed to reconcile its exploitation with the imperatives of environmental stewardship, compatibility with EU climate change goals (e.g. preventing emissions of methane) as well as optimal management and sustainable use of the subsurface.

Nuclear fusion: while current research and innovation efforts aiming at the production of electricity from fusion have a much longer time perspective, and are therefore not covered in this short analysis, their success would represent a very significant contribution to the overall EU energy security.

Integrated energy system infrastructures: EU energy research is supporting a closer integration of different energy production, delivery and storage infrastructures, which will bring an important contribution to the security of supply and to the efficiency of the pan-European energy system by offering promising opportunities for the balancing of electricity generation and demand.

Electricity networks: research supporting smarter, stronger and more coordinated electricity networks will contribute to security of supply by reinforcing the market-based exchanges among Member States with a different energy mix, while also enabling the integration and transfer of vast indigenous renewable resources to the load centres.

For the 2014-2020 period, the EU is ramping up investment in energy research and innovation. Under Horizon 2020, the new Union research and innovation programme, close to €6 billion (around a doubling compared to FP7) will be dedicated to energy efficiency, to smart cities and communities and to secure, clean and low carbon technologies. This is done in close coordination with industrial stakeholders, through Public-Private Partnerships (the Energy-efficient Buildings PPP, the Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) PPP, as well as the European Green Vehicles Initiative contractual PPP). At least 85% of this budget has been ring-fenced for renewable energy, end-user energy efficiency, smart grids and energy storage. In addition, close to €1.3 billion will be dedicated to nuclear fission and €4.1 billion to nuclear fusion (including close to €3 billion for ITER). Increased funds will also be available for financial instruments, public private partnerships and SME projects in the field of energy technology and innovation. Furthermore, EU funding during the period 2014–2020 is also available under the European Structural and Investment Funds, where a minimum of EUR 23 billion has been ring-fenced for the "Shift to low-carbon economy" Thematic Objective. This represents a significant increase in EU support for mass-deployment of renewables, energy efficiency, low-carbon urban transport and smart grids solutions in the EU.

In addition, the Fuel Cells and Hydrogen 2 Joint Undertaking will continue to develop a portfolio of clean, efficient and affordable fuel cell and hydrogen technologies to the point of market introduction, while at the same time helping to secure the future international competitiveness of this strategically important sector in Europe. Transport -specific objectives include reduction of the production costs of fuel cells used in transport applications whilst increasing their lifetime to levels competitive with conventional technologies.

4.9 Country-specific supplier concentration indexes

To measure diversification, in this report we use an index that builds on a Herfindahl-Hirschmann index (HHI) and takes into account both the diversity of suppliers and the exposure of a country to external suppliers (see Le Coq and Paltseva 2008, 2009, Cohen et al 2011[97]). Other on-going work of the Commission services includes indicator-based assessment of energy dependency of Member States[98].

The country-specific supplier concentration index (SCI) by fuel is computed as the sum of squares of the quotient of net positive imports from a partner to an importing country (numerator) and the gross inland consumption of that fuel in the importing country (denominator). Smaller values of SCI indicate larger diversification and hence lower risk. All else equal, SCIs will be lower in countries where net imports form a smaller part of consumption; hence SCIs are likely to be correlated with the commonly used measure of import dependency[99].

For each fuel and country, three indices have been computed:

- SCI looking at total imports to a Member State, including intra-EU movements and imports coming from outside of the EU.
- SCI looking at the imports to a Member State that originate from outside of the EU, thus disregarding internal flows within the EU in the volume of imports of a Member State
- SCI looking at the imports to a Member State that originate from outside of the EEA, thus disregarding flows within the EEA area in the volume of imports of a Member State. Norway is the only EEA country exporting significant volumes of gas and oil to the EU.

In the case of **natural gas** calculations excluding imports from the European Economic Area , the SCI of the Baltics and Finland is at or above 100 indicating they have their entire consumption covered by a single supplier (above 100 indicates the role of storage in e.g. Latvia). Austria, the Czech Republic and Slovakia have SCIs above or close to 80. The high value of the SCI confirms the fact that a number of Member States have a large share or their entire natural gas consumption coming from a single supplier.

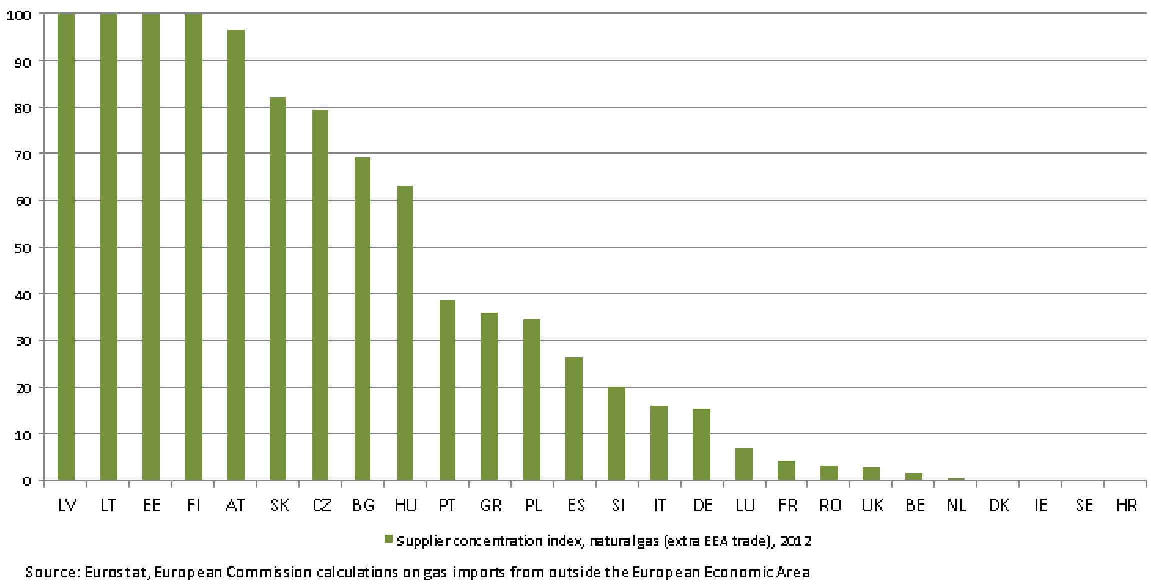
For some Member States the value of the SCI calculated on the basis of total imports and on the basis of extra-EEA imports changes significantly. For countries such as Belgium, Germany, France, Luxembourg, France and the UK that import significant quantities of gas from the Netherlands and Norway, as well as through intra-EU trade movements, the extra-EEA values are significantly lower than the values calculated with total imports. This confirms the fact that these countries have a much more balanced portfolio of suppliers, making extensive use of trade movements in the internal market and the EEA. Sweden and Ireland import volumes covering their entire consumption through transit flows from neighbouring countries. This is the reason that their supplier diversification index is 100 when looking at total imports, but zero when looking on the basis of extra-EU or extra-EEA.

[97] Cohen, G., Joutz, F. and Loungani, P. 2011. Measuring energy security: trends in the diversification of oil and natural gas supplies. In: Energy Policy 39 (2011), 4860-4869 and sources herein, including: Le Coq, C. and Paltseva, E. 2008. Common Energy Policy in the EU: the moral hazard of the security of external supply, SIEPS report 2008:1, Stockholm, Sweden and Le Coq, C. and Paltseva, E. 2009. Measuring the security of external supply in the European Union, in Energy Policy 37 (11), 4474-4481.

[98] http://ec.europa.eu/economy_finance/publications/occasional_paper/2013/pdf/ocp145_en.pdf

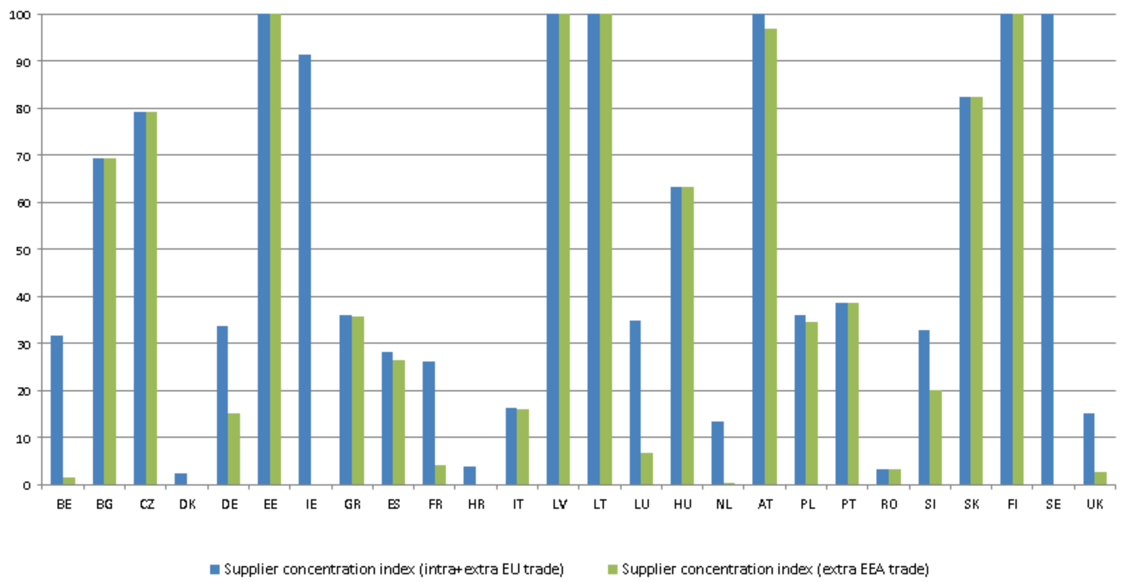
[99] Assuming perfect statistical data, the index takes values between 0 (no imports) and 100 (whereby the entire consumption of a product in a MS comes from a single supplier). Values above 100 can indicate storage/stocks and possible problems with statistical data e.g. unreported exports in the case of intra-EU trade movements mostly in transit countries (possibly CZ and AT for gas, NL for coal).

Figure 96. Country-specific supplier concentration index, natural gas, 2012 (extra-European Economic Area)



Source of data: Eurostat, energy. European Commission calculations. The vertical axis has been cut at 100; values above 100 may indicate storage or transit whereby some volumes have not been reported as exports.

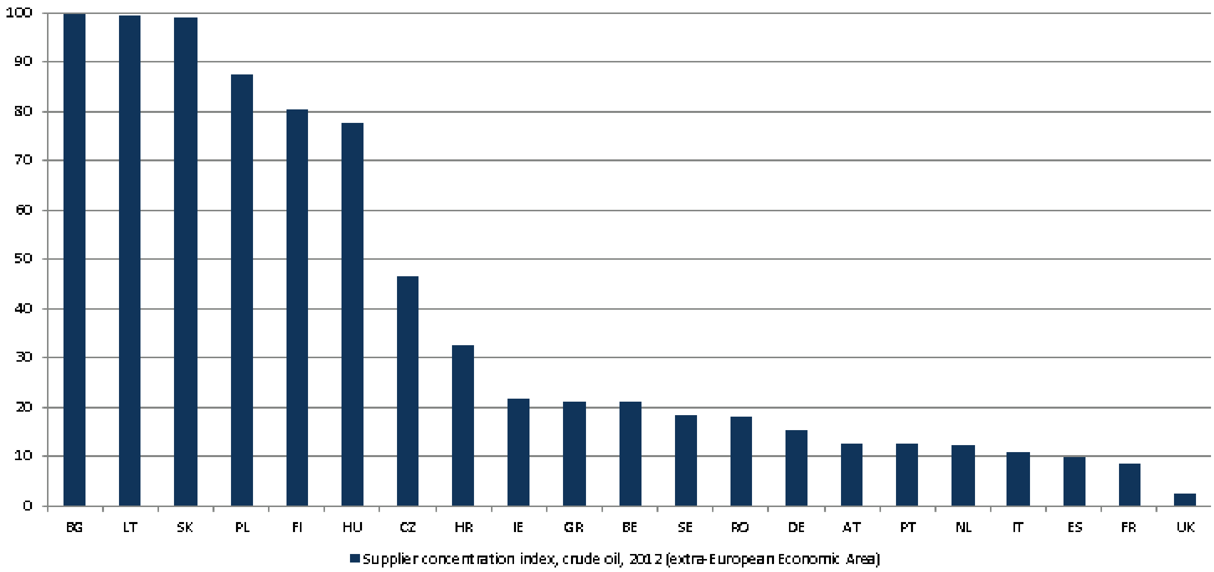
Figure 97. Country-specific supplier concentration index, natural gas, 2012 (total versus extra-European Economic Area)



Source of data: Eurostat, energy. European Commission calculations. The vertical axis has been cut at 100; values above 100 may indicate storage or transit whereby some volumes have not been reported as exports.

In the case of **crude oil**, Bulgaria, Lithuania, Slovakia, Poland, Hungary, Poland and Finland have relatively high SCI at or above 80. Excluding internal EU or EEA trade movements leads to significant change in the indexes for only two Member States (Denmark and the UK), pointing to the share of Norwegian imports in these countries.

Figure 98. Country-specific supplier concentration index, crude oil, 2012 (extra-European Economic Area)

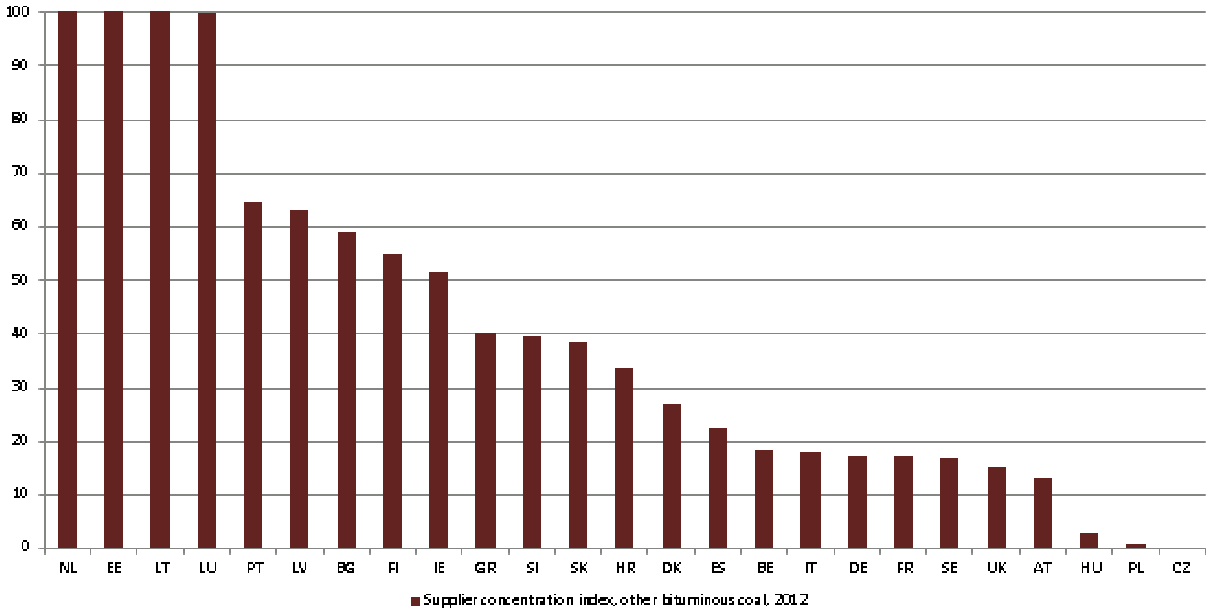


Source of data: Eurostat, European Commission calculations

The SCI of coal[100] confirms the fact that **coal** imports are much more diversified and account for a smaller share of consumption for most Member States. The SCI for other bituminous coal was around and above 80 for countries like Estonia, Lithuania and Luxembourg. In the case of the Netherlands, the value of SCI is extremely high and the likely explanation is that coal imports that enter through the seaports of the Netherlands, but are then reloaded and transported to consumers in other countries are probably reported in statistics as import volumes only, but not as export volumes. This data deficiency may result in lower than real SCI for coal in countries that import coal coming through Dutch ports.

[100] Other bituminous coal

Figure 99. Country-specific supplier concentration index, solid fuels, 2012



Source: Eurostat, energy. European Commission calculations. Includes other bituminous coal only. Romania does not report other bituminous coal consumption and imports in Eurostat. The vertical axis has been cut at 100; values above 100 may indicate storage or transit whereby some volumes have not been reported as exports.

The applicability of the country-specific diversification index cannot be fully justified in the case of electricity as electricity is prone to change flow direction between different markets more frequently than fossil fuels. Besides the EU member states mentioned in the electricity section of chapter 4, Luxembourg and Slovakia see significant electricity imports compared to their domestic consumption. In the case of Luxembourg imports from Germany and Belgium were significant in 2012, while in the case of Slovakia imports from the Czech Republic and Poland were dominant. Slovenia also imported a significant amount of its electricity need from neighbouring Austria in 2012. Denmark imported power from Sweden besides Norway, while the Netherlands imported significant amounts of cheap power from Germany (impact of renewables). All of the other EU member states import their electricity needs from another member states, besides the above-mentioned countries the other EU members are not affected by extra-EU imports[101]. Italy imports some of its power needs from Switzerland, but Switzerland is strongly integrated in the West European market and well supplied with German and French power.

[101] No data on Spain-Morocco

Table 11. Country-specific supplier concentration index, 2000-2012, by Member State and by fuel

	Country-diversification index (extra EEA trade)					
Crude Oil	**2000**	**2005**	**2009**	**2010**	**2011**	**2012**
AT	10.8	13.8	16.0	13.1	13.2	12.7
BE	7.3	22.3	16.1	21.8	24.8	21.0
BG	93.4	77.1	55.8	94.2	87.9	99.7
CY	41.4	0.0	0.0	0.0	0.0	0.0
CZ	66.1	54.4	52.6	46.2	42.4	46.5
DE	10.1	13.2	13.4	14.4	15.6	15.2
DK	0.0	0.0	0.0	0.1	0.2	0.0
EE						
EL	25.2	28.8	22.3	22.0	24.0	21.1
ES	10.0	9.4	9.0	9.7	10.6	10.0
FI	19.4	64.4	75.9	90.8	76.1	80.5
FR	5.3	5.5	7.1	8.3	7.2	8.4
HR	16.0	50.7	58.3	39.2	43.7	32.6
HU	71.6	84.2	73.6	80.5	79.7	77.5
IE	0.0	0.0	3.5	6.2	2.8	21.6
IT	12.4	13.6	13.6	11.6	9.2	10.7
LT	86.8	93.1	98.9	98.3	95.1	99.4
LU						
LV						
MT						
NL	7.6	16.1	13.3	12.6	12.4	12.3
PL	86.9	92.2	87.2	85.5	81.8	87.4
PT	14.3	10.9	9.4	9.8	12.8	12.5
RO	11.1	17.3	18.9	16.0	18.6	18.1
SE	1.4	13.1	14.4	19.5	27.0	18.3
SI	40.4					
SK	93.8	96.8	100.1	100.4	101.0	99.1
UK	0.6	0.5	0.6	0.6	1.0	2.5
Natural Gas	**2000**	**2005**	**2009**	**2010**	**2011**	**2012**
AT	42.7	49.0	63.7	61.8	79.8	96.8
BE	7.8	5.1	11.8	7.8	14.6	1.6
BG	87.5	76.8	97.3	85.8	74.1	69.5
CY						
CZ	61.1	56.4	46.6	57.3	118.5	79.3
DE	15.1	17.0	11.6	14.1	15.7	15.3
DK	0.0	0.0	0.0	0.0	0.0	0.0
EE	100.0	100.0	100.0	100.0	100.0	100.0
EL	60.5	71.3	38.1	39.8	40.1	35.7
ES	39.4	25.2	18.9	19.8	24.0	26.5
FI	100.0	100.0	100.0	100.0	100.0	100.0
FR	14.5	8.8	6.3	4.7	5.1	4.2
HR	16.8	15.3	11.7	10.4	0.0	0.0

HU	44.3	36.8	51.2	57.5	48.9	63.4
IE	0.0	0.0	0.0	0.0	0.0	0.0
IT	24.7	17.9	16.6	16.4	16.1	16.0
LT	100.1	101.3	100.7	99.4	100.5	100.1
LU	100.0	100.0	6.9	6.9	6.9	6.8
LV	103.9	111.5	130.1	38.2	119.7	129.5
MT						
NL	0.0	0.8	0.5	0.5	0.2	0.4
PL	30.0	22.7	31.0	38.8	41.4	34.7
PT	76.9	56.9	37.0	42.0	46.2	38.6
RO	3.9	9.1	2.2	2.7	3.6	3.3
SE	0.0	0.0	0.0	0.0	0.0	0.0
SI	51.2	51.3	31.9	32.5	28.2	20.1
SK	97.6	105.6	116.8	99.8	109.9	82.3
UK	0.0	0.0	0.4	2.2	6.5	
Other bituminous coal						
AT	0.0	0.0	0.1	8.1	0.1	13.1
BE	35.4	29.1	36.4	20.3	35.6	18.5
BG	51.8	41.9	44.4	50.8	57.5	59.2
CY						
CZ	0.0	0.0	0.3	0.7	0.5	0.2
DE	2.6	8.8	13.2	11.2	15.9	17.4
DK	11.7	18.6	28.0	10.3	39.7	27.1
EE	126.9	93.0	11.9	140.0	91.6	152.4
EL	29.7	52.3	47.9	44.7	46.1	40.1
ES	11.5	17.1	24.6	16.5	15.5	22.6
FI	39.2	73.2	105.1	41.2	153.7	54.9
FR	15.5	12.5	12.0	15.7	18.3	17.4
HR	40.9	22.3	17.5	47.0	43.9	33.6
HU		24.9	58.5	13.2	4.8	3.0
IE	16.6	21.7	50.7	36.6	87.8	51.6
IT	17.9	22.4	23.8	25.6	20.5	18.0
LT	100.0	100.0	102.4	144.3	141.9	115.4
LU	71.5	73.7	86.6	100.0	100.0	100.0
LV	64.7	91.8	92.5	75.2	35.1	63.3
MT						
NL	84.9	105.8	121.2	146.6	310.7	202.9
PL	0.0	0.1	1.1	1.3	1.7	1.0
PT	44.2	31.7	34.5	35.8	64.9	64.7
RO	7.2					
SE	8.0	18.9	19.4	10.2	21.4	16.8
SI	139.7	54.0	85.3	42.5	36.7	39.5
SK	12.9	93.5	55.4	21.6	27.2	38.7
UK	2.2	15.4	21.0	6.4	11.3	15.3

Source: Eurostat data, European Commission estimations

5 Conclusions

Chapter 2 of this report provides a review by fuel of the factors underpinning energy security, in particular consumption, production and import trends, infrastructure, suppliers and supply routes. Chapter 3 summarises the EU Reference scenario and 2030 policy framework projections on import dependency of fossil fuels

Chapter 4 of the report provides a detailed explanation of the different EU policies already in place that address the risks above and improve the resilience of the EU in the energy sector. It explores the resilience of the EU and of Member States to adjust to any such disruption, in terms of the scope for accessing alternative supplies, suppliers, fuel transport routes and fuel substitutes. The examination reveals the vulnerabilities broadly for the EU but more precisely, for the Member States who are most exposed to such risks.

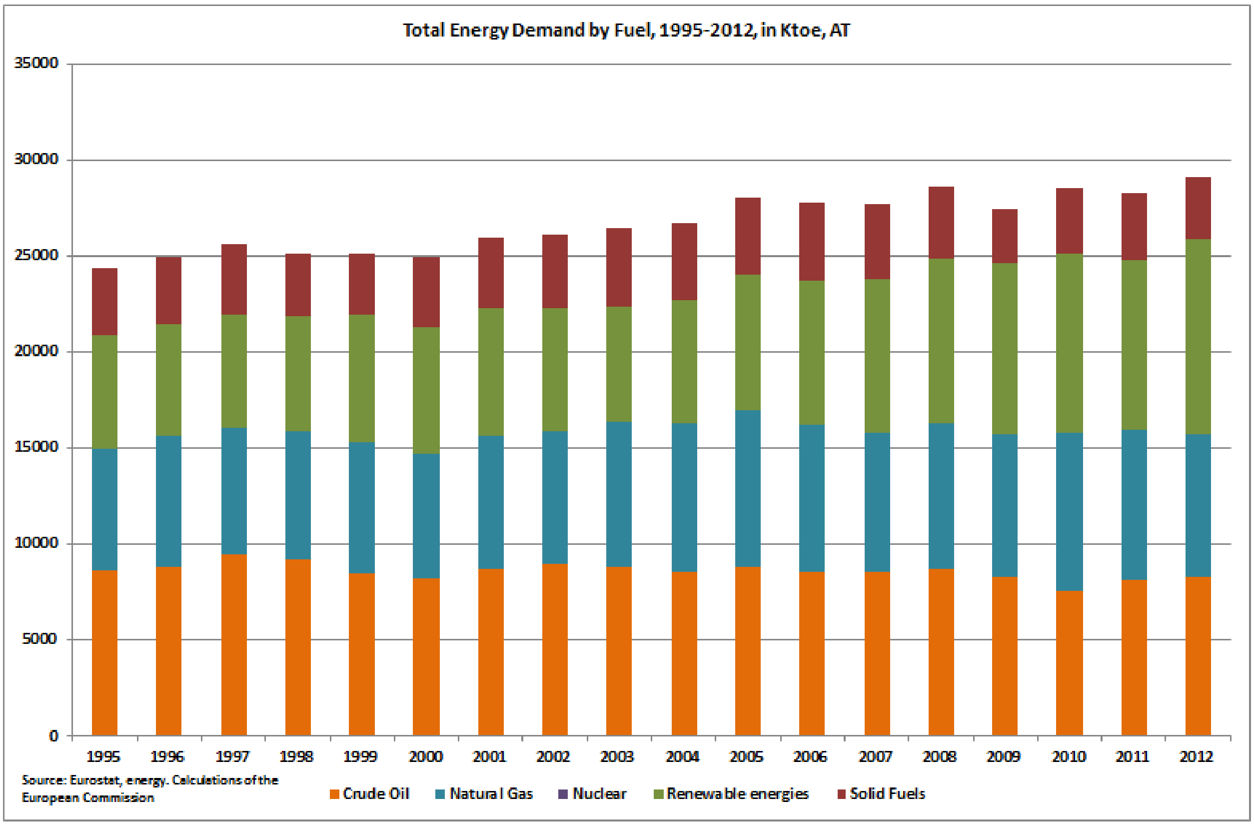
Measures to mitigate security of supply include short term ones such as holding fuel stocks, preparing emergency response plans to reduce consumption in the event of a fuel crisis, and improvements to infrastructure which enable reverse flows or other fuel diversion, again in the event of a short term crisis.

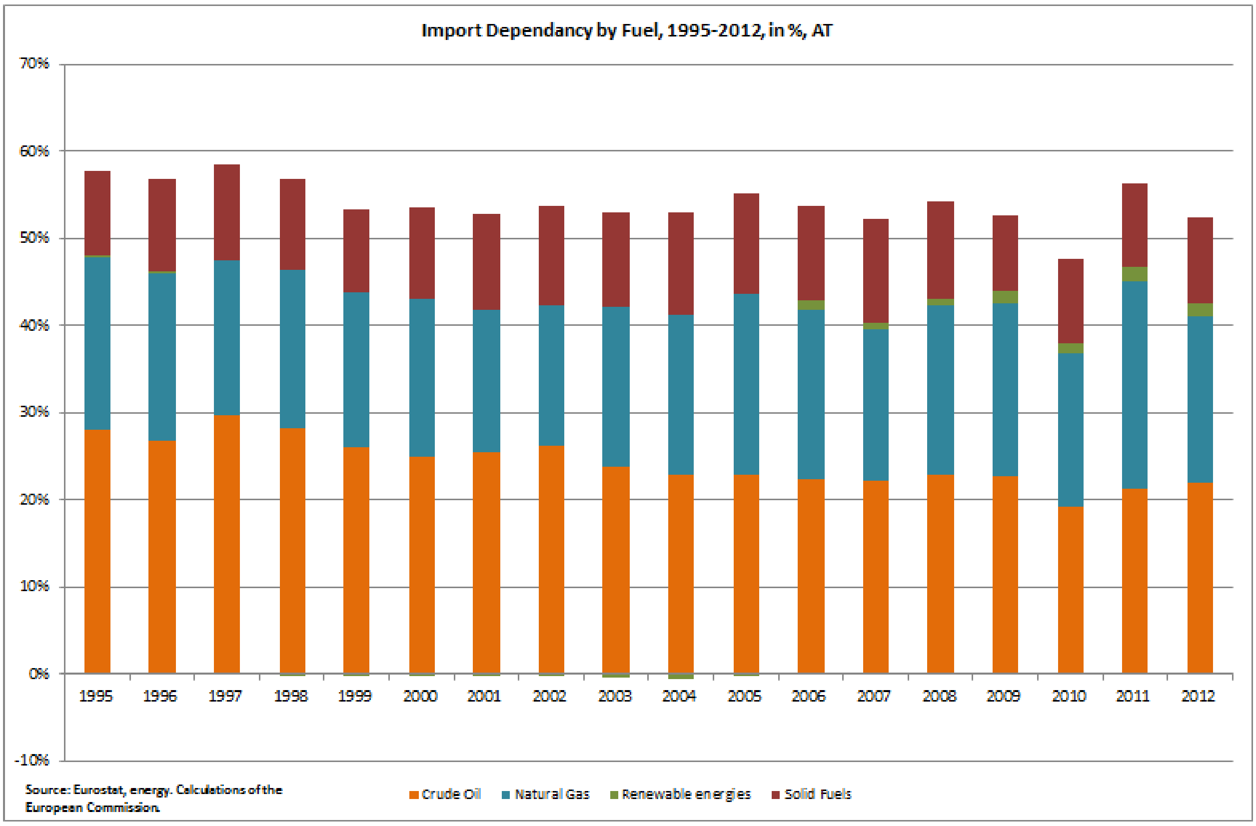
Current EU policies also include the longer term actions the EU has initiated to reduce energy consumption and import dependency, and to broaden the diversity and resilience of the energy sector. Climate and energy policies that have spurred energy efficiency and renewable energy measures also contribute directly to diversifying energy supplies and reducing fuel consumption. Similarly, the EU framework of the internal energy market and the accompanying infrastructure policies and plans help integrate the European market, stimulate competition and reduce the risk of exposure to limited supplies and energy suppliers.

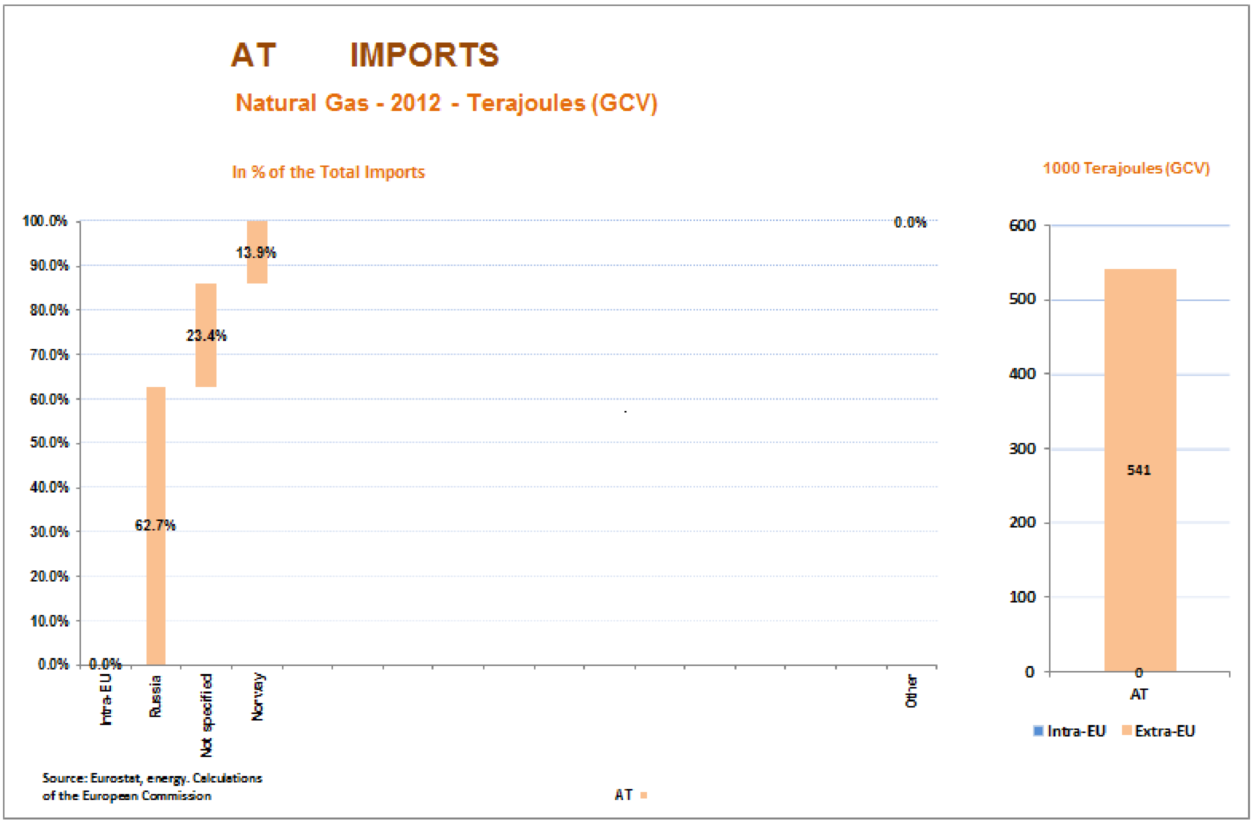
On the basis of this review, the accompanying European Energy Security Strategy explores the range of measures available to Europe to improve Europe's energy security. Further European cooperation regarding the development and diversity of national energy mixes will be an important means of reducing energy security risks. Other measures to further reduce consumption of energy and develop infrastructure that improves the flexibility of the energy system will also be explored. On this basis, Europe can work together to minimise energy risks in the short term and to maximise the resilience of the energy sector in the medium term.

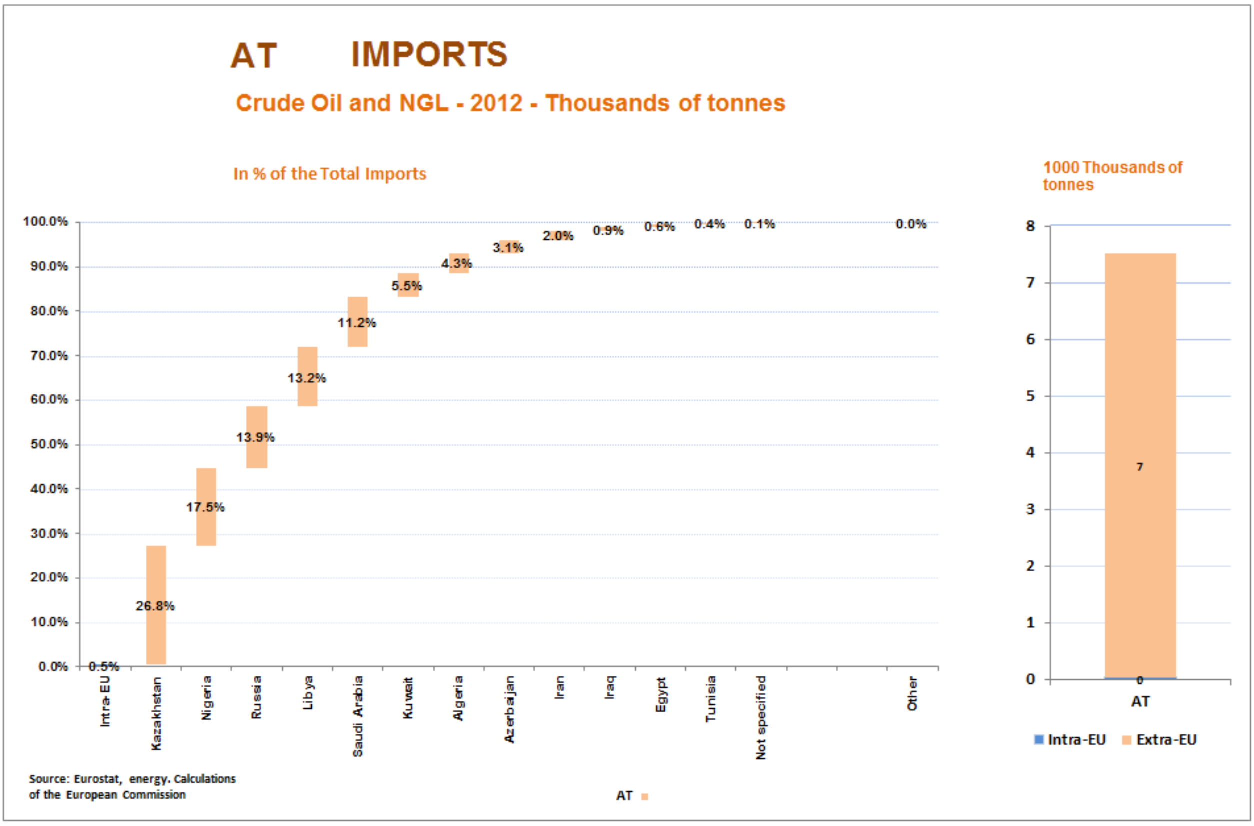
Annex I: Country annexes

Country Fiche: Austria

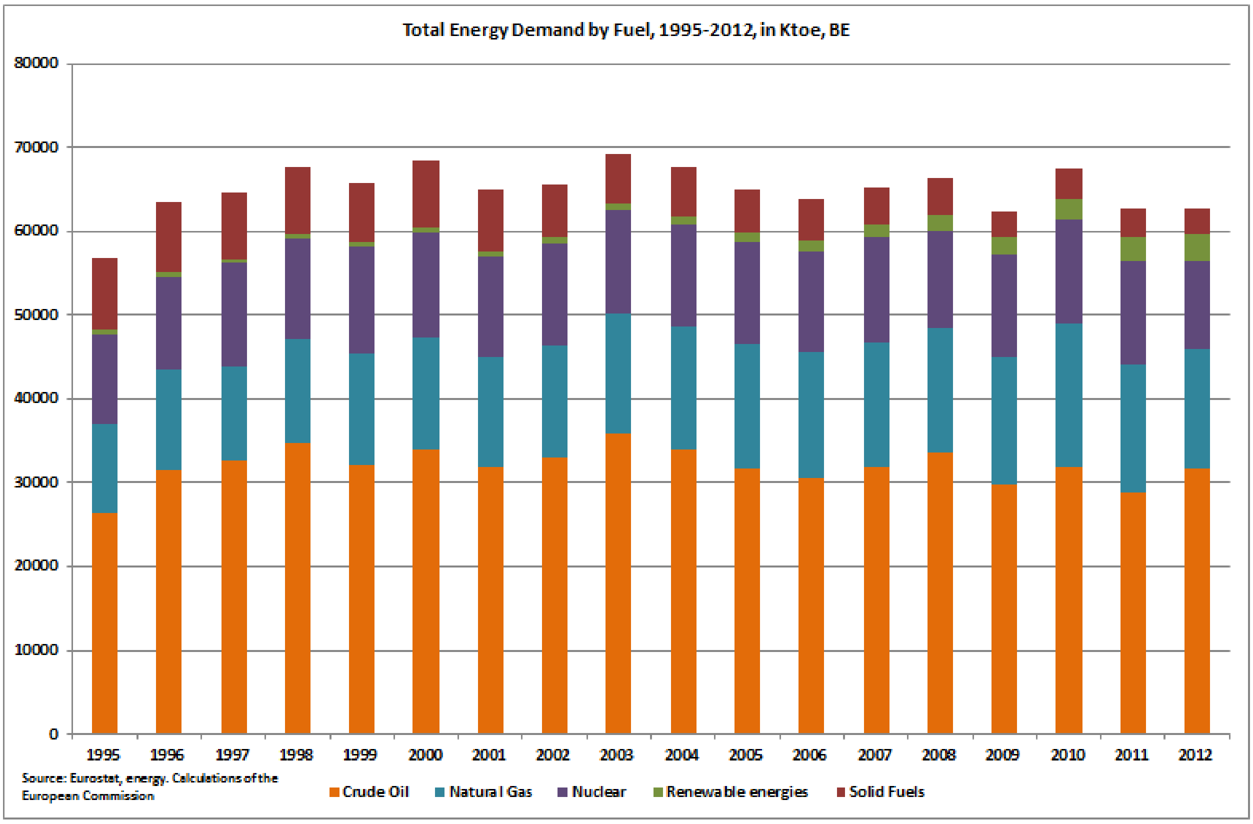


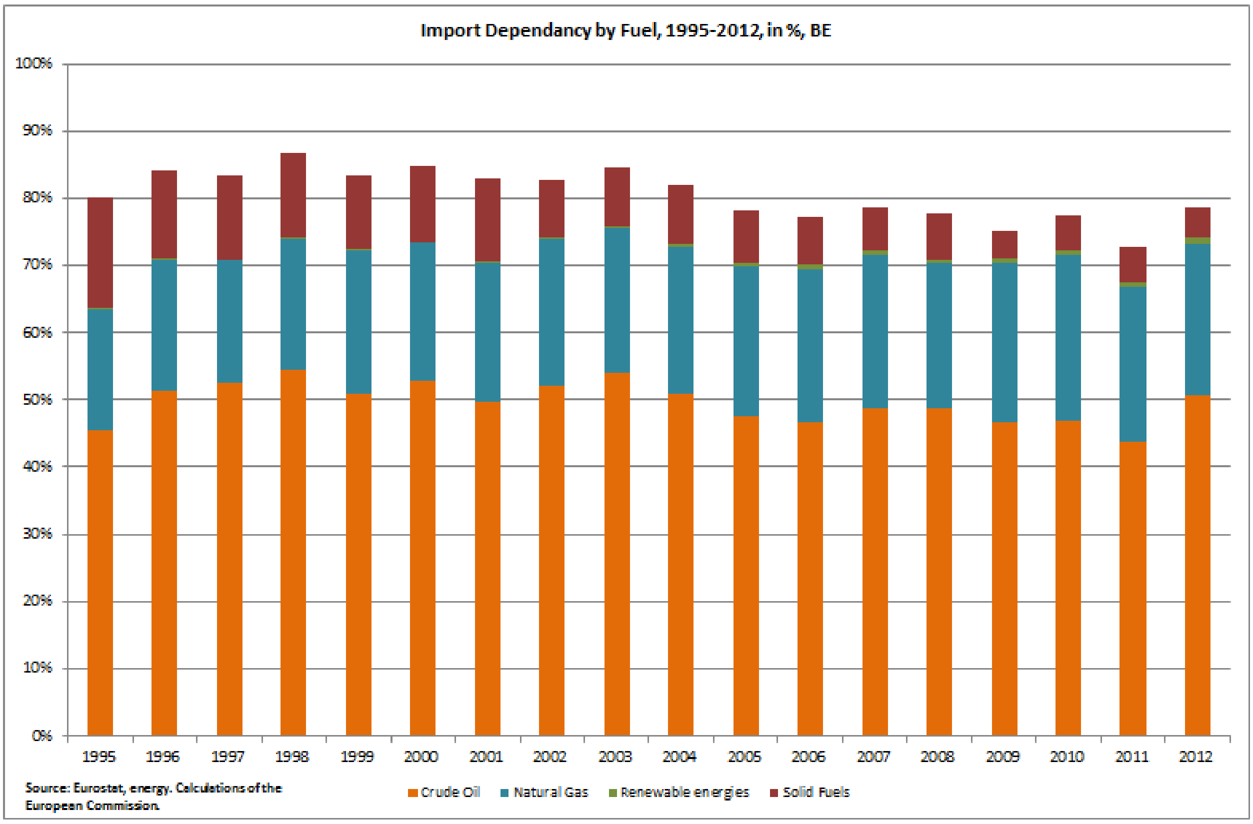


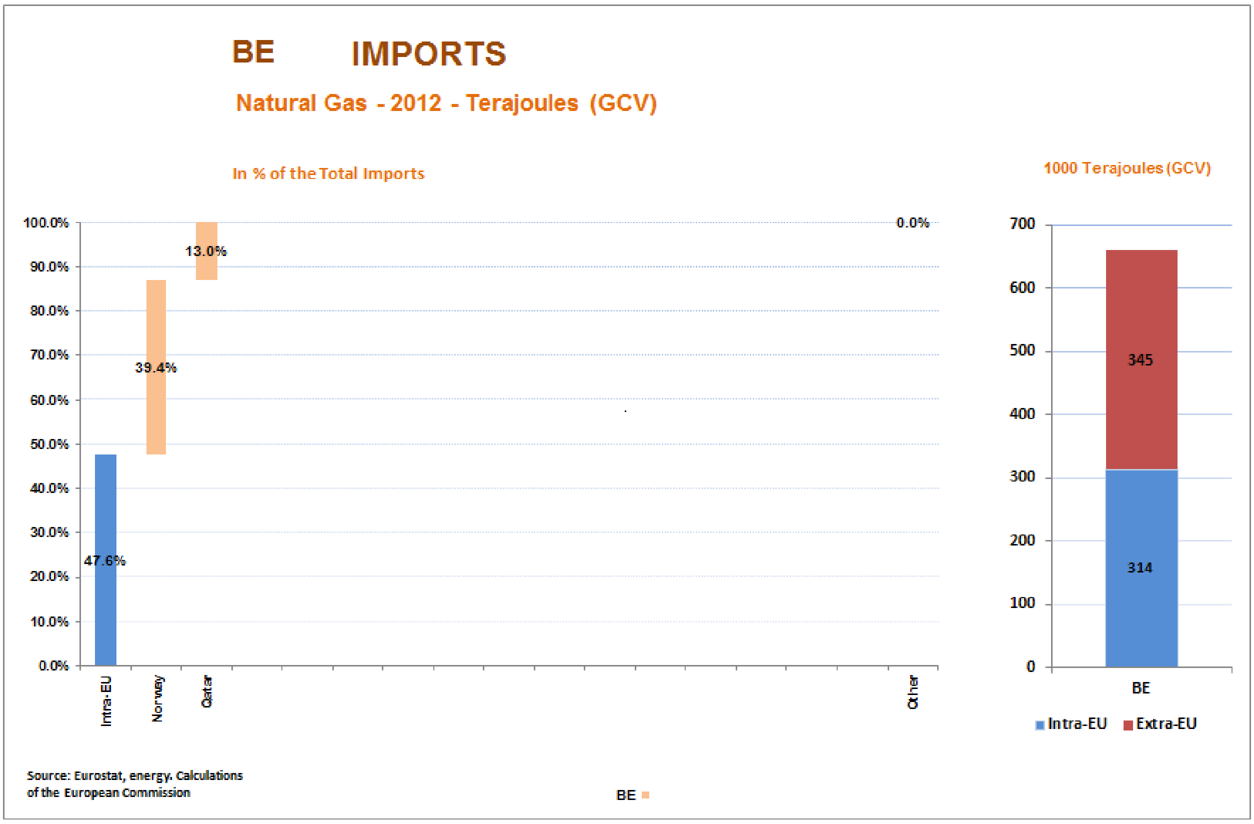

AT IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
62.7%
23.4%
13.9%
0.0%
Intra-EU
Russia
Not specified
Norway
Other
541
AT
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission

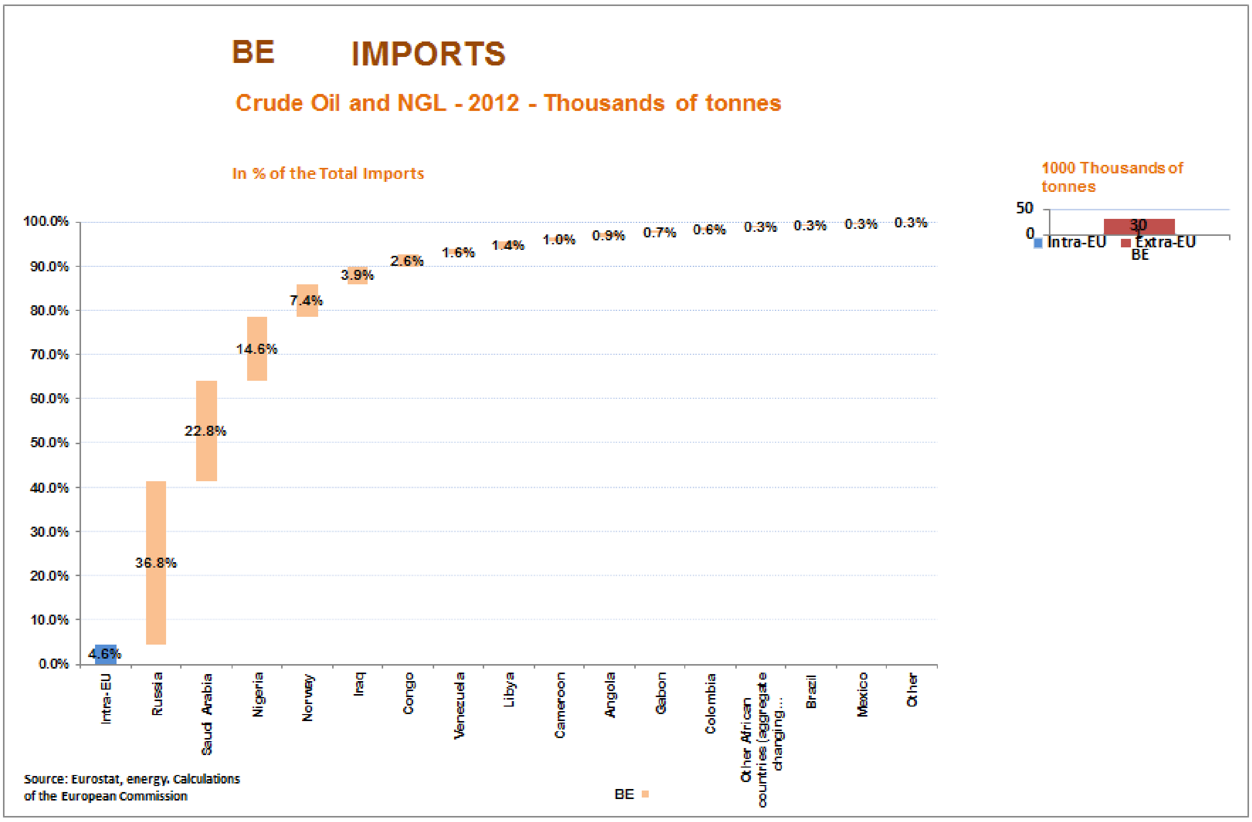

AT IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
0.5%
26.8%
17.5%
13.9%
13.2%
11.2%
5.5%
4.3%
3.1%
2.0%
0.9%
0.6%
0.4%
0.1%
0.0%
Intra-EU
Kazakhstan
Nigeria
Russia
Libya
Saudi Arabia
Kuwait
Algeria
Azerbaijan
Iran
Iraq
Egypt
Tunisia
Not specified
Other
7
AT
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission

Country Fiche: Belgium

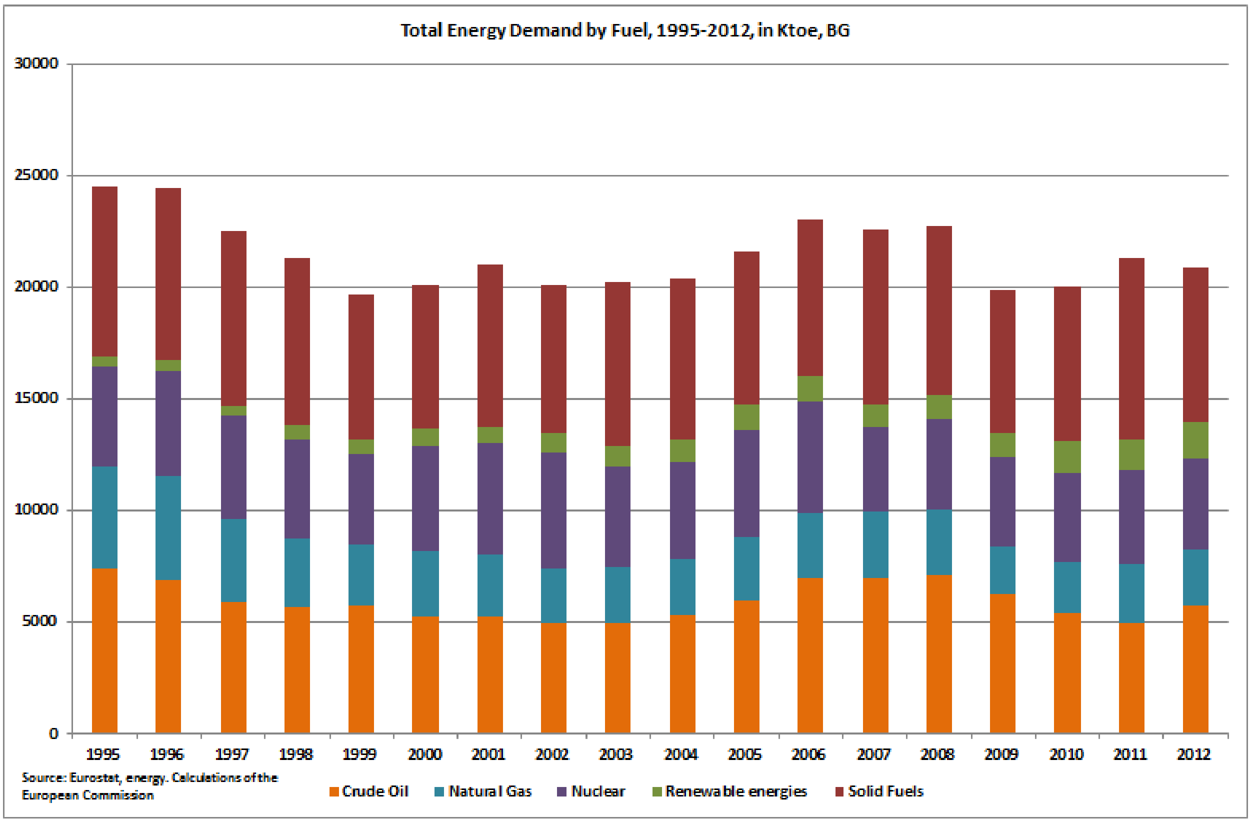


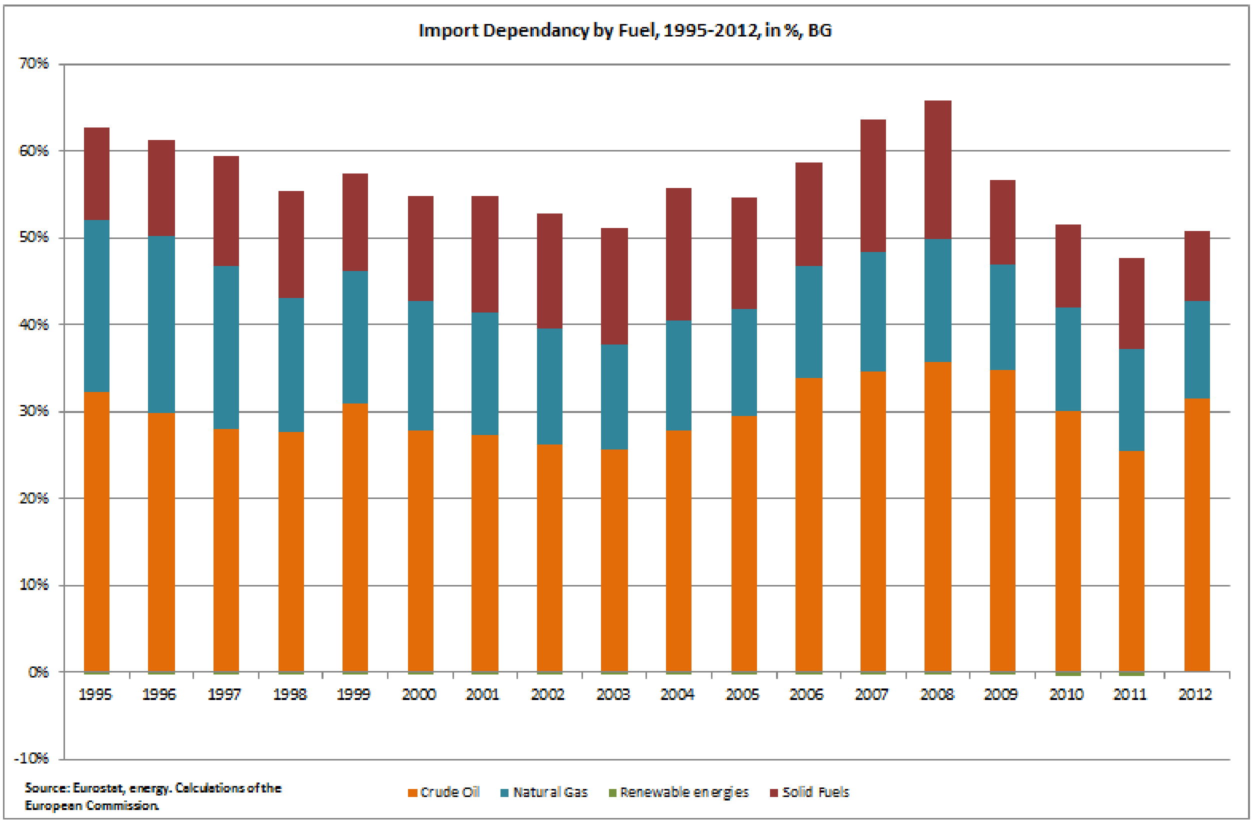


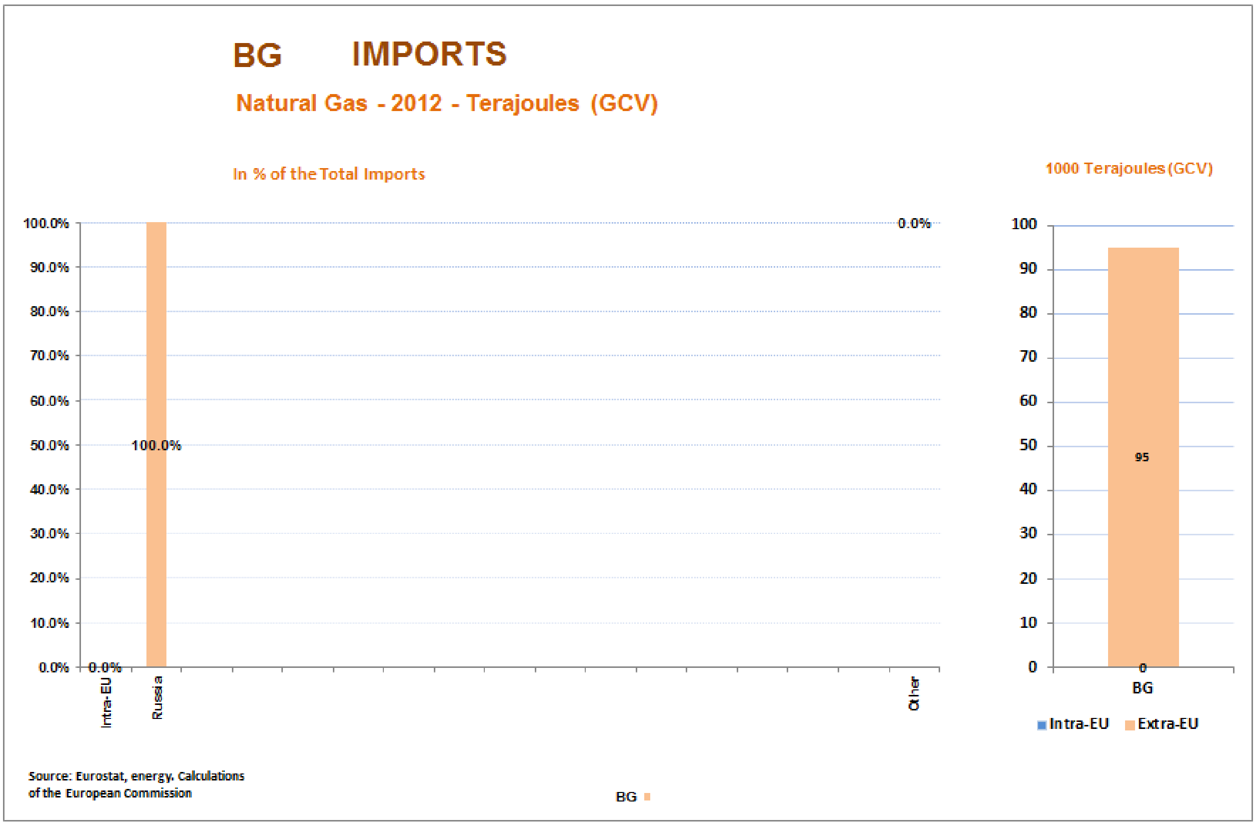

BE IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
47.6%
39.4%
13.0%
0.0%
Intra-EU
Norway
Qatar
Other
345
314
BE
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission


BE IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
4.6%
36.8%
22.8%
14.6%
7.4%
3.9%
2.6%
1.6%
1.4%
1.0%
0.9%
0.7%
0.6%
0.3%
0.3%
0.3%
0.3%
Intra-EU
Russia
Saudi Arabia
Nigeria
Norway
Iraq
Congo
Venezuela
Libya
Cameroon
Angola
Gabon
Colombia
Other African countries (aggregate changing...
Brazil
Mexico
Other
30
Intra-EU
Extra-EU
BE
Source: Eurostat, energy. Calculations of the European Commission

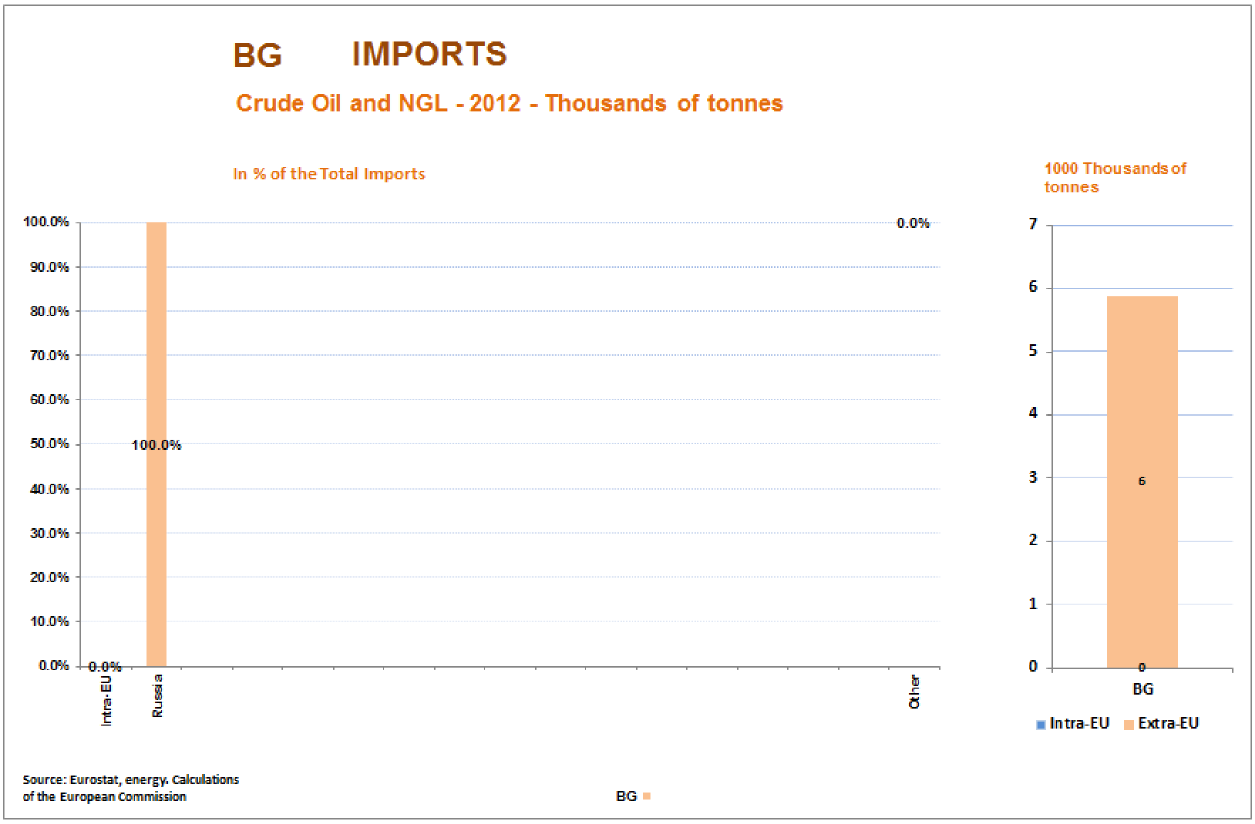
Country Fiche: Bulgaria







BG IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
0.0%
Intra-EU
Russia
Other
95
0
BG
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission



BG IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
0.0%
Intra-EU
Russia
Other
6
0
BG
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission

Bulgaria

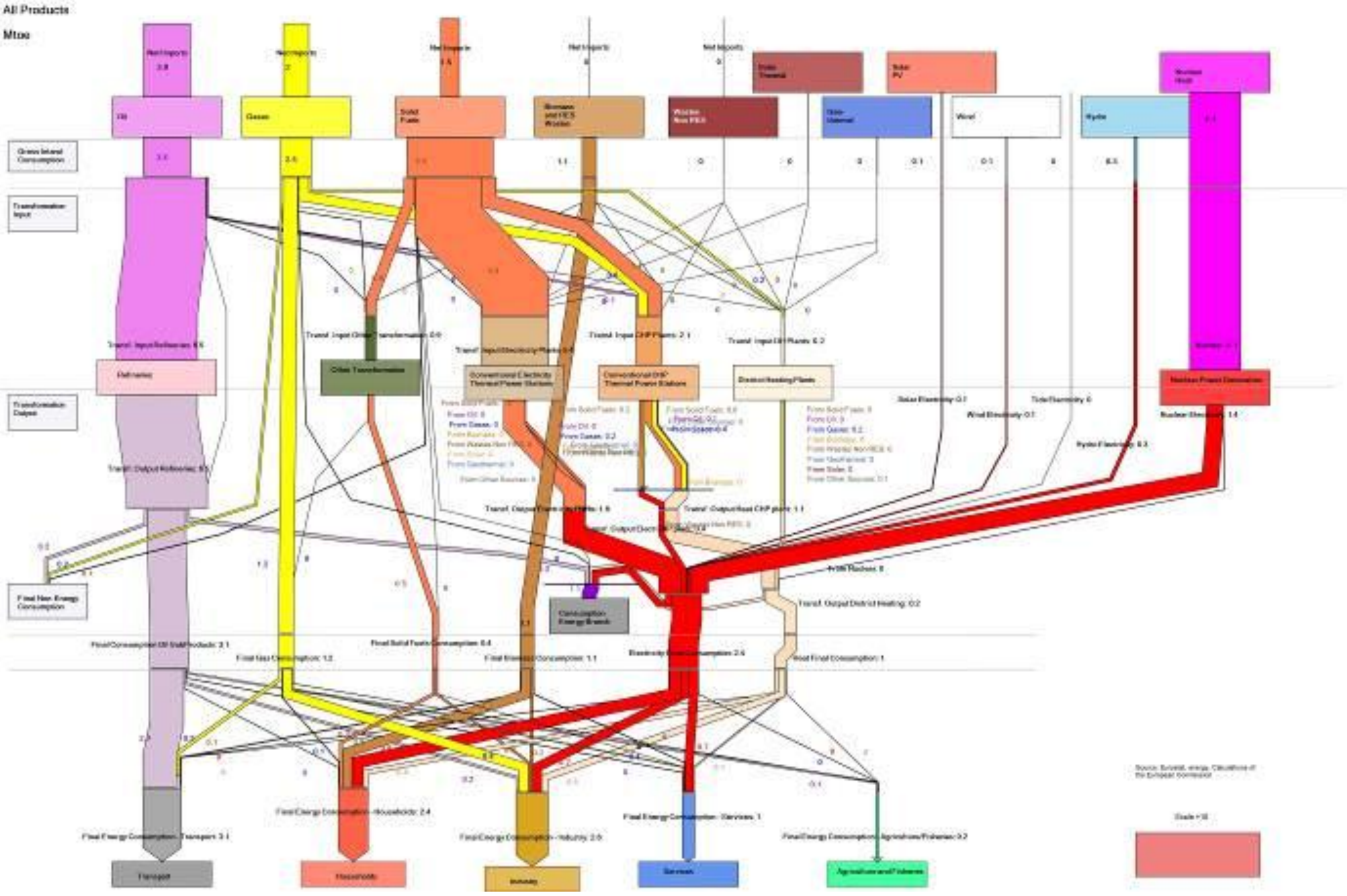
Total gas consumption / Russian imports	Total: 2.6 Bcm/y // RU: 2.6 Bcm/y
Gas storage capacity and current level:	Total: 0.5 Bcm // Current: 0.2 Bcm
Connections to other MSs and capacity:	BG→GR: 3.5 Bcm/y RO→BG (NV1): 4.9 Bcm/y RO→BG (NV2): 19.6 Bcm/y (incl. cap. to TR)
Alternative supply options:	The interconnection with Romania is expected to come online in June 2014 with a capacity of 0.5 Bcm/y (max capacity of 1.5 Bcm will be reached by 2016). Implementation of the interconnector BG-GR ongoing. Installing reverse flows between GR-BG is ongoing with a planned firm capacity of 036 Bcm/y.
Assessment: The new interconnection with Romania and the reverse flows from Greece would still not be enough to cover missing Russian gas.	

ENERGY FLOW

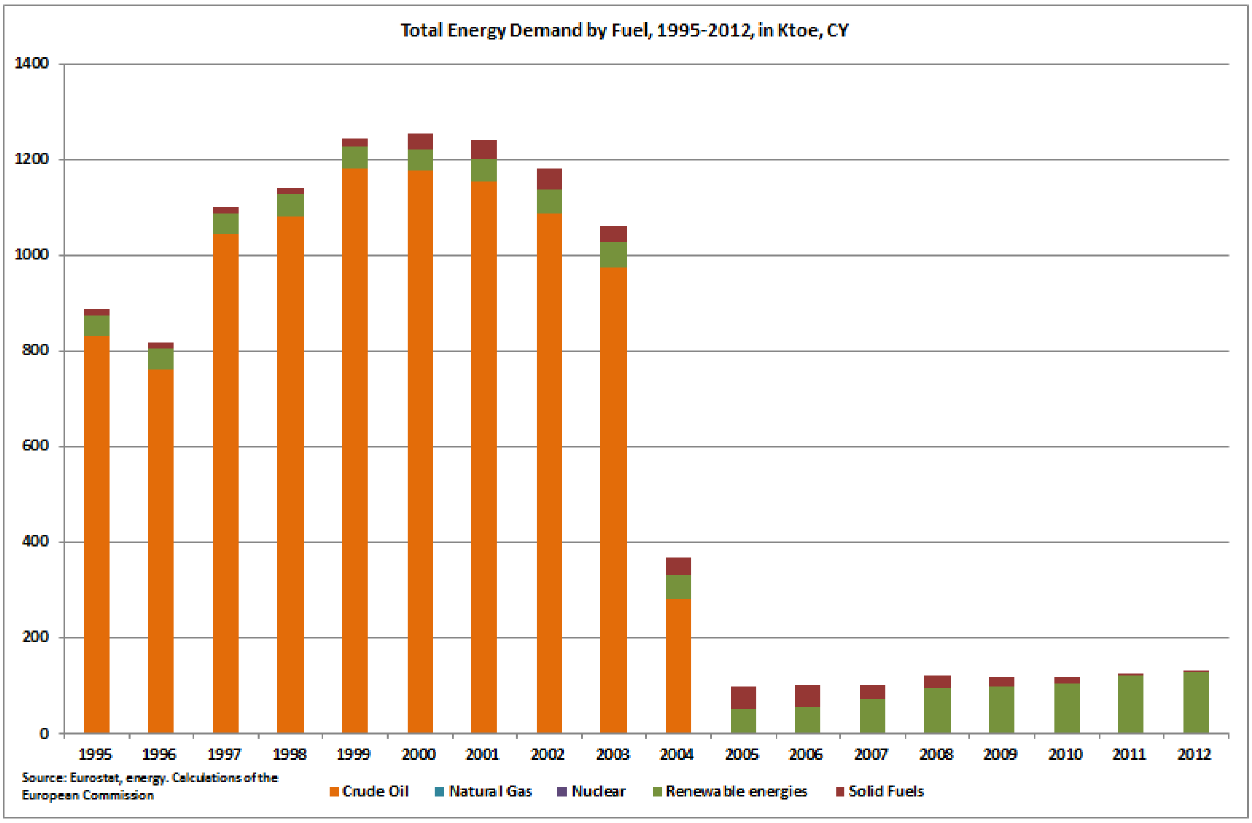
BG 2012

All Products

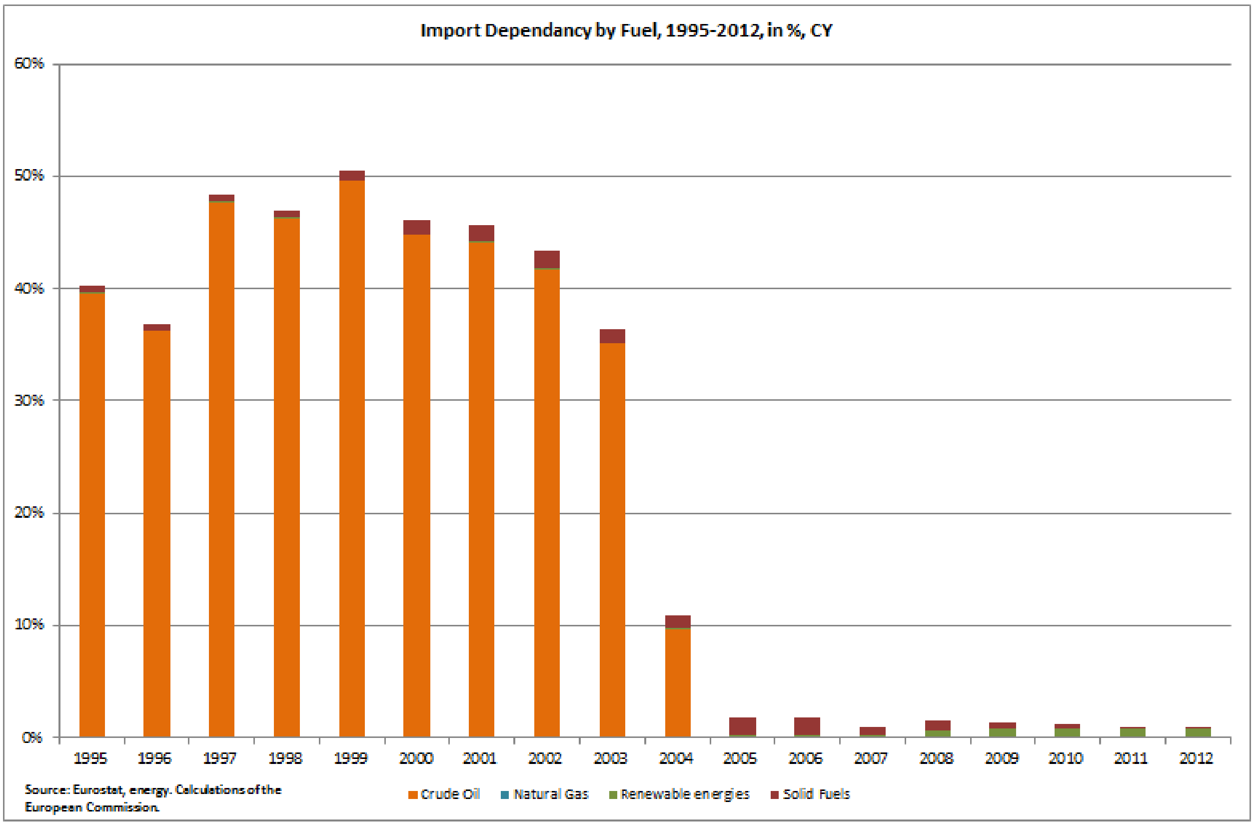
Mtoe



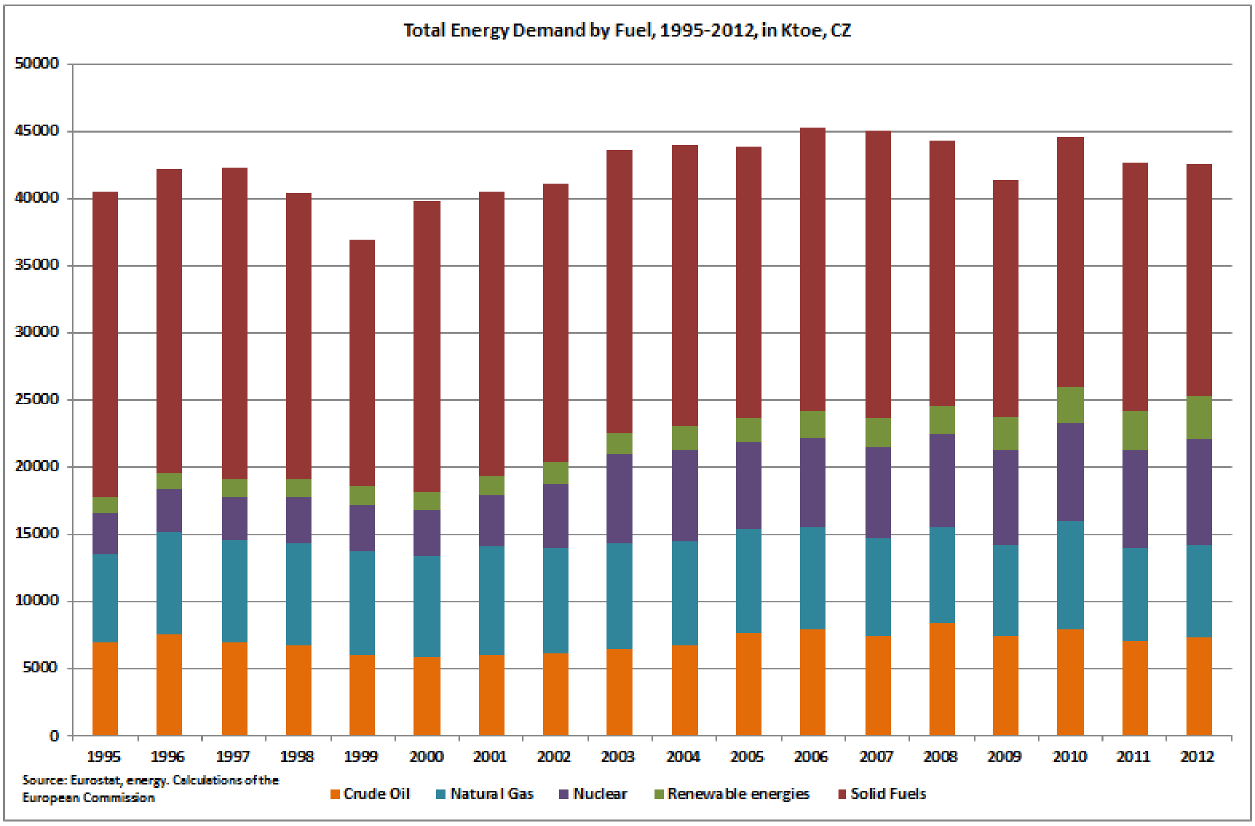
Country Fiche: Cyprus

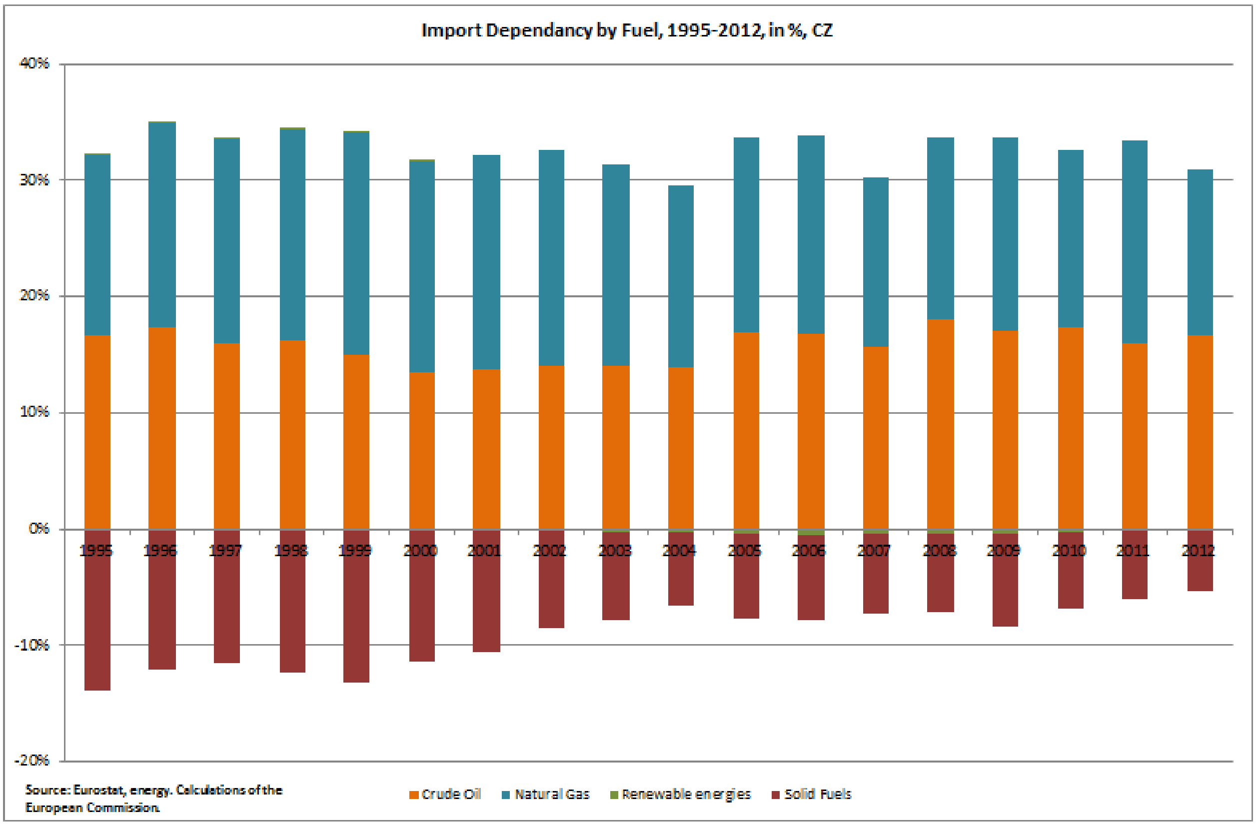


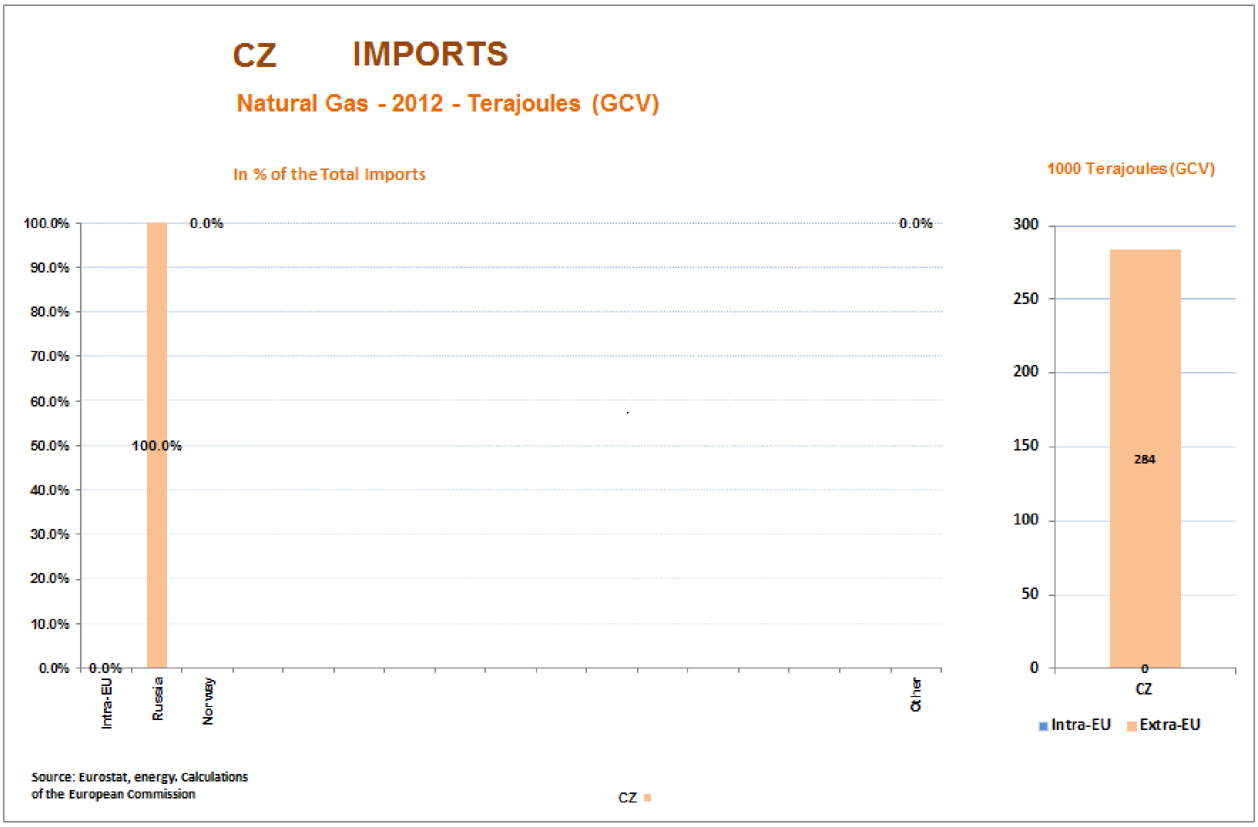
Note: Since 2005 Cyprus does not report crude oil data under energy transformation in the SIRENE database.



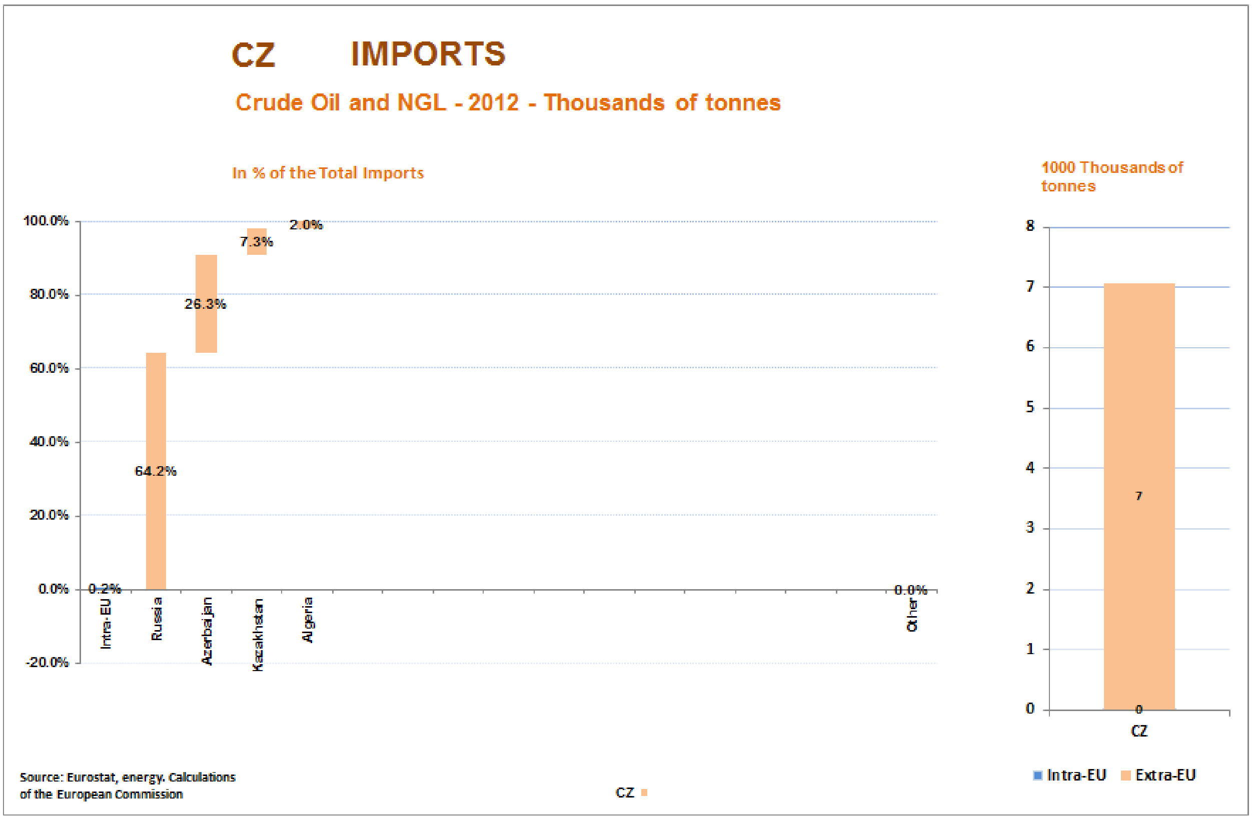
Country Fiche: Czech Republic





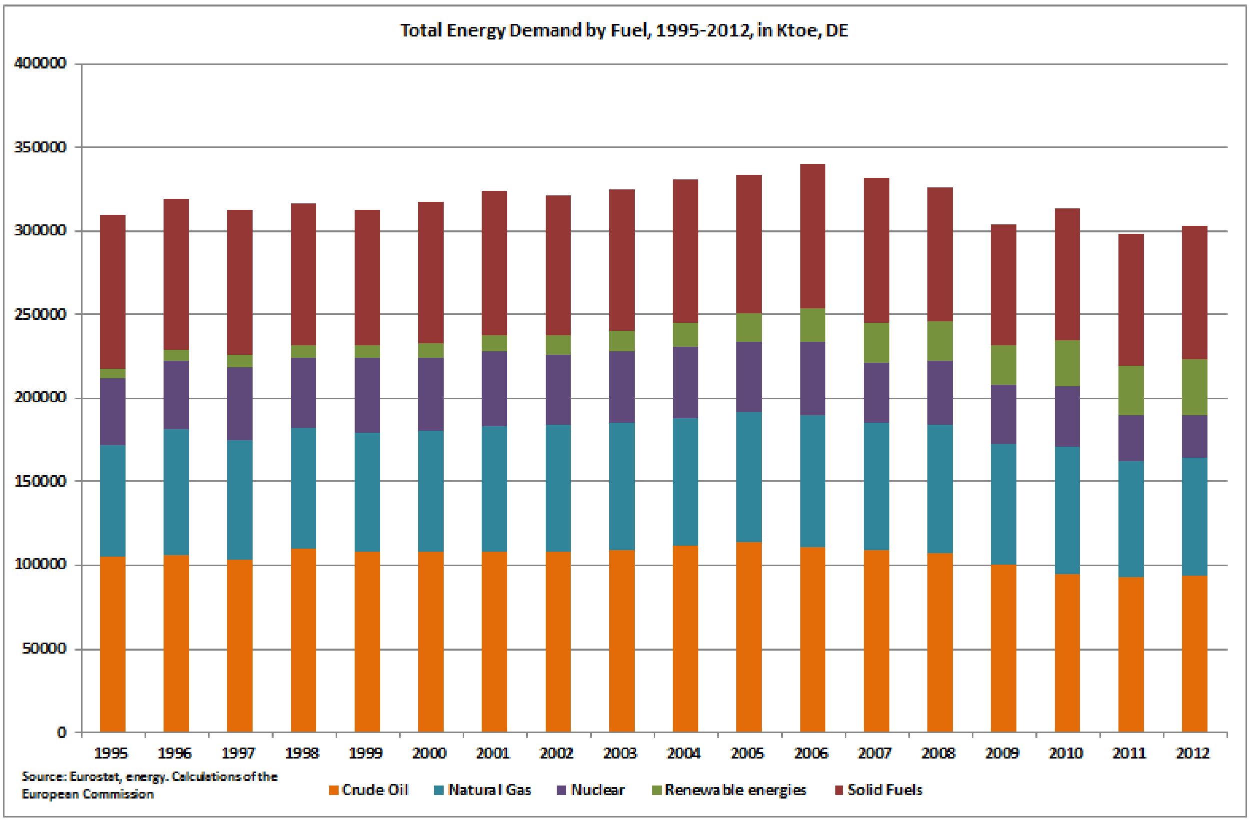


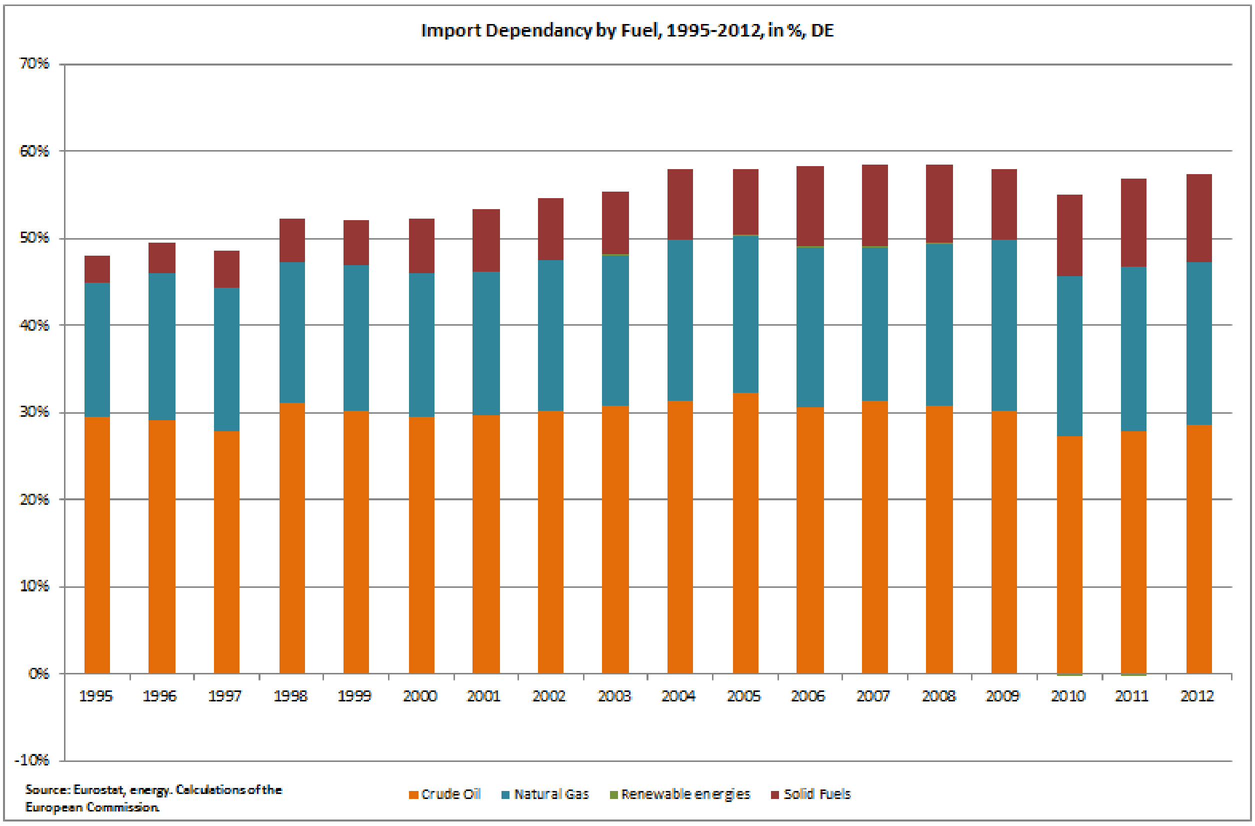
CZ IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
100.0%
0.0%
0.0%
Intra-EU
Russia
Norway
Other
1000 Terajoules (GCV)
300
250
200
150
100
50
0
284
0
CZ
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
CZ

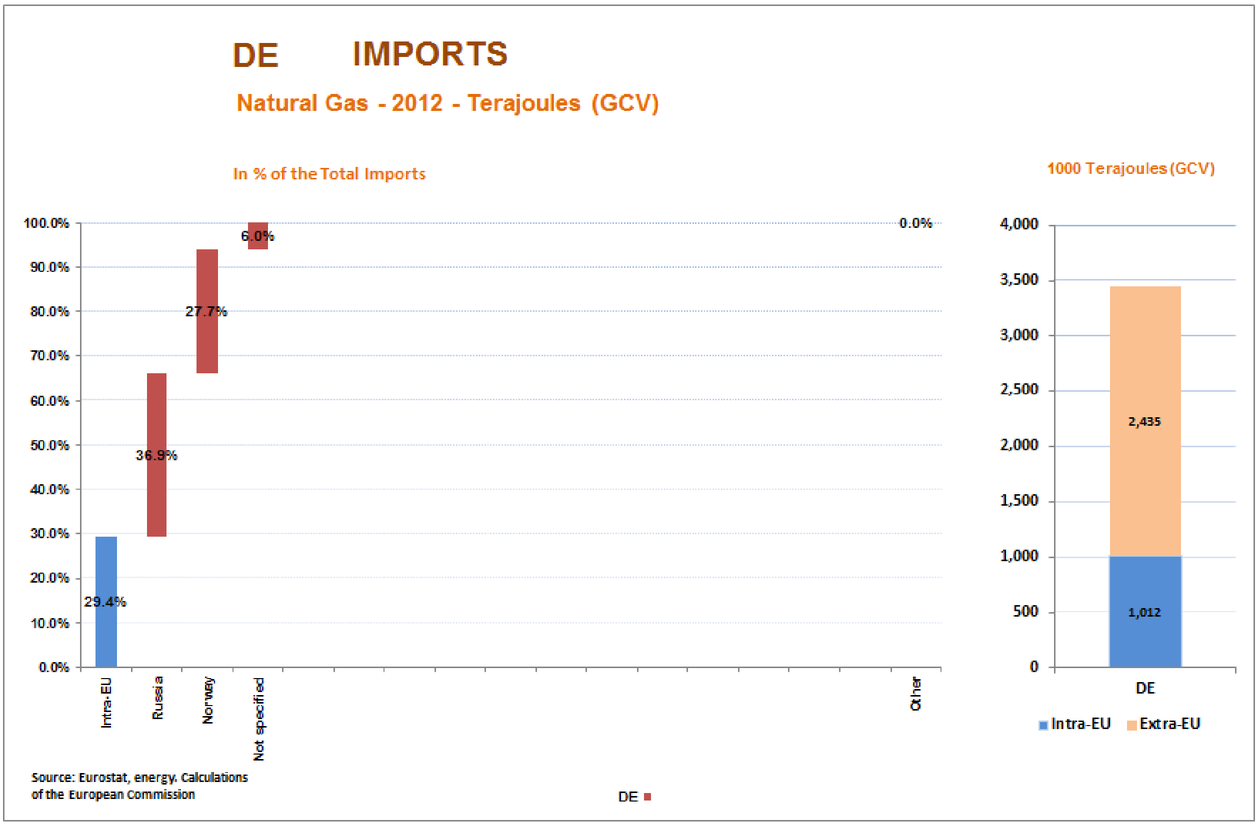


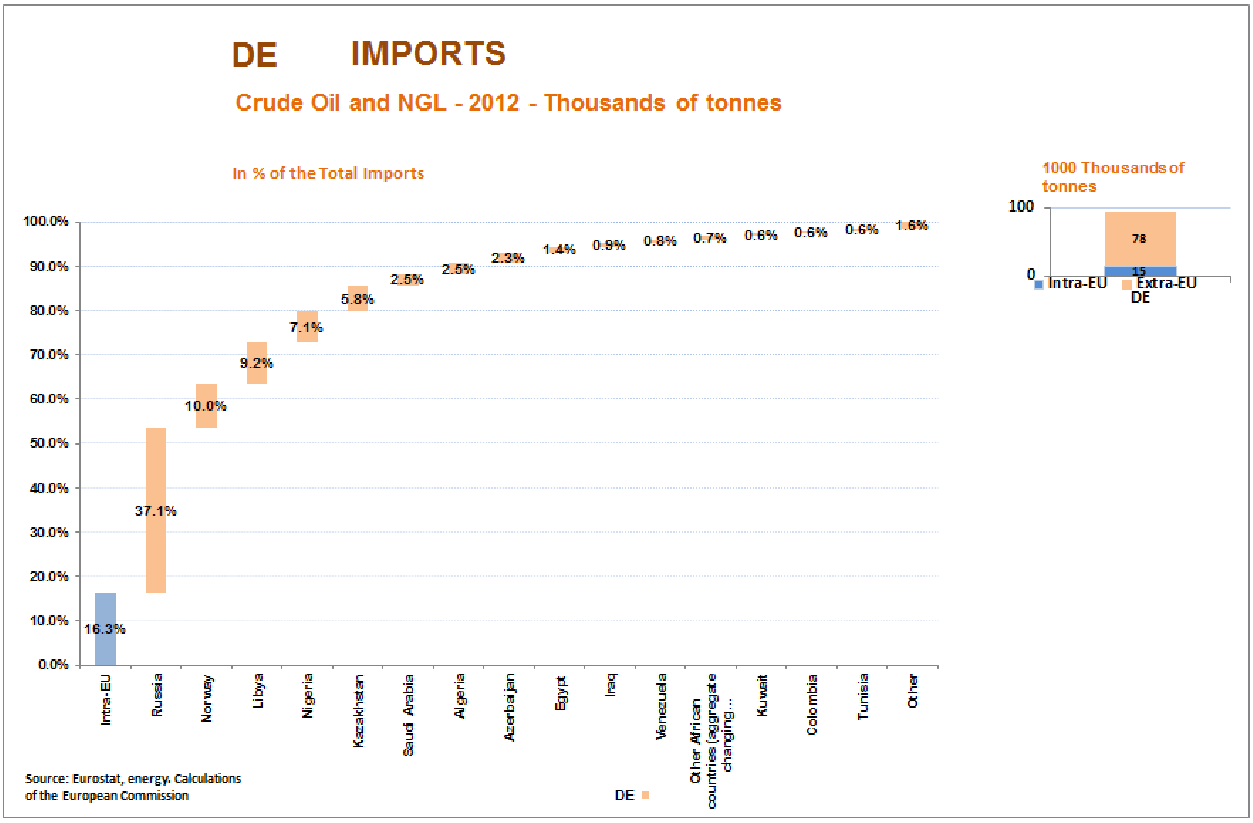
CZ IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
-20.0%
0.2%
64.2%
26.3%
7.3%
2.0%
0.0%
Intra-EU
Russia
Azerbaijan
Kazakhstan
Algeria
Other
1000 Thousands of tonnes
8
7
6
5
4
3
2
1
0
7
0
CZ
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
CZ

Country Fiche: Germany

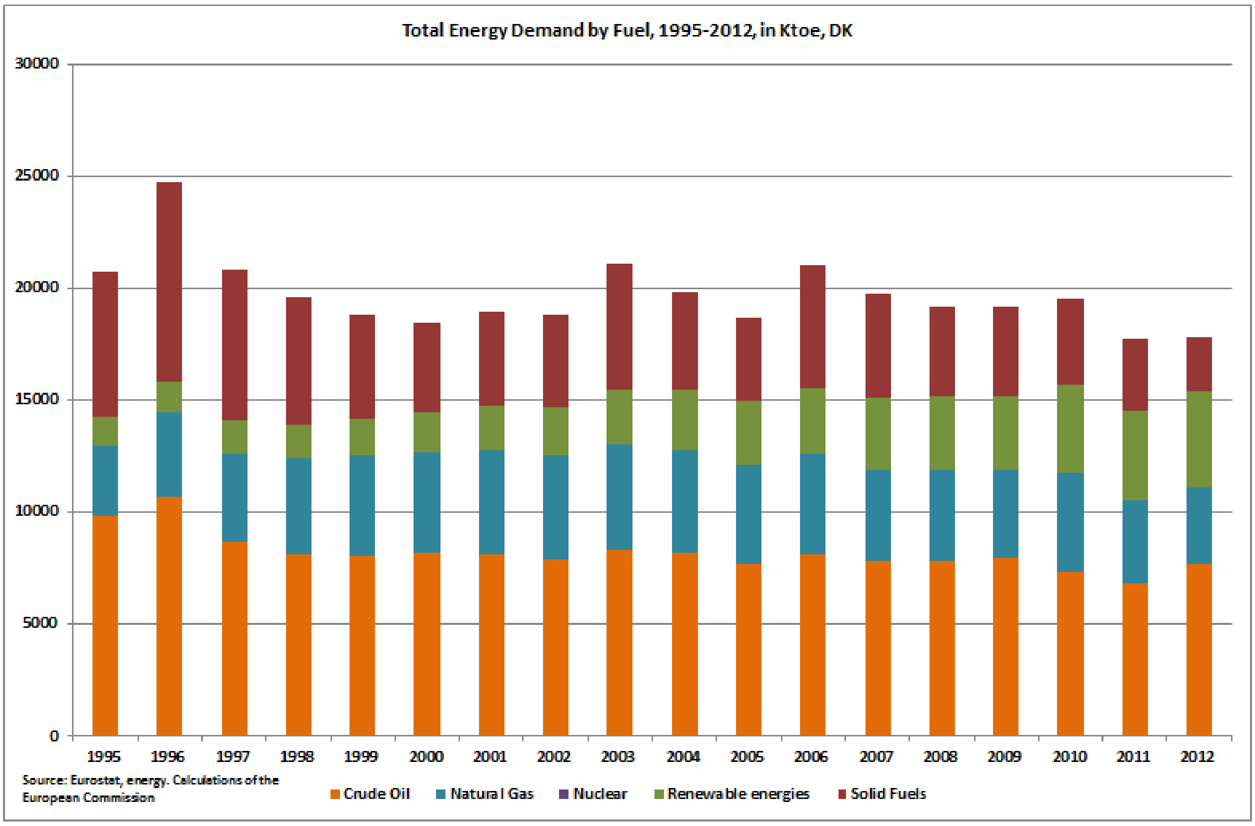


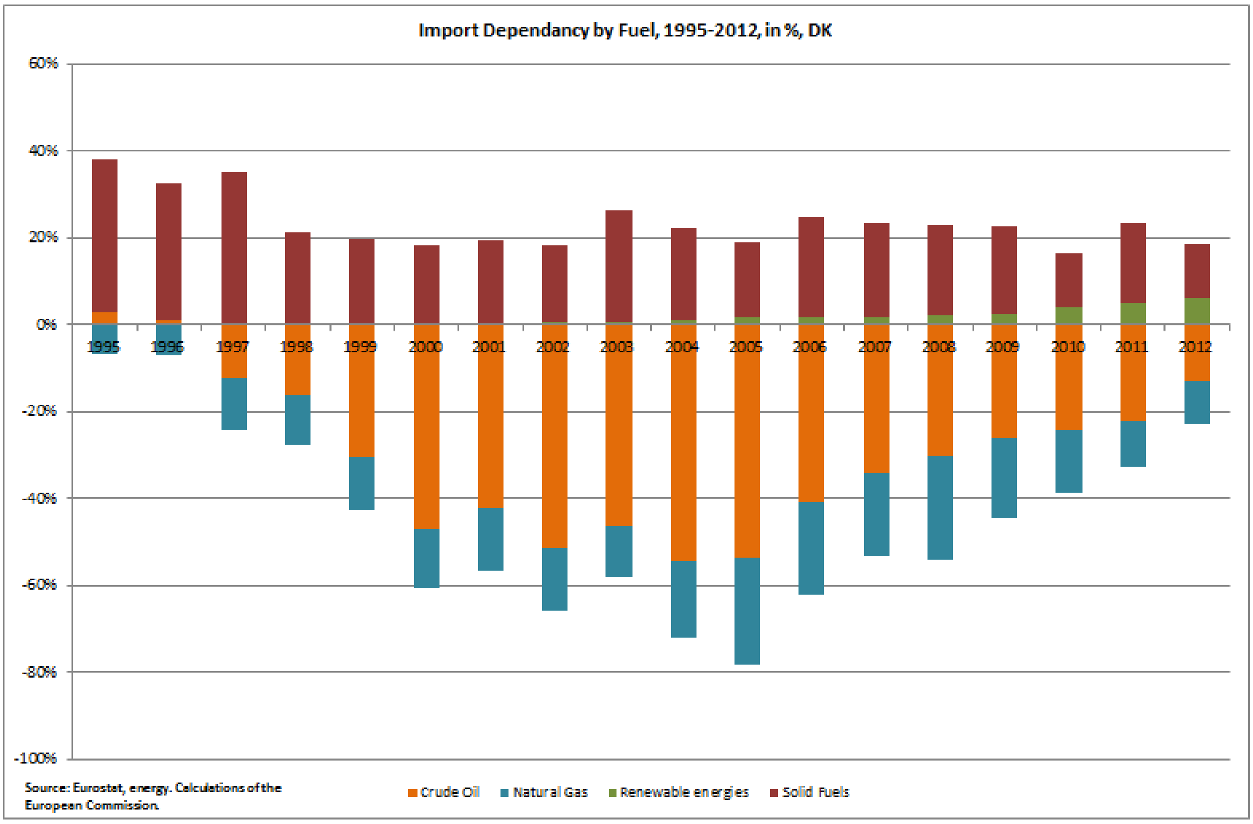


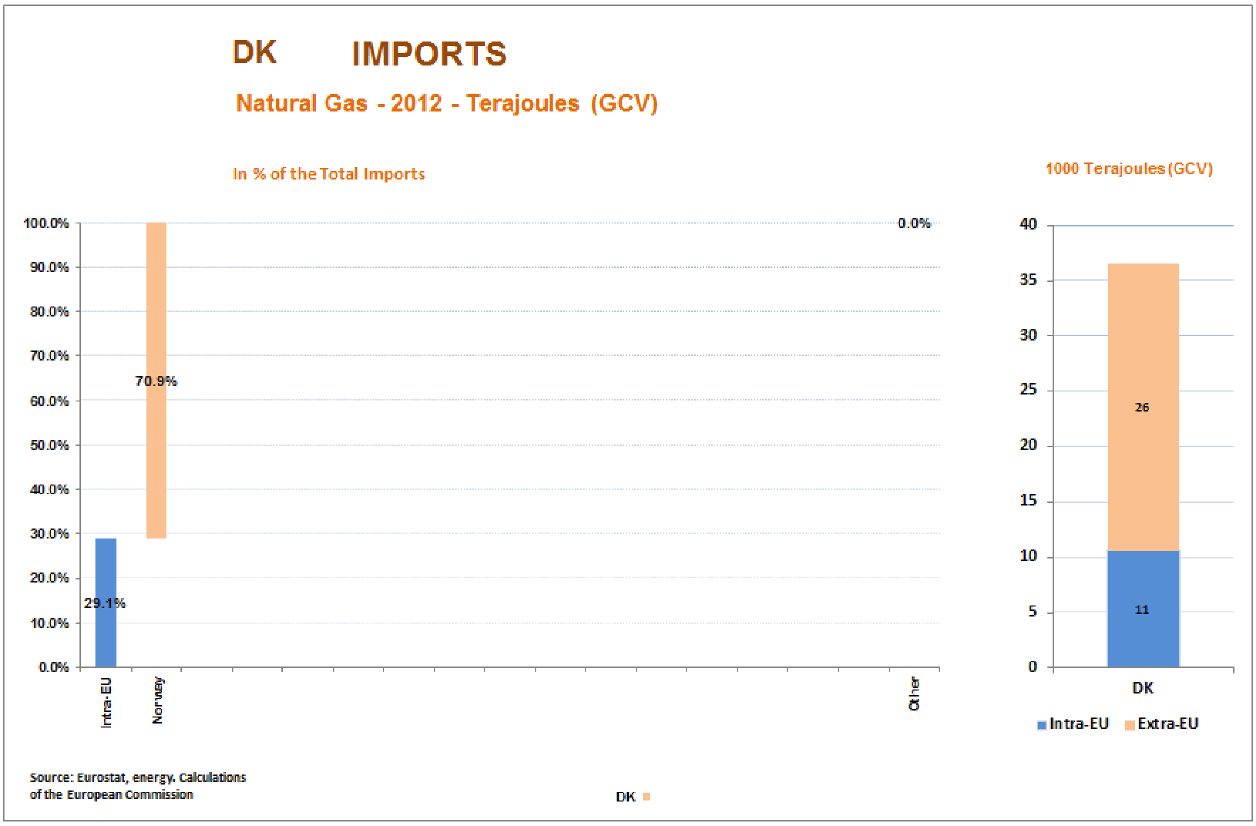

DE IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
29.4%
36.9%
27.7%
6.0%
0.0%
Intra-EU
Russia
Norway
Not specified
Other
2,435
1,012
DE
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission

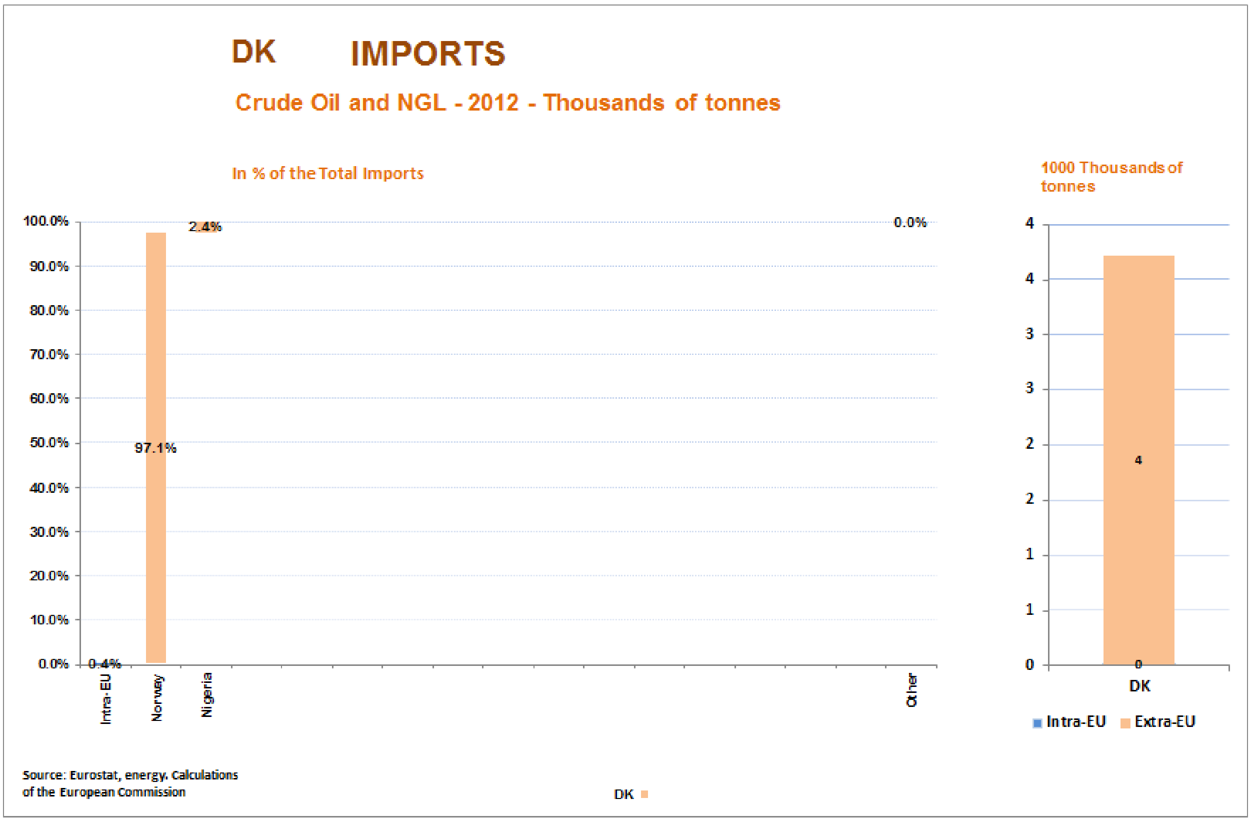

DE IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
16.3%
37.1%
10.0%
9.2%
7.1%
5.8%
2.5%
2.5%
2.3%
1.4%
0.9%
0.8%
0.7%
0.6%
0.6%
0.6%
1.6%
Intra-EU
Russia
Norway
Libya
Nigeria
Kazakhstan
Saudi Arabia
Algeria
Azerbaijan
Egypt
Iraq
Venezuela
Other African countries (aggregate changing...
Kuwait
Colombia
Tunisia
Other
78
15
Intra-EU
Extra-EU
DE
Source: Eurostat, energy. Calculations of the European Commission

Country Fiche: Denmark

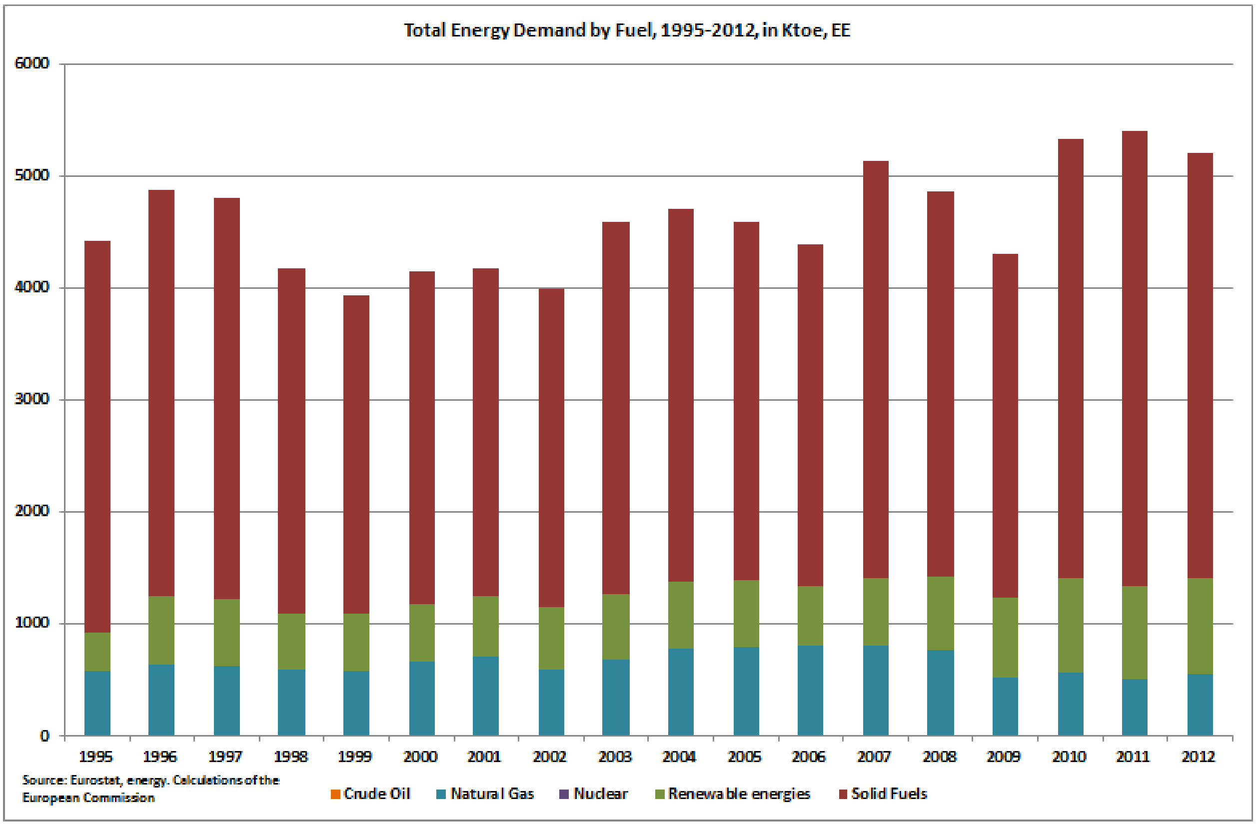


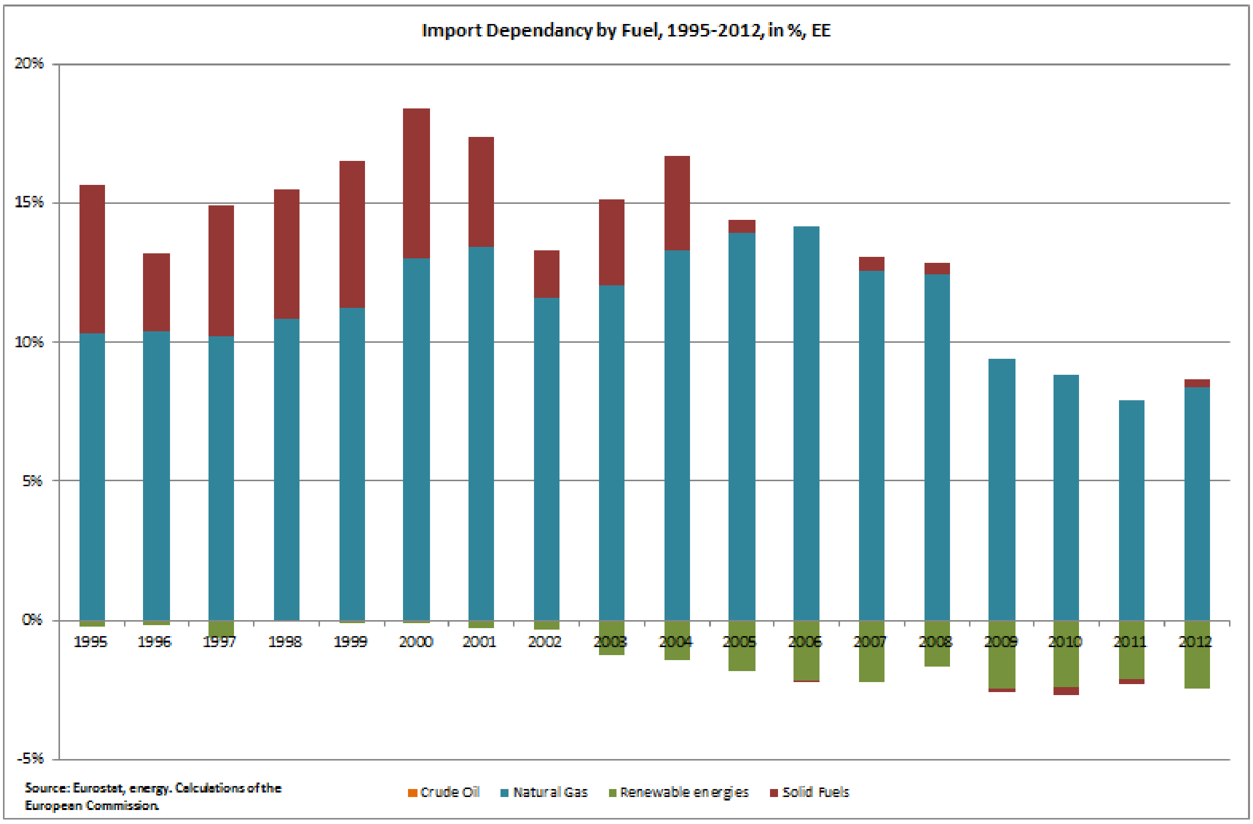


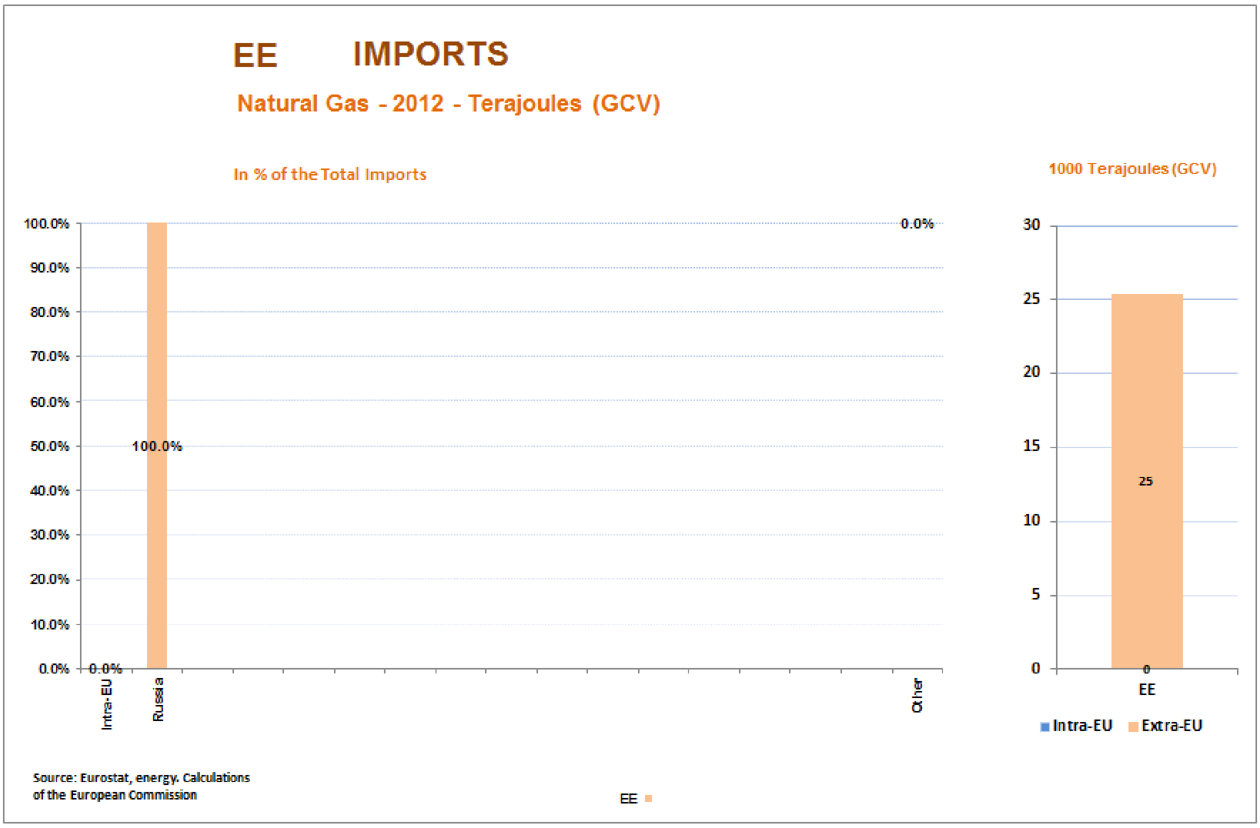

DK IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
29.1%
70.9%
0.0%
Intra-EU
Norway
Other
26
11
DK
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
DK

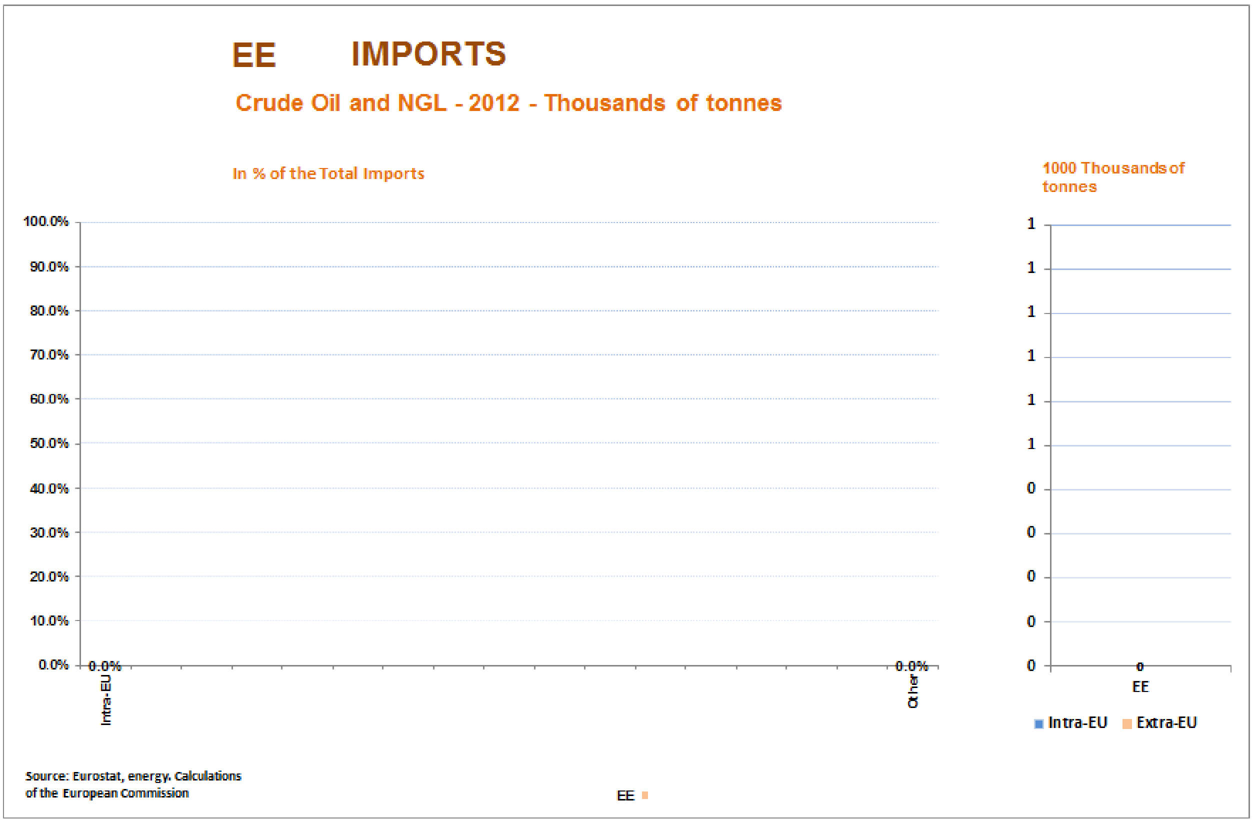

DK IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
0.4%
97.1%
2.4%
0.0%
Intra-EU
Norway
Nigeria
Other
4
0
DK
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
DK

Country Fiche: Estonia






EE IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
100.0%
0.0%
Intra-EU
Russia
Other
30
25
20
15
10
5
0
25
0
EE
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
EE


EE IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
0.0%
Intra-EU
Other
1
1
1
1
1
1
0
0
0
0
0
0
EE
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
EE

Estonia

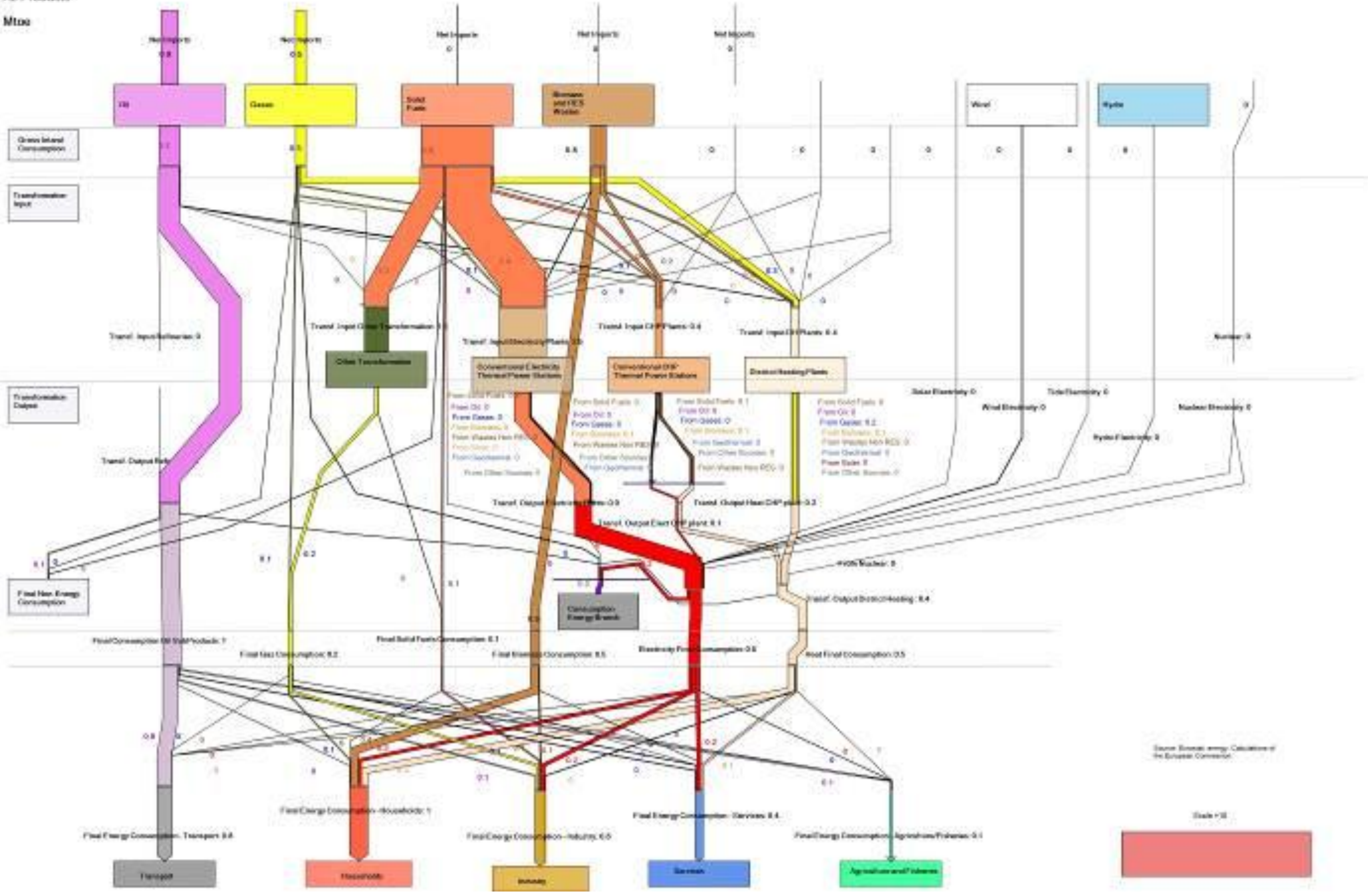
<table>
<tr><td>Total gas consumption / Russian imports</td><td>Total: 0.67 Bcm/y // RU: 0.67 Bcm/y</td></tr>
<tr><td>Gas storage capacity and current level:</td><td>n.a.</td></tr>
<tr><td>Connections to other MSs and capacity:</td><td>LV→EE: 2.5 Bcm/y</td></tr>
<tr><td>Alternative supply options:</td><td>Additional supplies to Lithuania via the regasification terminal could in theory allow for swaps and thus additional sources from the end of 2014. Physical impact on the Estonian market would though be limited. Baltic connector or the LNG terminal could provide diversification in the mid-term.</td></tr>
<tr><td colspan="2">Assessment: Estonia is fully and exclusively dependent on Russian gas imports. Because of the specific operating regime in Russia, Estonia receives gas in the summer directly from Russia, while in winter it receives gas from the Latvian storage facility Incukalns. As long as gas is stored in Incukalns, Estonia is safe. In the event of a disruption, Estonia must apply fuel switching.</td></tr>
</table>

ENERGY FLOW

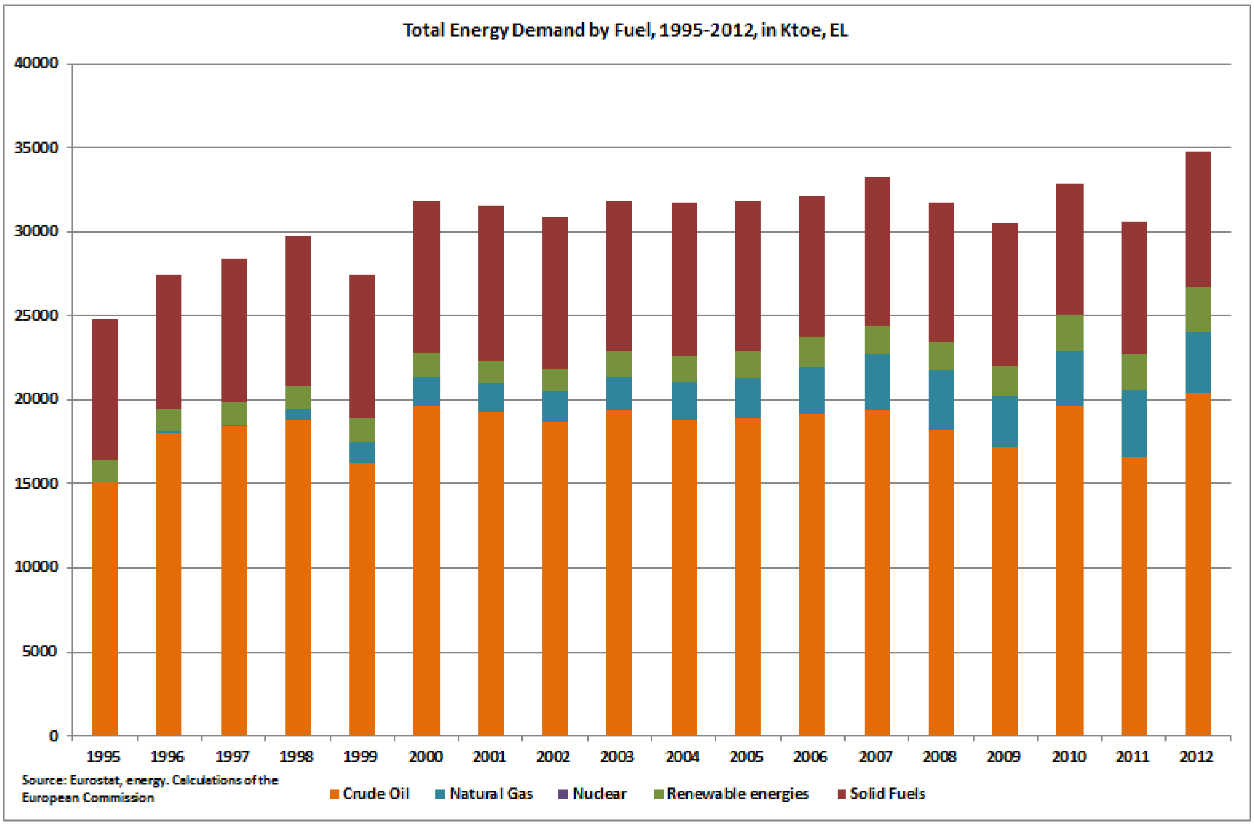
EE 2012

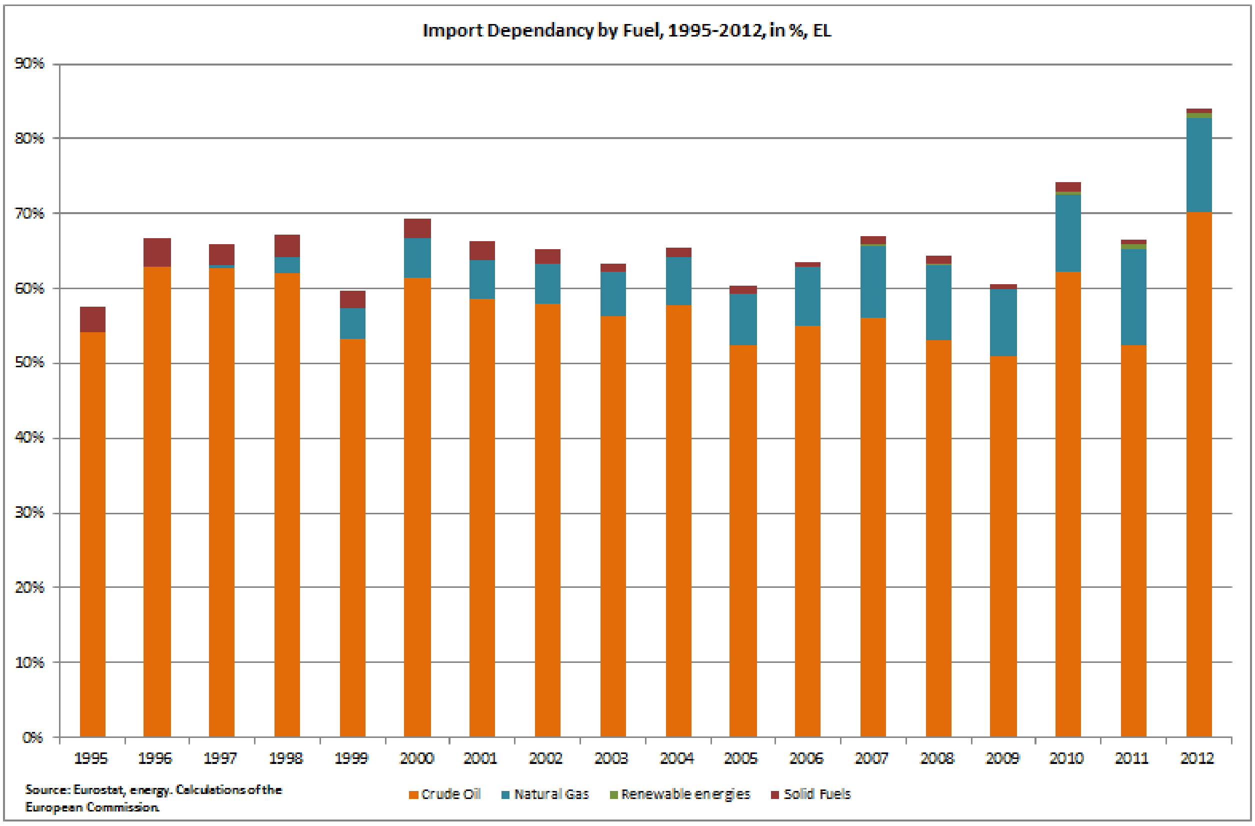
All Products

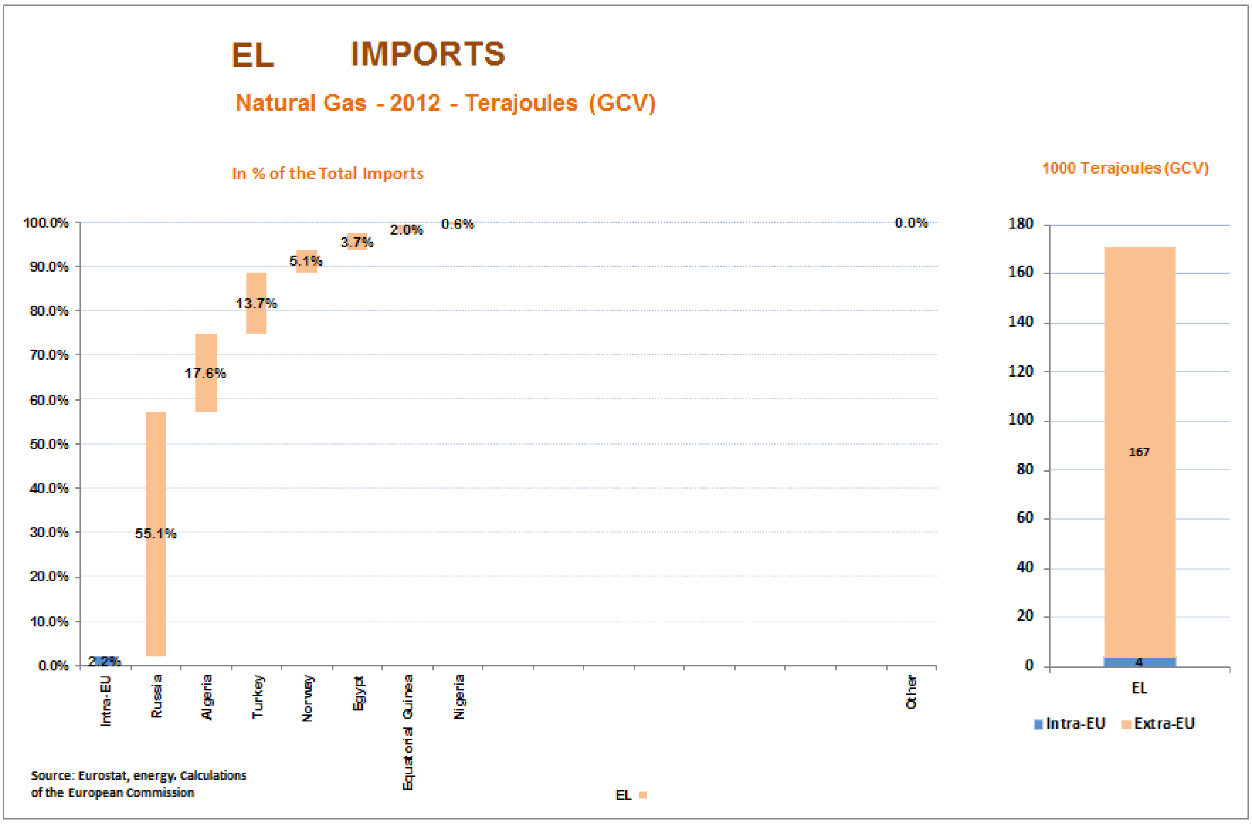
Mtoe

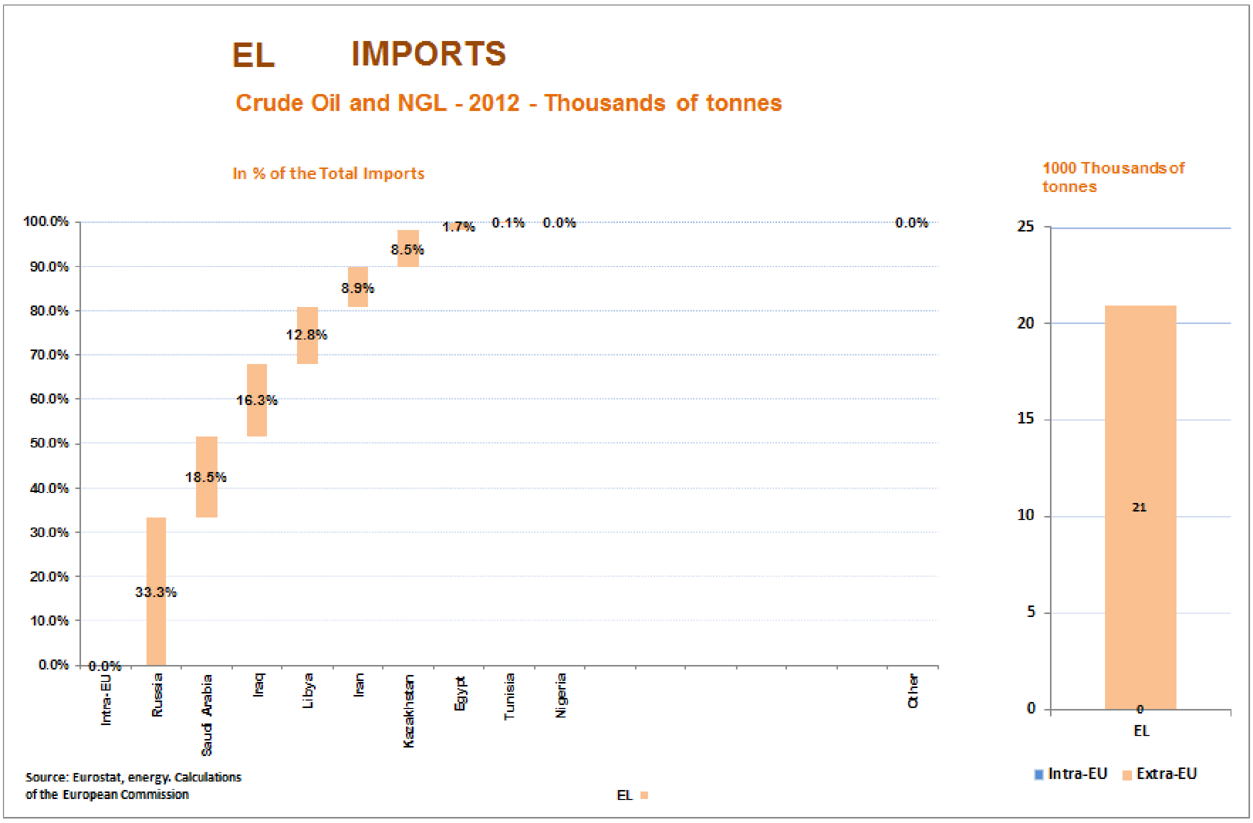


Country Fiche: Greece






EL IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
2.2%
55.1%
17.6%
13.7%
5.1%
3.7%
2.0%
0.6%
0.0%
Intra-EU
Russia
Algeria
Turkey
Norway
Egypt
Equatorial Guinea
Nigeria
Other
180
160
140
120
100
80
60
40
20
0
167
4
EL
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
EL


EL IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
33.3%
18.5%
16.3%
12.8%
8.9%
8.5%
1.7%
0.1%
0.0%
0.0%
Intra-EU
Russia
Saudi Arabia
Iraq
Libya
Iran
Kazakhstan
Egypt
Tunisia
Nigeria
Other
25
20
15
10
5
0
21
0
EL
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
EL

Greece

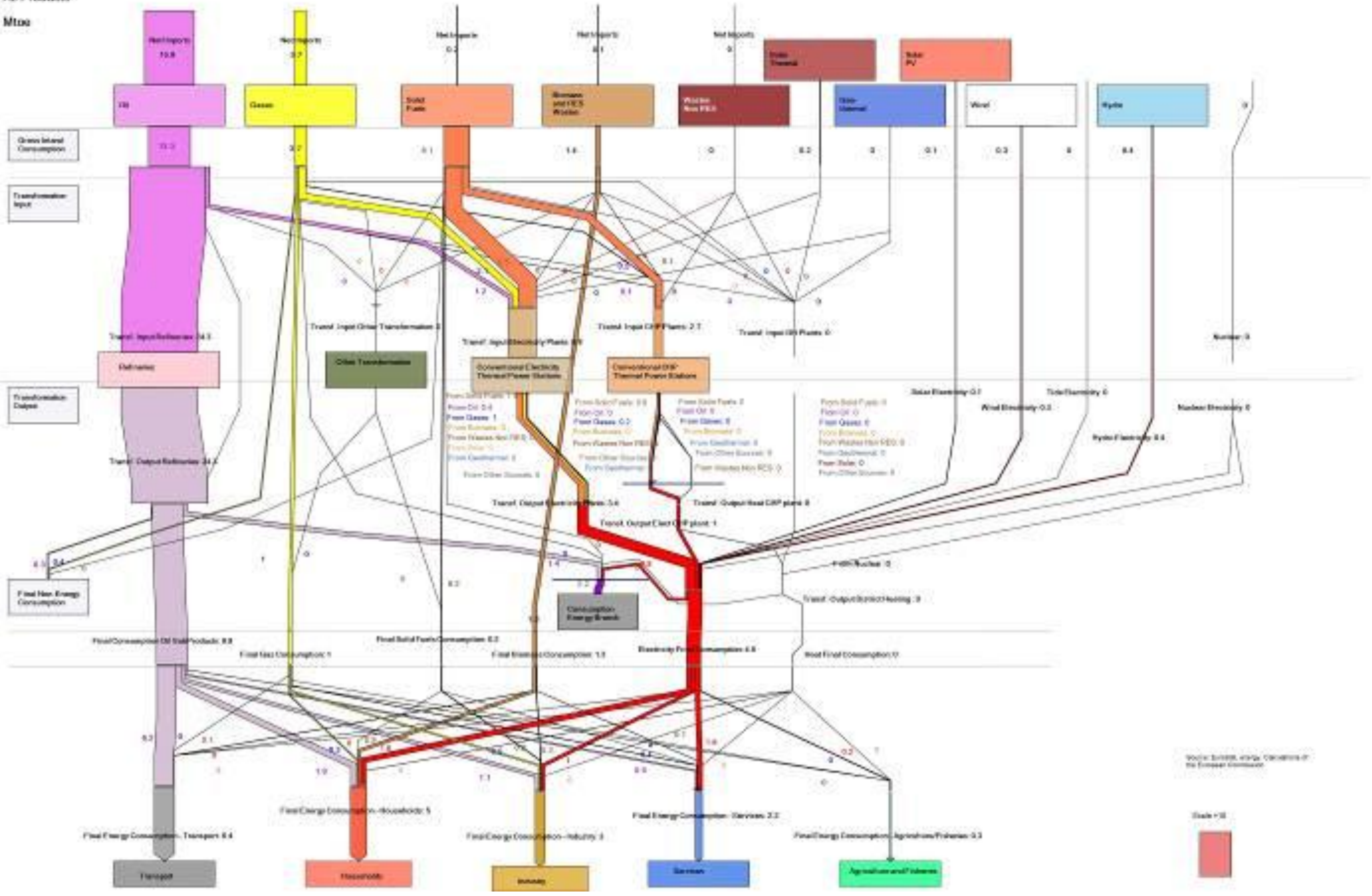
Total gas consumption / Russian imports	Total: 3.8 Bcm/y // RU: 2.6 Bcm/y
Gas storage capacity and current level:	n.a. – LNG tanks can store 130.000 cubic meters of LNG
Connections to other MSs and capacity:	BG→GR: 3.5 Bcm/y
Alternative supply options:	Implementation of the interconnector BG-GR ongoing. Installing reverse flows between GR-BG is ongoing with a planned firm capacity of 036 Bcm/y.
Assessment: Although the nominal capacity of the Revythousa LNG terminal is 5.3 Bcm/y, it is unlikely that Greece would financially be able cover its full gas demand from LNG.	

ENERGY FLOW

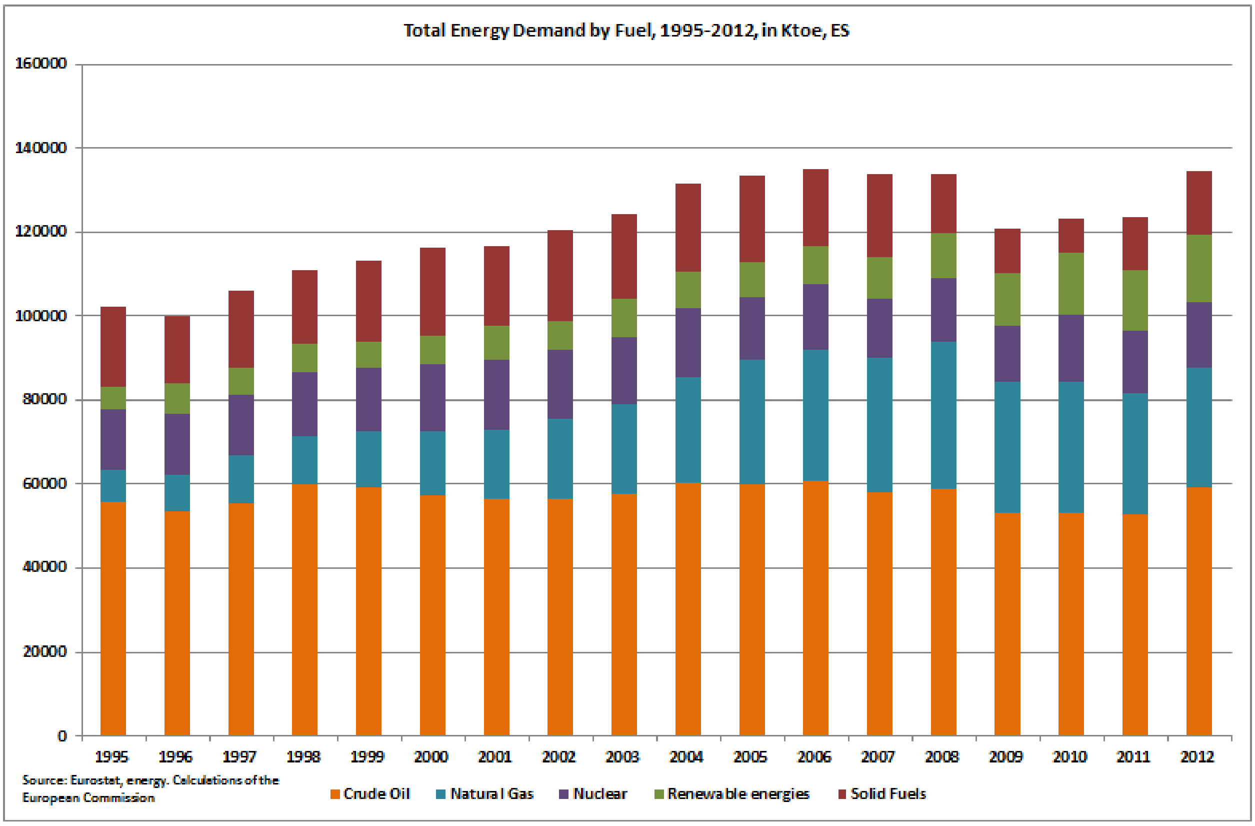
EL 2012

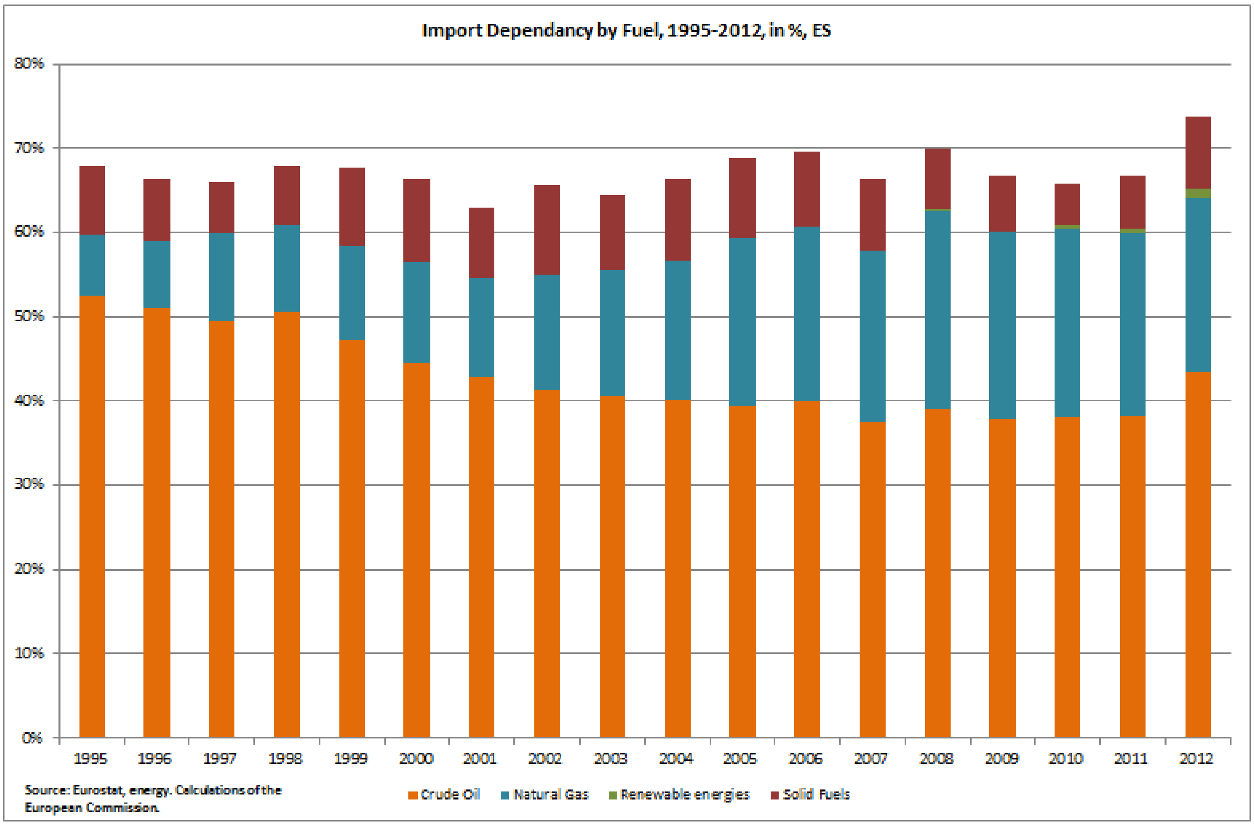
All Products

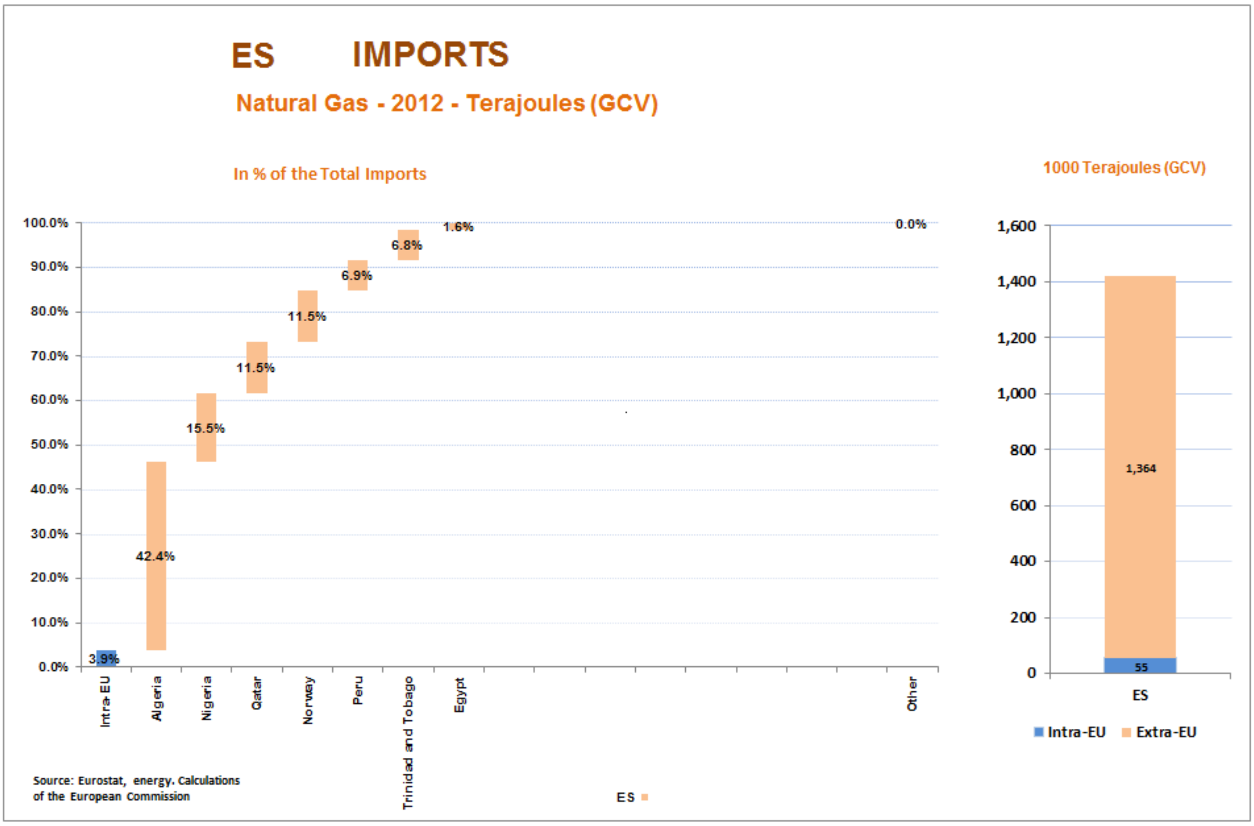
Mtoe

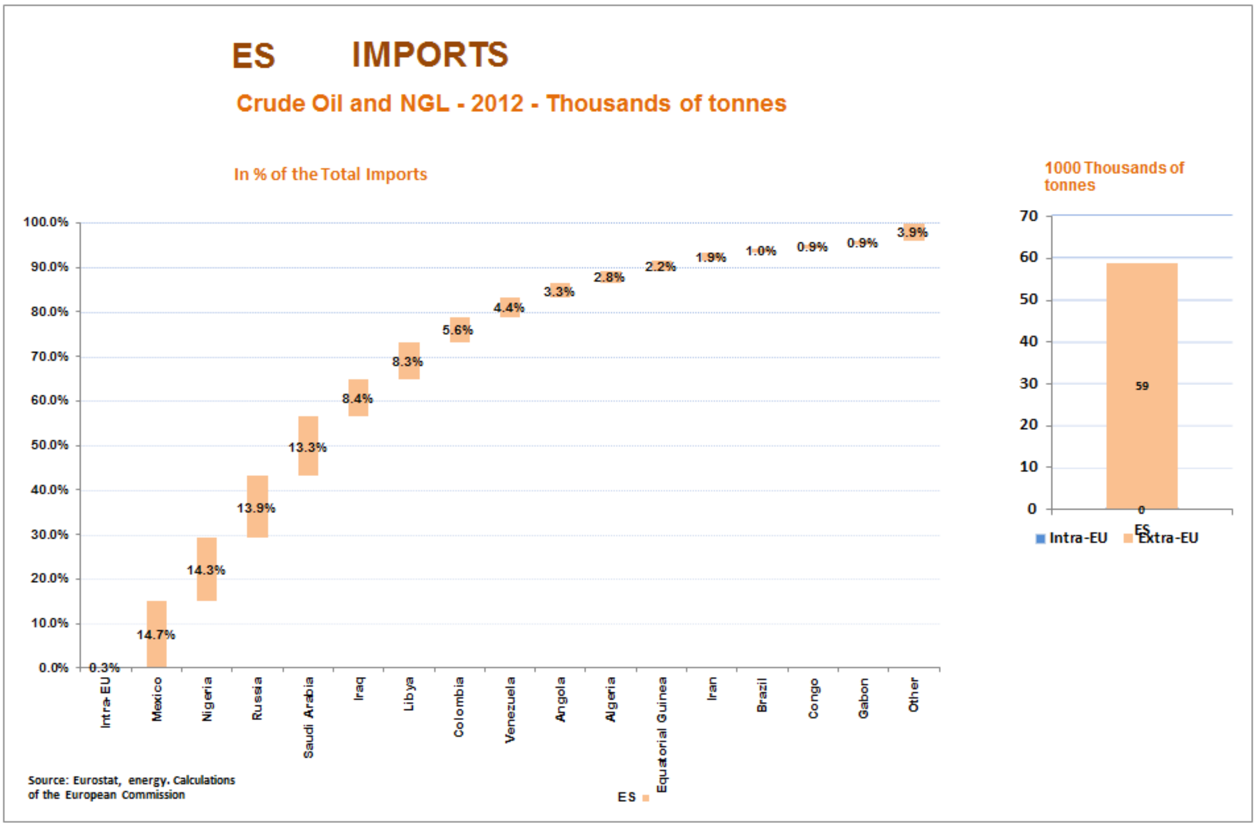


Country Fiche: Spain

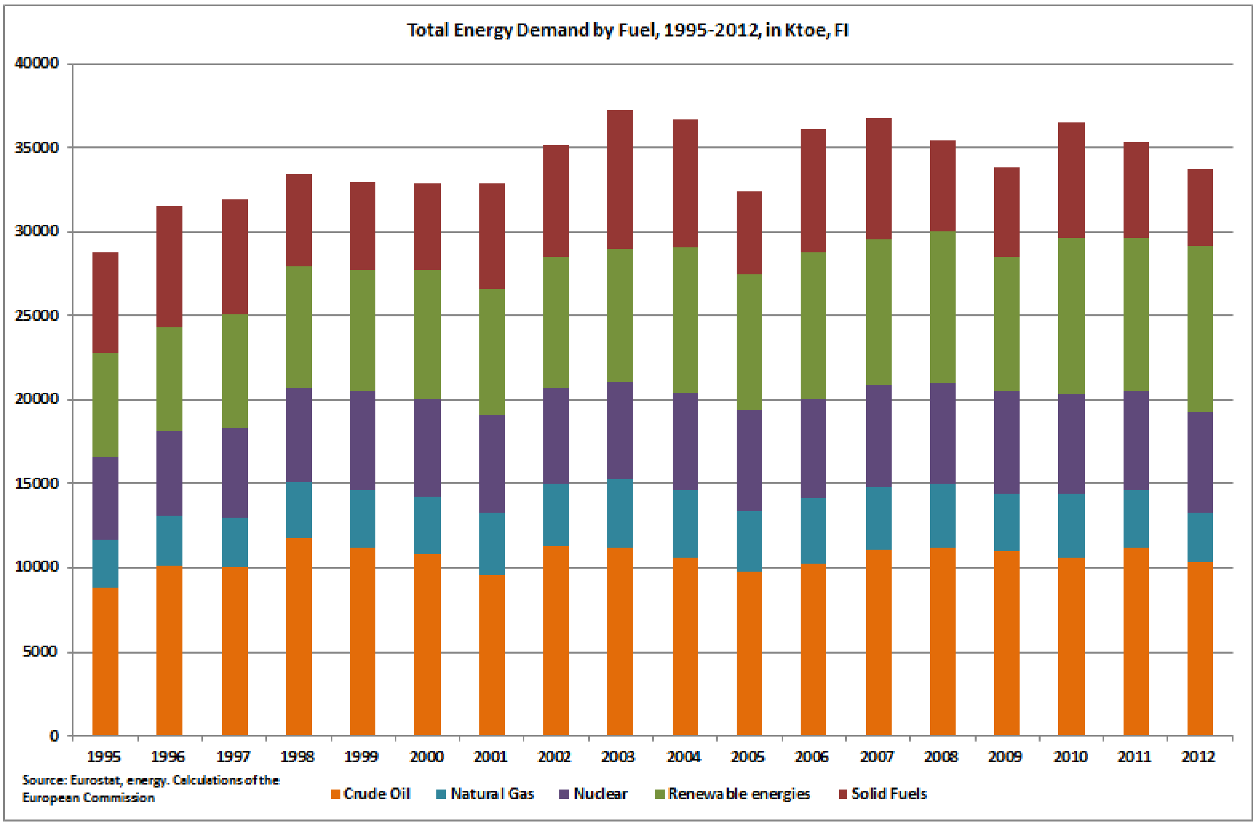


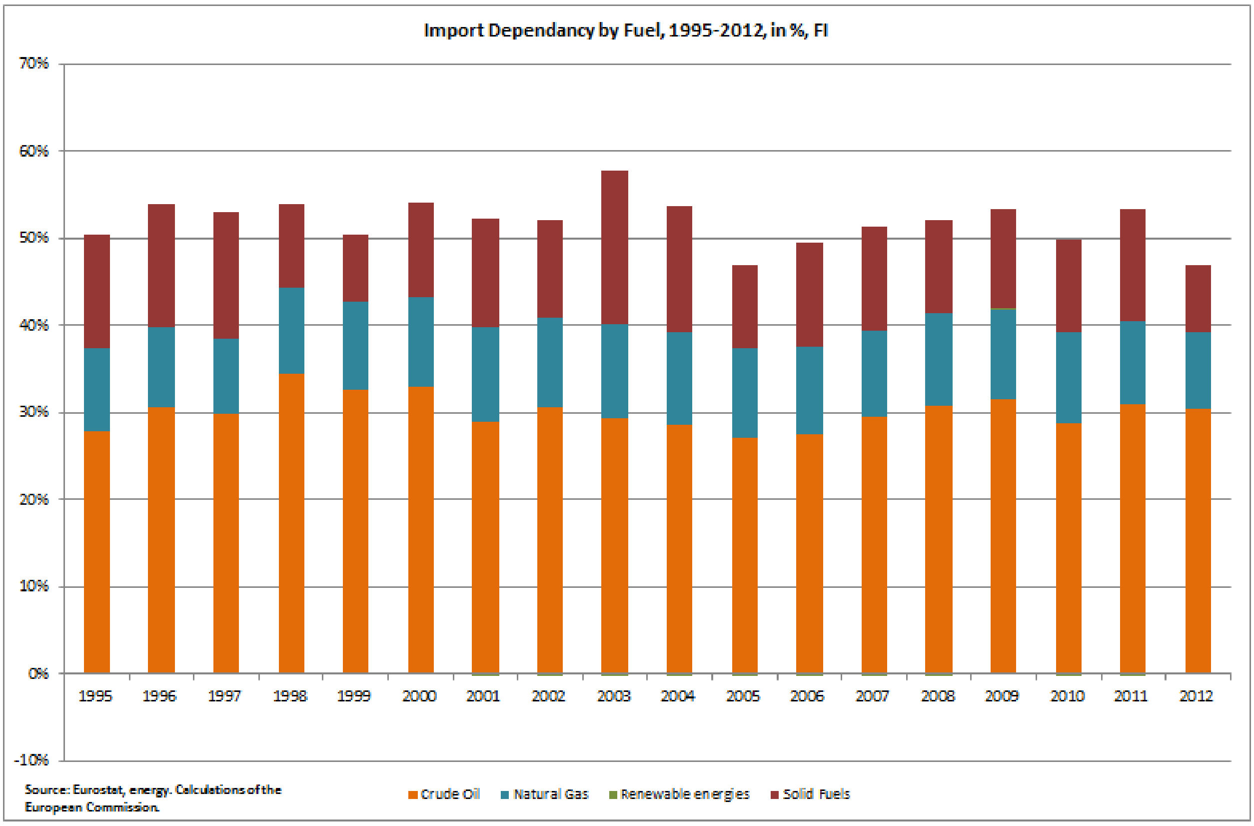


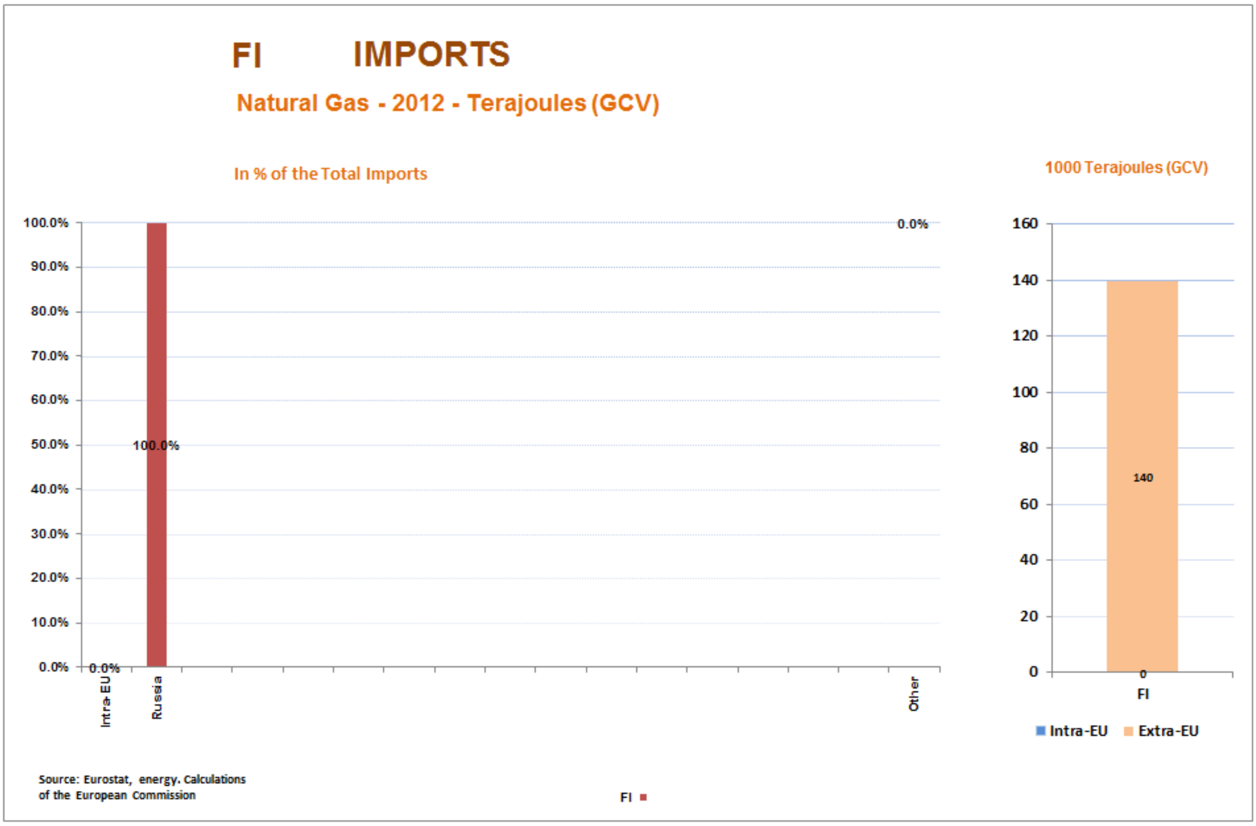

ES IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
3.9%
42.4%
15.5%
11.5%
11.5%
6.9%
6.8%
1.6%
0.0%
Intra-EU
Algeria
Nigeria
Qatar
Norway
Peru
Trinidad and Tobago
Egypt
Other
1,600
1,400
1,200
1,000
800
600
400
200
0
1,364
55
ES
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
ES


ES IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.3%
14.7%
14.3%
13.9%
13.3%
8.4%
8.3%
5.6%
4.4%
3.3%
2.8%
2.2%
1.9%
1.0%
0.9%
0.9%
3.9%
Intra-EU
Mexico
Nigeria
Russia
Saudi Arabia
Iraq
Libya
Colombia
Venezuela
Angola
Algeria
Equatorial Guinea
Iran
Brazil
Congo
Gabon
Other
70
60
50
40
30
20
10
0
59
0
ES
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
ES

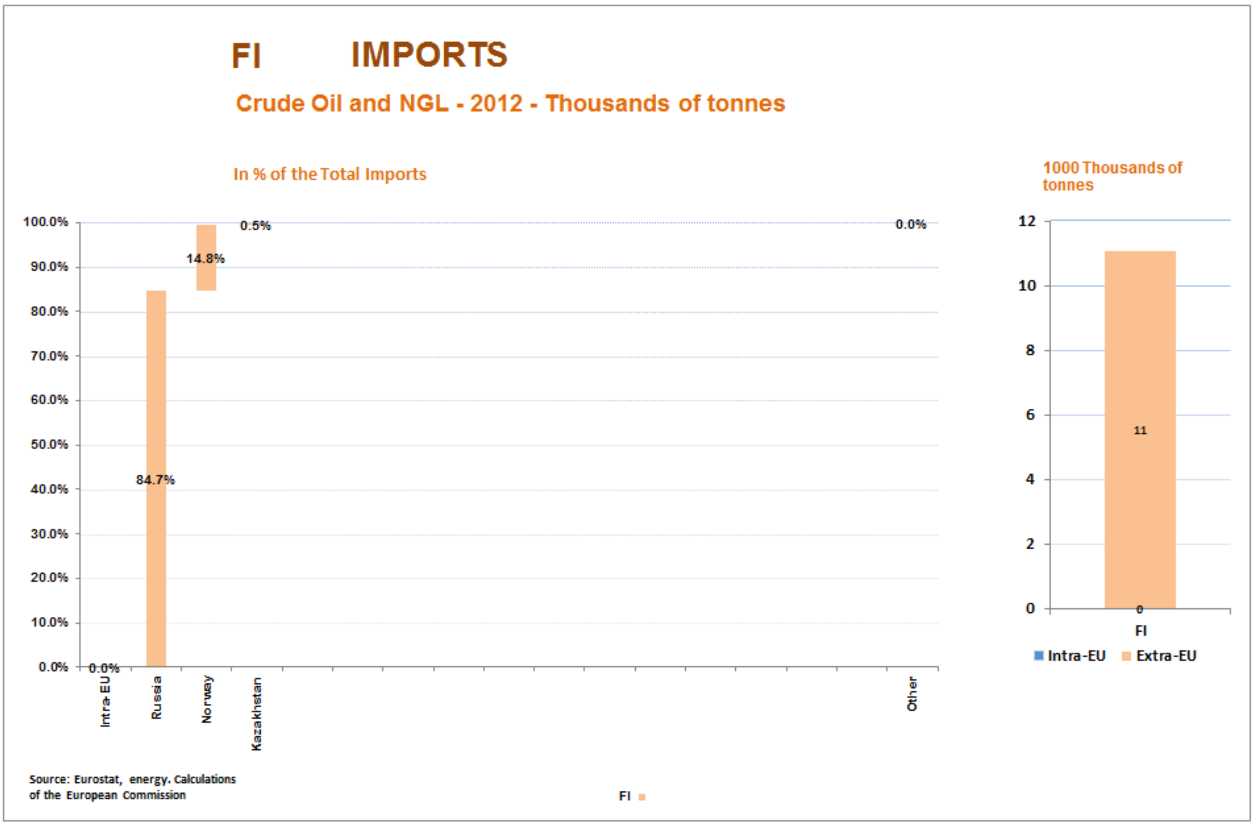
Country Fiche: Finland







FI IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
100.0%
0.0%
Intra-EU
Russia
Other
160
140
120
100
80
60
40
20
0
140
0
FI
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
FI



FI IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
84.7%
14.8%
0.5%
0.0%
Intra-EU
Russia
Norway
Kazakhstan
Other
12
10
8
6
4
2
0
11
0
FI
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
FI

Finland

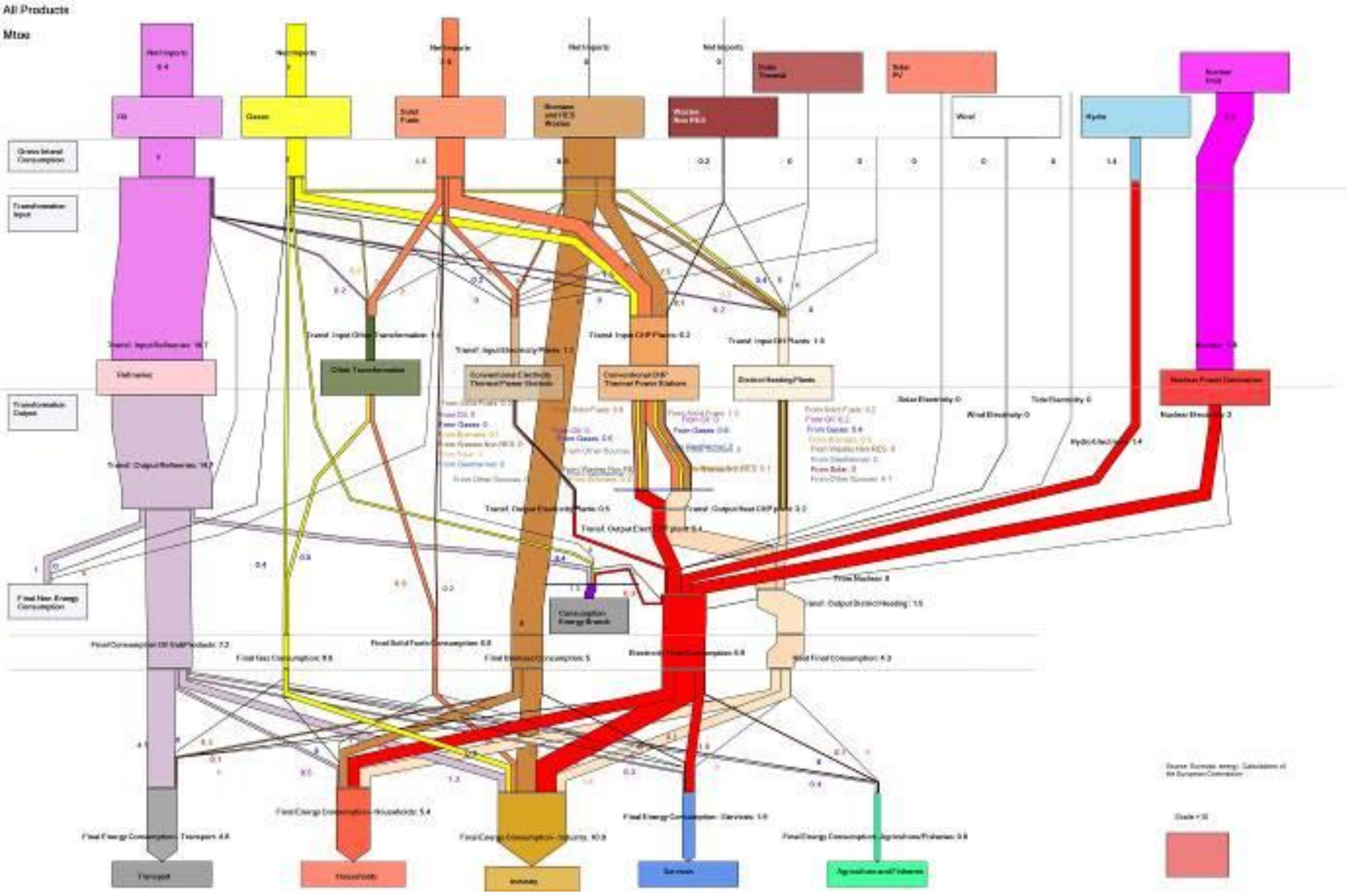
Total gas consumption / Russian imports	Total: 3.6 Bcm/y // RU: 3.6 Bcm/y
Gas storage capacity and current level:	n.a.
Connections to other MSs and capacity:	n.a
Alternative supply options:	No short-term alternative supply options. Baltic connector or the LNG terminal could provide diversification in the mid-term.
Assessment: Finland is fully and exclusively dependent on Russian gas imports. In the event of a disruption, Finland can use the line pack in the pipes for 4 days and 9 hours. After that, all major gas users must switch fuel and the air-propane stocks are activated, which can provide gas to protected customers to satisfy the 30 day obligation of the supply standard.	

ENERGY FLOW

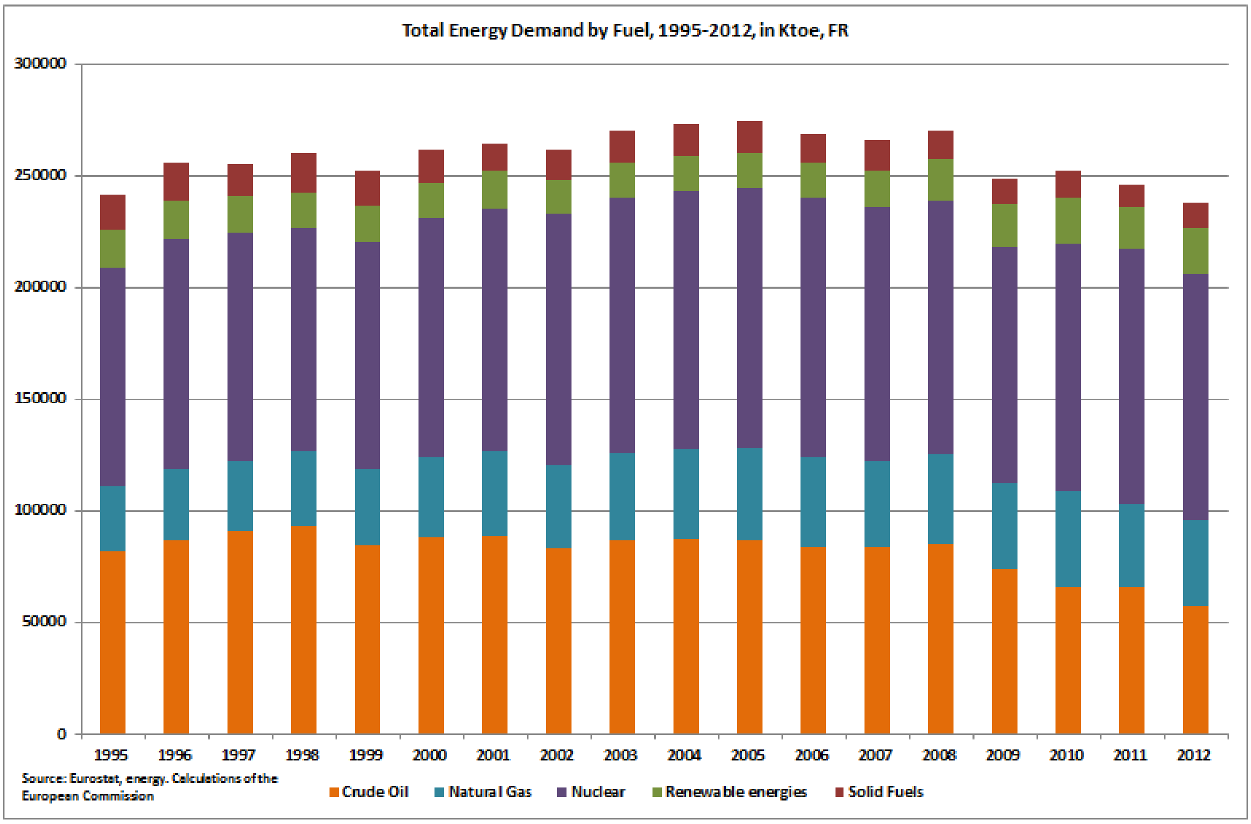
FI 2012

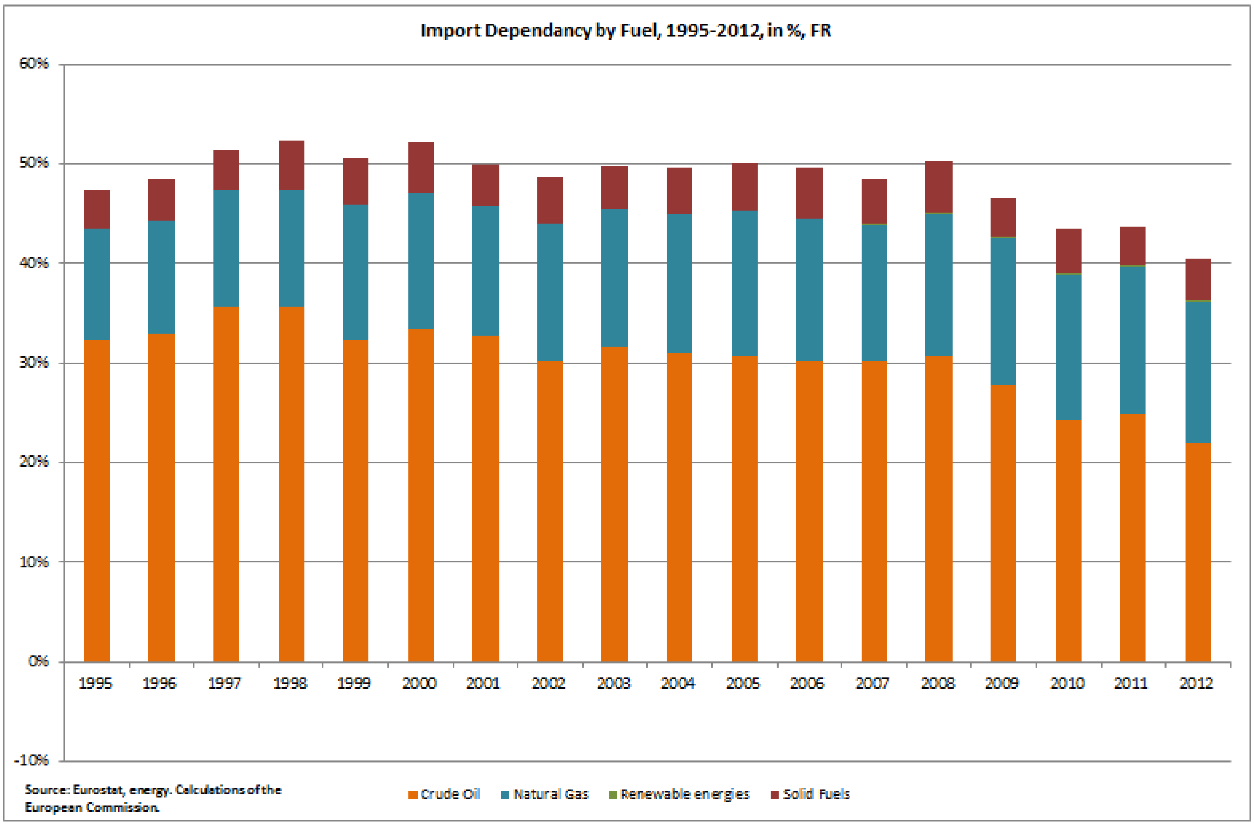
All Products

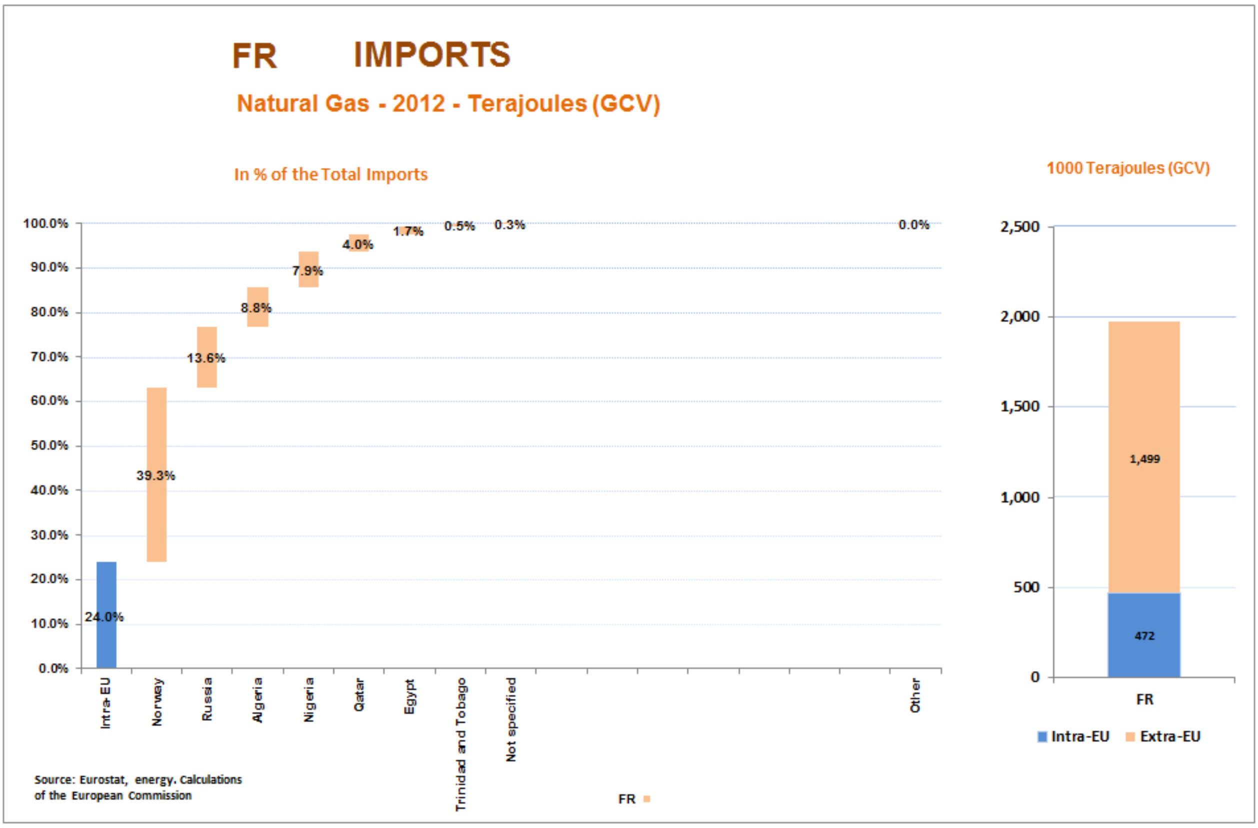
Mtoe

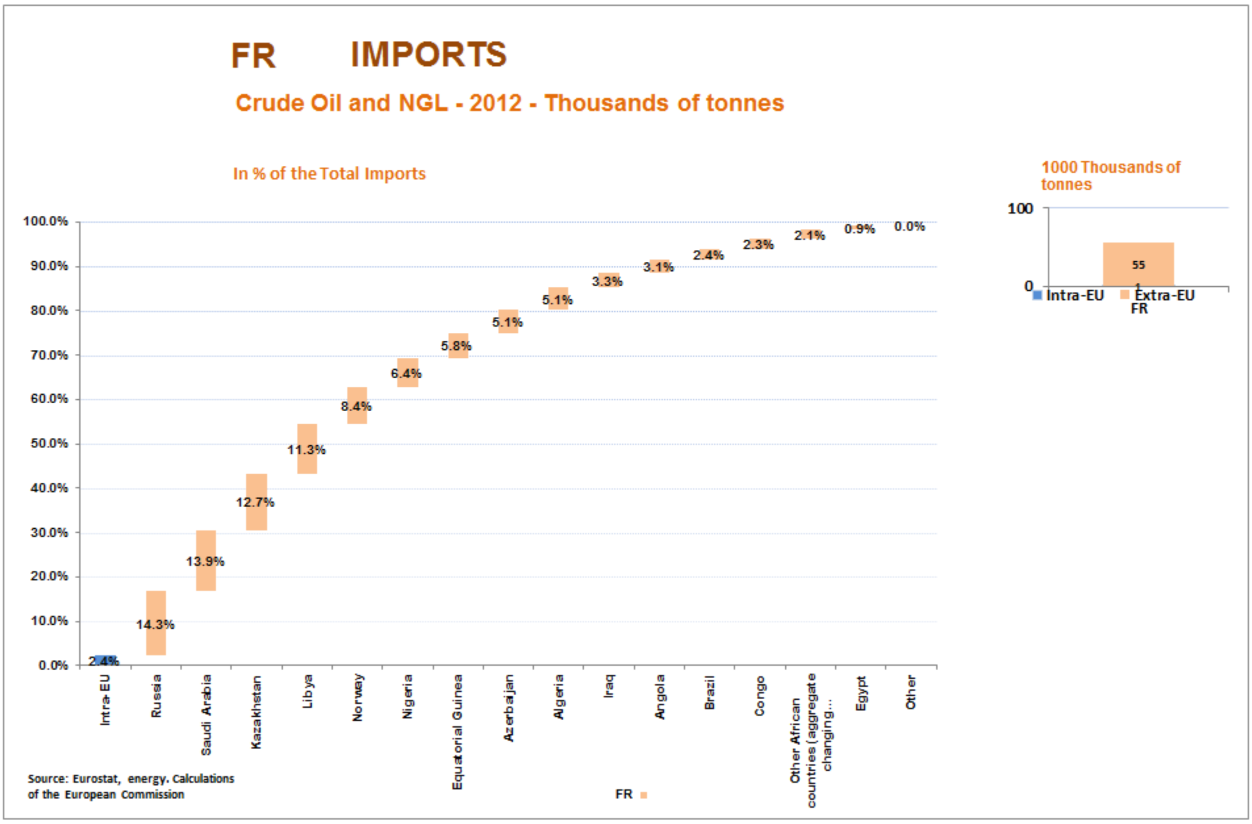


Country Fiche: France

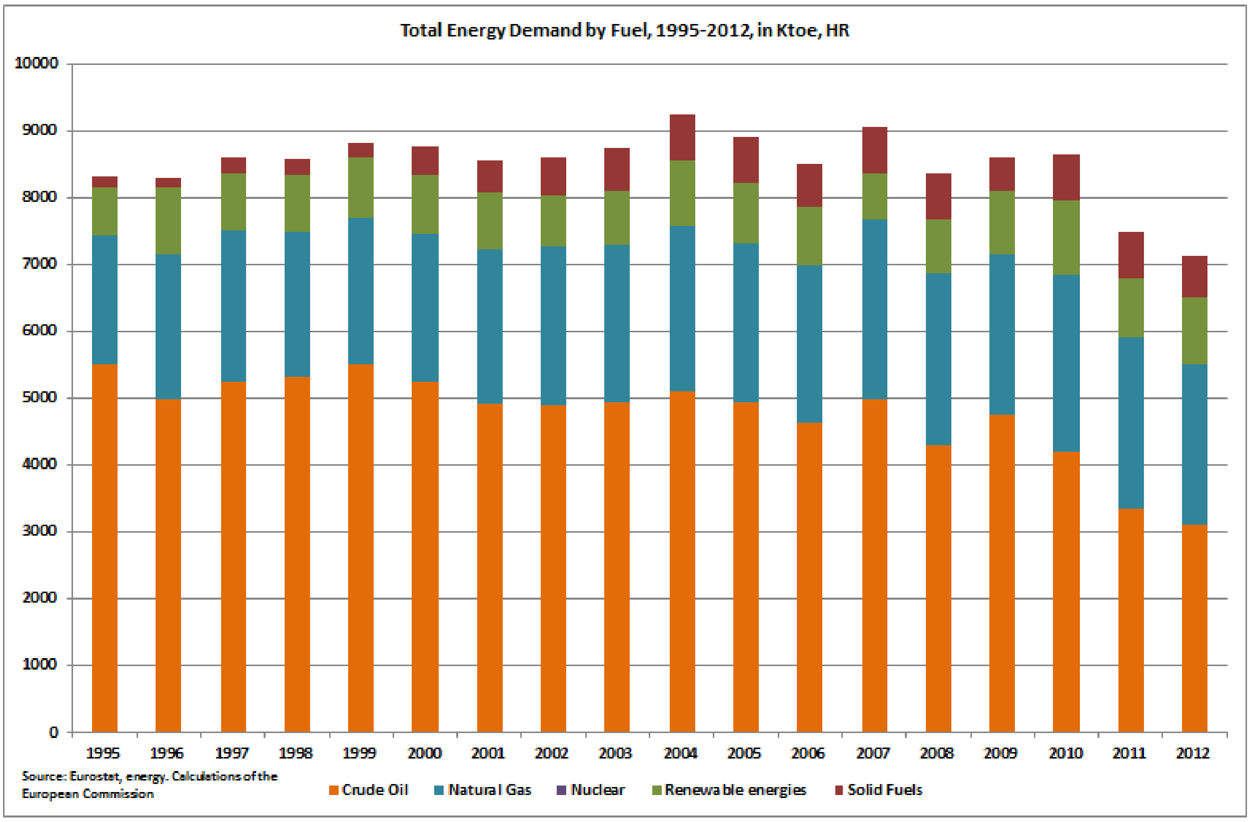


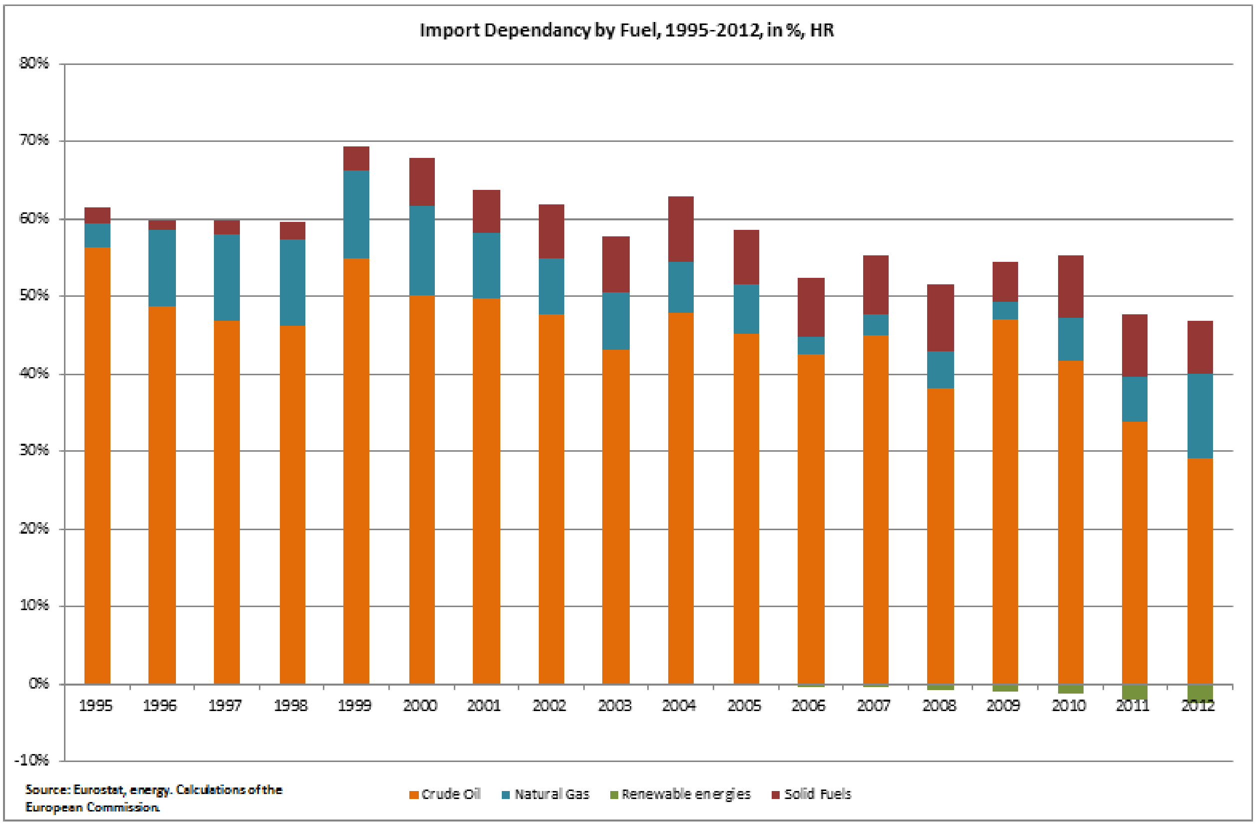



FR IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
24.0%
39.3%
13.6%
8.8%
7.9%
4.0%
1.7%
0.5%
0.3%
0.0%
Intra-EU
Norway
Russia
Algeria
Nigeria
Qatar
Egypt
Trinidad and Tobago
Not specified
Other
1,499
472
FR
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission

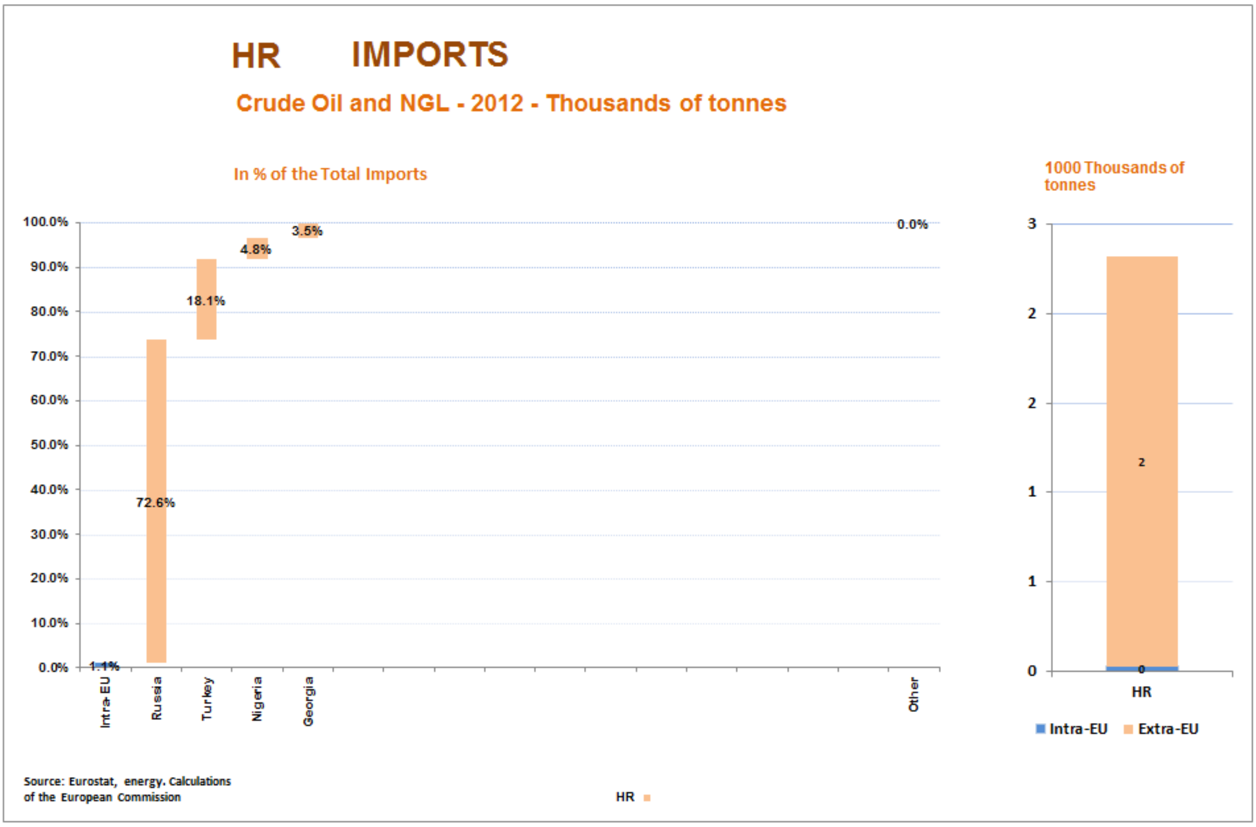

FR IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
2.4%
14.3%
13.9%
12.7%
11.3%
8.4%
6.4%
5.8%
5.1%
5.1%
3.3%
3.1%
2.4%
2.3%
2.1%
0.9%
0.0%
Intra-EU
Russia
Saudi Arabia
Kazakhstan
Libya
Norway
Nigeria
Equatorial Guinea
Azerbaijan
Algeria
Iraq
Angola
Brazil
Congo
Other African countries (aggregate changing...
Egypt
Other
55
1
Intra-EU
Extra-EU
FR
Source: Eurostat, energy. Calculations of the European Commission

Country Fiche: Croatia

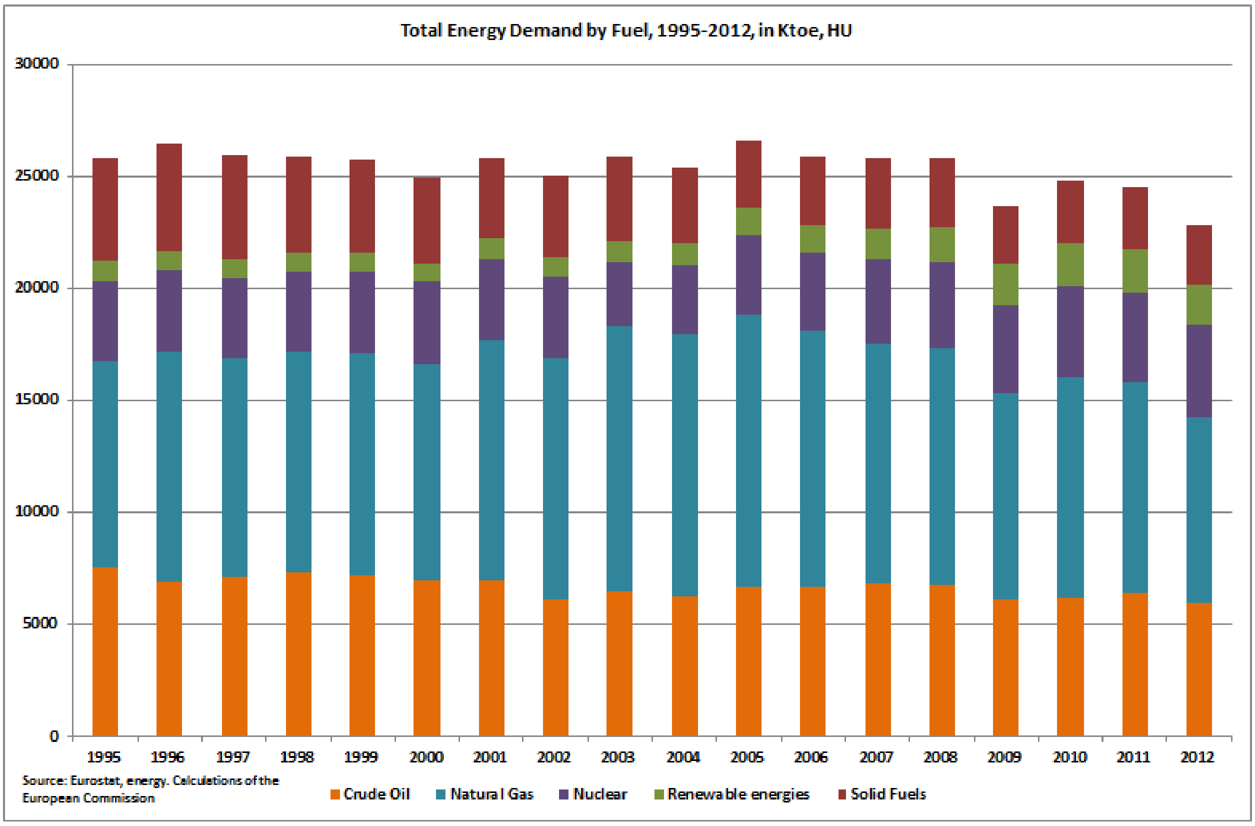


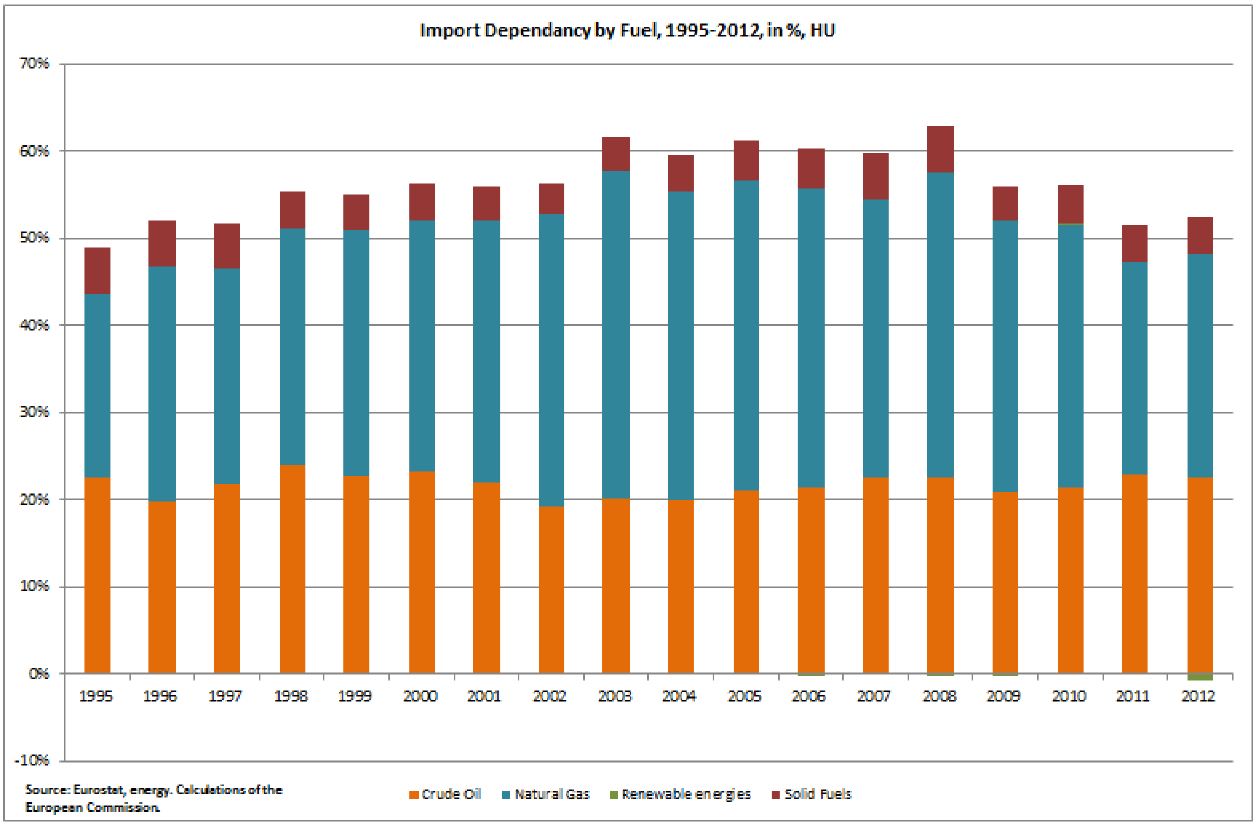


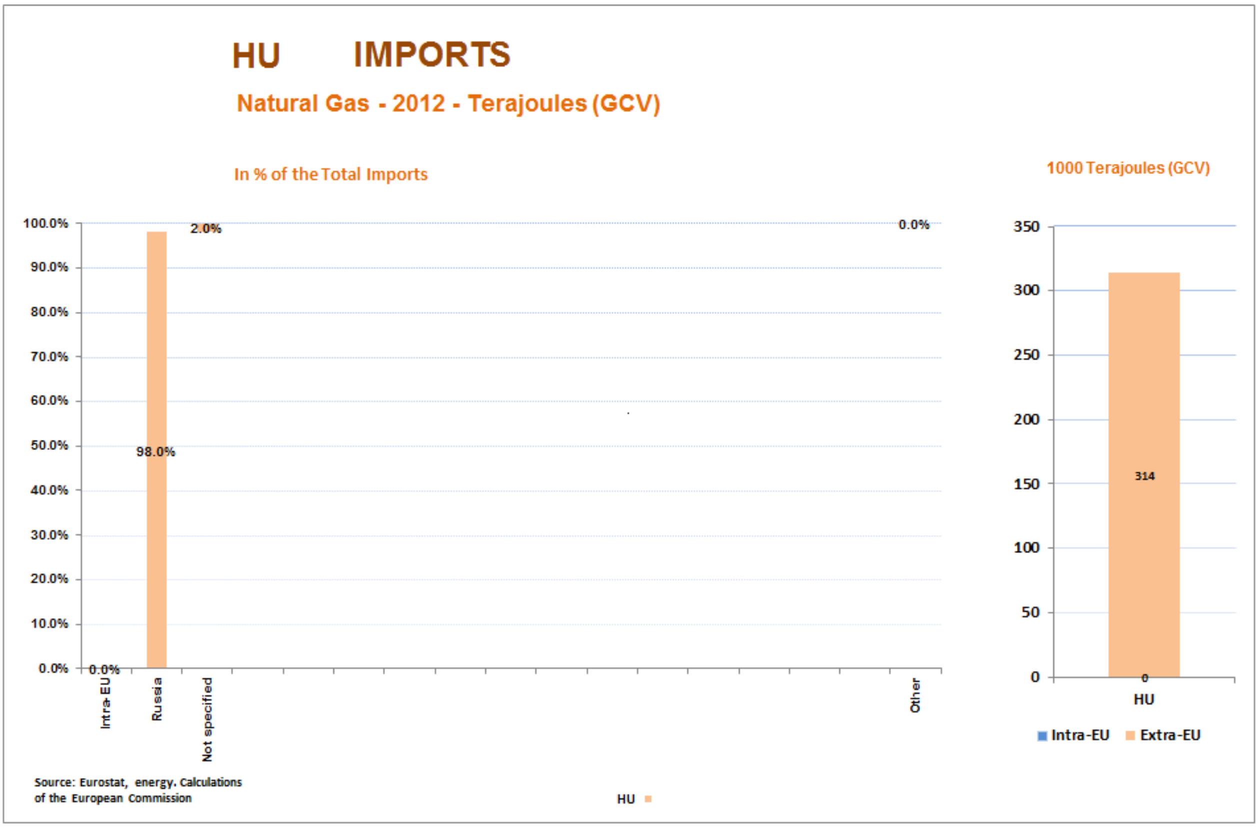

HR IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
0.0%
Intra-EU
Other
51
0
HR
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
HR

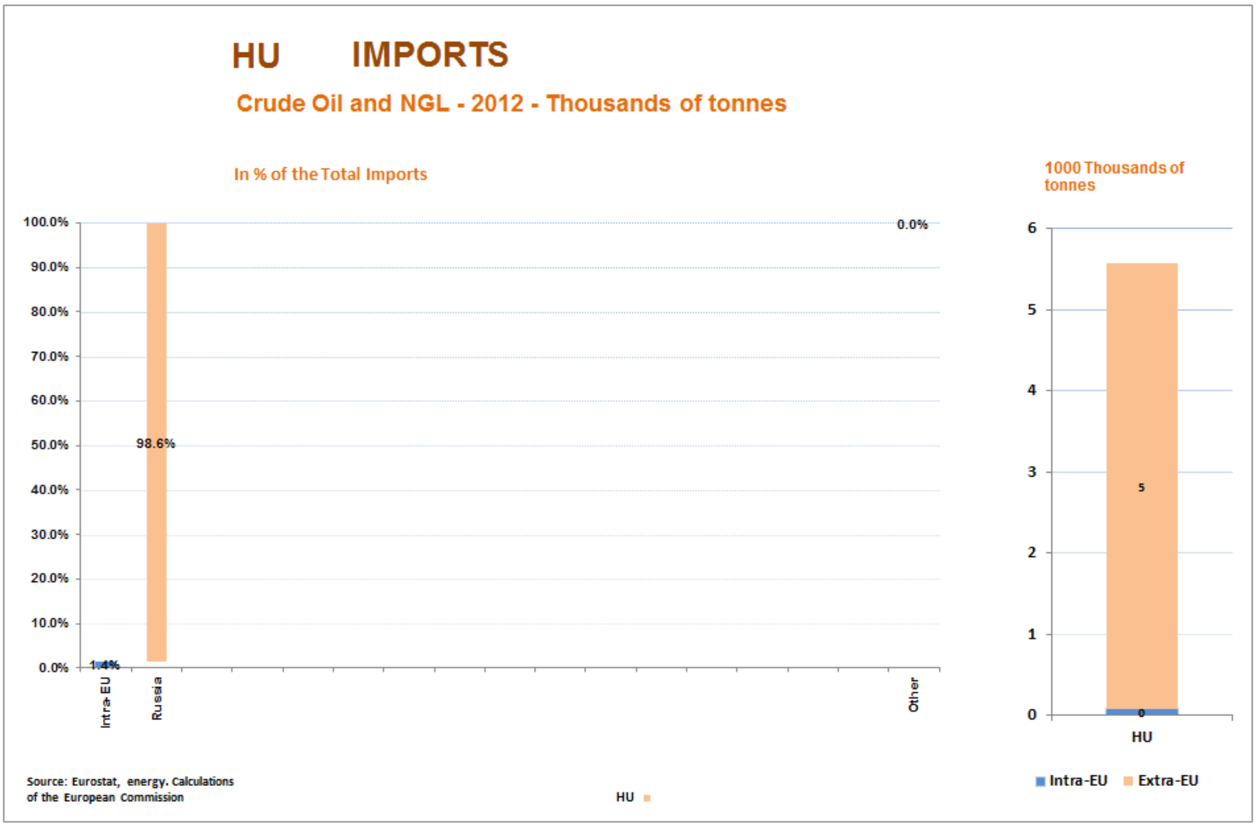

HR IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
1.1%
72.6%
18.1%
4.8%
3.5%
0.0%
Intra-EU
Russia
Turkey
Nigeria
Georgia
Other
2
0
HR
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
HR

Country Fiche: Hungary



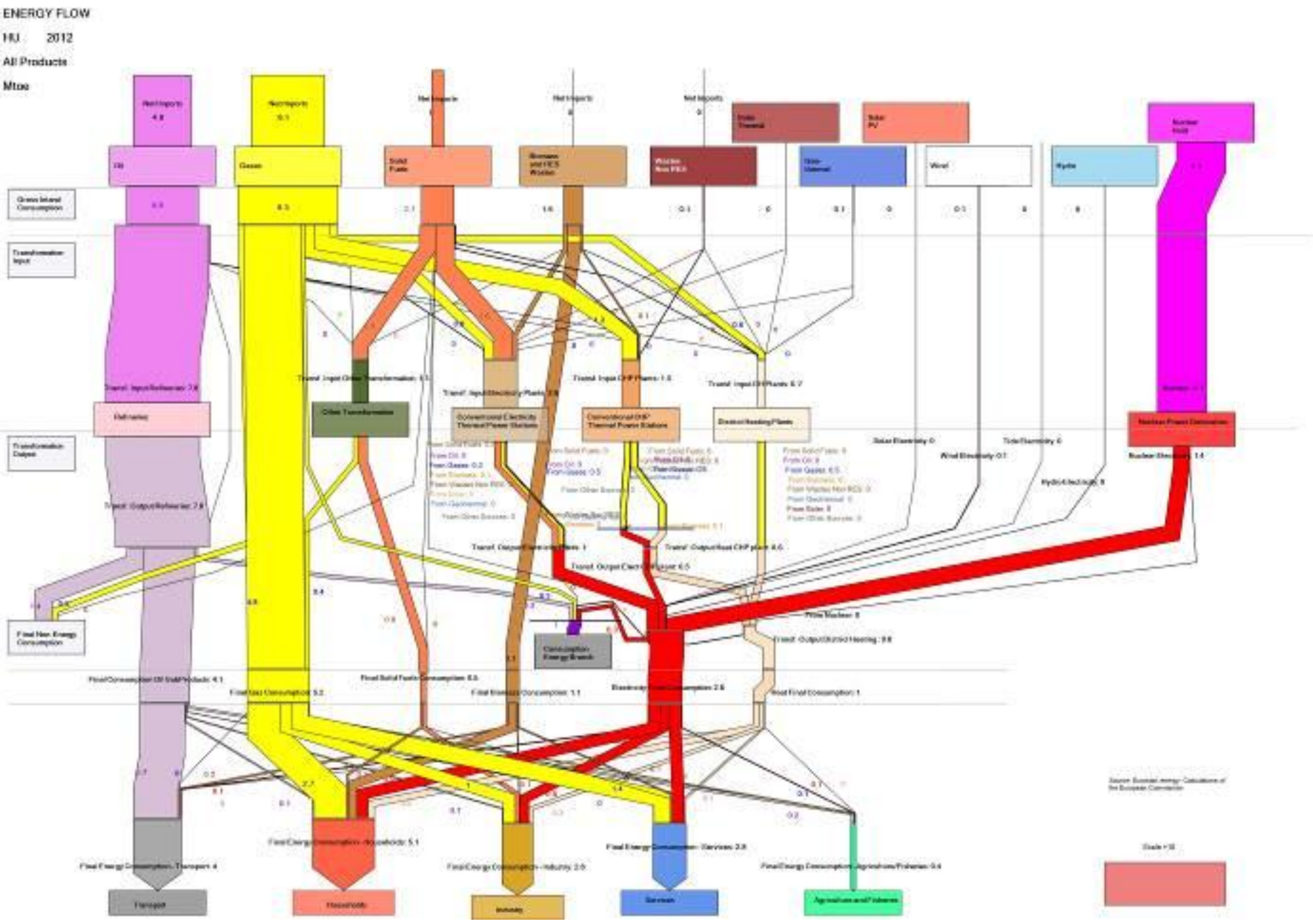



HU IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
98.0%
2.0%
0.0%
Intra-EU
Russia
Not specified
Other
350
300
250
200
150
100
50
0
314
0
HU
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
HU

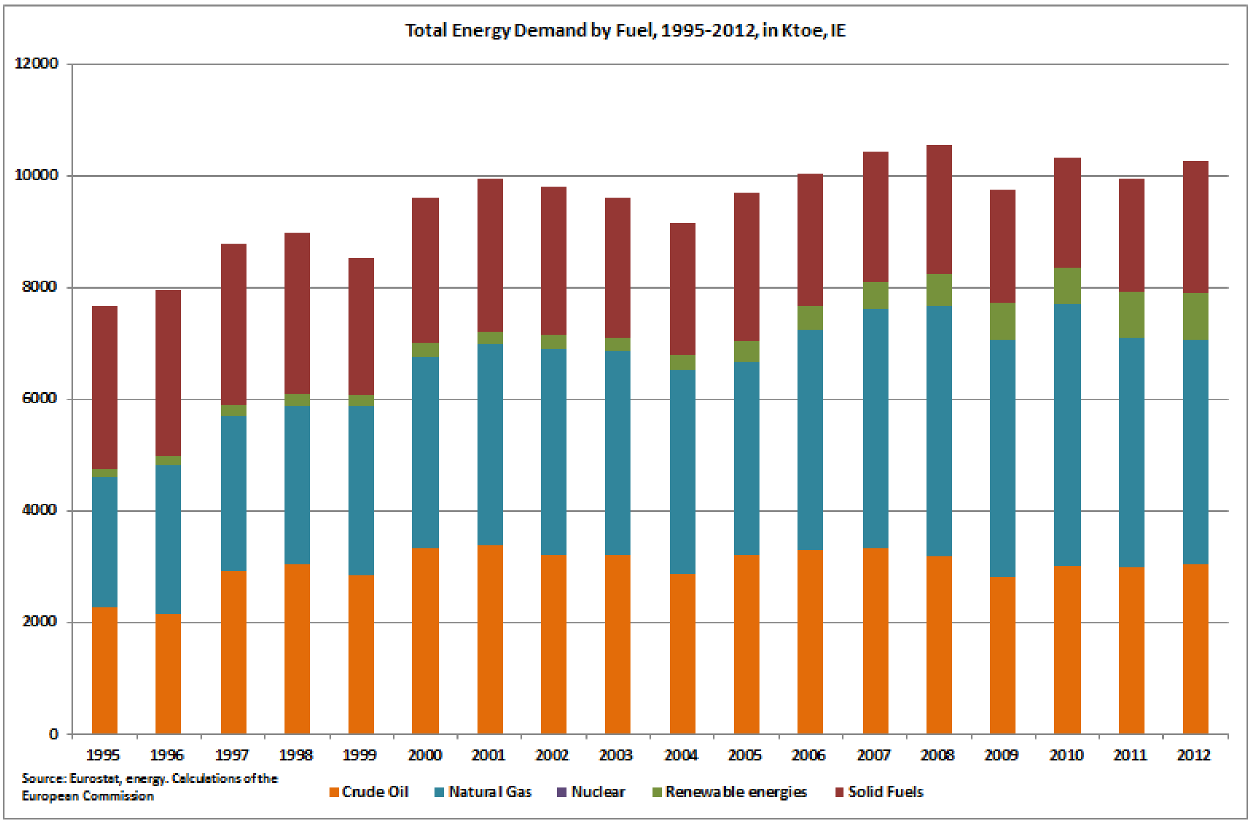

HU IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
1.4%
98.6%
0.0%
Intra-EU
Russia
Other
6
5
4
3
2
1
0
5
0
HU
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
HU

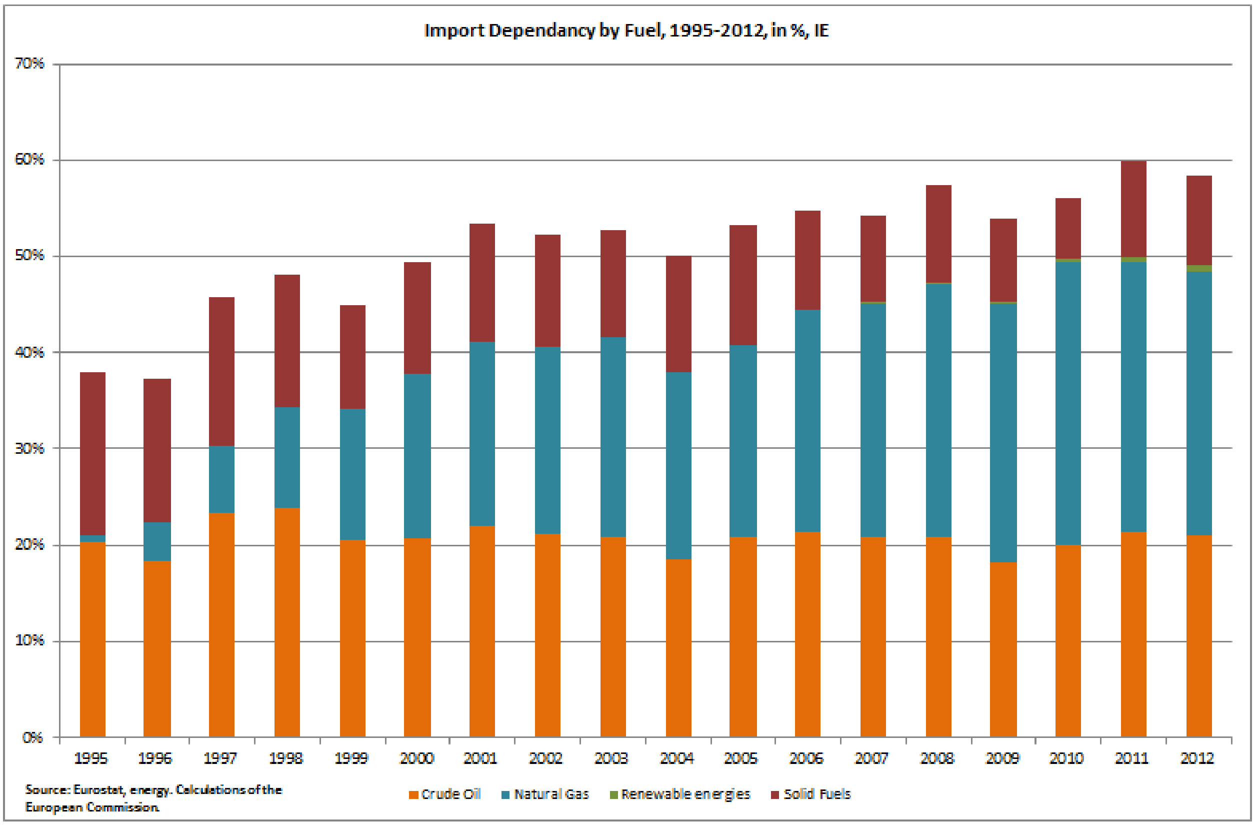
Hungary

Total gas consumption / Russian imports	Total: 9.3 Bcm/y // RU: 6 Bcm/y
Gas storage capacity and current level:	Total: 6.2 Bcm // Current: 1.2 Bcm
Connections to other MSs and capacity:	HU→CRO: 2.5 Bcm/y HU→RO: 1.7 Bcm/y AT→HU: 4.2 Bcm/y
Alternative supply options:	Reverse flows CRO and RO are being developed but these would not have a substantial impact on HU security of supply in the short-term.
Assessment: Hungary has considerable storage capacity compared to its annual gas consumption. However, storages could not be fully filled only from the Austrian route, Hungary needs to receive gas – at least throughout the whole injection period – to be able to secure 6.2 Bcm underground. With full storage use and maximizing imports from Austria, Hungary would still fall short if Russian gas was cut on a long-term period.	


ENERGY FLOW
HU 2012
All Products
Mtoe

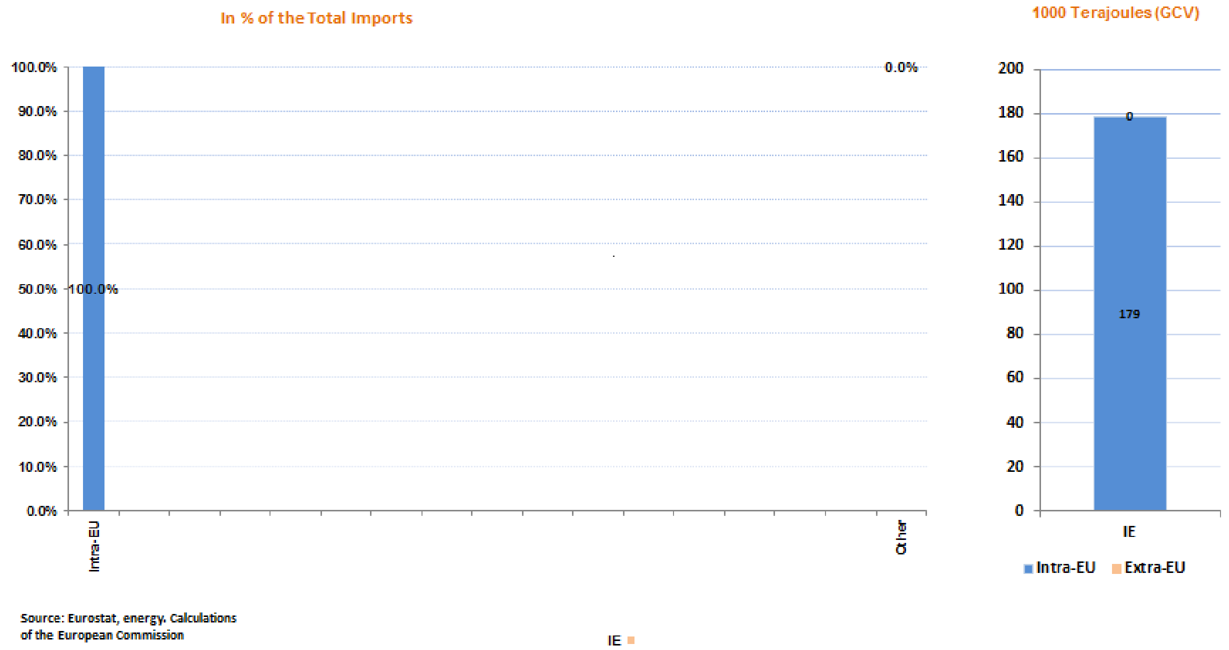
Country Fiche: Ireland





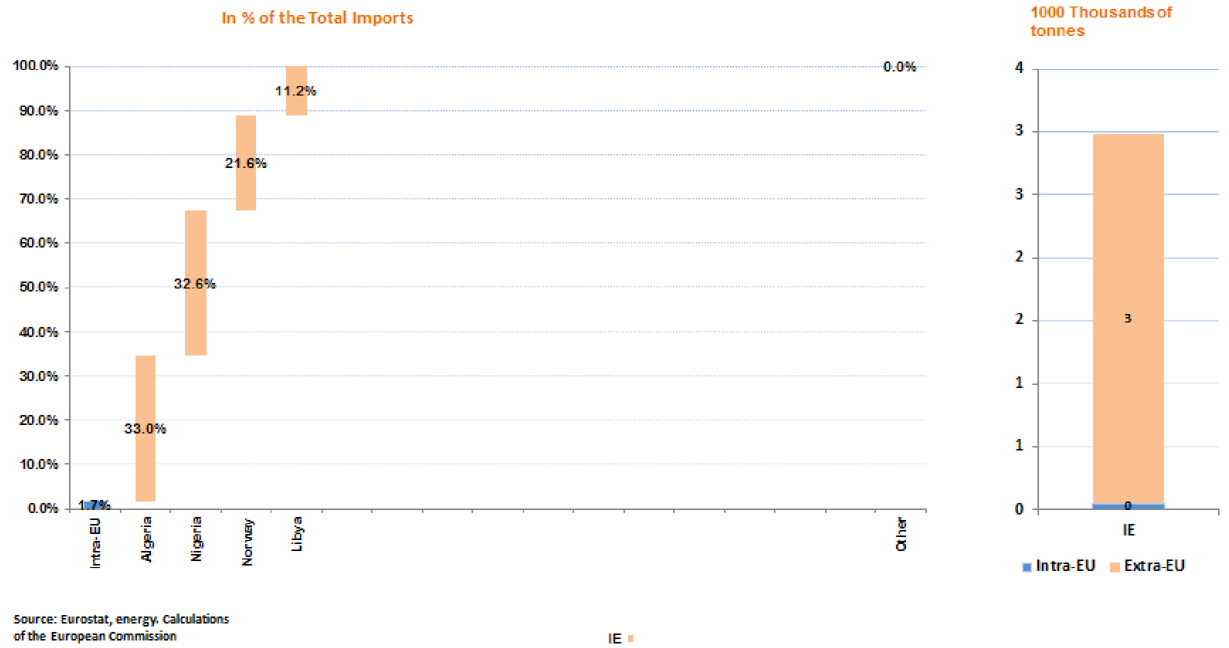
IE IMPORTS

Natural Gas - 2012 - Terajoules (GCV)

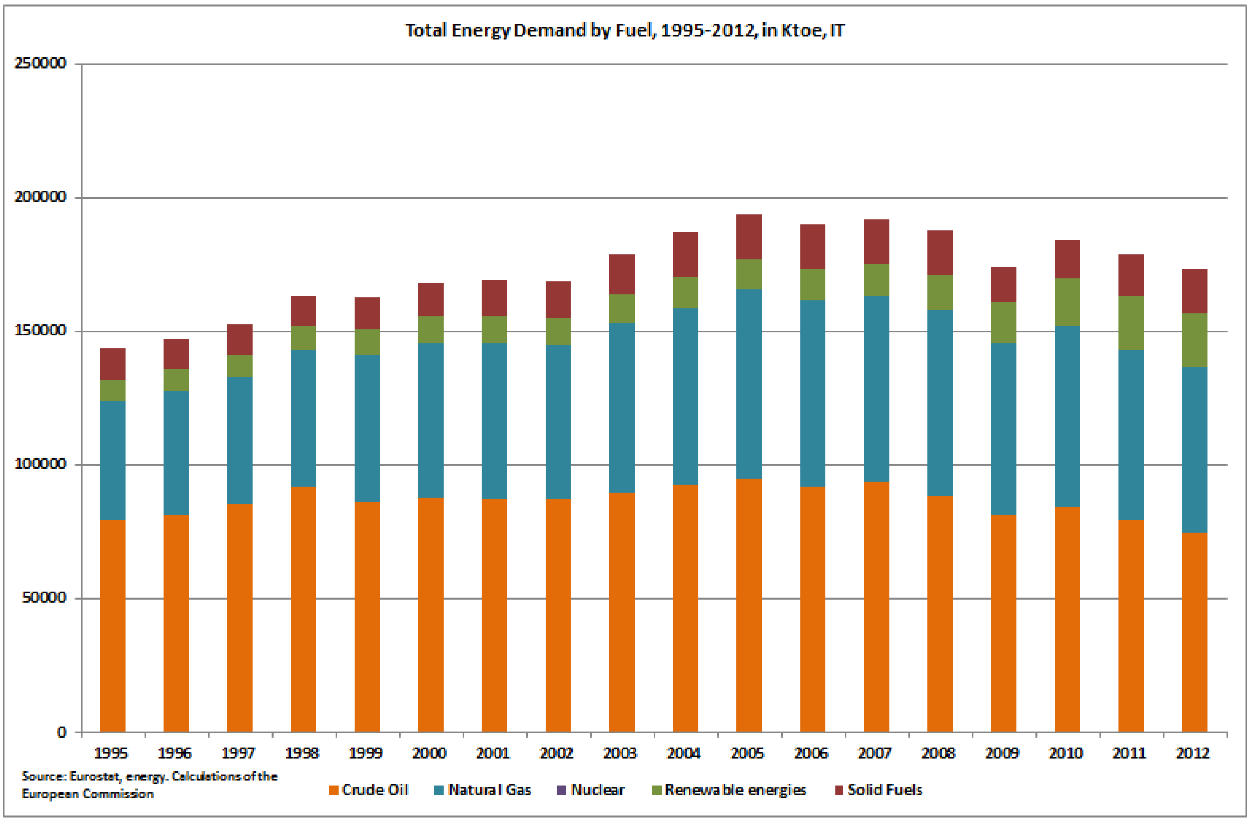


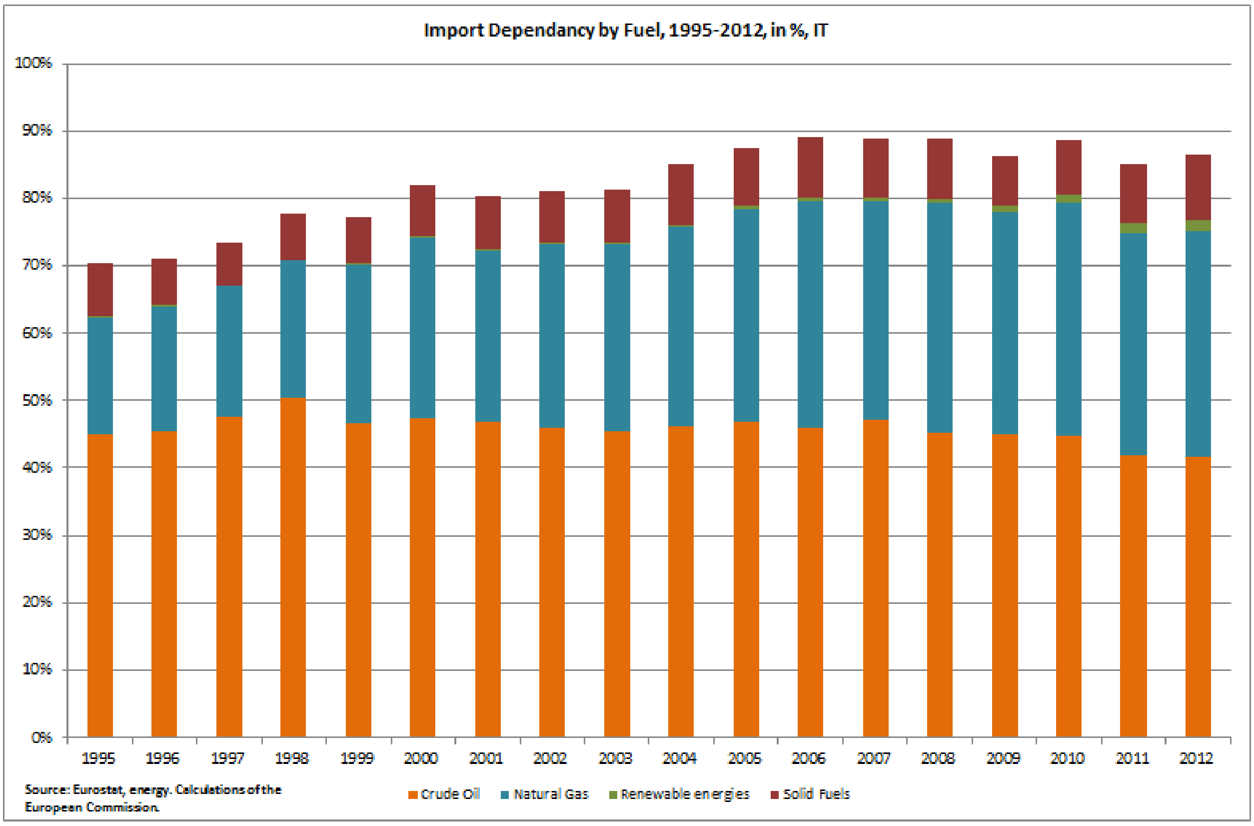
IE IMPORTS

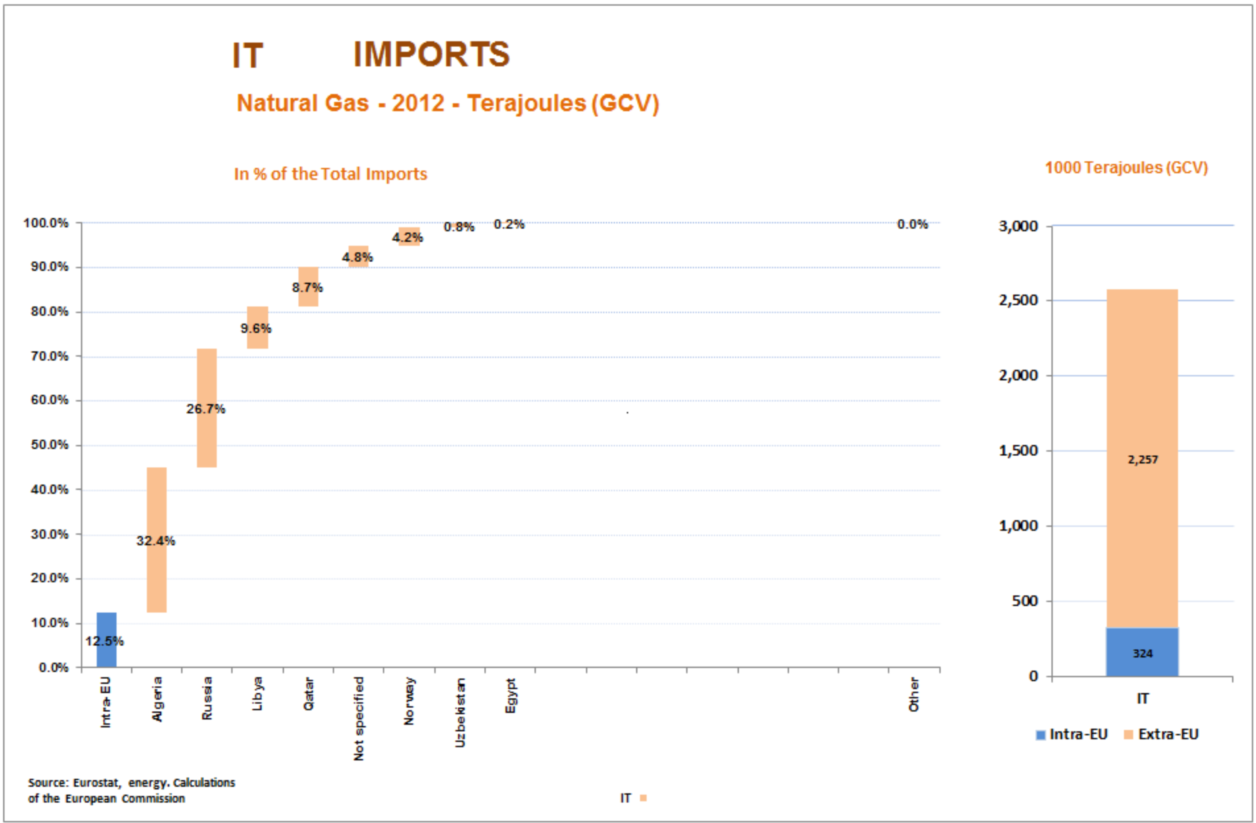
Crude Oil and NGL - 2012 - Thousands of tonnes



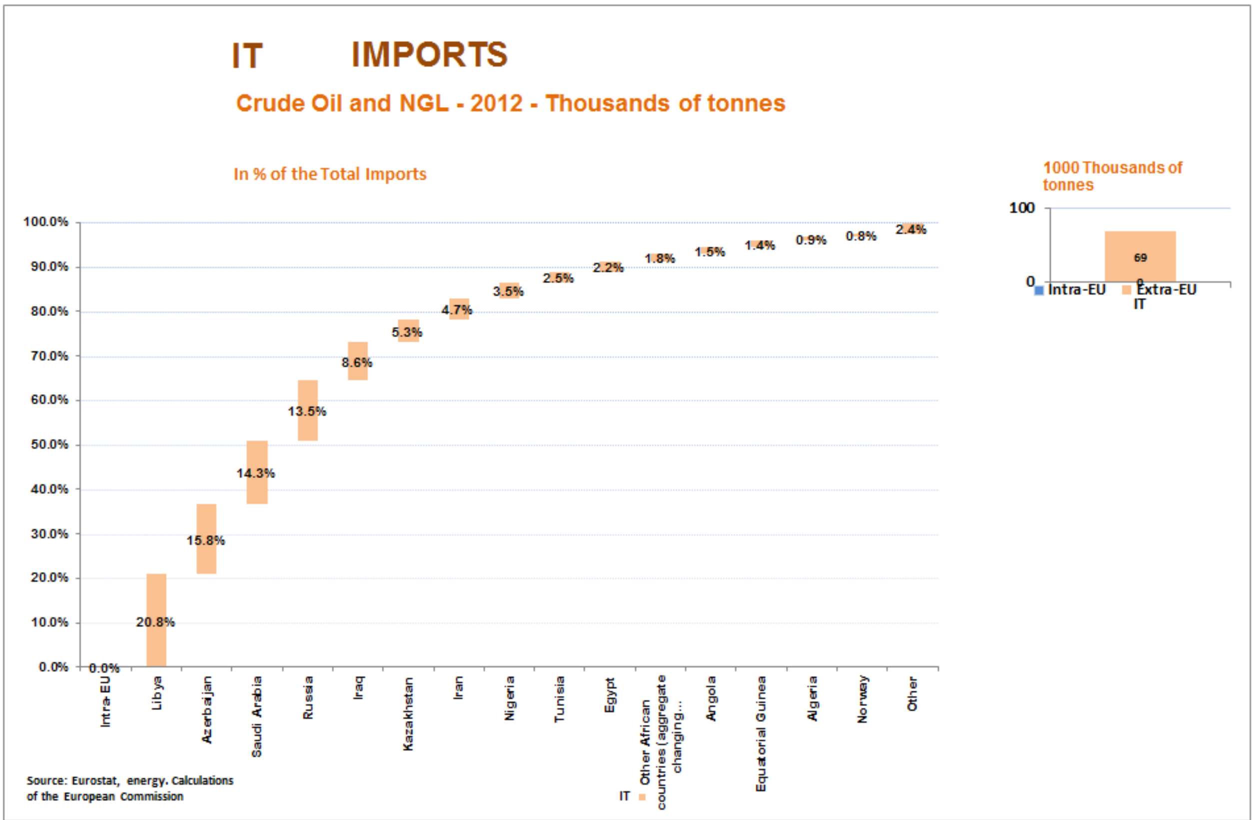
Country Fiche: Italy





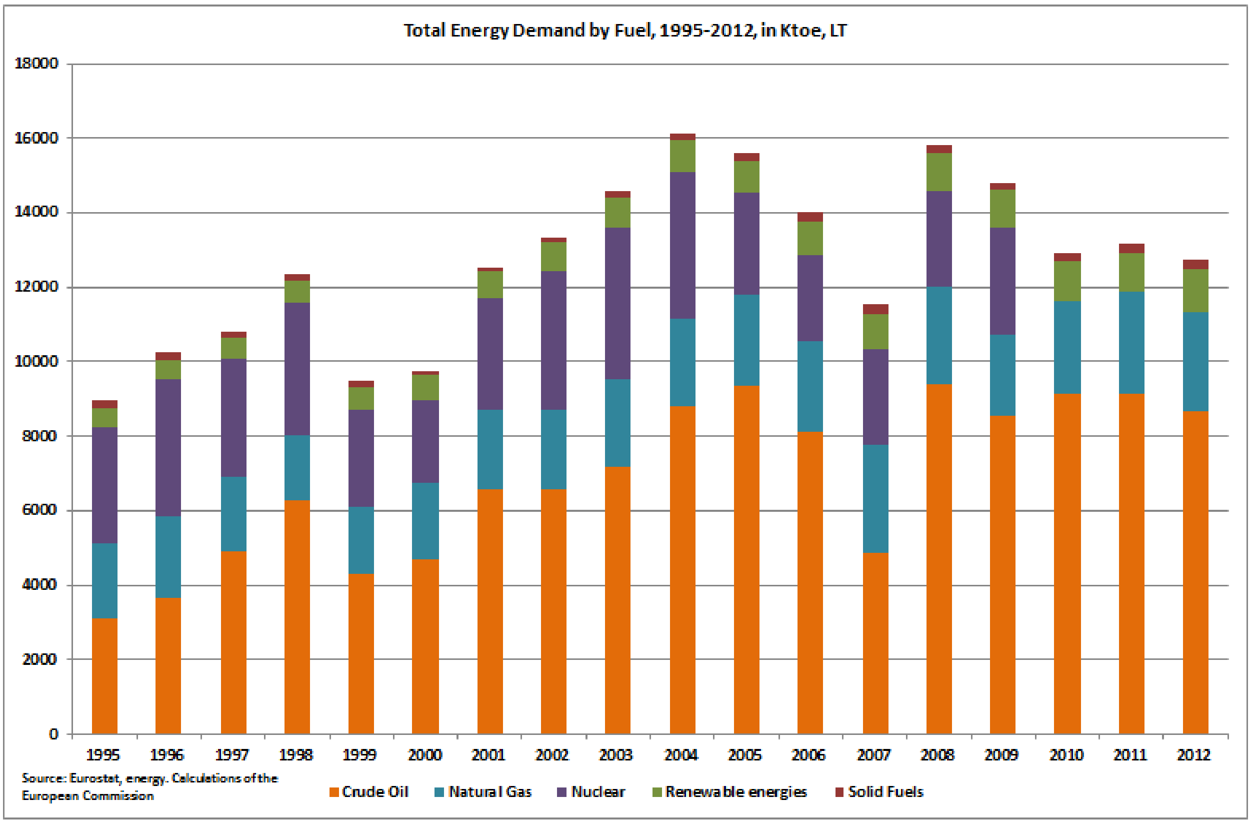


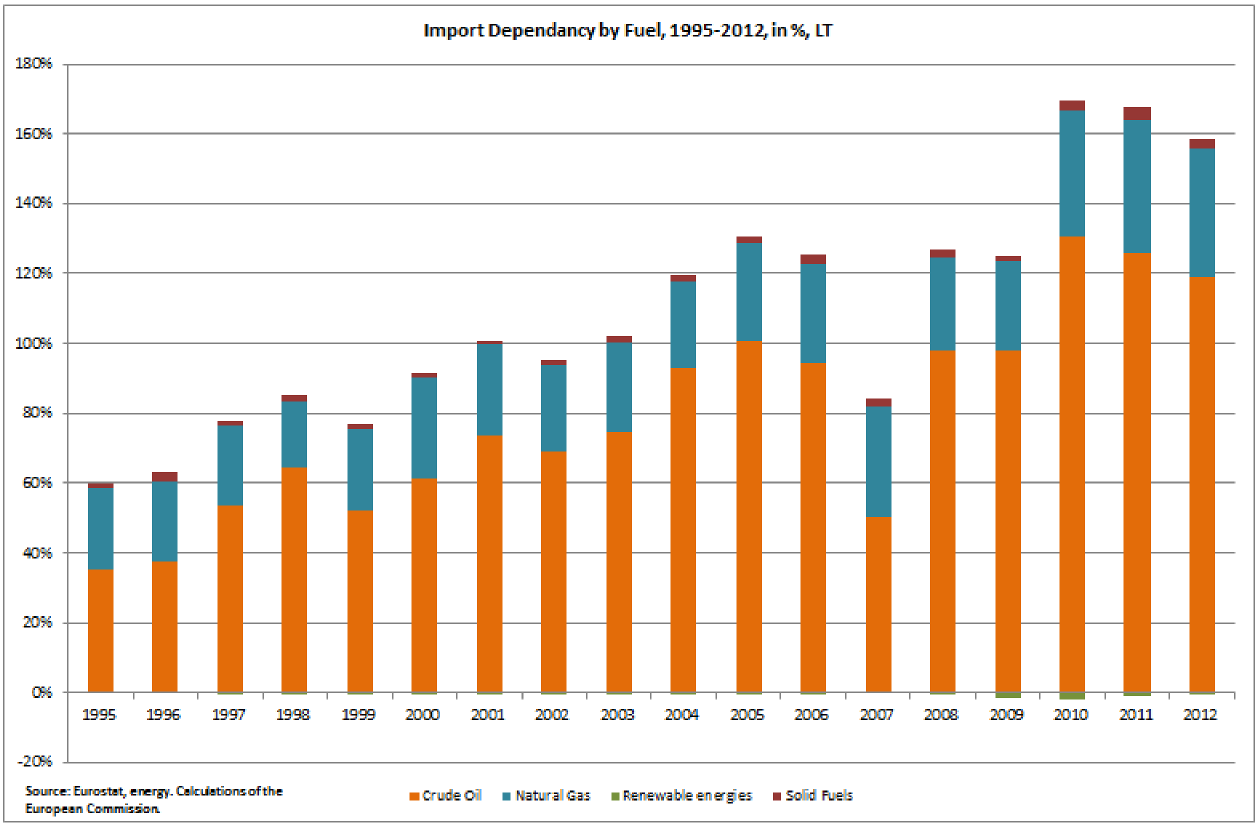
IT IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
12.5%
32.4%
26.7%
9.6%
8.7%
4.8%
4.2%
0.8%
0.2%
0.0%
Intra-EU
Algeria
Russia
Libya
Qatar
Not specified
Norway
Uzbekistan
Egypt
Other
3,000
2,500
2,000
1,500
1,000
500
0
2,257
324
IT
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
IT

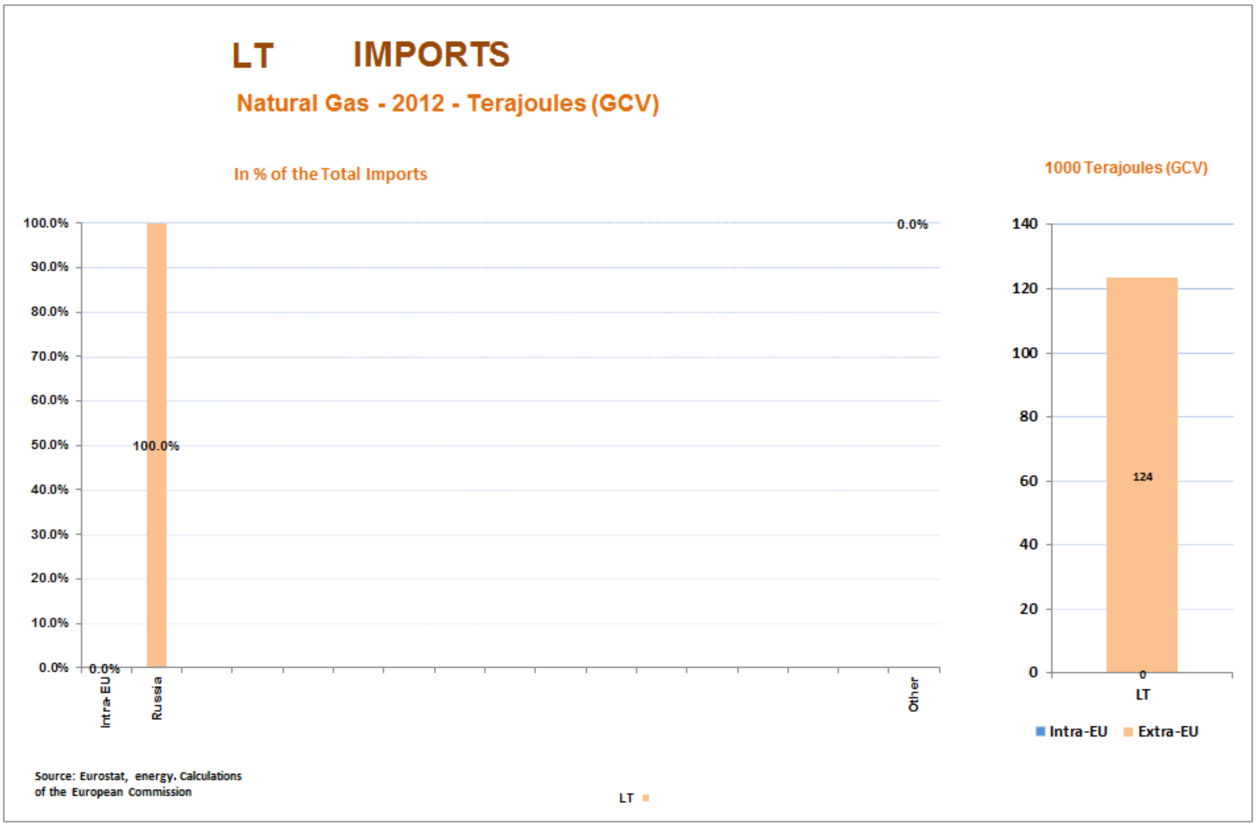


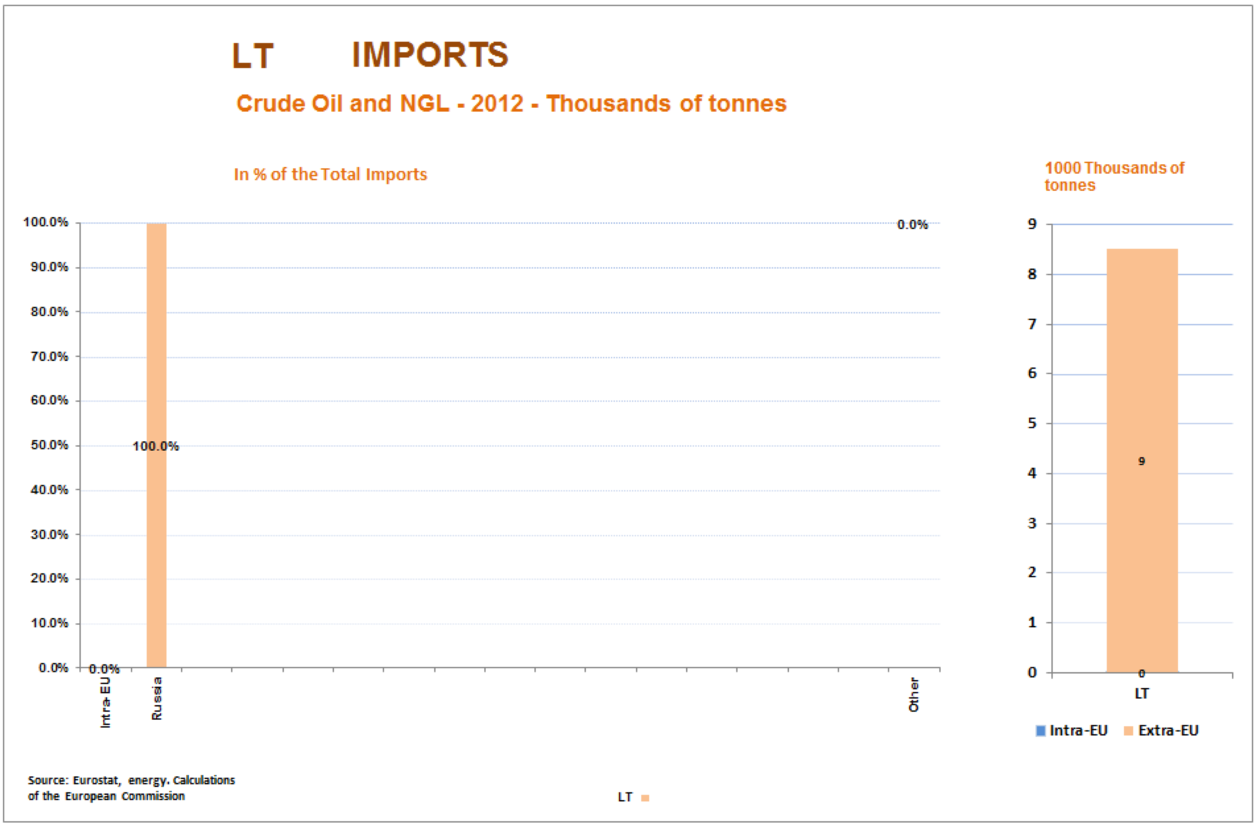
IT IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
20.8%
15.8%
14.3%
13.5%
8.6%
5.3%
4.7%
3.5%
2.5%
2.2%
1.8%
1.5%
1.4%
0.9%
0.8%
2.4%
Intra-EU
Libya
Azerbaijan
Saudi Arabia
Russia
Iraq
Kazakhstan
Iran
Nigeria
Tunisia
Egypt
Other African countries (aggregate changing...
Angola
Equatorial Guinea
Algeria
Norway
Other
100
0
69
0
Intra-EU
Extra-EU
IT
Source: Eurostat, energy. Calculations of the European Commission
IT

Country Fiche: Lithuania



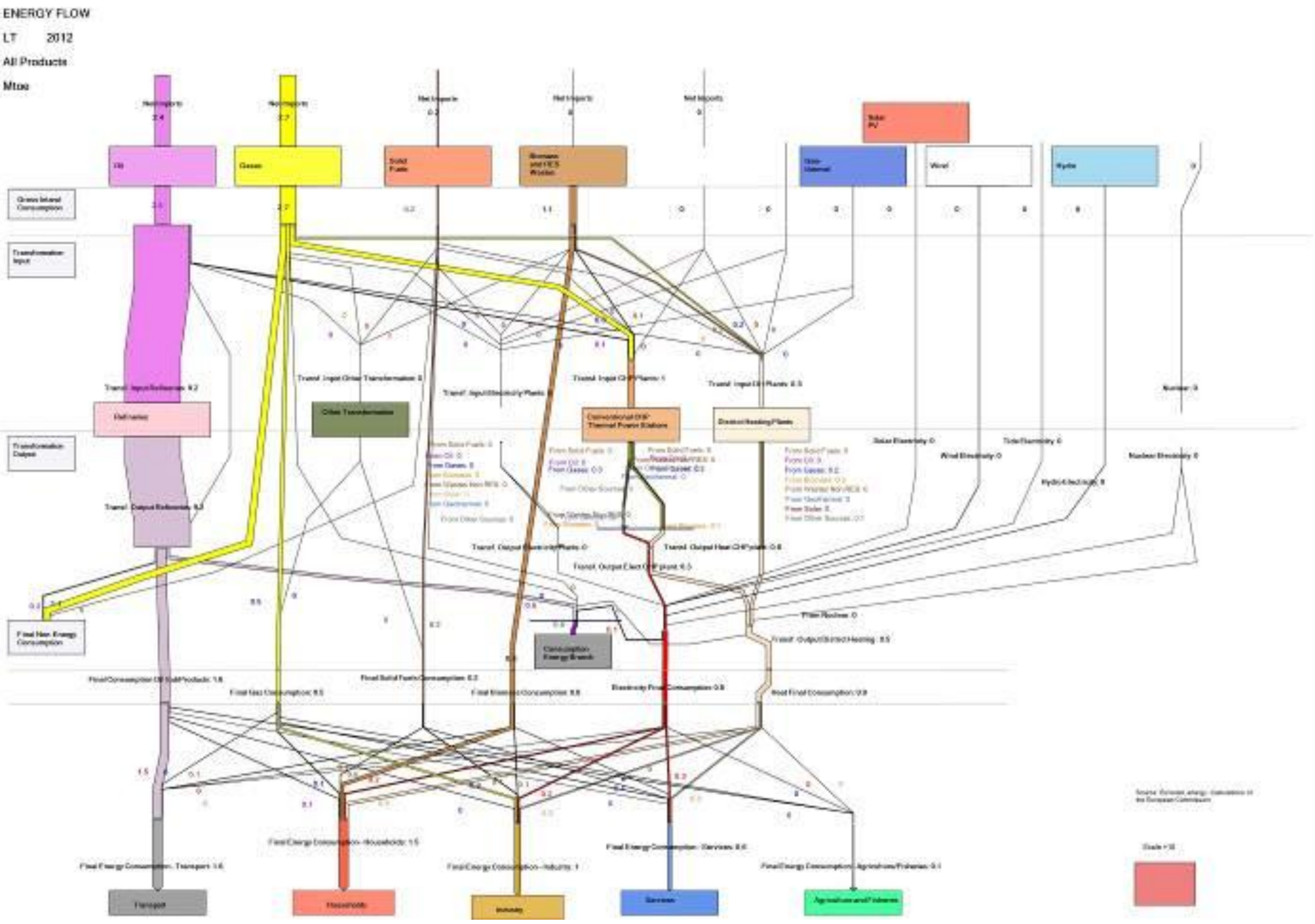



LT IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
0.0%
0.0%
Intra-EU
Russia
Other
124
0
LT
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
LT

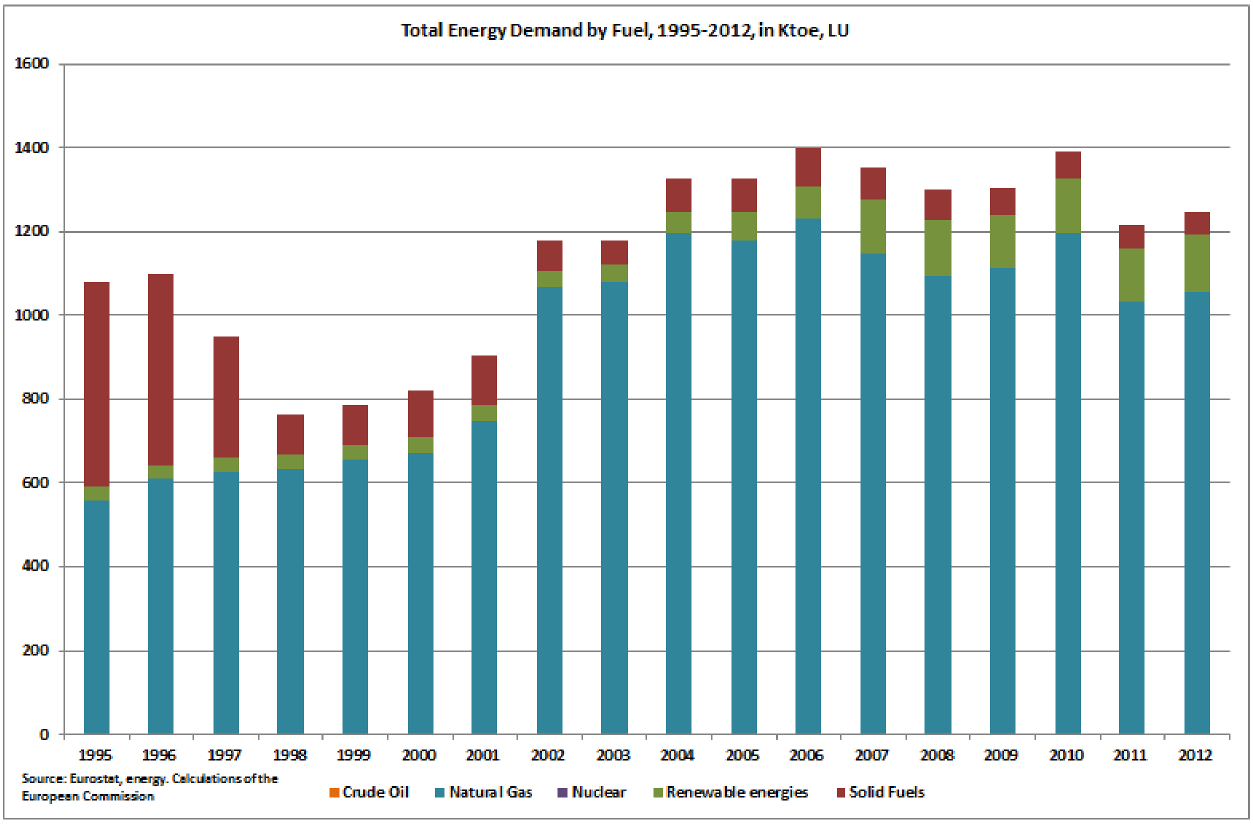

LT IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
0.0%
0.0%
Intra-EU
Russia
Other
9
0
LT
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
LT

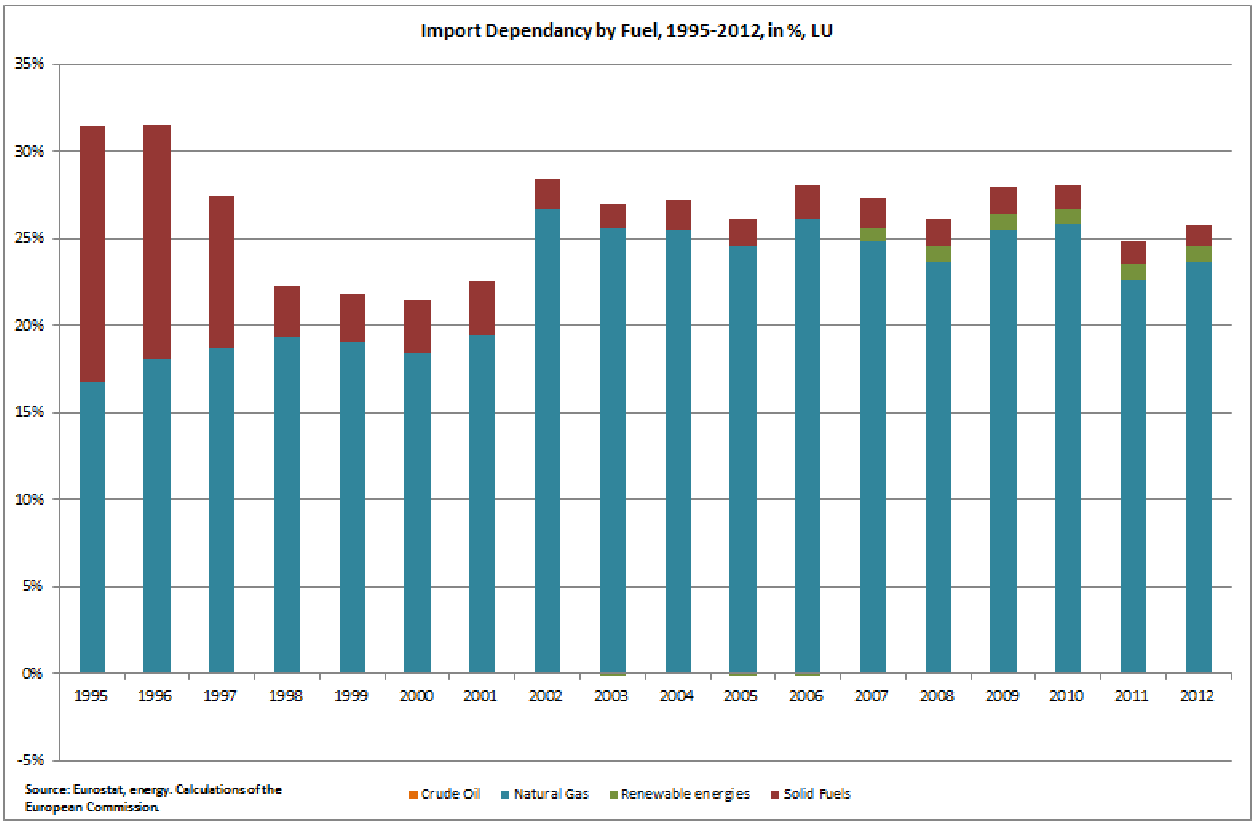
Lithuania

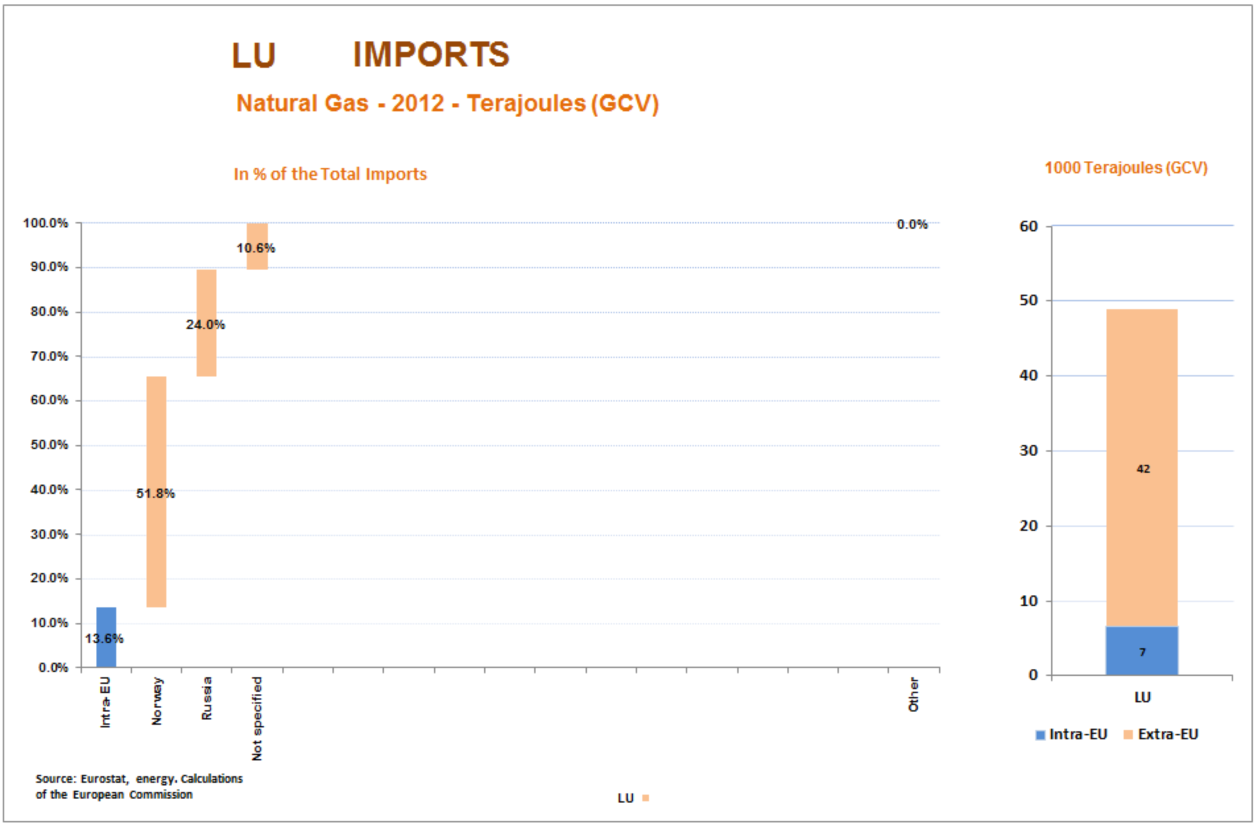
Total gas consumption / Russian imports	Total: 3.4 Bcm/y // RU: 3.4 Bcm/y
Gas storage capacity and current level:	n.a
Connections to other MSs and capacity:	LV→LT: 2.2 Bcm/y* (this figure is lower in winter because of limitations in the LV network)
Alternative supply options:	The planned LNG regasification unit is planned to come online by the end of 2014 with an initial capacity of 2 Bcm/y. The interconnection with Poland would improve the situation in the mid-term.
Assessment: Lithuania is the transit country for Russian gas to Kaliningrad. So far this has been its insurance policy, however, with the development of underground gas storages in Kaliningrad, short-term disruptions would no longer have an impact on the Russian enclave.	

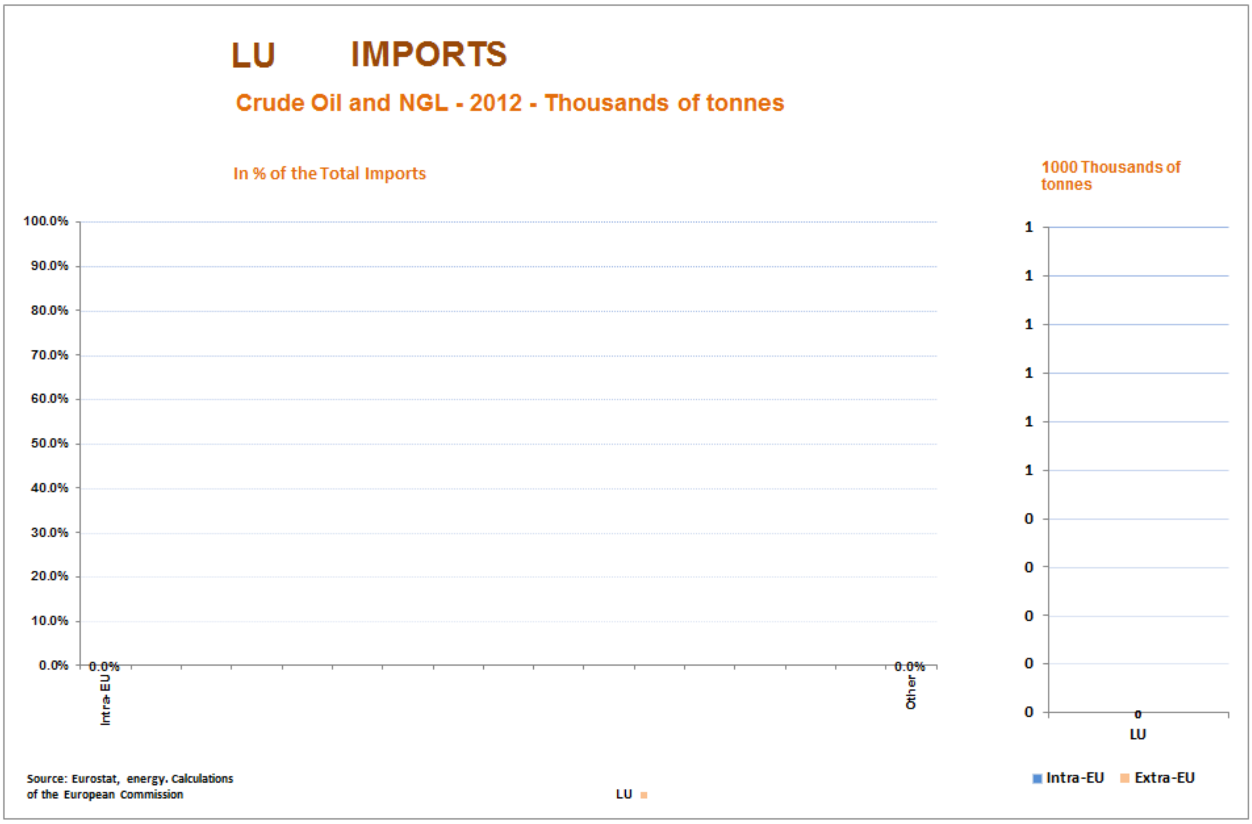

ENERGY FLOW
LT 2012
All Products
Mtoe

Country Fiche: Luxembourg

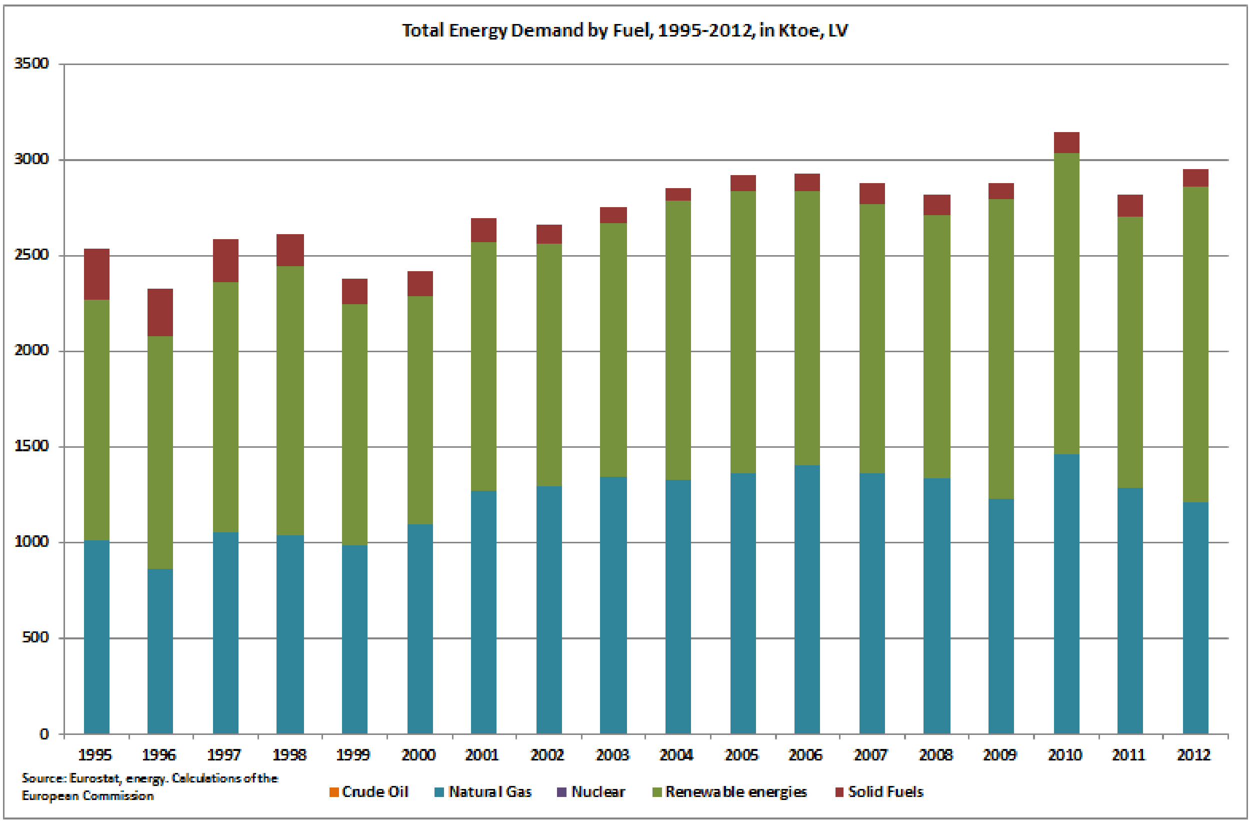


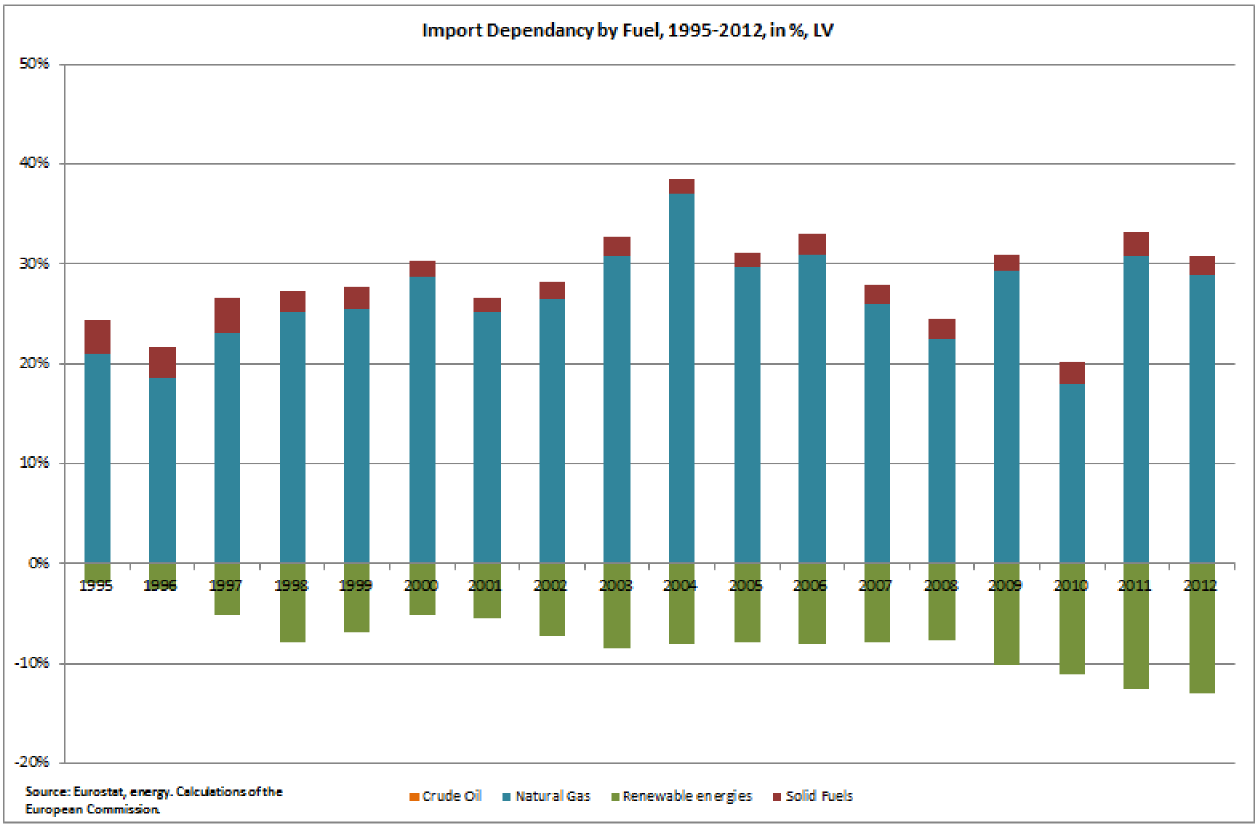


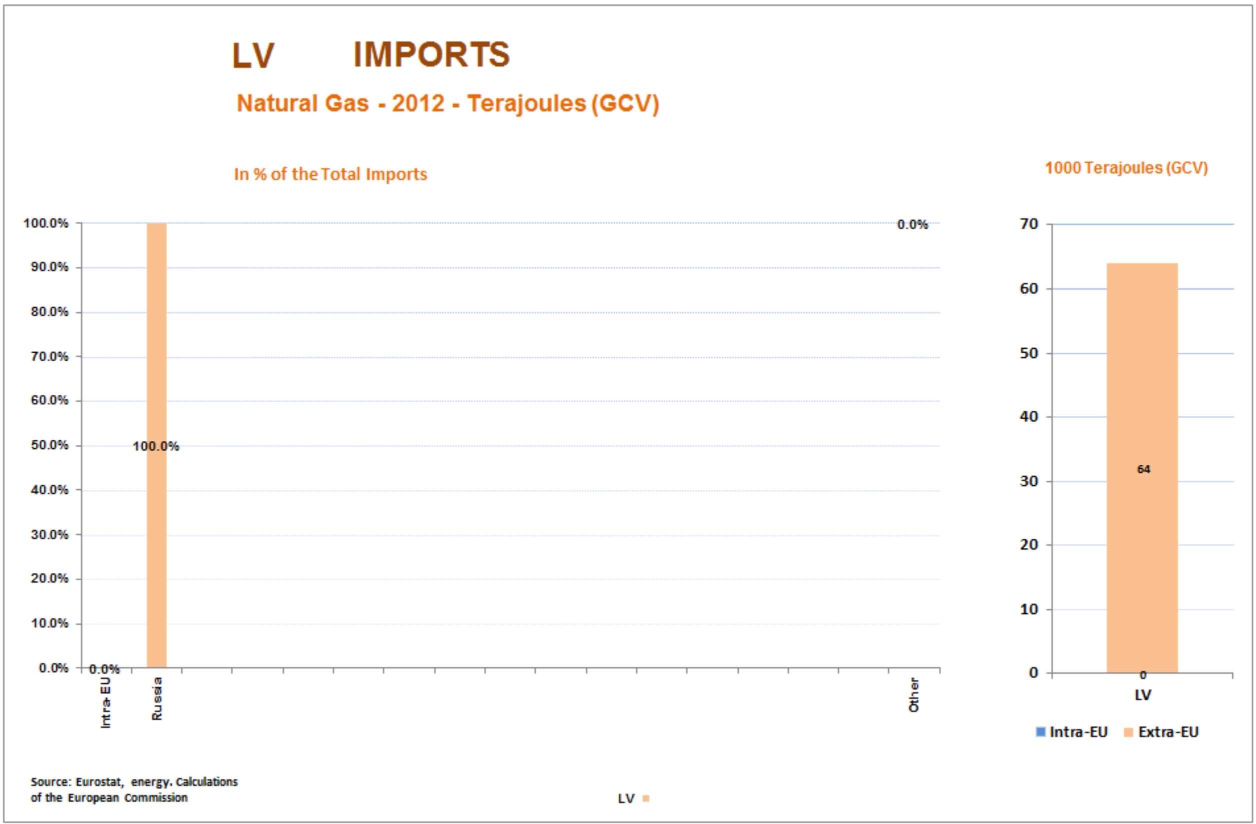

LU IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
13.6%
51.8%
24.0%
10.6%
0.0%
Intra-EU
Norway
Russia
Not specified
Other
60
50
40
30
20
10
0
42
7
LU
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
LU


LU IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
0.0%
Intra-EU
Other
1
1
1
1
1
1
0
0
0
0
0
0
LU
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
LU

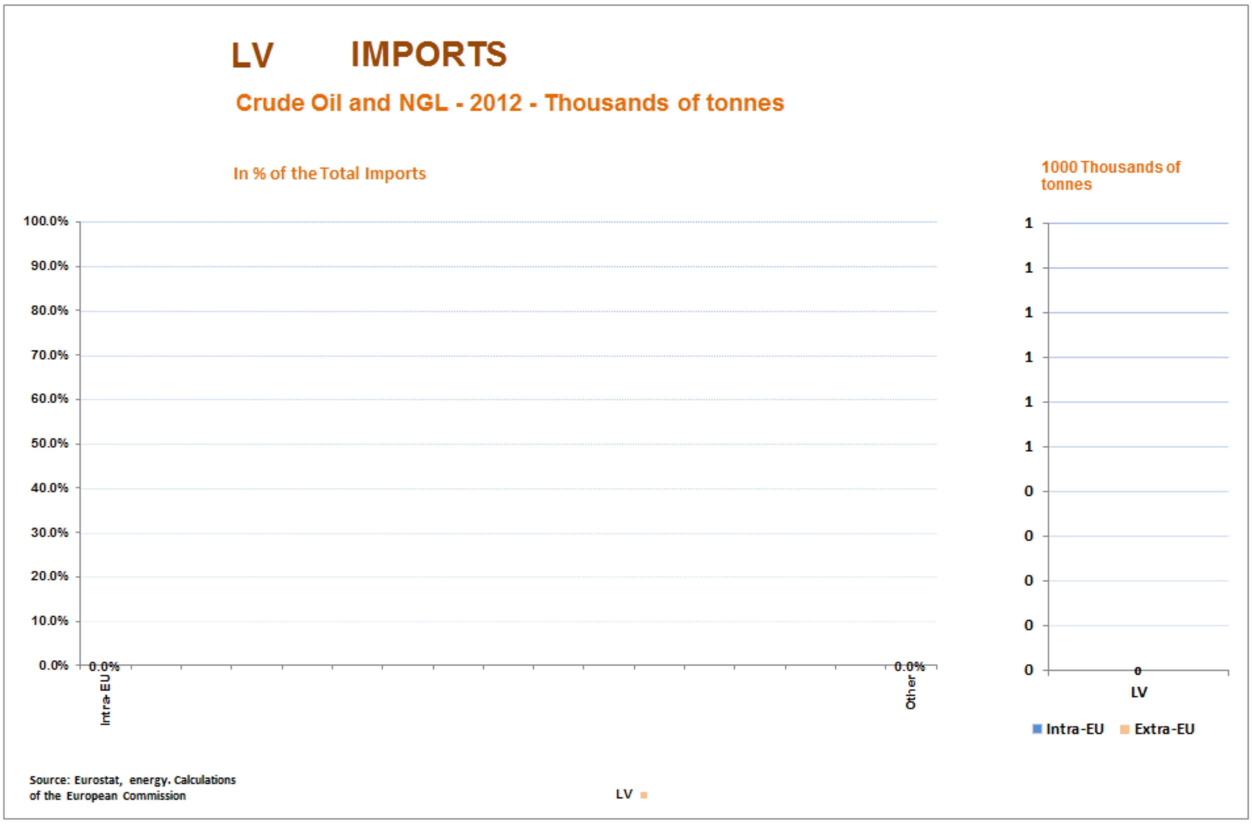
Country Fiche: Latvia







LV IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
0.0%
0.0%
Intra-EU
Russia
Other
64
0
LV
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
LV



LV IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
0.0%
0.0%
Intra-EU
Other
0
LV
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
LV

Latvia

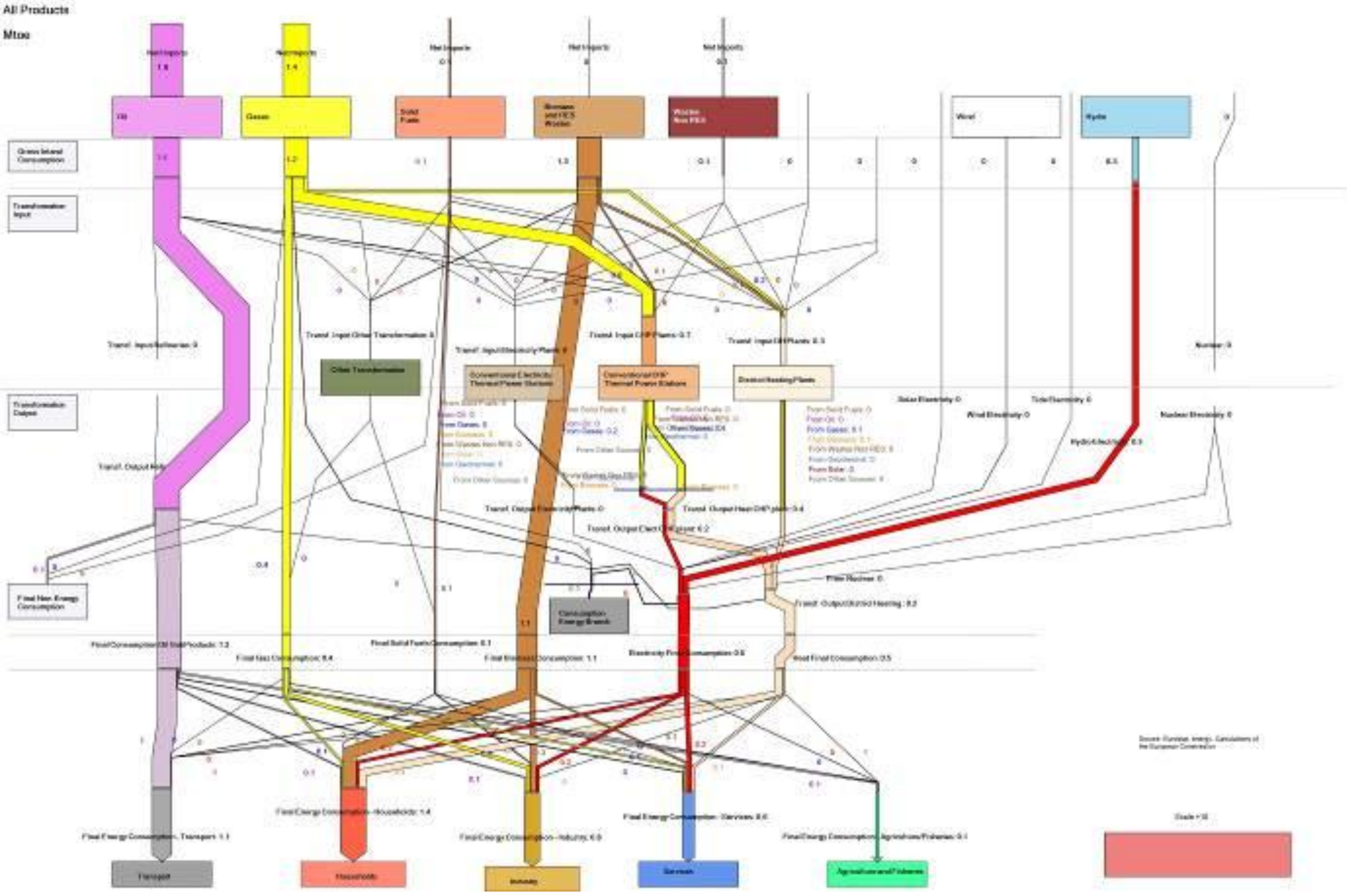
Total gas consumption / Russian imports	Total: 1.7 Bcm/y // RU: 1.7 Bcm/y
Gas storage capacity and current level:	Total: 2.35 Bcm // Current: NO DATA PUBLIC but based on usual curve ~1 Bcm
Connections to other MSs and capacity:	LV→EE: 2.5 Bcm/y LV→LT: 2.2 Bcm/y* (this figure is lower in winter because of limitations in the LV network)
Alternative supply options:	Additional supplies to Lithuania via the regasification terminal could allow for additional sources from the end of 2014. Physical impact on the Latvian market would though probably be limited. Baltic connector or the LNG terminal coupled with reverse flows from EE could bring new gas in mid-term. Connection between PL-LT could bring gas in the long-term.
Assessment: Latvia is fully and exclusively dependent on Russian gas imports. Because of the specific operating regime in Russia, Gazprom in winter time is not able to supply the St. Petersburg area from its own network. Hence, it uses the storage facility in Incukalns to send the gas towards Russia, Estonia and – to a smaller extent – Lithuania in the winter, and the facility is filled up during the summer, when the gas is physically flowing in from Russia. The disruption of the storage facility (or lack of injections) would have main impact not only in Latvia and Estonia but in Russia as well. This situation may change if Russia upgrades its domestic network and will no longer need to keep gas in Latvia for winter supplies.	

ENERGY FLOW

LV 2012

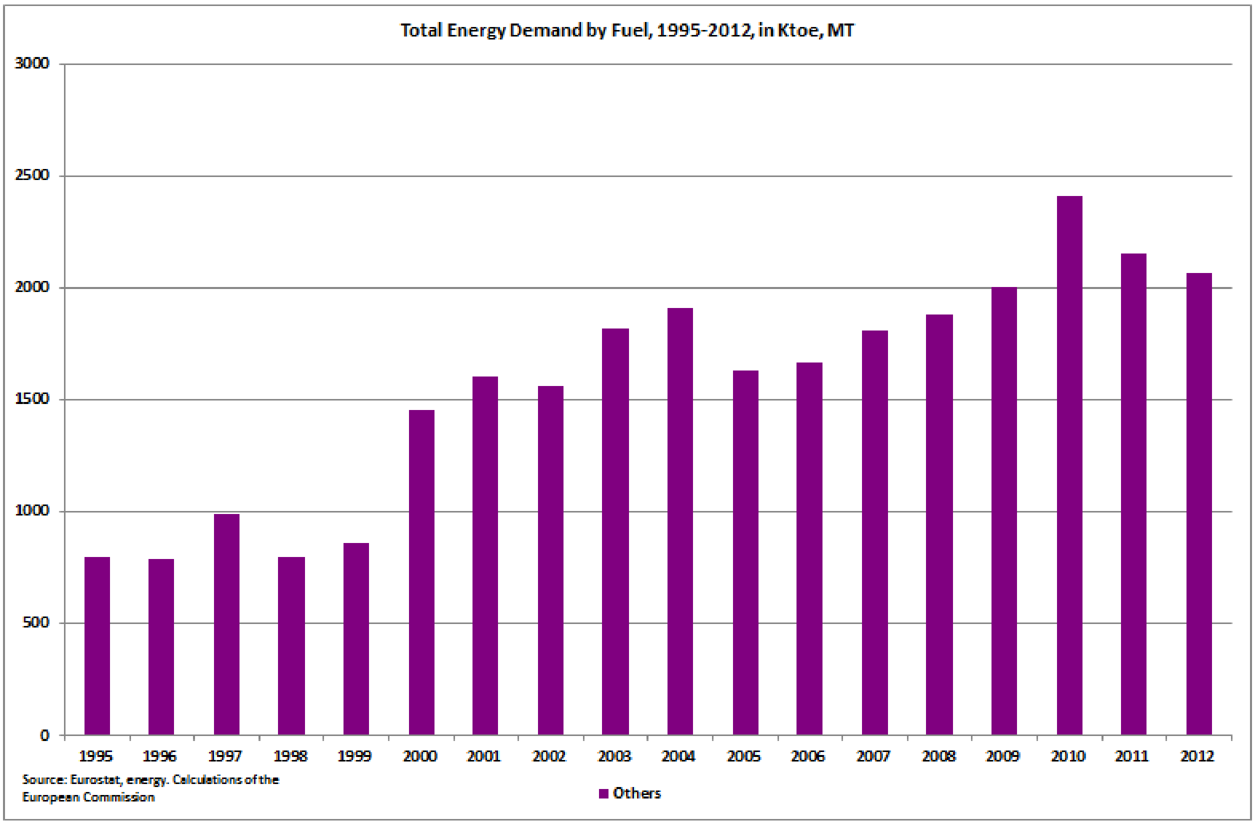
All Products

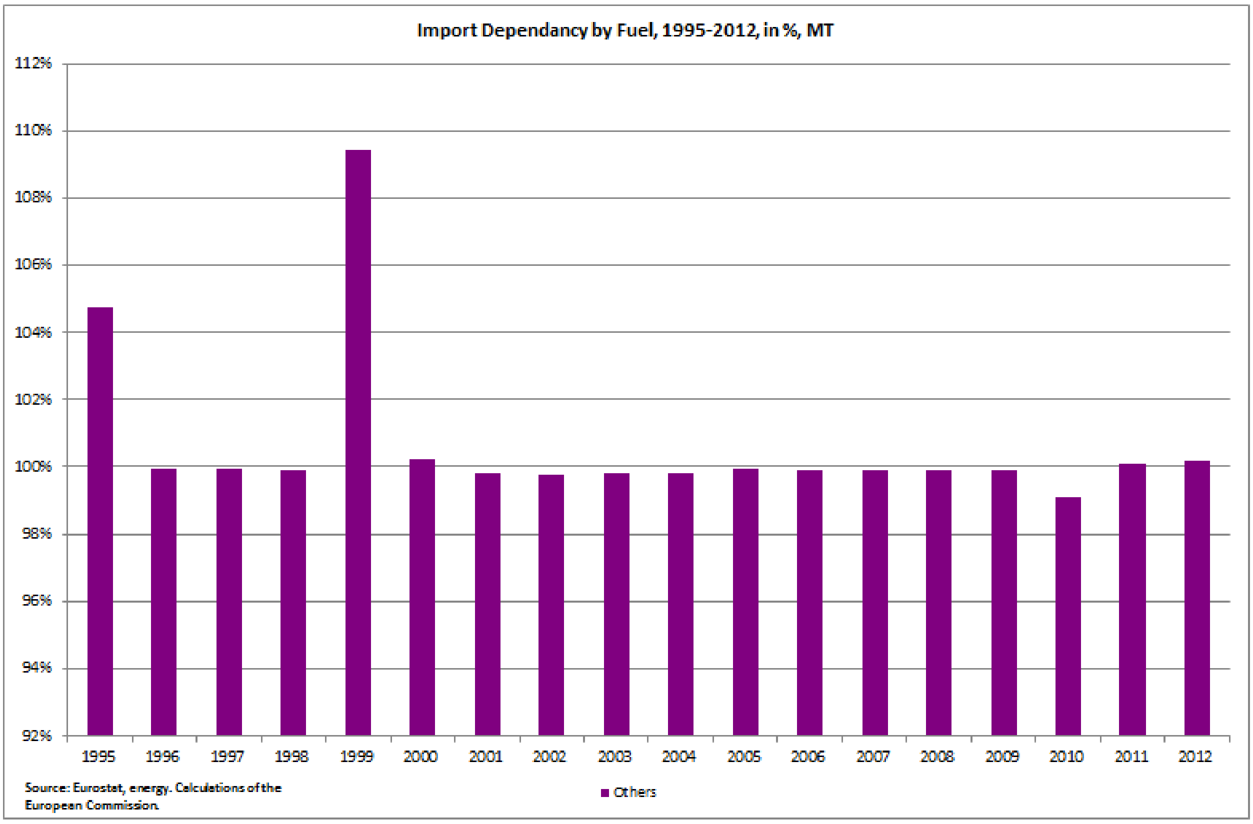
Mtoe



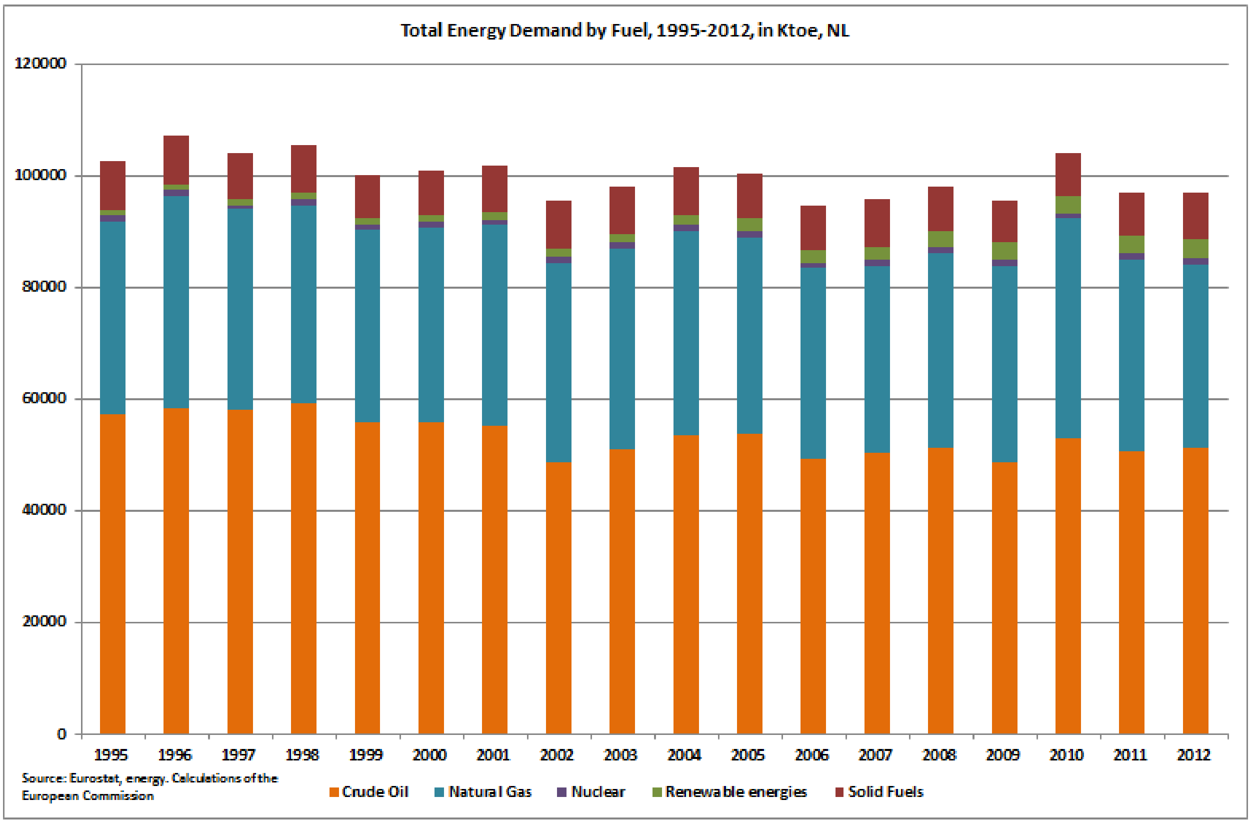
Country Fiche: Malta

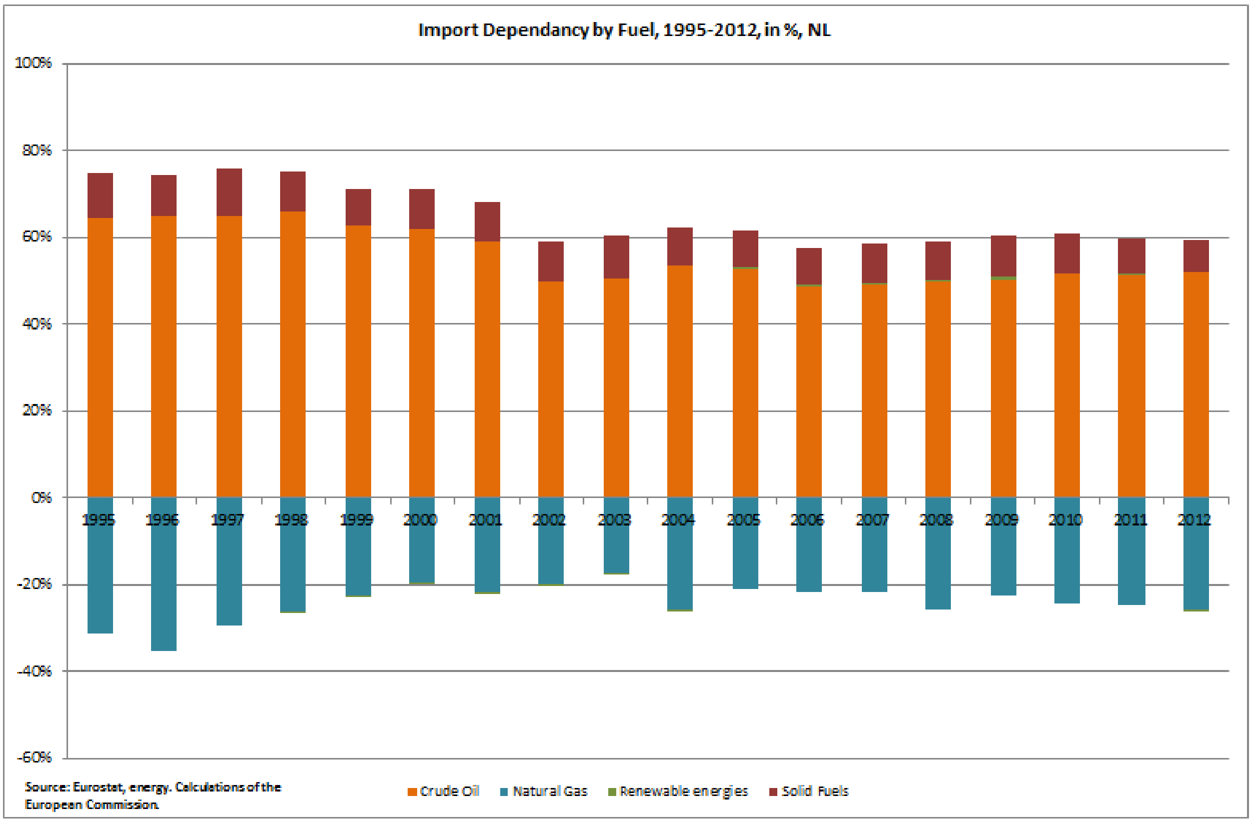
Note: Malta reports all energy sources, except for renewables, under the category "Others" in the SIRENE database. For this reason, no breakdown of total demand by fuel or of import dependency by fuel is presented.

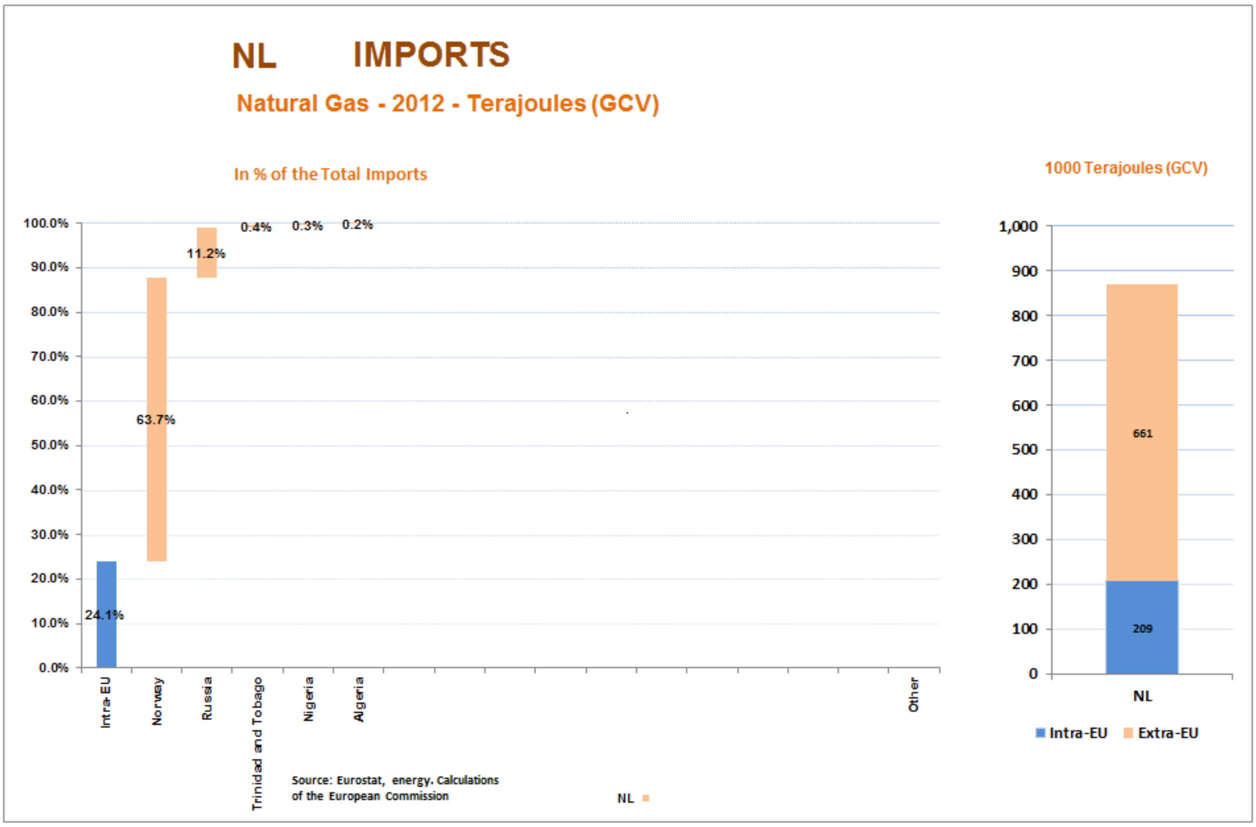


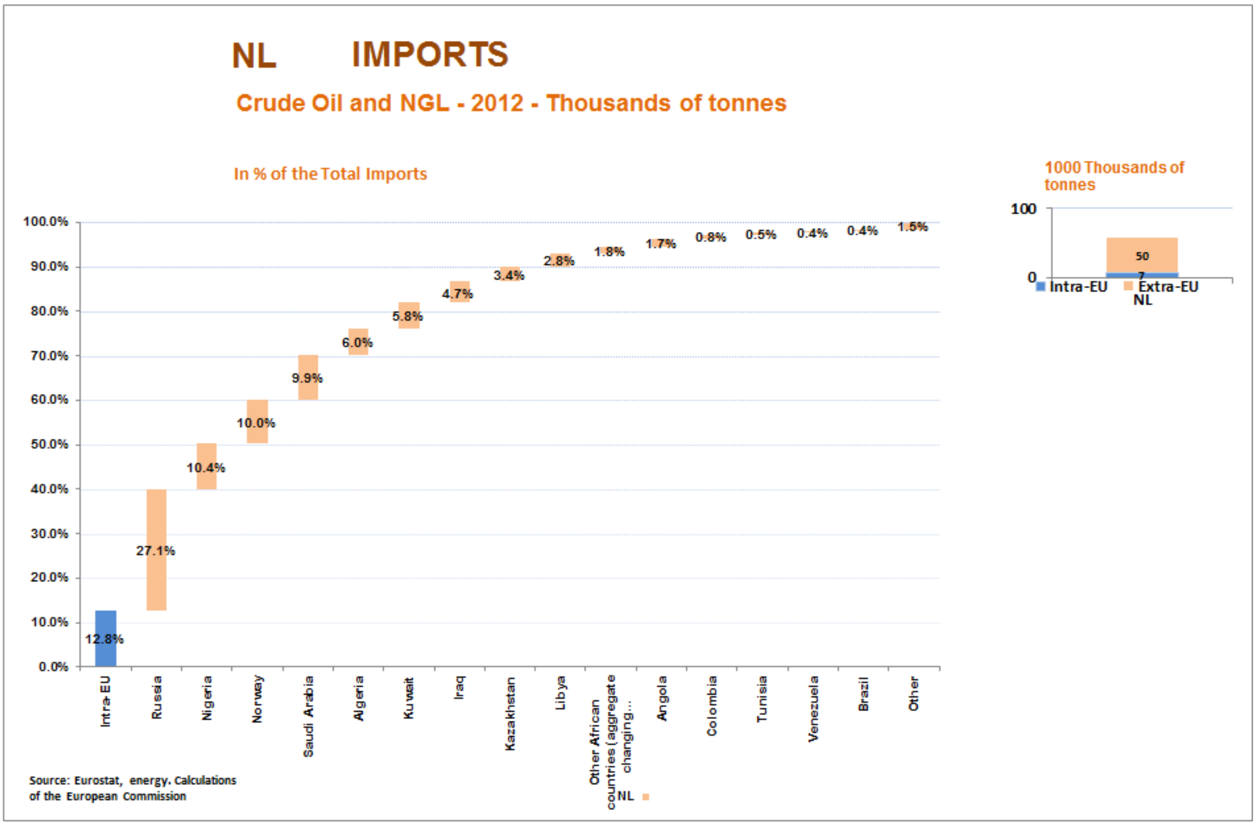


Country Fiche: The Netherlands

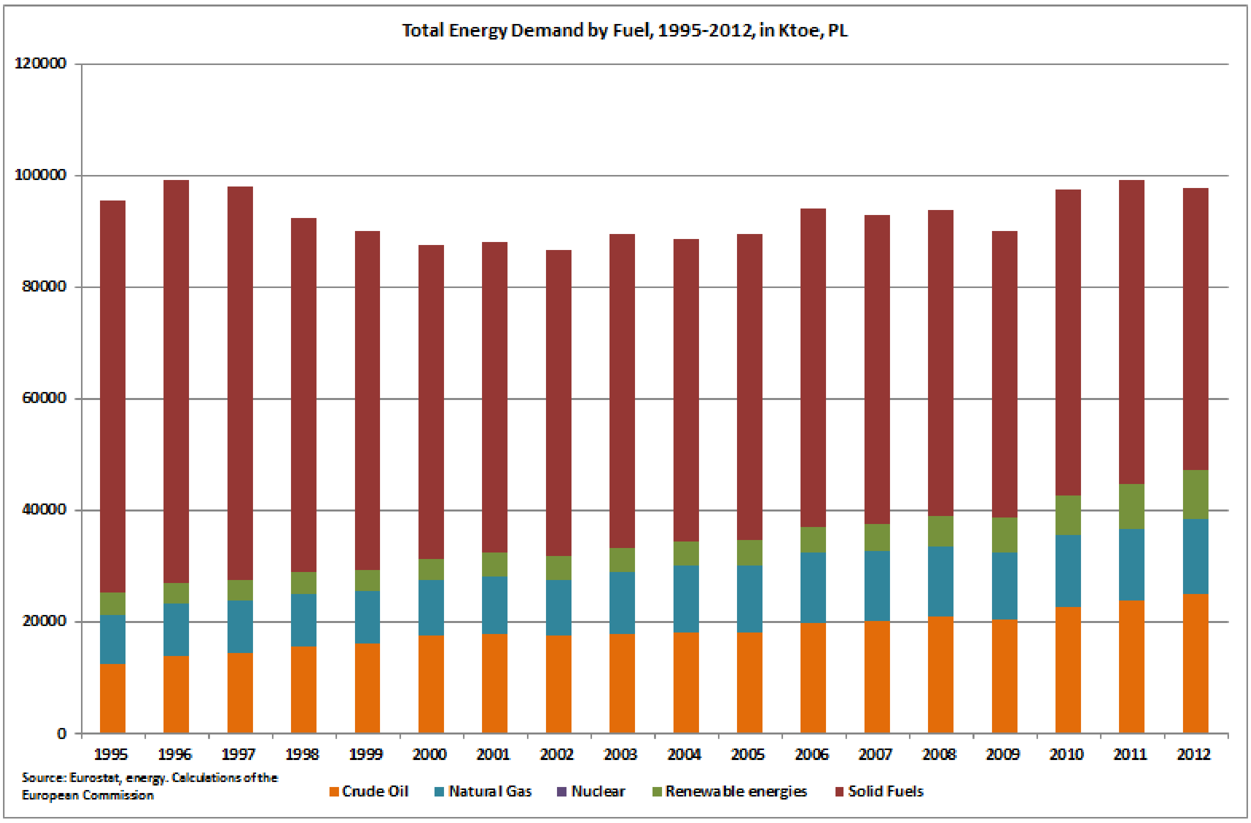


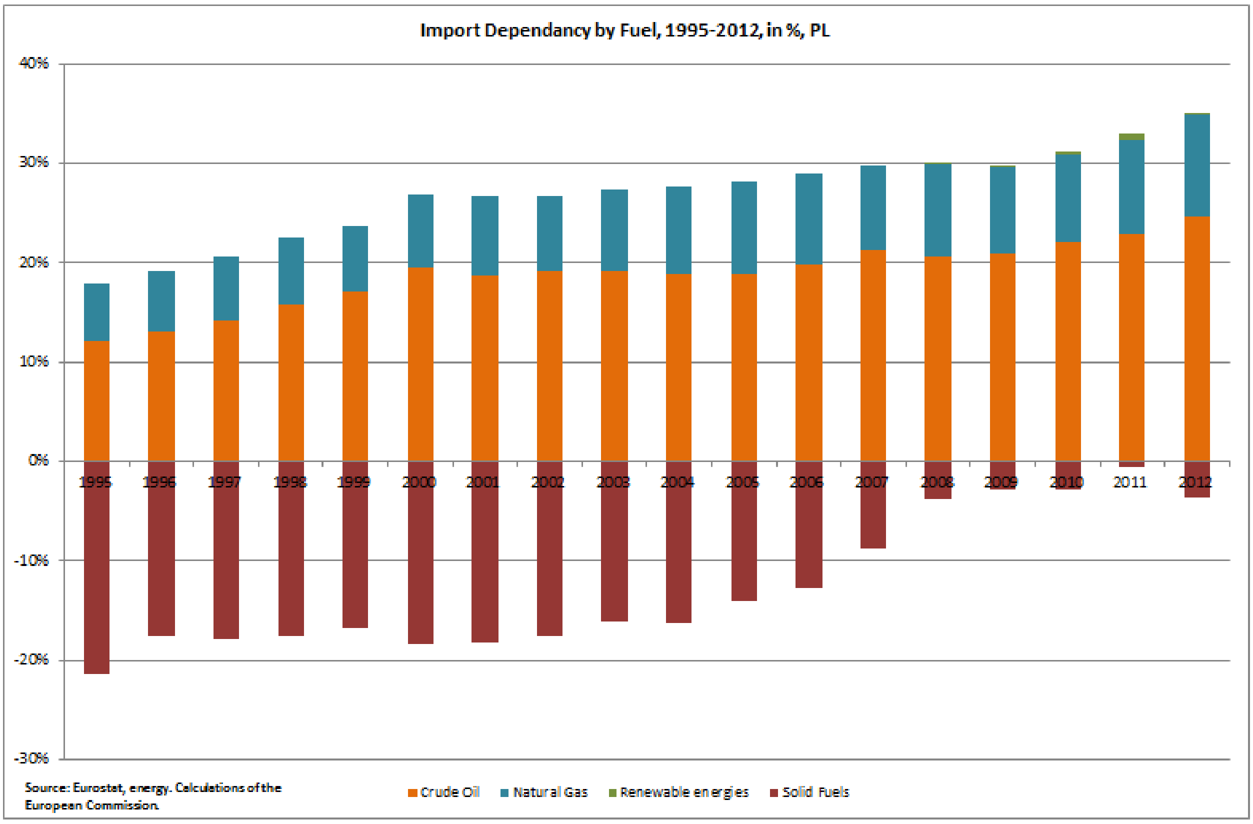


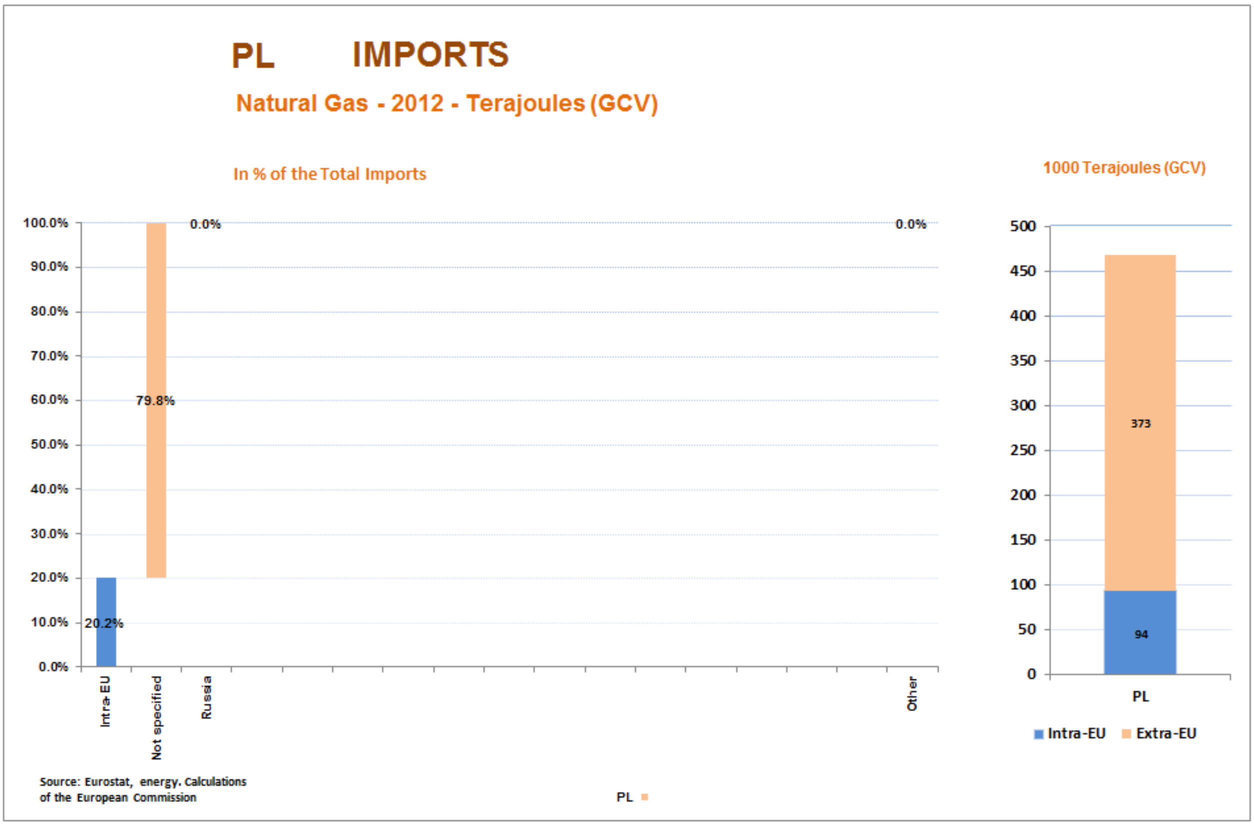

NL IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
24.1%
63.7%
11.2%
0.4%
0.3%
0.2%
Intra-EU
Norway
Russia
Trinidad and Tobago
Nigeria
Algeria
Other
Source: Eurostat, energy. Calculations of the European Commission
NL
1000 Terajoules (GCV)
1,000
900
800
700
600
500
400
300
200
100
0
661
209
NL
Intra-EU
Extra-EU


NL IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
12.8%
27.1%
10.4%
10.0%
9.9%
6.0%
5.8%
4.7%
3.4%
2.8%
1.8%
1.7%
0.8%
0.5%
0.4%
0.4%
1.5%
Intra-EU
Russia
Nigeria
Norway
Saudi Arabia
Algeria
Kuwait
Iraq
Kazakhstan
Libya
Other African countries (aggregate changing...
Angola
Colombia
Tunisia
Venezuela
Brazil
Other
Source: Eurostat, energy. Calculations of the European Commission
NL
1000 Thousands of tonnes
100
0
50
7
Intra-EU
Extra-EU
NL

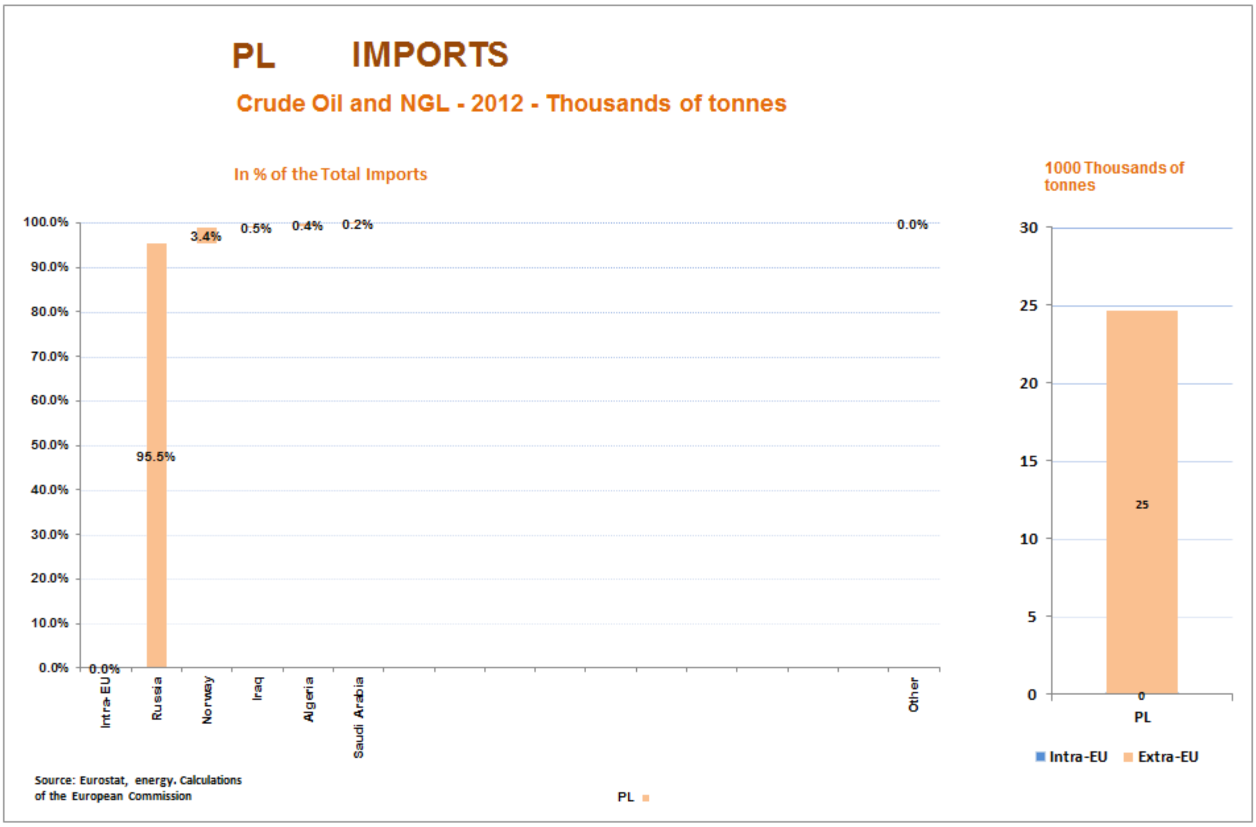
Country Fiche: Poland







PL IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
20.2%
79.8%
0.0%
0.0%
Intra-EU
Not specified
Russia
Other
500
450
400
350
300
250
200
150
100
50
0
373
94
PL
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
PL



PL IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
95.5%
3.4%
0.5%
0.4%
0.2%
0.0%
Intra-EU
Russia
Norway
Iraq
Algeria
Saudi Arabia
Other
30
25
20
15
10
5
0
25
0
PL
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
PL

Poland

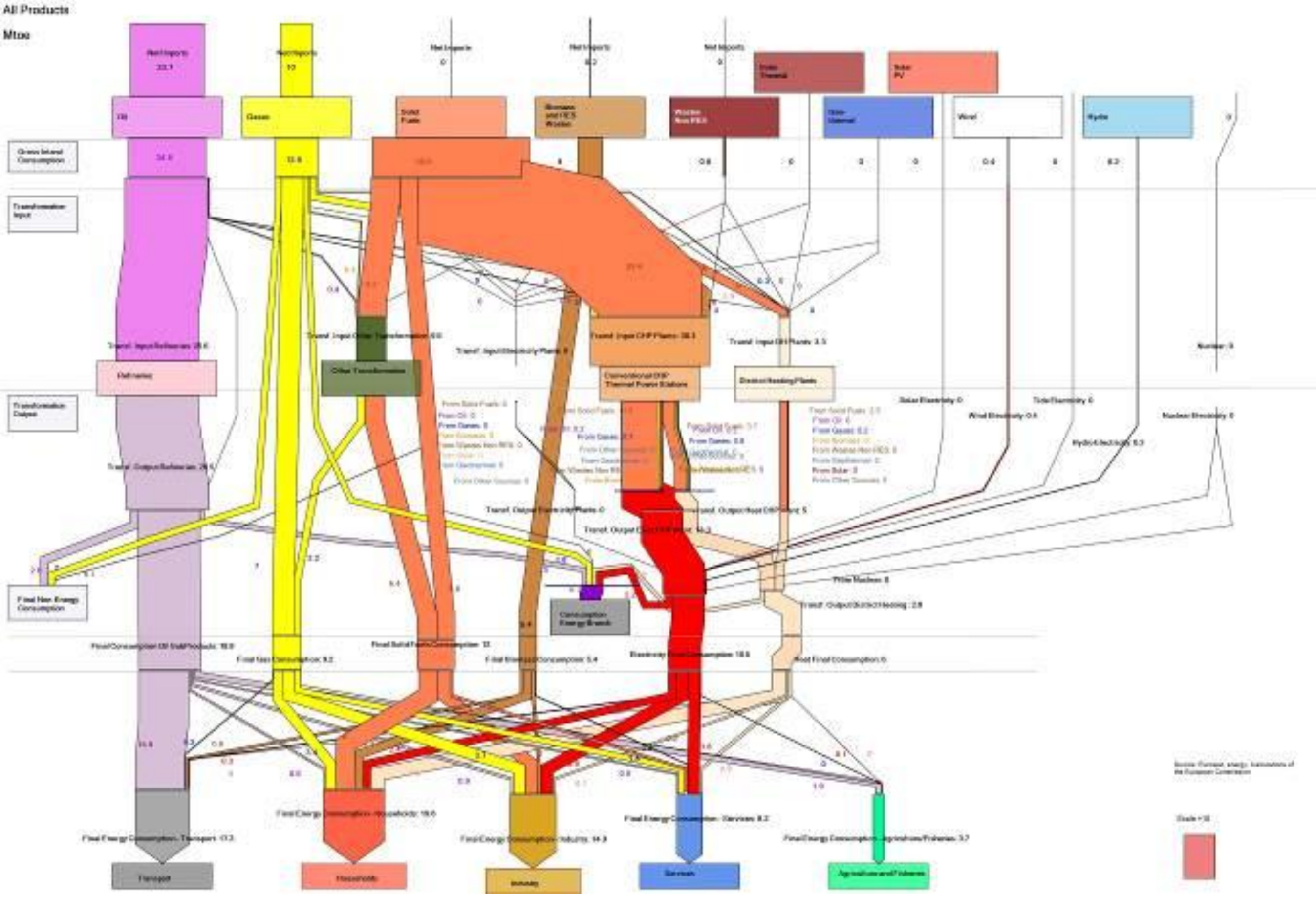
Total gas consumption / Russian imports	Total: 16.3 Bcm/y // RU: 9.8 Bcm/y
Gas storage capacity and current level:	Total: 1.75 Bcm // Current: 1.23 Bcm
Connections to other MSs and capacity:	PL→DE: 30.6 Bcm/y (Yamal) DE→PL: 1.6 Bcm/y (*from April extra 5.4 Bcm/y capacity expected to be added by implementing reverse flow on Yamal*) CZ→PL: 0.15 Bcm/y
Alternative supply options:	Physical reverse flows on the Yamal pipeline from DE – as a result of Regulation 994/2010 – will become operational from April 2014. The LNG terminal at Swinoujscie is planned to become operational by the end of 2014, with capacity of 5 Bcm/y. Expansion to 7.5 Bcm/y is part of the PCIs, with a target date of 2020.
Assessment: Poland receives part of its gas via direct interconnections with Belarus and Ukraine. In terms of quantities the LNG terminal and increased reverse flows from Germany could substitute missing Russian gas. However, these amounts may be difficult to be shipped to the South-Eastern part of Poland.	

ENERGY FLOW

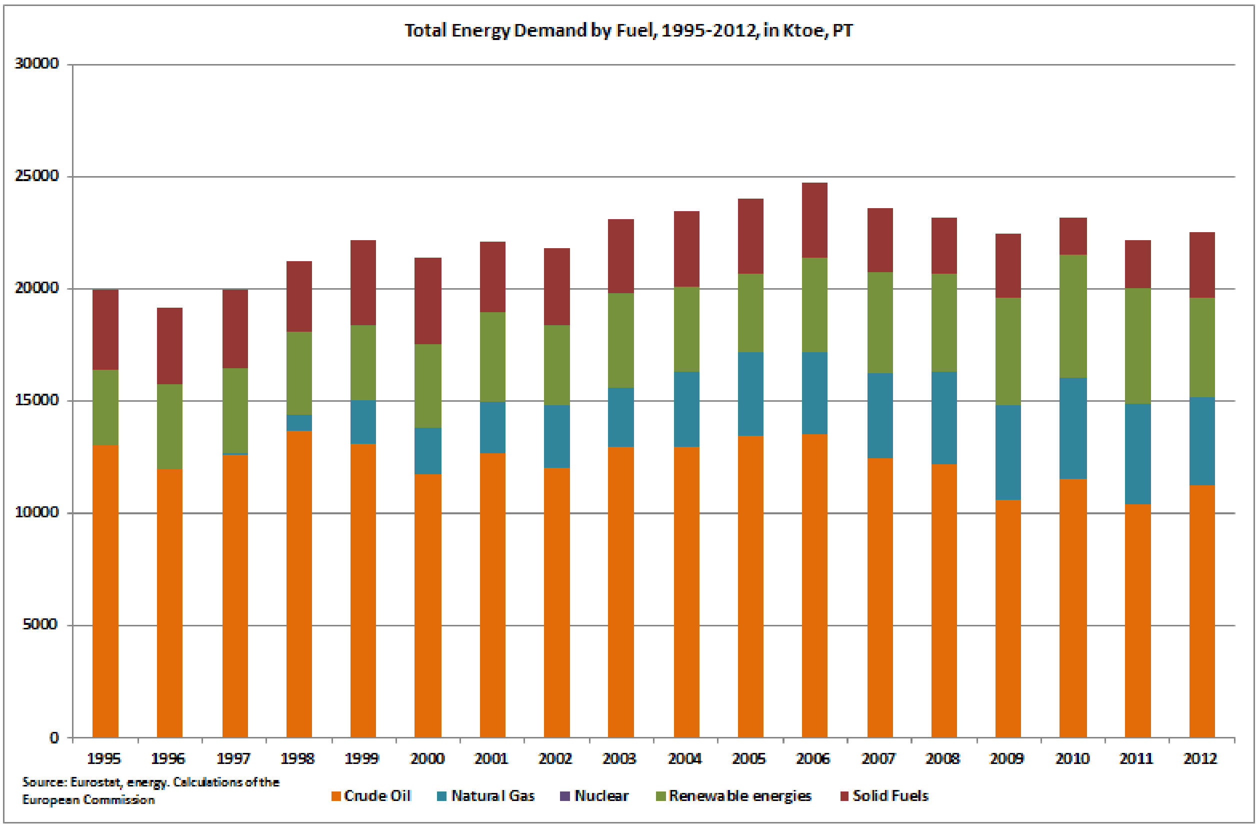
PL 2012

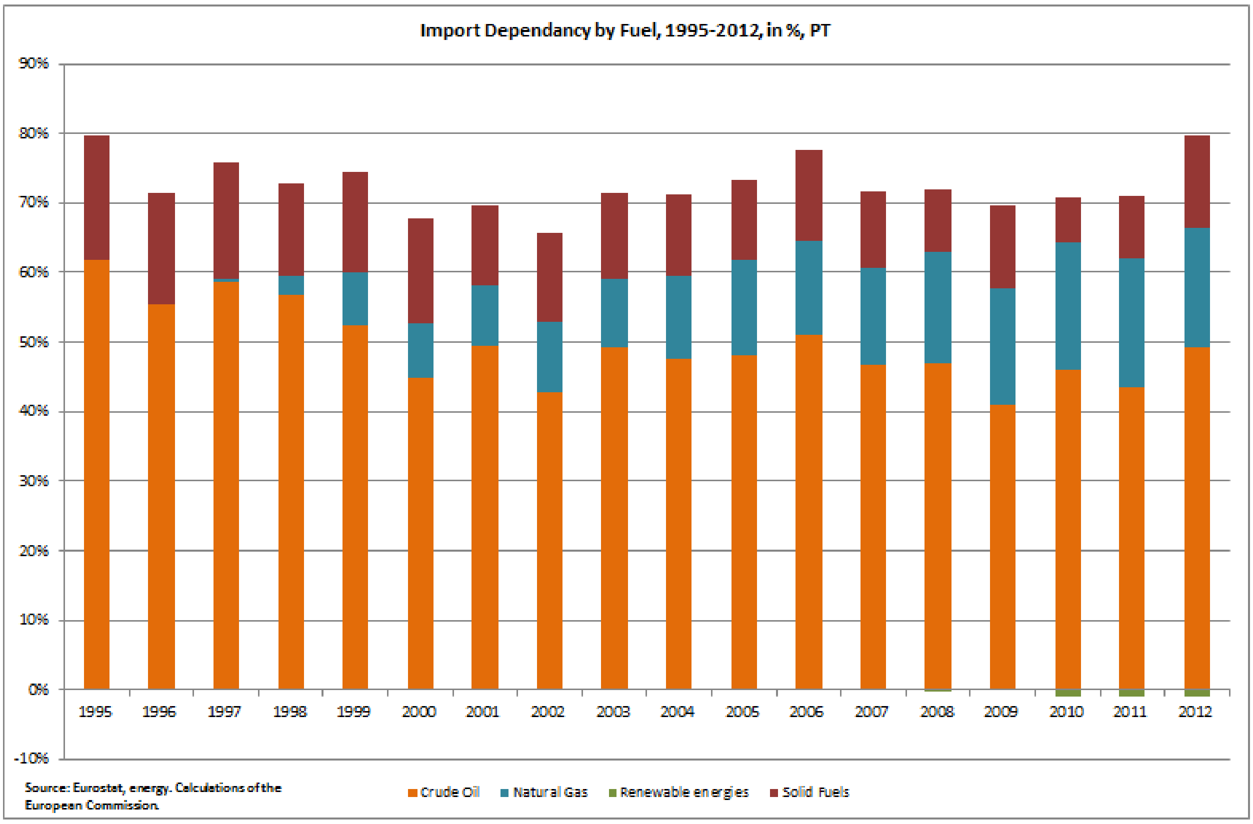
All Products

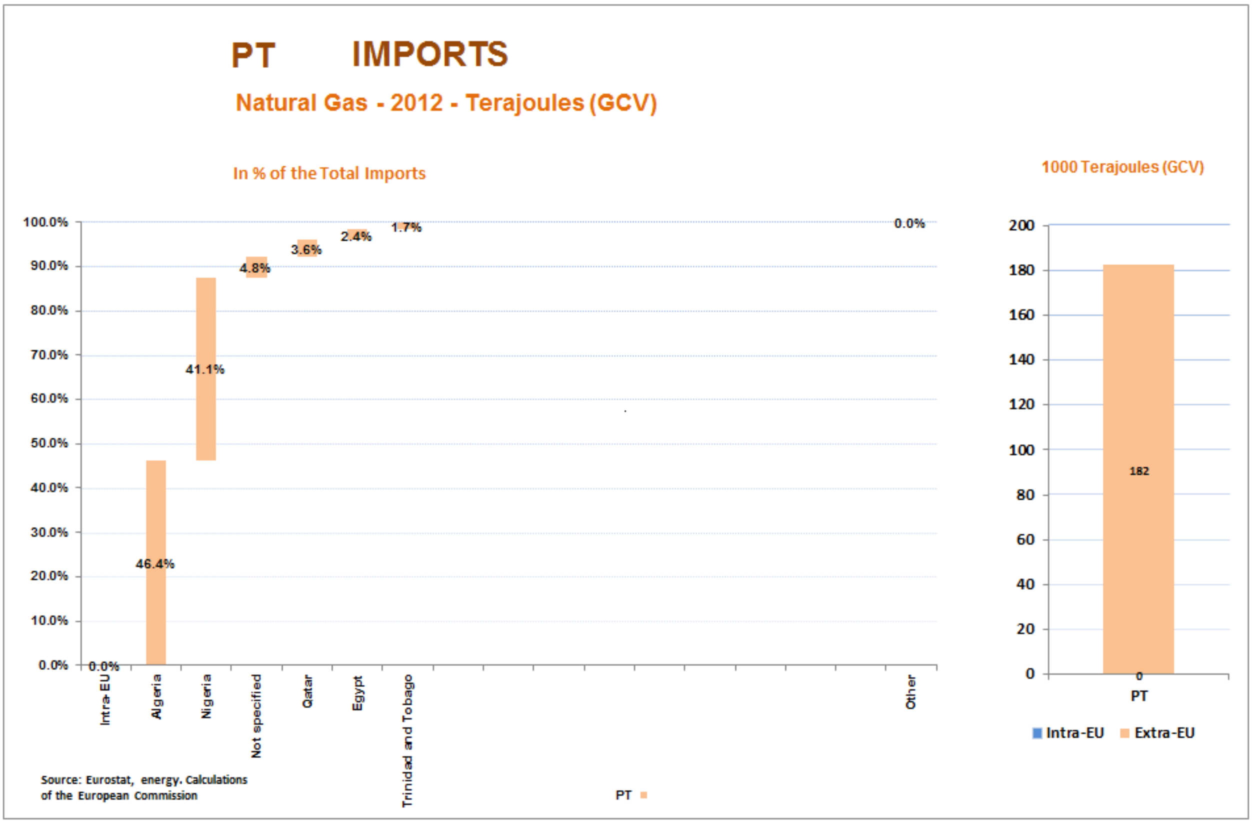
Mtoe

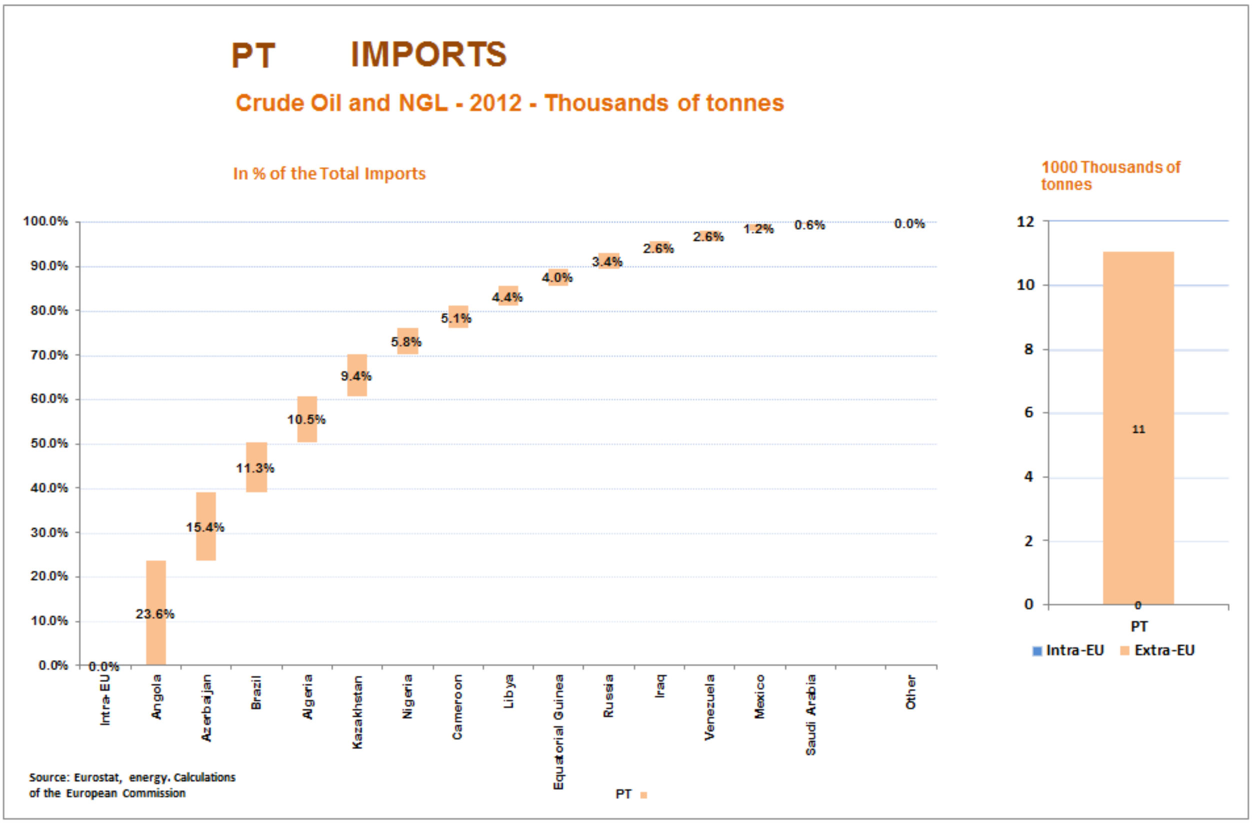


Country Fiche: Portugal

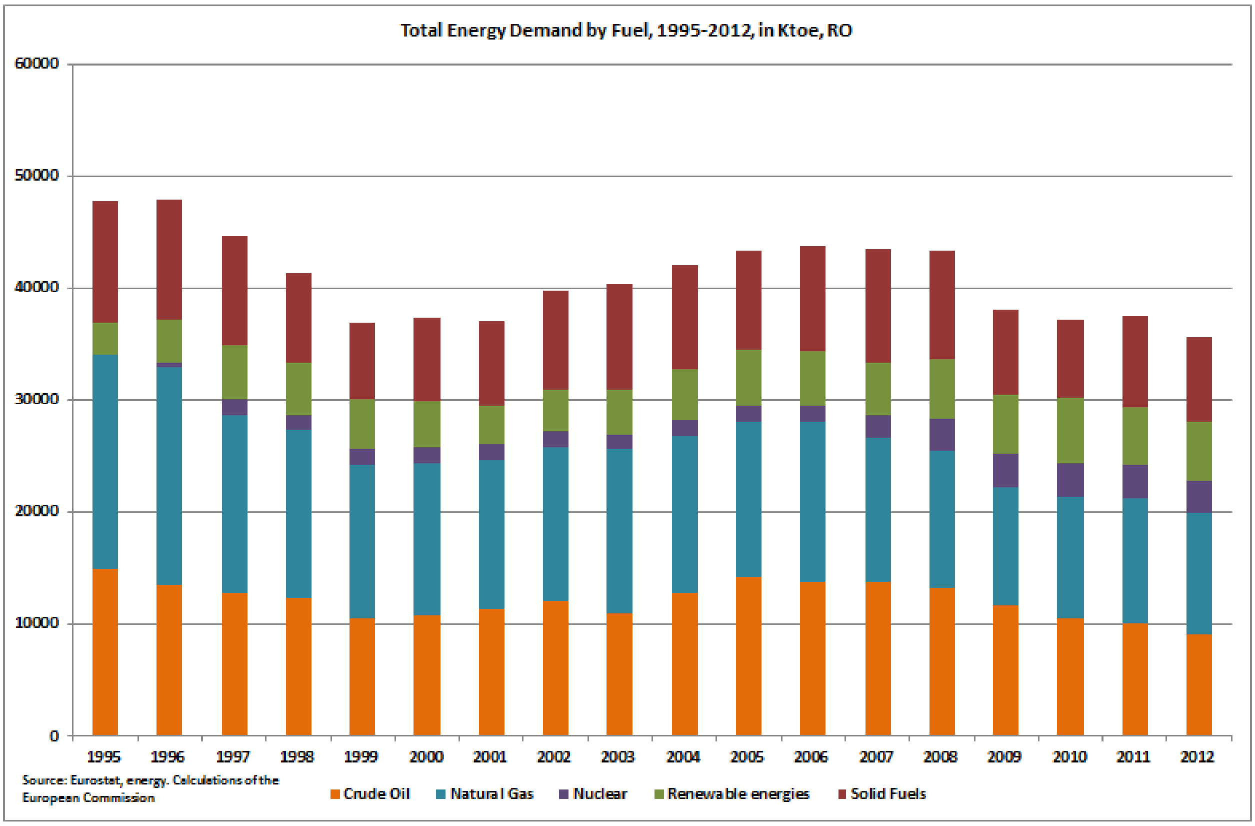


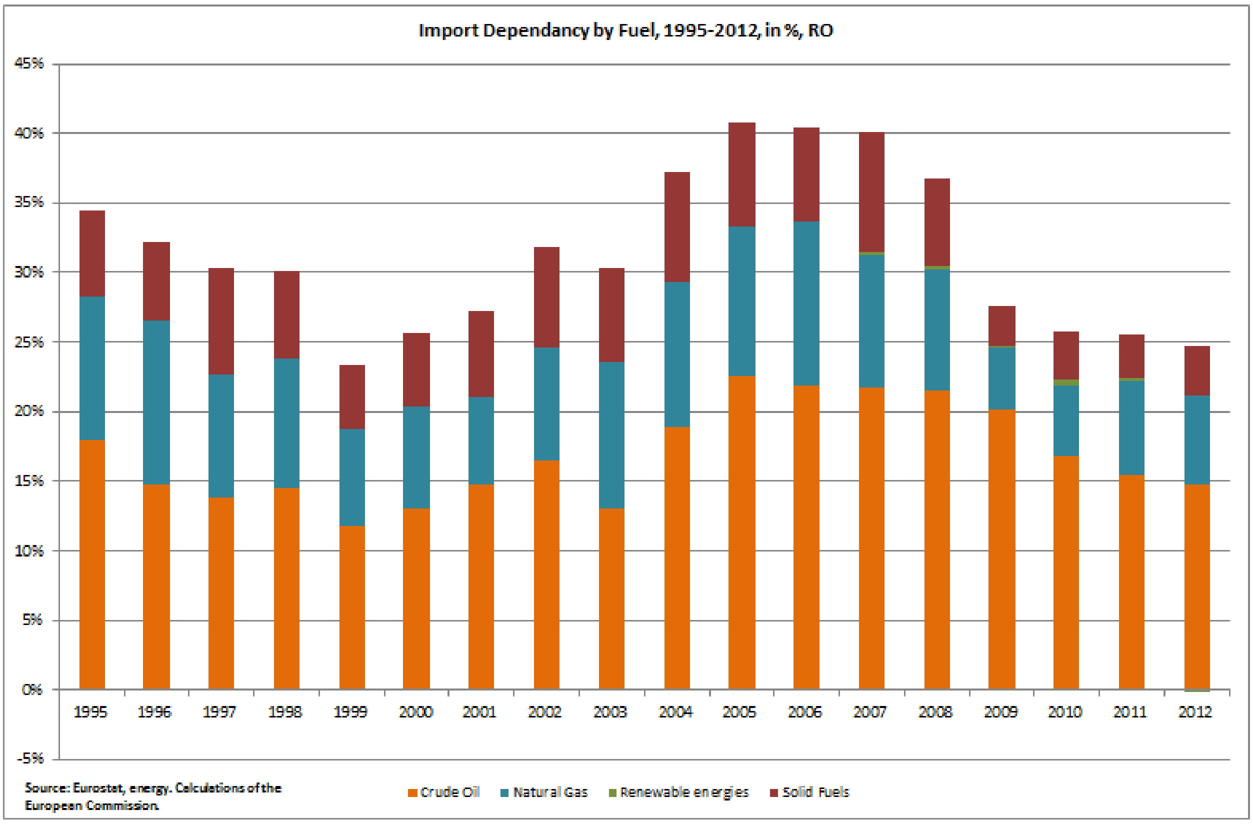


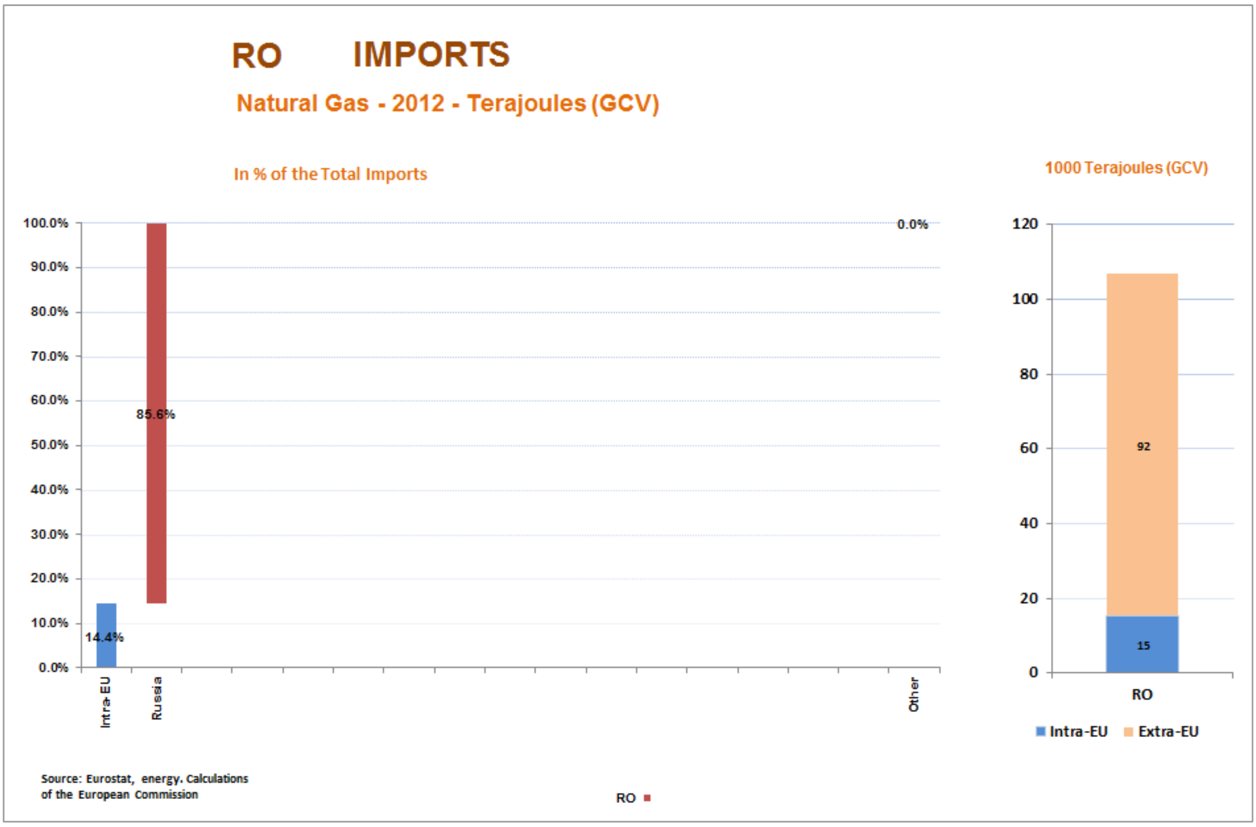

PT IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
0.0%
46.4%
41.1%
4.8%
3.6%
2.4%
1.7%
0.0%
Intra-EU
Algeria
Nigeria
Not specified
Qatar
Egypt
Trinidad and Tobago
Other
182
PT
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission

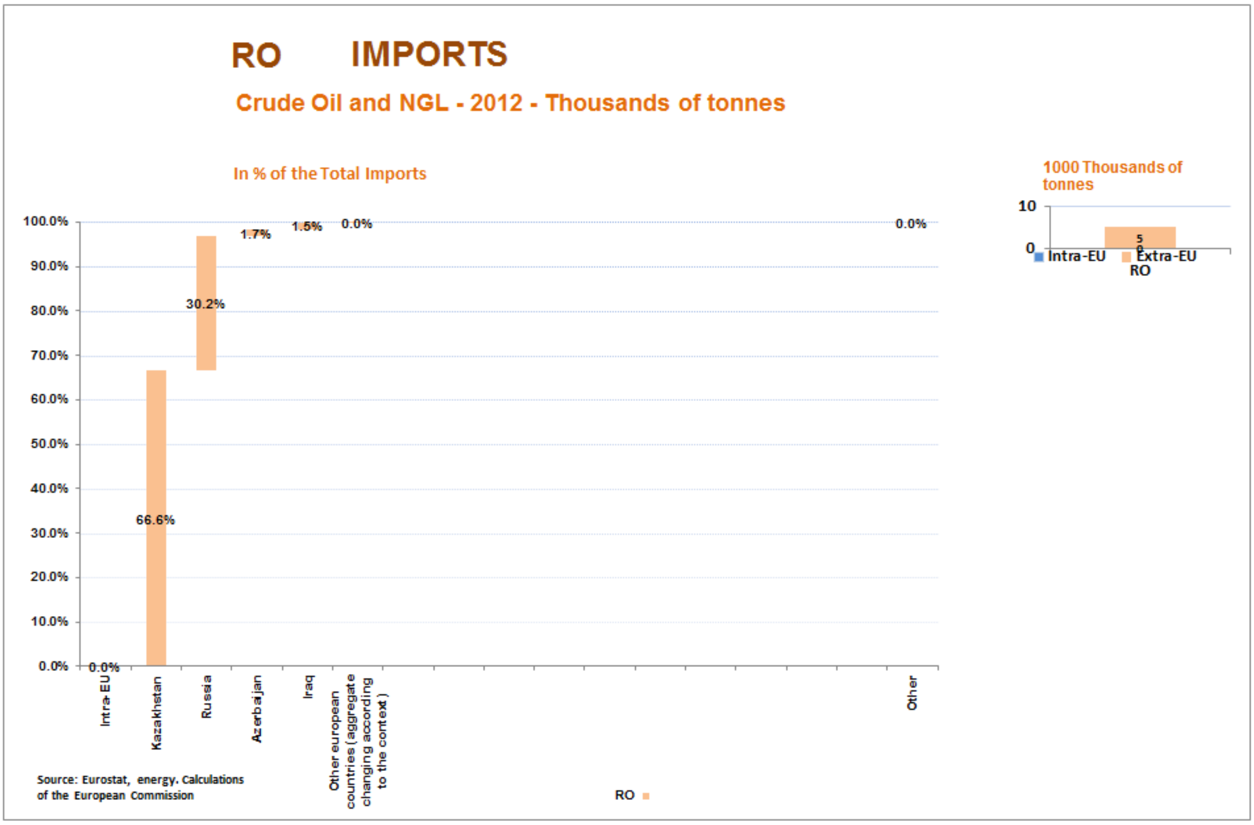

PT IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
0.0%
23.6%
15.4%
11.3%
10.5%
9.4%
5.8%
5.1%
4.4%
4.0%
3.4%
2.6%
2.6%
1.2%
0.6%
0.0%
Intra-EU
Angola
Azerbaijan
Brazil
Algeria
Kazakhstan
Nigeria
Cameroon
Libya
Equatorial Guinea
Russia
Iraq
Venezuela
Mexico
Saudi Arabia
Other
11
PT
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission

Country Fiche: Romania






RO IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
85.6%
14.4%
0.0%
Intra-EU
Russia
Other
Source: Eurostat, energy. Calculations of the European Commission
RO
1000 Terajoules (GCV)
120
100
80
60
40
20
0
92
15
RO
Intra-EU
Extra-EU


RO IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
66.6%
30.2%
1.7%
1.5%
0.0%
0.0%
Intra-EU
Kazakhstan
Russia
Azerbaijan
Iraq
Other european countries (aggregate changing according to the context)
Other
Source: Eurostat, energy. Calculations of the European Commission
RO
1000 Thousands of tonnes
10
0
5
0
Intra-EU
Extra-EU
RO

Romania

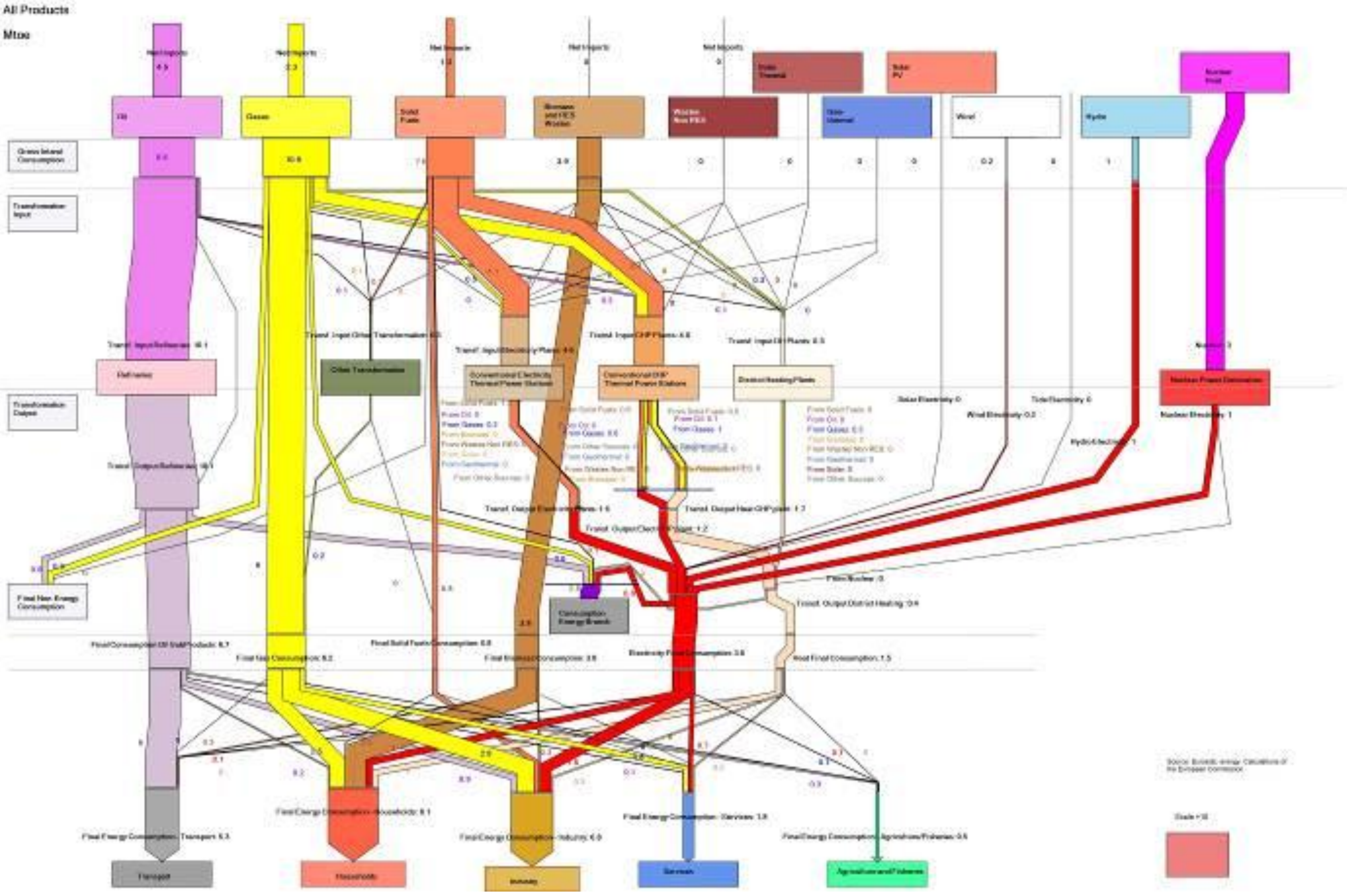
Total gas consumption / Russian imports	Total: 11.6 Bcm/y // RU: 1.2 Bcm/y
Gas storage capacity and current level:	Total: 2.7 Bcm // Current: NO DATA available in GSE's AGSI database
Connections to other MSs and capacity:	HU→RO: 1.7 Bcm/y
Alternative supply options:	The interconnection with Bulgaria is expected to come online in June 2014 with a capacity of 0.5 Bcm/y (max capacity of 1.5 Bcm will be reached by 2016).
Assessment: Romania has significant domestic production, therefore Russian imports constitute ~10% of its total demand. In quantities, the maximization of imports from Hungary could cover the missing volumes, but in reality Hungary is also dependent on the same Russian gas, therefore it is questionable whether this is a realistic option.	

ENERGY FLOW

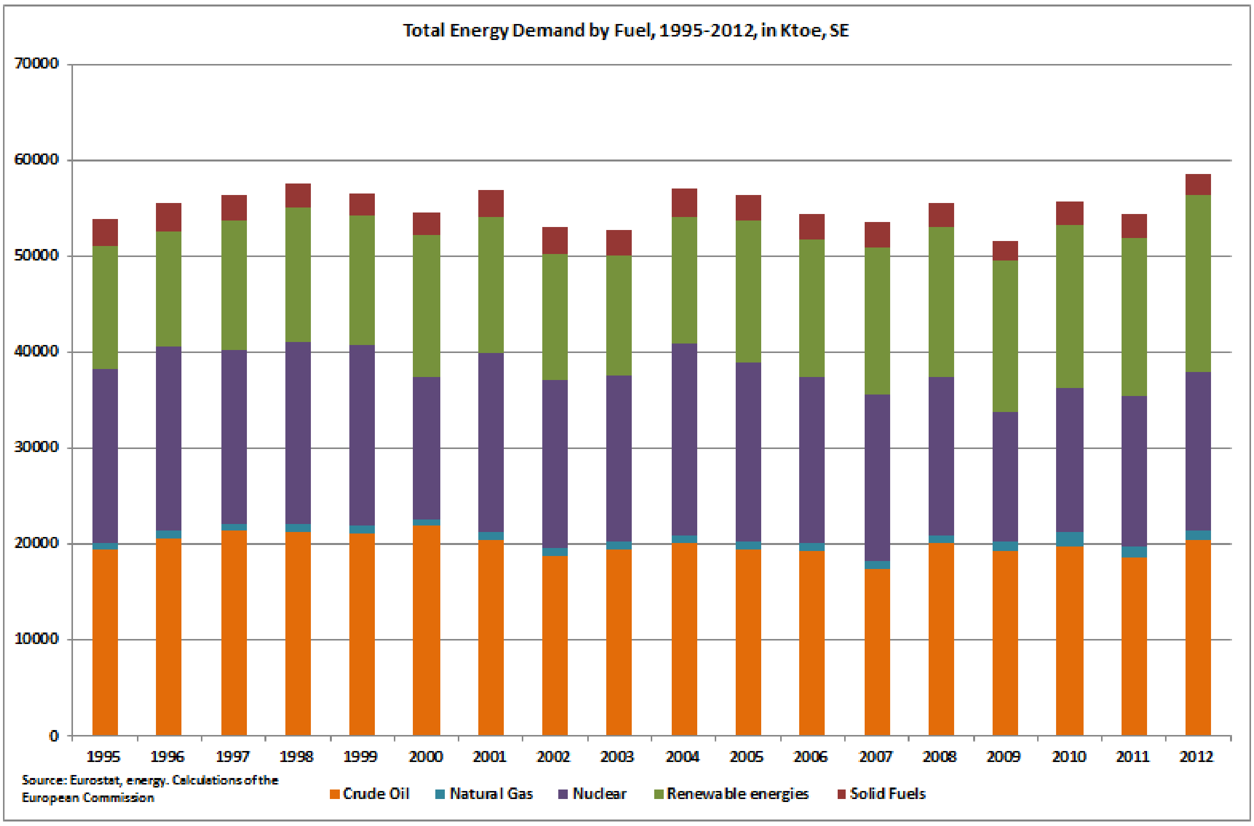
RO 2012

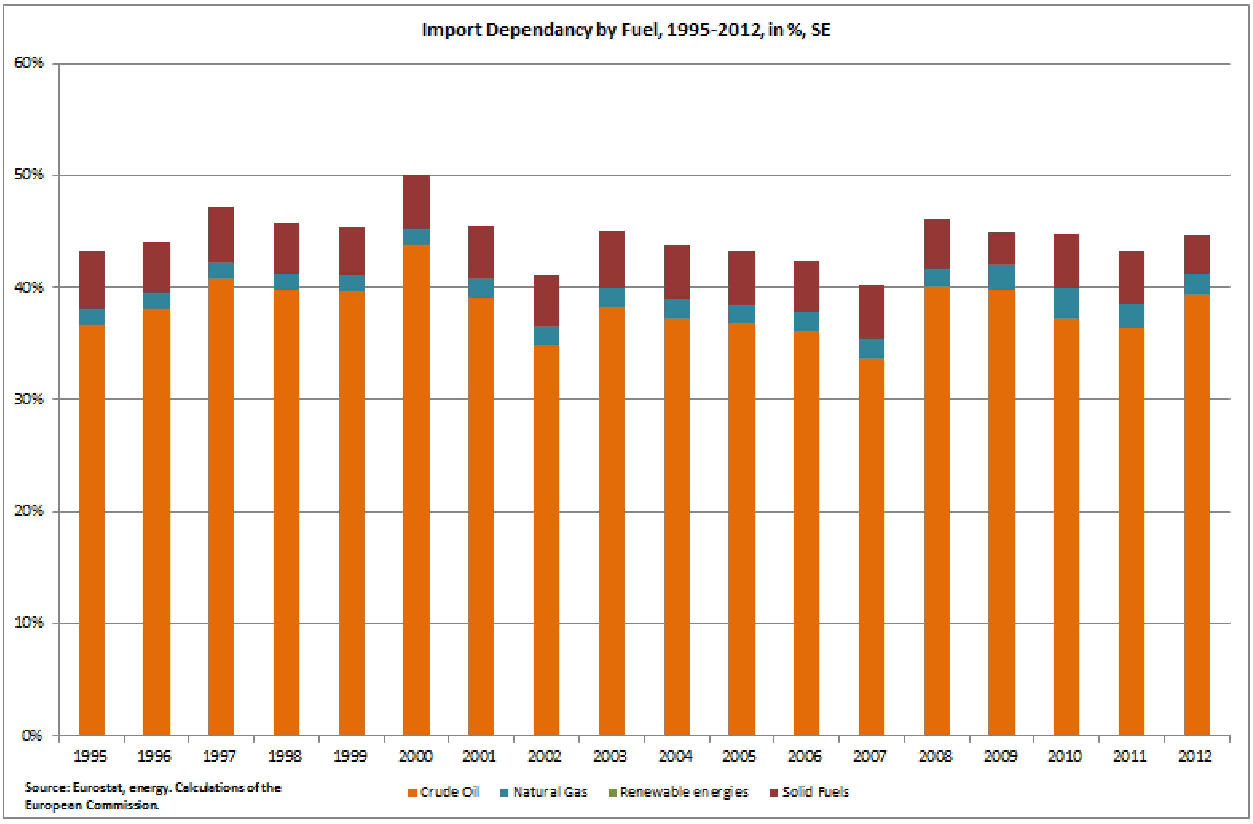
All Products

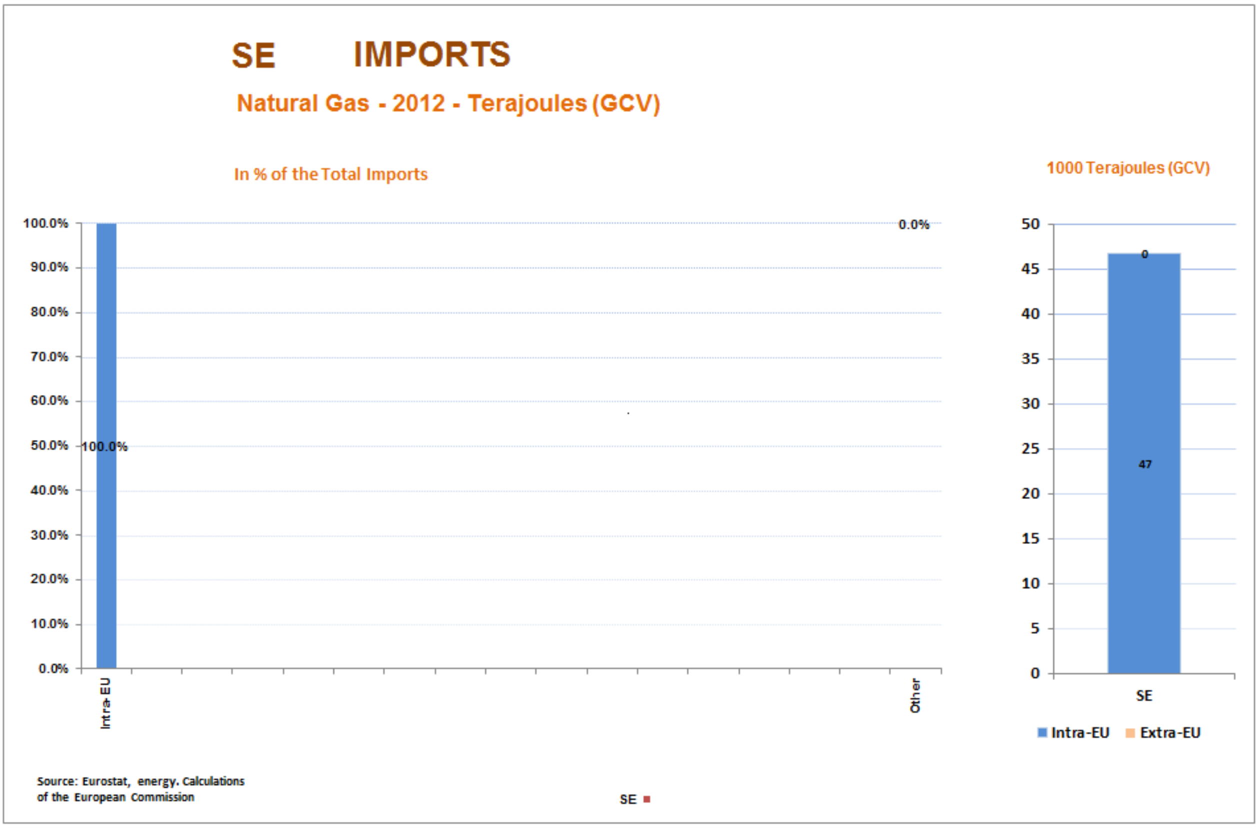
Mtoe

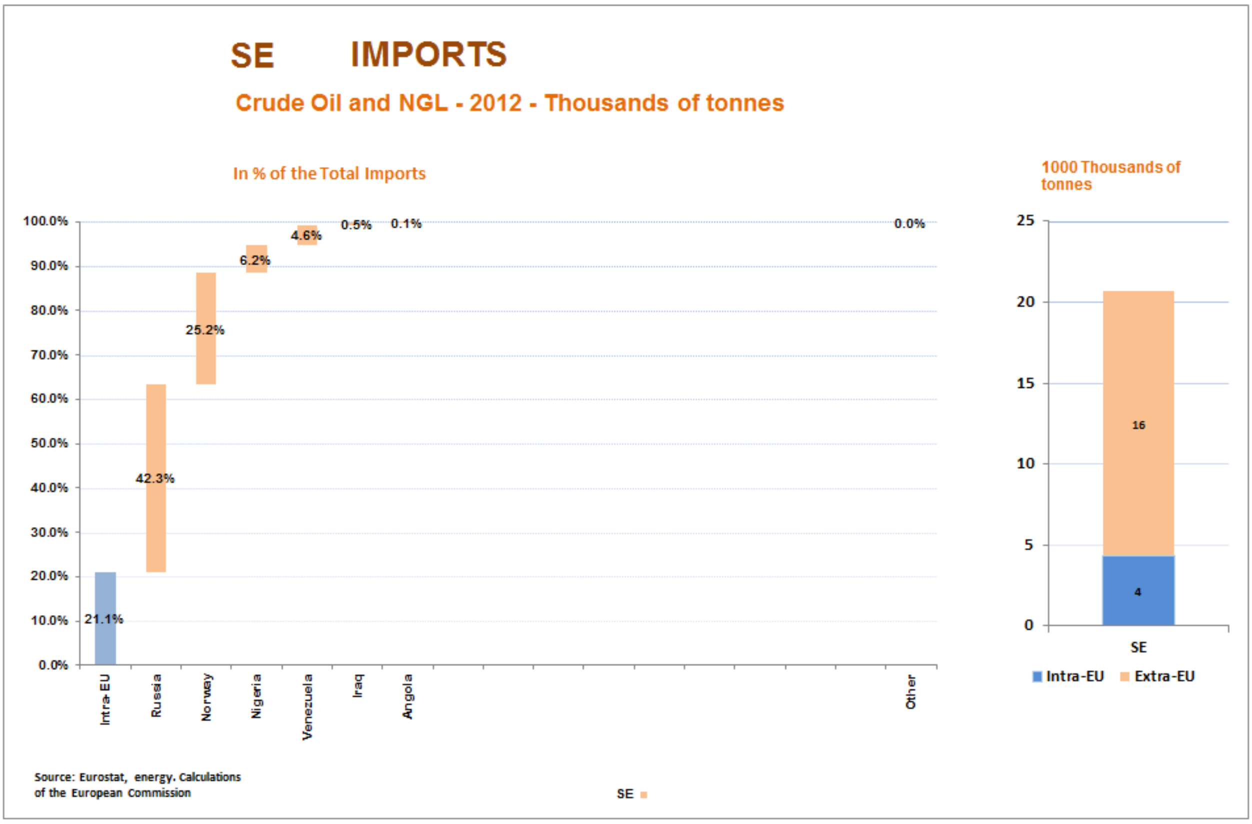


Country Fiche: Sweden

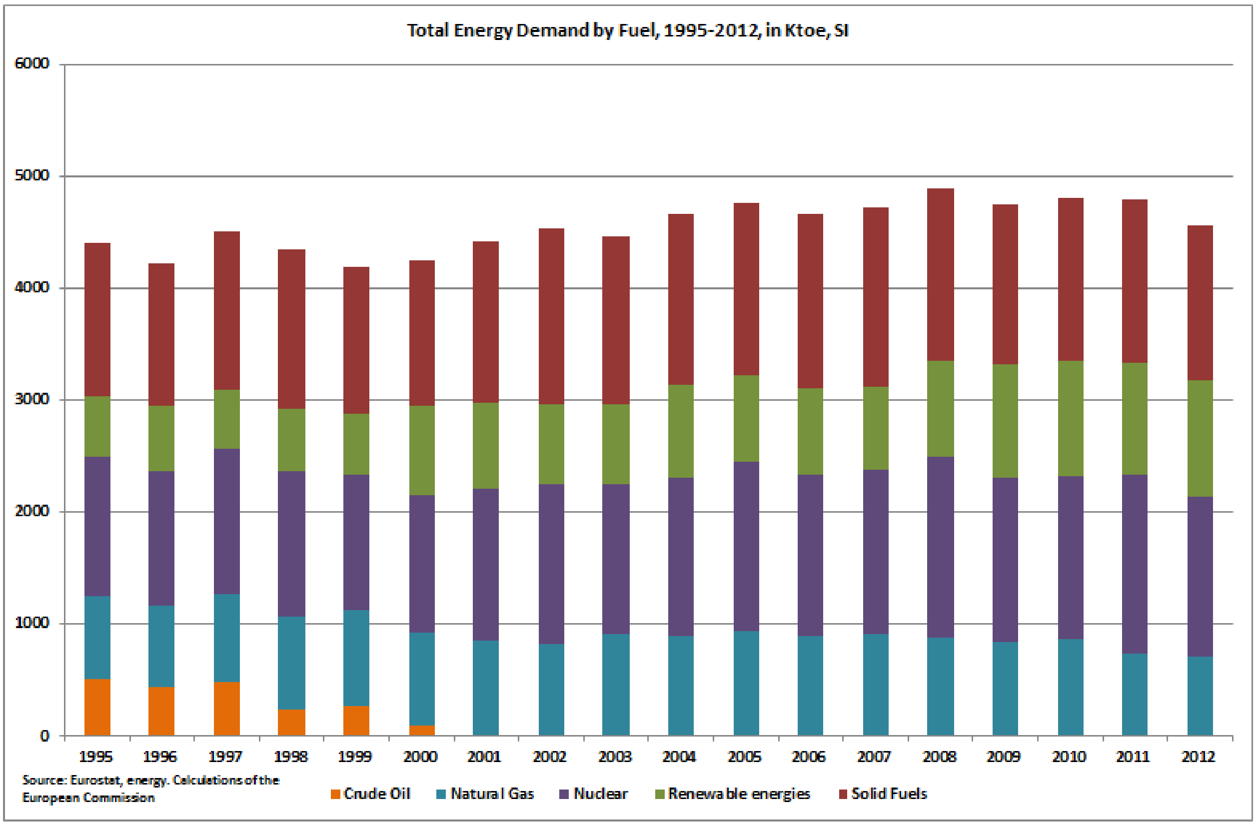


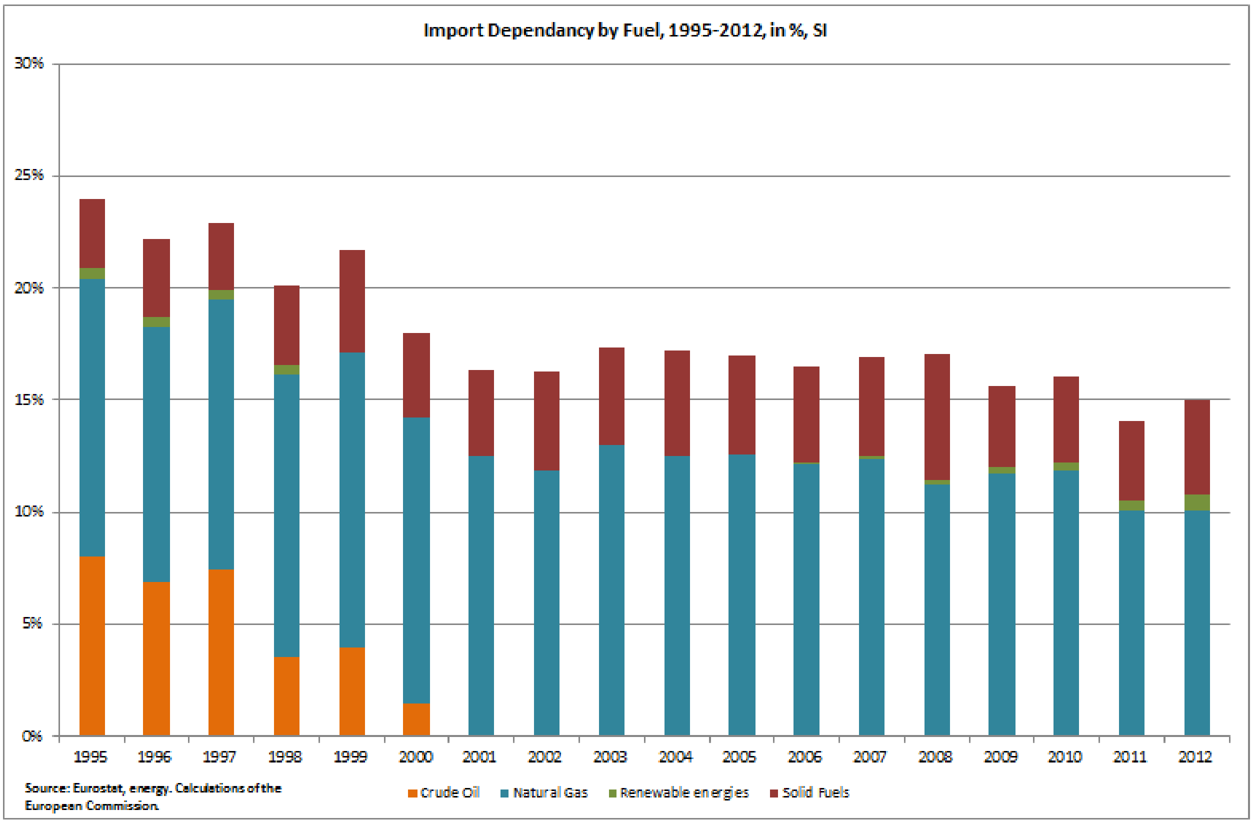



SE IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
0.0%
Intra-EU
Other
47
0
SE
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
SE


SE IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
21.1%
42.3%
25.2%
6.2%
4.6%
0.5%
0.1%
0.0%
Intra-EU
Russia
Norway
Nigeria
Venezuela
Iraq
Angola
Other
16
4
SE
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
SE

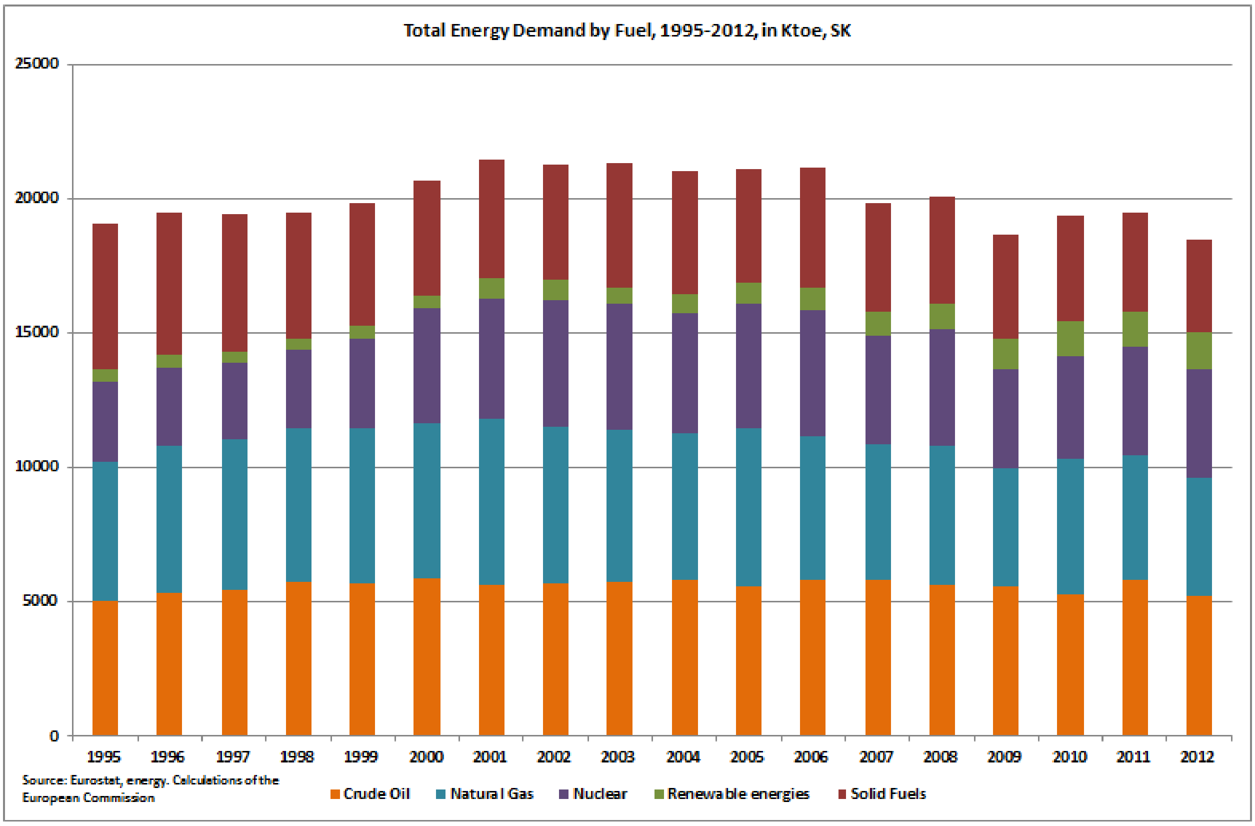
Country Fiche: Slovenia

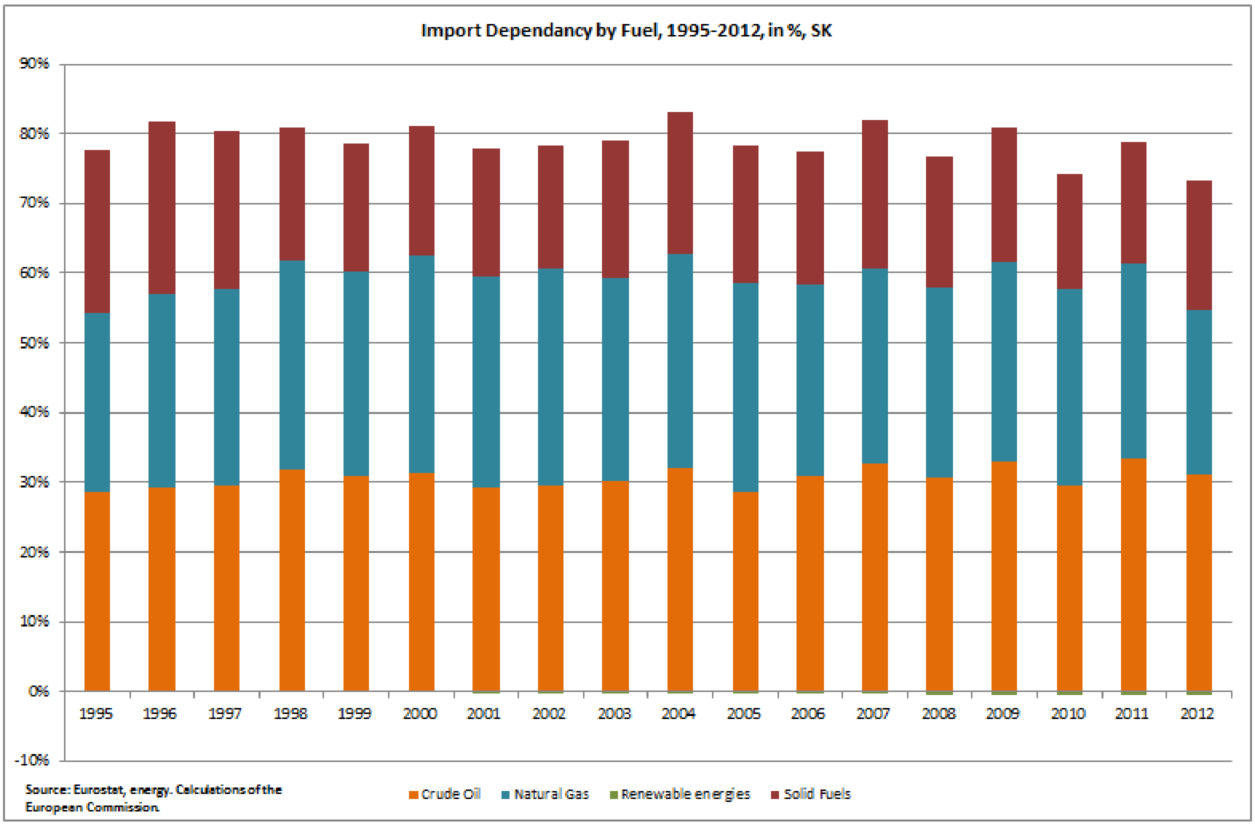




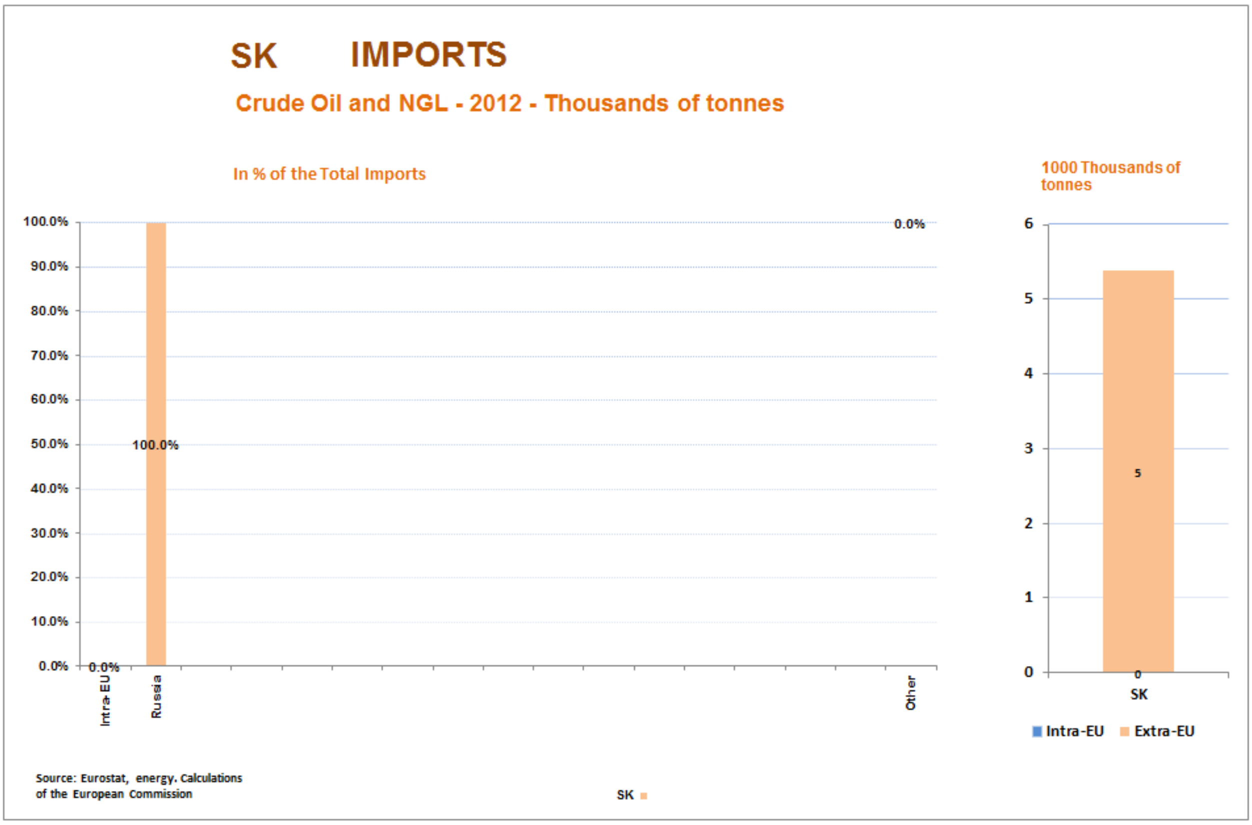
SI IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
42.0%
42.0%
16.0%
0.0%
Intra-EU
Russia
Algeria
Other
35
30
25
20
15
10
5
0
19
14
SI
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
SI

Country Fiche: Slovakia



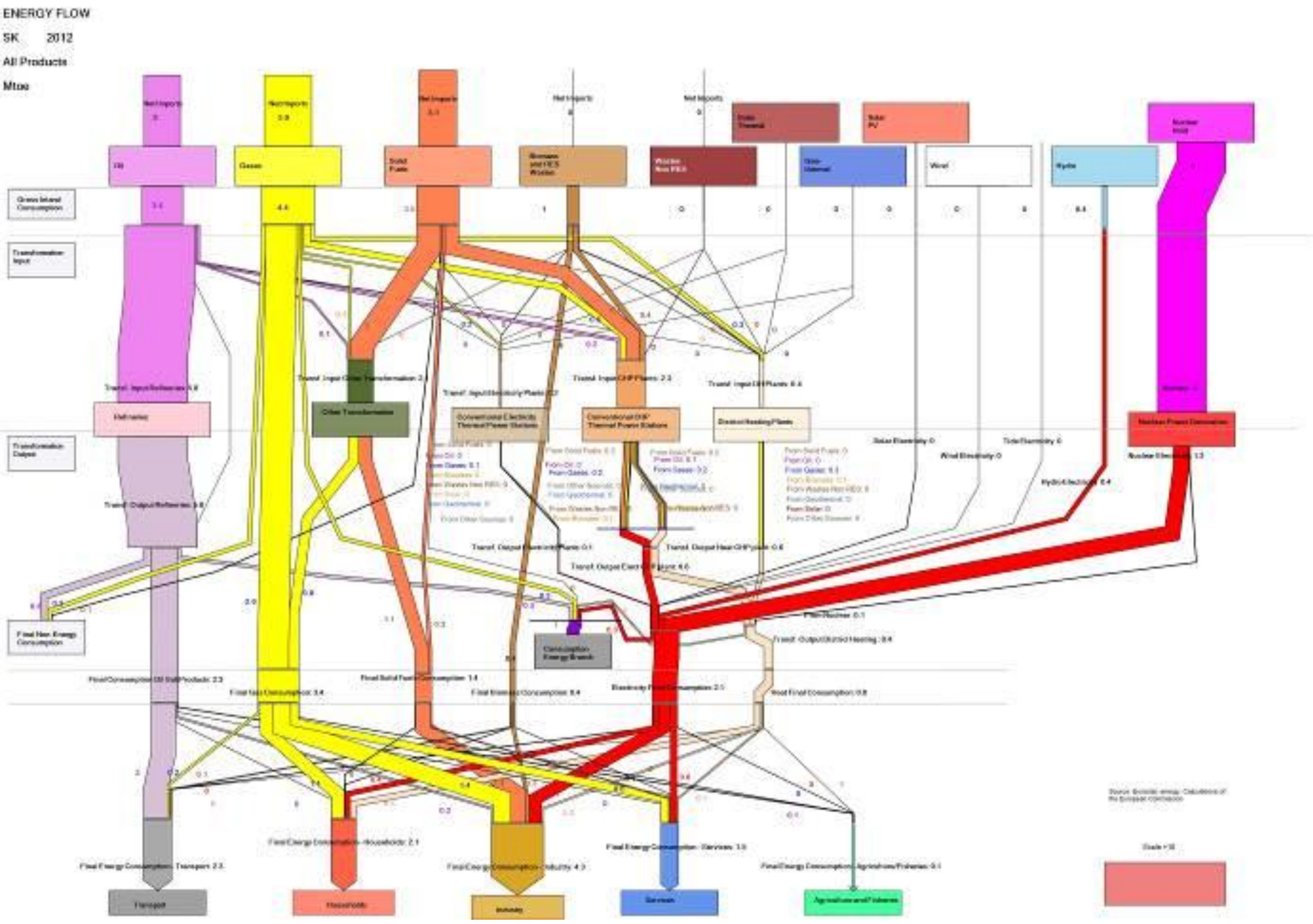



SK IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
100.0%
0.0%
Intra-EU
Russia
Other
200
180
160
140
120
100
80
60
40
20
0
184
0
SK
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
SK

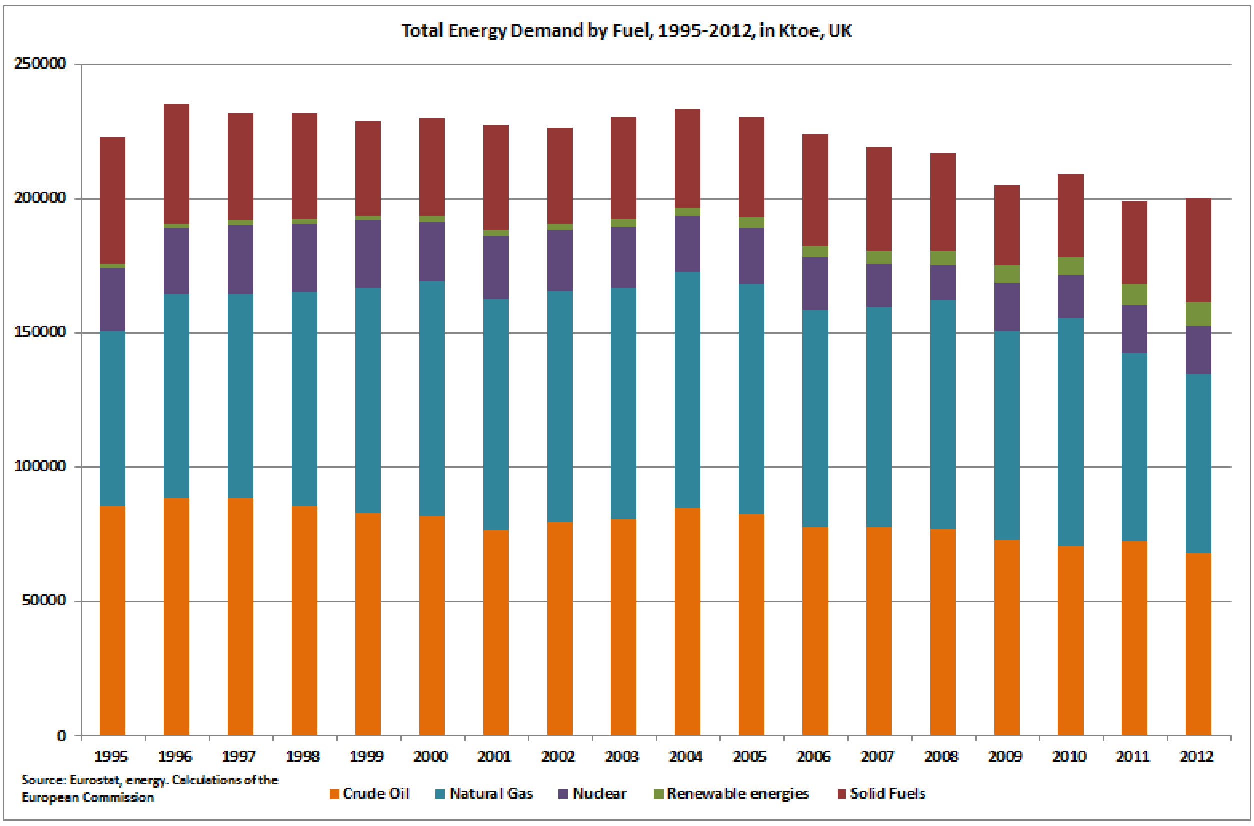

SK IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
100.0%
0.0%
Intra-EU
Russia
Other
6
5
4
3
2
1
0
5
0
SK
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
SK

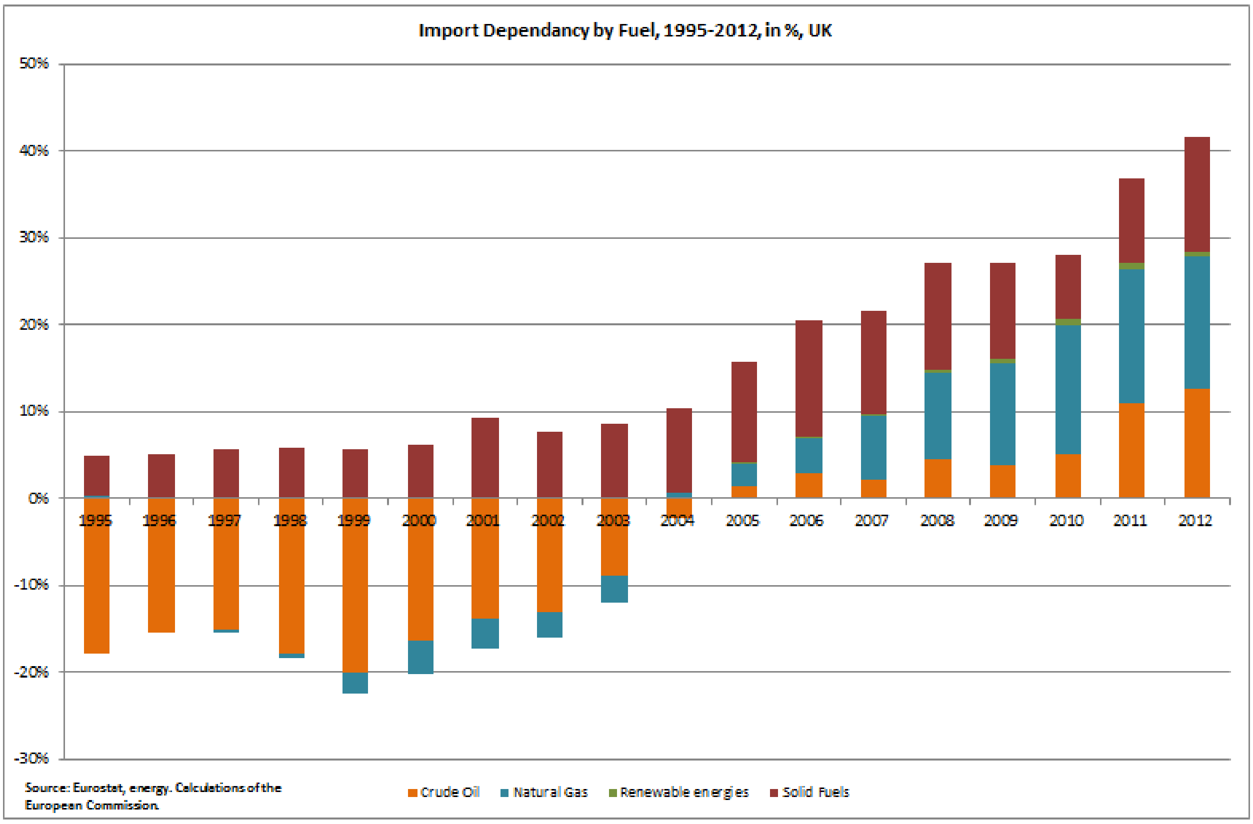
Slovakia

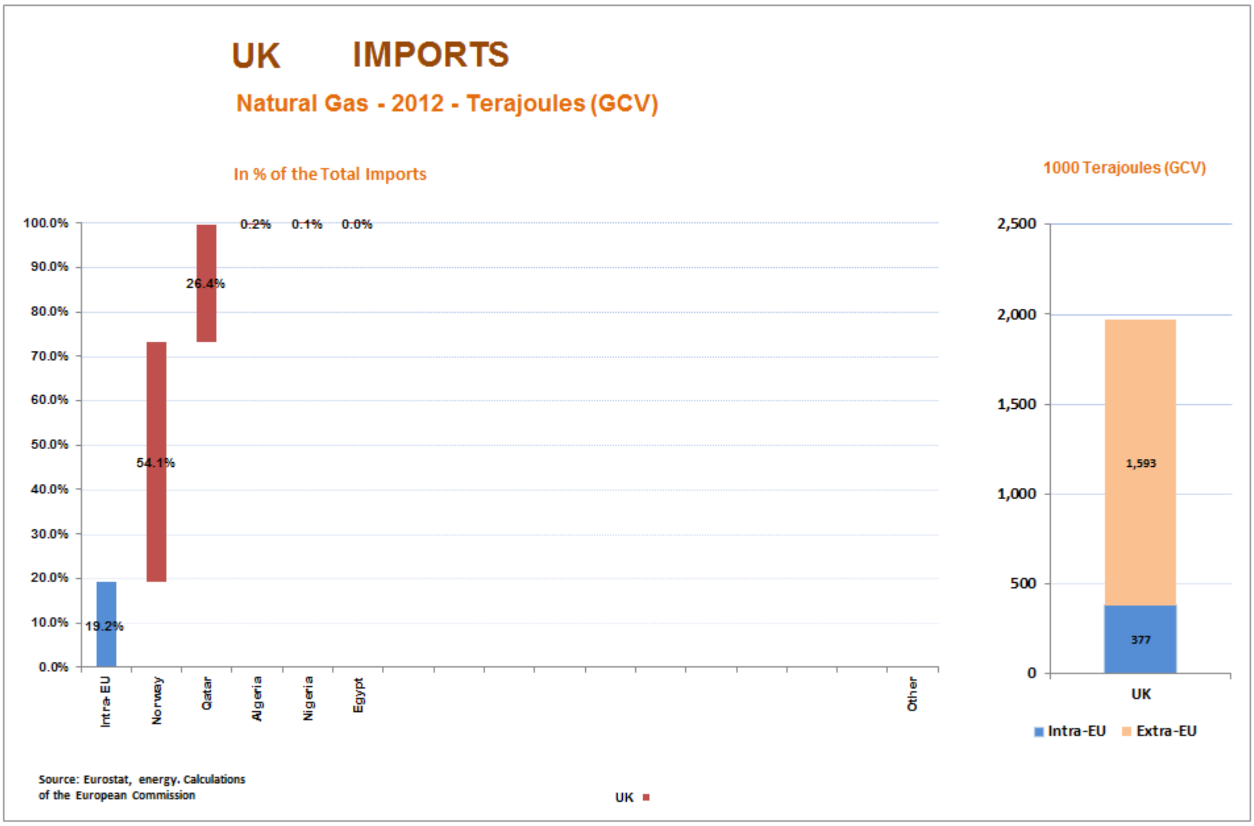
Total gas consumption / Russian imports	Total: 5.1 Bcm/y // RU: ~4.8 Bcm/y
Gas storage capacity and current level:	Total: 2.9 Bcm // Current: 1.15 Bcm
Connections to other MSs and capacity:	SK→CZ: 25.4 Bcm/y SK→AT: 56.7 Bcm/y CZ→SK: 13.2 Bcm/y AT→SK: 13.8 Bcm/y
Alternative supply options:	Interconnection with HU is expected to be fully operational from mid-2015. SK could receive ~1.6 Bcm/y and could transport to HU ~4.5 Bcm/y via that new link.
Assessment: Slovakia has considerably improved its security of supply after the 2009 gas crisis by putting in place massive reverse flow capacities that could cover its annual demand – in case there are enough sources and capacities from Western Europe.	

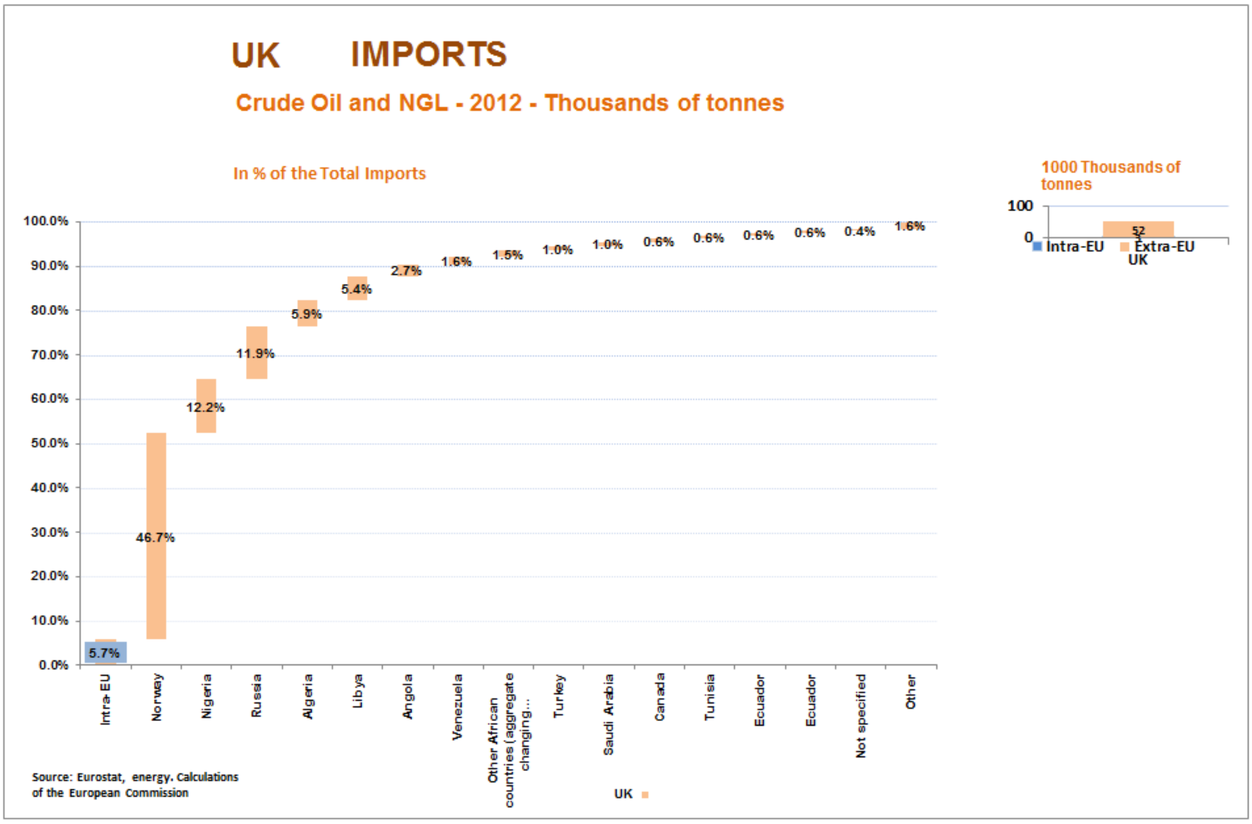

ENERGY FLOW
SK 2012
All Products
Mtoe

Country Fiche: United Kingdom






UK IMPORTS
Natural Gas - 2012 - Terajoules (GCV)
In % of the Total Imports
1000 Terajoules (GCV)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
19.2%
54.1%
26.4%
0.2%
0.1%
0.0%
Intra-EU
Norway
Qatar
Algeria
Nigeria
Egypt
Other
2,500
2,000
1,500
1,000
500
0
1,593
377
UK
Intra-EU
Extra-EU
Source: Eurostat, energy. Calculations of the European Commission
UK


UK IMPORTS
Crude Oil and NGL - 2012 - Thousands of tonnes
In % of the Total Imports
1000 Thousands of tonnes
100
0
52
Intra-EU
Extra-EU
UK
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
5.7%
46.7%
12.2%
11.9%
5.9%
5.4%
2.7%
1.6%
1.5%
1.0%
1.0%
0.6%
0.6%
0.6%
0.6%
0.4%
1.6%
Intra-EU
Norway
Nigeria
Russia
Algeria
Libya
Angola
Venezuela
Other African countries (aggregate changing...
Turkey
Saudi Arabia
Canada
Tunisia
Ecuador
Ecuador
Not specified
Other
Source: Eurostat, energy. Calculations of the European Commission
UK

Annex II: Emergency response tools to address an oil supply disruption

Member State	Emergency stocks			Demand restraint measures	Rationing/Allocation	Fuel switching	Production surge	Relaxing fuel specifications
	Quantity on 31/12/2013	Stockholding system	Release procedure					
Austria	3.0 Mt (99 days of net imports)	Obligation imposed on industry but most operators choose to hold their stocks at the private, non-profit stockholding company ELG which is Austria's central stockholding entity	Stocks to be released by ELG	Measures are grouped in three stages, depending on the nature and severity of the crisis, and would mostly concern the transport sector	The third stage of demand restraint measures would rely on coupon rationing for the private sector and allocation for fuel oil use in industry	Limited potential in power generation (low share of oil); some possibility in households to switch from heating oil to biomass	Not available	Product specifications can be relaxed for a limited period
Belgium	5.1 Mt (102 days of net imports)	All stocks held by APETRA, Belgium’s central stockholding entity	Stocks to be released by APETRA; APETRA also has Crude Against Product Agreements with refiners which allows the simultaneous sale of crude oil from APETRA and the purchase of products by APETRA	While there is no specific contingency plan for demand restraint measures, a number of decrees are available to activate such measures, including speed limits and driving restrictions	Rationing of distribution of fuel oil and motor fuels is possible; lists of priority endusers of petroleum products are available	Very limited potential in power generation (low share of oil)	Not available	
Bulgaria	0.8 Mt (70 days of net imports)	1/3 of the stocks held by the State Agency State Reserve and Wartime Stocks (SASRWTS), Bulgaria's central stockholding entity, with the rest to be covered by companies	Stocks to be released directly by SASRWTS or by temporarily decreasing the obligation of economic operators	Possibility to introduce restrictions on the consumption of petroleum products in the country	Possibility to allocate products for specific groups of consumers		Not available	
Croatia	0.7 Mt (89 days of net imports)	All stocks held by HANDA, Croatia's central stockholding entity	Pursuant to the decision of the government, stocks are released by HANDA through tenders	Possibility to introduce demand restraint measures including speed limits, driving restrictions and limiting the opening hours of petrol stations				
Cyprus	0.5 Mt (84 days of net imports)	KODAP/COSMOS, the country's central stockholding entity is responsible for maintaining the emergency stocks; part of the stocks are held by the Electricity Authority Cyprus and oil companies	The minister has the right to order KODAP/COSMOS and operators the release all or part of the stocks	The minister can impose demand restraint measures	The minister can allocate products to specific groups of customers		Not relevant	
Czech Republic	2.3 Mt (102 days of net imports)	All stocks held by the Administration of State Material Reserves (ASMR) which is the country's central stockholding entity	Stocks to be released by ASMR by tender or loan	Possible measures include appeals to the public for voluntary measures, speed limits, driving restrictions and regulating petrol station operations	A card system for priority users and a coupon distribution to private vehicles has been devised and could be implemented quickly in a severe disruption	Insignificant	Not available	
Denmark	1.5 Mt (74 days of consumption)	Stockholding obligation imposed on industry but about 70% of the stocks are held by FDO, the Danish central stockholding entity	The Danish Energy Agency can instruct FDO to release stocks or temporarily lower the companies’ obligation	Light handed measures would be considered (supplementary to stock release) in a severe and long lasting disruption, including information campaigns and making alternative forms of transportation more attractive		Limited potential for switching from oil to coal or natural gas in power and heating plants	Although Denmark is a significant producer, production in the North Sea is normally operated at full capacity with no or minimal potential to increase output	

Member State	Emergency stocks			Demand restraint measures	Rationing/Allocation	Fuel switching	Production surge	Relaxing fuel specifications
	Quantity on 31/12/2013	Stockholding system	Release procedure					
Estonia	0.2 Mt (73 days of consumption)	All stocks held by OSPA, the Estonian central stockholding entity	Stocks to be sold at market prices to shortlisted market players based on their market share	Possible measures include ecodriving, car pooling and sharing, better utilisation of public transport, speed limits, encouraging home office; estimated saving of ~8%		Limited scope for fuel switching; to a small extent local shale oil can replace imported fuel oil	Not available	The government can authorise the non-application of requirements related to climatic conditions
Finland	3.7 Mt (162 days of net imports)	Government stocks held by the National Emergency Supply Agency (NESA), complemented by a stockholding obligation imposed on industry	NESA releases stocks by public tender; NESA may also authorize industry to use their obligated stocks	Considered as a secondary measure that could complement a stock release in case of a long lasting severe supply disruption; possible measures include lowering room temperatures and speed limits, limitations of car use	Possible rationing of traffic fuels and light/heavy fuel oils in space heating, industrial use and agricultural use	Little potential, estimated at maximum 3% of the total oil consumption in the industry and transformation sector	Not available	
France	19.3 Mt (91 days of net imports)	Stockholding obligation imposed on companies which has to delegate part of their obligation to SAGESS, the country's central stockholding entity	SAGESS stocks can be loaned or exchanged with industry stocks (relocalisation); the industry's stockholding obligation can be lowered	A wide range of measures are set out in the Hydrocarbon Resources Plan, ranging from voluntary (e.g. information campaigns) to compulsory (e.g. lower speed limits, limiting fuel distribution); certain measures can be decided at regional (department) level	Mandatory rationing and allocation of fuels to priority consumers is possible; estimated saving is maximum 9%	Little scope for fuel switching	Not relevant	
Germany	24.8 Mt (105 days of net imports)	All emergency stocks are held by EBV, the Germen central stockholding entity	EBV offers the stocks to its member companies at market prices	Several measures are available, including speed limits, prohibitions on the use of vehicles and a ban on Sunday driving; such measures are considered in the event of a severe or long-lasting disruption	Rationing of motor fuels (issuing ration coupons) and heating oil (selling only partial amounts to consumers) is foreseen as a last resort; in case of motor fuels, a saving of up to 50 % is estimated	Very limited possibilities for reducing oil consumption in the short term by fuel switching	Not available	
Greece	3.3 Mt (96 days of net imports)	Stockholding obligation imposed on industry (importers and large consumers); the new law allows the establishing of a central stockholding entity by a decree	Stocks are released by a temporary decrease of the obligation or by instructing companies to reduce stock levels	Several voluntary (e.g. encouraging public transport and car sharing) and compulsory (e.g. restrictions of car use and fuel sales) measures are foreseen		Oil products are widely used for electricity generation, especially in the islands, but these plants cannot switch to alternative fuels	Not relevant	
Hungary	1.1 Mt (98 days of net imports)	All emergency stocks are held by HUSA, the country's central stockholding entity	Stocks are offered to HUSA's member companies through a tender or the Minister can determine which consumers are entitled to purchase the released stocks	Light (e.g. encouraging public transport and lower temperatures in buildings) and heavy-handed (e.g. speed and driving restrictions, restricting fuel sales) measures are available	For motor fuel, rationing tickets can be introduced; for fuel oil, quotas can be established	There is virtually no ability to switch from oil to other fuels	Not available	

Member State	Emergency stocks			Demand restraint measures	Rationing/Allocation	Fuel switching	Production surge	Relaxing fuel specifications
	Quantity on 31/12/2013	Stockholding system	Release procedure					
Ireland	1.6 Mt (92 days of net imports)	Practically all emergency stocks are held by NORA, the Irish central stockholding entity	In a domestic supply disruption, NORA stocks would be allocated to companies on the basis of their market share; in a global disruption, stocks would be made available to the market by tender	Considered secondary, to be introduced incrementally after a stock release; possible measures include speed limits, traffic restrictions and restrictions of fuel sales; the impact of voluntary measures (e.g. carpooling, increased use of public transport) is estimated at 6% of all transport demand		The limited role of oil in electricity generation makes the fuel switching potential negligible	Not relevant	
Italy	13.2 Mt (90 days of net imports)	Stockholding obligation imposed in industry but the newly established central stockholding entity (OCSIT) will gradually take over 1/3 of the obligation	A ministerial decree would authorise companies to reduce their mandatory stocks by a certain amount, and to make these stocks available to the market	The measures foreseen include appeals to the public for voluntary measures to limit consumption, a reduction in domestic heating and driving restrictions/bans		Around a third of oil-fired electricity generation plants can switch to natural gas in the event of an emergency; however, the share of oil is shrinking in this sector	Very limited potential as active fields operate at or close to maximum capacity	Not foreseen as it would cause practical difficulties (segregation of products intended for export to countries that have not implemented such measures)
Latvia	0.3 Mt (94 days of net imports)	The Ministry of Economy acts as the Latvian central stockholding entity; the Ministry purchases emergency oil stocks service from economic operators selected by open tenders	The companies holding the stocks for the benefit of the central stockholding entity would be authorized to use/sell (part of) the stocks	Depending on the level of the crisis (3 levels), the consumption of different user groups (3 groups) can be restricted by a predetermined maximum percentage (up to 100% for the third group)	Supplies can be prioritised to certain groups of energy users		Not relevant	
Lithuania	0.5 Mt (95 days of net imports)	The Lithuanian Oil Products Agency, the country's central stockholding entity, holds 30 days of specific stocks, with the rest of the obligation covered by companies	The Government can decide on the use of stocks; in case of industry stocks, the obligation would be lowered	Possible limitation of energy supply to consumers			Not relevant	
Luxembourg	0.7 Mt (91 days of net imports)	Stockholding obligation imposed on importers; the new draft law envisages the establishing of a central stockholding entity but it is role is not clear yet	The minister can request companies to release stocks	A coordination of demand restraint measures (e.g. speed limits, driving bans reduced deliveries) is foreseen with the other Benelux countries		There is no potential to switch away from oil to other energy sources in power generation	Not relevant	
Malta	0.2 Mt (78 days of net imports)	Stockholding obligation imposed on the industry, overseen by the Malta Resources Authority (MRA)	The Minister may direct the MRA to release stocks	The Minister may direct the MRA to impose restrictions on consumption	Possible allocation of oil products to certain groups of users on a priority basis		Not relevant	

Member State	Emergency stocks			Demand restraint measures	Rationing/Allocation	Fuel switching	Production surge	Relaxing fuel specifications
	Quantity on 31/12/2013	Stockholding system	Release procedure					
Netherlands	5.6 Mt (108 days of net imports)	The stockholding obligation is shared between COVA, the Dutch central stockholding entity and oil companies	COVA stocks are made available through a tendering mechanism; for industry-held stocks, the obligation can be lowered	Focus on voluntary measures; if voluntary measures prove to be inadequate, the authorities can proceed to obligatory measures (e.g. speed limits and Sunday driving bans); in practice, demand restraint measures would only be considered for longer lasting supply disruptions	Supply to priority end-users and critical infrastructure sectors	Inconsequential (oil use is concentrated in transport and the petrochemical sector where it has no viable alternatives)	Not available as oil fields are normally operated at full capacity	
Poland	6.6 Mt (101 days of net imports)	Stockholding obligation imposed on industry, complemented by government stocks held by the Material Reserve Agency	Government stocks can be released through auction, tender or sales to specific entities; industry stocks can be made available by reducing the obligation or instructing industry to make a stockdraw	Ranging from light-handed (e.g. encouraging ecodriving and public transport) to compulsory measures (e.g. restrictions on fuel sales, speed limits, driving restrictions/bans); savings can reach up to an estimated 20% of transport fuel consumption	Rationing of fuels is possible	Fuel switching capacity in the transformation sector is estimated to be insignificant	Not available	
Portugal	2.7 Mt (94 days of net imports)	EGREP, the central stockholding entity holds 1/3 of the emergency stocks, with the rest of the obligation imposed on industry	EGREP stocks are offered at market price to industry operators based on their market share; for industry stocks, the minister can lower the obligation - oil companies may be requested to demonstrate that they are not hoarding products	Both voluntary (e.g. media campaigns to encourage lower energy use) and compulsory (e.g. speed limits, driving bans, restrictions of fuel sales) measures are available	Priority can be given to the supply of motor fuels to entities whose activity is considered essential	Fuel switching capacity is very limited in the short term	Not relevant	Possibility to increase available supplies by easing product specifications and allowing for possible relaxation of emission objectives in case of emergency
Romania	1.4 Mt (69 days of consumption)	Stockholding obligation imposed on the industry	The Government can decide on the use of stocks					
Slovakia	0.7 Mt (96 days of net imports)	Stockholding obligation imposed on the industry but stocks are held by the Emergency Oil Stocks Agency (EOSA), the country's central stockholding entity, on behalf of the industry	The release of public stocks could be implemented either in the form of loans or sales (preference for loans); private companies can be ordered to draw down their stocks in an emergency	5 different stages are foreseen, depending on the severity of the crisis; possible measures include speed limits, restrictions of motor vehicle use based on odd/even car plates, limiting the opening hours of petrol stations and other restrictions of fuel sales		Fuel switching capacity is considered inconsequential in the short term	Not available	
Slovenia	0.6 Mt (96 days of net imports)	All stocks are held by ZRSBR, the Slovenian central stockholding entity	The government can order the release of stocks; in that case, stocks are offered to the agency's member companies; as a second step, stocks could be sold through international tender	The government can order demand restraint measures	The government can decide on the allocation of oil products to certain groups of users on a priority basis		Not relevant	

Member State	Emergency stocks			Demand restraint measures	Rationing/Allocation	Fuel switching	Production surge	Relaxing fuel specifications
	Quantity on 31/12/2013	Stockholding system	Release procedure					
Spain	14.8 Mt (99 days of net imports)	Stockholding obligation imposed on companies, but about half of the stocks are held by CORES, the Spanish central stockholding entity	Industry stocks are released by lowering the stockholding obligation; CORES stocks would be sold to market operators based on their market share; in case of a regional disruption, stocks can also be relocated within the country	3 three sets of measures are distinguished according to the seriousness of the crisis; possible measures include carpooling, fare reduction and service increase in public transport, speed limits and driving bans based on odd/even license plates	Possible measures include the limitation or allocation of supply to consumers of any oil products as well as restrictions on their use	In the case of an emergency, some diesel-fuelled power stations can switch to heavy fuel oil but the saving would be negligible	Not available	
Sweden	2.6 Mt (84 days of net imports)	Stockholding obligation imposed on the industry	By reducing the obligation, thereby granting operators permission to draw stocks below the minimum level	Light handed measures (e.g. information campaign to encourage oil savings) would be considered to supplement stock release in case of a severe and long lasting crisis; speed limits and Sunday driving bans could be also used	A rationing system would be considered as a last resort; it would require parliamentary approval	Short-term fuel switching capacity is considered inconsequential and there are no incentives or policy options to incite such switching in case of a disruption	Not relevant	In the case of an oil crisis, no environmental regulations would be altered to allow for greater use of fuel switching
United Kingdom	11.7 Mt (60 days of consumption)	Stockholding obligation imposed on the industry (refiners and importers)	Stocks to be released through the reduction of the stockholding obligation; stocks will be expected to be drawn down within an agreed timeframe	The UK has a clearly defined demand restraint programme set out in the National Emergency Plan for Fuel which focuses on prioritising supply to critical users and filling stations while restricting the purchases of the general public (maximum purchase scheme)	Fuels can be prioritised to critical users (e.g. emergency services, utilities) through designated filling stations	As oil-fired electricity generation is minimal, the scope for fuel switching is limited	Not available, production is assumed to be operating at maximum economic rates	

The information in this table is primarily based on the findings of the IEA Emergency Response Reviews carried out in 2008-2013 and the national laws transposing Council Directive 2009/119/EC; in some cases the information could be incomplete and/or not entirely up-to-date