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Member State's Energy Dependence: An Indicator-Based Assessment

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Member State's Energy Dependence:

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ABBREVIATIONS

COUNTRIES

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	The Czech Republic
CIS	Commonwealth of Independent States
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	The Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RU	Russia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UA	Ukraine
UK	The United Kingdom
US	United States

OTHERS

bn	Billion
CA	Current account
CDM	Clean Development Mechanism
CHP	Combined heat and power
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
DG ENER	Directorate-General for Energy
DSO	Distribution system operator
EBRD	European Bank for Reconstruction and Development
EDI	Energy dependence indicators
EEPR	European Energy Programme for Recovery
EC	European Commission
EEA	European Economic Area
EMCC1	European Market Coupling Company

ERGEG	European Regulators' Group for Gas and Electricity
ESO	Electricity system operator
ETS	Emission Trading Scheme
EU	European Union
EUR	Euro
Euratom	European Atomic Energy Community
FEC	Final energy consumption
GDP	Gross domestic product
GIC	Gross inland consumption
GIS	Green Investment Scheme
GHG	Greenhouse gas
GVA	Gross value added
GWh	Gigawatt hour
HHI	Herfindahl-Hirschman index
HICP	Harmonized index of consumer prices
HVDC	High-voltage direct current
IEA	International Energy Agency
ILUC	Indirect land use change
ITO	Independent transmission system operator
JRC	Joint Research Center
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LTC	Long-term gas contract
LULUCF	Land use, land use change and forestry
kcal	Kilocalories
kg	Kilogram
km	Kilometre
ktoe	Kilo tonnes of oil equivalent
kV	Kilo volt
kWh	Kilowatt hour
mcm	Million cubic metre
MS	Member State
Mt	Million tonnes
Mtoe	Million tonnes of oil equivalent
MURE	Mesures d'Utilisation Rationnelle de l'Energie
MW	Megawatt
MWe	Megawatt electrical
NEEAP	National Energy Efficiency Action Plan
NGL	Natural Gas Liquids
NREAP	National Renewable Energy Action Plan
NTC	Net transfer capacity
OPEC	Organization of the Petroleum Exporting Countries
OTC	Over-the-counter
PJ	Petajoule
PPS	Purchasing power standard
pp	Percentage points
PSO	Public service obligation
PV	Photovoltaic
REFIT	Renewable energy feed-in tariff
RES	Renewable energy sources
SEM	Single electricity market
tCO2-eq	Tonnes of carbon dioxide equivalent
TSO	Transmission system operator

TJ	Terajoule
toe	Tonnes of oil equivalent
tU	Tonnes uranium
TWh	Terawatt hour
VAT	Value-added tax

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EXECUTIVE SUMMARY

The main objective of this report is to assess the recent development regarding Member States energy dependence and their potential vulnerability to energy price hikes and supply shortages. In order to assess it, a set of energy dependence indicators (EDI) was designed last year ([1]) and the present report looks at the evolution of these indicators over the recent years.

Chapter 1 analyses the diversification of EU imports. One of the main ways to reduce the vulnerability of Member States from energy supply shocks is to reduce the excessive reliance on a single supplier in order to benefit from competition and from reduced risks related to asymmetric events affecting only one supplier. While trading with partners within the Economic European Area (EEA) may present additional benefits in the form of stronger market integration, trading outside of it may imply the risk of increased reliance on the market power of one exporter that may in turn impact on trade and diplomatic relations. For this reason the share of imports from non-EEA countries is also assessed.

As far as gas is concerned, the EU increased the diversification of its import sources from EEA and non EEA countries, but only very marginally reduced its import dependence. Some Member States are still highly reliant on a single supplier outside the EEA, e.g. Bulgaria, Estonia, Finland, Lithuania, Slovakia and Latvia import their gas needs from Russia.

The situation is more contrasted for solid fuels. The concentration of import sources and the import from non-EEA countries both grew markedly while import dependence increased albeit only slightly. The evolution of the solid fuels consumption will have to be monitored closely as there are indications of their growing importance especially in some large Member States. The availability of cheap American coal can be observed in the fast increasing share of imports coming from the US. This evolution has had negative impacts on the diversification of import sources and will also affect the carbon performances of Member States which may in the future face higher costs.

By contrast, the evolution of the indicators related to petroleum products provides with a more stable picture. The diversification of import sources slightly improved while the import dependence deteriorated. At Member States level the tendency has been towards a generalised decrease of the importance of petroleum products in the energy mix. At the same time however some traditionally oil producing countries are registering a fast decline in their crude oil output which will imply a growing import dependence for them and a potentially higher reliance on other import sources for their neighbouring Member States.

The second chapter of this report focuses on the energy efficiency developments over the past decades. One way to reduce the vulnerability of a country to price shock is to reduce its energy intensity. Low energy intensity means low energy use per unit of GDP, which implies that the economy is less influenced by changes in energy prices. However, energy intensity evolution may not only indicate improvements in energy savings, but also structural changes in the economy. For this reason, the chapter disentangles the energy efficiency effect from the restructuring effect. It also analyses the main drivers behind energy intensity developments.

Over the past decades, the energy intensity of EU economies has improved, in line with the Europe 2020 strategy. The improvement has been, however, achieved in various ways across the EU-28. For instance, in most new Member States it has been very much dependent on a sectoral reallocation in the economy at large, but also within the manufacturing sector. Moreover, the improvement of energy intensity is not spread evenly across sectors but depends to a large extent on the performance of manufacturing. Other

([1]) Member State's Energy Dependence: An Indicator-Based Assessment, Occasional Paper, 145/April 2013. Three dimensions of energy dependence are considered for this analysis: (1) security of energy supply, (2) energy and carbon intensity, and (3) contribution of energy products to trade. The performance of each of the 28 Member States is analysed and compared along each of these three dimensions.

sectors, such as transport and services, seem to have ample space to increase their contribution to energy savings.

The analysis of the drivers suggests that energy efficiency improvements are mostly driven by economic wealth, but also by investments and innovation. Green innovation can push the technological frontier and plays a critical role in boosting energy efficiency in goods and services. At the same time, the role of energy prices as a signal to invest in clean technologies or to reduce energy consumption has to be acknowledged and calls for the use of market-based instruments.

Part I

1. ENERGY DEPENDENCE IN MEMBER STATES AND DIVERSIFICATION OF ENERGY IMPORTS

The purpose of the Energy Dependence Indicators (EDI) ([2]) is to assess the main dimensions of energy dependence. Three broad dimensions are identified as relevant: (1) security of supply, defined as the uninterrupted availability of energy sources at an affordable price; (2) energy and carbon intensity as their improvement contributes to reducing energy dependence while bringing additional economic and environmental benefits; (3) the contribution of energy products to trade given its potential impact on the current account deficit.

1.1. ENERGY DEPENDENCE IN EU MEMBER STATES

1.1.1. Security of Energy Supply

The first pillar of the EDI relates to security of energy supply ([3]) and it is composed of three sets of data on energy dependence, the diversification of the import sources and the composition of the energy mix.

In 2012, total primary energy dependence for the EU stabilizes at roughly half of the EU's energy needs, essentially the same level as in 2006. After a period of constant growth, between 2000 and 2006, energy dependence seems now to be fluctuating at around 52-53%, with a noticeable spike in 2008 when it reached 55%.

Between 2008 and 2012, a clearly declining trend can be observed for the vast majority of Member States. However if the comparison is made, with levels from the beginning of the century a more mixed picture emerges. Similarly as for the aggregate figures of the whole EU, energy dependence has almost invariably increased between 2001 and 2008, when it started to slowly decline. This appears to be due in part to the drop in energy consumption at the beginning of the crisis and in part to the rapid development of domestic renewable energy sources. A particularly large increase between 2008 and 2012 took place in the United Kingdom and Lithuania. For the United Kingdom it remains at a relatively low level, but for Lithuania it has now reached 80%, well above the EU average. Finally Denmark remains the only Member State to be a net energy exporter although increasingly less so: energy dependence went from -6.1% in 2011 to -3.4% in 2012.

Petroleum products import dependence is very high in the EU and it equalled 86% in 2012. Most Member States depend fully or almost fully on imports for their petroleum products supply. Their degree of dependence in 2012 has remained broadly stable compared to the levels recorded both in 2001 and 2008. Some notable exceptions are Estonia and Finland, where import dependence declined by 18% and 10% respectively compared to 2001; in Lithuania import dependence increased significantly by 26%, while the United Kingdom went from being a net exporter to becoming a net importer of some 36% of its petroleum products consumption. Finally, Denmark remains the only net exporter in the EU, but its degree of net export in 2012 was 35% down from 49% in 2008 and this is the lowest level registered in a decade.

Gas import dependence in the EU has been on an almost constant increasing trend since the beginning of the century when it was less than 50% compared to 66% in 2012. This can also be observed at Member States level where gas import dependence compared to 2001 has increased (or at best remained stable) in all countries, with the exception of Bulgaria and the Czech Republic. Overall, gas import dependence in Member States remains very high with 14 countries still recording levels of 90% or above. A slightly more mixed picture emerges when studying the evolution since 2008. Several countries reduced their gas import dependence, most notably Romania and Hungary, besides Bulgaria and the Czech Republic since then. Conversely dependence increased significantly in the United Kingdom and Croatia where domestic gas production has been diminishing at a rapid pace and as a result these

([2]) European Commission (2013),

([3]) Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance, while long-term energy security is linked to timely investments in energy supply and infrastructure;

Table I.1.1:

Energy dependence indicators related to the security of energy supply dimension*

	Security of energy supply																
	Import dependence**				HHI energy imports			Non-EEA share of imports			Gross inland energy consumption, shares by fuel						
	Gas (%)	Oil (%)	Solid fuels (%)	**Total Primary (%)**	Gas	Oil	Solid fuels	Gas (%)	Oil (%)	Solid fuels (%)	Gas (%)	Oil (%)	Nuclear (%)	Renewables (%)	Solid fuels (%)	HHI energy sources
	2008-2012	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**
AT	87	91	100	66	0.47	0.12	0.32	86	55	18	23	37	0	27	10	0.27
BE	99	100	96	77	0.27	0.17	0.21	30	57	89	26	40	20	4	6	0.28
BG	91	99	28	42	1.00	0.53	0.53	100	87	99	13	22	22	7	39	0.27
CY				97		0.08	0.96		45	100	0	95	0	4	0	0.91
CZ	97	96	-16	27	0.78	0.28	0.62	85	72	12	16	21	17	6	42	0.28
DE	84	95	39	61	0.30	0.13	0.15	45	58	86	22	34	10	9	24	0.24
DK	-78	-47	96	-13		0.18	0.28		23	91	20	39	0	19	18	0.27
EE	100	61	0	18	1.00	0.28	0.75	100	42	99	10	19	0	13	61	0.44
ES	100	99	79	77	0.21	0.06	0.18	89	83	99	23	46	12	10	9	0.30
FI	100	96	68	51	1.00	0.59	0.45	100	84	90	10	28	17	26	16	0.21
FR	98	98	99	50	0.20	0.07	0.15	46	73	87	15	32	42	7	4	0.31
EL	100	98	3	68	0.41	0.15	0.39	98	88	83	12	52	0	7	28	0.37
HR	20		98	54	0.78	0.33	0.31	57	71	95	29	46	0	11	8	0.31
HU	78	81	40	57	0.83	0.67	0.31	96	84	61	37	26	16	7	11	0.25
IE	95	99	61	88	1.00	0.49	0.48	0	12	85	29	51	0	5	15	0.37
IT	90	92	99	83	0.21	0.11	0.18	83	95	95	38	40	0	10	9	0.33
LT	99	93	94	70	1.00	0.83	0.66	100	95	98	33	33	12	14	3	0.29
LU	100	100	100	97	0.34	0.59	0.58	36	0	100	24	63	0	3	1	0.46
LV	96	99	97	56	1.00	0.24	0.67	100	48	92	28	33	0	33	2	0.30
MT		100		100							0	100	0	0	0	0.99
NL	-68	95	107	32	0.38	0.08	0.25	14	62	95	43	41	1	4	9	0.36
PL	72	97	-5	31	0.69	0.61	0.41	87	83	81	13	25	0	7	54	0.38
PT	101	100	99	79	0.43	0.08	0.44	100	81	96	18	50	0	20	10	0.33
RO	21	51	18	23	0.88	0.29	0.23	94	86	64	30	26	8	15	22	0.23
SE	98	99	88	35	1.00	0.22	0.18	0	40	72	2	27	31	34	5	0.29
SI	100	101	21	51	0.35	0.22	0.52	73	17	78	11	36	21	14	20	0.25
SK	100	89	83	64	1.00	0.67	0.29	100	84	41	27	21	23	7	22	0.22
UK	37	19	68	32	0.40	0.18	0.27	26	40	97	37	35	8	3	16	0.29
EA											24	37	15	9	13	0.25
EU28	64	85	42	54	0.17	0.09	0.14	59	67	87	24	35	14	9	17	0.24

*For sources and indicators, see Annex 1. Please note that colours only indicate top and bottom values and have no qualitative assessment attached.

**Total import dependence does not include electricity. Data for import dependence in solid fuels come from DG ENER's Country Factsheets, while all the other data come from Eurostat.

two countries increasingly rely on imports for their gas needs.

Solid fuels import dependence for the EU increased between 2001 and 2012 by 25%. However after reaching its peak in 2008 at 44%, solid fuels import dependence started to slowly decrease and in 2012 it was equal to 42%. In 9 Member States solid fuels import dependence remains very high with levels of 90% or above. Since 2001 the biggest increase occurred in Latvia, where its imports of solid fuels went from 50% to 100% of its consumption. The dependence also increased substantially in Germany and Spain. More recent trends show that since 2008 there has been a generalised decline in solid fuels import dependence, most notably in Bulgaria, Greece, Romania and Slovenia. A case to be singled out is Estonia, which went from being a net exporter in 2009-2011 to becoming a net importer in 2012, albeit with a small margin. The Czech Republic and Poland are the only two remaining net exporters of solid fuels, but their net exports have decreased dramatically since 2001.

While import dependence may be an inescapable necessity for Member States without sufficient domestic energy sources, the diversification of import origins may help to limit the potential impact from supply disruptions and bring benefits in terms of wider competition. In addition, the share of imports from non-EEA countries is regarded as a proxy for political stability risks. Member States relying more on EEA imports can be considered to be less exposed to possible energy supply disruptions due to political or diplomatic crisis. A more detailed treatment of the evolution of import diversification in Member States can be found in section 2.2.

For petroleum products the import sources of the EU are well diversified and the HHI remained broadly stable since 2008 at around 0.09 ([4]). The share of imports from non-EEA has, however, steadily increased moving from 64% in 2006, to 67% in 2008 and to 69% in 2012.

The evolution of the diversification of gas imports to the EU has progressed quite well since 2006. The share of gas imports from non-EEA has at the same time continuously dropped, from 62% in 2006 to 60% in 2010 and to 55% in 2012.

For solid fuels the diversification of import sources has deteriorated since 2008. Thus, the share of imports from non-EEA countries has increased from 87% in 2008 to 89% in 2012. In particular the share of US imports has increased significantly over this period, going from just 12% in 2008 to 21% in 2012. A similar trend can be observed for the imports from Colombia, which went from 10% to 21%. Both the US and Colombia have almost reached the level of Russia's import share.

Another indicator that can be assessed is the HHI for the energy mix, i.e. the degree of diversification of the composition of the energy mix of a Member State. All other things being equal, the more diversified a country's energy mix is, the less likely it is to suffer from the impact of a supply shock affecting one specific energy source.

The HHI for the energy mix of the whole EU has been progressively decreasing, signalling a growing diversification of the mix. It has gone from 0.25 in 2008 to 0.23 in 2012. In terms of energy sources, renewable energy continues to increase its importance and recorded the greatest percentage increase going from 8% in 2008 to 11% in 2012. The share of solid fuels recorded an increase between 2010 and 2011, going from 16% to 17% bringing it back to its 2008 level, while the share of gas dropped of 2 pp compared to 2008. This is a remarkable inversion of the trend after a decade of almost uninterrupted growth of the gas use. The share of nuclear slightly increased compared to 2008, while the share of petroleum products, similarly to gas, dropped of 2 pp. The oil share had been steadily declining from the early 2000s.

The share of petroleum products has generally decreased across Member States between 2001 and 2012. The only exceptions have been Slovakia and Poland (+ 3 pp), Lithuania and the Netherlands (+ 4 pp) and the Czech Republic (+ 1 pp). However all these countries, except Lithuania, have reverted the trend since 2008, when the share of petroleum products started decreasing everywhere in the EU. Finally, Cyprus and Malta remain almost completely dependent on petroleum products for their energy mix; nonetheless a small decline took place in both countries.

The contribution of gas to Member States' energy mixes did not follow a homogeneous trend. Between 2001 and 2012 roughly half of the countries increased their share of gas, while the other half decreased it. The most remarkable changes occurred in Greece, where it tripled, and in Portugal and Spain, where it doubled. At the other end of the ranks are Estonia, Finland, Slovakia and Slovenia, where the biggest decline in the share of gas took place.

The evolution of the share of solid fuels has known a marked and rather generalised decrease between 2001 and 2012. However some notable exceptions are Lithuania, Italy, Croatia, the United Kingdom and Estonia where the share has gone up considerably. It is to be noted that since 2008 the share of solid fuels has started growing again in a substantial number of countries; besides those mentioned above the positive trend can also be observed in Portugal, Ireland, Spain, Greece and Germany. The Member States with the highest shares of solid fuels in 2012 were Estonia, Bulgaria, Czech Republic, Greece and Poland, which are all characterized by a significant domestic production.

Nuclear energy plays a significant role in some Member States, while it is not used at all by 14 of them. The share of nuclear energy has been steadily declining between 2001 and 2008, but it has picked up again in a number of Member States since 2008. This is particularly the case of the United Kingdom, the Czech Republic, Hungary, Romania and Spain. At the same time, Lithuania has phased out nuclear energy completely since

([4]) It must underlined, however, that if only crude oil imports is considered the import diversification is lower with the HHI being 0.14.

Table I.1.2:
Electricity mix in the EU*

	Import dependence	Share electricity generation by fuel					
	Electricity (%)	Gas (%)	Oil (%)	Nuclear (%)	Rene-wables (%)	Solid fuels (%)	HHI electricity generation
	2008-2012	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**	**2008-2012**
AT	6	20	2	0	71	7	0.55
BE	5	32	0	52	9	5	0.38
BG	-27	5	1	34	11	50	0.38
CY	0	0	98	0	2	0	0.96
CZ	-26	5	0	33	8	55	0.42
DE	-3	15	1	20	19	43	0.29
DK	5	18	2	0	35	43	0.35
EE	-29	6	0	0	8	86	0.76
ES	-4	32	6	20	28	14	0.25
FI	17	14	1	31	34	20	0.27
FR	-10	5	1	77	14	4	0.61
EL	8	20	12	0	15	53	0.36
HR	41	21	10	0	51	19	0.35
HU	17	31	1	42	7	18	0.32
IE	2	56	3	0	16	25	0.41
IT	15	51	8	0	26	14	0.36
LT	36	39	6	0	23	0	0.47
LU	64	66	0	0	33	0	0.55
LV	25	41	0	0	59	0	0.52
MT	0	0	100	0	0	0	0.99
NL	9	62	1	4	10	21	0.44
PL	-2	4	2	0	7	87	0.76
PT	12	28	6	0	43	22	0.33
RO	-5	14	1	19	28	38	0.28
SE	-3	1	1	40	57	1	0.48
SI	-15	3	0	36	28	32	0.32
SK	3	10	2	54	20	14	0.36
UK	2	41	1	17	9	31	0.31
EA	1						
EU28	1	23	3	27	21	26	0.24

* For sources and indicators, see Annex 1

2009 and Germany decreased the share from 12.5% to 8%.

Renewable energy has been growing steadily as a share of Member States' energy mixes since 2001. The starting points of Member States differed considerably. For example Austria, Latvia, Finland and Sweden had shares of renewables above 20% already at the beginning of the decade. At the same time a number of other Member States had shares of renewables below 2%. Among these Member States, there are some, such as Belgium, Ireland and the United Kingdom, which have made dramatic progress but yet display relatively low shares. Some of the most remarkable increases were recorded in Spain, Italy, Bulgaria and Greece, all of which nearly doubled their shares of renewables between 2008 and 2012. Malta remains the country with the lowest share of renewables, barely 1% in 2012.

Electricity import dependence is virtually non-existent for the EU as a whole; however several countries import a significant share of their electricity needs, essentially from other EU Member States. In 2012, the Member States with the highest import dependence for electricity were Latvia, Lithuania, Croatia, Luxembourg and Hungary. Electricity dependence appears as a rather structural phenomenon, with some Member States constantly being net importers and others being net exporters. Lithuania is a special case as it turned in two years, between 2009 and 2010, from being a net exporter to having to import more than 70% of its electricity consumption. This reflects the phase out of nuclear energy. A similar turnaround happened in Slovakia between 2006 and 2007 albeit on a much less dramatic scale, the country went from an import dependence of -10% to +7%.

Renewables and solid fuels are the only two sources which increased their respective shares in the EU electricity mix. The most dramatic drop was that of gas which went from a share of 24% in 2008 to 19% in 2012. Member States where the share of solid fuels increased the most over the period 2008-2012 were Italy and the United Kingdom. At the same time the share of renewables increased everywhere in different degrees, except in Romania. As regards the other fuels, the share of gas declined in the EU electricity mix, most notably in the United Kingdom, Spain, Portugal, Sweden and Finland. The share of nuclear has also decreased (from 23% to 16% in Germany, from 28% to 0% in Lithuania).

1.1.2. Energy and Carbon Intensity

The second pillar of the EDI assesses the performances of Member States in terms of energy intensity ([5]) and carbon intensity ([6]).

The EU as a whole has made stable progress in terms of reducing the energy intensity of the economy. The declining trend has been uninterrupted for the most part of the past decade, with the exception of 2010 when a small increase took place compared to the previous year. In 2011 and 2012, the energy intensity of the economy declined bringing it down to an historical low.

Member States' performances have also been characterised by a generalised decline in energy intensity of the economy. Between 2001 and 2012 all Member States improved their performances to different degrees, depending also on their starting points. However, since 2008 this development was reversed in a group of countries as the energy intensity increased in Latvia, Greece and Estonia, while in the other countries their improvements continued. Most notably, Greece has been increasing its energy intensity since 2010 ([7]) and it is now back to a level close to the level it had in 2005.

The CO2 intensity of the economy for the whole EU decreased substantially since 2001 by about 23%. It declined for all Member States. However, similarly to the energy intensity, a trend break occurred around 2008 for a group of countries when the carbon intensity of these economies started increasing. This is the case for Bulgaria,

([5]) All other things being equal, the higher the energy intensity of the economy, the more vulnerable a Member State is to energy price shocks and the more prone it is to face negative consequences in terms of GDP loss. Moreover, the more energy intensive the industrial and the transport sectors are, the more vulnerable a Member State is to competitiveness loss. The higher the share of energy of households' consumption, the more significant the impact of energy policies are on households’ overall consumption patterns.

([6]) All other things being equal, the higher the carbon intensity of the energy sector, the more vulnerable a Member State is to more stringent climate change mitigation policies and the more inclined it is to face negative consequences in terms of related inflationary pressures and competitiveness loss. Moreover, the higher the share of energy intensive industries and the more carbon intensive the transport sector, the more potentially vulnerable the Member State is to competitiveness loss and the risk of carbon leakage.

([7]) This reflects the fact that GDP has been falling more than the gross inland energy consumption.

Table I.1.3:
Energy dependence indicators related to the energy and carbon intensity dimension*

	Energy and carbon intensity of the economy									
	Energy intensity of the economy (kgoe/1000 EUR)	Energy intensity of industry (kgoe/1000 EUR)	Energy intensity of transport (kgoe/1000 EUR)	Energy intensity of households (kgoe/1000 EUR)	CO2 intensity of the economy (ton CO2 eq./1000 EUR)	CO2 intensity of energy use (ton CO2 eq./toe)	Share of energy intensive sectors in total GVA (%)	CO2 intensity of transport sector (ton CO2 eq./1000 EUR)	CO2 intensity of households (ton CO2 eq./1000 EUR)	Weight of energy in HICP basket (%)
	2008-2012	2008-2012	2008-2012	2008-2012	2007-2011	2007-2011	2008-2012	2007-2011	2009-2011	2008-2012
AT	127	160	801	47	0.3	1.9	11.8	2.1	0.11	9
BE	182	236	617	50	0.4	1.8	11.1	1.6	0.17	11
BG	683	522	2398	120	2.4	2.6	12.7	6.4	0.06	13
CY	178	174	1656	33	0.6	2.7		3.5	0.18	10
CZ	364	226	891	107	1.2	2.6	15.3	2.5	0.15	14
DE	136	110	654	45	0.4	2.4	10.3	1.7	0.14	12
DK	92	77	435	44	0.3	2.5	9.9	1.2	0.09	11
EE	500	265	1035	155	1.6	2.9	12.2	2.9	0.19	13
ES	138	156	948	30	0.4	2.2	8.4	2.5	0.12	11
FI	212	321	615	61	0.4	1.6	11.2	1.7	0.08	8
FR	147	137	647	42	0.3	1.4	6.9	1.7	0.12	9
EL	154	176		38	0.6	3.3	7.2	2.0	0.12	8
HR	229	216		83	0.8	2.5			0.24	13
HU	284	142	1086	122	0.8	2.0	10.5	3.0	0.26	15
IE	88	75	1160	38	0.4	2.8		3.1	0.18	10
IT	121	127	645	36	0.4	2.4	8.8	1.8	0.13	8
LT	330	180	648	106	1.0	1.6		2.0	0.11	14
LU	137	335	1996	44	0.4	2.3		4.8	0.15	12
LV	342	382	1133	163	0.8	1.8		3.4	0.20	14
MT	165		275	22	0.6	2.9		0.6	0.10	6
NL	150	158	630	42	0.4	2.0	10.5	1.4	0.16	11
PL	320	206	1236	104	1.3	3.3	13.6	3.4	0.25	14
PT	154	216		30	0.5	2.1	9.1	2.8	0.12	12
RO	393	315	951	116	1.4	2.3	10.8	2.5	0.19	16
SE	152	194	506	46	0.2	1.0		1.2	0.07	11
SI	229	176	1132	69	0.6	2.2	14.7	3.4	0.20	14
SK	357	316	1085	83	1.0	1.8	15.8	2.9	0.19	17
UK	108	109		34	0.3	2.4	7.5	1.7	0.12	9
EA	142	141	709	41			9.2			10
EU28	148	144	729	44	0.6	2.2	9.2	1.9	0.19	10

* For sources and indicators, see Annex 1. Energy intensities are expressed in kgoe/1000 EUR, carbon intensities in tonnes of CO_2 eq./1000 EUR. Please note that colours only indicate top and bottom values and have no qualitative assessment attached.

Estonia, Greece and Latvia. In Romania the declining trend also stopped between 2010 and 2011, when **CO2** intensity increased by 4%.

Energy intensity of the industry in the EU fell by about 8% between 2008 and 2012. Since early 2000 energy intensity of the EU industry has been on a steadily declining trend. All Member States, except Luxembourg, decreased their energy intensity of industry over the period 2001-2012. Considering only the period 2008-2012, a more mixed picture emerged as the trend reverted in a number of countries, namely Lithuania, Finland, Latvia and Belgium. These results should be seen in the context of broadly stable levels of the share of energy intensive sectors in the gross value added (GVA). This share decreased slightly; from 10% to 9% at EU level, with as more significant decrease recorded for some Member States, notably the United Kingdom, Poland and Hungary.

The CO2 intensity of the power sector decreased in the EU between 2007 and 2011. The greatest drop took place in Belgium, Finland and Denmark. Conversely, in Bulgaria, Lithuania and Estonia the CO**2** intensity of energy use has increased. Looking at more recent developments, between 2010 and 2011 a slight increase in CO**2** intensity of energy use was recorded in several Member States. While it is too early to regard this as a reversal of the trend, it may nonetheless be ascribed to the growing share of coal in the energy and electricity mix of several Member States.

At EU level, energy intensity of transport has declined slightly by about 3% since 2008. The same trend can be observed for most Member States, with some countries recording much larger declines, notably Spain, Lithuania and Latvia. Conversely, in five Member States an increase in energy intensity of transport took place over the period 2008-2012. This is the case of Austria, Bulgaria, Cyprus, Romania and Germany.

The CO2 intensity of transport at EU level started to increase from 2009 after a decline since 2003. A similar mixed picture emerges in the Member States. The countries where the CO**2** intensity of transport has increased the most between 2007 and 2011 are Greece, Bulgaria and Romania. While for Greece the level has gone back to its 2003 values, for Bulgaria and Romania the CO**2** intensity of transport has reached record highs. Conversely, Lithuania, Latvia and Spain are the Member States which recorded the biggest decrease in CO**2** intensity of transport over the period 2007-2011.

The energy intensity of households at EU level has declined for the most part of the decade. However a break in the trend seems to be occurring in recent years and in 2012 it reached a level above the level of 2007. Generally the evolution of energy intensity of households is less positive than the evolution for the whole economy. Three countries (Italy, Greece and Spain) record a higher level in2012 than that they had in 2001. More worryingly, since 2008 the majority of Member States recorded an increase in energy intensity of households. Over this period the biggest increases took place in Lithuania, Italy, Greece and Croatia.

The CO2 intensity of households for the whole EU has declined by around 10% between 2008 and 2011. While many Member States recorded a steady decline over this period some others actually worsened their performances. Most notably this was the case in Estonia, Croatia, Romania and Latvia, whose absolute levels are among the highest in the EU.

Over the past decade all Member States experienced an increase in the weight of energy items in the consumers' basket (HICP) ([8]), with the exception of Denmark, Sweden and Romania. In some countries, notably Ireland, Italy, Luxembourg, Malta, Greece and United Kingdom the share doubled or more. The smallest increases took place in the Czech Republic, Slovakia and Bulgaria and Portugal. In 2013 the highest weights of energy in the HICP could be found in Hungary, Latvia, Lithuania, Croatia and Slovakia, while Italy and Greece left the group of the five lowest Member States as the weight of energy in households' consumption has continuously increased over time. This increasing trend of the weight of energy item in the consumers' basket indicate a growing vulnerability of Member States to energy price shocks and strengthen the case for renewed attention to the security of energy supply issue.

1.1.3. Contribution of energy products to trade

The analysis of the **contribution of energy products to trade** is organised around one key indicator and three indicators which result from a decomposition of the key indicator ([9]).

The European Union remains heavily dependent on import for its energy supply and

([8]) Another way to assess the vulnerability of Member States to energy supply shock is to look at the importance of energy items in the consumers' basket (HICP). Given the variety of weights that energy has in the consumers' basket of Member States, a rise in energy prices would impact differently on the disposable income of households.

([9]) The **(net) energy trade balance** is expressed as a percentage of GDP. All other things being equal, the more negative this balance, the higher the likelihood that the current account is vulnerable to energy price shocks, and hence the bigger the contribution of trade in energy products to an external imbalance. **Relative energy trade balance**, i.e. in terms of the size of_total cross-border energy trade (i.e. the sum of energy exports and imports). All other things being equal, the more energy imports outstrip energy exports relative to total trade in energy, the larger the energy trade deficit becomes and hence the more vulnerable the country is to energy shocks related to trade. **Share of energy trade in total trade**: all other things being equal, the larger the share of energy in a country's international trade, the larger the impact of the relative energy trade balance is on the net energy trade balance. **Macro trade openness**: the relative size of a country's international trade vis-à-vis the size of its economy. Note that this indicator is not energy-related. It expresses the notion that a higher macro trade openness amplifies the effects of the previous two factors.

Table I.1.4:

Energy dependence indicators related to the trade dimension*

Contribution of energy products to trade balance							
	Trade balance of energy products (% of GDP)			*Current account balance (% of GDP)*	DECOMPOSITION (related to total energy trade)		
	Petro-leum products	Gas	Total		Relative energy trade balance (%)	Share of energy in total trade (%)	*Macro trade openness (% of GDP)*
	2009-2013	**2009-2013**	**2009-2013**	**2008-2012**	**2013**	**2013**	**2013**
AT	-2.4	-0.8	-3.4	*2.8*	-61.8	6.8	85.8
BE	-2.8	-1.3	-4.3	*-0.7*	-15.9	15.6	181.0
BG	-4.3	-2.3	-6.4	*-6.9*	-28.0	19.4	120.4
CY	-6.7	-0.2	-6.9	*-10.5*	-70.0	26.2	38.0
CZ	-2.9	-1.6	-3.8	*-2.7*	-47.0	6.2	153.6
DE	-2.2	-1.0	-3.3	*6.3*	-59.6	8.3	72.7
DK	0.6	0.2	0.6	*4.6*	1.7	10.0	62.5
EE	-1.5	-1.2	-1.6	*-0.4*	-15.2	11.2	140.7
ES	-2.3	-0.9	-3.3	*-4.7*	-43.3	16.1	48.2
FI	-2.0	-0.4	-3.0	*0.5*	-26.9	16.8	59.1
FR	-2.1	-0.7	-2.8	*-1.8*	-63.4	10.7	46.1
EL	-2.7	-0.5	-3.3	*-9.8*	-22.4	37.7	40.8
HR	-3.3	-0.4	-4.7	*-3.0*	-45.1	19.7	57.0
HU	-2.8	-2.4	-5.8	*-0.8*	-52.1	7.8	159.8
IE	-2.2	-0.8	-3.1	*-0.2*	-71.8	5.9	82.4
IT	-1.8	-1.4	-3.4	*-2.4*	-58.6	12.1	48.0
LT	-3.4	-2.8	-6.8	*-2.7*	-18.2	27.3	147.4
LU	-4.1	0.0	-4.0	*6.7*	-90.9	6.1	74.7
LV	-3.2	-2.1	-5.2	*-1.1*	-43.1	11.5	103.8
MT	-4.7	-0.2	-4.9	*-3.4*	-44.8	22.9	97.8
NL	-3.3	-0.2	-3.6	*7.5*	-14.6	19.1	157.6
PL	-3.0	-0.3	-2.9	*-4.8*	-42.3	8.3	78.7
PT	-2.7	-0.9	-3.8	*-8.5*	-38.5	15.4	62.7
RO	-1.7	-0.5	-2.3	*-5.7*	-33.2	7.8	73.7
SE	-1.4	-0.2	-1.7	*7.3*	-23.7	11.3	58.7
SI	-4.7	-1.1	-5.6	*-1.0*	-38.7	10.1	144.3
SK	-2.2	-2.7	-5.8	*-2.5*	-37.0	9.3	175.3
UK	-0.3	-0.3	-0.8	*-2.2*	-16.7	12.6	47.4
EA	-2.2	-0.9	-3.3	*-0.1*			
EU28	-1.9	-0.8	-2.9	*-0.7*	-36.7	12.1	94.2

this is apparent in the persistently negative energy trade balance which in 2013 amounted to 3.1% of EU GDP up from 2.1% of 2009.

The main determinant of such trade deficit is the deficit for oil products which has shown an uninterrupted upward trend over the past ten years and it reached 2.1% of EU GDP in 2013. The gas trade balance has also been increasingly negative at EU level, albeit smaller in size and equalled 0.8% of EU GDP in 2013.

As far as Member States are concerned, the total energy trade deficit increased across the board between 2009 and 2013. The greatest energy trade deficits can be found in Malta Bulgaria, Cyprus Hungary and Lithuania. Denmark is the only EU Member State to have a positive energy trade balance although on a steadily declining trend since 2006 when it was 2.1% of GDP, until 2013 when it was a mere 0.1% of GDP.

The gas trade balance ([10]) is negative for all Member States except Denmark, where in 2013 it equalled 0.1% of GDP. The gas trade deficit increased in most Member States between 2009 and 2013. The biggest deficits can be found in Bulgaria, Hungary, Lithuania, Latvia and Slovakia where it is above 2% of GDP.

The relative trade balance for energy for the whole EU has slightly decreased from 2009 to 2013 going from 41.3% of GDP to 36.7%. A similar declining trend can be observed in the majority of Member States while a notable exception is Malta, where the relative trade deficit went from 0.4% in 2009 to 44.8% in 2013. Some minor increases took place also in the United Kingdom and the Netherlands, which however display some of the lowest relative trade deficits in the EU together with Belgium and Estonia. Denmark is the only country to display a positive relative trade balance in 2013, of 1.7% of GDP.

The share of energy in total trade has generally increased between 2009 and 2013 for the majority of Member States. The highest increase took place in Greece, Luxembourg, Portugal and Belgium, while the share decreased somewhat in Romania and Estonia.

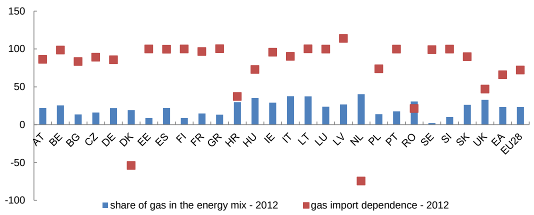
([10]) Reported as non-confidential and disseminated publicly. As already mentioned in European Commission (2013), due to data confidentiality, some of the statistics might not be complete for some Member States, which calls for caution when interpreting the results.

1.2. DIVERSIFICATION OF IMPORT SOURCES IN MEMBER STATES

One of the main ways to reduce the vulnerability of Member States from energy supply shocks is to reduce the excessive reliance on a single supplier. A well-diversified supply could bring benefits from competition and from reduced risks related to asymmetric events affecting only one supplier. In addition trading with partners within the EEA may present additional benefits in the form of stronger economic and political ties. For this reason the share of imports from non-EEA countries is also assessed, as a proxy for possible risks of diplomatic or political crisis that may in turn have an impact trade relations.

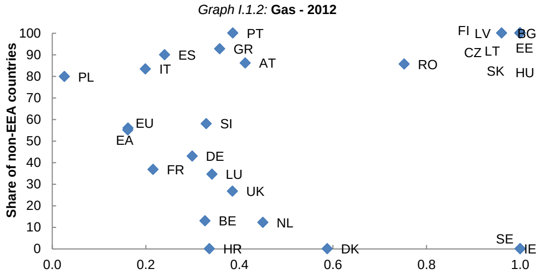
1.2.1. Gas

Graph I.1.1: **Share of gas in the energy mix and import dependence**



Source: Eurostat

Graph I.1.2: **Gas - 2012**



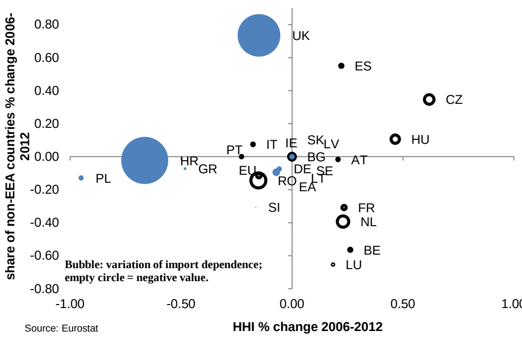
Source: Eurostat

Import dependence for gas is very high in a number of Member States. This is not surprising as domestic gas production in the EU is very limited and covers only around 30% of EU gas needs. More worrying is the extreme degree of concentration of import sources for several EU Member States. In fact the EU appears to be split in two groups of countries, those who have a wide pool of import routes and those that rely on only one supplier. This latter group includes the Member States in the upper right corner of Graph I.1.2. These countries also display a complete or almost complete import dependence. In the case of Latvia, Lithuania and Hungary the high import dependence and the high import concentration index is accompanied by a share of gas in the energy mix, which is considerably higher than the EU average. Conversely, in Finland, Estonia and Bulgaria gas plays a relatively more limited role in the energy mix.

When looking at the origin of the imports of these countries there is a further distinction to be made. Sweden and Ireland, despite being fully dependent on a single supplier, import all their gas needs via EEA countries, namely Denmark and the United Kingdom respectively. The remaining Member States in this group depend completely on Russia for their gas supply. These countries therefore present the highest degree of vulnerability from potential gas supply shocks ([11]).

In terms of evolution of the HHI for gas imports ([12]), the EU can be roughly divided into three groups of countries. About a third of the Member States had basically a stable position over time, another third increased its diversification and a third deteriorated their position. Croatia, Greece, Portugal, Italy and Slovenia are the Member States where diversification of import sources increased the most. Conversely the Czech Republic, Hungary, Belgium, France and the Netherlands are the Member States where the degree of diversification deteriorated the most.

Graph I.1.3: **Gas - evolution**



Source: Eurostat

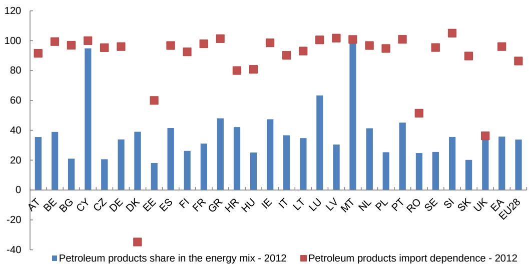
([11]) See also In-depth study on European Energy Security, European Commission SWD(2014)330.

([12]) The HHI is calculated as the sum of the squares of the import share of each supplying country. In the European Energy Security Strategy Communication (SWD/2014/330), the country-specific supplier concentration index (SCI) by fuel was computed. This is calculated 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).

While for the vast majority of Member States the share of imports from non-EEA countries either declined or remained unchanged, some noticeable exceptions can be observed. Between 2006 and 2012, the Czech Republic and Hungary become reliant exclusively on Russia's imports. However, interestingly, these two countries also experienced one of the fastest declines in gas import dependence, reducing their dependence by 15% and 11% respectively. The United Kingdom and Spain have increased their exposure to non-EEA countries with a significant increase of their supplies originating from Qatar (for the United Kingdom) and Algeria (for Spain). The United Kingdom and Croatia are also the Member States where import dependence increased the most. While both countries still have a low import dependence in absolute terms, the dramatic increase experienced over the past years indicates a steep decline in the availability of domestic gas and therefore calls for appropriate measures to mitigate possible supply shocks.

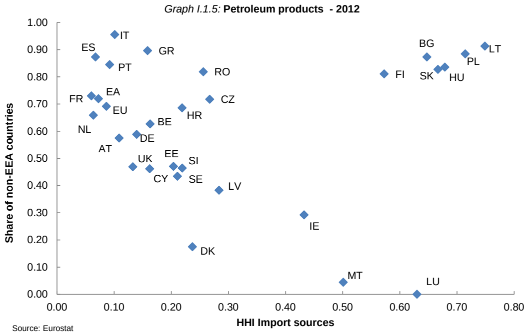
1.2.2. Petroleum products

Graph I.1.4: **Share of Petroleum products in energy mix and import dependence**



Source: Eurostat

Graph I.1.5: **Petroleum products - 2012**



Source: Eurostat

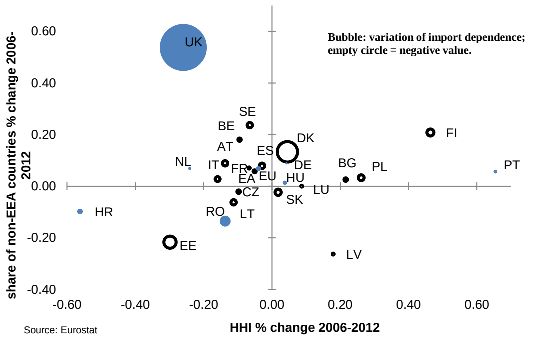
The vast majority of Member States display a very high import dependence for petroleum products, while no country depends fully on a single supplier. Member States with the lowest degree of diversification of import sources are

Lithuania, Bulgaria, Poland, Hungary and Finland. Of these countries only Lithuania displays a share of petroleum products in the energy mix above the EU average while the others are significantly below. It should however be noted that considering only crude oil, the diversification of import sources is in some cases much more reduced and some Member States (Slovakia, Hungary, Poland, Lithuania and Bulgaria) depend essentially on only one supplier, Russia.

The degree of dependence from non-EEA import sources varies significantly across the EU. For example Italy imports almost all of its petroleum products from non-EEA countries, and it has one of the most diversified pool of importers in the EU which somewhat shelter the country from potential shocks. Conversely, a group of Member States, Bulgaria, Lithuania, Poland, Hungary, and Slovakia (and to a lesser extent Finland) not only depend on non-EEA countries for almost all their petroleum products supply, but heavily rely on one exporter (Russia) for the bulk of their supply. These Member States are therefore more exposed to potential supply shocks.

Since 2006, it can be observed that the overall import dependence remained essentially stable. The exceptions are the United Kingdom and Romania were import dependence significantly increased, and in Denmark and Estonia where it on the other hand was substantially reduced.

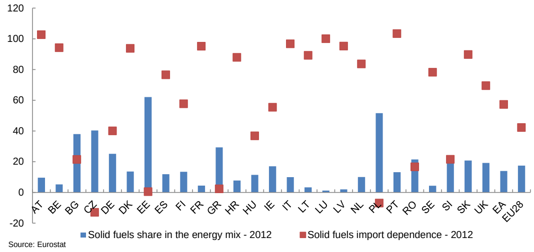
Graph I.1.6: **Petroleum products - evolution**



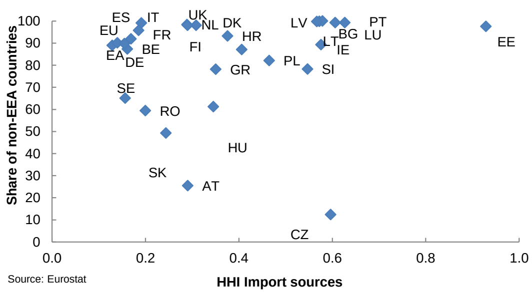
Over time there has been a generalised, gradual improvement in the diversification of import sources. There are some noticeable exceptions such as Finland and Portugal, and to a lesser degree Poland and Bulgaria, where the diversification has actually diminished. The share of import from non-EEA countries has nonetheless increased almost everywhere except in a few exceptional cases.

1.2.3. Solid fuels

Graph I.1.7: **Share of solid fuels in energy mix and import dependence**



Graph I.1.8: **Solid fuels - 2012**



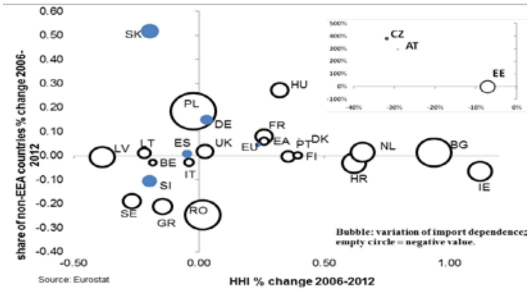
Import dependence for solid fuels is generally lower than for other energy sources as many Member States can count on domestic production. However, among those Member States that do import substantial quantities of solid fuels, most of them do so via a well-diversified pool of importing countries. The Member States, which combine high import dependence with a low degree of diversification of import sources, are Lithuania, Latvia, Luxembourg and Portugal. However for all these countries, solid fuels represent a very marginal share of the energy mix. Estonia's import dependence is negligible, however it only import solid fuels from Russia and in minor quantities from Latvia.

The vast majority of EU Member States count for their solid fuels supply solely on non-EEA countries. The countries that appear the most exposed in this sense are Luxembourg, Portugal, Bulgaria, Latvia, Lithuania and to a lesser extent Ireland (due to its relatively low level of solid fuels import dependence). Portugal depends largely on Colombia and the US, the share of imports from the two countries have been increasing substantially over the last years reaching 72% and

22% respectively in 2012. Luxembourg relies mainly on South Africa. Lithuania relies essentially on Russia, while Latvia imports 75% of its solid fuels from Russia but has increasing trade relations with the US, which share in imports went from 0 to 22% between 2009 and 2012. Finally Bulgaria's main supplier is Ukraine followed by Russia.

The import dependence for solid fuels has been diminishing over time in the vast majority of Member States, in particular in Estonia, Poland and Romania. The exceptions have been Austria, Slovakia, Spain, Germany and Slovenia, where nonetheless the increase has been moderate. At the same time, however, the diversification of import sources measured in terms of HHI has deteriorated for more than half of the Member States.

Graph I.1.9: **Solid fuels - evolution**



The concentration of imports has increased particularly in Croatia, Bulgaria, the Netherlands, Luxembourg and Ireland. In Latvia, Austria, Sweden and Lithuania the diversification has on the other hand improved significantly. The share of imports from non-EEA countries has increased significantly in several Member States, and this was particularly the case of the Czech Republic, Austria and Slovakia and to a lesser extent also of Hungary, Poland and Germany. On the other hand exposure to non-EEA suppliers was considerably reduced in Romania, Greece, Sweden, Slovenia and Ireland.

1.2.4. Conclusions

Considering the EU as a whole it is possible to draw some broad conclusions on the evolution of the indicators related to diversification of energy supply and energy dependence.

As far as gas is concerned, the EU increased the diversification of its import sources, decreased the share of imports from non-EEA countries and only very marginally reduced the import dependence. Some Member States are reliant on a single supplier outside the EEA, i.e. Russia. Little or no improvements have taken place in this regard and for the Czech Republic and Hungary the situation has clearly deteriorated over recent years thereby increasing the dependence on Russia.

By contrast, the evolution worsened for solid fuel over recent years. The concentration of import sources and the import from non-EEA countries both grew markedly, while import dependence increased albeit only slightly. The evolution of the solid fuels consumption will have to be monitored closely as there are indications of their growing importance especially in some Member States. The availability of cheap American coal can be observed in the fast increasing share of imports from the US. This evolution has had negative impacts on the diversification of import sources but will also affect the carbon performances of Member States, which may in the future face higher costs due to climate change measures.

The analysis of the evolution of the indicators related to petroleum products shows a more stable picture. The diversification of import sources improved slightly while the import dependence deteriorated. This is confirmed at Member States level where no country depends fully on a single supplier.

1.3. REFERENCES

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2. ENERGY EFFICIENCY DEVELOPMENTS IN THE EU

One of the priorities of the Europe 2020 strategy is to achieve sustainable growth by moving towards a low-carbon economy. The targets set for climate change and energy sustainability are to decrease greenhouse gas emissions by 20% compared to the 1990 levels, achieve 20% of gross final energy consumption from renewables and increase the energy efficiency by 20%.

In general, the focus on energy efficiency is not only due to environmental aspirations (fight against climate change) or safeguarding of resources (resource efficiency). Energy efficiency can also bring macroeconomic advantages. It stimulates growth through two main channels: first, increased investment in energy-saving technologies; and second, the income effect of lower energy bills. The positive effects of energy efficiency measures on the economy stemming from these channels are various. Job creation is supported through the former, e.g. in the construction sector when investment is directed to insulation of buildings. It also has the potential to provide business opportunities for new firms and spur innovation. Lower energy bills, on the other hand, boost disposable income which in turn can be used in other ways for consumption or savings. To this end, energy saving has also a potential positive impact on social conditions. Moreover, correct implementation of energy efficiency measures decreases the country's need for energy imports and thereby contribute to diminish the risks of security of supply. In this respect, energy efficiency is referred to as a new energy source in terms of avoided energy use ([13]).

The objective of this paper is to assess the drivers of energy efficiency or intensity improvements. Section 1 describes energy intensity in EU-28 and Member States. Section 2 provides insights on energy intensity evolution by disentangling the restructuring effect from the pure energy efficiency effect. Section 3 carries out an empirical analysis on the drivers of energy intensity developments in Member States. Section 4 concludes this section.

2.1. ENERGY INTENSITY DEVELOPMENTS IN THE EU-28: STYLIZED FACTS

2.1.1. Preliminary remarks: measurement

There is a wide discussion among various stakeholders, think tanks and Member States on how to measure progress in energy efficiency. In general, there are two ways of measuring energy efficiency: by looking at either an absolute or a relative level of energy consumption. The absolute value is defined by the primary or final energy consumption measured in Mtoe while the relative one provides the primary energy consumption expressed in amount of energy needed to produce one unit of GDP. While the 2020 target was expressed in terms of absolute primary energy consumption, the relative level of energy consumption is currently more widely acknowledged as it can more clearly distinguish energy savings from business cycle. An alternative approach is to consider a hybrid indicator combining both an absolute and a relative approach ([14]).

In this chapter, energy efficiency is measured by energy intensity, i.e. the amount of energy needed to produce one unit of GDP (for methodological discussion, see Appendix I). As traditionally an increase in energy consumption is highly correlated to output growth, it is possible to overcome the effect of possible slowdown of the economy (which automatically leads to lower energy consumption) with this measure and to show a decoupling of energy consumption and output growth. However, it is acknowledged that this measure is not perfect as energy consumption is influenced also by other factors than the efficiency of its use. This includes factors such as structural changes of the economy, energy prices, climate, weather or even ageing of population. One aim of the analysis presented in the text is to separate these effects and pinpoint the factors that contribute the most to the changes in energy intensity.

([13]) OECD/IEA (2013)

([14]) See discussions in European Commission (2014a)

Box I.2.1: **Energy efficiency in the EU**

Energy efficiency has been closely looked at in many Member States during the 2014 European Semester, triggering country-specific recommendations in CZ, EE, HU, LT, LV and RO. It will also remain high on the political agenda for at least two reasons. First, a Directive on Energy Efficiency ([1]) was adopted by the Council and the Parliament in October 2012, and should be implemented by Member States by June 2014. Second, analyses show that the energy efficiency target – a 20% decrease in primary energy use by 2020 compared to projections made in 2007 – as defined in the Climate and Energy package and reaffirmed under the Europe 2020 Strategy, is the least likely to be achieved under current conditions among the climate and energy targets. Member States are therefore expected to speed up reforms to ensure that EU commitments are to be achieved in the most cost-effective way.

The Directive on Energy Efficiency establishes a common framework for promoting energy efficiency in the Union so as to ensure the target of 20 % primary energy savings by 2020 is met and to pave the way for further energy efficiency afterwards. It lays down rules designed to remove barriers and overcome some of the market failures that impede efficiency in the supply and use of energy. It further reinforces the already existing legislation on buildings (i.e. the Energy Performance of Buildings Directive 2010/31/EU) and energy-related products (i.e. the Energy Labelling Directive 2010/30/EU and Ecodesign Directive 2009/125/EC).

For end-use sectors, the Directive focuses on measures that lay down requirements on the public sector, both as regards renovating central government buildings (a 3% mandatory annual renovation rate) and applying high energy efficiency standards to the purchase of buildings, products and services. The Directive requires Member States to establish national energy efficiency obligation schemes, or alternative policy measures, which should achieve a cumulative target of new savings each year equal to at least 1.5% of the annual energy sales to final consumers (with possible exclusion of energy used in the transport sector) over the 2014-2020 period. It requires regular mandatory energy audits for large companies and lays down a series of requirements on energy companies regarding metering and billing.

For the energy supply sector, the Directive requires Member States to assess the potential for high-efficiency generation and efficient district heating and cooling, to translate the results of the assessment into adequate measures and to require that energy generation installations above 20 MW also assess the possibilities for the use of cogeneration. Both assessments have to be based on a cost-benefit analysis. If the results prove to be positive, Member States will have to require installations to recover waste heat through cogeneration or district heating and cooling networks.

Other measures include efficiency requirements introduced by national energy regulators, awareness-raising actions, requirements on the availability of certification schemes, promotion of energy services, and an obligation to remove obstacles to energy efficiency, such as to address the split of incentives between the owner and the tenant. Finally, the Directive provides for the establishment of national indicative energy efficiency targets for 2020 and requires the Commission to assess in 2014 whether the Union can achieve its target of 20 % primary energy savings by 2020. The assessment of the Commission will be submitted to the European Parliament and the Council, followed, if appropriate, by proposals for further measures.

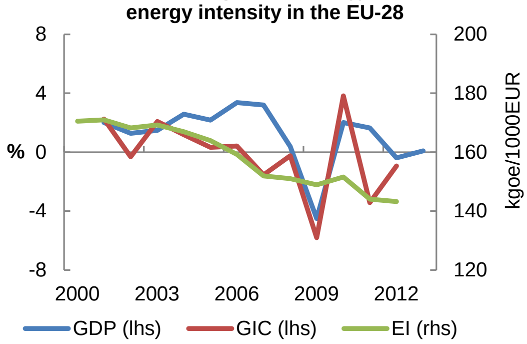
While the 2030 Communication ([2]) published on 22 January 2014 proposes a new target of 40% reduction of greenhouse gas emissions by 2030 (relative to 1990) and states that such a target should by itself encourage a greater share of renewable energy in the EU of at least 27%, it leaves the decision on a possible energy efficiency target open for the review of the Energy Efficiency Directive.

([1]) 2012/27/EU
([2]) European Commission (2014b)

2.1.2. Evolution of energy intensity in the EU-28 and Member States

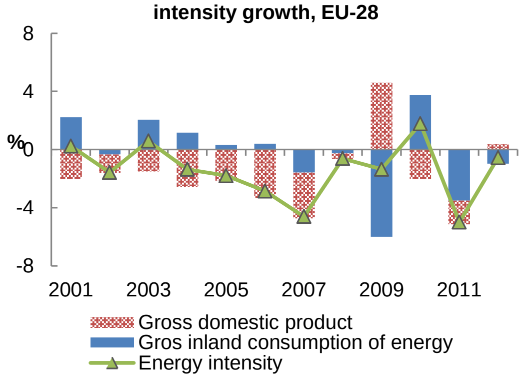
Looking at the period 2000-2012, gross energy intensity has declined by 16% in EU-28. This decreasing trend was almost constant over the whole period thereby pointing to a successful decoupling of energy consumption from output growth. The only exception to this trend was the renewed activity immediately after the trough of GDP growth in 2009 caused by the economic and financial crisis. While up until 2009 GDP was growing faster than gross inland consumption, in 2010 the energy consumption hiked more than the GDP and caused a short-lived increase of energy intensity by 1.7% (see Graphs I.2.1 and I.2.2).

Graph I.2.1: **Growth in GDP and gross inland consumption of energy, level of energy intensity in the EU-28**



Source: Eurostat

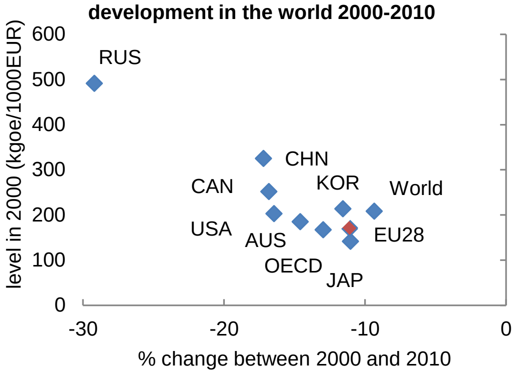
Graph I.2.2: **Contributions to energy intensity growth, EU-28**



Source: Eurostat

Compared to other world economies and regions, the decline of gross energy intensity in the EU-28 has been limited. In 2000, the EU-28 had, together with Japan, the lowest level of gross energy intensity. Since then, its development has been in line with the decreases recorded in other economies (see Graph I.2.3). By 2010 EU-28 gross energy intensity was still among the lowest ones in the world.

Graph I.2.3: **Gross energy intensity development in the world 2000-2010**

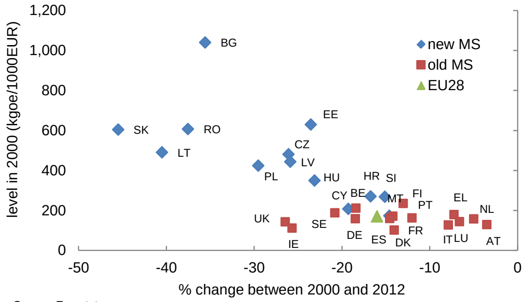


Source: OECD, Eurostat

In parallel to the EU-28 development, gross energy intensity has followed a decreasing trend in all Member States (see Graph I.2.4). While real GDP grew over the observed period in all Member States, energy consumption growth has not reached the same rate and even decreased in twelve countries. This development points to a process of decoupling output from energy consumption.

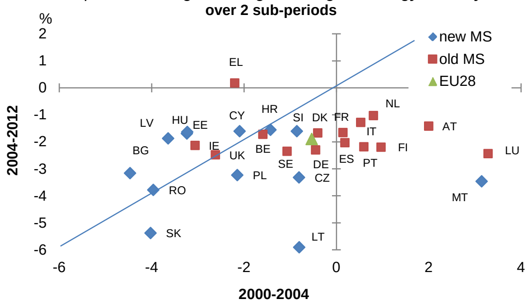
There is a large heterogeneity among Member States in respect to the rate of decline of energy intensity. Between 2000 and 2012, the declines lay in the range from -3% in Austria to -45% in Slovakia. A large part of this heterogeneity is explained by a catching up effect in new Member States. These countries, which have higher initial energy intensity levels, tend to record higher declines corresponding to larger improvements. However, there are also a few countries, such as United Kingdom and Ireland, which are outperforming some highly energy intensive economies during this period.

Graph I.2.4: **Gross energy intensity in EU-28 Member States**



Source: Eurostat

Graph I.2.5: **Average annual growth in gross energy intensity over 2 sub-periods**



Source: Eurostat
Note: Countries above the 45' line contributed more to the energy intensity decline in the first period

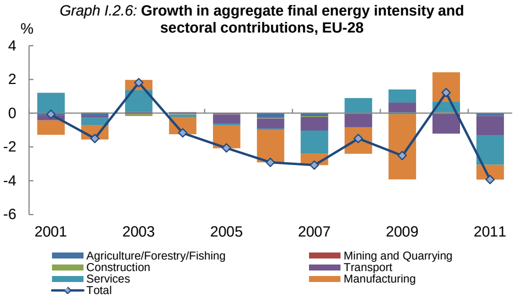
In some Member States, improvements in energy intensity have not been equally distributed over time. All countries recorded a decline in gross energy intensity since 2004, but some countries, such as Greece, Bulgaria, Latvia, Hungary and Estonia ([15]) concentrated most of their efforts to the beginning of 2000s ([16]). On the other hand, in some Member States (Luxembourg, Malta, Austria, Finland, the Netherlands, Portugal, Italy, Spain and France) gross energy intensity actually increased in the beginning of 2000s (see Graph I.2.5).

2.2. SECTORAL DEVELOPMENT OF ENERGY INTENSITY IN THE EU-28

2.2.1. Sectoral development in the economy at large

The sector which traditionally drives final energy intensity developments in the economy is manufacturing, followed by transport and services (see Graph I.2.6). Manufacturing covers around 35% of final energy consumption and 18% of gross value added over the period 2001-2011. Its energy intensity contributed by 1.4 pp on average to the changes in total energy intensity.

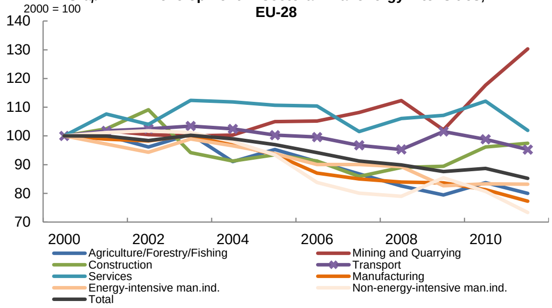
Graph I.2.6: **Growth in aggregate final energy intensity and sectoral contributions, EU-28**



Source: Eurostat, own calculations
Note: The sectors are weighted by their share in gross value added in respective year

While final energy intensity in total economy follows a decreasing trend since early 2000s, this is not the case for some sectors of the economy such as mining and quarrying and services (see Graph I.2.7). The biggest declines were recorded in manufacturing (both energy intensive and not energy intensive sectors), as well as agriculture, forestry and fishing. The construction sector followed a decreasing trend until 2007, before rising to almost the same level as in 2000. On the other hand, energy intensity in transport remained almost constant in the last ten years.

Graph I.2.7: **Development in sectoral final energy intensities, EU-28**



Source: Eurostat, own calculations

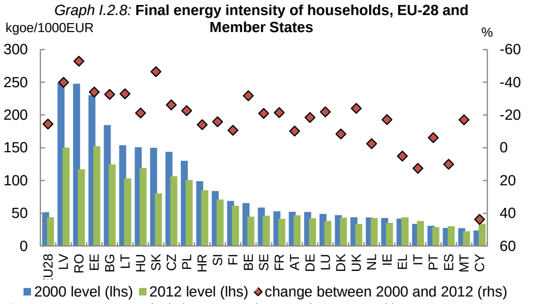
([15]) Six 'new' Member States for which one would assume that EU membership would provide a higher incentive to improve energy efficiency concentrated most of their efforts between 2000 and 2004.
([16]) The choice of the two sub-periods is based on the assumption that the EU accession might have triggered higher energy efficiency efforts. For simplification, we use the year 2004 when 10 out of the 13 'new' Member States joined the EU.

2.2.2. Residential sector

Over the period 2000-2012, final energy intensity of households ([17]) has decreased by 14% in the EU-28 (see Graph I.2.8). The average annual decline of -1.3% is in line with the one of total economy (-1.5%) and slightly below the decline recorded in total industry (-1.8%). However, the manufacturing sector outperforms these achievements substantially (-2.3%). In comparison, transport recorded only a marginal average annual decrease (-0.4%) while energy intensity of services actually increased (by 0.1% annually).

However, there is a large heterogeneity between Member States. While in most Member States the final energy intensity of households followed a declining trend over the last decade, it actually increased in Greece, Italy, Spain and Cyprus. The changes between 2000 and 2012 all lie in the range of an improvement of of -53% in Romania and a deterioration of 44% in Cyprus. The catching-up effect is clearly visible as 11 out of the 13 new Member States were recording the highest level of energy intensity of households in 2000, and eight of them displayed the largest declines up to 2012.

Graph I.2.8: **Final energy intensity of households, EU-28 and Member States**



Source: Eurostat, own calculations; Note: The countries are sorted by energy intensity in 2000

After adjusting for heat-degree days, the heterogeneity of the Member States remains high, but the range of recorded decreases shrinks. As final energy consumption of households largely depends on energy consumed for heating purposes, it is desirable to adjust the data when possible. However, heat-degree days are available only until 2009 (see Appendix III).

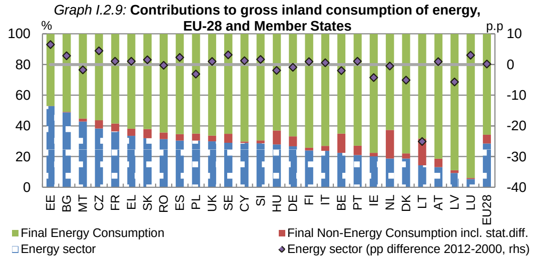
([17]) Calculated as final energy consumption of households divided by final consumption expenditure of households

2.2.3. Energy sector

The power sector accounts for a large part of gross energy consumption. Since 2000, the share of the energy sector ([18]) in gross inland consumption of energy has remained stable around 29% in the EU-28 (see Graph I.2.9). In most Member States the energy sector covers at least 20% of gross inland consumption of energy. The most outstanding exceptions are Luxembourg and Latvia, where the shares stand at only 6% and 9% respectively.

The efficiency of the energy sector varies substantially across Member States: while distribution losses in Cyprus cover only 2% of energy sector consumption, it is 35% in Latvia. Transformation rate ([19]), on the other hand, depends among others on the prevailing energy sources used for electricity and heat generation. Countries with a higher share of renewable energy in electricity generation tend in general to record higher transformation rates, while power plants based on fossil fuels require higher energy inputs and record higher transformation losses.

Graph I.2.9: **Contributions to gross inland consumption of energy, EU-28 and Member States**



Source: Eurostat, own calculations; Note: The countries are sorted by share of energy sector in gross inland consumption of energy.

2.3. ENERGY EFFICIENCY POLICY MEASURES IN EU-28 AND MEMBER STATES

Energy efficiency is one pillar of the EU Climate and Energy Framework. For this reason, Member States are expected to implement measures to improve energy efficiency (see Box I.2.2 for the EU policies).

([18]) Energy sector includes data on transformation (transformation input - output), transfers (exchanges, transfers, returns), its consumption and distribution losses.

([19]) Calculated as transformation output divided by input.

Box I.2.2: Tracking energy Efficiency measures – the MURE database

The MURE database is part of the Odyssee-MURE project. It is co-financed by the European Commission (Intelligent Energy Europe programme). It includes policy measures targeting efficiency of use of energy sources in the EU, EU-28 Member States and Norway.

There are in total 2,011 policy measures recorded in the MURE database which are effective from 1990 onwards (Table 1) at the EU level as well as across Member States. The most important category in respect of the status are measures which are still on-going, that is covering 72% of all measures.

However, there is evident heterogeneity between countries. The most outstanding example is Spain which records in total the highest number of measures targeted at energy efficiency, but half of them are already completed. Estonia, on the other hand, is a country with the highest share of proposed, but not yet active, measures (34% of total).

Table 1:
Energy effciency measures since 1990

	Total	Completed	Ongoing	Proposed
ES	**133**	66	67	--
FR	**119**	18	94	4
DE	**100**	18	69	5
EE	**112**	5	66	38
FI	**105**	14	85	--
EU	**100**	9	74	7
IE	**96**	19	69	7
BG	**84**	5	55	8
IT	**83**	18	64	--
NL	**77**	30	40	5
SK	**73**	12	60	1
BE	**70**	1	59	1
HR	**71**	7	62	--
MT	**63**	12	41	6
LT	**61**	14	41	--
GB	**58**	7	49	1
HU	**60**	16	30	14
PT	**57**	19	35	2
CZ	**58**	9	47	1
LU	**58**	8	22	4
LV	**52**	10	39	1
SI	**52**	4	43	1
SE	**48**	10	35	--
EL	**48**	1	39	7
AT	**37**	--	33	--
RO	**42**	2	39	--
PL	**35**	--	32	2
CY	**32**	4	28	--
DK	**27**	--	25	1
Total	**2011**	338	1442	116

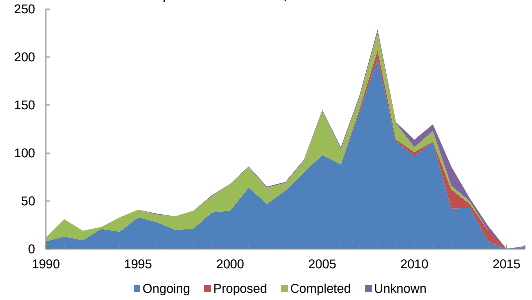
Source: MURE database.

(Continued on the next page)

Box (continued)

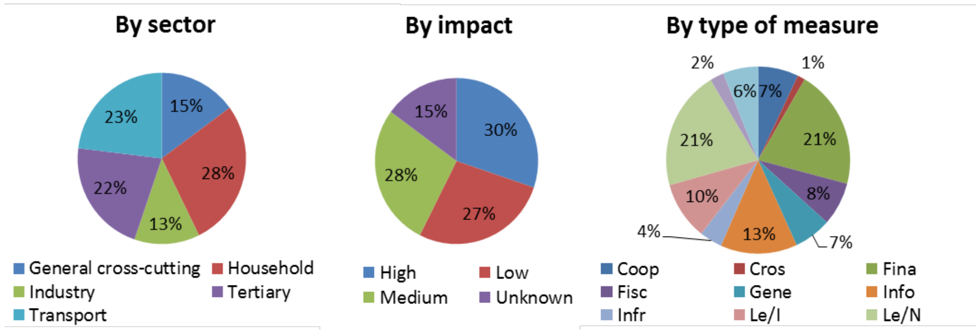
The most fruitful year in bringing about new measures was 2008, when 12.1% of all measures since 1990 came into force (Graph 1). Until then number of measures was increasing, while since 2008 there is an apparent decline in new measures.

Graph 1: **New measures, all EU MSs and EU**



As regards sectoral coverage, most of the energy efficiency measures target households, followed by transport and tertiary sectors (Graph 2). In terms of impact, most measures are assigned a high impact on energy efficiency, but followed closely by medium and low impact measures. Turning to the type of measures, the majority of measures are financial and legislative/normative ones.

Graph 2: **Ongoing measures by category, all EU MSs and EU**

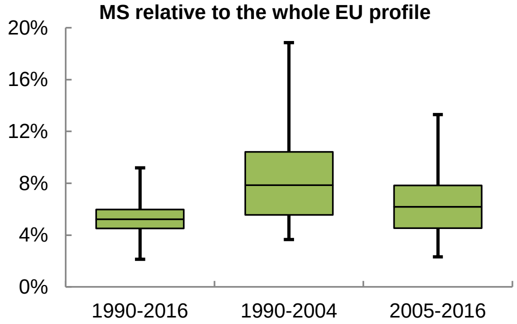


Source: MURE database
Note: Coop: Co-operative Measures, Cros: Cross-cutting with sector-specific characteristics, Fina: Financial, Fisc: Fiscal/Tariffs, Info: Information/Education/Training/SocialPlanning/Organisational, Le/I: Legislative/Informative, Le/N: Legislative/Normative, Mbl: Market-based Instruments/New Market-based Instruments, Infr: Infrastructure, Gene: General Energy Efficiency / Climate Change / Renewable Programmes

Over the period 1990-2016 Member States follow a relatively similar profile of energy efficiency policy measures (Graph I.2.10). Overall, Member States display the same preferences for sectors, i.e. households, transport and services, as well as for types of instrument such as financial support.

The post-2005 period seems to be the most homogenous in terms of preferences for energy efficiency measures. Some Member States such as Greece, Malta, Latvia and Croatia diverge substantially from the EU average, in particular in the 1990s.

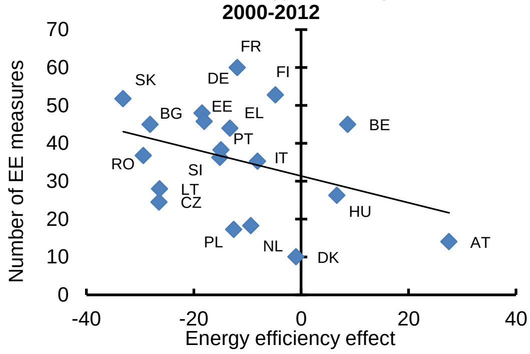
Graph I.2.10: **Dispersion of the indicator of revealed preference based on the type of measures and their sectoral allocation by MS relative to the whole EU profile**



Source: MURE database, own calculation

There is some, albeit weak, correlation between the number of energy efficiency measures and the energy efficiency improvement (see Graph I.2.11). While some countries managed to decrease energy intensity via energy efficiency policy with a relatively small number of measures, others needed many more in order to achieve a small improvement.

Graph I.2.11: **Number of energy efficiency measures and energy efficiency effect, 2000-2012**



Source: MURE database, Eurostat, own calculation
Note: Energy efficiency effect is calculated in Section 2.4 of this report and reflects the contribution of energy efficiency to energy intensity change
Energy efficiency measures include measures which are ongoing or completed. They are weighted by their impact (high = 1; medium = 0.75; low = 0.5; unknown = 0.25). Some countries are missing due to the lack of data available for calculating the energy efficiency effect

2.4. DISENTANGLING EFFECT OF RESTRUCTURING FROM ENERGY INTENSITY DEVELOPMENTS IN THE EU-28 AND MEMBER STATES

The structure of the economy has a large impact on the development of energy intensity. Sectoral restructuring is one of the main channels through which a country can achieve improvements in energy intensity. In order to distinguish such effects from the energy efficiency improvements, a shift-share analysis is carried out (for methodological discussion see Appendix II). It can provide an answer to the question of how energy intensity would have developed if the structure of the economy remained unchanged, i.e. how large part of the energy intensity growth corresponds to the restructuring of the economy.

Shift-share analysis estimates three effects which have an influence on the growth of energy intensity:

- **a within subsector effect** measures the improvement of energy intensity, keeping the share of sectors in total value added constant. Therefore, this effect includes the pure energy efficiency improvements and is referred to as energy efficiency effect.

- **a restructuring effect** measures the changes in the share of sectors in total gross value added, keeping the energy intensity constant. If energy intensity increases thanks to the restructuring effect, it can be said that the structure of the economy shifted towards more energy intensive sectors.

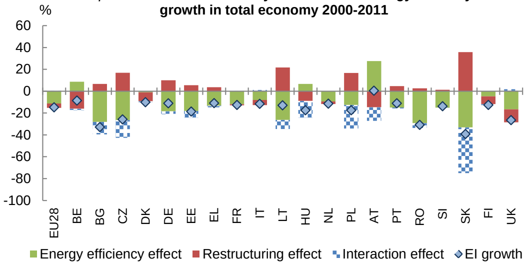
- **an interaction effect** captures the dynamic component of restructuring by measuring the co-movement between energy intensity and shares in gross value added. If it is positive, it signals that energy intensity is rising in subsectors that are expanding, and/or it is falling in shrinking sectors, i.e. the two effects complement each other.

2.4.1. Restructuring vs. energy efficiency in total economy, EU-28 and MSs

In the EU-28 as a whole, most of the final energy intensity decline was achieved through energy efficiency efforts. Over the period 2000-2011, the energy efficiency effect contributed by -11.3 pp to the final energy intensity change while static restructuring of the economy brought about another 5 pp of the decline (see Graph I.2.12).

Most Member States' economies have achieved significant energy efficiency improvements in the past decade. In some countries, despite positive energy efficiency efforts, the structure of the economy shifted towards more energy intensive sectors such as manufacturing (Bulgaria, Czech Republic, Estonia, Poland, Romania, Slovenia, Slovakia) or transport (Germany, Greece, Lithuania, Portugal). In other countries, such as Belgium and Hungary, a deterioration of energy efficiency has been outweighed by a shift towards less energy intensive sectors. Austria is the only country where energy intensity actually grew over the observed period.

Graph I.2.12: **Shift-share analysis of the final energy intensity growth in total economy 2000-2011**



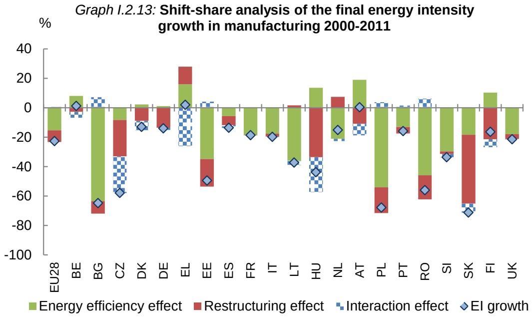
Source: Own calculation based on Eurostat data
Note: Data for IE, ES, HR, CY, LV, LU, MT and SE are not available to sufficient detail. Due to data availability, EL covers the period 2000-2010, PL 2001-2010 and RO 2001-2011 Some sectoral data for final energy consumption are equal to zero which might influence the accuracy of the method: for DE, construction sector after 2003 and agriculture, forestry and fishing after 2007. For the UK, mining and quarrying after 2004 and wood and wood products after 2005

2.4.2. Restructuring vs. energy efficiency in manufacturing, EU-28 and MSs

Most of the final energy intensity developments in manufacturing are driven by energy efficiency improvements. Between 2000 and 2011, final energy intensity in manufacturing decreased by 21.8% in the EU-28, out of which 14.5 pp were due to energy efficiency efforts and 7.4 pp due to restructuring (see Graph I.2.13).

However, there are three countries where final energy intensity of manufacturing actually increased over the sample period, namely Belgium, Greece and Austria. In these three countries, the development was dominated by the increase in the energy efficiency effect suggesting poor energy efficiency performance. By contrast, in Czech Republic, Denmark, Germany, Hungary, Slovakia and Finland final energy intensity declines were largely due to a shift towards less energy intensive manufacturing sectors such as transport equipment or machinery.

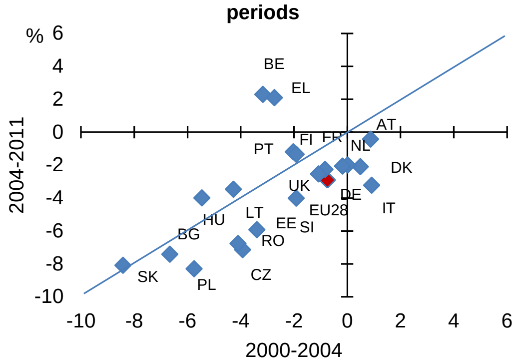
Graph I.2.13: **Shift-share analysis of the final energy intensity growth in manufacturing 2000-2011**



Source: Own calculation based on Eurostat data; Note: Data for IE, HR, CY, LV, LU, MT and SE are not available to sufficient detail

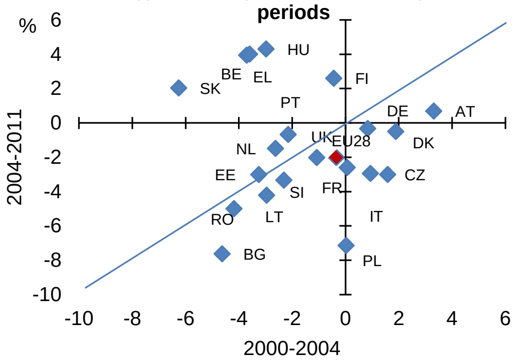
In most Member States, final energy intensity of manufacturing has decreased similarly in the beginning of 2000s as well as since 2004 (see Graph I.2.14). The notable exceptions are Belgium and Greece which have recorded an actual increase of final energy intensity over the period 2004-2011, outperforming the positive trend of early 2000s. New Member States record significant progress over both periods, probably mainly driven by restructuring of the manufacturing sector.

Graph I.2.14: **Average annual growth in final energy intensity of manufacturing, over 2 periods**



Source: Own calculation based on Eurostat data
Note: Data for IE, ES, HR, CY, LV, LU, MT and SE are not available to sufficient detail. Energy efficiency is represented by the 'within subsector effect' computed in the shift-share analysis, i.e. decreases of the effect reflect improvements in energy efficiency. Countries above the 45' line contributed more to the indicator decline in the first period

Graph I.2.15: **Average annual growth in energy efficiency of manufacturing, over 2 periods**



Source: Own calculation based on Eurostat data
Note: Data for IE, ES, HR, CY, LV, LU, MT and SE are not available to sufficient detail. Energy efficiency is represented by the 'within subsector effect' computed in the shift-share analysis, i.e. decreases of the effect reflect improvements in energy efficiency. Countries above the 45' line contributed more to the indicator decline in the first period

When looking at the energy efficiency improvements, the performance of Member States is more randomly disbursed over time (see Graph I.2.15). While some countries improved their energy efficiency of manufacturing in the beginning of 2000s (e.g. Hungary, Greece, Belgium or Slovakia), some others recorded such improvements only in later 2000s (e.g. Czech Republic, Italy or Denmark). For only eight Member States the energy efficiency effect contributed in the right direction to the energy intensity decline over both sample periods.

2.5. ASSESSING THE DRIVERS OF ENERGY INTENSITY DEVELOPMENTS

In order to be able to identify the channels through which energy efficiency can be influenced, it is necessary to conduct an analysis of drivers of energy intensity developments. However, the drivers are not in general known and need to be singled out using an encompassing approach.

2.5.1. Model

Previous sections showed that restructuring has had a large influence on energy intensity developments, reflecting the role of the sectoral composition of the economy. At the same time, pure energy efficiency effects have played a positive role, in particular in old Member States having reached a certain level of income. These effects could be related to the structural composition of GDP, where lower income economies move towards energy intensive sectors while at higher stage of developments the share of less energy intensive sectors, including services, increase ([20]).

In addition, the composition of the economy will play a role, in particular when the economy shifts towards more energy intensive sectors such as manufacturing and transport.

By contrast, and as mentioned above, the correlation between energy efficiency policy measures and energy efficiency improvement is low. For this reason, the direct role of these policy measures is not included in the empirical analysis, in line with some other empirical work ([21]).

Energy prices are expected to influence energy consumption. High energy prices tend to incentivise consumers to reduce their energy consumption. Higher energy prices in Europe compared to other parts of the world, could, among other factors, explain why the EU manufacturing is energy efficient compared to its international competitors in the US, China and Russia ([22]).

Beyond the price signal, it is also widely acknowledged that the transition to low carbon and energy intensive economies will require investments. According to some estimates, an annual increase in investments of EUR 270 bn would be required for the transition to a low carbon economy by 2050 ([23]). Some of these investments would be needed to improve energy efficiency. They should come from both private and public sources, and would contribute to provide the right enabling conditions for the transition to the low carbon economy.

Linked to investments, innovation is a key dimension of energy efficiency as it can help to decrease the costs of reducing energy consumption in a durable way. Innovation in the field of the

([20]) See Sur and al (1998). The authors discuss the Environmental Kuznets Curve. As high energy intensity is correlated to high pollution intensity, the authors use both terms interchangeably.
([21]) Suri and al (1998) suggests that there are no sizable effects of environmental regulations on energy demand.
([22]) European Commission (2014c)
([23]) COM(2011)112. These figures encompass all types of investments beyond the energy efficiency ones.

Box I.2.3: Methodology

In order to estimate the drivers of energy intensity, a panel data analysis is applied. It allows discovering shared pattern for 28 EU Member States while overcome some difficulties with missing observations ([1]).

Table 1:
Variables used in panel data analysis

Variable	Definition
GDPC	GDP per capita
FCEPOP	Final consumption expenditure per capita
GIC	Gross inland consumption of energy
EI = GIC/GDP	Energy intensity
MAN	Share of manufacturing in GDP
GFCFY	Share of gross fixed capital formation in GDP
PAT	Green patents (% total PCT patents)
ENP	HICP of energy products

Insert table XX

The dependent variable is gross energy intensity of total economy while exogenous variables are defined in Table XX. The estimated equation has following general form:

$$y_{it} = \alpha + \chi_i + \theta_t + \beta_i X_{it} + \varepsilon_{it} \ ,$$

where i stands for countries, t for time, β_i is a vector of coefficients and X_{it} is a vector of explanatory variables.

As the variables differ in their denominations, an individual approach is applied to each of them. Some can be made stationary by differencing while others (e.g. patents) is stationary. Moreover, some of the variables need a logarithmic transformation in order to avoid increasing amplitude of their differences. Therefore, following two specifications are considered:

$$\Delta \log(ei_{it}) = \alpha + \chi_i + \theta_t + \beta_{i1}\Delta \log(fcepop_{it}) + \beta_{i2}\, pat_{it} + \beta_{i3}\Delta(man_{it}) + \beta_{i4}\Delta(enp_{it}) +$$

and

$$\Delta \log(ei_{it}) =$$
$$\alpha + \chi_i + \theta_t + \beta_{i1}\Delta \log(fcepop_{it}) + \beta_{i2}\Delta \log(gfcfy_{it}) + \beta_{i3}\Delta(man_{it}) + \beta_{i4}\Delta(enp_{it}) + \varepsilon_{it}$$

Following LM and Hausman tests, country-specific (χ_i) as well as time-specific (θ_t) fixed effects are included in all tested specifications. Also, tests exclude the hypothesis of cointegration in the panel.

([1]) This analysis is inspired by the Kiel Working Paper No 1393 from January 2008: 'Energy Savings via FDI? Empirical Evidence from Developing Countries.' The choice of indicators followed the same logic.

Green Economy can be divided into two types: (1) improvements in traditional environmental sectors such as renewables, energy saving technologies, etc.; (2) radical new emission free technologies ([24]).

([24]) Aghion P. and Veugelers, R.(2011) explore the factors explaining firms' propensity to pursue clean innovation and identify, among other factors, the existing stock of clean patents. Their empirical work confirms the idea of an innovation technology path which would depend on past behaviours, hence the need to develop a green innovation/industrial policy.

Table I.2.1:
Results of panel data analysis

Dependent variable	Energy intensity (log diff.)				
	(1)	(2)	(3)	(4)	(5)
Explanatory variables					
constant	-0.023 ***	-0.014 ***	-0.008 **	-0.014 ***	0.000
GDP per capita (log diff.)		-0.383 ***	-0.489 ***		
Final consumption expenditure per capita (log diff.)				-0.288 ***	-0.571 ***
Gross fixed capital formation (% of GDP, log diff.)	0.183 ***	-0.054 *	-0.012	-0.113 ***	
Green patents (% total PCT patents)					-0.001 *
Share of manufacturing in GVA (diff.)		0.422 *		0.214	0.221
HICP of energy products (diff.)			-0.001 *	-0.001 **	0.000
Sample	1991-2012	1991-2012	1997-2012	1997-2012	1997-2010
Countries	28	27	28	27	21
Observations	532	487	407	389	267
R2	0.279	0.424	0.389	0.171	0.134
adj-R2	0.206	0.358	0.313	0.162	0.120
DW-stat	2.173	2.297	2.364	2.188	1.746
F-stat	3.814	6.416	5.113	19.813	10.111
P(F-stat)	0.000	0.000	0.000	0.000	0.000
Country-spec. fixed effects	yes	yes	yes	yes	yes
Time-spec. fixed effects	yes	yes	yes	yes	yes

Note: *, **, *** Indicates significance at 10%, 5% and 1% confidence level.
Source: Own calculation based on Eurostat data

In order to assess the drivers of energy efficiency, the following are included:

- **Wealth**: It is assumed that higher income economies (measured by GDP per capita) are more energy efficient. In other words, wealthier economies invest more in energy savings and can afford the more expensive energy efficient products/services.

- **Size of manufacturing industry**: The manufacturing sector includes the most energy intensive part of the economy, i.e. the energy intensive sectors. The size of manufacturing might therefore have a negative effect on total energy intensity.

- **Energy prices**: As economic agents make an informed choice when allocating their resources, low energy prices might have an adverse effect on energy efficiency efforts.

- **Investment**: Restructuring of the economy is usually supported by larger investments. Energy efficiency measures are sometimes accompanied by funding resources, which give final consumers incentives to invest.

- **Innovation**: Innovation (measured by the number of green patents) should spur a larger availability and uptake of energy efficient equipment and processes.

2.5.2. Results

The econometric analysis confirms the prominence of economic developments. The preferred specification (4) shows a very strong relationship between energy intensity and wealth (measured by final consumption expenditure per capita), which confirms the importance of the level of economic development for energy intensity improvement ([25]).

At the same time, investment is a significant driver of energy intensity improvement. When the investment is replaced by the share of green patents (specification (5)), the patents are significant with negative coefficient, which shows the positive role of innovation in driving energy efficiency.

Also energy prices play a positive role as they provide incentives to reduce energy consumption and invest in clean technologies.

At the same time, while the size of manufacturing does not seem to be significant in the model, the sign of its coefficient confirms the right direction of causality. Hence, the bigger the manufacturing sector is the higher the energy intensity of a given economy tends to be.

([25]) Hübler,M. and A. Keller (2008)

2.6. CONCLUSIONS

While energy intensity follows a decreasing trend in the EU-28, there are some potential for improvements, especially in the services and transport sectors, as well as to some extent in the construction sector.

Improvements in energy intensity have been the result of both restructuring of the economy and of increased energy efficiency efforts. There is, however, a substantial heterogeneity among Member States with respect to their individual achievements.

The scope for energy intensity improvements and a decoupling of energy consumption from GDP growth is closely linked to the level of economic development of a country. In general, in economies with relatively lower incomes, more energy is needed in order to accomplish a higher growth in output. There appears to exist a benchmark income at which richer economies can achieve higher growth without increasing – or even while decreasing – their energy consumption. From a policy perspective, the support of EU funds to energy efficiency improvements is crucial as this support can contribute to make these investments less costly and thereby help poorer EU countries to achieve a given level of energy efficiency.

The analysis presented in this chapter also suggests that higher energy efficiency can be achieved easier in conjunction with GDP growth, i.e. when the society becomes richer. While structural reforms can contribute to increasing output, it is important to foster investment and create an enabling environment that supports these investments. However, it might be a challenge to channel the investments into the right sectors. Innovation is one of the avenues which can contribute to the most cost-effective use of resources and its support should be of an utmost importance for investors.

Last but not least, it needs to be recalled that while correct policies can shape the direction of investment flows, energy prices together with other market-based price instruments, provide the signal to the final consumers of the necessity to embark on energy efficiency.

2.7. REFERENCES

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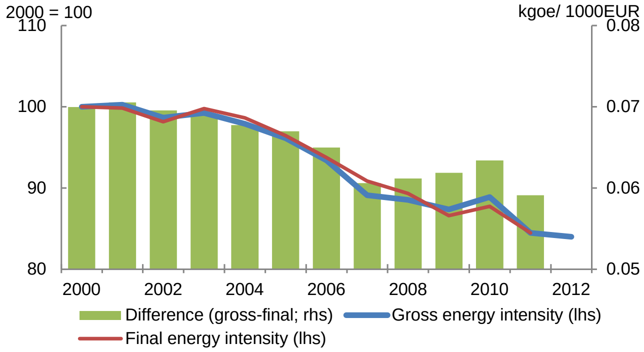
APPENDICES TO CHAPTER I.2

Appendix 1 – Methodological remarks

Energy intensity in total economy and in sectors

Gross energy intensity is calculated as gross inland consumption ([26]) of energy divided by real GDP ([27]). To be able to describe energy intensity developments at sectoral level, analysis of final energy consumption and value added for corresponding sectoral disaggregation needs to be available. The resulting measure, here called final energy intensity, is slightly different from the gross energy intensity ([28]) while their development follows a very similar pattern (see Graph I.2.App.1).

Graph I.2.App.1: **Gross and final energy intensity, EU-28**



Source: Own calculation based on Eurostat data

Final energy consumption excludes energy consumption by the power sector as well as non-energy consumption of energy sources. Gross value added, on the other hand, differs from GDP by inclusion of taxes and subsidies.

For the purpose of the analysis of the total economy, final energy consumption in the following sectors is taken into account: agriculture/forestry/fishing, mining and quarrying, construction, manufacturing, transport and services. The gross value added has been aggregated from NACE Rev.2, There are 64 branches that has been aggregated in order to match the coverage of the energy statistics (leaving out feedstock ([29])). While it is recognised that this approach entails several caveats, it approximates the reality well. The calculated aggregated final energy consumption is not equal to the final energy consumption as reported in the energy statistics of Eurostat, as it only covers the branches which can be attributed to a relevant economic activity from the perspective of gross value added.

For the purpose of the analysis of manufacturing, the shift share analysis takes into account final energy consumption in the following sectors: metals, chemical and petrochemical, non-metallic minerals, food and tobacco, textile and leather, paper, pulp and print, transport equipment, machinery, wood and wood products and non-specified. Again, the gross value added has been aggregated from NACE Rev.2 over 64 branches in order to match the coverage of energy statistics.

([26]) In the case of data from EEA, gross inland consumption (GIC) corresponds to total primary energy sources (TPES).
([27]) An alternative approach would be to define energy intensity as energy consumption divided by population (tons of oil equivalents per capita). This approach is followed e.g. by OECD (Green Growth module).
([28]) That is final energy consumption divided by corresponding value added
([29]) C19 branch (Manufacture of coke and refined petroleum products)

Table I.2.App.1:
Corresponding definitions of GVA and final energy consumption by sectors

	Gross value added NACE rev.2, 64 branches		Final energy consumption	
Agriculture/Forestry/Fishing	A01	Crop and animal production, hunting and related service activities	B_102020	Fishing
	A02	Forestry and logging	B_102030	Agriculture/Forestry
	A03	Fishing and aquaculture		
Metals	C24	Manufacture of basic metals	B_101805	Iron and Steel
			B_101810	Non-Ferrous Metals
Chemical and Petrochemical	C20	Manufacture of chemicals and chemical products	B_101815	Chemical and Petrochemical
	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations		
Non-Metallic Minerals	C23	Manufacture of other non-metallic mineral products	B_101820	Non-Metallic Minerals
Mining and Quarrying	B	Mining and quarrying	B_101825	Mining and Quarrying
Food and Tobacco	C10_C12	Manufacture of food products; beverages and tobacco products	B_101830	Food and Tobacco
Textile and Leather	C13_C15	Manufacture of textiles, wearing apparel, leather and related products	B_101835	Textile and Leather
Paper, Pulp and Print	C17	Manufacture of paper and paper products	B_101840	Paper, Pulp and Print
	C18	Printing and reproduction of recorded media		
Transport Equipment	C29	Manufacture of motor vehicles, trailers and semi-trailers	B_101846	Transport Equipment
	C30	Manufacture of other transport equipment		
Machinery	C25	Manufacture of fabricated metal products, except machinery and equipment	B_101847	Machinery
	C26	Manufacture of computer, electronic and optical products		
	C27	Manufacture of electrical equipment		
	C28	Manufacture of machinery and equipment n.e.c.		
Wood and Wood Products	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	B_101851	Wood and Wood Products
Construction	F	Construction	B_101852	Construction
Non-specified (Industry)	C22	Manufacture of rubber and plastic products	B_101853	Non-specified (Industry)
	C31_C32	Manufacture of furniture; other manufacturing		
Transport	H49	Land transport and transport via pipelines	B_101900	Final Energy Consumption - Transport
	H50	Water transport		
	H51	Air transport		
Services	H52	Warehousing and support activities for transportation	B_102035	Services
	H53	Postal and courier activities		
	I	Accommodation and food service activities		
	J58	Publishing activities		
	J59_J60	Motion picture, video, television programme production; programming and broadcasting activities		
	J61	Telecommunications		
	J62_J63	Computer programming, consultancy, and information service activities		
	K64	Financial service activities, except insurance and pension funding		
	K65	Insurance, reinsurance and pension funding, except compulsory social security		
	K66	Activities auxiliary to financial services and insurance activities		
	L	Real estate activities		
	M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities		
	M71	Architectural and engineering activities; technical testing and analysis		
	M72	Scientific research and development		
	M73	Advertising and market research		
	M74_M75	Other professional, scientific and technical activities; veterinary activities		
	N77	Rental and leasing activities		
	N78	Employment activities		
	N79	Travel agency, tour operator reservation service and related activities		
	N80_N82	Security and investigation, service and landscape, office administrative and support activities		
	O	Public administration and defence; compulsory social security		
	P	Education		
	Q86	Human health activities		
	Q87_Q88	Residential care activities and social work activities without accommodation		
	R90_R92	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities		
	R93	Sports activities and amusement and recreation activities		
	S94	Activities of membership organisations		
	S95	Repair of computers and personal and household goods		
	S96	Other personal service activities		

Source: Based on Eurostat nomenclature definitions

Appendix 2 – Shift-share analysis

Shift-share analysis estimates three effects which have an influence on the growth of the observed variable: within subsector effect, restructuring effect and interaction effect. The latter two are sometimes added up in order to present a so-called total restructuring effect, i.e. while the restructuring effect itself is referred to as a static one, the interaction effect can be described as dynamic restructuring. Restructuring is measured by changes in the importance of a given sector in total gross value added.

The shift share analysis presented in the paper is based on the following decomposition of the growth of final energy intensity (EI) between period 0 and period T:

$$\frac{\Delta EI_T}{EI_0} = \underbrace{\frac{\sum_i \Delta EI_{i,T} * w_{i,0}}{EI_0}}_{\text{within subsector effect}} + \underbrace{\frac{\sum_i \Delta w_{i,T} * EI_{i,0}}{EI_0}}_{\text{restructuring effect}} + \underbrace{\frac{\sum_i \Delta w_{i,T} * \Delta EI_{i,T}}{EI_0}}_{\text{interaction effect}}$$

Where $\Delta EI_T = EI_T - EI_0$, *i* denotes a given subsector of total economy (resp. manufacturing), $w_{i,T}$ denotes the share of sector *i* in the value added of total economy (resp. manufacturing) in period *T*, and $\Delta w_{i,T} = w_{i,T} - w_{i,0}$.

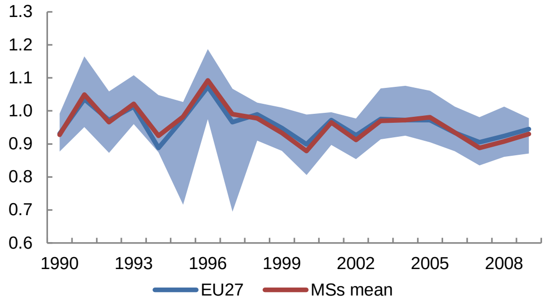
Appendix 3 – Data considerations for panel data analysis

Weather conditions

While it is understood that weather conditions influence energy consumption (being it heating or cooling), this aspect is intentionally left out from the analysis. There are several arguments supporting this decision.

First, it can be argued that the EU is still a very homogeneous unit and therefore development of the weather conditions is in general very similar across countries, i.e. hot summers vs. cold winters throughout the continent. Second, as the panel data analysis includes country- and period-specific fixed effects, they would entail possible divergences from the trend. Third, there are several data limitations with respect to weather conditions: in Eurostat, only data on heat-degree days are available (i.e. no information on air-conditioning) and the latest reported year is 2009.

Graph I.2.App.2: **Relative heating degree-days, EU-28**



Source: Eurostat; Note: The country data are excluding Malta and Cyprus; Relative heating degree-days is a ratio between actual heating degree-days and mean heating degree-days (over period 1980 – 2004), as defined by Eurostat

Energy prices

There are two options in how to include energy prices into the model. First, one can take absolute levels of prices for households and industry users. Second, the HICP of energy can be considered.

While the first option is methodically more correct as it reflects actual prices paid by households as well as industrial consumers, the time coverage of this statistic is an important limitation as the data are only available from Eurostat since 2002 and therefore would shorten the sample by several years.

HICP of energy, on the other hand, reflects mainly prices paid by domestic end-users. As it is an index, it makes it more complicated to interpret the results. However, its time coverage is sufficiently long in order to pose no restrictions to the model.

When running the model using shorter time sample and including final electricity prices for households and industry instead of HICP, the results are providing the same signal. While the coefficients for electricity prices are not statistically significant, they have negative signs suggesting that the higher electricity prices, the lower energy intensity tend to be.

Table I.2.App.2:

Description of variables used in the energy intenisty model

Variable	Description	Unit	Source	Sample
GDP per capita	Gross domestic product per person	Euro per inhabitant	Eurostat	EU 28
Final consumption expenditure per capita	Amount of euros spent on goods and services per person	Thousands of euros (chain-linked volumes, reference year 2005) per person	Own calculation based on Eurostat data	EU 28
Energy intensity	Amount of energy used to produce a unit of GDP	Kilograms of oil equivalent per thousand of euros	Own calculation based on Eurostat data	EU 28
Share of manufacturing in GDP	Value added of manufacturing sectors divided by GDP	% of GDP	Own calculation based on Eurostat data	EU 28 excl. MT
Share of gross fixed capital formation in GDP	Gross fixed capital formation divided by GDP	% of GDP	Own calculation based on Eurostat data	EU 28
Green patents	Patent applications filed under the Patent Cooperation Treaty (PCT); total green patents is the sum of patents on electric and hybrid vehicles, energy efficiency in buildings and lightning, renewable energy generation, air pollution and water pollution abatement and waste management	% total PCT patents	OECD	EU 28 excl. BG, HR, CY, LV, LT, MT, RO
HICP of energy	Harmonised Indices of Consumer Prices	Index, 2005 = 100	Eurostat	EU 28

ANNEX 1

Definition of indicators used in the EDI

A1.1. SECURITY OF ENERGY SUPPLY

A1.1.1. Import dependency - Primary sources

Import dependency shows the extent to which a country relies upon imports in order to meet its energy needs. It is calculated using the following formula:

Import dependency	$$\frac{M_j - X_j}{GIC_j + Bunk_j}$$	X= export M = Import j= energy product GIC = Gross Inland Consumption Bunk = Consumption of International Bunkers Unit = % Source: own calculations from EUROSTAT (energy statistics)

Import dependency has been calculated for the following energy products: **natural gas**, **total petroleum products, solid fuels** (hard coal and derivatives, and lignite and derivatives) plus the **total** that is all of the above products together.

HHI energy imports

This indicator is a measure of the degree of concentration of import sources, by country, in relation to total imports of an energy product. It has been calculated for each category of energy products mentioned above and for each Member State, using the following formula:

HHI energy imports	$$\sum_{i=1}^{N} IS_{i,j}^2$$	IS = import share per source country i = source country N = total number of source country j = energy product Unit of imports: terajoules (gas), 1000 tonnes (solid fuels, petroleum products) Source: EUROSTAT (COMEXT)

Gross inland energy consumption by fuel

This indicator measures the share of each energy source in gross inland consumption. Gross Inland energy Consumption corresponds to the sum of final consumption, distribution losses, transformation losses and statistical differences minus exports and consumption of international bunkers.

Gross inland energy consumption by fuel	$\frac{GIC_j}{GIC}$	j = energy product GIC: Gross Inland Consumption Unit: % Source: EUROSTAT (energy statistics)

HHI energy mix

This indicator measures the degree of concentration of the energy mix of Member States. It is calculated as follows:

HHI energy mix	$\sum_{j=1}^{J} s_j^2$	s = share of energy product in gross inland consumption j = energy product J = total energy products Unit of gross inland consumption: 1000 tonnes of oil equivalent Source: EUROSTAT (energy statistics)

A1.1.2. Import dependency – Secondary sources

To avoid double counting, electricity shall be treated differently given its nature of secondary source produced with primary energy sources. In the context of this note electricity import dependency is therefore calculated as follows:

Electricity import dependency	$\frac{M_e - X_e}{FinC_e} \frac{M_e - X_e}{FinC_e}$	M= imports X = exports e = electricity FinC= final energy consumption Source: Eurostat (energy

statistics)

Electricity mix

This indicator shows the share of each energy source in electricity generation in a country.

Electricity mix	$\frac{GEGj}{TEG}\ \frac{GEGj}{TEG}$	GEG= gross electricity generation; j= energy product; TEG= total electricity generation; Unit: % Source: DG ENER, Country Factsheets.

HHI Electricity mix

This Herfindahl Index indicates the degree of diversification of energy sources in electricity generation for any given country. It is calculated in the same way as the HHI for the energy mix, using the share of each energy product in gross electricity generation. The closer the value is to 1 the less the mix is diversified.

A1.2. ENERGY AND CARBON INTENSITY OF THE ECONOMY ([30])

Energy intensity of the economy

Energy Intensity gives an indication of the effectiveness with which energy is being used to produce added value. It measures the energy consumption of an economy and its overall energy efficiency. Its formula is:

Energy intensity of the economy	$\frac{GIC}{GDP}$	GIC = Gross Inland Consumption GDP = Gross Domestic Product in constant prices (2005)

([30]) The sectoral indicators in this section which refer to the industry and transport sectors are calculated using the Nace Rev. 2. sectoral breakdown in this edition. The first edition of Member States' Energy Dependence (DG ECFIN Occasional Papers 145) was using Nace Rev. 1. due to better data availability, however this data is no longer updated by Eurostat. The change from Nace Rev. 1. to Nace Rev. 2. implies that the sectoral data of this edition may not be comparable with those of the previous edition. Indicators that are affected by this issue are: Energy intensity of industry, Energy intensity of transport, Share of energy intensive sectors in total gross value added, Carbon intensity of transport sector.

Unit = KG of oil equivalent per 1000 euros

Source: EUROSTAT

Energy intensity of industry

This indicator gives an indication of the effectiveness with which energy is being used to produce added value in the industrial sector. It is calculated as follows:

Energy intensity of industry	$\frac{FinC_{IND}}{GVA_{IND}}$	FinC = Final energy consumption IND = Industry GVA = gross value added Unit: KG of oil equivalent per 1000 euros Source: EUROSTAT (energy statistics, national accounts by 10 branches).

Energy intensity of transport

This indicator gives an indication of the effectiveness with which energy is being used to produce added value in the transport sector. It is the ratio between the final energy consumption of energy in transport and the gross value added of the transport and storage sector.

Energy Intensity of transport	$\frac{FinC_{TRAN}}{GVA_{TS}}$	FinC = Final energy consumption TRAN = transport sector (rail, road, international and domestic air transport and inland navigation/coastal shipping, with the exception of maritime shipping); TS = Transport and Storage Unit: KG of oil equivalent per 1000 euros Source: EUROSTAT (energy statistics, national accounts by 38 branches)

Energy Intensity of households

This indicator gives an indication of the effectiveness with which energy is being used by households. It is the ratio between the final energy consumption and the final consumption expenditures of households.

Energy Intensity of households	$$\frac{FinC_{House}}{FCE_{House}}$$	FinC = Final energy consumption House = households; FCE= Final consumption expenditures; Unit: KG of oil equivalent per 1000 euros Source: EUROSTAT

Carbon intensity of the economy

This indicator measures the average amount of GHG emissions associated with each unit of gross domestic product.

Carbon intensity of the economy	$$\frac{CO2}{GDP}$$	CO2 = GHG emissions of the whole economy GDP = Gross Domestic Product in constant prices (2005).) Unit: 1000 tonnes of CO2 equivalent per million euros Source: EUROSTAT (environment statistics, national accounts) on EEA data.

Carbon intensity of the transport sector

This indicator measures the average amount of GHG emissions associated with each unit of gross value added produced by the transport, storage and communication sector.

Carbon intensity of the transport sector	$$\frac{CO2_{tran}}{GVA_{ts}}$$	CO2tran = GHG emissions of the transport sector (road, rail, inland navigation and domestic aviation).

GVA = Gross Value Added

TS = Transport and Storage.

Unit: 1000 tonnes of CO2 equivalent per million euros

Source: EUROSTAT (environment statistics on EEA data, national accounts by 38 branches)

Carbon intensity of energy use

This indicator measures the amount of GHG emissions associated with gross inland consumption of energy. It is calculated as follows:

Carbon intensity of energy use	$\frac{CO2_{ENER}}{GIC}$	CO2 = GHG emissions ENER = energy sector GIC = Gross Inland Consumption Unit: tons of CO2 / tons of oil equivalent Source: Energy Pocket Book

Carbon Intensity of households

This indicator measures the average amount of GHG emissions associated with each unit of energy consumed by households.

Carbon intensity of households	$\frac{CO2_{House}}{FCE_{House}}$ $\frac{CO2_{House}}{FCE_{House}}$	CO2 = GHG emissions House= households; FCE= Final Consumption expenditures Unit: 1000 tonnes of CO2 equivalent per million euros Source: EUROSTAT

Share of energy-intensive sectors in total gross value added

This indicator is a measure of the weight of energy-intensive sectors in total economic activity. Energy-intensive sectors are defined at Nace Rev.2 level and include: Mining and quarrying; Manufacture of wood, paper, printing and reproduction; Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products; Manufacture of basic pharmaceutical products and pharmaceutical preparations; Manufacture of rubber and plastic products and other non-metallic mineral products; Manufacture of basic metals and fabricated metal products, except machinery and equipment; Electricity, gas, steam and air conditioning supply

Share of energy-intensive sectors in total gross value added	$\frac{EIIva}{GVA}$	EIIva = energy-intensive sectors value added GVA = total gross value added of the economy Unit: % Source: EUROSTAT (national accounts by 38 branches)

Weight of energy in HICP basket

The HICP is calculated as a weighted average of price changes for a wide range of product groups, using the respective share of each group in the total expenditure of all households for the goods and services covered by the index. The product group weights are representative of the average household consumption expenditure at national level. Energy includes: electricity, gas, liquid fuels, solid fuels, heat energy and fuels and lubricants for personal transport equipment.

Weight of energy in HICP basket	$\frac{HICP_E}{HICP_T}$	HICP = Harmonized Index of Consumer Prices E = electricity, gas, liquid fuels, solid fuels, heat energy and fuels and lubricants for personal transport equipment T = all product categories included in HICP Unit: % Source: EUROSTAT

A1.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE BALANCE

Net trade balance of energy products as % of GDP

This indicator measures the trade balance as a percentage of GDP for the following categories of products: coal, coke and briquettes; petroleum, petroleum products and related materials; gas, natural and manufactured; electric current; and for the total. It is calculated as the ratio between net exports (i.e. exports minus imports) of the energy product category in question or the total, and GDP.

Trade balance of energy products as % of GDP

$$\frac{X_j - M_j}{GDP}$$

j = reference energy product

X = export; M = import

GDP = gross domestic product

Unit: %

Source: EUROSTAT (COMEXT and national account)

Decomposition of the net trade balance of energy products

Relative trade balance for energy products

This indicator is defined as the share of the net exports in energy products (total of specific product group) in total cross-border energy trade.

$$\frac{X_j - M_j}{X_E + M_E}$$

j = reference energy product (coal, coke and briquettes; petroleum, petroleum products and related materials; gas, natural and manufactured; electric current)

X = export; M = import

E = all energy products

Unit: %

Source: EUROSTAT COMEXT

Share of the energy trade balance in total trade

This indicator is defined as the share of the total trade in energy products (i.e. the sum of exports and imports) in the total trade of a country.

$$\frac{X_E + M_E}{X_T + M_T}$$

X = export; M = import

E = all energy products

T = total trade

Unit: %

Source: EUROSTAT COMEXT

Macro trade openness

This indicator expresses the relative size of a country's international trade vis-à-vis the size of its economy. It is defined as the ratio between total trade (i.e. the sum of exports and imports) and GDP. Note that this indicator is not energy-related.

$$\frac{X_T + M_T}{GDP}$$

X = export; M = import

T = total trade

GDP: gross domestic product

Unit: %

Source: EUROSTAT (COMEXT and national account)

ANNEX 2

Energy dependence indicators for 2008 and 2012

Energy dependence indicators for 2008

	Security of energy supply															
	Import dependence				HHI energy imports			Non-EEA share of imports			Gross inland energy consumption, shares by fuel					
	Gas (%)	Oil (%)	Solid fuels (%)	**Total Primary (%)**	Gas	Oil	Solid fuels	Gas (%)	Oil (%)	Solid fuels (%)	Gas (%)	Oil (%)	Nuc-lear (%)	Rene-wables (%)	Solid fuels (%)	HHI energy sources
	2008	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**
AT	88	92	104	69	0.47	0.11	0.34	86	55	11	22	39	0	25	11	0.27
BE	100	101	107	81	0.30	0.16	0.20	23	56	93	25	42	20	3	7	0.29
BG	96	99	43	52	1.00	0.40	0.42	100	88	99	15	24	21	5	38	0.27
CY				98		0.13	0.95		46	100	0	96	0	3	1	0.91
CZ	99	98	-16	28	0.64	0.29	0.81	76	72	3	16	22	15	5	44	0.29
DE	82	95	38	61	0.32	0.12	0.14	49	56	85	23	35	11	7	24	0.25
DK	-121	-49	109	-21		0.17	0.26		24	91	20	40	0	16	20	0.27
EE	100	66	1	25	1.00	0.27	0.48	100	72	99	13	20	0	11	58	0.40
ES	101	100	79	81	0.21	0.06	0.17	93	81	99	25	48	11	7	10	0.32
FI	100	101	72	54	1.00	0.54	0.38	100	81	89	11	29	16	25	15	0.21
FR	98	98	110	51	0.20	0.07	0.15	50	72	86	15	33	42	7	5	0.31
EL	100	101	5	73	0.50	0.16	0.29	100	87	88	11	56	0	5	26	0.40
HR	17	84	112	60	0.79	0.41	0.22	88	68	98	28	49	0	9	8	0.33
HU	88	81	47	63	0.63	0.66	0.25	99	83	64	40	27	14	6	11	0.27
IE	93	101	69	91	1.00	0.48	0.18	0	6	85	28	53	0	4	15	0.39
IT	90	92	102	86	0.24	0.13	0.16	82	94	93	39	43	0	7	9	0.34
LT	96	92	107	58	1.00	0.85	0.69	100	97	94	28	32	28	11	2	0.27
LU	100	100	100	97	0.31	0.54	0.51	41	0	100	24	63	0	3	2	0.45
LV	82	99	97	59	1.00	0.29	0.82	100	48	92	28	35	0	29	2	0.29
MT		100		100							0	100	0	0	0	1.00
NL	-73	98	106	34	0.33	0.08	0.16	20	64	94	42	41	1	3	10	0.36
PL	73	96	-7	30	0.54	0.54	0.30	92	81	79	13	25	0	6	56	0.40
PT	100	103	91	83	0.51	0.07	0.35	100	84	94	16	53	0	17	10	0.35
RO	29	52	27	28	0.95	0.34	0.20	100	92	79	30	26	7	13	24	0.24
SE	97	103	94	37	1.00	0.21	0.19	0	35	76	2	28	33	32	5	0.29
SI	100	102	29	55	0.36	0.23	0.54	78	16	79	11	39	21	11	20	0.26
SK	96	91	86	64	1.00	0.66	0.29	100	84	46	28	20	24	5	22	0.23
UK	26	9	75	26	0.54	0.19	0.28	2	40	97	39	35	6	2	17	0.31
EA											24	39	15	8	13	0.26
EU28	62	84	45	55	0.19	0.09	0.12	60	67	87	25	36	13	8	17	0.25

	Import dependency	Share electricity generation by fuel					
	Electricity (%)	Gas (%)	Oil (%)	Nuclear (%)	Rene-w ables (%)	Solid fuels (%)	HHI electricity generation
	2008	**2008**	**2008**	**2008**	**2008**	**2008**	**2008**
AT	8	19	2	0	70	8	0.54
BE	13	31	0	54	7	7	0.39
BG	-19	5	1	35	8	51	0.40
CY	0	0	100	0	0	0	0.99
CZ	-20	5	0	32	5	58	0.45
DE	-4	16	2	23	16	43	0.29
DK	4	19	3	0	28	48	0.34
EE	-13	7	0	0	2	91	0.84
ES	-4	39	6	19	21	16	0.26
FI	15	15	1	30	36	18	0.27
FR	-11	4	1	77	14	4	0.61
EL	10	22	16	0	10	52	0.36
HR	41	20	16	0	44	20	0.30
HU	11	38	1	37	6	18	0.32
IE	2	55	6	0	13	26	0.39
IT	13	56	10	0	20	13	0.38
LT	-11	15	4	71	9	0	0.54
LU	66	67	0	0	31	0	0.55
LV	38	39	0	0	61	0	0.52
MT	0	0	100	0	0	0	1.00
NL	15	62	2	4	9	22	0.44
PL	-1	4	2	0	5	89	0.80
PT	20	33	9	0	33	24	0.29
RO	-10	15	1	17	27	40	0.28
SE	-2	1	1	43	54	1	0.48
SI	-12	3	0	38	26	32	0.32
SK	2	7	2	58	16	16	0.39
UK	3	46	2	13	7	32	0.33
EA	1						
EU28	1	24	3	28	18	27	0.24

	Energy and carbon intensity of the economy									
	Energy intensity of the economy (kgoe/1000 EUR)	Energy intensity of industry (kgoe/1000 EUR)	Energy intensity of transport (kgoe/1000 EUR)	Energy intensity of households (kgoe/1000 EUR)	CO2 intensity of the economy (ton CO2 eq./1000 EUR)	CO2 intensity of energy use (ton CO2 eq./toe)	Share of energy intensive sectors in total GVA (%)	CO2 intensity of transport sector (ton CO2 eq./1000 EUR)	CO2 intensity of households (ton CO2 eq./1000 EUR)	Weight of energy in HICP basket (%)
	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
AT	128	159	751	47	0.3	1.9	11.8	1.9	0.11	9
BE	184	222	637	55	0.4	1.9	11.4	1.6	0.18	11
BG	712	656	2283	108	2.4	2.5	13.3	6.3	0.05	14
CY	187	209	1543	31	0.7	2.7		3.3	0.17	12
CZ	371	226	898	106	1.2	2.6	17.0	2.6	0.15	15
DE	140	110	630	47	0.4	2.4	10.7	1.6	0.16	12
DK	93	79	479	42	0.3	2.5	10.4	1.2	0.09	11
EE	469	326	994	134	1.5	2.8	11.3	2.8	0.14	12
ES	144	174	1060	28	0.4	2.2	8.7	2.7	0.13	10
FI	207	299	595	58	0.4	1.5	11.6	1.7	0.09	8
FR	151	145	643	43	0.3	1.4	7.1	1.7	0.13	9
EL	151	209	568	35	0.6	3.3	6.8	1.5	0.12	7
HR	224	237		75	0.8	2.5			0.20	12
HU	286	156	1124	115	0.8	2.0	12.0	3.0	0.25	14
IE	89	81	1299	39	0.4	2.9		3.2	0.18	9
IT	122	134	645	32	0.4	2.5	9.3	1.8	0.13	8
LT	363	176	770	90	1.0	1.4		2.3	0.11	13
LU	138	311	1925	47	0.4	2.3		4.7	0.17	12
LV	306	347	1322	139	0.8	1.8		3.7	0.13	11
MT	177		319	24	0.6	2.8		0.6	0.10	6
NL	149	168	633	39	0.4	2.1	10.5	1.4	0.16	11
PL	337	239	1217	105	1.4	3.3	13.1	3.4	0.24	13
PT	159	220	1074	31	0.5	2.2	9.3	2.8	0.12	10
RO	410	396	806	108	1.4	2.4	10.6	2.3	0.17	18
SE	154	195	504	45	0.2	0.9		1.2	0.07	11
SI	231	187	1222	65	0.6	2.3	14.7	3.7	0.20	13
SK	376	327	1144	82	1.0	1.8	18.0	2.8	0.18	17
UK	111	116	694	35	0.3	2.4	8.1	1.6	0.12	7
EA	145	147	707	41			9.5			10
EU28	151	151	720	44	0.6	2.2	9.5	1.8	0.19	10

Contribution of energy products to trade balance							
	Trade balance of energy products (% of GDP)			*Current account balance (% of GDP)*	DECOMPOSITION (related to total energy trade)		
	Petro-leum products	Gas	Total		Relative energy trade balance (%)	Share of energy in total trade (%)	*Macro trade openness (% of GDP)*
	2009	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**
AT	-1.7	-0.6	-2.5	*2.7*	-52.9	6.4	72.7
BE	-2.1	-1.1	-3.3	*-1.4*	-21.9	9.9	152.7
BG	-3.5	-1.8	-5.3	*-8.9*	-38.1	17.1	81.8
CY	-4.9	-0.1	-5.1	*-10.7*	-76.0	17.3	38.7
CZ	-2.2	-1.4	-2.9	*-2.4*	-42.7	6.1	109.9
DE	-1.5	-0.9	-2.5	*6.0*	-64.5	6.3	61.8
DK	0.8	0.0	0.8	*3.4*	21.4	6.7	56.8
EE	-1.7	-1.1	-2.3	*3.4*	-12.9	17.8	98.5
ES	-1.5	-0.7	-2.4	*-4.8*	-57.6	11.5	35.6
FI	-1.5	-0.5	-2.5	*1.8*	-43.0	11.4	51.5
FR	-1.4	-0.6	-2.0	*-1.3*	-58.5	8.7	39.9
EL	-1.9	-0.3	-2.3	*-11.2*	-43.4	17.7	30.1
HR	-2.5	-0.1	-3.6	*-4.9*	-45.3	15.5	50.8
HU	-2.0	-2.3	-4.9	*-0.2*	-61.0	6.4	126.1
IE	-1.7	-0.6	-2.4	*-2.3*	-76.3	3.9	78.9
IT	-1.3	-1.2	-2.7	*-2.0*	-65.2	10.7	38.8
LT	-2.4	-2.1	-4.2	*3.7*	-18.1	24.6	93.5
LU	-2.9	0.0	-2.7	*7.2*	-81.1	3.5	94.1
LV	-2.4	-2.0	-4.5	*8.6*	-60.1	10.9	67.8
MT	0.1	-0.1	-0.1	*-7.4*	-0.4	16.0	88.3
NL	-1.7	0.0	-1.8	*5.2*	-12.5	12.2	117.7
PL	-2.3	-0.2	-2.3	*-3.9*	-53.9	6.4	66.0
PT	-2.0	-0.7	-2.9	*-10.9*	-61.5	9.6	49.3
RO	-1.2	-0.3	-1.6	*-4.2*	-35.6	7.9	57.6
SE	-1.0	-0.2	-1.3	*6.7*	-23.8	8.9	61.4
SI	-3.3	-0.9	-4.0	*-0.7*	-57.4	6.6	106.6
SK	-1.2	-2.4	-4.4	*-2.6*	-43.3	8.0	127.6
UK	0.0	-0.2	-0.4	*-1.4*	-10.0	10.3	39.4
EA	-1.5	-0.8	-2.4	*-0.2*			
EU28	-1.3	-0.7	-2.1	*-0.7*	-41.3	9.0	75.1

Energy dependence indicators for 2012

	Security of energy supply															
	Import dependence				HHI energy imports			Non-EEA share of imports			Gross inland energy consumption, shares by fuel					
	Gas (%)	Oil (%)	Solid fuels (%)	**Total Primary (%)**	Gas	Oil	Solid fuels	Gas (%)	Oil (%)	Solid fuels (%)	Gas (%)	Oil (%)	Nuc-lear (%)	Rene-wables (%)	Solid fuels (%)	HHI energy sources
	2012	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**
AT	86	92	103	64	0.47	0.11	0.29	86	57	25	22	36	0	30	10	0.27
BE	99	99	94	74	0.33	0.16	0.18	13	63	87	26	39	18	6	5	0.26
BG	83	97	21	36	1.00	0.65	0.57	100	87	100	13	21	22	9	38	0.27
CY			100	97		0.07	1.00		46	100	0	95	0	5	0	0.90
CZ	89	95	-13	25	1.00	0.27	0.60	100	72	12	16	21	18	8	40	0.27
DE	86	96	40	61	0.30	0.14	0.16	43	59	89	22	34	8	10	25	0.24
DK	-54	-35	94	-3	0.59	0.24	0.31	0	17	93	19	39	0	23	14	0.26
EE	100	60	1	17	1.00	0.20	0.93	100	47	98	9	18	0	14	62	0.45
ES	100	97	77	73	0.24	0.07	0.19	85	87	98	22	42	12	13	12	0.27
FI	100	93	58	45	1.00	0.57	0.41	100	81	87	9	26	17	29	13	0.21
FR	97	98	95	48	0.22	0.06	0.17	37	73	92	15	31	42	8	4	0.31
EL	100	101	2	67	0.36	0.16	0.35	93	90	78	13	48	0	9	29	0.34
HR	37		88	54	0.34	0.22	0.38	0	69	93	30	42	0	12	8	0.29
HU	73	81	37	52	0.96	0.68	0.35	100	84	61	35	25	17	8	11	0.24
IE	96	99	55	85	1.00	0.43	0.59	0	29	89	29	47	0	6	17	0.34
IT	90	90	97	81	0.20	0.10	0.19	84	96	96	38	37	0	13	10	0.30
LT	100	93	89	80	1.00	0.75	0.63	100	91	99	37	35	0	16	3	0.29
LU	100	101	100	97	0.35	0.63	0.64	35	0	100	24	63	0	3	1	0.46
LV	114	102	95	56	1.00	0.28	0.61	100	38	99	27	30	0	36	2	0.30
MT		101		101		0.50			5		0	99	0	1	0	0.98
NL	-75	97	84	31	0.45	0.10	0.29	12	66	98	40	41	1	4	10	0.35
PL	74	95	-7	31	0.66	0.71	0.46	80	88	82	14	25	0	9	52	0.36
PT	100	101	103	80	0.39	0.09	0.57	100	84	100	18	45	0	20	13	0.29
RO	21	51	17	23	0.75	0.26	0.20	86	82	59	31	25	8	15	21	0.23
SE	99	95	78	29	1.00	0.21	0.16	0	43	65	2	25	33	37	4	0.32
SI	100	105	22	52	0.33	0.22	0.55	58	47	78	10	35	20	15	20	0.24
SK	90	90	90	60	1.00	0.67	0.25	100	83	49	26	20	24	8	21	0.22
UK	47	36	70	42	0.39	0.13	0.29	27	47	98	33	34	9	4	19	0.27
EA											23	36	15	11	14	0.24
EU28	66	86	42	53	0.16	0.09	0.16	55	69	90	23	34	14	11	17	0.23

	Import dependency	Share electricity generation by fuel					
	Electricity (%)	Gas (%)	Oil (%)	Nuclear (%)	Rene-w ables (%)	Solid fuels (%)	HHI electricity generation
	2012	2012	2012	2012	2012	2012	2012
AT	4	16	1	0	76	6	0.61
BE	12	31	0	49	14	4	0.35
BG	-30	5	0	33	13	48	0.36
CY	0	0	95	0	5	0	0.90
CZ	-30	4	0	35	10	51	0.39
DE	-4	14	1	16	24	44	0.29
DK	17	14	1	0	48	34	0.37
EE	-32	5	0	0	12	82	0.69
ES	-5	25	5	21	30	19	0.23
FI	22	10	0	33	41	15	0.30
FR	-10	4	1	75	16	3	0.60
EL	3	22	10	0	17	51	0.35
HR	50	24	6	0	50	21	0.35
HU	24	28	1	46	8	18	0.32
IE	2	50	1	0	20	29	0.37
IT	15	45	6	0	31	16	0.33
LT	74	57	5	0	34	0	0.44
LU	66	63	0	0	36	0	0.52
LV	25	33	0	0	67	0	0.56
MT	0	0	99	0	1	0	0.98
NL	16	57	1	4	12	24	0.40
PL	-2	5	1	0	11	83	0.70
PT	17	23	5	0	44	28	0.33
RO	1	15	1	19	26	39	0.28
SE	-15	1	0	38	59	1	0.50
SI	-7	3	0	35	29	33	0.31
SK	2	12	2	54	20	12	0.36
UK	4	28	1	19	12	39	0.28
EA	1						
EU28	1	19	2	27	24	27	0.24

	Energy and carbon intensity of the economy									
	Energy intensity of the economy (kgoe/1000 EUR)	Energy intensity of industry (kgoe/1000 EUR)	Energy intensity of transport (kgoe/1000 EUR)	Energy intensity of households (kgoe/1000 EUR)	CO2 intensity of the economy (ton CO2 eq./1000 EUR)	CO2 intensity of energy use (ton CO2 eq./toe)	Share of energy intensive sectors in total GVA (%)	CO2 intensity of transport sector (ton CO2 eq./1000 EUR)	CO2 intensity of households (ton CO2 eq./1000 EUR)	Weight of energy in HICP basket (%)
	2012	2012	2012	2012	2011	2011	2012	2011	2011	2012
AT	124	153	808	47	0.3	1.8	11.4	2.1	0.11	9
BE	172	265	559	45	0.4	1.6	11.2	1.5	0.15	12
BG	670	464	2407	125	2.4	2.7	12.4	7.4	0.06	14
CY	167	136	1737	34	0.6	2.7		3.8	0.18	9
CZ	355	212	859	106	1.1	2.5	14.6	2.5	0.15	14
DE	129	108	644	42	0.4	2.4	10.2	1.6	0.13	13
DK	87	74	384	43	0.3	2.3	9.6	1.1	0.08	11
EE	481	225	958	152	1.7	3.0	12.6	3.1	0.20	15
ES	136	145	776	30	0.4	2.1	8.6	2.2	0.12	12
FI	204	334	572	62	0.4	1.5	11.3	1.6	0.06	8
FR	143	132	636	42	0.3	1.3	6.6	1.7	0.12	10
EL	166	165		44	0.6	3.3	7.5	2.4	0.12	8
HR	225	194		85	0.8	2.4			0.23	14
HU	269	127	988	119	0.7	1.9	9.6	2.8	0.25	17
IE	83	74	1036	35	0.3	2.6		2.8	0.17	13
IT	117	122	644	38	0.3	2.4	8.7	1.8	0.12	10
LT	292	183	565	103	0.9	1.7		1.7	0.09	16
LU	134	319	1929	38	0.4	2.3		5.5	0.15	12
LV	329	387	950	150	0.9	1.8		2.9	0.22	16
MT	148		251	23	0.5	2.9		0.5	0.10	7
NL	149	154	614	43	0.4	2.0	10.6	1.5	0.16	11
PL	299	183	1101	101	1.2	3.2	14.2	3.3	0.23	15
PT	147	194		29	0.4	2.1	9.2	2.6	0.12	14
RO	379	292	1050	117	1.3	2.4	10.6	3.0	0.19	13
SE	148	182	476	46	0.2	0.9		1.1	0.06	12
SI	228	167	1137	71	0.6	2.2	15.2	3.3	0.19	15
SK	329	296	932	80	0.9	1.8	15.0	2.7	0.18	19
UK	105	107		34	0.3	2.3	7.1	1.7	0.11	10
EA	138	136	680	41			9.1			11
EU28	143	139	701	44	0.5	2.1	9.0	1.8	0.17	11

Contribution of energy products to trade balance							
	Trade balance of energy products (% of GDP)			*Current account*	DECOMPOSITION (related to total energy trade)		
	Petro-leum products	Gas	Total	*balance (% of GDP)*	Relative energy trade balance (%)	Share of energy in total trade (%)	*Macro trade openness (% of GDP)*
	2013	**2013**	**2013**	**2012**	**2013**	**2013**	**2013**
AT	-2.4	-0.9	-3.6	*1.8*	-61.8	6.8	85.8
BE	-2.6	-1.5	-4.5	*-1.4*	-15.9	15.6	181.0
BG	-4.4	-2.4	-6.5	*-1.3*	-28.0	19.4	120.4
CY	-6.7	-0.2	-7.0	*-11.7*	-70.0	26.2	38.0
CZ	-3.2	-1.8	-4.5	*-2.5*	-47.0	6.2	153.6
DE	-2.4	-1.0	-3.6	*7.0*	-59.6	8.3	72.7
DK	0.2	0.1	0.1	*5.2*	1.7	10.0	62.5
EE	-2.2	-1.3	-2.4	*-1.2*	-15.2	11.2	140.7
ES	-2.4	-0.9	-3.4	*-1.1*	-43.3	16.1	48.2
FI	-2.1	-0.1	-2.7	*-1.9*	-26.9	16.8	59.1
FR	-2.3	-0.8	-3.1	*-2.3*	-63.4	10.7	46.1
EL	-2.7	-0.7	-3.5	*-3.1*	-22.4	37.7	40.8
HR	-3.4	-0.8	-5.1	*0.1*	-45.1	19.7	57.0
HU	-3.3	-2.5	-6.5	*1.6*	-52.1	7.8	159.8
IE	-2.4	-0.9	-3.5	*4.9*	-71.8	5.9	82.4
IT	-1.8	-1.4	-3.4	*-0.7*	-58.6	12.1	48.0
LT	-4.0	-2.8	-7.3	*-0.5*	-18.2	27.3	147.4
LU	-4.3	0.0	-4.1	*5.6*	-90.9	6.1	74.7
LV	-3.4	-2.2	-5.2	*-1.7*	-43.1	11.5	103.8
MT	-9.9	-0.2	-10.0	*0.4*	-44.8	22.9	97.8
NL	-3.7	-0.5	-4.4	*9.9*	-14.6	19.1	157.6
PL	-2.9	-0.2	-2.7	*-3.5*	-42.3	8.3	78.7
PT	-2.5	-1.0	-3.7	*-1.5*	-38.5	15.4	62.7
RO	-1.6	-0.2	-1.9	*-4.0*	-33.2	7.8	73.7
SE	-1.4	-0.2	-1.6	*7.1*	-23.7	11.3	58.7
SI	-4.9	-1.0	-5.7	*2.3*	-38.7	10.1	144.3
SK	-2.5	-2.9	-6.0	*2.3*	-37.0	9.3	175.3
UK	-0.4	-0.3	-1.0	*-3.7*	-16.7	12.6	47.4
EA	-2.4	-1.0	-3.5	*1.2*			
EU28	-2.1	-0.8	-3.1	*0.3*	-36.7	12.1	94.2

Part II

Country profiles

INTRODUCTION TO THE COUNTRY FICHES

This part presents ten country fiches for the Member States which are not considered as vulnerable from an energy dependence point of view. These Member States are Austria, Belgium, Germany, Denmark, Finland, France, the Netherlands, Spain, Sweden and the United Kingdom ([31]).

Each of the fiches has been divided into three chapters mirroring the three broad dimensions of energy dependence, i.e. security of energy supply, energy and carbon intensity and contribution of energy products to trade. The assessment endeavours to identify the main drivers behind the performances of the Member States in each dimension with a view to framing the profile of the countries in a broader context, taking into account of structural features of their economy and national policy orientations.

The cut-off date for the use of published information is end of April 2014, while data published until 15 May 2014 have been included.

([31]) For an assessment of the vulnerabilities, see Member State's Energy Dependence: An Indicator-Based Assessment, Occasional Paper, 145/April 2013.

1. AUSTRIA

Key Insights

Security of Energy Supply

- Austria's import dependence of energy sources is moderately high in line with EU performance.

- Thanks to an already well-developed renewables sector, electricity prices in Austria are lower than in neighbouring countries Germany, Italy or the Czech Republic.

- One challenge facing Austria is the weak diversification of gas supply as the country currently relies on a few source countries. Projects aiming to diversify gas imports should be continued, as well as investments in electricity interconnectors that would serve to build a well-integrated regional electricity market.

Energy and Carbon Intensity

- Austria is one of the least energy intensive economies in Europe. The country surpassed its intermediate targets set by the second National Energy Efficiency Action Plan.

- However, if Austria is to meet its overall 2016 energy efficiency targets more measures need to be taken in the transport (especially heavy goods vehicles) and industry sectors.

- Although Austria is also among the least carbon-intense members of the EU, there is a risk that it will not be able to meet its 2020 emission reduction targets for non-ETS sectors without additional measures.

Trade Balance of energy products

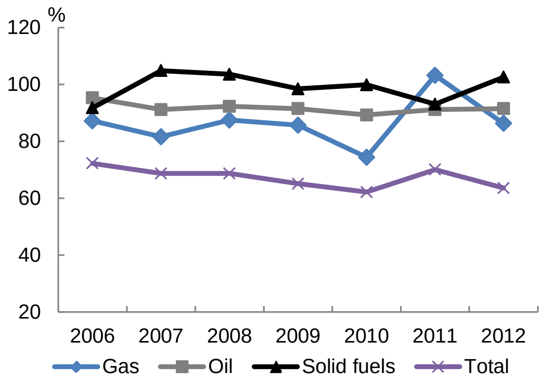
- The contribution of energy to trade in Austria is similar to the EU average.

- The presence of a rather high energy trade deficit is overshadowed by the fact that energy trade represents a small share of total Austrian trade in a context where the current account has remained positive and stable over time.

1.1. SECURITY AND ENERGY SUPPLY

Total energy import dependence has decreased in Austria from 69% in 2008 to 64% in 2012 which was 10% above the average for the EU-28. Since the beginning of the past decade Austria has maintained a relatively well diversified energy mix with energy generated evenly from oil, gas and renewable sources and to a lesser extent solid fuels.

Graph II.1.1: **Austria - Import dependence**



Source: Eurostat

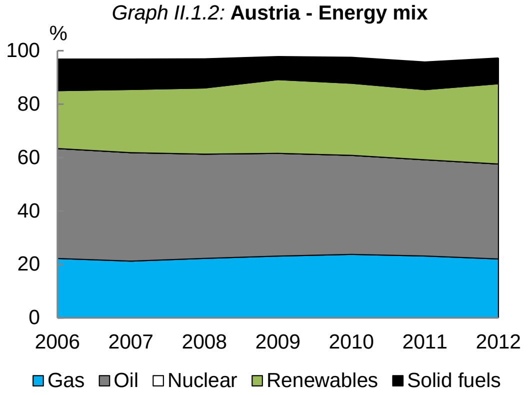
1.1.1. Primary energy sources

1.1.1.1. Oil

In 2012, oil was the dominant source of energy in Austria accounting for 36% of the energy consumed in the country – a drop from 39% observed in 2008. In 2012 92% of oil used in Austria was imported from abroad which is 6%

more than the EU-28 average and on the same level as 5 years before. Main import countries for crude oil were Kazakhstan (27%), Nigeria (18%), Russia (14%), Libya (13%) and Saudi Arabia (11%). Petroleum products are sourced from a highly diversified range of countries including Germany (21%), Kazakhstan (15%), Nigeria (10%), Russia (8%) and Saudi Arabia (6.3%).

Graph II.1.2: **Austria - Energy mix**



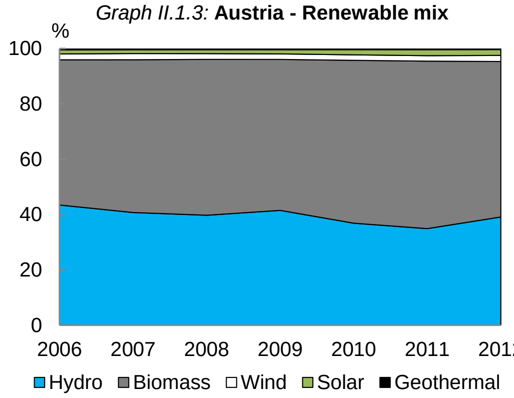
Source: Eurostat

One project designed to enhance Austria's security of oil supply is the construction of the 60 km long Bratislava-Schwechat-Pipeline between Austria and Slovakia which will close an important gap in the Trans-European pipeline network. The pipeline, which is meant to transport 2.5 to 5 million tonnes of oil per year, will directly link the Russian oil network Druschba to the oil refinery in Schwechat thereby reducing Austria's dependence on other countries' oil networks. Currently, the OMV refinery is supplied by the harbour in Trieste, Italy via the Transalpine and Adria-Wien pipelines. The planned pipeline will be able to transport crude oil in both directions which makes it beneficial also for Slovakia's security of oil supply. However, the project has recently seen growing opposition from the inhabitants of Bratislava who criticize the route of the pipeline which is meant to run directly under the capital city.

1.1.1.2. Renewables

In 2012, 30% ([32]) of energy in Austria came from renewable sources which have become the second largest component of its energy mix rising from 25% in 2008 and overtaking gas as the second energy source. This share is well above the EU-28 average of 11% and is the third highest after Latvia and Sweden. Austria is, therefore, well on its way of reaching its 2020 renewable energy target of 34%. Austria plans to reach its renewable energy targets in two ways: by reducing its final energy consumption by 13% compared to the reference scenario from 2005 levels and increasing the volume of renewable energy by 18% from 2008 levels ([33]). These two objectives are important to the government and together with the target of assuring security energy supply, they are regarded as the main pillars of Austria's official Energy Strategy.

Graph II.1.3: **Austria - Renewable mix**



Source: Eurostat

The largest and growing proportion of renewable energy stems from biomass, which generates in 2011 60% of the renewable mix, an increase of 5 percentage points since 2007. Hydropower accounts for 35% of renewable energy. It has historically been an important source of energy in Austria, but has been dropping steadily from a level of 54% in 2000. Wind and solar power account for only 2% of all renewable energy.

In its renewable energy action plan adopted in 2010, the government plans to increase hydro-power generation by 3500 GWh until 2015, double the amount of power generated from wind by 2020

([32]) The share of renewables in the energy consumption is here defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.

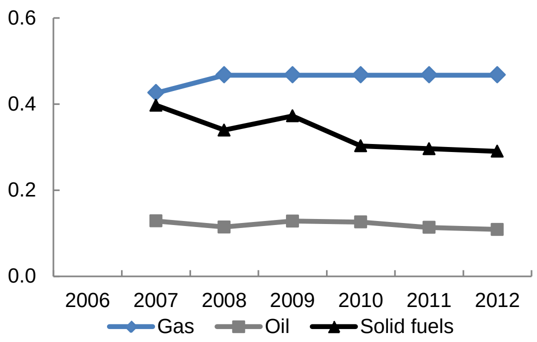
([33]) Republic of Austria (2010a)

and integrate the use of solar panels in the construction of new buildings.

1.1.1.3. Gas

Gas is the third source of energy used in Austria covering 22% of the energy mix in 2012 – nearly equal to the EU-28 average and the same share as in 2008. The majority of the gas is imported from only two countries, Russia (63%) and Norway (14%), Interestingly, in February 2011, for the first time, Austria became a net exporter of gas, a fact that can be attributed to the increase in exports from the storage and production facilities in Upper Austria to Germany ([34]).

Graph II.1.4: **Austria - HHI index energy imports**

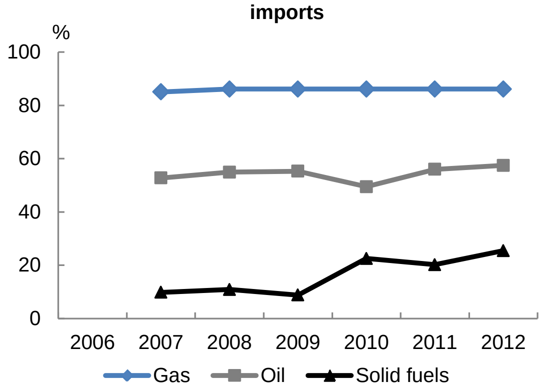


Source: Eurostat

There exists a number of on-going or stalled projects that are designed to diversify the routes and sources of gas supply to Austria, most of which are large international projects backed by the European Union.

One project to diversify gas supply away from Russian imports led by Austrian oil and gas corporation OMV failed in 2013. The 1315 km long Nabucco pipeline, that was planned to deliver Caspian Sea gas from Azerbaijan through Turkey, Bulgaria, Romania and Hungary and end in Austria, failed when the operator of the gas fields Shah Deniz consortium announced that it would send its gas via the Trans-Adriatic Pipeline (TAP). The decision was motivated by the higher gas prices in Greece and Italy where TAP is planned to be constructed. OMV reacted to this failure by stating that it would build its own pipeline if its gas explorations in the Black Sea off the coast of Romania.

Graph II.1.5: **Austria - Non-EEA share of imports**



Source: Eurostat

In 2010, Austria signed an agreement with Russia and committed to building part of the planned South Stream pipeline that is to deliver Russian gas through the Black Sea, Bulgaria and further to Austria. The South Stream project is viewed in Austria as a meaningful contributor to European gas supply security, especially given the interruptions of gas supply via the politically unstable Ukraine in 2006 and 2009. Since, there has not been an official withdrawal on the side of Gazprom from the plans to extend the pipeline to Austria, and negotiations with the Austrian government might be continued. ([35])

The natural gas hub in Baumgarten is the entry point to Western Europe for gas imported from Russia. Its shareholders, Austrian energy company OMV and the Vienna stock exchange would like to capitalize on its central geographical location and make the Vienna-based Central European Gas Hub one of the largest gas trading platforms in Europe, boosting gas trade especially as countries east of Baumgarten liberalise their gas markets. To achieve this, improvements in cross-regional gas networks, particularly interconnectors with the Czech Republic and Slovakia, are necessary and appropriate regulations are needed to integrate gas markets. To achieve reversibility of gas flows in these interconnectors would require only limited investments in compressor and monitoring

([34]) Energie-Control

([35]) According to the latest available information, a Memorandum of Understanding has been signed between OMV and Gazprom stating that South Stream will end in Austria already at the initial stage of the project.

stations ([36]). Additionally, extra storage capacity should be made available due to the volatile interaction between demand and supply in the Austrian and European gas markets. Gas storage capacities (68 GWh) cover about 90% of annual gas demand (91 GWh). Additional expansion of gas storage capacity was undertaken in early 2014.

A well-functioning and interconnected gas market with competitive and market-based prices should provide the correct incentives for further investments and signals to consumers for an efficient and sustainable use of resources. Both elements are conducive to reducing the vulnerability of the country to energy-related shocks.

Austria's National Energy regulator reports significant changes on the gas market in 2012 that resulted from shifts in wholesale gas prices. A number of new suppliers (also foreign, i.e. Montana Energie) entered the market to take advantage of high gas prices while existing suppliers pushed to renegotiate import agreements to align them with spot market prices. However, the Austrian consumer market still remains quite concentrated. In 2012 the combined market share of the three largest suppliers was 72% and that of the five largest suppliers 81% ([37]). As part of the unbundling process, Gas Connect Austria GmbH became the independent transmission system operator. Major changes have taken place in access to the transmission grid under the "New Market model" which enables suppliers to trade gas without making transport capacity reservations (i.e. contractually agreeing transport routes), but instead provide access to the grid on an entry-exit basis and trade via a Virtual Trading Platform.

Gas prices for domestic consumers in Austria are relatively high. In the first half of 2013 they have increased to a level above the one of Italy - which was Austria's only neighbouring country where domestic consumers were charged more. A different pattern is seen among gas prices for industrial consumers. The price paid by Austrian industry is lower than the EU average ([38]).

1.1.1.4. Solid fuels

10% of the energy mix in Austria was composed by solid fuels in 2012. 100% of solid fuels are imported to Austria. However, these resources are mainly imported from EEA countries, the Czech Republic and Poland but in recent years the share of imports from the US increased significantly, from 5% in 2006 to 25% in 2012.

Austria has been reducing coal mining since the 1960s and eventually shut down the last opencast lignite mine in 2005 and recultivated the Oberdorf lignite mine in 2006. Although large lignite resources remain, their extraction would not be economic ([39]).

The largest consumers of solid fuels are the steel industry and the power sector, i.e. the VOESTALPINE AG steel works at Linz and the MW Dürnrohr power plant in Lower Austria ([40]). Smaller volumes of coal are used by the cement and paper industries.

1.1.1.5. Nuclear

In 1997 the Austrian Parliament passed a resolution that made Austria a **nuclear-free country**.

1.1.2. Secondary energy sources

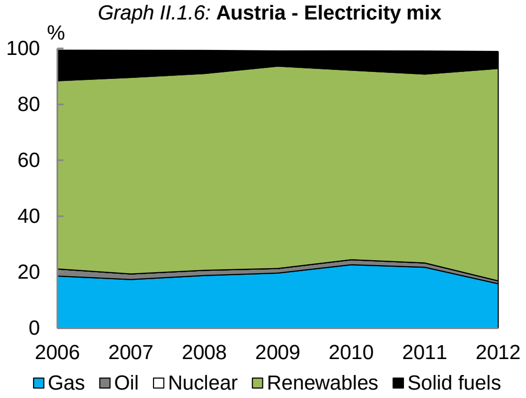
Austria is a net importer of electricity having imported 4% of the electricity in 2012, which is 3 percentage points more than the EU-28 average and a significant decline since 2008 when it imported 8% of electricity consumed in that year. The majority of imported electricity in 2012 came from Germany (53%), followed by the Czech Republic (44%) and marginal volumes from Slovenia, Switzerland, Italy and Hungary.

Throughout the past decade the electricity mix in Austria has been characterized by a high reliance on renewable energy. In 2012 76% of electricity was produced from renewable sources, which is a record achievement in the EU. The second most important fuel for electricity generation was gas which accounted for 16% of

([36]) Republic of Austria (2010b)
([37]) Energie-Control
([38]) EUROSTAT
([39]) EUROCOAL (www.eurocoal.org)
([40]) Recently one block of Dürnrohr has been shut down.

the electricity mix followed by solid fuels (6%), and petrol (1%).

Graph II.1.6: **Austria - Electricity mix**



Source: Eurostat

Recently, due to lower demand for electricity caused by bleaker economic prospects, some less cost-efficient gas-fired power stations have become unprofitable and been pushed out of the market. This resulted in a decrease of gas consumption for electricity generation in 2011 and 2012 ([41]).

In terms of continuity of electricity supply, Austria fares very well compared to its EU peers. Over the years, it has consistently been among the member states with the least number of minutes of interrupted supply, losing only around 20-30 minutes per customer per year – comparably to Germany, Denmark and Sweden ([42]).

Until 2020, electricity demand is forecasted to increase by 1.24% annually and to reach 70189 GWh. This increase is expected to be easily met by an increase in power generation capacities due to investment in thermal and hydro power stations and other renewable energies (biomass, photovoltaic and wind-power). Until 2020 power generation is expected to increase by 6742 MW and reach 29553 MW of capacity. All models of forecasted load peaks until 2020 suggest that Austria will be in a very comfortable situation being able to fully cover power demand. In the conservative scenario, a capacity surplus of over 10 GW is expected on average in January 2020.

Further development of cross-border interconnectors with neighbouring countries is expected in order to increase the security of electricity supply and enable the functioning of a cross-border electricity market, especially accommodating for the demands placed on the Austrian grid by Germany's *Energiewende*. Since 2009, the transmission network operator APG is obliged to regularly publish a master plan for medium- and long-term network planning.

Austria's National Energy Regulator reports that there were no significant improvements to competition in the electricity sector in 2012. The shift from the procurement of control energy under long-term agreements to ongoing auctions of short-term products did not have the desired effect of boosting competition ([43]). In the retail market in 2012, there were 15 nationwide suppliers of electricity which means that there had been one new entrant since the previous year. However, the number of offered services increased during 2012, e.g. the number of services offered to costumers in Vienna rose from 25 to 35. In 2012, the cumulative share of the three largest suppliers of electricity to households and SMEs remained at a level of 56%. The largest five suppliers to households kept a share of 70% of the market.

In 2013, due to decreasing economic activity and, on the supply side, continued decreases in coal and carbon emission prices throughout the year, wholesale electricity prices have fallen below 30 €/MWh at the end of Q2 2013, for the first time since March 2007. Retail prices in Austria remain clearly below the EU-28 average although much more so for industry than for households.

1.1.3. Conclusions

Austria does not present particular elements of vulnerability in terms of security of energy supply. The country's reliance on renewable sources also puts the country ahead of many other member states in building a low carbon emission economy. The maturity of the renewables sector has also enabled Austria to enjoy relatively low electricity prices as compared to its neighbouring countries. Although, Austria is dependent on imports of most of its energy fuels, imports of its

([41]) Energie-Control
([42]) CEER
([43]) Energie-control

most important source of energy, oil, are well diversified.

Austria is striving to diversify imports in the gas sector. However, many projects aimed at diversifying gas supply have been cancelled or postponed due to the failures or decisions of external parties. Austria should further pursue the gas supply diversification objective along with projects to further improve security of oil supply and investments in electricity interconnectors that would better integrate the regional electricity market, keep electricity prices low and maintain solid continuity of electricity supply.

1.2. ENERGY AND CARBON INTENSITY

Austria has one of the lowest energy intensities in the EU. In 2012 the value of its energy intensity equalled 123.9 kgoe/1000 EUR which placed it just behind Ireland, Denmark, the UK and Italy. Energy intensity measured in relation to GDP has followed a downward trend, decreasing cumulatively by 12% (over the period 2005-2012).

In 2007, Austria's first National Energy Efficiency Action Plan (NEEAP) set out energy saving targets until 2016 according to the Energy End-use Efficiency and Energy Services Directive ([44]). Until 2010, Austria planned to save 2% of final energy consumption compared to the baseline (average final energy consumption between 2001 and 2005) thanks to improved energy efficiency. The target for 2016 was set at 9%. By 2020, Austria intends to stabilise its final energy consumption at 2005 levels, i.e. energy consumption is not to exceed 1,100 PJ annually by that year which is 20% less compared to the baseline year.

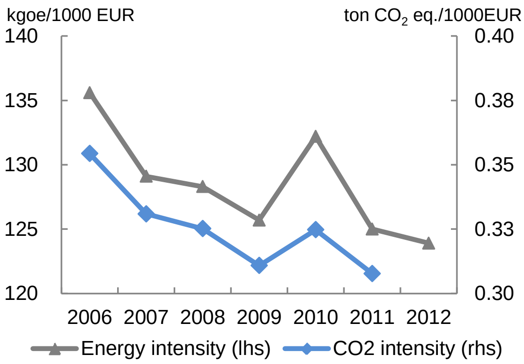
A bottom-up review of the energy-efficiency measures presented in the second NEEAP showed that the 2% intermediate target in 2010 was considerably surpassed and, according to the monitoring body, amounted to 49,384 TJ which corresponds to about 6% of the baseline energy quantity. Considering that most of the already implemented energy efficiency measures will still be effective in 2016 and taking into account programmes already in the phase of implementation today, the 2016 target is expected to be achieved to 98%. If further measures were to be implemented in the future, Austria should also surpass its 2016 energy efficiency target ([45]).

The Energy Efficiency Directive (EED) requires Member States to formulate an indicative energy efficiency target for the year 2020. Austria reaffirmed its commitment to reach a target of final energy consumption for 2020 of 1 100 PJ, which corresponds to a reduction of about 20% compared to the baseline scenario.

The carbon intensity of the Austrian economy equalled 0.31 tonnes CO2eq./1000 EUR in 2011 which was slightly better than in 2007 (when it equalled 0.33 tonnes of CO2eq./1000 EUR) and one of the lowest results in Europe along with Denmark, Sweden, Finland and the UK.

Contrary to Austria's energy efficiency performance, the country has not seen that much success in further curbing its GHG emissions. The Kyoto target for Austria was a reduction of GHG emissions during the period 2008-2012 by 13% compared to the 1990 level of emissions. Austria made substantial use of the flexible mechanisms of the Kyoto Protocol to meet its target as its average 2008-2012 GHG emissions were estimated in the latest progress report to equal 83 Mt CO2-equivalent, 5% above the 1990 baseline level of 78.2 Mt CO2-equivalent. This represents a significant gap of 18% from its Kyoto protocol target ([46]).

Graph II.1.7: **Austria - Energy and carbon intensity of the economy**



Source: Eurostat

([44]) Republic of Austria (2007)

([45]) Republic of Austria (2011)

([46]) European Environment Agency (2013)

Table II.1.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	124	-3.4
CO2 intensity of the economy 2)	0.31	-5.4
Share of energy intensive sectors in Gross Value Added 3)	11.4	1.6
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

The sectors not covered by the EU ETS did not deliver the necessary reduction to meet Austria's Kyoto target. On average, between 2008 and 2012, emissions from non-ETS sectors were 15% higher than 1990 levels - a gap of 19% from the Kyoto target. Under the Effort Sharing Decision ([47]), Austria has committed to reduce its GHG emissions in non-ETS sectors by 16% until 2020 compared to the 2005 level. However, according to the latest projections, Austria is likely to miss its 2020 target by about 7% without additional measures ([48]).

The share of GHG emissions falling under the ETS equals 36% of total emissions, below the EU average of 40%. Since the third phase of the scheme started in 2013, there has been an EU-wide emissions cap and emissions allowances are auctioned while so far they had been granted for free. This is expected to impact on the energy costs of industries which will likely pass them onto consumers.

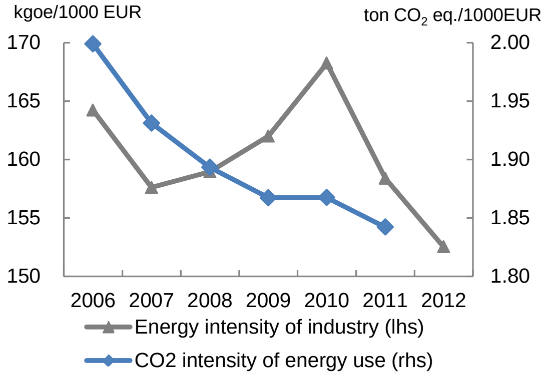
1.2.1. Industry

The energy intensity of Austrian industry is above the EU performance and in 2012 equalled 153 kgoe/1000 EUR which is a slight improvement of 3.7% from 2008. The share of energy-intensive sectors in total gross value added in Austria was 11.4% in 2012 - higher than 9% seen in the whole EU.

The industry's share of total final energy consumption in 2012 equalled 30% which has remained around this level throughout the 2000s ([49]).

The second NEEAP reports that the industries are expected to account for about 7.5% of the overall energy saving target to be reached by 2016. With early action measures and those adopted between 2008 and 2010 the industrial sector has already achieve about 35% of its expected saving ([50]). Most of these savings were achieved in mining and the rest in non-classified production sub-sectors.

Graph II.1.8: **Austria - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

([47]) Decision 406/2009/EC
([48]) European Commission (2013). This analysis does not yet take into account the use of flexibilities provided for in the Effort Sharing Decision (406/2009/EC), such as the use of international project credits or transfers of surplus emissions allocations among Member States.
([49]) Statistik Austria
([50]) Energy efficiency measures that were introduced before 2008 and that will still be effective in 2016.

One mechanism that could contribute to the energy efficiency of the Austrian industry sector are domestic environmental investment grants financed by the Federal and state authorities that cover up to 30% of the costs incurred by businesses undertaking environment-related investments. According to bottom-up calculations in the NEEAP, this measure has brought in energy savings of 2,675 TJ per year and is projected to raise these savings to 5,578 TJ per year by 2016. The mechanism is complemented by "energy efficiency vouchers" which is an energy advice programme directed at SMEs.

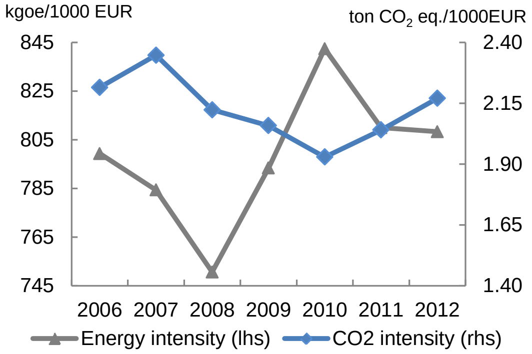
The carbon intensity of the energy sector has slightly improved between 2007 and 2011 dropping from 1.93 to 1.84 tonnes CO2/1000 EUR which remains below average EU levels.

1.2.2. Transport

Energy intensity of the Austrian transport sector is above the EU performance and equals in 2012 808 kgoe/1000 EUR which is higher than the 751 kgoe/1000 EUR reported in 2008. Since 1995, energy efficiency has been flat in the transport sector according to the NEEAP. When broken up in segments, the heavy goods vehicle sector has deteriorated its energy efficiency whereas the railway sector has significantly improved its energy efficiency – by 40% since 1995. The share of international freight services in total freight activities is among the highest in the EU, around 13% ([51]). According to bottom-up calculations in the NEEAP, the mobility sector generated energy savings of 1,804 TJ between 2008 and 2010 which accounts for 3.65% of all the savings achieved within this period and almost half of savings expected in this sector by 2016.

The transport sector accounted for a third of the final energy consumption in 2012, similarly as throughout the 2000s.

Graph II.1.9: **Austria - Energy and carbon intensity of transport**



Source: Eurostat

There are three energy efficiency measures aimed at mobility and mentioned in the second NEEAP. One of them is a set of traffic measures financed by the Climate and Energy Fund that aim at improving the efficiency and attractiveness of intermodal transport systems. The Austrian government and federals states also invested, among others, in mobility projects like 'park & ride', bicycle and car sharing infrastructure as well as took actions to reduce transport speed. The emissions benefits of all these measures are, however, difficult to estimate. One measurable instrument - the 'klima:aktiv' iniative, aimed at environment-friendly and sustainable traffic development, has brought in annual savings of 1,804 TJ in 2010 and is projected to generate 3,666 TJ of annual savings in 2016.

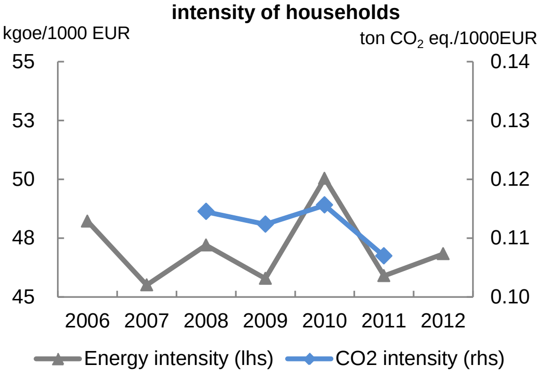
Similarly to energy intensity of the transport sector, carbon intensity is higher than in the rest of the EU and in 2011 totalled 2.1 tonnes of CO2eq./1000 EUR, which is a deterioration since 2006 when the indicator read 1.6 tonnes of CO2eq./1000 EUR.

1.2.3. Households

Energy intensity of Austrian households in 2012 equalled 46.8 kgoe/1000 EUR – more or less in line with the performance of the EU as a whole.

([51]) Eurostat

Graph II.1.10: **Austria - Energy and carbon intensity of households**



Source: Eurostat

The second NEEAP reports that savings in household energy use amounted to 44,626 TJ which is about 90% of all bottom-up energy savings reported in the second NEEAP and 65% of savings that are expected in this sector by 2016 ([52]). The latter result suggests that the housing sector has performed better than the other sectors in meeting its 2016 targets. Over 75% of these savings were achieved in heating, followed by electrical appliances (largest contributions from more efficient refrigerators and freezers), hot water and lighting. Since 1995, the total usable area in residential buildings has grown steadily by 30% whilst energy consumption for heating dropped by 5% implying significant improvements in heating intensity. Although, the short-term trend for hot water is positive, in the long-run, since 1995, energy efficiency in this area has deteriorated by around 6%.

Measures for improving energy efficiency of households mainly concentrate on investment in buildings. By 2016, the largest and most significant annual savings are expected to be achieved through improvements in residential building shells (22,705 TJ), efficient heating systems in residential buildings (18,821 TJ) and by tightening construction law requirements (18,676 TJ).

Relative to the peer economies mentioned above, Austrian households perform better than Belgium but worse than Sweden in carbon intensity which has been stable between 2007 and 2011 amounting to 0.11 tonnes CO2eq./1000 EUR.

([52]) Considering both early actions and measures adopted in the period 2008-2010.

1.2.4. Conclusions

Austria is one of the least energy-intensive countries in Europe. It has clearly surpassed its intermediate 2010 energy efficiency targets set out in the National Energy Efficiency Action Plan. However, 90% of this achievement can be attributed to the housing sector which is well on track to meeting its 2016 target. If Austria is to meet its overall 2016 energy efficiency targets more measures need to be taken in the transport and industry sectors. This is especially important given Austrian industry and transport sectors being relatively more energy intensive than the overall EU performance.

Although Austria is also among the least carbon-intensive members of the EU, it has been historically less successful in meeting its GHG emission targets. By introducing new energy efficiency measures over the course of the next couple of years and clearly surpassing the 2016 targets outlined in the first NEEAP, it would certainly ease the task of cutting GHG emissions.

1.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

1.3.1. Net energy trade balance

In 2013 Austria had an energy trade deficit of 3.6% of GDP which was slightly larger than the average EU-28 3.1% energy trade deficit. Since 2001, when the trade deficit equalled 1.9%, it deteriorated steadily until 2006 hitting 3.6% of GDP. Since then, the deficit has been fluctuating around the levels of between 3% and 3.5%.

A significant role in the energy trade deficit is played by petroleum products which saw a trade deficit of 2.4% of GDP in 2013, up from 1.7% in 2009. Similarly to the overall energy trade balance, the trade gap in oil rose most rapidly until 2006 when it stabilized and began to fluctuate around 2% and 2.5% of GDP. Oil has been the decisive driver of the trend in overall energy trade balance as it persistently accounts for around 70% of the nominal energy trade deficit.

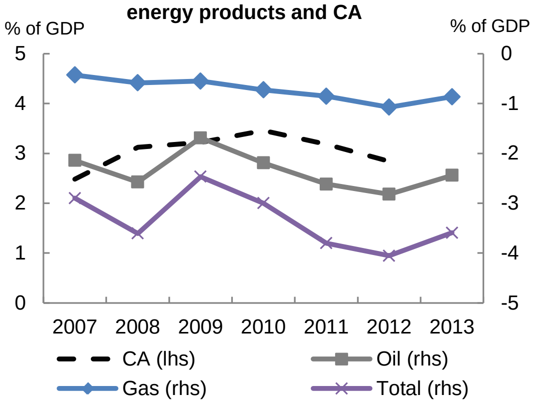
Table II.1.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-2.5	-3.0	-3.8	-4.1	-3.6
Relative trade balance (%)	-52.9	-54.3	-57.3	-57.2	-61.8
Share of energy in total trade (%)	6.4	6.7	7.5	8.1	6.8
Macro trade openness (% GDP)	72.7	82.4	88.5	87.5	85.8

Source : Eurostat

Around 20% of the nominal energy trade deficit can be attributed to gas. In 2013, the gas trade deficit corresponded to 0.9% of Austrian GDP. Throughout the 2000s Austria's trade deficit in this energy source fluctuated between 0.4% and 0.8% of GDP.

Graph II.1.11: **Austria - Trade balance of energy products and CA**



Source: Eurostat

The energy trade deficit needs to be viewed against the background of the country's current account balance. **In the case of Austria, the energy trade deficit is outweighed by the current account surplus which in 2013 corresponded to 1.8% of GDP** which nevertheless is worse than in 2007 when the current account surplus equalled 3.5%. Since 2001, Austria has consistently had a current account surplus large enough to cover for and exceed the trade gap in the energy sector.

1.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade, and the ratio of total trade to GDP (macro openness to trade).

Austria's relative trade deficit in 2013 was 63.8% which is one of the five highest in the EU. Throughout the 2000s the country's relative trade balance has fluctuated between -45% and -65%.

The rather high relative trade deficit is, however, compensated by a very low share of energy trade in total trade which is among the five lowest in the European Union. The proportion of total trade that can be attributed to energy was rising from 4.3% in 2001 until 2005 when it stabilized and began fluctuating and in 2013 equalled 6.4%. A further factor that mildly mitigates the effect of the energy trade deficit on the current account is the below EU-average macro openness of Austrian trade which in 2013 amounted to 85.8% of GDP compared to 94.2% recorded for the EU as a whole.

1.3.3. Conclusions

The contribution of energy to trade in Austria is similar to the EU average. Although the country has a substantial energy trade deficit, its relevance to total trade and the relatively moderate openness of the Austrian economy renders its effect less detrimental to the current account which remains positive over time.

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2. BELGIUM

Key Insights

Security of Energy Supply

- Belgium's high dependence on imported energy sources, with imports covering 74% of the country's total energy needs, is mitigated by the country's well diversified energy mix and the diversification of the countries of origin of the imported fuels.

- Going forward, some issues related to the energy supply require close attention, in particular the planned phasing-out of nuclear reactors from 2015 and the low potential of renewable energy.

Energy and Carbon Intensity

- Belgium's energy intensity is above the energy intensity of the EU as whole. The country has considerable potential to improve energy intensity, especially in household and industry sectors.

- Even if Belgium's carbon intensity is two thirds of the EU level, Belgium is expected to miss by a wide margin its 2020 target to reduce greenhouse gas emissions. Therefore additional measures are needed to address the emissions, especially in the transport sector and in buildings.

Trade balance for energy products

- Belgium's energy trade deficit indicates some vulnerability concerns as it is the largest among the EU15. It should be seen against the background of its current account deficit, which has gradually emerged in recent years.

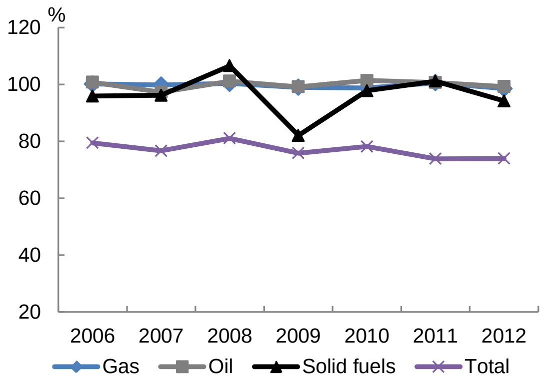
- The deteriorating energy trade deficit and the fact that the share of energy products in trade is quite high suggests that the impact of energy price shocks on the economy may not be negligible.

2.1. SECURITY OF ENERGY SUPPLY

Belgium imported 74% of its energy sources from abroad in 2012. Belgium's import dependence was far above the EU average, of 53%. Belgium's domestic energy production comes from nuclear power generation and renewable energy sources, while the country has no own production of fossil fuels.

The country's energy mix is rather well diversified. It has higher shares of oil, gas and nuclear power than the EU average, and lower shares of solid fuels and renewables.

Graph II.2.1: **Belgium - Import dependence**



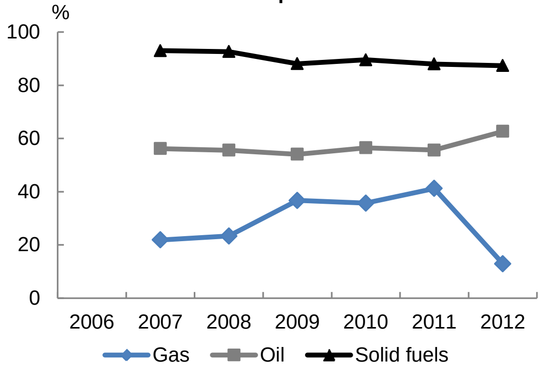
Source: Eurostat

2.1.1. Primary Energy Sources

2.1.1.1. Oil

Oil is the largest source of energy used in Belgium. It accounted for 39% of gross inland energy consumption in 2012, 5 percentage points above the EU average. Belgium has no domestic oil production. The country's crude oil imports are rather well diversified, coming from a broad range of countries. The most important suppliers in 2012 were Russia (37%), Saudi Arabia (23%), Nigeria (15%), Norway (7%), the UK and Iraq.

Graph II.2.2: **Belgium - Non-EEA share of imports**



Source: Eurostat

Belgium has five oil refineries located in the port area of Antwerp, with a distillation capacity above 40 million tons per year. Crude oil is delivered to them by pipelines, ship and barge. Moreover, Belgium's imports of processed petroleum products slightly exceed its exports. Two thirds of these products are imported from the Netherlands.

2.1.1.2. Gas

The second source of energy used in Belgium is gas. It accounted for 26% of gross inland energy consumption in 2012, which was slightly above EU average of 23%. Belgium imports all the gas which the country consumes, as it has no domestic gas production.

The level of diversification of gas imports by country of origin, measured by HHI index, is one of the highest among the Member States. The most important gas suppliers in 2012 were Norway (39%), the Netherlands (38%) and Qatar (13%). The share of EEA countries in gas imports to Belgium is among the highest in the EU.

A well-functioning and interconnected gas market with competitive and market-based prices should provide the correct incentives for further investments and signals to consumers for an efficient and sustainable use of resources. Both elements are conducive to reducing the vulnerability of the country to energy-related shocks.

Belgium is well connected by gas pipelines with neighbouring countries, although contractual congestion (capacity booked, but not used) is still a problem. An important part is also delivered in the form of LNG through the Zeebrugge LNG terminal. In 2010, LNG represented almost 30% of the gas supply to Belgium, but this share has decreased since then. Most of gas (62% of total gas supply in 2012) is based on long-term contracts with natural gas producers, i.e. with duration above 5 years. The share of gas based on short-term contracts (below 1 year) in total gas supply to Belgium has grown from 22% in 2011 to 34% in 2012. Belgium has a physical wholesale gas trading hub in Zeebrugge. The country's gas storage capacity is close to 1 billion m³, corresponding to 5% of annual gas consumption, most of it in one underground facility.

The level of concentration on the Belgian gas market is still high, but competitive pressure is exerted by emerging companies. At a wholesale level, three major suppliers covered 79% of the market in 2012. At a retail level, the three biggest suppliers covered 76% of gas consumption, with ECS (Electrabel, a subsidiary of GDF Suez) having a dominant position ([53]). Final gas prices for both industrial consumers and households, including taxes, were in 2013 slightly above the EU average.

2.1.1.3. Nuclear

Nuclear is the third source of energy used in Belgium, accounting for 18% of gross energy consumption. This is the sixth highest share among the Member States. Nuclear provides 49% of Belgium's electricity generation, which is the third highest share in the EU after France and Slovakia. Belgium has currently seven operating nuclear units in two sites, i.e. Doel in Flanders and Tihange in Wallonia. Electrabel and EDF are the main shareholders in these power plants.

The nuclear units in operation are 29 to 39 years old and their possible phase out has been discussed

([53]) European Commission (2014) http://ec.europa.eu/energy/gas_electricity/internal_market_en.htm for many years. A law, adopted in 2003, prohibits the building of new nuclear power plants and limits the operating lives of the existing ones to 40 years. This can, however, be changed if Belgium's security of supply is threatened. In 2012 the government decided that two of the oldest reactors (Doel 1 and 2) were to close in 2015, and the third oldest one (Tihange 1) would be permitted to operate until 2025 ([54]). The other four Belgian reactors will reach 40 years between 2022 and 2025.

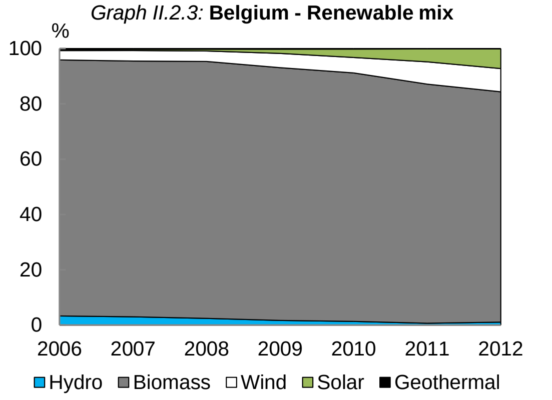
The phasing out of nuclear power will have major implications on Belgium's energy system. First, it will increase the already high dependence of Belgium on imported energy sources as nuclear power would be at least partially replaced by power based on imported fossil fuels. In the short term, electricity imports will also increase. Second, a nuclear power phase-out requires new investment in domestic power generation, and a review of the contingency planning of the energy capacity ([55]). In order to provide a stable framework for investment, the uncertainty about the allowed life expectancy of the existing nuclear plants should be removed. On the other hand, extending the life of 40-years nuclear reactors could pose serious safety risks and requires large investment to satisfy safety regulations (e.g. estimated at EUR 500 million in case of Tihange.

2.1.1.4. Renewables

Renewable energy accounted for 6% of Belgium's energy mix in 2012. This was among the lowest shares of the Member States.

Belgium has a binding target introduced by Directive 2009/28/EC to increase the share of renewable energy to 13% of gross final energy consumption by 2020. With a share of 5.2% in 2011 and 6.8% in 2012, progress has been made towards achieving this target despite the lack of a common strategy between the different entities ([56]).

Graph II.2.3: **Belgium - Renewable mix**



Source: Eurostat

The share of gross electricity generated from renewable sources was 14% in 2012 and has increased substantially from 3% in 2006. The corresponding share for the EU as a whole is 24%. Close to half of renewable electricity is produced from biomass and waste. Hydro power production represents some 14% of renewable electricity production. The shares of wind and solar power in renewable electricity are close to 23% and 18% respectively and have been growing fast in recent years.

The share of renewables in heating and cooling and in transport in Belgium is among the lowest in the EU. In heating and cooling, the share of renewables amounted to 4.3% in 2011, 11 percentage points below the EU average. In transport, the share of renewables amounted to 4.3% in 2010, close to the EU average. However, according to Eurostat, it has fallen to 0.3% in 2011 due to the application of the biofuels compliance rules ([57]).

The main instrument to support renewable electricity is a quota obligation system with tradable green certificates, introduced in 2002. The system is applied in all three regions, but the

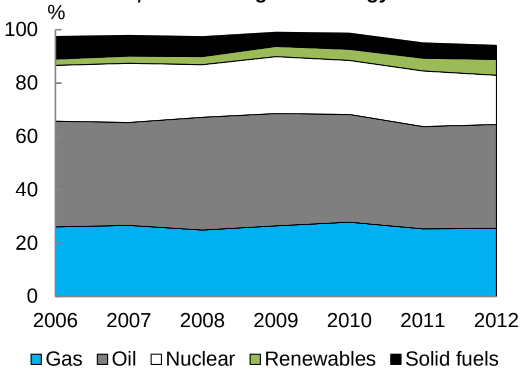
([54]) World Nuclear Association, Nuclear Power in Belgium, www.world-nuclear.org
([55]) European Commission (2013a)
([56]) The share of renewables in the energy consumption (in the first paragraph of this section) is here defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC (in the second paragraph of this section) are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.
([57]) As of 2011, only biofuels and bioliquids reported as compliant are counted towards the respective shares of renewables. This implies compliance with both Article 17 (Sustainability criteria) and Article 18 (Verification) of the Renewable Energy Directive 2009/28/EC (European Commission 2013b).

minimum prices and fines for suppliers that do not meet the monthly obligation differ according to region ([58]). System operators are obliged to purchase certificates from producers for the established minimum price. The main instrument to promote renewables in transport is a tax exemption for the production of biodiesel and bioethanol, within a certain quota.

2.1.1.5. Solid fuels

The fifth energy source in Belgium is solid fuels. They accounted for 5% of the country's energy mix in 2012, much below the EU average of 17%. The share of coal has gradually decreased from 8% in 2006.

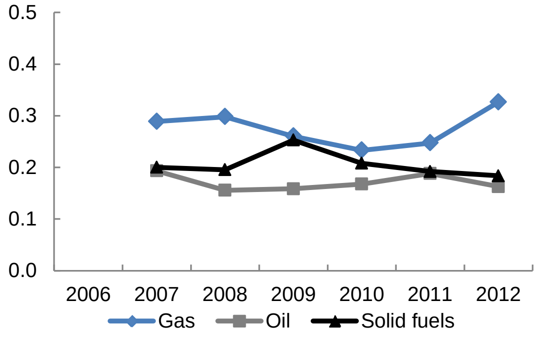
Graph II.2.4: **Belgium - Energy mix**



Source: Eurostat

Belgium has indigenous coal resources, but because of high production costs, all coal mines have been closed, the last one in 1992. Therefore all solid fuels are imported. Belgium's coal imports are well diversified. In 2012, 30% of hard coal was sourced from the US, 22% from Australia, followed by Germany (10%) and South Africa (8%).

Graph II.2.5: **Belgium - HHI index energy imports**



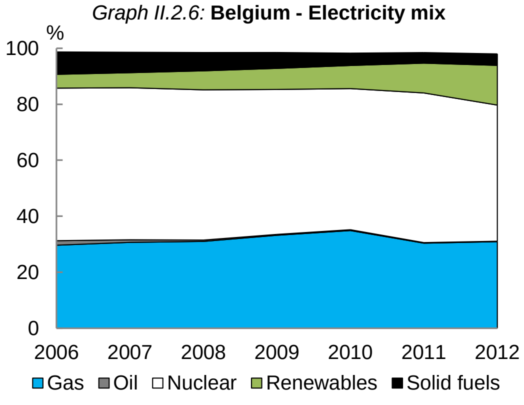
Source: Eurostat

Belgium's coal imports were decreasing over the latest period, with a 30% decrease between 2007 and 2011. It is not clear yet to what extent this trend has been reversed recently, in 2012-13. In some EU countries falling coal prices have prompted electricity generators to switch from gas to coal in recent years, but in Belgium electricity generation in coal-fired power plants remained stable in 2011-13.

2.1.2. Secondary Energy Sources

Belgium is a net importer of electricity. Net imports represented 8% of Belgium's electricity consumption in 2012. Belgium is usually a net energy importer from France and a net exporter to the Netherlands, although strong fluctuations are observed.

Graph II.2.6: **Belgium - Electricity mix**



Source: Eurostat

Belgium's electricity mix in 2012 is dominated by nuclear power (with a 49% share) and gas (31%). The role of renewables and coal is smaller (14 and

([58]) Re-Shaping project, Renewable Energy Policy - Country Profiles, Report D15, 2011

4% respectively), while the use of oil is now marginal.

The decision to close the oldest three nuclear power plants in 2015 has raised concerns about the security of the Belgian electricity supply over the medium term, especially given the shutting down of several other (gas-fired) power plants. Within this context, the authorities adopted some measures aimed at improving the security of electricity supply, including the extension of the operation lifetime (+ 10 years) of one of the three oldest nuclear power plants, the creation of a strategic back-up capacity through an annual tender procedure, a call for bids for the subsidized construction of new gas-fired plants, as well as a re-design of the support scheme for offshore wind farms.

Good electricity interconnections and adequate domestic infrastructure capacity are important to shelter the country from supply shocks and to enable a proper absorption of renewables. A competitive and dynamic electricity market should cater the necessary investment incentives and provide the right price signals to consumers.

Belgium is well interconnected with electricity grids of the neighbouring countries ([59]). Belgium is part of the Central Western Europe area, which shows high market integration measured, for instance, by high convergence of wholesale electricity prices. The interconnection at the Belgian-French border was reinforced in 2010 ([60]). A new major interconnector, the Nemo Link, is planned between Belgium and the UK; it is planned to be in commercial operation by 2018.

Both electricity generation and retail market are strongly concentrated, with a strong role of the incumbent Electrabel and its subsidiaries. Its market share as the largest electricity producer was 71% in 2011, and over 60% in the electricity retail market. However, the rate of supplier switching was high, over 8% in Flanders. Final electricity prices for industrial consumers, including taxes and charges were in 2013 slightly below the EU average, while the prices for households were 15% above the EU average. The independence of the Belgian federal energy regulator CREG has further improved recently.

2.1.3. Conclusions

Belgium's high dependence on imported energy sources, with imports covering 75% of the country's total energy needs, is mitigated by the country's well diversified energy mix, including a high share of nuclear power. The diversification of the countries of origin of the imported fuels also improves the security of the energy supply. However, some issues related to the energy supply require close attention, in particular the planned phasing out of nuclear reactors as of 2015 and the low potential of renewable energy.

2.2. ENERGY AND CARBON INTENSITY

In 2012 Belgium's energy intensity was the second highest, after Finland, among the "old" Member-States (EU15). Energy intensity declined slowly between 2000 and 2007 and then fluctuated from one year to another. Altogether, over the period 2000-2012, energy intensity of the Belgian economy fell by 17%.

Belgium's National Energy Efficiency Action Plan (NEEAP) runs for the period 2008-2016 and sets targets and measures to enhance energy efficiency. The savings target to be reached by 2016, in line with Directive 2006/32/EC, is an overall decrease in final energy consumption by 9% compared to the average final energy consumption between 2001 and 2005. The second NEEAP of 2011 reported that the intermediate target for 2010 (energy consumption lower by at least 3%) had been exceeded in both Flanders and Wallonia.

Belgium has set and notified to the European Commission an indicative energy efficiency target of 18% reduction in primary energy consumption by 2020, relative to the Primes 2007 baseline (53.3 Mtoe). This corresponds to energy savings equal to 9.6 Mtoe by 2020. According to Belgium's notification ([61]), energy savings are expected to be achieved mainly thanks to the

([59]) In some cases electricity imports came very close to full capacity, for instance in winter 2012/2013
([60]) ACER/CEER (November 2013)
([61]) Notification of the indicative national energy efficiency target 2020 for Belgium according to the requirements of the Energy Efficiency Directive 2012/27/EU

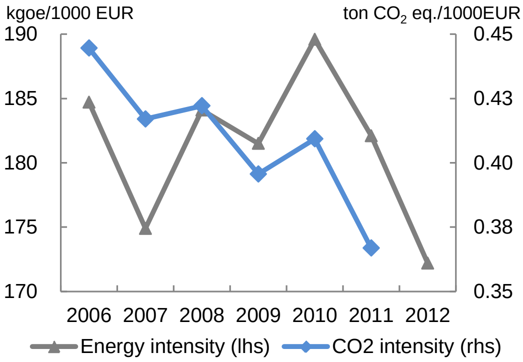
Table II.2.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	172	-6.5
CO2 intensity of the economy 2)	0.37	-13.1
Share of energy intensive sectors in Gross Value Added 3)	11.2	-0.8
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

implementation of Directive 2006/32/EC on energy end-use efficiency and energy services (2.8 Mtoe), implementation of eco-design and eco-labelling Directives 2009/25/EC and 2010/30/EC (2.7 Mtoe), voluntary agreements with the ETS industry (1.6 Mtoe) and the impact of the economic crisis (2 Mtoe). The savings can be higher thanks to the implementation of the recent energy efficiency directive 2012/27/EC, as the impact of this directive has not been fully taken into account.

Graph II.2.7: **Belgium - Energy and carbon intensity of the economy**



Source: Eurostat

Belgium's carbon intensity is one third lower than the EU level.

As regards greenhouse gas emissions reduction, Belgium had a shortfall of 2.3% in achieving its Kyoto target through domestic emission reductions ([62]). Under the Kyoto Protocol, Belgium has an obligation to reduce greenhouse gas emissions by 7.5% in 2008-2012 below their 1990 level. Belgium planned to meet its target by using the Kyoto flexible mechanisms rather than by undertaking domestic emission reductions.

In the framework of the Effort Sharing Decision ([63]) Belgium is expected to limit its greenhouse gas emissions not covered by the Emission Trading System by 15% in 2020 in comparison to their 2005 level. By 2012, Belgium has reduced emissions by 6%. However, according to the latest emission projections with the existing measures, Belgium is expected to reduce its 2020 non-ETS emissions by 4% only. This would leave a 11 percentage point gap between the projected emission and the binding target for 2020 ([64]).

The share of the country's emissions falling under the ETS is 36%, four points below the EU average. While emissions allowances have so far been granted for free, the third phase of the ETS foresees an EU-wide emissions cap and the adoption of auctioning of allowances. However, the extent of the impact of carbon prices may be limited by the currently low prices of CO2 allowances.

Belgium has a lower share of **environmental taxation** to GDP than the EU average and there was no significant tax shift in recent years.

([62]) European Commission (2013c)

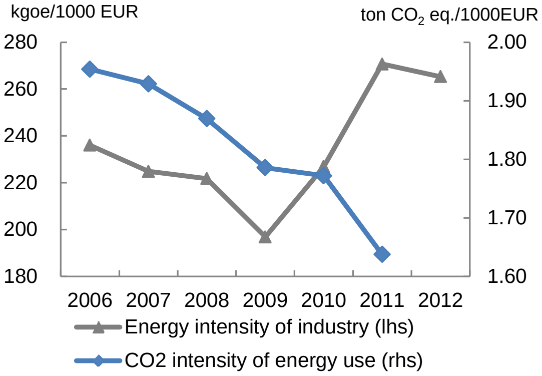
([63]) Decision 406/2009/EC
([64]) European Commission (2013c)

2.2.1. Industry

The energy intensity of the Belgian industry is 50% above the energy intensity in the EU, and the second highest in EU15, after Finland. Energy intensity in industry has, however, improved by 5% between 2000 and 2012.

This high energy intensity of the industry may be explained by a large manufacturing and energy-intensive industrial sector with production of chemicals, iron, steel, cement and sugar. Moreover, some Belgian energy intensive sectors have a much higher energy intensity than the EU. This concerns, in particular, the chemical and petrochemical sector ([65]).

Graph II.2.8: **Belgium - Energy intensity of industry, carbon intensity of energy use**



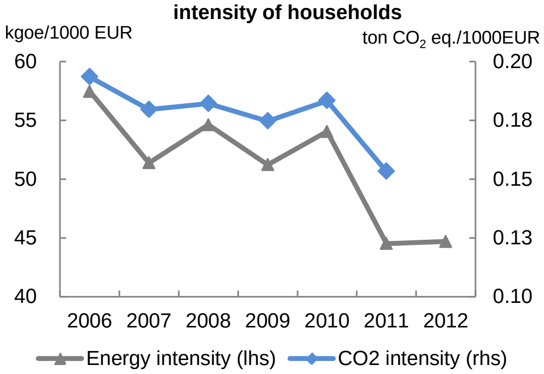
Source: Eurostat

The efforts to improve the energy efficiency in the industrial sector rely mainly on voluntary agreements with the industrial firms. The Flemish region applies "benchmarking covenants" with large industrial companies covered by the ETS. Under these covenants, companies invest to be among the top world performers in terms of energy efficiency. In return they receive investment support and are allocated relevant emission allowances under the EU-ETS ([66]). Other voluntary agreements include audit covenants, where audits determine the energy savings potential and the necessary investment, and in return companies receive fiscal incentives from the authorities.

2.2.2. Households

Belgian households' energy intensity is slightly above the EU performance. It is also higher than the intensity in any of its neighbouring countries, despite similar climate conditions. **The carbon intensity of households** is also above the EU average.

Graph II.2.9: **Belgium - Energy and carbon intensity of households**



Source: Eurostat

According to the IEA, one of the main sources of this inefficiency is poor compliance with existing building standards ([67]).

The efforts to improve the energy efficiency of buildings focus primarily on implementing the EU Directive on the Energy Performance of Buildings, which will both strengthen the building code standards and increase monitoring and enforcement. In spite of the efforts and some financial incentives for insulation of residential housing, Belgium still has substantial potential for improvement in this field.

2.2.3. Transport

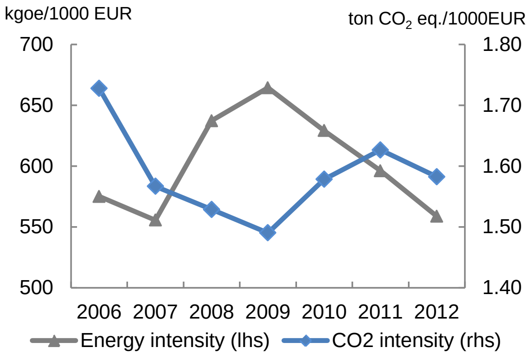
The energy intensity of the transport sector is 20% below the EU figure. The carbon intensity of transport in Belgium is among the five lowest in the EU. One of the reasons for this is an advantageous modal split in transport; in freight, road accounted in 2011 for 66% of total inland tonne-km, against 76% on average in the EU, and waterways for 19%, against 6% in the EU ([68]). The motorization rate in Belgium does not differ much

([65]) Because of its geographical location Belgium has a relatively large number of oil refineries and hence a large petro-chemical industry, which uses oil not only for energy generation but also as a basis for production.
([66]) International Energy Agency (2006)

([67]) Ibidem
([68]) Eurostat (2013)

from the neighbouring countries (apart from Luxembourg, where it is much higher).

Graph II.2.10: **Belgium - Energy and carbon intensity of transport**



Source: Eurostat

Belgium has, however, further potential to reduce energy and carbon intensity of its transport sector. Belgium grants substantial tax exemptions and rebates for road transport, such as exemptions for company cars and rebates for diesel fuel. Phasing out these tax reductions, as well as the improvements in the functioning of railways and public transport, would lead to energy savings, reduced carbon emissions and environmental benefits.

2.2.4. Conclusions

Belgium's energy intensity is above the EU average. The country has potential to improve energy intensity, especially in households and industry. Belgium needs to continue its efforts in this field through the implementation of the measures included in the National Energy Efficiency Action Plan, such as voluntary agreements with the industrial firms and improving insulation in buildings.

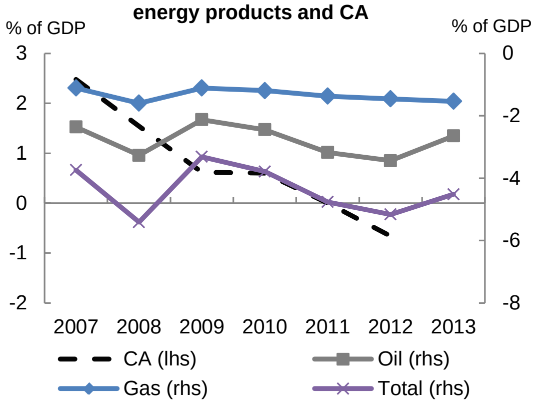
While Belgium's carbon intensity is lower by one third in comparison to the EU average level, Belgium is expected to miss its 2020 target to reduce greenhouse gas emissions by a wide margin. Therefore additional measures are needed, especially in buildings and transport.

2.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

2.3.1. Net energy trade balance

Belgium had an average energy trade deficit of 4.5% of GDP in 2013. This was the highest deficit among the "old" Member States (EU15). Since 2007 it has deteriorated substantially from 3.7% of GDP.

Graph II.2.11: **Belgium - Trade balance of energy products and CA**



Source: Eurostat

The deficit can mainly be attributed to the trade in oil and petroleum products and in natural gas. The respective deficits amounted to 2.6% and 1.5% of GDP in 2013.

The size of Belgium's energy trade deficit should be seen against the background of its current account deficit, which has deteriorated from a surplus of 1.9% of GDP in 2007 to a deficit of 1.4% of GDP in 2012. The deterioration of energy trade deficit has been a contributing factor to the overall deterioration of the trade balance.

2.3.2. Decomposition of the net energy trade

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade and the macro openness to trade (i.e. the ratio of total trade to GDP).

Table II.2.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-3.3	-3.8	-4.8	-5.2	-4.5
Relative trade balance (%)	-21.9	-19.8	-19.2	-19.5	-15.9
Share of energy in total trade (%)	9.9	11.3	13.5	14.4	15.6
Macro trade openness (% GDP)	152.7	169.4	183.4	183.3	181.0

Source : Eurostat

Belgium's relative energy trade balance is one of the smallest in the EU, which can be explained by substantial exports and imports of energy products. There is in particular a large trade in oil and petroleum products due to the substantial refining industry in the country.

However, this modest relative energy trade balance translates into a relatively large energy trade deficit in GDP terms, because of Belgium's very high macro-trade openness, the highest in the EU. While the relatively high share of energy products in total trade (16% in 2013) appears to have had a smaller effect, it serves as a reminder that Belgium's trade in energy products is far from negligible and hence deserves close monitoring in view of its potential role of exposing Belgium's current account and hence its economy to energy price shocks.

2.3.3. Conclusions

Belgium's energy trade deficit indicates some vulnerability concerns as it is the largest among EU15 countries. It should be seen against the background of its current account deficit, which has emerged in recent years. The deteriorating energy trade deficit and that fact that the share of energy products in trade is quite high suggests that the impact of energy price shocks on the economy may not be negligible.

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3. GERMANY

Key Insights

Security of Energy Supply

- Germany performs relatively well in terms of security of energy supply. The share of domestic sources is expected to increase due to the massive uptake of renewables that the Government has planned in its Energiewende.

- The diversification of trade partners and the large share of import from EEA-countries should constitute an important mitigating factor to the expected short-term increase of import dependence due to the rapid phase-out of nuclear energy.

- To facilitate the implementation of the Energiewende, Germany needs to speed up the deployment of electricity grid expansion projects and improve its energy policy coordination with its neighbours.

Energy and Carbon Intensity

- Germany performs well in terms of energy and carbon intensities. Despite the rather high share of energy intensive sectors, the energy intensity of the German industry is among the lowest in the EU. In addition, the other two sectors (transport and households) have made substantial progress in terms of energy savings.

- The deployment of the Energiewende in terms of more stringent energy efficiency requirements and de-carbonisation efforts affects the German energy sector and the German consumers for which energy represents a relatively high share of expenditures. These developments require a stringent monitoring of the costs evolution of the reforms.

Trade balance for energy products

- The contribution of energy products to trade is not a matter of concern for Germany. Despite the growing energy trade deficit, the small share of energy trade in total trade mitigates the impact on the current account, which shows one of the highest surpluses in the EU.

- However the energy transformation that the country is undertaking is likely to have a significant impact on its energy balance and therefore also on the energy trade.

3.1. SECURITY OF ENERGY SUPPLY

Overall energy import dependence in Germany was around 61% in 2012, almost 10 percentage points above the EU average, and it has remained broadly stable since 2008. The diversification of the energy mix is among the five best ones in the EU and it has slightly improved between 2008 and 2012.

In 2010, Germany adopted a comprehensive energy strategy, the Energy Concept ([69]), which sets its long-term energy and climate objectives. Following the Fukushima's accident, the government accelerated plans to phase out nuclear and adopted a legislative package in 2011 (Energy Package). The overall strategy to transform the energy system is generally denoted the "Energiewende".

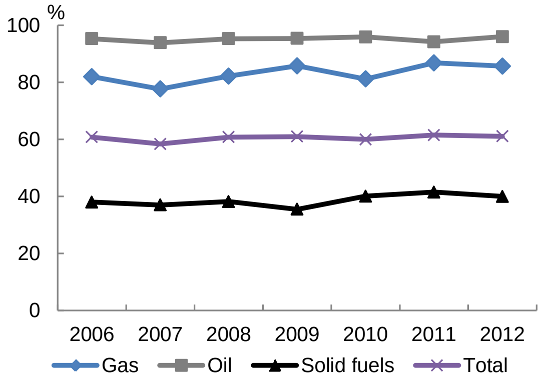
This strategy aims at transforming the energy sector of the country by phasing out nuclear power, reducing overall energy consumption by 50% by 2050 (compared to 2008), reducing by 80% greenhouse gas emissions and increasing the share of renewables in final energy consumption to 60% by 2050 (compared to 1990). In addition, it also strengthens the targets for energy efficiency (see section 2).

As a consequence, the energy mix of Germany is expected to shift towards the least carbon intense resources in the medium to long term. In the short term, the shutdown of the nuclear power plants is likely to result in a higher use of gas and coal. This is also starting to appear in the composition of the German energy mix. Due to the relatively cheaper coal prices compared to those of gas, the share of

([69]) Federal Ministry of Economics (2010).

coal in the energy mix has increased by 1 percentage point between 2008 and 2012 while the share of gas has declined by more or less the same amount. The first Monitoring Report ([70]) on the evolution of the Energiewende records among other indicators, a reduction of energy consumption in 2011 of 4.9% compared to 2008 and a rise of the share of renewables in final energy consumption to 12% compared to 6% in 2006.

Graph II.3.1: **Germany - Import dependence**



Source: Eurostat

As of December 2012, some 160 measures have been adopted by the German Government to implement the Energiewende.

3.1.1. Primary Energy Sources

3.1.1.1. Oil

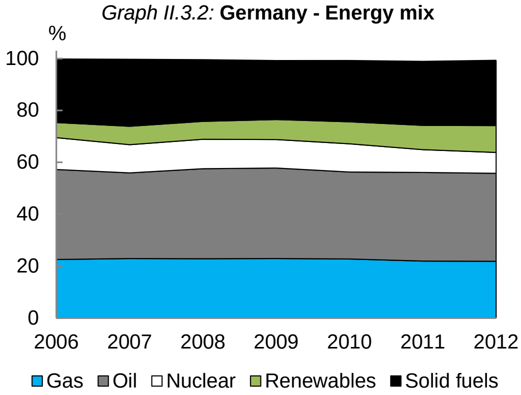
Oil is the most used primary energy source in Germany. Its share represented 34% of the energy mix in 2012, down from 35% in 2008.

About 96% of the oil is imported. Germany has one of the most diversified pools of trade partners in the EU, of which almost half is composed by Members of the European Economic Area (EEA).

Domestic production of oil has always been marginal and it has reached in 2010 its lowest point since 1990 with 2.5 Mtoe compared to 3.4 Mtoe in 2006. Final energy consumption of petroleum products has also declined significantly since 2006, by around 9%.

([70]) Federal Ministry of Economics (2012)

Graph II.3.2: **Germany - Energy mix**



Source: Eurostat

Germany has 14 oil refineries and one of the largest refinery capacities in the EU ([71]). The capacity has steadily increased since 1985, reaching at the end of 2011 2,364 kilobarrels/day. However exports of refined products have markedly decreased over the period 2006-2010, falling by 35%.

The deployment of the Energiewende is likely to have an impact on the use of fossil fuels - due to the ambitious targets set in terms of decrease in GHG emissions and increase in renewable energy - and the decrease in consumption of oil and petroleum products is therefore likely to continue.

3.1.1.2. Solid fuels

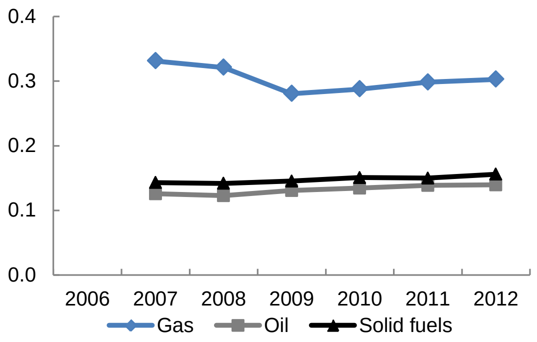
Solid fuels are the second source of energy used in Germany, representing 25% of the energy mix in 2012, one percentage point more than in 2008. In 2012, 60% of the solid fuels used were domestically produced while the remaining 40% are imported through a well-diversified pool of countries. About 89% of imports originated outside the EEA. In 2012 the main import sources were Russia and the US with 20% share each followed by Colombia 17% and Poland 9%. The import dependence for solid fuels increased by two percentage points between 2008 and 2012.

Between 2006 and 2010, domestic production of solid fuels decreased by 15%. The production amounted to 45 Mtoe in 2010, the lowest quantity since 1990. Hard coal production also reached its lowest point since 1990 in 2010, 8.5 Mtoe, which

([71]) IEA (2012).

corresponds to half of the quantity produced in 2006. At the same time net imports increased by 10% since 2006.

Graph II.3.3: **Germany - HHI index energy imports**



Source: Eurostat

Following the introduction of the Energiewende, the use of coal in Germany's energy mix is expected to halve by 2020 and then halve again by 2050. Subsidies to coal production (amounting to some EUR 2.5 bn/year) should be phased out by 2018 ([72]).

However a countervailing phenomenon is taking place as a result of the development of the US shale gas. An excess of US coal production on the world market has contributed to lowering coal prices. The low level of coal prices combined with low carbon prices, led to higher dark spreads ([73]), which made coal power plants more competitive than combine cycle natural gas plants. This is the main reason why Germany is still investing in new coal power plants. If this trend continues, the switching preferences from gas to coal power plants will be stronger and the efforts to reduce coal consumption and GHG emission in Germany would be jeopardized.

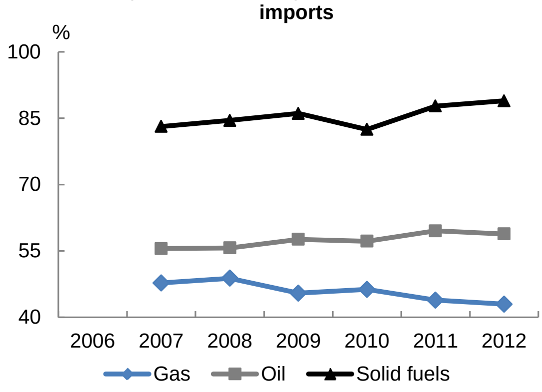
3.1.1.3. Gas

Natural gas is the third primary energy source used in Germany. In 2012, it covered 22% of the energy mix, a reduction of one percentage point compared to 2008.

In 2012, import dependence of gas was 86%, recording a slight increase compared to 2008 when it was 82%. At the same time the country has a very wide spectrum of import countries. This diversification has actually increased over the five years considered, but the share of non-EEA countries has been reduced from 49% in 2008 to 43% in 2012.

Domestic production of natural gas has decreased substantially, by more than 30% since 2006. Net imports also declined by 10% reflecting a fall in final energy consumption of natural gas of almost the same magnitude over 2006-2010 period.

Graph II.3.4: **Germany - Non-EEA share of imports**



Source: Eurostat

A well-functioning and interconnected gas market with competitive and market-based prices should provide the correct incentives for further investments and signals to consumers for an efficient and sustainable use of resources. Both elements are conducive to reduce the vulnerability of the country to energy-related shocks.

Germany has undertaken significant efficiency improvements in the organization of the gas market. The number of market areas has been reduced from the initial 20 areas in 2006 to just 2 in 2012. This has increased the liquidity of the markets and induced more distributors to switch from long-term supply contracts to short-term spot-market contracts. The volume traded in the virtual trading points has increased by 216% between 2009 and 2010, and increased again by 25% between 2011 and 2012 ([74]). Further legislation has recently been approved by the

([72]) Eurocoal.
([73]) A dark spread is the difference between the price received by a generator for electricity produced and the cost of coal needed to produce that electricity.

([74]) Federal Network Agency (2012).

German Government to increase the use of capacity auctions on a centralized booking platform ([75]). Moreover, Germany has the biggest natural gas storage capacity in the EU. In 2012, the capacity was 22 bn m^3, an increase of 2 bn compared to the previous year. ([76])

In terms of import/export capacity, good progresses have been made on the Nord Stream pipelines connecting Germany and Russia and on reverse flows with Austria. However, bottlenecks remain to be addressed on the boarders with Denmark and Poland and within southern Germany.

Germany has 18 Transmission System Operators on the gas network and 743 Distribution System Operators. There are essentially 5 companies transporting domestic or imported natural gas in Germany and supplying it to local distributors and retailers. The biggest company has a market share of about 50%, while the others cover between 5% and 16% of the market. The degree of competition at retail level is rather good, which is demonstrated by switching rates of the order of 10% in 2010 and 11% in 2011. Consumers can choose among 30 to 50 gas suppliers depending on the area of the country. However, there is a certain degree of complexity in the market structure since some of transmission companies also supply final consumers and some local retailers have regional distribution activities ([77]).

The gas end-user's prices for industrial consumers were among the highest in the EU in 2012, while for households they are more aligned with the EU average.

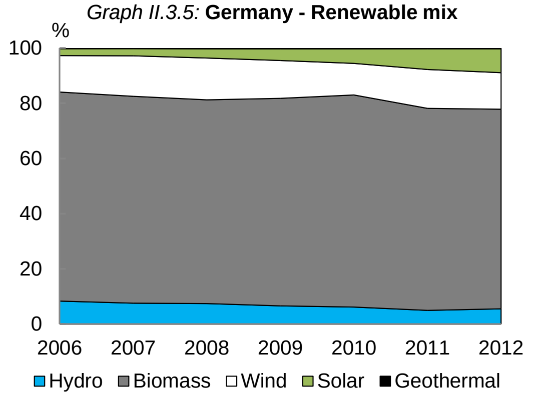
3.1.1.4. Renewables

Renewables accounted in 2012 for 10% of the energy mix, an increase of 3 pp compared to 2008. ([78]) The renewable mix is composed mainly of biomass (around 73%) and to a smaller extent of wind power (ca. 13%), hydropower and photovoltaic (around 5% and 7% respectively), with negligible quantities of geothermal energy. According to the monitoring mechanism set up by the German government to follow the evolution of the Energiewende, the share of renewables in final energy consumption had reached 12% in 2011 and it is foreseen to increase up to 60% by 2050.

To reach such ambitious target, the Government ([79]) expects that investment should total EUR 550 bn by 2050. That is an annual investment of the magnitude of EUR 15 bn, comprising, however also about EUR 300 bn for energy efficiency improvements, including building retrofitting.

Investment in offshore wind capacity will have to amount to about EUR 75 bn by 2030 with the objective of increasing capacity to 25 GW. At the same time the cost of the support scheme for renewable electricity generation has substantially increased from EUR 0.9 bn in 2000 to EUR 14 bn in 2012. The Government intends to monitor the evolution of the sector in order to keep the support scheme within cost-efficient margins and the Renewable Energy Sources Act is being revised in 2014.

Graph II.3.5: **Germany - Renewable mix**



Source: Eurostat

3.1.1.5. Nuclear

In 2012, the share of nuclear in the German energy mix was equal to 8%, a decline of 3 percentage points compared to 2008.

([75]) European Commission (2012a).
([76]) European Commission (2012a).
([77]) International Energy Agency (2012).
([78]) The share of renewables in the energy consumption is here defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.

([79]) Federal Ministry of Economics and Technology BMWi (p.13, 2012).

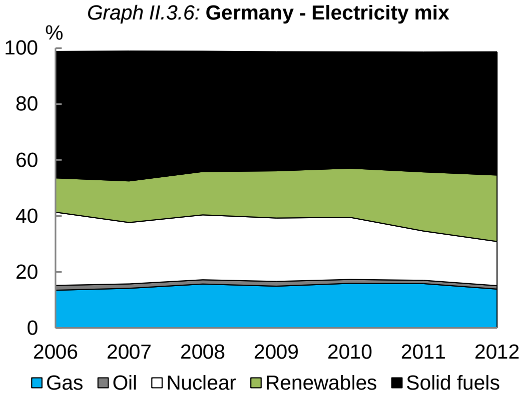
Following the accident in Fukushima, the German Government decided in 2011 to immediately shutdown 8 nuclear reactors, leaving only 9 reactors operating. Total capacity was reduced from 20 MWe to 12 MWe. In addition, the Government also decreed the complete phase out of all nuclear reactors by 2022.

This decision has put pressure on the four leading network operators in Germany and introduced a significant challenge to them; i.e. how to reliably balance fluctuations in the intermittent renewable generation in the interests of security of supply. However, these circumstances were expected, given the transformation of the energy system ([80]). The German government acknowledged that the shutdown of the nuclear plants will have an upward effect on consumer electricity prices, which is estimated to be in the range of EUR 0.005-0.015 per KWh ([81]).

3.1.2. Secondary Energy Sources

The electricity mix of Germany consisted in 2012 of 44% solid fuels, 16% nuclear, 24% renewables and 14% gas. The country was a net exporter of electricity albeit by a very thin margin. The picture in 2008 was only partially different with a relatively higher proportion of nuclear and solid fuels and 9 percentage points less renewables.

Graph II.3.6: **Germany - Electricity mix**



Source: Eurostat

Following the adoption of the Energiewende and the shutdown of a large share of nuclear generation capacity, the power generation mix experienced further changes. In 2012, gas decreased to 14%, renewables went up to 20% and solid fuels reached 44%, while nuclear fell to 16%. Further rebalancing of the mix is expected if the country is to achieve the targets set in the Energiewende of 80% renewable electricity by 2050. Recent energy trade data show that imports of coal have increased significantly in Germany (+37% between 2011 and 2012). Driven by the comparatively low prices on the global market, coal is increasing its importance in the energy mix of the country, mainly at the expenses of natural gas ([82]).

Good electricity interconnections and adequate domestic infrastructure capacity are important to shelter the country from supply shocks and to enable a proper absorption of renewables. A competitive and dynamic electricity market should cater the necessary investment incentives and provide the right price signals to consumers.

Existing electricity infrastructures were exposed to considerable pressure following the decision in 2011 to shut down 8 nuclear reactors. In particular the increase in electricity flows from the northern part of the country to the southern part has caused serious problems of loop-flows on neighbouring countries' grids, especially in Poland and Czech Republic. Acknowledging such drawbacks, the German government incorporated in its Energiewende provisions aiming at expanding and strengthening the electricity grid with a particular focus on the North-South axis (which will also receive some EUR 100 million from the European Energy Programme for recovery), the roll-out of smart metering and an enhanced integration with the European networks. Reportedly, the development of the grid has so far only made extremely slow progress due to, among other reasons, public acceptance issues as well as lack of spatial planning and licencing coordination across local entities ([83]).

A new National Network Development plan has been approved by the energy regulator and several projects have also been submitted for funding under the Connecting Europe Facility

([80]) Update of Bundesnetzagentur report on the impact of nuclear power moratorium on the transmission networks and security of supply, May 2011.
([81]) Federal Ministry of Economics and Technology (2012).
([82]) DG ENER (2012).
([83]) Federal Network Agency (2012).

programme ([84]). The estimated investment needs for the transmission grid are about EUR 30 bn. Investment needs in the distribution grid are expected to be greater. In 2010 and 2011 only the DSOs invested a total of about EUR 12 bn in infrastructure development. The increased investments of the network operators are reflected in the system charges which have increased substantially over the past years. As a result, transmission tariffs increased by 16.7% and distribution tariffs by 8.8% ([85]) between 2011 and 2012.

Congestion management and transparency provisions for access to the network for cross-border electricity exchange still lack appropriate regulation ([86]). Between 2010 and 2011, cross-border capacity decreased by 7.1% with the most problematic areas being the French-German and the Danish-German borders and the Baltic cable between Germany and Sweden.

On the other hand market coupling has been successfully agreed with the Central and Western Europe, and started in 2013. Thanks to this additional market coupling, the electricity exchange of Germany is now integrated with that of eight other Member States thereby increasing the liquidity of both the futures and option market, EEX located in Leipzig and the day-ahead market, EPEX Spot operated in Paris.

Wholesale power generation in Germany is dominated by four large companies covering all together some 82% of the market in 2010. However, due to the simultaneous shutdown of 8 nuclear power plants and the increasing role of dispersed renewable power generation, the share of these 4 companies on the wholesale market fell to 73% in 2012 ([87]).

The same four companies are also active at the retail level and in 2011 their cumulative share was 45%, also declining from previous years (it was 50% in 2008). The switching rates have increased over the years, from 4.9% in 2009 to 6.3% in 2010. Only 3% of industrial customers remained with their incumbent suppliers in 2011, this percentage was 40% in the households segment.

Electricity prices are among the highest in the EU both for households and industries, despite a slight decrease between 2011 and 2012. The high level is mainly explained by very high taxes and levies. The burden of the costs of the renewable support schemes is allocated unevenly across consumer groups, mainly due to exceptions of energy intensive industries. This has raised concerns about the affordability of electricity, in particular for households.

3.1.3. Conclusions

Germany does not present particular elements of vulnerability in terms of security of energy supply. Despite the shutdown of the nuclear plants, the share of domestic sources is expected to increase in the long run due to the increased use of renewable energy that the Government has planned in its Energiewende. Import dependence might, however, increase in the short term as power production based on coal is competitive and is used to replace nuclear energy. In terms of energy imports, the diversification of the trade partners and the large share of import countries belonging to the EEA should constitute an important mitigating effect to the expected short-term increase of foreign dependence.

Germany needs to step up efforts to improve the infrastructure in the electricity and gas sectors, which have been put under considerable strain due to the sudden drop in nuclear power generation. In addition to speeding up the deployment of fundamental expansion projects, the country should also improve its future energy policy coordination with its neighbours. The integration of the European energy market implies that major unilateral decisions will affect the surrounding energy systems. It is therefore important, for a smooth functioning of the energy markets, that Germany regularly coordinates its actions with the neighbour countries throughout the implementation of its energy transformation.

([84]) European Commission (2012a).
([85]) Federal Network Agency (2012).
([86]) An infringement procedure is open for failure to implement relevant measures contained in the Second Energy Package. European Commission, Making the Internal Energy Market work, 15/11/2012
([87]) Federal Network Agency (2012).

Table II.3.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	129	-7.9
CO2 intensity of the economy 2)	0.37	-7.8
Share of energy intensive sectors in Gross Value Added 3)	10.2	-1.2
memo items: EU28		
Energy intensity of the economy 1)	152	-4.5
CO2 intensity of the economy 2)	0.56	-9.7
Share of energy intensive sectors in Gross Value Added 3)	8.9	-0.9

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

3.2. ENERGY AND CARBON INTENSITY

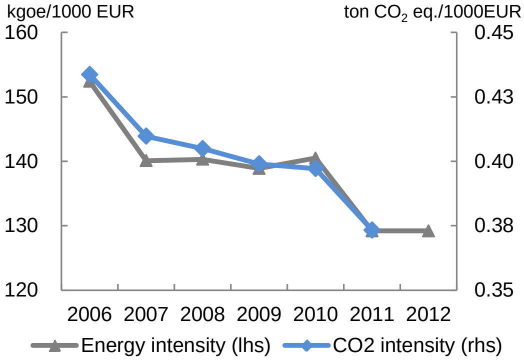
In 2012 the energy intensity of the economy in Germany is below the intensity of the EU, and it has decreased by 5% compared to 2008 which is in line with the development in the EU**.**

The Energiewende sets very ambitious targets in terms of energy efficiency. For a start primary energy consumption should be considerably reduced: by 20% in 2020 and by 50% by 2050 (compared to 2008 levels). Electricity consumption should also be cut by 10% and 25% respectively by 2020 and 2050, considering 2008 as a base year. This would imply annual gains in energy productivity ([88]) of about 2.1%. The monitoring exercise carried out by the Government in 2012 reported that compared to 2008, primary energy consumption had been reduced by 6% and electricity consumption by 2% in 2011. The energy productivity has increased at a pace of 2%, essentially in line with expectations.

The National Energy Efficiency Action Plan (NEEAP) covers the period 2008-2016. The savings target to be reached by 2016, in line with Directive 2006/32/EC, is an overall decrease in final energy consumption by 9% compared to the baseline level ([89]). According to the Second National Energy Efficiency Action Plan, the intermediate target for 2010 was greatly exceeded. Moreover, Germany expects to over-achieve the savings target for the period 2008-2016, achieving total savings of about 17% by 2016. ([90])

The carbon intensity of the German economy was in 2011 in line with the EU average and decreased by 8% compared to 2008.

Graph II.3.7: **Germany - Energy and carbon intensity of the economy**



Source: Eurostat

Under the Kyoto Protocol, Germany has an obligation to reduce greenhouse gas emissions by 21% against 1990 levels during the period 2008-2012 ([91]). According to the latest progress report, GHG emissions in Germany in 2011 were 26% below the base year, the country is therefore ahead of its targets under the Kyoto Protocol. Emissions per capita also fell significantly since 1990, by more than 30%.

The country appears to have made sufficient progress in the non-ETS sector. Under the Effort

([88]) Defined as the ratio of output divided by final energy consumption (IEA definition).
([89]) The baseline is the average annual final energy consumption over the period 2001-2005.
([90]) Federal Republic of Germany (2011).
([91]) European Environment Agency (2013)

Sharing Decision (92), Germany has committed to reduce its GHG emissions in non-ETS sectors by 14% (compared to 2005) by 2020. Recent projections show that, in 2012 Germany had already achieved a reduction of 6% and it is expected to exceed its target by 2% with existing measures by 2020 (93).

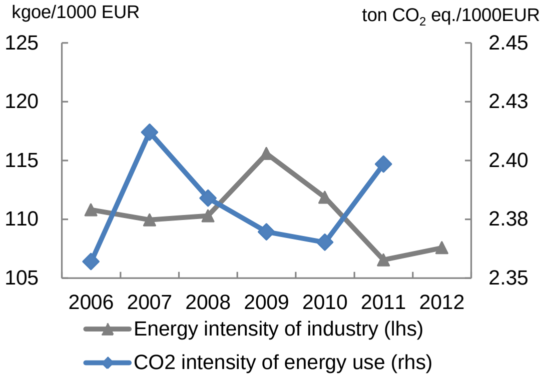
The share of GHG emissions falling under the ETS equals 48% of total emissions, above the EU average of 40%. Since the third phase of the scheme started in 2013, there has been an EU-wide emissions cap and emission allowances are auctioned while so far they had been granted for free. This is expected to impact on the energy costs of industries which are likely to pass them on to consumers. The effects of auctioning on the German economy will largely depend on the carbon price, which is currently very low, and on the ability of the German energy system to decarbonize itself. The decarbonisation process may also be hampered in the short term by the very competitive prices of coal, which is currently increasing its share in the energy mix.

The energy transformation that the country is undertaking will in the short run shift power generation from nuclear to coal and gas, which are relatively more carbon intensive. Between 2008 and 2012 GHG emissions from combustion installations have systematically exceeded the free allowances that were allocated to them (94). The carbon intensity of the German energy sector is above the EU average and remained essentially stable over the period 2008-2012. Given the growing share of coal and gas in electricity generation, the situation is therefore likely to become more critical in the next phase of the ETS.

3.2.1. Industry

Industry energy intensity was in 2012 among the lowest in the EU and declined by 2.4% compared to 2008. According to the Second National Energy Efficiency Action Plan, industry's energy savings amounted in 2010 to 58% of the targeted savings for the period 2008-2016 and out of the total saving of 434 PJ, 252 PJ have already been achieved.

Graph II.3.8: **Germany - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

The share of energy intensive sectors accounted for above to 10% of the gross value added in Germany between 2008-2012. This represents a relatively higher share than the average for the EU-27, which was just below 10%. This share has remained broadly stable since the early 2000s until 2008. Specifically, the chemicals, rubber and plastic, fabricated metals and electricity supply have a share of value added well above the EU average.

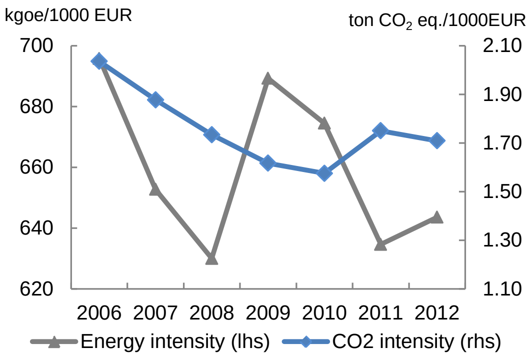
3.2.2. Transport

Energy intensity of the German transport sector was in 2012 more or less in line with the performance of the EU as a whole, and it increased by 2% compared to 2008. The same is true also for carbon intensity of the sector, where the value for Germany is also in line with the EU performance and slightly increased compared to 2008.

According to the Energiewende, final energy consumption in the transport sector is to fall by about 10% by 2020 and by about 40% by 2050, compared to the 2005 baseline. The first monitoring exercise carried out by the German Government shows that compared to 2005, in 2011 the transport sector had reduced its energy consumption by 0.5%.

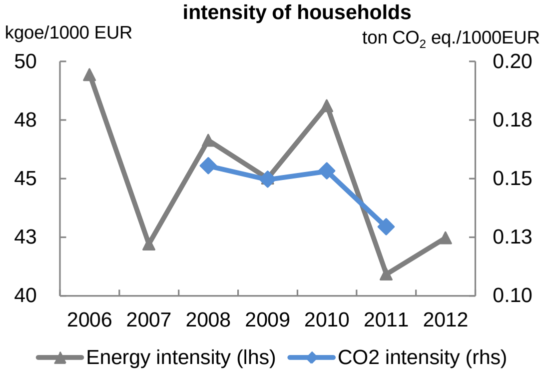
(92) Decision 406/2009/EC
(93) European Commission, Europe 2020 Targets: Climate change and energy, Thematic fiche for the European Semester, February 2014.
(94) European Environment Agency, EU Emissions Trading System (ETS) data viewer

Graph II.3.9: **Germany - Energy and carbon intensity of transport**



Source: Eurostat

Graph II.3.10: **Germany - Energy and carbon intensity of households**



Source: Eurostat

The National Energy Efficiency Action Plan of Germany sets a savings target for the Transport sector of 314 PJ for the period 2008-2016 and in the second NEEAP, the Government reported that 29% of this saving had been reached in 2010.

It is worth noting that unlike many other EU Member States, Germany's railways have seen their relative shares increase both in freight and passengers services between 1996 and 2011. This may have helped the transport sector to progressively decarbonize and reduce its energy consumption. ([95])

3.2.3. Households

Energy intensity of households was in 2012 in line with the EU performance and it declined by 9% compared to 2008. Carbon intensity of households was below the EU performance in 2011 but it has declined considerably compared to 2008 by 17%.

According to the Energiewende, buildings renovation rate should be around 2% per year of the current building stock. The first monitoring exercise of the Government states that up to 2011 the rate of modernization of the buildings was approximately 1% per year. Starting with 2012 some EUR 1.5 bn are foreseen to be available annually until 2014 for de-carbonization measures in buildings. This funding should help doubling the rate of modernisation up to 2050.

According to the NEEAP, the residential sector should achieve saving of about 610 PJ in the period 2008-2016. In 2010 around 60% of these savings had already been achieved.

3.2.4. Conclusions

Germany performs well as far as energy and carbon intensities are concerned. Despite the rather high share of energy intensive sectors, the energy intensity of the German industry is among the lowest of the EU. In addition, the transport and household sectors have made substantial progress in terms of energy savings.

The impact of the Energiewende in terms of more stringent energy efficiency requirements and de-carbonisation efforts is likely to become more evident in the coming years. The third phase of the ETS will also affect the German energy sector, which is becoming increasing reliant on fossil fuels following the shutdown of the nuclear reactors. These developments are likely to raise costs for industry and household consumers. This may have a greater impact than in other Member States given the specific energy intensive industrial structure of the country. A stringent monitoring of the evolution of the costs of the energy transformation is therefore warranted in order to limit adverse effects on the economy.

([95]) European Commission (2013).

3.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

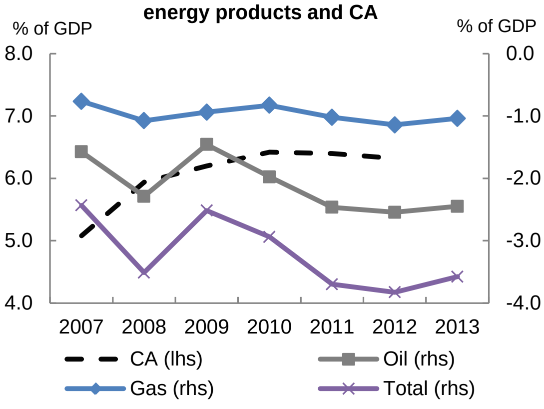
3.3.1. Net energy trade balance

The total energy trade balance over GDP of Germany in 2013 was equal to a deficit of 3.6%. This is not among the highest in the EU and comparable to that of other major economies in the EU. The 2013 deficit remained at the highest levels recorded after 2011. The evolution of the energy trade deficit over the past ten years can be divided into two periods. Before 2005, it fluctuated at or below 2%, while in 2005 to 2013, it fluctuated constantly above 2% and close to 3%, with two peaks in 2008 and in 2012.

A major part of the energy trade deficit is due to the oil trade deficit, which in 2013 was equal to 2.4% of GDP, once again one of the greatest deficit since 2001. The oil trade deficit experienced, like the overall energy trade deficit, a marked increase until 2010, since then it never fell below 2%.

The gas trade deficit trended in a very stable way between 2001 and 2005, swinging from 0.6% to 0.7% and then it increased to around 1%, reaching its peak at 1.1% in 2008 and 2012, while in 2013 it decreased marginally to 1%.

Graph II.3.11: **Germany - Trade balance of energy products and CA**



Source: Eurostat

The energy trade balance shall however be looked at in combination with the current account. In the case of the Germany the energy trade deficit has to be seen against the background of a significant and persistent current account surplus, which has remained at a level of 6-7% since 2007. It appears that the good performance of the German tradable sectors has counterbalanced the effects of the deficit in energy trade.

3.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade, and the ratio of total trade to GDP (macro openness to trade).

Germany had in 2013 one of the five biggest relative energy trade deficit in the EU of 60%. Its trend shows an interesting U-shape since 2001, when it was 75%, and then it declined all throughout the decade, reaching its lowest point in 2007, it picked up again the next year and then it kept increasing until 2011 and then decreased in 2012 and 2013.

The big relative energy trade deficit has however always been compensated by a very low share of energy trade in total trade, actually one of the five lowest in the EU. This share has, however, constantly increased over the past decade going from 4.6% in 2001 to 8.3% in 2013 (despite a temporary fall in 2008 and 2009). This signals that there has been an increase in importance of energy items in German trade. The small absolute size of this share has so far mitigated the impact of the energy trade deficit on the current account balance of the country.

3.3.3. Conclusions

The contribution of energy products to trade is not a matter of concern for Germany. Despite the growing energy trade deficit, the small share of energy trade in total trade helps to mitigate the impact on the current account which remains positive and one of the highest in the EU.

However, the energy transformation that the country is undertaking is likely to have a significant impact on its energy balance and therefore also on energy trade. These consequences have not yet been captured by the current statistics that stop in 2012. Further monitoring of the evolution of the German trade

Table II.3.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-2.5	-2.9	-3.7	-3.8	-3.6
Relative trade balance (%)	-64.5	-65.8	-65.9	-60.7	-59.6
Share of energy in total trade (%)	6.3	6.4	7.5	8.4	8.3
Macro trade openness (% GDP)	61.8	70.0	75.1	75.0	72.7

Source : Eurostat

balances will therefore be needed once the impact of the energy transformation becomes more tangible.

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4. DENMARK

Key Insights

Security of Energy Supply

- Denmark is a net exporter of oil and gas and as such is largely self-sufficient with regards to energy supply.

- Risk of energy supply might appear in the future as a consequence of country's long-term strategy to become fully fossil fuel-free by 2050. With even larger wind penetration, generation capacity needs to be available to balance the variable wind energy, which can be achieved by good interconnections with neighbouring countries.

Energy and Carbon Intensity

- Denmark is performing relatively well with respect to energy and carbon intensities compared to other EU countries. However, energy and carbon intensities of transport sector have increased over the last decade (albeit the country remains the best performer in the EU) and households' energy intensity has also deteriorated. Firm commitment is needed in order to ensure that Denmark retains a status of a front-runner in environmental policies and their implementation.

- Denmark is on track to reach its energy saving targets by 2016, but Denmark needs to continuously focus on energy saving measures in order to maintain the positive trend in energy efficiency.

Trade balance for energy products

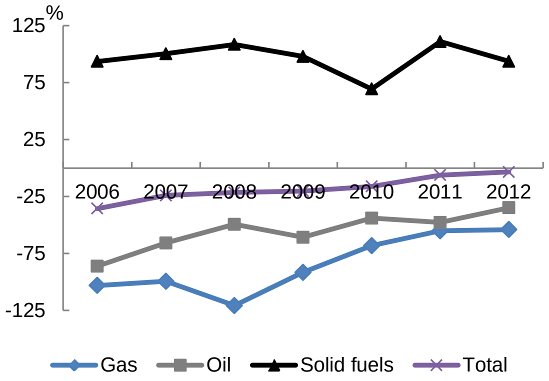
- Denmark is the only country in the EU with trade surplus of energy products. At the same time, as a net energy exporter Denmark records a positive relative energy trade balance.

- Denmark is likely to become increasingly dependent on energy import as of 2022 when domestic fossil energy sources are projected to no longer be able to cover the country's needs. However, risks of future energy trade deficit are mitigated by the fact that energy currently does not play a major role in total trade.

4.1. SECURITY OF ENERGY SUPPLY

Denmark is the only country in the EU which has a negative import dependence of primary energy sources as it is a net exporter of oil and gas. In 2012, net exports of primary energy sources amounted to 3.4% of its energy needs. However, at the same time net exports are decreasing since the peak in 2005, when Denmark exported almost the double of the imported primary energy sources. This decrease is happening mainly on the back of decreasing primary production while the share of exports expressed as percentage of primary production remained stable at around 75-80%.

Graph II.4.1: **Denmark - Import dependence**



Source: Eurostat

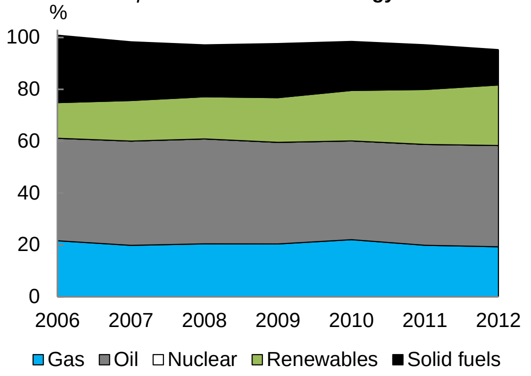
The country's energy mix is well diversified. Each of the four available sources of energy covers at least 14% of gross inland energy consumption.

4.1.1. Primary energy sources

4.1.1.1. Oil

Oil is the most important energy source in Denmark, covering 39% of the country's energy consumption in 2012. At the same time, oil's share in the supply mix has been reduced dramatically from the nearly 90% it represented in the early 1970s.

Graph II.4.2: **Denmark - Energy mix**



Source: Eurostat

Denmark is a net exporter of crude oil since the mid-1990s. Oil production in Denmark began in 1972 and rose steadily until reaching a peak in 2004 when it began to decline steeply. Danish oil production comes exclusively from offshore installations in the Danish North Sea, where there are 19 producing fields ([96]). In 2012, Dansk Undergrunds Consortium (DUC), consisting of 4 companies (Shell, A.P.Møller-Mærsk, Chevron and Nordsøfonden), accounted for 87% of oil production ([97]). Oil production is expected to continue to decline in the coming years. According to the Danish Energy Agency (DEA), Denmark is expected to remain a net exporter of oil up to and including 2020, based on the expected production profile ([98]).

In 2012, net exports of total petroleum products in Denmark equalled 26% of domestic primary production (down from its peak of 54% in 2004). Imported crude oil originated mainly in Norway while imported refined petroleum products originated in the United Kingdom, Sweden, Norway and Russia. Denmark has two refineries ([99]) which produce a surplus of gasoline and residual fuel oil and a deficit of middle distillates when comparing to domestic oil demand ([100]). Only a minor amount of jet fuel is produced in Denmark.

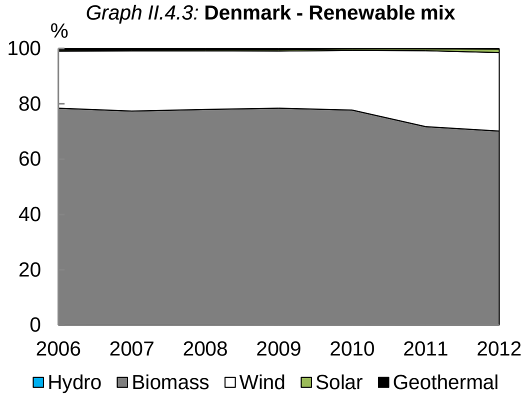
According to the Council Directive 2009/119/EC of 14 September 2009, Denmark has an obligation to hold stocks equal to 61 days of the country's consumption. However, it has decided unilaterally to hold stocks at a level of 73.2 days of consumption. The regulation stipulates that any company that produces or imports more than 1,000 toe per year must hold compulsory stocks corresponding to 22.2% of their annual domestic sales. As of 31 May 2012, FDO has been appointed as a central stockholding entity for Denmark. FDO holds 51.2 days-worth of supplies, while the oil companies themselves hold the remainder. As of 1 January 2013, all Compulsory Storage Obligated (CSO) companies have 70% of their obligation covered by the FDO ([101]).

4.1.1.2. Renewables

Renewables represented 23% of the inland energy consumption in the country's energy mix in 2012. In line with the country's ambition, the use of RES follows a constantly increasing trend. In 2006 it composed 14% of the energy mix, up from 8% in 1999. ([102])

([96]) Danish Energy Agency (2013)
([97]) Danish Energy Agency (2013)
([98]) If technological and prospective resources are included, they are expected to contribute substantially to reducing Denmark's net oil imports in the 2025 to 2035 period, after which the estimated production is expected to decline again.
([99]) In Kalundborg and in Fredericia.
([100]) International Energy Agency (2011a)
([101]) www.fdo.dk
([102]) The share of renewables in the energy consumption is here defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.

Graph II.4.3: **Denmark - Renewable mix**



Source: Eurostat

The Danish target envisages a share of renewable energy in gross final energy consumption of 30% by 2020 ([103]), another 7 pp above the current level. Danish Energy Strategy sets out several milestones aiming at reaching an energy and transport system based on 100% renewable energy by 2050 (e.g. by 2035 the electricity and heat supply should be covered fully by RES) ([104]).

According to Eurostat data, the share of renewables in gross final energy consumption amounted to 26% in 2012. In 2011, the share of renewables in heating and cooling was 33.6% while the target for 2020 is set at 39.8%; the share of renewables in electricity was 35.9% with a projected target of 51.9% by 2020; renewables in transport presented 0.3% and the target for 2020 is set at 10.1%. Total primary production of renewable energy was 3,114 ktoe in 2012 and the bulk of it was composed of wind power and biomass.

Denmark has developed in particular its wind energy sector. It has the highest share of wind power in electricity generation among all Member States (35% in 2012 ([105])). Denmark benefits from good conditions for wind power, with good wind resources, large, shallow offshore areas, and with many companies involved in the development and production of wind turbines. Denmark also enjoys first-mover advantage in the wind power sector and has built up a strong technological and research capacity, which supports a solid manufacturing base. ([106])

In addition, in the long term, both wave energy and solar energy might, depending on their future cost reduction, become valuable supplements to wind (and biomass) in order to mitigate the risk of energy supply stemming from variable energy sources.

Like other countries, Denmark uses support instruments for renewable energy, including premium tariffs, feed-in tariffs, investment incentives and tax deductions.

4.1.1.3. Gas

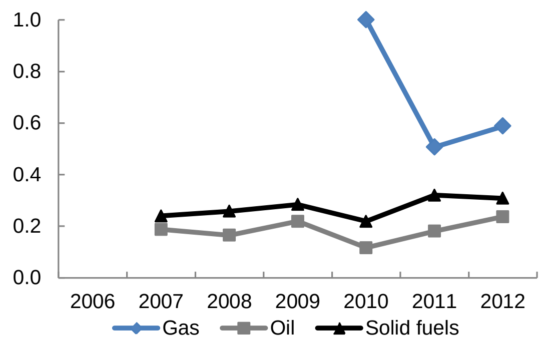
The third largest source of energy in Denmark's energy mix is gas, which accounted for 19% of energy consumption in 2012 (slightly below the EU average). This share remained broadly stable over the last decade.

Denmark is a net exporter of gas since 1984 when it began producing natural gas from the North Sea. The production volume was increasing until it peaked in 2005, after which it recorded a fast decline. According to DEA, Denmark is expected to remain a net exporter of gas, up to and including 2022, based on the expected production profile ([107]).

In 2012, net exports of gas covered 36% of its primary production (compared to the peak in 2008 when it exported 55% of its production); the recipients of Danish gas are Sweden (38%) ([108]),the Netherlands (35%) and Germany (27%). At the same time, for third consecutive year, Denmark imported natural gas. 71% of imports came from Norway and 29% from Germany, together amounting to 50% of Danish final gas consumption.

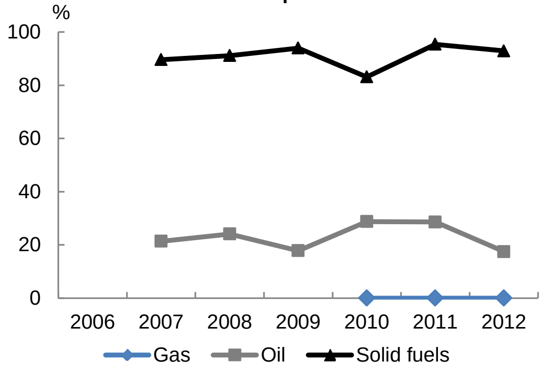
([103]) Directive 2009/28/EC
([104]) Danish government (2011)
([105]) Danish Energy Regulatory Authority (2013)
([106]) International Energy Agency (2011b)
([107]) When including technological resources and prospective resources, the Denmark is estimated to remain a net exporter of natural gas until about 2035.
([108]) Swedish gas demand is supplied entirely with gas flows from the Danish network. According to IEA calculations, outlook for Danish production indicates that the combined gas demand of Denmark and Sweden will increasingly require the Danish network to source from external suppliers to a greater extent.

Graph II.4.4: **Denmark - HHI index energy imports**



Source: Eurostat

Graph II.4.5: **Denmark - Non-EEA share of imports**



Source: Eurostat

A well-functioning and interconnected gas market with competitive and market-based prices should provide the correct incentives for further investments and signals to consumers for an efficient and sustainable use of resources. Both elements are conducive to reducing the vulnerability of the country to energy-related shocks.

The interconnection of Danish gas market has improved since the country can receive imports from Germany via the transit point at Ellund (this was made possible in 2010). From the Danish production fields in the North Sea gas is transported to Denmark at Nybro (gas treatment plant) or exported to the Netherlands. From onshore, gas is traded in Denmark or exported to Sweden at Dragør or Germany at Ellund.

As Danish Energy Regulatory Authority (DERA) ([109]) suggests, **the Danish wholesale gas market is rather concentrated, even though the concentration decreased recently.** The majority of Denmark's gas supplies are sourced from the fields operated by the Danish Underground Consortium (DUC) while DONG Energy disposes of about 80% of the Danish gas production, either by purchasing from DUC on long-term contracts or by own production. To promote competition in the Danish wholesale market DUC has been required to sell 17% to other companies than DONG Energy. LNG plays no role in the Danish wholesale market.

The gas transmission network on land is owned and operated by Energinet.dk which is the sole TSO in Denmark and is owned by the State. Its gas facilities consist of ca. 860 km of gas pipelines, 42 meter and regulator (M/R) stations and 4 meter stations. A gas treatment plant at Nybro is owned by DONG Energy. There are two underground gas storage facilities in Denmark, one in Lille Torup in Jutland (owned by Energinet.dk) and one in Stenlille on Zealand (owned by DONG Energy). As Energinet.dk is responsible for security of supply and the balance of the Danish gas transmission network, there is a storage agreement between DONG Energy and Energinet.dk in place, which gives Energinet.dk the right to use the storage capacity to ensure balance and security of the gas transmission network.

In 2010, 90% of the traded volume on the Danish wholesale market was conducted under long-term contracts and only 9% and 1% of the volume was conducted under OTC and exchange contracts, respectively. The gas exchange in Denmark Gaspoint Nordic (until July 2013 known as Nord Pool Gas) also facilitates an increased competition on the wholesale market. The shippers can trade anonymously as the gas exchange is always the counterpart in all trades. 'PRISMA Primary' is a service for shippers who wants to trade gas capacity across European borders (it is cooperation between Energinet.dk and the large transmission system operators in Austria, Belgium, Germany, France, Italy and the Netherlands). 28 companies are registered as shippers by Energinet.dk. However, it is estimated that the number of companies actually active on the wholesale market is much smaller.

([109]) Danish Energy Regulatory Authority (2011)

Regarding the retail market, there is some evidence of decreasing concentration. In 2012, there existed four distribution companies ([110]) and 14 gas suppliers. The 6 incumbents consisted of 3 supply obligation licensees with regulated prices and their affiliated commercial supply companies. The Danish gas market has been liberalized since 2004. However, both regulated prices and market prices still coexisted on the Danish retail market until 1 May 2013. About 80% of the Danish gas customers were supplied at regulated prices, and these were mainly households. In 2012 the regulation of prices remained unchanged but it was to be succeeded by a new regulation on 1 May 2013 ([111]). The legislation was passed by the Danish Parliament in December 2012.

The rate of switching within the natural gas market remains very low, especially for households (0.9% in 2010). Price level for industrial and households users are among the highest in the EU. Taking into account PPS, prices for households are just above the EU median and industrial consumers have one of the lowest prices in the EU.

4.1.1.4. Solid fuels

Finally solid fuels represented 14% of the country's energy mix in 2012 and were mainly used for electricity and heat generation. Denmark does not produce any solid fuels and hard coal represents virtually the only solid fuel imported to Denmark (amounting to 4 Mt in 2012). In 2012, 93% of solid fuels were imported from non-EEA region (main trading partners were Colombia with 38%, Russia with 35% and South Africa with 20% of total imports of solid fuels). This share remained more or less stable during the past 5 years. At the same time, the HHI index suggests a low level of geographical concentration of solid fuels importers.

The new Danish Energy Strategy envisages that hard coal will be phased out from the Danish power plants by 2030 ([112]).

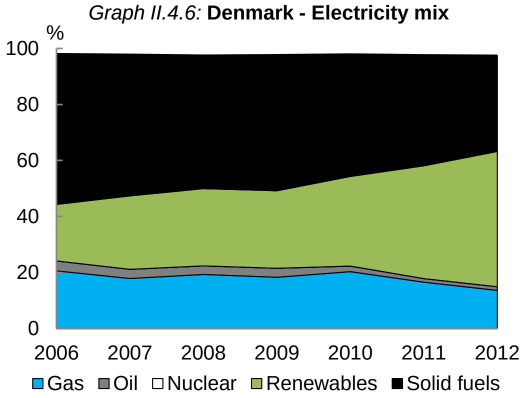
([110]) Dong Gas Distribution, HMN Naturgas, Naturgas Fyn Distribution and Aalborg Kommune, Gasforsyningen.
([111]) Danish Energy Regulatory Authority (2013)
([112]) Danish Government (2011)

4.1.2. Secondary energy sources

On average, Denmark is a net importer of electricity (it imported annually on average 5% of its final electricity consumption over the period 2008-2012). However, when looking at individual years, the position of net exporter and net importer varies considerably.

Denmark trades with its neighbouring countries. Germany covered 27% of imports and 58% of exports of electricity over 2008-2012, Sweden 43% and 26% and Norway 30% and 16%, respectively. Typically Denmark is a transit country for electricity from Norway and Sweden to continental Europe.

Graph II.4.6: **Denmark - Electricity mix**



Source: Eurostat

In 2012, renewables were the main component of electricity generation (with 48%), followed by solid fuels (34%), natural gas (14%) and oil (1%). While the shares of solid fuels, gas and oil are constantly decreasing, the share of renewables in the electricity mix recorded a large increase over past years. This is in line with the national energy strategy, which projects that electricity generation should be supplied solely by renewables by 2035.

Good electricity interconnections and adequate domestic infrastructure capacity are important to shelter the country from supply shocks and to enable a proper absorption of renewables. A competitive and dynamic electricity market should cater the necessary investment incentives and provide the right price signals to consumers.

Concerning the development of wholesale market concentration, DONG Energy and Vattenfall are the major players when it comes to electricity generation. They account for almost 2/3 of the capacity, the remaining 1/3 being represented by a large number of smaller companies. The Danish wholesale market in electricity is highly integrated with its neighbouring markets. In the Nordic countries roughly 75% of the energy traded is via the power exchange Nord Pool Spot (NPS). On the borders to Germany, EMCC1 is coupling the markets via volume coupling.

The Danish retail market for electricity is fully liberalised and all consumers have thereby access to free choice of supplier.

In 2012, DERA analysis ([113]) concluded that a special legislation on supply obligation obstructs competition. At that time 85% of Danish households and small businesses were supply obligation customers paying regulated prices for their electricity consumption. As a result, DERA recommended the Government and the Parliament to review the regulation of the supply obligation ([114]).

In 2012, there were 25-30 suppliers offering electricity products in the market and the supplier switching rate of households and small businesses increased in 2012 to 6.7% (from 3.5% in 2011). According to DERA, there were not many information campaigns launched to make customers aware of the switching opportunities.

There is a large difference between prices for industrial and household consumers. For industrial users, the prices of electricity were below the EU average in the second half of 2013 and they recorded only a slight increase since 2007. However, electricity prices for households were the second highest in the EU in 2013S2 and still above the EU average when taking into account purchasing powers. Taxes and levies on the household consumers' electricity prices are the highest in the EU composing more than a half of the final price in the second half of 2013. Therein are included Public Service Obligations (PSO) payments (incl. subsidies for renewable energy) which have increased by 11% in 2012 ([115]).

([113]) Danish Energy Regulatory Authority (2012)

([114]) According to the latest information, from 1 January 2013, the regulatory regime for the award of supply obligation licenses was modified and the previous price regulation has been abandoned. Moreover, a legislative proposal has been submitted to the Danish Parliament whereby the electricity supply obligation regulation will be abolished altogether from 1 October 2015.

4.1.3. Conclusions

In 2012, Denmark was the least vulnerable country in the EU in terms of security of energy supply; this is an unchanged position compared to 2008. Denmark is the only country in the EU with negative import dependence; it supplies EU markets with oil and gas from its production fields in the North Sea.

Denmark's ambition to become 100% fossil-fuel-free by 2050 translates into the large renewables share in electricity generation, mainly thanks to favourable locations for wind farms. Denmark has a long history of wind energy and it was one of the first countries to exploit this type of energy. However, it is likely to face additional costs when replacing out-dated technology with newly developed and more cost-effective parts.

At the same time, Denmark has made clear progress on interconnections and cooperates with fellow Scandinavian and Baltic countries in the Nordic Pool which in turn makes possible for the grid to accept such a large penetration of variable wind energy.

Even though Danish gas and electricity markets are liberalized, legislation on supply obligation obstructs competition. More information campaigns might increase the switching rate and support competition which in turn could bring the prices for end-user down.

4.2. ENERGY AND CARBON INTENSITY

Danish economy is one of the least energy intensive economies in the EU, consistently with historical pattern. Indeed, while Denmark's gross inland consumption of energy products remained broadly stable over the last 20 years, GDP grew until its peak in 2007 (by an annual average of 2.2% between 1990 and 2007) before being slashed as a consequence of the global economic crisis.

([115]) Danish Energy Regulatory Authority (2012)

Table II.4.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	87	-5.8
CO2 intensity of the economy 2)	0.27	-8.7
Share of energy intensive sectors in Gross Value Added 3)	9.6	-1.5
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

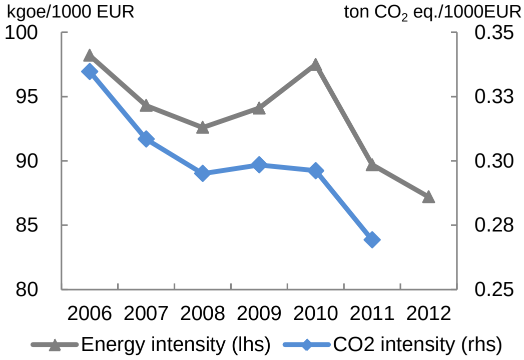
Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

Under Article 4 of Directive 2006/32/EC the final energy consumption (FEC) saving target for Denmark for the period 2008-2016 is set at 9% of the baseline. The Second National Energy Efficiency Action Plan (NEEAP) of Denmark ([116]) recalculates national saving targets ([117]) into EC reporting scheme and reports that average annual final energy consumption should equal 6.28 PJ over the period 2008-2016 (56.5 PJ in total).

According to the plan, the intermediate target of 18.8 PJ by 2010 was exceeded with savings amounting to 27.8 PJ, while the final target for 2016 would not be achieved (missing the target by 2.7 PJ) when taking into account the already adopted measures. However, the estimated 2016 savings do not include non-quantified savings in the transport area and other effects stemming from national strategy plans.

Under Article 3 of the Directive 2012/27/EU on energy efficiency, each Member State should set an indicative national energy efficiency target, taking into account, among others, the EU's 2020 energy consumption target. Complying with this provision, Denmark set its indicative energy saving target in 2020 at 12.6% reduction in primary energy consumption compared to 2006 (resulting in primary energy consumption of 744.4 PJ in 2020).

Graph II.4.7: **Denmark - Energy and carbon intensity of the economy**



Source: Eurostat

Overall, the carbon intensity of Denmark's economy is among the lowest ones in the EU and remained virtually unchanged in the last decade. In 2010, CO2 was the main source of greenhouse gas (GHG) in Denmark (representing 80% of the total GHG emissions calculated in CO2e, excluding LULUCF ([118])). The high share of CO2 is the result of a GHG emissions structure dominated by energy-related releases: in 2011, 54% of the total GHG emissions were generated by energy production and distribution while 23% by transport.

Under the Kyoto Protocol, Denmark has an obligation to reduce greenhouse gas (GHG) emissions to an average of 21% below their 1990 level during the period 2008-2012. According to the latest Commission report ([119]), Denmark is one of the countries which are likely to

([116]) Danish Ministry of Transport and Energy (2011)
([117]) Specified in Danish Energy Policy Agreements, i.e. for 2008-2009 1.15% per year of FEC based on 2003, for 2010-2016 1.5% per year of FEC based on 2006

([118]) Land Use, Land Use Change and Forestry
([119]) European Commission (2013)

meet their target by using Kyoto flexible mechanisms. GHG emissions have decreased by 18% between 1990 and 2011.

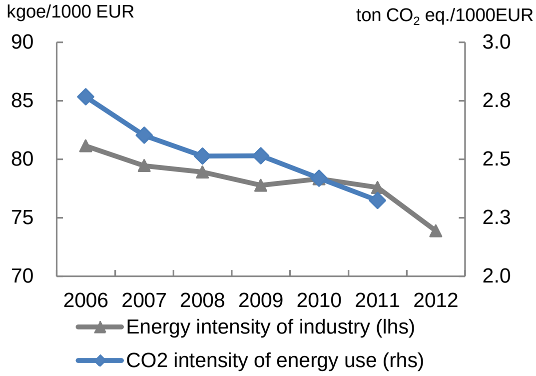
Within the EU, Denmark has an obligation to reduce non-ETS emissions by 20% in 2020 compared with 2005. Moreover, Denmark is committed to cut its overall GHG emissions beyond the international commitments and sets a target to 40% reduction by 2020 compared to 1990 levels. According to its latest reports ([120]), the government believes that the country is on track with reaching the EU target but acknowledges that further emissions-cutting measures need to be implemented. This is supported also by Commission reports ([121]).

The share of GHG emissions falling under the ETS was equal to 38% in 2011. Roughly 380 Danish production units are covered by the CO2 allowance trading scheme. In 2011, for the first time, ETS verified emissions did not reach the obtained annual allowances (covering 90%). During the third phase of the scheme there will be an EU-wide emissions cap and allowances previously allocated for free will have to be auctioned. This will increase energy costs of companies that are likely to pass them on to consumers in the form of higher prices. The magnitude of the impacts on electricity prices will be largely determined by carbon prices and by the extent to which the power sector will pursue decarbonisation efforts. The declining trend of emissions registered in the power sector is promising in this sense.

4.2.1. Industry

The energy intensity of Danish industry is one of the lowest in the EU and steadily decreasing over the last decade. However, while final energy consumption of industry decreased by 16% since 2006, Gross Value Added (GVA) also declined (by 8%). This decrease in GVA due to the crisis came after gradually rising GVA up to 2008. In 2009 it recorded a sharp decline of 11%. However, GVA started to increase again from the through in 2009 which sheds some positive light for further improvement of the energy intensity in the near future.

Graph II.4.8: **Denmark - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

In 2012, final energy consumption of industry equalled 16% of total final energy consumption, down from 17% in 2008. The main sectors consuming final energy were food and tobacco (28%) and non-metallic minerals (17%). This corresponds to the fact that the share of energy intensive sectors in total GVA is below the EU average.

According to the second NEEAP, there are several measures targeted on decreasing energy and carbon intensities of Danish industry. In 2009 the Danish government adopted a green tax reform which e.g. introduced a new energy tax on fuel and electricity in industry ([122]) and a gradual reduction of the tax reduction for heavy-process companies not otherwise covered by allowances. These measures, together with tax increases for energy use by households, should bring about annual energy savings of 4PJ by 2016.

The carbon intensity of the energy sector remained above the EU average in 2011 and declined by 10% since 2007, compared to the EU average decline of 4%. At the same time, the country performance vis-à-vis other Member States slightly improved.

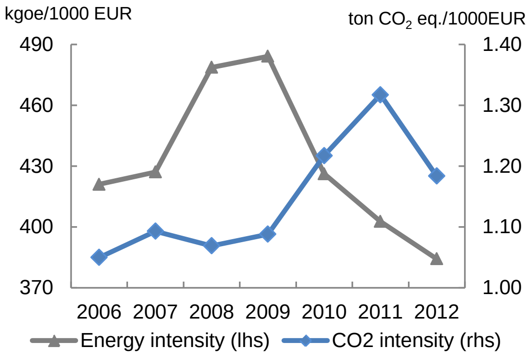
4.2.2. Transport

The energy intensity of the transport sector was the second lowest in the EU in 2012, decreasing since its peak in 2009. This happened on the back of decrease in final energy consumption and

([120]) E.g. Danish Government (2013)
([121]) European Commission (2012)

([122]) Except mineralogical and metallurgic processes, chemical reduction and electrolysis as well as primary agriculture increase in GVA (-17% and 4% over 2008-2012, respectively).

Graph II.4.9: **Denmark - Energy and carbon intensity of transport**



Source: Eurostat

In 2012, final energy consumption of transport equalled 33% of total final energy consumption, virtually unchanged compared to 2008. The main sectors consuming final energy were road transport (74%) and international aviation (18%).

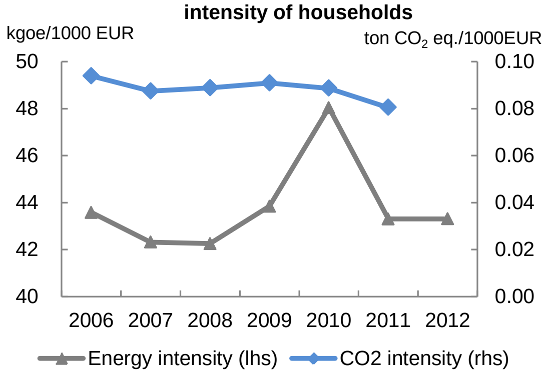
The carbon intensity of transport was the second lowest in the EU in 2011 and continued its decreasing trend since 2008. In 2011, GHG emissions in transport sector recorded their smallest value. The cumulative decline over the period 2007-2011 reached -10%. In 2011, the share of transport in total energy consumption and total GHG emissions recorded the highest values since 1990 (23% and 30%, respectively).

The second NEEAP states that as part of the Danish government's long-term objective for independence from fossil fuels, the strategy sustainable transport from 2008 includes a number of CO2 reduction measures in the form of increased public transport, amendments of vehicle taxation and better fuel technologies to ensure that the transport sector contributes towards the target ([123]). The share of renewable energy in fuel consumption of transport in Denmark was 5.8% in 2012, which is slightly above the EU-28 average.

4.2.3. Households

Households' energy intensity was in the median of the EU countries in 2012. Denmark's position vis-à-vis other Member States slightly deteriorated since 2008, increasing by 13%. This is supported by a slight increase in final energy consumption of households in total energy consumption, from 28% in 2008 to 31% in 2012.

Graph II.4.10: **Denmark - Energy and carbon intensity of households**



Source: Eurostat

The second NEEAP states that the implemented measures to reduce energy consumption by households (electricity use) achieved 15.6 PJ savings in 2010, i.e. 55% of total savings for that year. Further measures include subsidies for installations of energy-efficient equipment in households or increase of the energy tax on heat and electricity for households by ca. 15%.

On the other hand, carbon intensity of the household sector is one of the lowest in the EU and continues its downward path. Nevertheless, residential sector covered 68% of final energy consumption of RES in 2011, down from 79% in 2007.

4.2.4. Conclusions

Overall, Denmark is performing well in terms of energy intensity. This is true for industry, households as well as transport, especially when compared to other EU Member States. However, even though the absolute level seems to be fine, development over time brings out some worries. Energy intensity of transport and households has deteriorated and a firm commitment and action is needed in order to keep Denmark as a front-runner in environmental policies and their implementation.

([123]) The energy saving stemming from the measures is estimated to reach 2.5 PJ by 2016.

Denmark's carbon intensity is also one of the lowest in the EU, with the exception of industry. This, on the other hand, follows a downward path. However, special attention should be paid to GHG emissions of energy use and transport.

According to the Second NEEAP, the country needs to be successful in implementing additional measures in order to achieve its energy savings target by 2016.

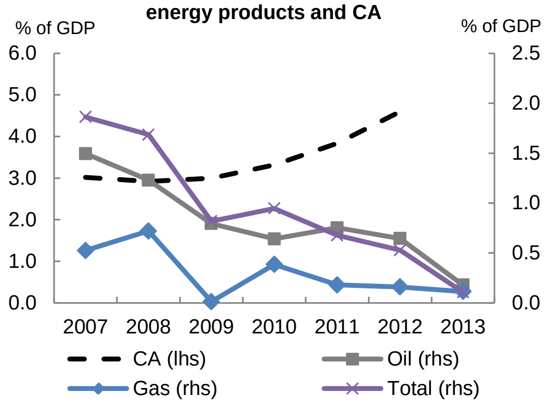
4.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

4.3.1. Net energy trade balance

Denmark is the only country in the EU with energy trade surplus which appears to be persistent. The largest trade surplus of 2.1% of GDP was recorded in 2006, roughly coinciding with the peak years of oil and gas production. The trade balance started to decrease afterwards to 0.1% in 2013.

Looking at product categories, both oil and gas contribute to the overall energy trade surplus. Denmark benefits from relatively large production fields in the North Sea and plays therefore the role of net exporter which in turn has a positive effect on its energy trade balance. However, as described in section 1, based on expected production profile, DEA (Danish Energy Agency) assumes that Denmark will remain a net exporter of gas up to 2022 and of oil up to 2020. Afterwards, Denmark will need to top up its production by imports (or by larger RES penetration) in order to cover its energy needs which will have an impact on energy trade balance.

Graph II.4.11: **Denmark - Trade balance of energy products and CA**



Source: Eurostat

The size of the energy trade balance should be seen against the background of the country's current account balance. **Over the whole period 2008-2012, the current account surplus was well above the EU levels** (amounting to 5.2% of GDP in 2012). This confirms that the current account surplus is a persistent feature of the economy and takes away the concerns over possible future energy trade deficit.

4.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade and the macro openness to trade (i.e. the ratio of total trade to GDP).

Thanks to its position as net exporter of oil and gas, Denmark is the only country in the EU with relative energy trade surplus. However, hand in hand with decreasing net exports Denmark's relative trade surplus amounted to only 1.7% in 2013 while in the past decade it varied between 18.5% (in 2002) and 37.1% (in 2006).

At the same time energy does not play a major role in total trade, representing 10% in 2013. Still, this is the second largest share in historical comparison after 10.3% in 2012.

Table II.4.2:

Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	0.8	0.9	0.7	0.5	0.1
Relative trade balance (%)	21.4	19.2	11.2	8.2	1.7
Share of energy in total trade (%)	6.7	8.6	9.8	10.3	10.0
Macro trade openness (% GDP)	56.8	57.3	62.0	62.6	62.5

Source : Eurostat

Macro trade openness of Denmark seems to be stable over the last decade, ranking somewhat below EU median.

4.3.3. Conclusions

Denmark has the best position of the EU countries with regard to natural resources (oil and gas in the North Sea). This allows the country to currently have the unique role of net exporter of energy products, which translates into energy trade surplus. However, as natural resources are not unlimited and Denmark is nearing their depletion, the country will ultimately have to become dependent on energy imports. Moreover, Denmark's ambitious goal to become fossil fuel-free by 2050 can be achieved only by either increased imports or by strengthening alternative energy sources. This should be combined with its pursued energy efficiency policy, which will make the country less dependent on energy.

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5. SPAIN

KEY INSIGHTS

Security of energy supply

- Spain's high dependence on imported energy sources and its full dependence on imported oil and gas are mitigated by the country's highly diversified energy mix and the diversification of the countries of origin of the imported fuels.

- Several issues related to the energy supply require a close attention, in particular the issue of electricity tariff deficit, the cost-efficiency of energy subsidies, in particular to renewable energy, and the completion of electricity and gas interconnectors with France.

Energy and carbon intensity

- Spain's energy intensity is slightly below the EU energy intensity, while its carbon intensity is close to the overall EU performance.

- The most problematic issue is related to the high energy and carbon intensities of the transport sector, caused by a very high share of road transport in the modal split. This might be an issue of concern in case of oil price hikes.

Trade balance for energy products

- Spain's energy trade deficit is larger than the EU average but not among the largest in the EU.

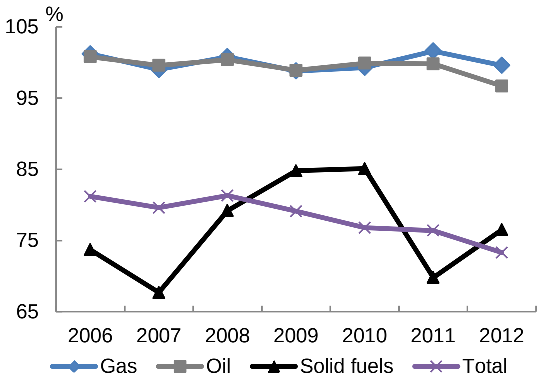
- The share of energy products in trade is relatively high, indicating that the trade in energy products is significant. This suggests that the economic impacts in case of energy price shocks are not negligible.

5.1. SECURITY OF ENERGY SUPPLY

Spain imported 73% of its energy sources from abroad in 2012. Spain's import dependence was far above the EU average, which amounted to 53%. Spain's domestic energy production comes mainly from nuclear power generation and renewable energy sources. The country has also a small subsidized production of hard coal.

The country's energy mix is rather well diversified. It has higher shares of oil and renewables than EU average, and a lower share of solid fuels.

Graph II.5.1: **Spain - Import dependence**



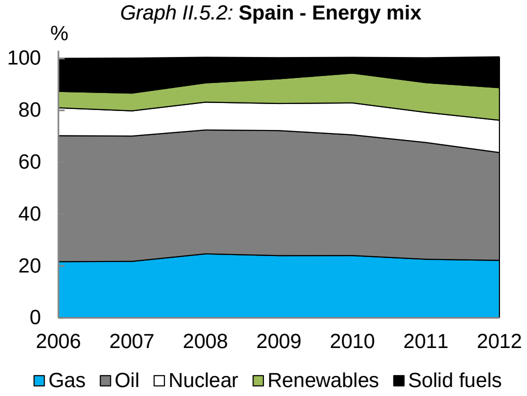
Source: Eurostat

5.1.1. Primary energy sources

5.1.1.1. Oil

The largest source of energy used in Spain is oil. It accounts for 42% of gross inland consumption in 2012, 8 percentage points above the EU average. Its share has been slowly decreasing from 49% in 2006. The proven oil reserves are small (20 Mtoe) and Spain imports almost all the oil and petroleum products used domestically. However, oil is imported from a broad range of countries. The country has well diversified sources from several regions: the most important suppliers are Russia (14%), Mexico (15%), and OPEC countries (57%). Spain is also a significant net importer of petroleum products, especially gasoil.

Graph II.5.2: **Spain - Energy mix**

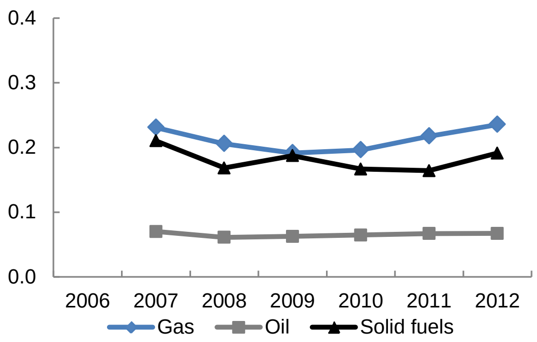


Source: Eurostat

5.1.1.2. Gas

The second source of energy used in Spain is gas. It accounted for 22% of gross inland consumption in 2012, slightly below the EU average. Spain imports almost all the gas it consumes; domestic gas production is very low, and the existing fields are close to depletion. The gas is also imported from a broad range of countries. The main supplier countries are Algeria (42% of imports), Nigeria (15%) and Qatar (12%). The main factor which contributes to the diversification of the gas import is heavy investment in liquefied natural gas (LNG). With 60% of gas delivered in the form of LNG, Spain is the leader of the development of LNG in Europe.

Graph II.5.3: **Spain - HHI index energy imports**

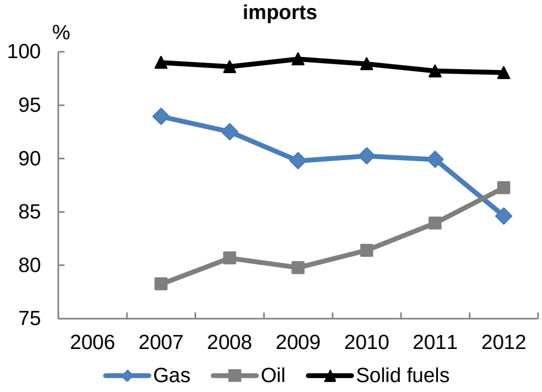


Source: Eurostat

The low interconnection level between the Spanish and French gas systems has been identified as an important infrastructure bottleneck; two existing interconnections between Spain and France (Larrau and Biriatou) have faced permanent congestion. Enhancing the capacity of these interconnections is necessary to fully integrate the Iberian gas market with the Western European market, increase security of supply and stimulate competition in the European gas market.

The Spain-France gas axis has been a priority for over a decade. Some investment has been made; in particular, the Larrau interconnection has been reinforced as a reversible flow facility, with the support of EERP (European Energy Programme for Recovery) funds. This project, including a compression station and a pipeline, is operational since September 2012. On the other hand, the development of the new pipeline between Spain and France in Catalonia, the Midcat project has been included on the list of Project of Common Interest adopted by the European Commission in October 2013 ([124]) and is supposed to be constructed by 2020. Spain is also connected to Portugal by two gas pipelines and to Algeria by another two pipelines: one of them is running from Algeria to Tarifa (Spain) through Morocco, and the other one (Medgas pipeline), completed in 2011, connects directly Algeria and Spain under the Mediterranean sea. All these connections have some spare capacity.

Graph II.5.4: **Spain - Non-EEA share of imports**



Source: Eurostat

The level of competition on the Spanish gas market is quite high. There are eighteen companies injecting gas in the system, and the

([124]) http://ec.europa.eu/energy/infrastructure/pci/pci_en.htm market share of the largest gas importer is 48%. The gas retail market shows moderate concentration with the three largest companies covering almost 70% of market share. The total number of gas consumers in December 2012 was 7.4 million. 69% of customers were supplied at a free price, while 31% remained under the regulated last resort tariffs, available only to small customers ([125]). Final gas prices for industrial consumers, including taxes, were in 2013 at the EU average level, while gas prices for households were some 15% above the EU average.

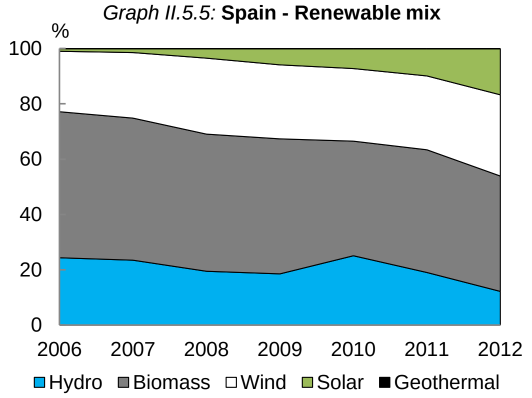
5.1.1.3. Renewables

The fourth source of energy used in Spain is renewable energy, accounting for 12.6% of energy consumption in 2012, slightly above the EU average.

Spain has a binding target under Directive 2009/28/EC to increase the share of renewable energy to 20% of gross final energy consumption ([126]) by 2020. In 2012, this share was 14%, well above the indicative target of 11% for 2011-2012.

The share of renewables in electricity generation in 2012 is 30%, six percentage points above the EU average. Hydro power has traditionally played an important role in electricity generation, and biomass in heating. In the 2000-2010, a dynamic expansion of wind and solar power took place. In 2012, wind accounted for 17% of Spain's electricity generation (a significant increase compared to 2005 when it was around 7%). The share of hydro power was 8%, solar energy is 4% and biomass 2%.

Graph II.5.5: **Spain - Renewable mix**



Source: Eurostat

The rapid development of solar and wind energy was largely due to the very generous subsidies granted to producers in the past years (see 5.1.2). In the late 2000s, Spain became the world's most attractive market for renewables. This, in turn, inflated the amount of support financed partially by energy consumers, but also by increasing the energy tariff deficit in the energy sector. The authorities have tried to align support schemes with decreasing investment costs, but reducing the burden of the support has proven difficult as investment was based on multiannual contracts. In January 2012 the government almost completely suspended support to all newly-built renewable power plants including wind, solar, biomass and hydro technologies.

5.1.1.4. Nuclear

Nuclear is the third source of energy used in Spain, accounting for 12.5% of gross energy consumption and 21% of electricity generation. Spain has currently seven operating nuclear units on five sites. These reactors are in operation since 1981-1987 ([127]).

In 1983, a moratorium on the construction of new nuclear power plants was established, and it has not been lifted by the successive governments. However, some of the existing reactors were upgraded and their nuclear capacity increased by up to 13%. Nuclear reactors were normally expected to operate for 40 years, but the licences of 6 out of 7 reactors were extended until 2020-

([125]) European Commission (2014a).
([126]) The share of renewables in the energy consumption (in the first paragraph of this section) is here defined as the share of renewable energy in gross inland energy consumption. The EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are, in contrast, expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.

([127]) World Nuclear Association, Nuclear Power in Spain, www.world-nuclear.org

2021; the licence of the seventh reactor currently expires at the end of 2014. The industry claims that the life of these reactors should be extended by another ten years. The eight and oldest Spanish nuclear reactor, in Garoña, was closed in December 2012.

5.1.1.5. Solid fuels

The fifth source of energy used in Spain is solid fuels, which account for 11.9% of Spain's gross inland energy consumption in 2012. The consumption of coal has substantially decreased since 2006. Imports cover 86% of the country's use of solid fuels. Coal imports are, however, well diversified, originating from a broad range of countries. This is demonstrated by the HHI for solid fuel imports, which is among the lowest in the EU-28. Domestic hard coal production is small and gradually falling; between 2006 and 2012, it fell from 6 Mtoe to 2.5 Mtoe.

The Spanish hard coal production is not competitive and it is highly dependent on substantial state aid. The authorities have planned to end subsidies to domestic coal production by the end of 2014, but following widespread protests of miners and trade unions these subsidies were extended until the end of 2018 ([128]). This is in line with an EU decision allowing coal subsidies until that deadline. The support to coal mines includes not only operating aid to the coal sector (some EUR 75 million in 2012), but also subsidies to power plants running on domestic coal (almost EUR 500 million in 2012) and inherited liabilities due to coal mining (another 350 million).

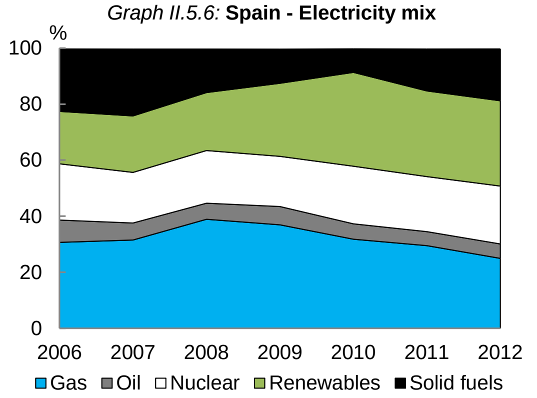
5.1.2. Secondary energy source

Spain is normally a net exporter of electricity. In 2012, net exports represented 5% of Spain's electricity consumption; this share was higher than in the preceding years. Spain is usually a net energy exporter to Portugal and Morocco and a net importer from France, although strong fluctuations are observed.

Spain has one of the best diversified electricity mixes in the EU. In 2012, the share of renewables was 30%, gas 25%, nuclear 21% and coal 18%, with a smaller role played by oil and other energy sources.

Spain has interconnections with France, Portugal (both frequently congested), Morocco and Andorra. Reinforcing these interconnections is important for the integration of the Spanish, Portuguese and French electricity markets. It is also essential in order to facilitate the integration of renewable energy sources into the network and to reinforce the security of electricity supply. In 2011, two Spain-Portugal interconnection reinforcement projects have been completed. A new Spain-France underground interconnector (Baixas-Sta Llogaia) started to be constructed in 2012; it is aimed to double the existing connection capacities between these countries. The line is expected to have a maximum capacity of up to 2000 MW and to be finalized in 2015. However, Spain is still far away from the minimum 10% rate of interconnection capacity (related to its installed capacity) that any Member State should reach, as agreed by the European Council in March 2002. In fact, the electricity interconnection rate between Spain and the rest of Member States is one of the lowest within the EU.

Graph II.5.6: **Spain - Electricity mix**



Source: Eurostat

Seen from the cross-country perspective, based on the indicators of market concentration, the electricity generation market looks competitive. The market share of the largest generator was only 24% in 2012, and three other generators have a market share above 5%. Nevertheless, at various occasions, the competition authority and the energy regulator have assessed the degree of competition in the wholesale market as not

([128]) Spain prolongs subsidies for domestic coal, ENDS Europe, 25 September 2013 sufficient ([129]). The Spanish electricity market is well integrated with the Portuguese market through the Iberian Electricity Market (MIBEL). MIBEL has a joint spot market operator (OMIE) and a futures market operator (OMIP). The entire electricity transmission network is owned and operated by Red Eléctrica de España (REE), a certified TSO, which is independent from the other companies in the sector.

The Spanish electricity retail market is being liberalised. Electricity prices for households will be partially free from July 2014, with exception of social, i.e. reduced, tariffs for vulnerable consumers. The largest retailer at the end of 2012 was Endesa with a 37% market share of the whole free market. Final electricity prices for industrial consumers, including taxes, were in 2013 23% higher than the EU average prices, while electricity prices for households were 28% above the EU average. High final prices partially reflect an ambitious energy policy, which has resulted in an increase in network access tariffs and the growing share of non-energy component in the final price of electricity.

Since 2000, Spain has had a tariff deficit in the energy sector. The tariffs covering the regulated part of the electricity bill, e.g. network costs and renewable surcharges, have been set by the government at a level which is not sufficient for the electricity companies to recover the corresponding costs. According to provisional estimates, this gap between the tariff revenues and costs amounted to EUR 3.6 billion in 2013, while the cumulative amount of debt generated by these deficits reached EUR 26 billion the same year. The financial burden resulting from the tariff deficit was initially borne by the electricity companies. However, following court decisions, the electricity companies are entitled to recover the amount of their deficits through the state budget. The rights of the utilities to recover the accrued tariff deficits have been turned into fixed-income securities; the securitisation of this debt was largely done in 2011 and 2012.

([129]) For instance: (1) CNC, IPN 103/13 Anteproyecto de Ley del sector eléctrico, September 2013; (2) CNE, Informe sobre la evolución de la competencia en los mercados de gas y electricidad. Periodo 2008-2010 y avance 2011, September 2012; (3) CNE, Informe sobre el sector energético español, Parte III. Medidas sobre los mercados mayoristas de electricidad, March 2012

In order to prevent the creation of new tariff deficits, the authorities have implemented a number of measures since early 2012. They include some increases in access tariffs and suspension of support to new renewable installations, as well as reductions of some access costs. Moreover, new taxes on electricity production and on specific technologies (hydro, nuclear, fossil fuels) were introduced. In July 2013, Spain replaced its feed-in tariff for renewable energy by a compensation mechanism guaranteeing renewable producers a certain yearly rate of return on investment. Similar rules were introduced for energy transmission and distribution, while capacity payments for gas plants were substantially reduced. However, it is not yet clear whether these measures will be sufficient to fully prevent the emergence of new tariff deficits.

5.1.3. Conclusions

Spain's large dependence on imported energy sources is mitigated by the country's highly diversified energy mix. The import covers 73% of the total energy supply, while the share of renewables is 13%. Moreover, the import is well diversified in terms of the countries of origin. However, several issues related to the energy supply require close attention, in particular the issue of electricity tariff deficit, the cost-efficiency of the support schemes for renewables and other energy sources, and the completion of electricity and gas interconnectors with France.

5.2. ENERGY AND CARBON INTENSITY

The energy intensity of the Spanish economy is slightly below the overall EU energy intensity. Between 2006 and 2013, energy intensity in the economy decreased by 14%. Spain's National Energy Efficiency Action Plans (NEEAP) set targets and measures in terms of energy efficiency. The first target to be reached by 2016, in line with Directive 2006/32/EC, is an overall decrease in final energy consumption by 9% compared to the average final energy consumption between 2001 and 2005. The second NEEAP ([130]) of 2011 reported that the energy consumption in 2010 had

([130]) Saving and energy efficiency action plan 2011-2020 (2nd National Energy Efficiency Action Plan)

Table II.5.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	136	-4.9
CO2 intensity of the economy 2)	0.37	-8.5
Share of energy intensive sectors in Gross Value Added 3)	8.6	-1.7
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

already fallen by 9.2% compared to this base period, which means that the 2016 target was achieved already in 2010. The second NEEAP set a more ambitious target of 20% savings of primary energy consumption by 2020, which is equivalent to 12.7% savings of final energy consumption.

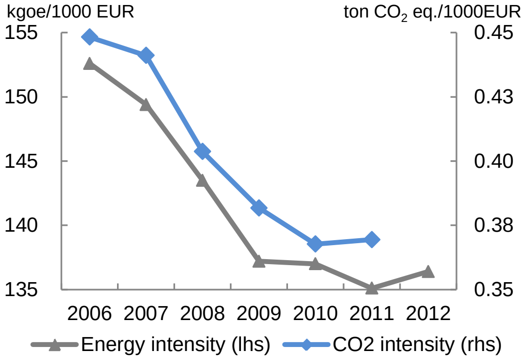
Under Article 3 of the Directive 2012/27/EU on energy efficiency, Spain set its indicative energy saving target resulting in primary energy consumption of 121.6 Mtoe in 2020. This is an equivalent of 82.9 Mtoe of final energy consumption in 2020.

Spain's carbon intensity is close to the EU average level and has been relatively stable since 2008.

As regards greenhouse gas emissions reduction, Spain had a shortfall of 2.8% in achieving its Kyoto target through domestic emission reductions, according to the European Commission's progress report ([131]). Under the Kyoto Protocol, Spain was allowed to increase its greenhouse gas emissions by no more than 15% in 2008-2012 above their 1990 level. Spain planned to meet its target by using the flexible mechanisms which are provided in the Kyoto protocol.

In the framework of the Effort Sharing Decision ([132]), Spain has to reduce its greenhouse gas emissions not covered by the Emission Trading System by 10% in 2020 in comparison to 2005 level. By 2012, Spain had reduced its emissions by 14%. However, according to the latest emission projections with the existing measures, Spain is expected to reduce its 2020 non-ETS emissions by 2% only. This would leave a 8 percentage point gap between the projected emission and the binding target for 2020 and implies that additional measures are needed.

Graph II.5.7: **Spain - Energy and carbon intensity of the economy**



Source: Eurostat

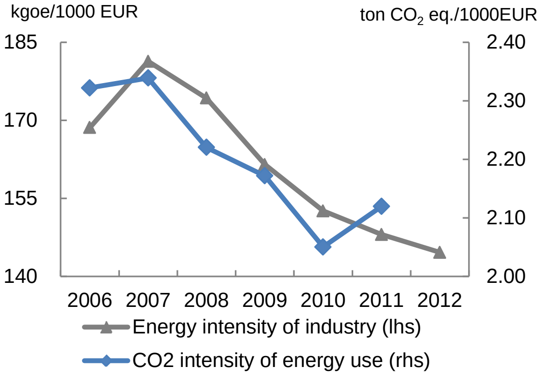
The share of the country's emissions falling under the ETS is 38%, similar to the EU average. While emissions allowances have so far been granted for free, the third phase of the ETS starting in 2013 foresees an EU-wide emissions cap and the adoption of the auctioning. This is expected to have an impact on the energy costs of industries and electricity producers which are likely to pass them on to consumers. The extent of this impact may be limited by the currently low carbon prices.

([131]) European Commission (2013).
([132]) Decision 406/2009/EC

5.2.1. Industry

The energy intensity of industry as a whole is slightly above the EU performance. The energy intensity of the industry peaked in 2007 and then it slowly decreased until 2011 probably reflecting the impact of the crisis. The share of energy intensive sectors in total gross value added of industry is 8.6%, slightly below the EU average. Among the energy intensive sectors, the sector of mining and quarrying in Spain is one of the most energy intensive among European countries.

Graph II.5.8: **Spain - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

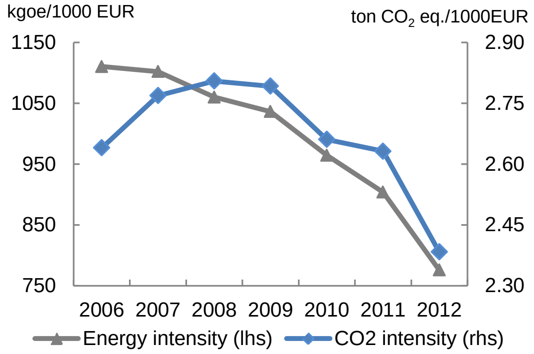
Over the recent years, important energy efficiency measures have been implemented in the Spanish industrial sector, including voluntary agreements with industry associations.

5.2.2. Transport

The energy intensity of the transport sector is above the EU performance although it has improved by 27% between 2008 and 2012. The carbon intensity of transport is some 20% above the EU average albeit decreasing.

One of the reasons for these high intensities is the high share of road in the modal split of transport. In freight, road transport accounts for 97% of total inland tonne-km, against 78% on average in the EU. This may be partially explained by a permanent underinvestment in freight and non-major railways. In addition, the size and the age of the national fleet of hauliers and cars is another explanation for high carbon intensity.

Graph II.5.9: **Spain - Energy and carbon intensity of transport**



Source: Eurostat

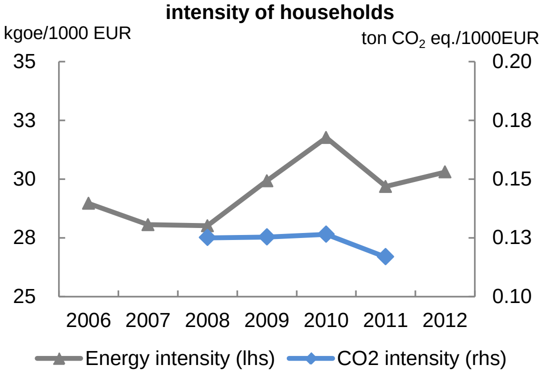
Spain had the lowest share of environmentally related taxes to GDP in the EU-27 in 2011, i.e. 1.57% of GDP, against an EU average of 2.39%. New energy taxes introduced in early 2013 are expected to increase the tax-to-GDP ratio by some 0.25%, but there is still a gap vis-à-vis the EU average. Further possibilities to raise energy taxes exist, in particular as regards taxes on petrol and diesel which remain relatively low. The share of taxation in petrol price is 50% (compared to an EU average of 57%), while the share of taxation in diesel price is 45% (compared to an EU average of 50%). There is also scope for revising the existing exemptions and rebates in other energy-related taxes, such as taxation of private use of company cars. The measures to exempt low-emission vehicles from payment of the vehicle-registration fee and charging higher fees to high-emission vehicles are measures that go in the right direction and that can be expected to reduce the carbon and energy intensity of the car fleet.

5.2.3. Households

Energy intensity of Spanish households was in 2012 the third lowest in the EU, 27% below the EU average, although it has slightly increased since 2008. Carbon intensity of households was by one third below the EU performance in 2011, and it has declined by 8% compared to 2008.

These low intensities are in particular explained by the milder climate, which reduces the demand for space heating. The ownership of electronic equipment, which used to be lower than the EU average, has now reached a level on par with the EU, which is evidenced by the increase in electricity consumption for electrical appliances and lighting per dwelling. It is now close to the EU average since 2005. Since then, the progress in energy efficiency has been slightly higher at the EU level. A lower penetration of the most efficient appliances could be among the possible causes of this slowdown in Spain. This last point seems to be confirmed by a high savings potential from electrical appliances for households.

Graph II.5.10: **Spain - Energy and carbon intensity of households**



Source: Eurostat

More generally, the electricity and fuel savings potential is substantial. This applies to both buildings and appliances. Some policy measures are being implemented in these two domains. In recent years, there has been a serie of improvements in the specific legislation as regards the efficiency of the building sector. They include e.g. the approval of the Technical Building Code, the revision of the Regulation on Building Heating Installations, and the approval of a Building Energy Certification procedure for new buildings. Also, the implementation of EU legislation on eco-design for various electrical appliances should contribute to the savings.

5.2.4. Conclusions

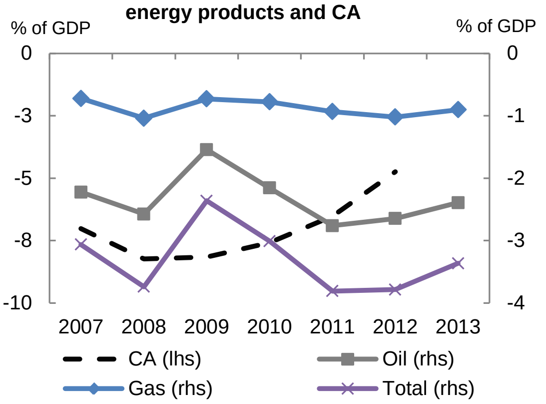
Spain's energy intensity is below the EU energy intensity while its carbon intensity is close to the EU performance. The most problematic issue is related to the high energy and carbon intensity of the transport sector, which is due to a very large share of road transport in the modal split. This might be an issue of concern, for instance in case of oil price hikes.

5.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

5.3.1. Net energy trade balance

Spain's energy trade deficit which amounted to 3.4% of GDP in 2013 is higher than the EU average, but does not belong to the largest ones in the EU. There seems to have been a persistent deterioration of the energy trade deficit, as the deficit varied around 2% of GDP in the first half of the last decade while it has generally been larger than 3% of GDP in the second half of the decade.

Graph II.5.11: **Spain - Trade balance of energy products and CA**



Source: Eurostat

The deficit can be mostly attributed to the trade in oil and petroleum products and in natural gas. The respective deficits amounted to 2.4% and 0.9% of GDP in 2013.

The size of Spain's energy trade deficit should be seen against the background of its current account deficit, which has improved over the period 2007-2012. The country had a current account deficit of close to 10% of GDP in 2007 which has decreased to around 1% in 2012-2013. This positive evolution is explained by non-energy products trade improvements, as the energy trade deficit has been persistent in size and even has deteriorated during this period.

5.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy

Table II.5.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-2.4	-3.0	-3.8	-3.8	-3.4
Relative trade balance (%)	-57.6	-55.8	-55.0	-46.0	-43.3
Share of energy in total trade (%)	11.5	12.9	14.8	17.2	16.1
Macro trade openness (% GDP)	35.6	41.9	46.9	47.8	48.2

Source : Eurostat

trade), the share of energy in total trade and the macro openness to trade (i.e. the ratio of total trade to GDP).

Spain's relative energy trade balance is rather large when compared to that of many other EU countries, and higher than the average. However, this does not translate into a relatively large energy trade deficit in GDP terms, because of Spain's limited macro-trade openness. While the relatively high share of energy products in total trade, over 16% in 2013, appears to have had a smaller countervailing effect, it serves as a reminder that Spain's trade in energy products is far from negligible. As identified in the 2014 in-depth review on the prevention and correction of macroeconomic imbalances, high dependence of Spain on energy products represents a weakness for its external position. ([133]) The trade in energy could deserve monitoring in view of its potential role of exposing Spain's current account and hence its economy to energy price shocks.

5.3.3. Conclusions

Spain's energy trade deficit does not seem to indicate a major vulnerability concern. The energy deficit is not large in relation to other EU countries, while Spain's current account deficit has been successfully reduced in size. However, the energy trade deficit has been increasing, even if it appears to stabilising recently, and the share of energy products in total trade is quite high. This suggests that the trade in energy products and the related impacts of energy price shocks may not be negligible.

5.4. REFERENCES

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([133]) European Commission, (2014b)

6. FINLAND

Key Insights

Security of Energy Supply

- Finnish energy mix is well diversified (it uses all 5 groups of energy sources), although it is fully dependent on imports of oil and gas, originating mainly from Russia.

- Finland continues to cooperate within the Scandinavian and Baltic regions with regards to electricity and gas markets. While Finland is currently bringing all country's gas needs from Russia, new interconnection should be built with Estonia.

Energy and Carbon Intensity

- Finland energy intensity is higher than the EU as a whole. This is especially due to the specialisation of Finnish industry in energy intensive sectors. At the same time, the country is on track to achieve its energy savings target by 2016.

- Finland's carbon intensity is in line with the EU level, but is performing very well with regards to the energy use, transport sector and households. While it is on track to achieving its Kyoto objective, it lags behind in implementing measures to reach the emissions reduction indicated in the EU's Effort Sharing Decision.

Trade balance for energy products

- Finland does not appear to be very vulnerable in terms of the external dimension of energy trade.

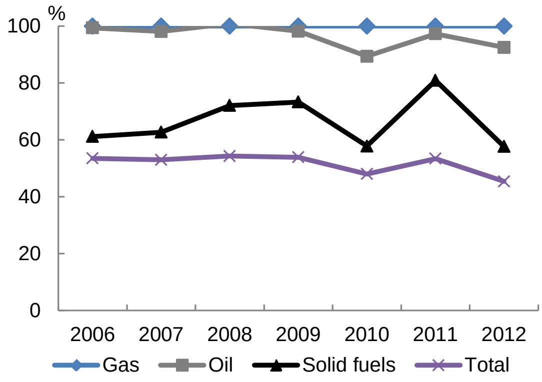
- However, there is some caution needed in respect to the increasing trade deficit of energy products and emerging current account deficit.

6.1. SECURITY OF ENERGY SUPPLY

In 2012, Finland imported 45% of its primary energy sources form abroad. Over the last decade, the degree of import dependence remained broadly stable and in line with the EU average. The diversification of trade partners for the energy import has, however, deteriorated over the last decade.

The country's energy mix is well diversified. It uses all five types of energy sources and in 2012 non-fossil fuels covered 47% of its gross inland energy consumption, one of the highest shares in the EU.

Graph II.6.1: **Finland - Import dependence**



Source: Eurostat

6.1.1. Primary energy sources

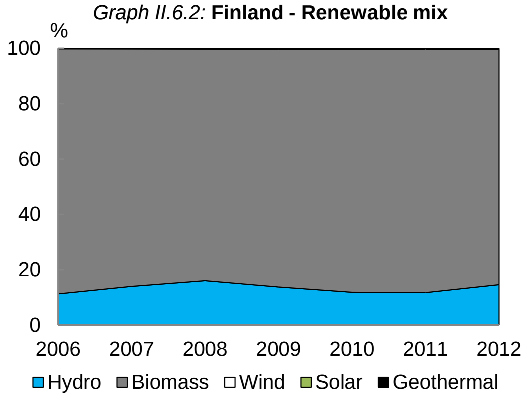
6.1.1.1. Renewables

For the first time, renewables covered the highest share of energy sources in Finland's energy mix. They represented 29% of gross inland energy consumption in 2012, one of the highest shares in the EU. This share follows an increasing trend and seems to be historically determined as in 1990 it already reached 19%.

When expressed in the same way as in the EU2020 Strategy, Finland's gross final energy consumption was covered from 34.3% by renewables in 2012, the third largest share in the EU. ([134]) This is in line with Finland's ambitious target which envisages a share of renewable energy in gross final energy consumption at 38% by 2020 ([135]), another 3.7 pp above the current level.

According to the 2013 Progress Report on Renewables of Finland ([136]), the share of renewables in gross final energy consumption amounted to 35.1% in 2012. The share of renewable energy in heating and cooling was 48.2% while the target for 2020 is set at 47%; the share of renewables in electricity was 29.5% with a projected target of 33% by 2020; renewables in transport presented 7.9% and the target for 2020 is set at 20%. Finland appears to be well on track towards their overall target as they outperformed the 2010 interim target by more than 2 pp ([137]), going hand-in-hand with the good performance with respect to the sectoral targets in heating and cooling as well as electricity. However, by 2012 the 2010 intermediate target for the share of renewable energy in transport has not been reached yet.

Graph II.6.2: **Finland - Renewable mix**



Source: Eurostat

([134]) The share of renewables in the energy consumption (in the first paragraph of this section) is defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.
([135]) Directive 2009/28/EC
([136]) In compliance with Art. 22.1 of Directive 2009/28/EC
([137]) European Commission (2013a)

Finland profits from the second largest forests in the EU (just after Sweden). In 2012 woodland covered 71.8% of Finland's territory ([138]). Therefore, the main source of renewable energy is biomass, especially wood and wood waste. With a large gap the second renewable energy source is hydropower, followed by increasing use of wind energy.

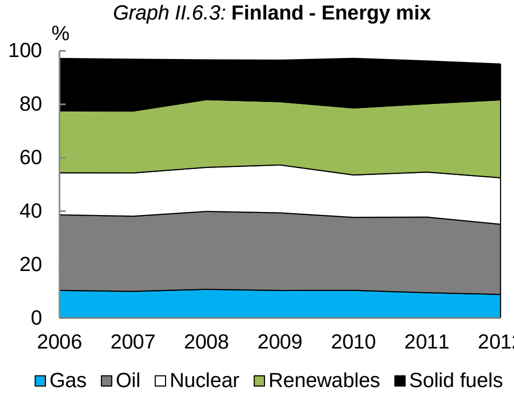
Like other countries, Finland uses support instruments for renewable energy, including feed-in tariffs, subsidies for investment, tax deductions and biofuels quota.

6.1.1.2. Oil

Oil is one of the most important primary energy sources in Finland, covering 26% of the country's energy consumption in 2012, less than the EU average. This is in line with historical data: in 1990 oil covered 35% of the gross inland energy consumption and its use was decreasing only at a very moderate pace.

As Finland does not have any own crude oil production, it is fully dependent on its imports. In 2012, 85% of crude oil and NGL was imported from Russia and 15% from Norway. The high share of Russia among the importing countries has gradually been growing up to the peak in 2010 (when it covered 94% of imports): in 1996 imports were shared more evenly between the United Kingdom, Norway, Russia, Denmark and Kazakhstan (with 33%, 28%, 18%, 13% and 6%, respectively).

Graph II.6.3: **Finland - Energy mix**



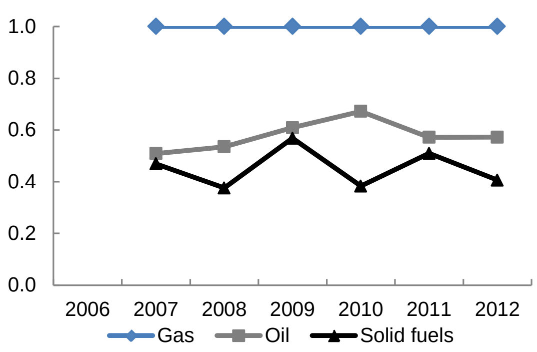
Source: Eurostat

([138]) Eurostat database

However, in 2012 Finland was a net exporter of refined petroleum products, consistent with the performance since 1998. The biggest single share of exports goes to Sweden (26%), followed by the Netherlands (14%) and the United States (11%). On the other hand, imports of refined products to Finland are largely covered by Russia (52%).

Finnish Petroleum Federation (FPF) is a collective industry association that represents the interests of 7 member oil companies ([139]) in Finland. It covers around 95% of the oil products market ([140]).

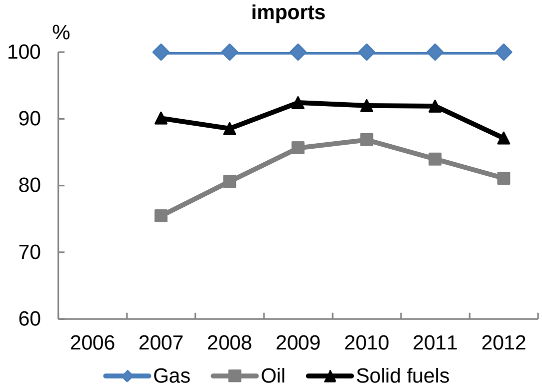
Graph II.6.4: **Finland - HHI index energy imports**



Source: Eurostat

Oil infrastructure is limited to two refineries ([141]) (at Porvoo and at Naantali, both owned by the majority state-owned company Neste Oil Oy) and 25 coastal and inland major storage facilities. Finland does not have either cross border or domestic oil pipelines and majority of oil trade (import, export as well as delivery to domestic consumers) is executed by sea. There are 6 main oil import terminals out of which only Porvoo and Naantali can import crude oil. ([142])

Graph II.6.5: **Finland - Non-EEA share of imports**



Source: Eurostat

According to the Council Directive 2009/119/EC of 14 September 2009, Finland has an obligation to hold stocks equal to 90 days of average daily net imports while at the same time, according to the emergency reserve target set by the Finnish government, the country should hold a total of five months' stocks of imported fossil fuels (oil, natural gas and coal). Even though there is no official objective for each imported fuel, the government makes efforts to keep a stockholding level of each fuel close to five months of consumption ([143]). National Emergency Supply Agency (NESA) is responsible for ensuring the implementation of the oil stockpiling obligations. Public stocks of crude oil are located in both refineries while Finnish oil importers may hold up to 20% of stocks in the countries which have concluded bilateral agreement with Finland (Sweden, Denmark, Estonia and Latvia) ([144]).

6.1.1.3. Nuclear

Nuclear power has a stable share in Finland's energy mix, accounting for 17% of energy sources in 2012. This is slightly exceeding the EU average.

Finland has four active nuclear reactors at two nuclear power plants (Loviisa and Olkiluoto) which produced 23.2 TWh of electricity in 2011, i.e. 32% of total electricity generation, while the combined generation capacity is 2,741 net MWe. The existing reactors are among the world's most

([139]) Neste Oil Corporation, Neste Markkinointi Oy, St1 Oy, Suomen Osuuskauppojen Keskuskunta SOK, Oy Teboil Ab and Finnish Oil and Gas Technology Association.
([140]) International Energy Agency (2012)
([141]) They are specifically designed to use Russian crude oil.
([142]) International Energy Agency (2012)
([143]) International Energy Agency (2013)
([144]) International Energy Agency (2012)

efficient ones, with an average lifetime capacity factor of over 85% ([145]).

The Finnish private utility Teollisuuden Voima Oyj (TVO), which operates under the so-called Mankala principle ([146]), runs the boiling-water-type nuclear power plant in Olkiluoto and Fortum Power and Heat Oyj (which is also a shareholder of TVO) runs two pressurised water reactors in Loviisa.

Currently there is one reactor under construction in Finland and two more are planned. The reactor under construction is at the Olkiluoto site and should be open for commercial operation in 2016. It will provide additional 1,600 net MWe of generation capacity. The start of construction of the other two reactors (Olkiluoto 4 and Hanhikivi 1) is planned for 2016 and 2018, respectively ([147]).

There are no operating uranium mines in Finland; all uranium is imported from Canada, Africa and Australia.

6.1.1.4. Solid fuels

Solid fuels represented 13% of the country's energy mix in 2012, slightly below the EU average. Whereas the use of solid fuels follows a declining trend, the import dependence remains broadly stable, fluctuating around 70% (and reaching 81% in 2011, its peak since 1990).

As a domestic source of energy, peat is regarded as very important to the economy. In 2012 it covered 3% of gross inland consumption of energy sources. However, the utilisation of peat for energy is planned to be reduced due to emissions and other environmental damage caused. At the same time, it should not be replaced by coal ([148]). The Government sets the objective of reducing the use of peat for energy by a third from the average level of previous years by 2025.

While Finland has a stable production of peat (covering 22% of the country's gross inland consumption of solid fuels in 2012), it imports the rest of solid fuels used in the country (hard coal and, to a small extent, coke). Even though HHI concentration index of imports (0.41 in 2011) does not reach the highest values in the EU, it still points to a concentrated market. Indeed, with 62% of the solid fuels imports in 2012, Russia is Finland's main trading partner. The importance of Russian hard coal increased substantially over the past two decades at the expense of imports from Poland. In 1992 Russia covered only 18%, while Poland 48% of all solid fuels' imports to Finland. Moreover, imports from non-EEA region reached their peak in 2009 with 92% share (and remained at these heights also in 2010 and 2011). Exports of solid fuels from Finland are virtually non-existent.

Solid fuels are mainly used for electricity and heat generation. However, the Finnish Government's Strategy ([149]) foresees that the coal used in power plants will be gradually replaced by emission-free fuels (such as nuclear and wind power) and forest-based biomass, with the target to phase out coal in power plants by 2025. Moreover, most coal used for heat generation in cities should be replaced with biomass.

6.1.1.5. Gas

Of the main energy sources, gas accounted for 9% of gross inland energy consumption in 2012. This share remained broadly stable over the last two decades and counts among the smallest ones in the EU.

Finland does not produce any gas and imports all of its supply from Russia. The demand for natural gas reached its peak in 2003 when Finland imported 4,084 toe and has declined since (to 3,005 toe in 2012). It is estimated that the demand will remain at the current level or decline further during the next decade because of relatively high prices.

A well-functioning and interconnected gas market with competitive and market-based

([145]) World Nuclear Association (2013)
([146]) 'The Mankala-principle is a widely used business model in Finland, and notably in the electricity sector, whereby a company operates like a zero-profit-making co-operative for the benefit of its shareholders. The costs are distributed in proportion to each shareholder's stake in the company, and ownership gives each shareholder a proportional share of the produced electricity., International Energy Agency (2013)
([147]) World Nuclear Association, country profile on http://www.world-nuclear.org
([148]) Finnish Government (2013)
([149]) Finnish Government (2013)

prices should provide the correct incentives for further investments and signals to consumers for an efficient and sustainable use of resources. Both elements are conducive to reducing the vulnerability of the country to energy-related shocks.

All Finnish gas imports are supplied via twin gas pipes from Russia. There is currently no other connection to neighbouring countries. Under the Baltic connector project there is a plan to connect Finland to Estonia via a new pipeline. Its construction should start in 2015. At the same time a LNG import terminal should be built at the reception point in Finland (so-called Finngulf LNG terminal project) ([150]).

The Finnish wholesale gas market is concentrated as Gasum Oy is the sole wholesale supplier. As Finland profits from an exemption in the Natural Gas Market Directive (2009/73/EC), there is no requirement for legal or ownership unbundling of natural gas transmission and distribution system operators ([151]). Gasum Oy is also the single importer of gas to Finland and has a contract with Russia (Gazprom) until 2026 ([152]).

At the same time, Gasum Oy is the sole TSO, operating 1,314 km of transmission pipelines. The gas grid currently covers only the southern part of Finland but Gasum Oy is planning to expand its network also to the western region.

As Finland has no large scale gas storage capacity, the key for Finland's gas security are compulsory stocks in the form of alternative fuels for fuel switching. The gas importer and gas plants are required to hold alternative fuel stocks (light or heavy fuel oil and/or propane gas) corresponding to three months' natural gas import. In addition, Gasum Oy operates a production facility for LNG in Porvoo, which also acts as storage.

A subsidiary of Gasum Oy runs a secondary market called Gas Exchange which intermediates around 5-10% of gas trades. The Exchange is opened only to customers who consume over 5 mcm per year and certain retail sellers. Around 45% of the total gas consumption is used at power plants, followed by heavy industry (with 42%).

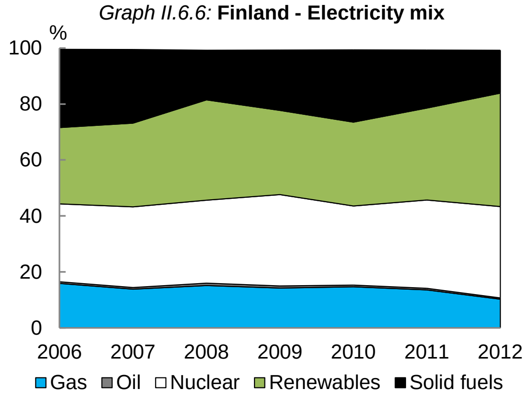
Concentration of retail market is relatively high, as the top three retail suppliers cover about 50% of the market. At the end of 2011 there were 23 natural gas retail suppliers. However, all suppliers are monopolies within their network area and there is no supplier switching in the Finnish gas market . Moreover, the retail supply of natural gas covers only about 5% of total consumption and there are only 36,000 customers in the natural gas market.

Prices (excluding VAT) for industrial users are among the highest in the EU and they recorded the third highest increase in the last 5 years (63% from H2 2009 to H2 2013). However, when assessing the prices in PPS, they are among the lowest in the EU.

6.1.2. Secondary energy sources

Finland is a significant net importer of electricity; in 2012 22% of its final electricity consumption was imported (this is one of the highest shares in the EU). At the same time, Finland recorded the highest share of imported electricity in the last two decades.

Graph II.6.6: **Finland - Electricity mix**



Source: Eurostat

While Finland imported electricity traditionally from Russia (68.9% of total electricity imports on average between 2007 and 2011) and exported to Sweden (which covered on average 92.7% of exports between 2007 and 2011), in 2012 the main partners were Sweden in terms of imports (covering 75%) and Estonia in terms of exports (covering 93%). Since 2006 a link with Estonia

([150]) www.gasum.com
([151]) Energy Market Authority, Finland (2012)
([152]) International Energy Agency (2012)

has been established, gradually increasing the importance of the country in electricity flow ([153]). There is also a negligible trade with Norway.

The main fuels for electricity generation are renewables and nuclear, both covering close to one third of total electricity generation. Solid fuels were used to generate 26% of electricity in 2010, gas 15% and oil mere 1%. While the share of gas and solid fuels in the electricity mix is gradually decreasing, nuclear and especially renewables are following an upward trend. Moreover, given that new nuclear reactors are under construction, it can be expected that nuclear will cover even more electricity needs in the future.

Good electricity interconnections and adequate domestic infrastructure capacity are important to shelter the country from supply shocks and to enable a proper absorption of renewables. A competitive and dynamic electricity market should cater the necessary investment incentives and provide the right price signals to consumers.

Fingrid, the TSO, owns the Finnish main grid and all significant cross-border connections. In April 2011 the State of Finland bought Fingrid shares of the electricity producers, increasing the state ownership to 53.1% and herewith achieving the effective unbundling from electricity production. Moreover, in July 2012 a total of 53 distribution system operators (out of 87 operators) were legally unbundled in Finland ([154]).

The Finnish electricity wholesale market is part of the Nord European power market that includes Denmark, Norway, Finland, Sweden, Estonia, Latvia and Lithuania. In November 2011 a new DC (direct current) cable between Finland and Sweden was commissioned, increasing the transmission capacity between Finland and neighbouring countries up to 4,650 MW. In addition, a new DC interconnection between Finland and Estonia is also in use. Moreover, the Nordic market is connected to the Central Western European electricity market by the EMCC1 (European Market Coupling Company) initiative.

([153]) In 2014, a new interconnection between Finland and Estonia, EstLink2, was made operational, increasing the transmission capacity to 1,000MW.
([154]) Energy Market Authority, Finland (2012)

The Finnish electricity generation sector is characterized by a large number of actors: there are about 120 companies producing electricity in Finland and operating some 550 production plants. However, the shares of the three ([155]) largest companies cover some 45-50% of total installed capacity.

Regarding the retail market, there were 73 suppliers in Finland in 2011, out of which only 4 retailers have a market share larger than 5% and the three largest retailers cover some 45-50% of the market. Many of the electricity retailers are part of companies involved in the network business. The switching rate was 7.6% in 2011, unchanged from 2010.

Electricity prices for households rank in the median of the EU countries, but when taking into account PPS, they are one of the lowest in the EU. This was the case over the whole period.

Electricity prices for industrial consumers also count among the lowest in the EU. For industrial users, the largest bulk of the end-price comes from energy and supply part (two thirds in the second half of 2013) while only 9% account to taxes and levies. On the other hand, electricity price components for households are almost evenly distributed between energy and supply, network costs and taxes and levies.

6.1.3. Conclusions

Thanks to the high share of domestically produced non-fossil fuels (renewables, nuclear) in the energy mix, Finland is relatively less vulnerable to supply shocks than the EU average. However, Finland is fully dependent on imports of crude oil, natural gas and solid fuels other than peat. Moreover, its only gas importing company has an exclusive contract with Russian Gazprom up to 2026 and oil is also imported only from Russia. Because gas and oil together cover 35% of Finnish energy mix, it is important to ensure higher diversification of import sources.

At the same time, Finland is working on making its power generators less dependent on fossil fuels and it is advanced in the RES penetration. It steadily improves interconnections with

([155]) Fortum, Pohjolan Voima and Teollisuuden Voima.

Table II.6.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	204	-1.4
CO2 intensity of the economy 2)	0.40	-1.8
Share of energy intensive sectors in Gross Value Added 3)	11.3	-3.3
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

neighbouring countries and its electricity market is well integrated in the Nordic market.

6.2. ENERGY AND CARBON INTENSITY

Finnish economy performs somewhat worse than the EU as a whole in terms of energy intensity (and is recording the highest levels from the EU-15 Member States), consistently with historical pattern. Energy intensity in absolute terms is slowly decreasing over time (and reached its lowest level in 2012) while both GDP and gross inland consumption of energy are increasing. Moreover, in the recent years it seems that Finland finally achieved decoupling of energy use and GDP growth: gross inland consumption of energy is fluctuating around 36.000 toe since 2003 while GDP increased by 14% over the same period (2003-2012). Although this is an encouraging observation, Finnish economy has not managed to fully resume its pre-crisis growth yet (and actually contracted in 2012).

Under the Energy Savings Directive ([156]) the final energy consumption saving target for Finland for the period 2008-2016 is set at 9% of the baseline. The first National Energy Efficiency Action Plan (NEEAP) of Finland ([157]) used the mean final energy use for 2001-2005 to set the savings target of 17.8 TWh by 2016 (with interim target for 2010 of 5.9 TWh).

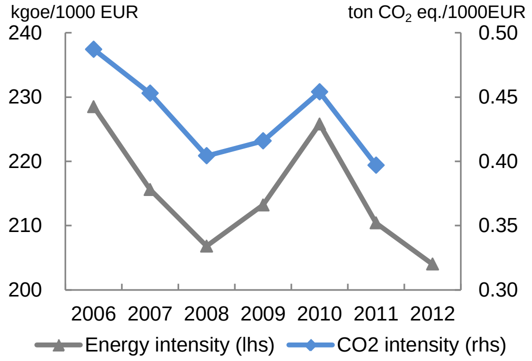
According to the second NEEAP ([158]), Finland exceeded its intermediate target by more than a double and reached Energy Services Directive relevant savings of 12.1 TWh. Moreover, Finland projects to achieve savings of 24.7 TWh by 2016 which correspond to ca. 12.5% of the baseline scenario (well above the target). By using all the measures set out in the action plan, it is estimated that energy savings will increase to ca. 17% by 2020 (i.e. 33.7 TWh).

In addition to the savings in the context of the Energy Savings Directive, Finland also presents measures aimed at energy outside its scope which would increase the final savings in 2020 to 43.8 TWh.

Under Article 3 of the Energy Efficiency Directive ([159]), each Member State should set an indicative national energy efficiency target, taking into account, among others, the EU's 2020 energy consumption target. Complying with this provision, Finland set its indicative energy saving target in 2020 as an absolute level of final energy consumption of 310 TWh (corresponding to an absolute level of primary energy consumption of 417 TWh). ([160])

([156]) Art.4 of Directive 2006/32/EC
([157]) Finland (2007)
([158]) Finland (2011)
([159]) Directive 2012/27/EU
([160]) While the level is the same as specified in the 2013 update of the National Energy and Climate Strategy, the data are not directly comparable due to methodological changes.

Graph II.6.7: **Finland - Energy and carbon intensity of the economy**



Source: Eurostat

The carbon intensity of Finnish economy lies somewhere in the middle field of all EU countries and is slightly higher than the EU's overall carbon intensity. During the recent crisis it followed a decreasing trend, but in 2010 together with the renewed economic activity, it increased back to the level of 2007 before falling to an all-times low in 2011.

Under the Kyoto Protocol, Finland has an obligation to maintain its greenhouse gas (GHG) emissions at the same level as in the base year 1990 for the period 2008-2012. According to the European Environmental Agency ([161]), Finland is on track to achieving its target through domestic reductions only. GHG emissions have decreased by 5% between 1990 and 2011.

Within the EU's Effort Sharing Decision ([162]), Finland has an obligation to reduce non-ETS emissions by 16% by 2020 compared with 2005. However, the latest projections indicate that current measures planned at national level will not be sufficient to bring 2020 emissions below their target under the Effort Sharing Decision ([163]).

Roughly 600 Finnish operators are included in the EU ETS. The share of GHG emissions falling under the ETS was equal to 48% in 2012. In the second trading phase (2008-2012) Finland issued on average 37.5 mil EU allowances per year, which was 12% more than in the initial phase. While the number of allowances was gradually increasing over the second phase, the verified emissions did not reach the obtained annual allowances in 2011 and 2012 (covering only 92% and 77%, respectively).

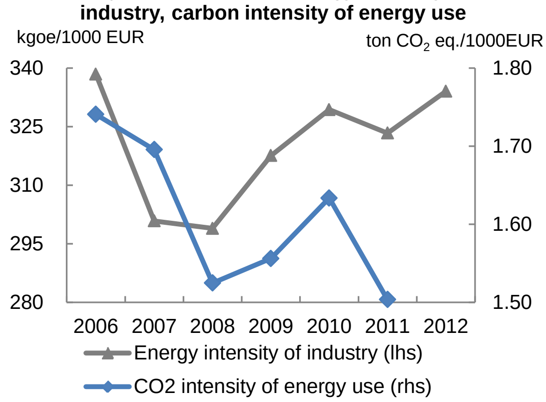
During the third phase of the scheme starting in 2013, there will be an EU-wide emissions cap and some of the allowances previously allocated for free will have to be auctioned. This will increase energy costs of companies covered by the ETS, including fossil based power producers. Some of these companies are likely to pass these costs on to consumers in the form of higher prices. Special provisions, with free allocation based on technology benchmarking, are in place for energy intensive and trade exposed industries.

6.2.1. Industry

The energy intensity of Finnish industry is one of the highest in the EU. While it followed a downward trend until its trough in 2008, renewed economic activity in the aftermath of the recent crisis caused an increase which brought the energy intensity of industry back to 2006 level.

In 2012, final energy consumption of industry equalled 43% of total final energy consumption, down from 47% in 2008. The main sectors consuming final energy were the traditionally energy intensive industries: paper and pulp (56%) and iron and steel (12%). The share of energy intensive sectors in total GVA is higher than the EU average, although it does not reach the highest shares recorded in the EU.

Graph II.6.8: **Finland - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

([161]) European Environmental Agency (2013)
([162]) Decision No 406/2009/EC
([163]) European Commission (2013b); European Environmental Agency (2013)

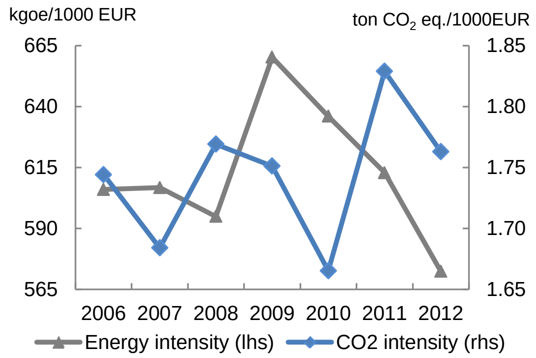
According to the second NEEAP, there are three measures targeted on decreasing energy intensity of Finnish industry: energy audits, energy efficiency agreement for business – medium-sized industry and energy efficiency agreement for business – energy intensive industry. The impact of these measures was estimated at 8% of total energy end-use of Finnish industry in 2010 and they should bring about annual energy savings of ca. 10.8 TWh by 2016 (out of which 2.6 TWh are relevant for the Energy Savings Directive).

The carbon intensity of the energy sector is among the lowest in the EU. This is thanks to the combination of, on one hand, the very efficient energy power plants and, on the other hand, the energy mix which is heavily reliant on non-fossil fuels. At the same time it is important to note that between 1990 and 2011 Finland was among the countries with the highest absolute increases in greenhouse gas emissions from the energy sector ([164]).

6.2.2. Transport

The energy intensity of the transport sector was lower than in the EU as a whole in 2012 and is following a declining trend since its peak in 2008. While the GVA of transporting activities is growing, so is its energy use, albeit to a smaller degree.

Graph II.6.9: **Finland - Energy and carbon intensity of transport**



Source: Eurostat

In 2012, final energy consumption of transport equalled 19% of total final energy consumption, unchanged from 2008. In line with the usual decomposition, the main sectors consuming final energy were road transport (80%) and international aviation (13%).

The crisis hit the transport sector severely – in 2009 the sectoral GVA recorded a decline of 13% compared to 2008, getting back to the level of 1997. On the other hand, the sector seems to have recovered rather fast as it reached a cumulative growth of 19% between 2009 and 2012.

Also the carbon intensity of transport was lower than of the EU as a whole in 2011. Even though its decrease is not constant, in 2011 it recorded the lowest figure since 2001. GHG emissions followed a similar pattern to GVA. After a period of constant increases, the emissions were slashed by 9% between 2007 and 2009. However, after an initial rise in 2010 they recorded another decrease in 2011 ending up only 2% above the through of 2007.

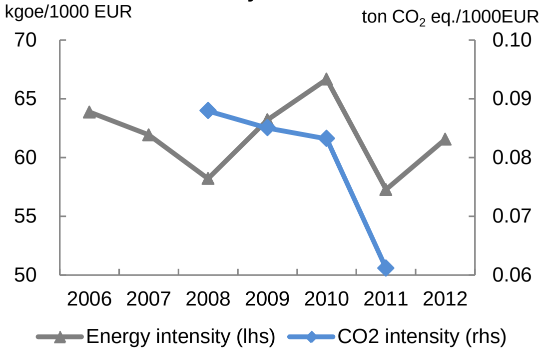
The second NEEAP presents eight measures aimed at energy savings in transport. The most significant one should improve energy efficiency of new cars and is estimated to contribute in 2016 by 63% to the overall transport energy savings (and in 2020 by 69%). Other measures include: training in economical ways of driving, promoting public transport, walking and cycling, special speed limits in winter and checks of tyre pressure. It is estimated that all these measures will correspond to energy savings of 5.5% of total energy consumption in transport by 2016 and 10% by 2020.

6.2.3. Households

Households' energy intensity was above the median of the EU countries in 2012. Finland's position vis-à-vis other Member States as well as its level remained stable since 2008. This is confirmed by the stable share of residential sector in final energy consumption which was about 20% in the past decade.

([164]) European Commission (2013c)

Graph II.6.10: **Finland - Energy and carbon intensity of households**



There are no specific measures aimed at the household sector included in the second NEEAP. However, other measures mentioned under the horizontal chapters should deliver 18-20% of energy savings by 2016 and 24-26% by 2020 (compared to 2009 level). For instance, 70-80% of the savings calculated for buildings is aimed at residential buildings. Measures targeted at this sector are the most important ones in the document (biggest energy savings are to be reached thanks to following: building regulations, heat-pumps for single-family dwellings and measures aimed at oil-heated single-family dwellings).

On the other hand, carbon intensity of the household sector is one of the lowest in the EU and continues its downward path. The share of residential sector in final energy consumption of renewables is stable and covers some 26% on average.

6.2.4. Conclusions

Finland energy intensity is higher than the EU as a whole. This is especially due to the high energy intensity of Finnish industry which relies on traditionally energy-intensive sectors like paper, pulp, iron and steel, which together covered 16% of GVA and 71% of energy consumption in manufacturing in 2012.

According to the Second NEEAP, the country is on track to achieve its energy savings target by 2016. However, it would be worthwhile investigating possible additional energy savings stemming from the industrial sector as the energy-intensive industries are steadily increasing their energy intensities.

Finland's carbon intensity is in line with the EU level but is performing very well with regards to the energy use, transport sector and households. This point to the fact that GHG emissions of the industrial sector are rather high, in line with the high share of energy intensive industries.

While Finland is on track to achieving its Kyoto objective, it seems to lag behind in implementing measures to reach the emissions reduction indicated in the EU's Effort Sharing Decision.

6.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

6.3.1. Net energy trade balance

Finland's energy trade deficit stood at 2.7% of GDP in 2013, slightly above the EU-28 deficit. While the performance was deteriorating over the past decade, it recorded a slight improvement in 2012 and remained stable in 2013. Still, the weak performance suggests that Finnish current account is more vulnerable to the energy price shocks than in many other EU countries.

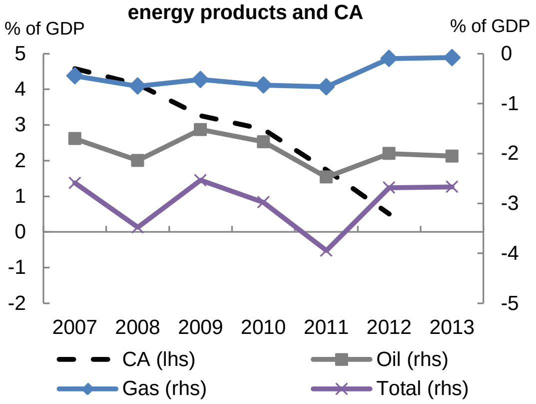
Looking at the two main energy sources imported into the country, both oil and gas contribute to the overall energy trade deficit, albeit to different extents. While both trade deficits were smaller than the EU's ones in 2013, with gas recording a balance of -0.1% of GDP and oil products of -2.1% of GDP.

Table II.6.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-2.5	-3.0	-3.9	-2.7	-2.7
Relative trade balance (%)	-43.0	-38.9	-39.6	-28.7	-26.9
Share of energy in total trade (%)	11.4	13.1	16.0	15.4	16.8
Macro trade openness (% GDP)	51.5	58.4	62.2	60.5	59.1

Source : Eurostat

Graph II.6.11: **Finland - Trade balance of energy products and CA**



Source: Eurostat

The size of the energy trade balance should be seen against the background of the country's current account balance. Historically, the current account in Finland was recording a surplus but this surplus was diminishing over the last decade until it turned into deficit in 2011, recording 1.5% of GDP (and 1.9% of GDP in 2012). Thus, one has to remain vigilant as regards the future development. Because both energy trade balance and current account balance are declining at the same time, it seems that the energy products have a negative impact on the total current account.

6.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade and the macro openness to trade (i.e. the ratio of total trade to GDP).

Finland does not stand out in regards to its relative energy trade balance; in fact in 2013 it recorded its ever smallest deficit of 26.9% (smaller than the EU-28 as a whole).

At the same time energy plays a decent role in total trade, representing 16.8% in 2013. This share displayed a substantial increase since 2002 when it reached only 6.7% of total trade. Thanks to this Finland became one of EU-15 countries where energy contributes to such a large extent to the total trade.

Macro trade openness, on the other hand, is quite stable over the last decade, ranking somewhat below EU median.

6.3.3. Conclusions

Finland does not appear to be very vulnerable in terms of the external dimension of energy trade. However, there is some caution needed in respect to the increasing trade deficit of energy products and emerging current account deficit. Moreover, while share of energy in total trade is increasing, relative energy trade balance remains stable.

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7. FRANCE

Key Insights

Security of Energy Supply

- France performs relatively well in terms of security of energy supply. The diversification of the trade partners and the large share of import countries belonging to the European Economic Area (EEA) represent an important mitigating effect to the high import dependence of oil and natural gas.

- Further promotion and development of cross-border infrastructure, in particular the completion of electricity and gas interconnectors with Spain, is essential to facilitate trade and to enhance the reliability of the energy system. The increasing shares of nuclear power and renewables will also contribute to make France less exposed to energy supply disruptions.

Energy and Carbon Intensity

- France is the best performing country in the EU in terms of carbon intensity, while its energy intensity is in line with the performance of the EU as a whole.

- Despite the decreasing trend of energy intensity in most of the economic sectors, there are still room to further improve energy efficiency. Households and services are expected to contribute the most to the country's energy savings target, followed by the transport sector and the industry.

Trade balance for energy products

- The contribution of energy products to trade is not a major matter of concern for France. Despite the growing energy trade deficit, the relative small share of energy trade in total trade contributes to mitigating the impact on the current account deficit, which appears moderate in size when compared to those of other EU countries.

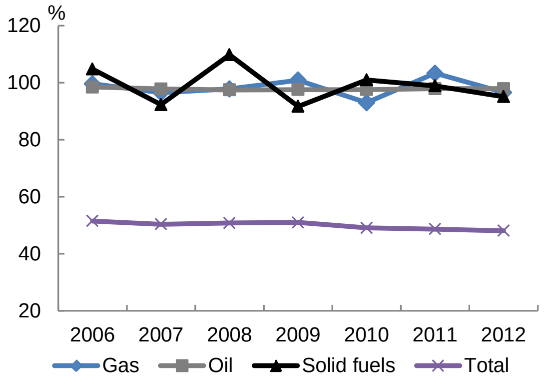
- The persistent increase of the energy trade deficit, which contributes to the current account deficit, suggests that the transition to a low carbon economy has a potential to lower this impact and make the economy less sensitive to external energy shocks.

7.1. SECURITY OF ENERGY SUPPLY

Overall energy import dependence in France was around 50% in 2012. This is lower than the average EU level, and the import share has declined since 2008.

The energy mix is one of the most diversified in the EU and it has remained stable since 2008.

Graph II.7.1: **France - Import dependence**



Source: Eurostat

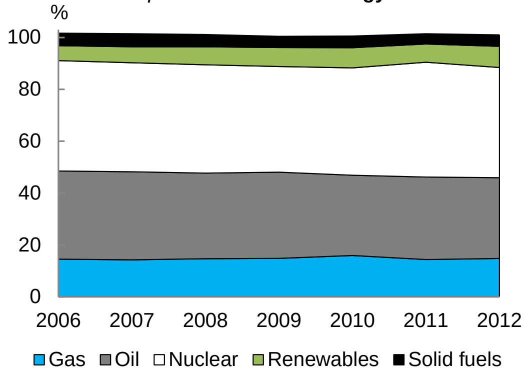
7.1.1. Primary Energy Sources

7.1.1.1. Nuclear

Nuclear is the first primary energy source used in France, representing a share of 42% in 2008-2012. This is, substantially above the EU average and any other country in the EU.

France has 58 active nuclear reactors operated by Electricity de France (EDF), with a total capacity of 63 MWe that accounts for over 75% of the domestically produced electricity

Graph II.7.2: **France - Energy mix**



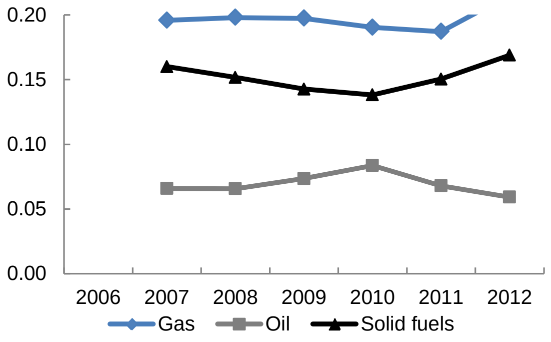
Source: Eurostat

French government has recently announced plans to reduce the share of nuclear to 50% of the electricity production, along with a second objective of reducing fossil energy consumption by 30 % by 2030. This decision should foster the development of renewable energy and contribute to a more secure energy supply. However, France will continue to exploit its comparative advantage in this industry by exporting nuclear technology to some new countries investing in nuclear energy (e.g. Saudi Arabia, Poland, Turkey), in addition to the established technology importers of South Africa, South Korea and China.

7.1.1.2. Oil

Oil represents approximately one-third of France's gross inland energy consumption and is the second largest energy source. In 2012 its share declined by two percentage points to 31% compare to 2008, as a result of the French energy policy which aims to decrease the energy reliance on external sources.

Graph II.7.3: **France - HHI index energy imports**



Source: Eurostat

France has marginal oil production and the country depends heavily on oil imports (98%) that mainly originate from outside the European Economic Area (EEA). The principal import countries in 2012 were Russia (14%), Saudi Arabia (14%), Kazakhstan (13%), Norway (8%), Nigeria (6%) and Algeria (5%). Despite the high reliance on imports, France has relatively well diversified oil import sources, both for crude oil and refined products ([165]).

The demand for refined products has also followed the trend of the demand for imported crude oil, i.e. declining significantly since 2006 by around 9% in particular during the 2007-2008 economic crisis.

There are ten refineries in operation on the mainland and one on the Martinique Island in the French Caribbean, positioning France as the fourth largest producer of refinery products in Europe. In 2012, three refineries were shut down and contributed to decreasing significantly the refinery capacity from 97.6 Mt/y to 68.7 Mt/y. The energy company Total is the largest refinery operator in France, owning almost half of the country's refinery capacity.

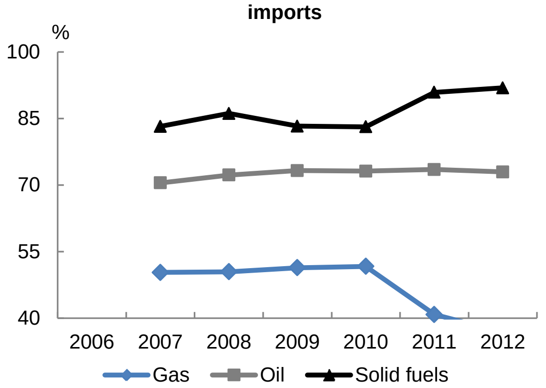
7.1.1.3. Gas

Natural gas is the third primary energy source used in France, accounting for almost 15% in 2012. It has followed a moderate, but increasing trend since 2006 and is growing more than any other energy source**.** Nevertheless, the share of gas is still one of the lowest in the EU and substantially below the EU average. In the future,

([165]) International Energy Agency (2012).

this share is expected to increase significantly as gas plants are planned to be used to replace part of the coal-based power generation.

Graph II.7.4: **France - Non-EEA share of imports**



Source: Eurostat

In 2012 import dependence of gas declined to reach 97%, after the high value of 103% recorded in 2011. At the same time the natural gas import is relatively well diversified by presenting a lower share of imports from non-EEA countries in relation to the EU average. In 2012 the main import countries were Norway (39%), Netherlands (15%), Russia (14%) and Algeria (9%). Imports from Algeria, as well as from Nigeria (8%), Qatar (4%) and Egypt (2%) concern liquefied natural gas. In general, imports are covered mainly by long term contracts and to a lesser extent by short term contracts and swaps operations.

Domestic production of natural gas has been negligible and the reserves are expected to be exhausted already by 2013. Although, France is estimated to have promising unconventional gas resources exploration has been halted by law.

A well-functioning and interconnected gas market with competitive and market-based prices should provide the correct incentives for further investments and signals to consumers for an efficient and sustainable use of resources. Both elements are conducive to reduce the vulnerability of the country to energy-related shocks.

France has one of the biggest natural gas storage capacities in the EU ([166]), representing a total volume of almost 135 TWh. GDF Suez operates 12 of these storage facilities, which represent 79% of the total capacity and TIGF operates 3, which account for the remaining share (21%). The storage facilities play a crucial role in the security of supply by ensuring that the supply will meet seasonal demand needs for natural gas. It is estimated that around 50% of the French's gas consumption can be satisfied by storage facilities. Given this, France has established a framework for transparent and non-discriminatory access to storage facilities by third parties.

In terms of transportation of natural gas, the network consists of five areas: north, south, east, west and the TIGF's balancing area. The length of the network is around 36,000 km, including 2 LNG terminals that cover 30% of the total domestic natural gas supply. Two companies own the networks: GRTgaz (88%) and TIGF (12%). There are seven entry/exit points in the country: Dunkerque (importing from Norway), Taisnières H & Taisnières B (for gas from Belgium), Obergailbach (Germany), Oltingue (to Switzerland), PIR Midi and TIGF (Spain) ([167]), which indicates that France have a well-diversified network with sufficient entry points ([168]).

France continues its efforts to enhance its gas interconnections, especially with Spain which will enable further the integration of the Iberian gas market with the Western European market. This will contribute both to increasing security of supply and stimulating competition in the European gas market. In this context, investments have been made in the two existing interconnections, Larrau and Biriatou, to avoid infrastructure bottlenecks. The Larrau ([169]) interconnection has been reinforced as a reversible flow facility, with the support of EERP (European Energy Programme for Recovery) funds. Additionally, a new pipeline (Midcat project) between Spain and France in Catalonia is foreseen to be constructed by 2020, as a project of common interest ([170]) for the European Commission.

([166]) European Commission (November 2012)

([167]) PIR midi stands for the entry/exit point between France and Spain, and TIGF is a subsidiary company of Total responsible for the development of natural gas transport and storage facilities.

([168]) Energy Delta Institute, Country gas profiles: France.

([169]) This project, including a compression station and a pipeline, is operational since September 2012.

([170]) http://ec.europa.eu/energy/infrastructure/pci/pci_en.htm

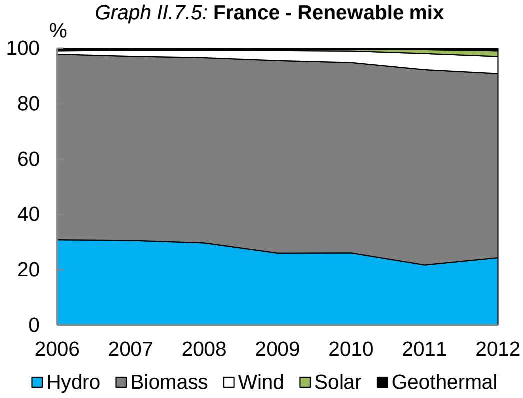
The distribution network consists of 181,500 km, which belong again to the two aforementioned companies. Under GRT gaz's network, 18 Distribution System Operators are supplying natural gas customers through 3,241 connections and under TIGF's network there are 9 DSOs, which manage 149 connections.

The end-user's prices for industrial consumers were in 2012 around the EU average, while the prices for households were among the highest in the EU.

7.1.1.4. Renewables

Renewables ([171]) were in 2012 one of the least used energy source in France, accounting for 8% of the energy mix. In 2012 the renewable mix is composed mainly of biomass (around 68%), hydropower (27%) and to a lesser extent of wind power (4%) and photovoltaic (1%), with negligible quantities of geothermal energy.

Graph II.7.5: **France - Renewable mix**



Source: Eurostat

According to the national action plan for the promotion of renewable energy, France has set an ambitious target for 2020, which establishes that the share of renewables will be 23% of the final energy consumption. To reach the target the government applies feed-in tariffs and other support measures, such as tax benefits, zero percent-interest loans, quotas etc., depending on the type of renewable source and the sector that it concerns. Additionally, the French government plans and conducts tenders for the construction of large renewable energy plants in order to reach the target capacity set by the multi-annual investment plan.

According to the latest report ([172]) of the French government regarding the promotion of renewable energy sources, which was submitted to the European Commission at the end of 2013, the share of renewable energy in gross final energy consumption was 13.7% for the year 2012. This figure is marginally lower than the 14% intermediate target based on its National Action Plan for 2012 and slightly better than the 2011 share, which was lagging behind by -0.8%.

7.1.1.5. Solid fuels

Solid fuels were the least used energy source in France, accounting for 4% of the energy mix in 2012. Its share declined marginally over the period 2008-2012, as nuclear generation substituted part of the coal-fired generation.

During the period of 2008-2012, total consumption of solid fuels was completely covered by imports that originated by 87% from non-EEA countries. The largest trade partners for import of solid fuels in 2012 were USA (24%), Australia (20%), Colombia (19%), Russia (15%) and South Africa (11%). Domestic production declined significantly over the last decade due to two main reasons: lower price of imports and environmental concerns. However, France took initiatives for encouraging coal mine methane (CMM) and coalbed methane (CBM) projects at abandoned mines. This was done through including methane in the renewable support systems and targets, and through promoting the CMM technology as a clean technology.

7.1.2. Secondary Energy Sources

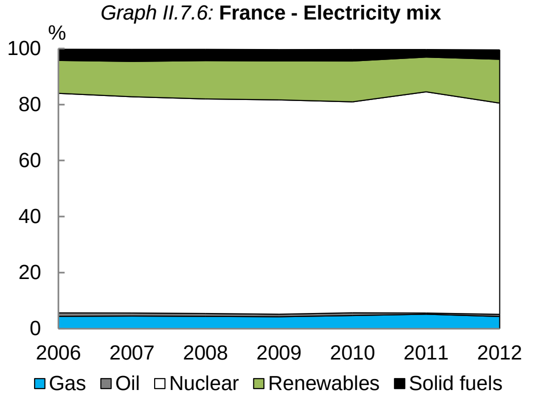
In 2012 France was one of the biggest net exporters of electricity in EU, by presenting an export balance greater than 30 TWh**.** The

([171]) The share of renewables in the energy consumption is here defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC (in the second paragraph of this section) are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.

([172]) Ministère de l'écologie, de l'énergie, du développement durable et la mer, Plan d'action national en faveur des énergies renouvelables: Période 2009-2020.

electricity mix of France in 2012 is heavily dependent on nuclear (75%), representing the highest share in the EU. The share of renewable sources, mainly hydro generation, wind and photovoltaic, in electricity production is around 15%, representing an increase since 2006. Gas and solid fuels account altogether for 10%, with the gas production exhibiting a slight increase in 2006-2012, while the share of solid fuels marginally declined.

Graph II.7.6: **France - Electricity mix**



Source: Eurostat

The electricity generation sector is highly concentrated, where Electricité de France (EDF) dominates by owning more than 90% of the total installed capacity. In July 2012, a new law ("NOME" - Nouvelle Organisation du Marché de l'Électricité), came into force in order to foster competition in the French electricity market and to reduce the market share of EDF. According to this law, EDF is obliged to sell part of its nuclear production to competitors at a predetermined price set by the Government. By this measure competitors will gain access to power produced at a low cost and will be able to compete with EDF.

In the beginning of 2009, France enhanced its collaboration with Germany by creating a common wholesale electricity market as a joint venture named EPEX SPOT SE. This company facilitates the hourly balancing of physical power delivered the following day on the French, German, Austrian and Swiss power hubs. Furthermore, in April 2009, German and French power derivatives' trading was transferred to EEX (European Energy Exchange) Power Derivatives GmbH, a subsidiary of EEX (80%) with headquarters in Leipzig. Clearing and settlement for all spot and derivatives transactions on power are provided by European Commodity Clearing AG (ECC), which had already been settling the natural gas transactions traded on the French wholesale market, Powernext, since November 2008.

France has completed the full transposition of the Third Energy Package directives into the national legislation. Based on the electricity directive, it has chosen to implement the Independent Transmission Operator (ITO) model for the unbundling of the TSO. The ownership of the transmission network belongs to Réseau de Transport d'Electricity (RTE) a subsidiary company of EDF that operates one of the largest networks in Europe of approximately 100,000 km. According to the French energy regulator (CRE) little progress has been made regarding the independence of Distribution System Operators (DSOs) with their parent companies. As in the case of transmission network, 95% of the distribution network is owned by Electricité Réseau Distribution France (ERDF), a subsidiary of EDF. The remaining of the DSOs companies consists of local companies, almost 160, which have negligible shares.

Good electricity interconnections and adequate domestic infrastructure capacity are important to shelter the country from supply shocks and to enable a proper absorption of renewables. A competitive and dynamic electricity market should cater the necessary investment incentives and provide the right price signals to consumers.

France currently holds the 43 electricity interconnections with neighbouring countries and continues its efforts to reinforce its interconnectors by investing in a number of projects. These include the Baixas-Santa Llogaia line with Spain, the line between Savoie and Piedmont with Italy and new interconnection lines with UK. Some of these projects receive funding by the European Investment Bank and grants under the European Energy Programme for Recovery ([173]). Additional development of interconnections is also under consideration, including with Belgium, Germany, Switzerland, Italy and Spain. These projects correspond to a total capacity of about 6000 MW.

Over the period 2008-2012 exports and imports represented almost 11% and 3% of the electricity

([173]) European Commission (2013a).

generation, respectively. Net exports increased significantly, especially in 2011, due to the decreasing imported volumes from Germany. This was due to the decommissioning of nuclear units in Germany, as well as lower demand and good availability of the indigenous nuclear plants in France.

Similarly to the generation activity, the retail activity is highly concentrated in France. The market share of the three largest suppliers exceeds 80% of the market in 2012, and EDF is the only supplier that has a market share above 5%. The switching rates increased marginally over the years and as a result large part of the industrial and residential consumers remained under the supply of the three largest companies and especially under the incumbent supplier.

Prices are among the lowest in the EU both for households and industries, despite a slight increase in 2011 and 2012, owing in particular to low energy supply costs.

7.1.3. Conclusions

France does not present particular elements of vulnerability in terms of security of energy supply. France has a high share of import of oil and natural gas, but this vulnerability is mitigated by well diversified trade partners and the large share of import countries belonging to the EEA. The large share of nuclear power and the increasing share of renewables also contribute to make France less sensitive to energy supply disruptions.

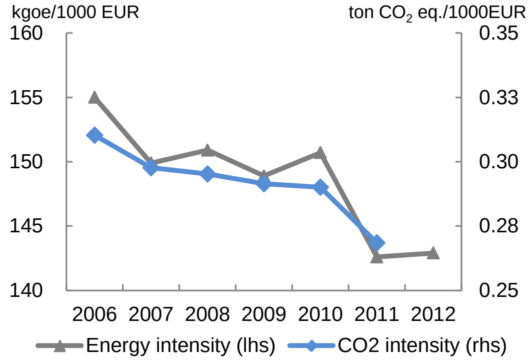
In this respect, France could enhance its efforts regarding the deployment of renewables and the development and reinforcement of cross-border infrastructure of the electricity and gas market. While the renewables penetration can contribute to reducing the dependence on fossil fuels imports, as well as its carbon intensity, the expansion of interconnection's infrastructure can enhance the security of electricity supply through better management of the peak demand periods. The lack of balancing capacity in France to cover peaks in the demand can be supplemented by facilitating electricity trade with neighbouring countries.

7.2. ENERGY AND CARBON INTENSITY

The energy intensity of the French economy in 2012 is on par with the EU performance and it has improved by almost 3% compared to 2008. This increase is also in line with the aggregate evolution of the EU energy intensity over the same period. The economic crisis played a crucial role in this development, especially during the period 2008-2009. According to the POPE Law ([174]) the final energy intensity is foreseen to decline by 2% per year until 2015 and by 2.5% per year between 2015 and 2030. Measures from that law should allow France to set an energy efficiency target involving a reduction of 17% of its final energy consumption by 2020 compared to baseline levels.

The first National Energy Efficiency Action Plan (NEEAP) runs for the period 2008-2016 and sets relative ambitious targets in terms of energy efficiency. The savings target to be reached by 2016, in line with Directive 2006/32/EC, is an overall decrease in final energy consumption by 9% compared to the average for the 2001 to 2005 period ([175]). The Second National Energy Efficiency Action Plan ([176]) reports that the intermediate target for 2010 would be achieved, as in the period 2007-2009 the volume of energy savings was 5,159 Mtoe and the intermediate indicative target for 2010 is 5,000 Mtoe.

Graph II.7.7: **France - Energy and carbon intensity of the economy**



Source: Eurostat

The carbon intensity of the French economy followed a decreasing trend over the period

([174]) Loi n° 2005-781 du 13 juillet 2005 de programme fixant les orientations de la politique énergétique.
([175]) European Commission (2013a).
([176]) Second National Energy Efficiency Action Plan (2011).

Table II.7.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	143	-5.3
CO2 intensity of the economy 2)	0.27	-9.1
Share of energy intensive sectors in Gross Value Added 3)	6.6	-0.7
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

2008-2012. It exhibits substantially lower levels than the EU as whole due to the extensive use of nuclear generation.

France has committed to providing for an improvement in energy efficiency by 20% in the European Union by 2020, as part of its obligations based on the energy-climate package of 2009. In addition, the French government has set ambitious plans for reducing greenhouse gas emissions (GHG) by 40% in 2030 and by 60% in 2040.

Under the Kyoto Protocol, France has an obligation to keep the greenhouse gas emissions at the 1990 levels during the period 2008-2012 ([177]). According to the latest progress report, GHG emissions in France over the above period were almost 7% below the average annual target. A percentage that renders France among the few large European economies that have overachieved their target. Also, emissions per capita fell significantly since 1990, by 35%. Therefore the country is ahead of its targets under the Kyoto Protocol.

The country appears to have made sufficient progress to reduce greenhouse emissions in the non-ETS sector. Under the Effort Sharing Decision ([178]), France has committed to reduce its emissions in non-ETS sectors by 14% in 2020 (compared to 2005). The latest data show that, France had already achieved a reduction of 11% in 2012 and it is currently projected to exceed its target by 2% with existing measures ([179]).

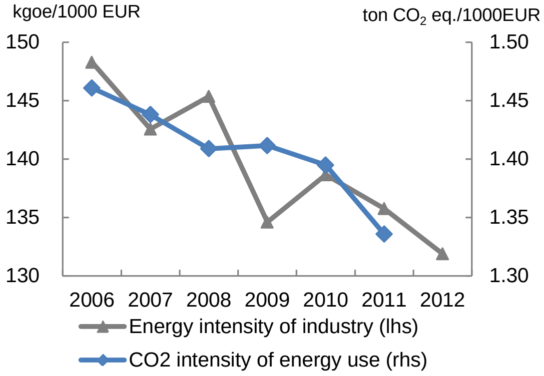
The share of GHG emissions falling under the ETS equals 21% of total emissions. This is substantially lower than the EU average of 40%. Since the third phase of the scheme started in 2013, there has been an EU-wide emissions cap and emission allowances are auctioned while so far they had been granted for free. This is expected to have an impact on the energy costs of industries, which are likely to pass through these costs to consumers, where possible. The effects of the auctioning on the French economy will largely depend on the carbon price, which is currently very low. Another factor is the ability of the French energy sector and industry to move to less carbon intensive alternatives.

7.2.1. Industry

The energy intensity of industry has decreased by 9%, in 2012 compared to 2008. This evolution can partly be explained by a declining share of energy intensive industries in manufacturing gross value added. This share declined from 7.1% in 2008 to 6.6% in 2012.

([177]) European Environment Agency (2013)
([178]) Decision 406/2009/EC
([179]) European Commission (2014).

Graph II.7.8: **France - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

The industry's energy savings (not including energy use in the sectors relating to EU ETS and solar thermal energy) in 2016 is expected to contribute marginally (1%) to the overall savings target set by the Second National Energy Efficiency Action Plan. According to this, industry will be the only final consumer which will present an increasing trend in its energy consumption over the period 2009-2020. In the period following 2016 the industrial energy consumption will increase at a slower pace, from 18.5 Mtoe in 2016 to 19.4 Mtoe in 2020. Among the measures that are to be used to reach those targets are financial incentives, regulatory measures, support for standardisation processes and support for development of the most efficient technologies.

The carbon intensity of industry has decreased considerably over the period 2008-2012, by more than 5% and is one of the lowest in the EU. Although industry presents a value added close to the EU average level, its GHG emissions decreased significantly.

The increased penetration of natural gas in the energy sector is expected to affect carbon-intensity. Between 2008 and 2012 GHG emissions from combustion installations were systematically below the free allowances that were allocated to them ([180]). The carbon intensity of the French energy sector declined significantly over the period 2010-2011, as a result of a high share of nuclear and growing share of renewables.

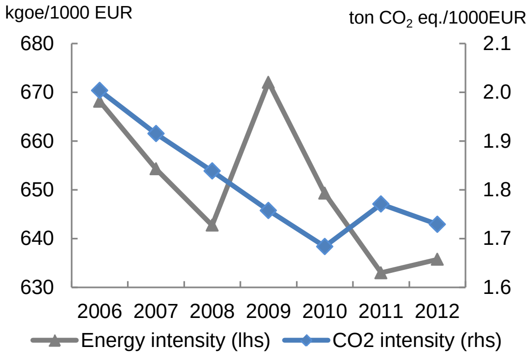
([180]) European Environment Agency, EU Emissions Trading System (ETS) data viewer.

7.2.2. Transport

Energy intensity of the French transport sector was lower than the EU performance in 2012, and it decreased by 1% compared to 2008. In contrast, the carbon intensity of this sector is in line with the EU performance and it declined marginally compared to 2008.

The transport sector represents almost one third of the final energy consumption in 2011 and 70% of its consumption concerns oil products. For this reason, it is one of the major contributors of greenhouse gas emissions, accounting for 27% of emissions. Measures that have been adopted in order to reduce its share of GHG emissions focus on efficiency improvements and improved incentives for modal shifts.

Graph II.7.9: **France - Energy and carbon intensity of transport**



Source: Eurostat

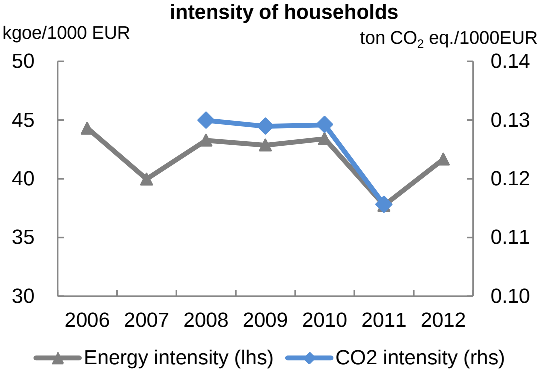
According to the Second National Energy Efficiency Action Plan in France, final energy consumption of the transport sector is projected to be 38.8 Mtoe in 2020, which corresponds to fall by about 1.9 Mtoe and 3.2 Mtoe in 2016 and 2020 respectively, compared to the baseline scenario. This indicates that the transport sector will contribute by 10% and 11% in 2016 and 2020 respectively, to the overall forecasted target of energy savings. The intermediate target in 2016 for transport is equal to 42.3 Mtoe. Measures that are expected to contribute to achieve the targets aim at modal shifting and at greater efficiency of the used transport modes. In this respect, the renewal of the vehicle fleet with lower consumption per kilometre and lower carbon dioxide emissions in relation to fuel consumption, as well as the increasing electrification of the transportation sector are steps in the right direction for meeting these targets.

7.2.3. Households

Energy intensity of households was in line with the corresponding value for the EU as a whole in 2012. It has improved by almost 4% compared to 2008**.** Similarly, the carbon intensity of households was close to the EU performance and declined substantially by 11% over the period 2008-2011.

According to the Second National Energy Efficiency Action Plan in France, households will be the biggest contributor to the country's energy savings in terms of the savings targets for both 2016 (15.9 Mtoe of savings) and 2020 (25 Mtoe of savings). Almost 88% of energy savings will come from households and services as a result of the implementation of the demand-side management programme in the construction sector, established by the Environment Round Table. Indeed, in recent years, the eco-designed and labelled products, as well as the ban on incandescent lamps have played a role in the decline of energy consumption. Additional measures that were established in order to reach these targets are the renovations of 500,000 dwellings per year, which will contribute to reducing the building sector's energy consumption by 38% in 2020. Further demand side management approaches and smart grids could be supplementary measures that will contribute to fulfilling these targets.

Graph II.7.10: **France - Energy and carbon intensity of households**



Source: Eurostat

7.2.4. Conclusions

France performs well as far as energy and carbon intensities are concerned. It is one of the least carbon intensive economies in EU as a result of the high share of nuclear in the energy fuel mix, while in terms of energy intensity it is close to the EU performance. This pattern holds true for the different sectors of the economy. This fact implies that the country is relatively less affected by more stringent climate change polices and volatile fossil fuel prices.

However, there is still room for improvement of energy intensity performance in all economic sectors. The National Energy Efficiency Plan has set ambitious targets and additional efforts need to be made in order to achieve them. Higher penetration of renewables, promotion of more efficient use of resources through price signals, demand side management approaches, increasing the electrification of the transport sector and smart grids could be some of these additional measures that will contribute to high energy savings.

7.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

7.3.1. Net energy trade balance

The total energy trade deficit of France was 3.1% of GDP in 2013. This is not among the highest in the EU and comparable to that of other major economies in the EU. The energy trade deficit exhibited an increasing trend until 2008, when it reached the level of 2.9%. It then decreased slightly to 2% before increasing again to its highest level in 2012 and improving slightly in 2013.

As in most countries, the oil trade contributes more than any other energy commodity to the energy trade deficit. In 2013 its deficit was equal to 2.3% of GDP, the second highest record after 2012 (3.5%) since 2001. The oil trade deficit is the driving factor of the overall energy trade deficit.

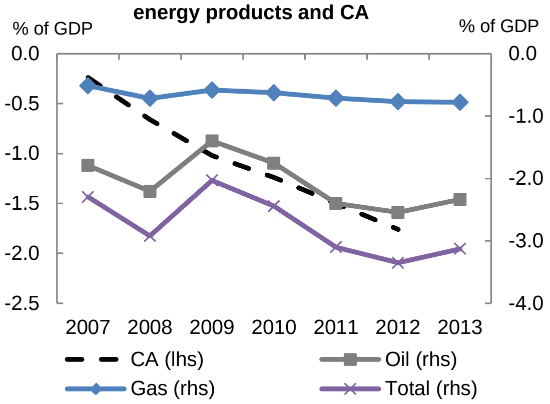
The gas trade deficit had the same pattern as the oil trade deficit, by has only presented marginal increases over time. In particular, in 2013 it reached the highest level of 0.8% compare to 2009 (0.6%).

Table II.7.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-2.0	-2.4	-3.1	-3.4	-3.1
Relative trade balance (%)	-58.5	-60.5	-60.2	-61.5	-63.4
Share of energy in total trade (%)	8.7	9.1	10.9	11.4	10.7
Macro trade openness (% GDP)	39.9	44.2	47.3	47.6	46.1

Source : Eurostat

Graph II.7.11: **France - Trade balance of energy products and CA**



Source: Eurostat

However, the developments and current size of the energy trade deficit should be seen against the background of the country's current account balance. The current account was positive until 2005, when it turned negative. Since then, it has deteriorated further reaching the largest deficit of 2.3% in 2012. The deterioration of the energy trade deficit can have been one factor that is likely to have contributed to the negative development of the current account, in particular since 2009.

7.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade, and the ratio of total trade to GDP (macro openness to trade).

The French relative energy trade deficit in 2013 was among the largest in the EU, around 63%. Although its trend is increasing, it is in line with that of the other larger EU countries. Similarly, the macro trade openness is among the lowest in the EU, together with other large countries, presenting marginal changes over the years.

The large relative energy trade deficit has however always been compensated by a very low share of energy trade in total trade. This share has, however, increased over the past decade from 5.5% in 2001 to the current 10.7% (despite a temporary and small fall in 2009 and 2013, respectively). This signals that there has been an increase in importance of energy items in the French trade. The small absolute size of this share has so far mitigated the effects of the energy trade deficit on the current account balance of the country.

7.3.3. Conclusions

The contribution of energy products to trade is not a matter of concern for France. Despite the growing energy trade deficit, the relative small share of energy trade in total trade contributes to mitigating the impact on the current account deficit, which appears moderate in size when compared to those of other EU countries.

However, it should be noted that the country has a significant trade deficit for oil and natural gas, which exposes the country to prices surges or supply shortages. In this respect the objective of reducing by 30% the consumption of fossil energy by 2030 should contribute to reducing the exposure to external energy shocks.

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8. THE NETHERLANDS

Key Insights

Security of Energy Supply

- Due to the availability of large domestic gas reserves and a solid energy infrastructure, the Netherlands has a favourable security of energy supply situation in the short and medium term. The Netherlands could, however, further improve the diversification of its energy mix, in particular through increasing the share of renewables.

- The long-term challenge for the Dutch energy system is related to the gradual reduction of the domestic natural gas production. This will inevitably render the country more dependent on energy imports. The strategy to transform the country into a major gas distributor seems reasonable, but is affected by risks related to the external environment.

- The overcapacity in electricity production poses a challenge for the future energy policy in view of the transition to a low carbon economy.

Energy and Carbon Intensity

- Further energy efficiency improvements seem vital in view of the "lock in" to Groningen gas supply in particular by the domestic household and commercial sector.

- The measures on energy efficiency and renewable energy in the Energy Agreement, agreed between the government, social partners and the energy sector, render the overall targets for renewable energy share in gross final energy consumption for the years 2020 and 2023 achievable provided that the agreed measures are timely implemented and progress is regularly monitored allowing for additional measures.

Trade balance for energy products

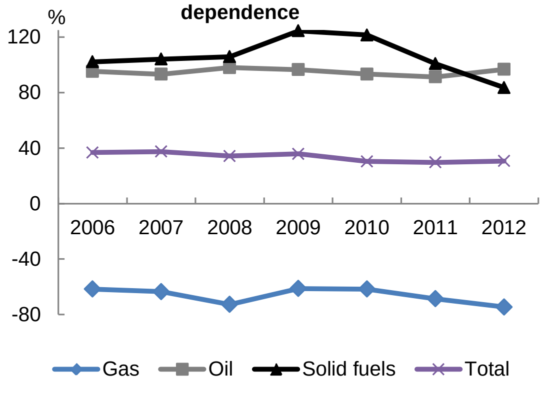
- The energy trade deficit can largely be attributed to the trade deficit in oil and petroleum products.

- The prospect of a growing energy trade deficit in the future does not seem to be a major concern due to the persistent large current account surplus.

8.1. SECURITY OF ENERGY SUPPLY

The Netherland's import dependence for primary energy sources has been well below the average of EU-28 in the period 2008-2012. Moreover, it decreased substantially from 34.3% in 2008 to 30.7% in 2012, against the backdrop of a small decrease in the EU average.

Graph II.8.1: **Netherlands - Import dependence**



Source: Eurostat

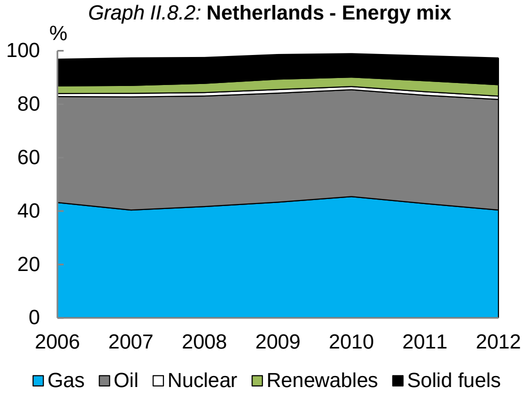
The country's energy mix reveals a high reliance on oil and gas, each having a share in energy consumption well above 40%. However, particular features of the Dutch energy system substantially mitigate the security of energy supply risks on the short and medium-term. The foreseen decline in domestic natural gas production in the next decades with a switch from a net exporter of gas to a net importer is likely to pose security of supply challenges in the longer term.

8.1.1. Primary energy sources

8.1.1.1. Gas

Gas is the most important primary energy source in the Netherlands, covering on average 43% of its energy consumption in the period 2008-2012. Next to a variation between 40 and 46%, there appears to be a modest declining trend over time. At the beginning of the decade, the 5-year moving average of this share was about 46%.

Graph II.8.2: **Netherlands - Energy mix**



Source: Eurostat

Next to Norway, the Netherlands has one of the largest proven reserves and the largest production of natural gas in Europe. Thus, the predominance of gas is a direct consequence of the exploitation of the huge domestic gas reserves. The major production site is the Groningen gas field which has figured among the ten largest gas fields in the world and is expected to remain in operation for decades to come. Its production remains larger than all other domestic onshore and offshore fields combined and exhibits much lower production costs. This situation allows it to function as the "swing supplier", filling the gap between, on the one hand, the increasing volume of gas supplied from the small fields, and, on the other hand, the demand for Dutch gas in the Netherlands and abroad which fluctuates over the day and over the year ([181]).

([181]) Correljé et al. (2003).

The domestic gas infrastructure is very elaborate. In 2011, 98% of the household were connected to the gas network, the highest coverage rate in the EU. The gas volumes are so large that they allow two separate networks throughout the country for low- and high-caloric gas, usually referred to "L-gas" and "H-gas" respectively ([182]). The Groningen gas field seems fairly unique in producing L-gas, whereas most of the smaller fields in the Netherlands, as usual elsewhere, produce H-gas. Nearly all domestic household and commercial consumers are equipped to use L-gas, whereas domestic industry and electricity producers mostly use H-gas.

L-gas users are dependent on supply from the Groningen field because of the barrier to switching to H-gas (or to another energy source) as it requires time and costs to adapt the infrastructure and equipment ([183]). Hence, such a switch can only be achieved in the long-term.

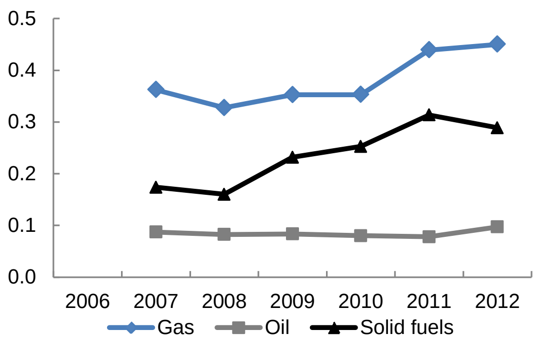
There is full ownership unbundling of the network infrastructure. The fully government-owned GasUnie operates the national transport network in its capacity as TSO (Transmission System Operator), whereas several DSOs (Distribution System Operators) act on a regional basis. The state participates in the various exploitation activities, both directly and through the state-owned enterprise EBN, typically with an overall 50% share. GasTerra is the major gas trading company with the exclusive right to sell the gas from the Groningen field. Also here the government has a 50% share, whereas the energy companies operating the Groningen field own the other half. **Many domestic sectors have become highly dependent on gas for their energy consumption.** The household sector depends for more than three quarters of their energy consumption on gas (in particular for heating), while industry for almost half and tertiary and public services for over half of their consumption ([184]). Moreover, industry also uses

([182]) IEA (2012) and GasTerra (2013). The dichotomy of H- and L-gas is not complete, as H-gas can be converted into L-gas through the addition of nitrogen. However, the capacity of the so-called conversion stations is limited in the short-term.
([183]) GasTerra (2013).
([184]) These shares are calculated on the basis of IEA (2013) energy balance statistics for the year 2011, taking account of both direct and indirect consumption.

gas as feedstock for non-energy purposes. An amount corresponding to more than 40% of its direct gas consumption volume is used as input for the production of basic chemicals.

Final gas prices for both industrial consumers and households, including taxes, were in 2013 well below the EU average, for households about 5% and for industrial consumers about 15%. Moreover, over the period 2008 – 2013 these final prices fell relative to the EU average.

Graph II.8.3: **Netherlands - HHI index energy imports**



Source: Eurostat

Due to the size of the gas reserves, the Netherlands has been a major gas exporter to neighbouring countries from the start of its gas exploitation. This is expressed in a negative gas import dependence, a feature which it only shares with Denmark in the EU. Germany is the most important destination market, accounting for over one third of export volumes, followed by Belgium, the UK, France, and Italy, roughly each getting about one sixth of gas exports ([185]). A large share of the export is carried out on the basis of long-term contracts, which often date back from decades ago ([186]).

Gas revenues have been a major source of income for the public budget, as the state has a large stake in the gas sector. Revenues currently amount to EUR 13 bn annually ([187]). In 2012, it amounted to EUR 14.5 bn. However, the yearly public revenue inflow varies considerably due to fluctuations in both in production volume and international energy prices. Over the period 2003-2013, the share in total central government's revenues has varied between the 5% and 10%. This also reflects an underlying structural rise in gas prices.

The rigidities in export and domestic demand patterns together with the cost profile of both production and the expansion of the smaller fields and the desire to prolong the use of the Groningen field have given rise to gas imports, mainly from Norway, UK and Russia. The import volume is currently about 40% of the export volumes.

In the coming two decades, the Netherlands is expected to gradually become more dependent on gas imports. A steady decline of domestic production is foreseen, in particular of the Groningen field, as well as an increase in domestic demand for gas as function of the expected rise in overall domestic energy demand. The corresponding reduction in gas exports will be less pronounced, in particular as regards L-gas, at least until the end of the next decade, due to long-standing contractual delivery obligations ([188]). It is foreseen that by 2025 the Netherlands will have become a net importer of gas ([189]). While the current gas imports seem rather well diversified, the strong increase in import volumes may change this picture significantly.

The national gas policy has been shaped in anticipation of this significant future change in gas import dependence ([190]). A related challenge arises from the inertia in domestic and foreign demand for Dutch gas. Timely action is important in view of declining public gas revenues, the costs and time-to-build of the necessary infrastructure and the increasing vulnerability to supply shocks due to the diminished buffer function of the Groningen field.

([185]) IEA (2012).
([186]) GasTerra has long-term L-gas export contracts with German, Belgium and French utility companies, and long-term H-gas export contracts with German, French, Swiss, UK and Italian utilities (GasTerra, 2013).
([187]) Out of this, EUR10 bn has come from the proceeds of the Groningen gas field (Netherlands Government, 2014a). The state receives up to 90% of the revenues of the Groningen field and about 65% of those of the smaller fields (see http://www.aardgas-in-nederland.nl).
([188]) See GasTerra (2013).
([189]) The Netherlands Government website (http://www.government.nl/issues/energy/gas) indicates "around 2025," whereas IEA (2012) says this will occur between 2020 and 2025.
([190]) http://www.government.nl/issues/energy/gas

The gas policy has five major elements:

First, domestic gas production from other sources are promoted in order to allow extending the supply from the Groningen field over a longer time. Production from the smaller fields is encouraged, as well as the exploration of new domestic gas sources, conventional as well as unconventional (shale-gas).

Second, there is a move away from long-term export contracts and in some cases also a shift to delivery abroad of H-gas instead of L-gas ([191]).

Third, the inland storage facilities are being expanded in order to improve the ability to respond to demand fluctuations and reduce the dependence on the immediate Groningen gas supply as a buffer.

Fourth, the Netherlands has been investing in gas transport facilities to allow more gas imports. This includes the connection to the Nord Stream pipeline, which connects Russia with Northern Germany through the Baltic, and the fully new elaborate large-scale LNG facilities in the Rotterdam port area ([192]).

Finally, the Netherlands has formulated a strategic ambition to turn from a gas exporter into the major distributor of foreign gas for North-West Europe ("the gas roundabout"). The aim is to exploit the comparative advantage of its geographical location and elaborated gas infrastructure, including the international connections, to become a gas hub. As reported by the national Court of Auditors (Algemene Rekenkamer, 2012, 2014), the State has already invested over EUR 8 bn in the related gas infrastructure (including the LNG terminal).

These strategic policy considerations have however come under some strain due to a combination of unanticipated events. First, the production volumes from the Groningen field have had to be reduced much quicker and sooner than foreseen because of the enhanced risk of damaging earthquakes in the exploitation area. A related issue concerns the compensation provisions for the inhabitants of the area. ([193]) Secondly, the prospects of pipeline imports of Russian gas have become more uncertain. Finally, there is the downward pressure on international gas prices worldwide, rendering investments in the smaller offshore fields less attractive, while simultaneously reducing the inflow of public gas revenues. The reduced buffer capacity of Groningen gas supply puts further pressure on this supply strategy.

8.1.1.2. Oil

Oil and oil products constitute the second largest source of primary energy in Netherlands's energy mix. Over the period 2007-2011, it accounts for 41% of the energy consumption, somewhat above the EU average. While the share for oil and oil products has remained broadly stable over the period considered, it appears to be somewhat higher than in the preceding years.

The large majority of oil (products) is imported, but the provenance is highly diversified and the share of non-EEA imports is close to the EU average. Domestic oil production is small ([194]), well below 3% of import volume of crude oil, and declining over time (IEA, 2012). Crude oil exports are also small in volume.

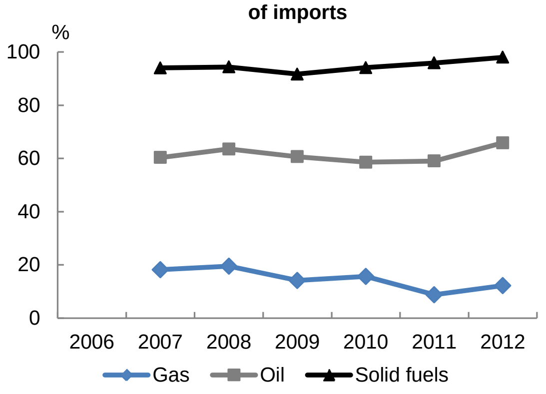
([191]) GasTerra (2013), and ICIS (2013). The announced reduction of L-gas volumes prompts the German TSOs to plan significant investments to switch to H-gas.

([192]) The "Gate" terminal is owned by tank storage service provider Vopak and the state-owned gas transport and infrastructure company GasUnie (for 42.5%). The terminal reportedly was completed in 2012 and can take account of about 20% of current domestic gas demand; while the current capacity rate of the storage tanks is only 10%, the storage is seen by the government and energy companies as a strategic capacity option (NOS Nieuws, 2014).

([193]) Netherlands Government (2014b) reveals a planned reduction of about a quarter of 2013 production level. It amounts a loss in public revenues of EUR 1.3 bn while for the compensation package EUR 1.2 bn has been set aside.

([194]) The shares are based on the IEA (2013) energy balance statistics for the year 2011.

Graph II.8.4: **Netherlands - Non-EEA share of imports**



Source: Eurostat

The Netherlands has five refineries, with four of them located in the Rotterdam port area. The Pernis refinery operated by Shell is the biggest in Europe, while the Europoort refinery operated by BP is only slightly smaller. The refineries process about 95% of all crude oil, with the remainder used as feedstock in the chemical industry.

The Netherlands is a net exporter of oil products, as total refinery output exceeds domestic demand by more than a factor of two. According to EIA (2012), the Netherlands is a key hub in the EU oil transport flows, with oil transit volumes being about four times larger than domestic demand. The available oil storage facilities reflect this status, with the Maasvlakte Oil Terminal among the world's largest oil terminals. The same holds for the port bunker facilities and international pipeline connections for crude oil as well as oil products.

8.1.1.3. Solid fuels

Solid fuels represented 9% of the country's energy mix over the period 2008-2012. The share has been quite stable over the last decade and half. After the exploitation of the Groningen gas field rendered coal production unprofitable, all domestic mines were closed in the 1960s and 1970s. Since then all solid fuels have been imported.

The primary use of coal is for electricity and heat generation, accounting for about two thirds of final solid fuel consumption. The other major use is in the iron and steel industry, with around a quarter of the consumption ([195]).

Despite the closure of the coal mines, coal is not being phased out as an important primary energy source for power production ([196]). Currently, coal-fired power plants provide over one fifth of the power production, a share which has been steadily falling over the last decade (from 27% in 2001 to 19% in 2010), but has since then been rising again. The electricity companies have agreed with the government to close the five oldest plants by 2017 at the latest ([197]). Four new plants will, however, enter into operation in the near future, making up for the loss in capacity.

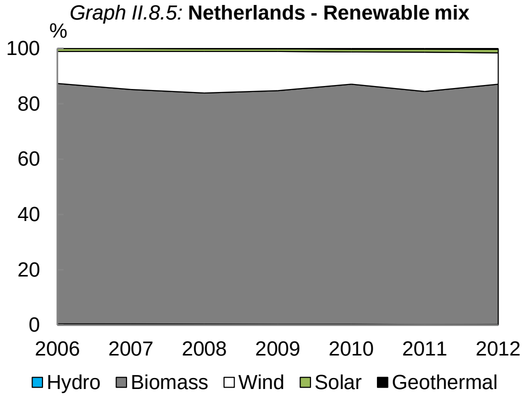
8.1.1.4. Renewables

Renewables only constitute an average of 3.9% of gross inland energy consumption over the period 2008-2012, one of the lowest in the EU. ([198]) In 2012, the country had the third lowest share of renewable energy in the EU-28, namely 4.5% of gross final energy consumption ([199]). The increase over time has also been quite modest.

Biomass accounts for the majority of renewable energy consumption in the Netherlands with a share of 85% of total renewable energy in 2011.Wind power is the second largest source with a share of 14%, whereas solar power and to a lesser extent geothermal heating and hydropower make up the remainder.

([195]) These shares are based on the IEA (2013) energy balance statistics for the year 2011.
([196]) See Netherlands Government (2014a), Annex, point 6. For an overview of the plants to be closed and those being built, see http://www.wijstoppensteenkool.nl/?page_id=4711
([197]) Notably, the competition authority has objected against the closure as it considers it a joint decision from the energy companies to reduce capacity leading to higher prices for Dutch customers with insufficient compensation for them in the form of environmental benefits (see ACM, 2013, and ECN, 2013a).
([198]) The share of renewables in the energy consumption is here defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.
([199]) Eurostat (2014)

Graph II.8.5: **Netherlands - Renewable mix**



Source: Eurostat

The Netherlands has committed to a national target of a renewable energy share in gross final energy consumption of 14% by 2020 (and 16% in 2023). The NREAP([200]) sets the sectoral RES targets on the basis of the overall target for the year 2020, namely 8.7% for RES for heating and cooling; 37% for RES in electricity consumption; and 10.3% for RES in transport. The country has, however, fallen behind the trajectory to achieve this target since the indicative target of 4.7% for the 2011-2012 period has not been met ([201]). The actual gap between planning and realisation is in fact much wider, as the authorities had foreseen a share of 5.6% ([202]) for 2012. The disappointing developments appear to be concentrated in the electricity and heating sector ([203]).

The government attempts to step up the investments in renewable energy through the "Energy Agreement" which it signed in September 2013 with the social partners and the other major energy stakeholders in society ([204]). As regards renewables, this agreement has a strong focus on wind power, in particular on measures to kick-start the expansion of offshore wind power plants and to sustain the ambitious plans to establish large-scale on-shore wind power plants. It also aims to promote biomass co-firing in fossil fuel power plants; decentralised solar power generation; renewable heat and gas are promoted.

The assessment of the agreement shows that the RES targets for 2020 and 2023 can be achieved when the agreed measures are timely implemented and progress is regularly monitored allowing for additional measures.

Like other countries, the Netherlands has a feed-in tariff system for promoting renewable energy. Since 2013, the scheme is financed through a special levy on the energy bills of both households and companies. The commercial sector can also claim a fiscal facility for renewable investments, but this has a fixed overall budget.

8.1.1.5. Nuclear energy

The Netherlands currently has one nuclear power plant located in Borssele, which provides almost 4% of its electricity consumption amounting to around 1 ¼% of its final energy consumption. Its share in electricity consumption seems to follow a slowly declining trend.

Currently, there are no concrete plans to build a new nuclear power plant. Two energy companies decided in 2012 to delay indefinitely their plans to add another nuclear unit at the Borssele site citing economic uncertainty as the main reason ([205]). **The Netherlands government does neither actively promote nor discourage nuclear power**, while stressing that it will not contribute to the financing of new nuclear capacity nor the costs of nuclear waste treatment and the plant's dismantling.

8.1.2. Secondary energy sources

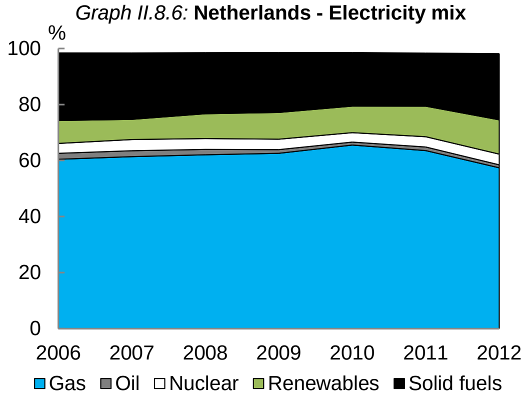
Gas is the dominant primary energy source for domestic electricity production, with an average share of 62% over the period 2008-2012, the highest in the EU. The high reliance on gas explains why the electricity mix tends to be less diversified than in neighbouring countries.

Coal comes second with a 24% share of domestic electricity production and renewables and nuclear as third and fourth with 12% and 4% respectively. The current RES share of renewable electricity seems rather far away from the target for 2020 of 37%. Oil products are used only in CHP plants,

([200]) National Renewable Energy Action Plan (Netherlands government, 2010).
([201]) As set in Directive 2009/28/EC.
([202]) NREAP (Netherlands government, 2010).
([203]) Netherlands government (2013b).
([204]) See Netherlands government (2013b and 2014a (Annex)) and the underlying reports SER(2013) and PBL-ECN (2013).
([205]) Source: http://www.rijksoverheid.nl/onderwerpen/kernenergie.

accounting for 1% of power generation. More generally, power produced in CHP plants account for almost half of domestic electricity generation.

Graph II.8.6: **Netherlands - Electricity mix**



Source: Eurostat

Good electricity interconnections and adequate domestic infrastructure capacity are important to shelter the country from supply shocks and to enable a proper absorption of renewables. A competitive and dynamic electricity market should cater the necessary investment incentives and provide the right price signals to consumers.

The Netherlands is strongly interconnected to neighbouring countries and is a structural net importer of electricity. Over the period 2008-2012, it imported on average 9% of its final electricity consumption reflecting the low import shares in the years 2009-2011. In 2012, the import share shot up to 16%, a value comparable to those of the preceding years. In the 2000-2008 period, the import share varied between 15 and 20%. The electricity market appears well diversified with five large electricity producers which tend to be major retail suppliers as well. There is full ownership unbundling: the fully government-owned TSO TenneT operates on national basis while the DSOs act on a regional basis. The government is the majority shareholder in the latter ones, whereas commercial parties are excluded from taking an equity stake.

The electricity companies report that there is currently a large overcapacity in power production which is likely to persist at least until 2020 ([206]), with a sustained pressure on prices and margins. Both for households and industrial consumers, final electricity prices (including taxes and charges) have fallen significantly relative to the EU average. For households this fall was from price levels in 2008 and 2009 well over 10% higher to just below the average in later years. For industrial consumers, the price fall was from a level in the years 2008 and 2009 just above the EU average to one almost 15% since 2011.

This situation is due partly to weak demand, both domestic and in neighbouring countries. Another factor is the availability of a growing renewable power supply in Germany. The "Energiewende" has resulted in a large supply of renewable-based electricity, which at favourable weather conditions results in an abundant supply at a low cost. The overall result for the Netherlands has been less demand for electricity imports in Germany. These developments, and possibly the falling world market prices on coal, which has reduced the relative advantage of gas-fired power production, have so far thwarted the national ambition to become net power exporter ([207]) which had prompted the surge in capacity investments in the last decade. According to press reports, in 2013 all major electricity companies made substantial losses and significant write-offs on their power plants.

The overcapacity may constitute a barrier for the required expansion of renewable based power production. However, as discussed above the "Energy Agreement" aims to boost wind power and biomass co-fuelling in coal plants. On the positive side, the up-take of solar power has been much higher than anticipated. The Dutch electricity grid is well interconnected with the other networks in the Central Western Europe area, which has led to high market integration as measured, for instance, by a near convergence of wholesale electricity prices. However, from mid-2012, Dutch wholesale prices have not fallen to the same degree as those in Germany. By mid-2013,

([206]) PWC - IPA (2013) estimates that for 2020 a peak demand of 20 GW with available capacity of 55 GW and " residual dependable capacity" of 16.5 GW (i.e. excluding interconnection and wind capacity).
([207]) ECN et al. (2013).

the future price for 2014 were in the Netherlands about 10 EUR/MWh higher than in Germany ([208]).

8.1.3. Conclusions

The Netherlands seems to have a favourable security of energy supply situation in the short to medium term due to the availability of large domestic gas reserves. The vulnerability related to oil imports is also reduced, as the country has exploited its excellent geographical location as a trading hub and has well-developed infrastructure. As a result the origin of the imports is very well diversified.

The Netherlands could, however, improve the diversification of its energy mix. Raising the share of renewables is one possibility. The Energy Agreement takes up this challenge.

The major long-term challenge for the Dutch energy system relates to the gradual reduction of the domestic natural gas production volumes. This will inevitably render the country much more dependent on energy imports. Managing this change is a challenge in view of the "lock in" of domestic sectors to domestic gas and the disappearance of a large public revenue stream.

The strategic aim of transforming the Netherlands from a gas producer towards a major gas distributor for the North-Western Europe seems sensible. Recent events have, however, underlined that such energy strategies unavoidably depend on an uncertain external and economic environment. Moreover, the ambition to turn the Netherlands into a major net exporter of electricity seems also to have backfired, as it has resulted in an overcapacity which depresses prices and profitability. This situation also makes further reforms more difficult.

8.2. ENERGY AND CARBON INTENSITY

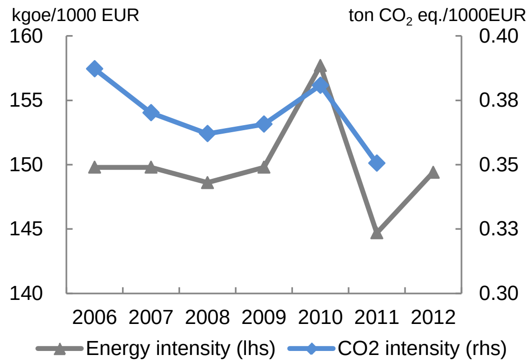
The energy intensity of the Dutch economy is in line with that of the EU average over the period 2008-2012. However, the structural decline in energy intensity over this period is among the lowest in the EU.

([208]) ECN et al. (2013c).

The Netherlands seems to be on track to achieve its energy efficiency targets. As confirmed in the second NEEAP ([209]), the Netherlands has committed to a 2% energy saving by 2010 and to 9% by 2016 as measured against the average energy consumption level over the period 2001-2005. The actual performance in energy savings seems to exceed the targets by a wide margin: the savings achieved by 2010 was 5% while the expected savings by 2016 is 13%.

The EED (Energy Efficiency Directive) ([210]) requires Member States to formulate an indicative energy efficiency target for the year 2020 in terms of cumulative savings over the period 2014-2020 relative to the average energy consumption over the baseline period 2010-2012. Without use of derogations, the target amounts to policy-induced efficiency improvements of 1.5% annually.

Graph II.8.7: **Netherlands - Energy and carbon intensity of the economy**



Source: Eurostat

The Netherlands has chosen an EED target of a cumulative reduction of final energy consumption of 482 PJ ([211]). In effect, it corresponds to a cumulative energy savings target of 31.5% in 2020, or, put it alternatively, an average savings of 1.13% annually up to the year 2020.

Moreover, the Netherlands has opted for achieving the target through the definition of alternative policies, rather than the default option of imposing

([209]) National Energy Efficiency Action Plan (Netherlands Government, 20117), based on the Directive on energy end-use efficiency and energy services 2006/32/EC (ESD).
([210]) According to Article 7 of the Energy Efficiency Directive 2012/27/EU; the default yearly reduction of 1.5% amounts to an overall reduction of 42% over the whole period; the target-reducing provisions are stated in article 7(2) and 7(3).
([211]) And some other adaptations; see ECN (2013b), but with a cap of 25% on the overall reduction effect.

Table II.8.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	149	0.5
CO2 intensity of the economy 2)	0.35	-3.2
Share of energy intensive sectors in Gross Value Added 3)	10.6	-0.5
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

obligations on suppliers. Through the set of existing policies, it expects to achieve savings in the range of 266-410 PJ (on average 336 PJ) ([212]), whereas new measures should bring savings in the range of 87 to 196 (on average 137 PJ) ([213]).

The Energy Agreement contains the new measures. They come on top of the existing policy programme as defined by the 2nd NEEAP and the Dutch Energy Savings Monitoring Protocol ([214]).

The carbon intensity in the Netherlands is about two third of the EU average level over the period 2007-2011. Moreover, the greenhouse gas emission (GHG) reductions seem broadly on track vis-à-vis the national target for 2020.

Under the Kyoto agreement, the Netherlands had committed to reduce its GHG emissions in the 2008-2010 period with 6% compared to base year levels, which is somewhat less than the overall reduction targeted for the EU15 in the same period. The Netherlands has met the target by using Kyoto flexible mechanisms on top of domestic emission reductions ([215]).

In the context of the Effort Sharing Decision, the Netherlands has a legally binding national target to reduce GHG emissions in the sectors not covered by the Emission Trading System (ETS) by 16% as compared to the 2005 level. So far, by 2012, an emission reduction of 9% has been achieved, which goes well beyond the trajectory target for that year. However, the latest emission projections indicate a slight shortfall of one pp in 2020 under existing policies ([216]).

8.2.1. Industry

The average energy intensity of the Dutch manufacturing industry has been slightly above the EU performance in 2008-2012**.** This is explained by the fact that the share of energy intensive industries in GDP is well above the EU average, given the country's locational advantage for refineries and petro-based industries. Whereas the share of energy intensive industries has not changed much over the last decade, the trend in the sector's energy intensity has also followed that of the EU as a whole. This suggests that the energy efficiency improvements and movement away from more energy intensive activities have been undertaken across-the-board throughout the Dutch manufacturing industry.

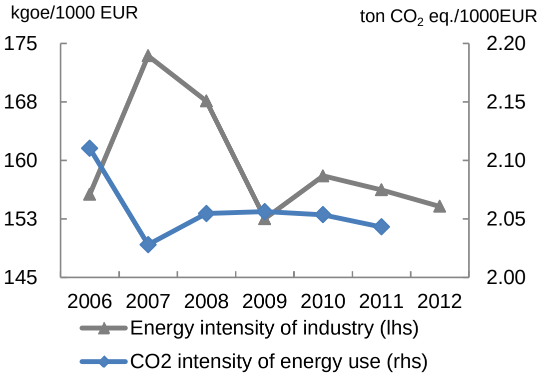
The economic crisis may have had some impact but does not seem to have altered the general picture. While in 2009, value added of manufacturing fell with 7.5% as compared to the previous year, both the sector's energy intensity and share of energy intensive industries fell more

([212]) Note also that the target setting in cumulative terms provides a strong incentive for speedy full compliance to existing policies.
([213]) ECN (2013b).
([214]) This Protocol sets an energy savings target of 2% annually over the period 2010 - 2020, but as explained by ECN (2013b), it is set on a fully different base and hence is not comparable with the Energy Efficiency Directive's target.
([215]) European Commission (2013).
([216]) The extent to which the measures of the Energy Agreement have been taken into account is not fully clear, also because reportedly the concrete content of many of these measures have not yet been fully worked out.

indicating that the crisis were more severe for the energy intensive industry.

Multi-annual Long-Term Agreements (LTAs) with specific manufacturing branches of industry is the approach ([217]) used by the government to promote energy and carbon efficiency improvements in manufacturing industry. The parties to these agreements are the sector organisation, the companies in the sector and the relevant Competent Authority. The LTA basically defines a four-year Energy Efficiency Plan based on a bottom-up selection of cost-effective measures in both production processes and within the supply chain as identified by the participating companies. This is complemented by an annual reporting on implementation progress by the companies to the sector organisation and Competent Authority. Thus the LTA is meant to promote the dissemination of know-how, the capture of spill-overs and a level playing field.

Graph II.8.8: **Netherlands - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

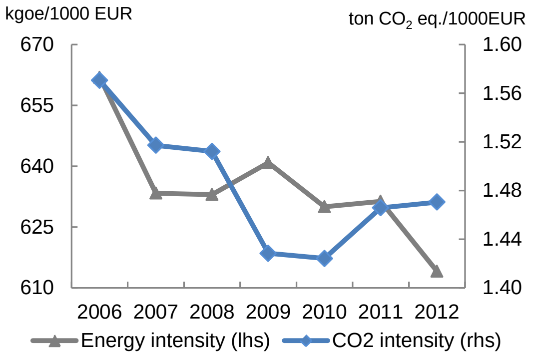
Usually the LTA is combined with supporting measures. These include the Energy Investment Allowance (EIA), a broad tax facility for the purchase of energy-efficient equipment and the more specific tax facilities MIA and VAMIL for the purchase of a prescribed list of environmentally-friendly equipment. These measures are supplemented by an Energy Research Subsidy facility and targeted "Green Deals" programme focussed on specific high-potential efforts from the ground. The latter two facilities are based on a fixed budget and selection of the best proposals. The Energy Agreement adds to this broad package. These measures are not yet fully defined, but combines enhancements of the EIA and LTAs are foreseen, as well as stricter enforcement for SMEs ([218]).

8.2.2. Transport

The energy intensity of the transport sector in the Netherlands has been below the intensity of the EU over the period 2008-2012. It has steadily declined over the last decade in at about the same pace as the change in the EU as a whole over this period.

The carbon intensity of this sector has been among the lowest in the EU. Over the period 2005-2009 it was the lowest in the EU, apart from Malta, Denmark and Sweden.

Graph II.8.9: **Netherlands - Energy and carbon intensity of transport**



Source: Eurostat

The NEEAP ([219]) reports substantial savings through measures in the transport sector, amounting to roughly a quarter of overall realised savings in 2010 and about a fifth of the projected savings in 2016. The measures include an array of tax benefits for fuel efficient cars and electric cars, a differentiation of cars taxation according to weight, and an increase in excise duties.

The Energy Agreement does not contain new measures for the transport sector ([220]). However, any further policy-induced savings in this sector up to 2020 will count against achieving the target.

([217]) Netherlands Government (2011); and ECN (2013b).

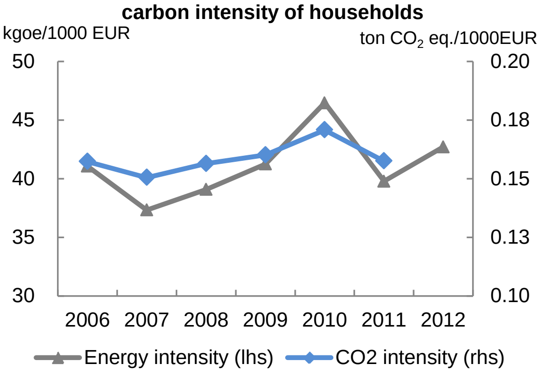
([218]) ECN (2013b); and PBL-ECN (2013).
([219]) Netherlands Government (2011) and ECN (2013b).
([220]) PBL-ECN (2013) and ECN (2013b).

8.2.3. Households

The average energy intensity of households over the period 2008-2012 is slightly below the EU performance and close to that of most neighbouring countries. Member States which have a decidedly lower energy intensity for households are all in the southern part of the EU with the exception of the UK. Whereas the year-by-year variation appears relatively high, over longer periods the Netherlands seems among the worst performers in terms of energy intensity improvements by the households.

The average carbon intensity over the period 2009-2011 is slightly below the EU average. The very high reliance of households on gas for their heating is a major driver of the carbon performance in this sector.

Graph II.8.10: **Netherlands - Energy and carbon intensity of households**



Source: Eurostat

The second NEEAP reports that households should achieve total savings over the period 2008-2020 of about 20% of their energy consumption in 2020 ([221]). The actual savings in the households sector amounted to 30% of total energy savings in 2010; for 2016 it is expected that households account for almost 40% of total savings. About half of the household savings relate to the use of electricity, while the other half are "housing-related" in which heating plays an important part.

It should be recalled that **the energy tax ([222]) provides a strong incentive for households to save energy**. The energy tax is levied on both gas and electricity consumption and households as small-scale consumers face a considerably higher energy tax rate than larger scales users.

However, there are **also positive incentives** such as subsidies, tax credits and discounts on mortgage rates aimed at encouraging energy-saving investments. Other measures relates to large scale use of smart meters, better home insulation and more sustainable heating systems. As regards the latter, it is worth mentioning the strong increase in solar power capacity installed by households to a total of 665 MW in 2013, a doubling as compared to the preceding year ([223]). Private initiative has played an important role here in the form of collective purchase actions and collective operation schemes.

Households are expected to contribute by a third of the total savings to meeting the EED target in 2020. The relevant new measures as agreed in the Energy Agreement include EUR 400 mn subsidies for the landlords in the social rental sector; a commitment of five housing corporations to renovate 111,000 existing homes; stronger enforcement of mandatory energy saving investments in commercial and social real estate ([224]). Smart financing of energy saving investments are also included, e.g. repayment of loans through the energy bill and the establishment of a revolving fund in the owner-occupier and rental sectors.

8.2.4. Conclusions

The Netherlands appear to have performed well as regards energy efficiency improvements and carbon emission reductions. While the country has a carbon intensity well below the EU, its energy intensity is close to the EU performance. The downwards trend in energy intensity is,

([221]) Netherlands Government (2011).
([222]) Netherlands Government (2011). Electricity users pay in the band 0 – 10 Mwh almost three, ten and hundred times as much per kWh than users in the next band of 10-50 MWh; 50-10 000 Mwh, and higher than 10 000 Mwh respectively. For gas consumption the digression in tax rates seems less extreme. The high incidence on small scale users is reportedly compensated by a reduction of wage and income taxes.
([223]) Expert estimate as reported in the press (http://www.nu.nl/economie/3734071/zonnestroom-in-jaar-tijd-bijna-verdubbeld.html)
([224]) The Environmental Management Act requires that the owners in question to carry out energy saving measures that can be earned back in five years.

Table II.8.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-1.8	-2.9	-3.8	-5.3	-4.4
Relative trade balance (%)	-12.5	-14.3	-14.4	-16.6	-14.6
Share of energy in total trade (%)	12.2	14.5	17.4	20.0	19.1
Macro trade openness (% GDP)	117.7	140.2	151.8	161.6	157.6

Source : Eurostat

however, less pronounced than in many other EU countries.

The new energy efficiency measures as agreed with the energy stakeholders under the Energy Agreement are to a large extent not (yet) specified, and hence do not seem to assure that the target will be met. Moreover, measurement of energy savings and target setting are quite different in the Effort Sharing Decision (ESD) and Energy Efficiency Directive (EED). Under the EED, the Netherlands has set a national energy savings target of on average 1.13% annually up to the year 2020.

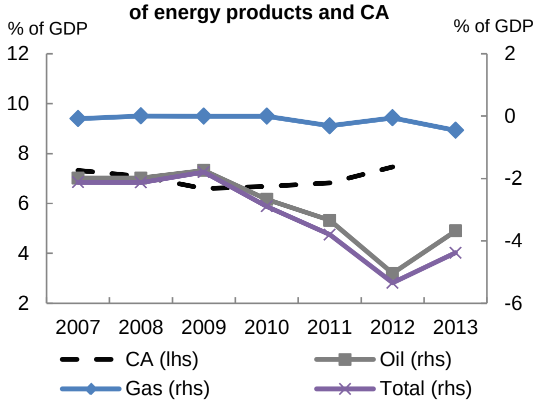
Further energy efficiency improvements seem vital in view of the "lock in" to Groningen gas supply, in particular by the domestic household and commercial sector. It is also a significant contributing factor to carbon emission reductions.

8.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

8.3.1. Net energy trade balance

The Netherlands has an energy trade deficit which is somewhat larger than the EU average. Since 2004, the yearly energy trade deficit has almost always been larger than its EU counterpart, but also more volatile. While in 2009, both deficits were about 2% of GDP, in 2013 the deficit for the Netherlands was about 1.3 pp higher than for the EU (4.4% and 3.1% of GDP respectively); in 2012 1.9 pp higher (5.3% and 3.1% of GDP respectively). The volatility seems to be a consequence of the high shares of oil products and gas in the exports. There appears to be a trend of energy trade deterioration as the trade deficits for the Netherlands have steadily grown larger at a somewhat larger extent than for the whole EU.

Graph II.8.11: **Netherlands - Trade balance of energy products and CA**



Source: Eurostat

The overall energy trade deficit almost completely coincides with the trade deficit for oil products, as the trade in gas appears nearly in balance for the period 2009-2013. For oil, the trade deficit has been sharply increasing, from 1.7% of GDP in 2009 to 5 and 3.7% of GDP in 2012 and 2013 respectively. It is actually one of the largest deteriorations of the oil trade deficit in the EU over this period. The underlying causes are not fully clear.

For gas, a small trade deficit in monetary terms is reported (225)**. This deficit contrasts with the large surplus in caloric terms** (where exports are at least twice as large as imports (226)). For solid fuels and electricity the trade balance figures have

(225) It concerns the gas trade reported as non-confidential and disseminated publicly. According to national statistics (published by Statistics Netherlands) the Netherlands have a substantial gas surplus in monetary terms of roughly EUR 5.4 bn in the year 2005 (the last annual value available).
(226) The trade data in caloric terms are from IEA (2013) energy balance statistics for the years 2010, 2011 and 2012.

to be of the same order of magnitude as for gas ([227]).

The size of the energy trade balance should be seen against the background of the country's persistent large current account surplus. Taken over the whole period 2008-2012, the current account surplus was the largest in the EU (amounting to 10% in 2011 and 2012). As evident from the years before 2008, the current account surplus is a persistent feature of the economy. The expected increase in the energy trade deficit due to the reduction of domestic gas production will contribute to reduce this large overall trade surplus.

8.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade and the macro openness to trade (i.e. the ratio of total trade to GDP).

Due to domestic natural gas production, the Netherlands has **one of the smallest relative energy trade deficits in 2012**. While quite variable over time in the years preceding the period under consideration, the Dutch relative energy trade deficit has been consistently well below the EU average. The volatility is due to the large quantities of imported oil and petroleum products which are exported after refinery and other processing, and to an increasing extent to the rise in gas imports.

The pivotal role of the Netherlands in energy trade in Europe is also expressed in the share of energy in total trade. This position is remarkable as the Netherlands is in general geared to international trade in goods and services over a broad range. This is in contrast with the five EU countries with the highest shares of energy in total trade which all have lower macro trade openness.

([227]) For the Netherlands, the electricity trade balance statistics are not available. However, as discussed in section 1.2, the Netherlands is a structural net importer of electricity. As wholesale prices in North-West Europe are converging, there cannot be a big countervailing price effect.

8.3.3. Conclusions

Judged against the persistent large current surplus, the energy trade deficit does not pose a significant challenge. The overall energy trade deficit almost completely coincides with the trade deficit for oil products. Further reduction of the gas exports in the decades to come will most likely increase the energy trade deficit, which can contribute to reduce the very large overall trade surplus.

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9. SWEDEN

Key Insights

Security of Energy Supply

- Sweden's dependence on imported energy sources is low (imports cover 36% of total country's energy needs) with an energy mix relying mainly on oil, renewables and nuclear energy. Sweden relies on imported oil, but the countries of origin of this import are, however, relatively well diversified.

- The political ambition to further increase the use of renewable energy could further reduce import dependence, but could also to some extent result in increased import of biomass and biofuels.

- Another issue related to the energy supply is uncertainty regarding the future nuclear policy in view of the forthcoming needs to replace ageing capacity, as the Swedish nuclear policy has shifted over time.

Energy and Carbon Intensity

- Sweden's overall energy intensity is slightly above the EU average, mainly due to its geographical location and a relatively energy intensive industrial structure. The country has implemented a comprehensive policy to improve energy efficiency, but there is scope to continue this work.

- Sweden's carbon intensity is currently about a third of the EU average level, and Sweden is expected to fulfil its 2020 with the existing measures. However, Sweden has committed to go further than this and has already set long term priorities for the climate and energy policy.

Trade balance for energy products

- Sweden's energy trade deficit indicates a low vulnerability to energy supply shocks as it is among the lowest in the EU. It should be seen against the background of its current account surplus, in combination with a low relative energy trade balance.

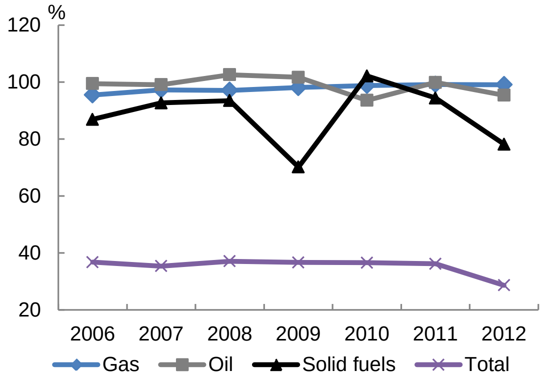
- The slightly deteriorating energy trade deficit as well as the growing share of energy products in overall trade point towards the fact that the vulnerability in terms of energy trade exposure appears to be growing.

9.1. SECURITY OF ENERGY SUPPLY

Sweden imported 35% of its total primary energy sources from abroad in 2008-2012. Sweden's import dependence was considerably below the EU average, which amounted to 54% in that period. Sweden's domestic energy production comes from nuclear and hydro power generation, and a substantial use of biomass as well as some other renewable energy sources. The country has no own production of fossil fuels.

The country's energy mix is slightly less diversified than the EU average, due to low shares of solid fuels and gas. Hence, the use is relatively evenly shared between oil, renewables and nuclear.

Graph II.9.1: **Sweden - Import dependence**



Source: Eurostat

9.1.1. Primary Energy Sources

9.1.1.1. Renewable

Renewable energy accounted on average for 34% of Sweden's energy mix in 2008-2012,

which was of the highest share among the EU Member States. ([228])

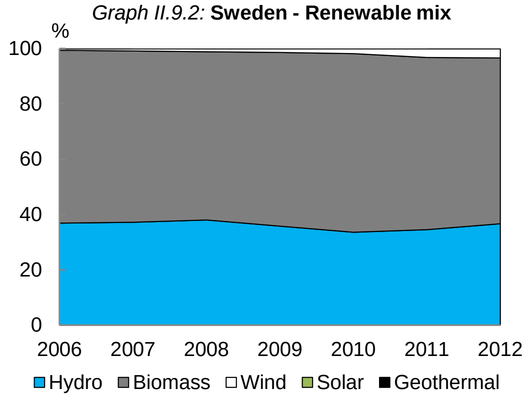
Sweden has a binding target as introduced by Directive 2009/28/EC to increase the share of renewable energy to 49% of gross final energy consumption. With a share of 49% in 2011 and 51% in 2012, Sweden has already achieved its target for 2020 ([229]). Sweden has committed to reach a renewable share of 50% of gross final energy consumption by 2020. In 2011, the sources of renewable energy were 36% hydro power, 60% biomass, and 3% wind energy.

The share of electricity generated from renewable sources has increased from 52% in 2006 to 59% in 2012. ([230]) Hydro power accounted for 48% of generation and wind for 4%. The rest would be from co-generation and industrial condensing power ([231]).

The share of renewables in heating and cooling in Sweden is the highest in the EU. It amounts to 64.5% in 2011, 49 pp above the EU average. In transport, the share of renewables amounted to 8.8% in 2011, more than the double of the EU average of 3.8% ([232]) In Sweden, there is an import of biofuels and biomass. Depending of the type of biofuel, the share of import can be high. The biodiesel (FAME and HVO) ([233]) are mainly imported, while import accounts for two thirds of the ethanol used in Sweden. For wood pellets, which are used for residential heating, the net import corresponds to 20% of demand ([234]).

The main instrument to support renewable electricity is a quota obligation system with tradable green certificates introduced in 2003. Power retailers and some other user categories are obliged to purchase certificates from generators or on the market (Nordpool) in proportion to their sales or use. Since 1 January, 2012, Sweden and Norway have a common market for green certificates. It has been agreed to increase production of renewable electricity by 26.4 TWh for the 2012-2020 period. There will be a review of the functioning of the system before the end of 2015.

Graph II.9.2: **Sweden - Renewable mix**



Source: Eurostat

The main instrument to promote renewables in the transport sector has been a tax exemption of the use of biodiesel and bioethanol. However, this is planned to be replaced by an obligation to blend a specified share of biofuels into diesel and petrol. The introduction is currently pending the approval according to the state aid rules of the Commission. The high share of renewable energy in heating and cooling can mainly be attributed to the relatively high energy and carbon taxes in this sector.

9.1.1.2. Nuclear

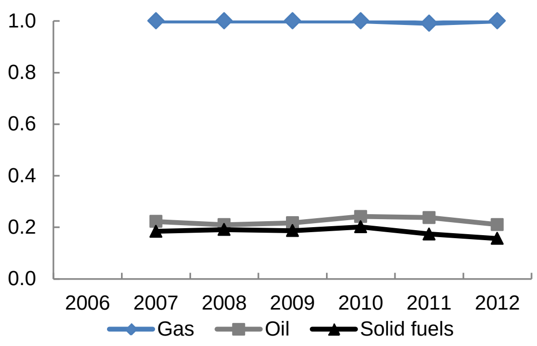
Nuclear is the second largest source of energy used in Sweden, accounting for 31% of gross energy consumption, which is the second highest share among Member States. Nuclear provided on average 38% of Sweden's electricity generation in 2012 period, but the share has varied between 39% and 47% during the 2006 to 2012 period. This is due both to variation in the production of hydro power and the operative availability of the nuclear reactors. Sweden has currently ten operating nuclear units in three sites (Oskarshamn, Ringhals, and Forsmark). The three incumbents, Vattenfall, Fortum and E.ON, have joint ownership of the nuclear power plants, which raises concerns in terms of information sharing and the competition

([228]) The share of renewables is here defined as the share of renewable energy in gross inland energy consumption. In contrast, the EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.
([229]) Eurostat (2014.)
([230]) Eurostat
([231]) Swedish Energy Agency (2013).
([232]) European Commission (2013a).
([233]) FAME- Fatty Acid Methyl Ester; HVO - Hydrotreated Vegetable oil.
([234]) Swedish Energy Agency (2013).

on the electricity market. ([235]) The Energy Market Inspectorate has implemented transparency measures to try to address this issue, including e.g. ethical rules for the owners and independent observers on the boards. ([236])

The nuclear units in operation were built in the 1972 to 1985 period. The nuclear policy in Sweden has shifted considerably over time. In 1980, the government decided, after a referendum, to phase out the nuclear power plants after a normal expected operating life of 25 year. In 1997, it was decided to close the two reactors at the Barsebäck site close to Copenhagen, but to allow the remaining ten reactors to operate longer than envisaged. Finally, the policy of a phase out was repealed in 2010, but on the condition that new reactors can only be built at the current sites to replace existing reactors.

Graph II.9.3: **Sweden - HHI index energy imports**



Source: Eurostat

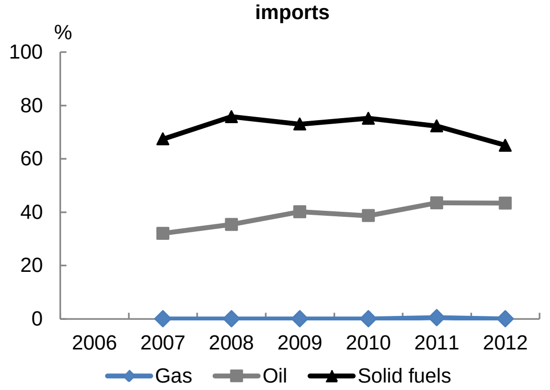
Substantial upgrades of the capacity and extension of the life time of the nuclear plants have been on-going since the first decade of the 21st century, partly as an effort to compensate for the two closed plants. In the beginning of 2014, Vattenfall also started public consultation regarding a possible new nuclear plant at the Ringhals site, where the two oldest units are expected to close by mid-2020. ([237])

([235]) European Commission (2013b).
([236]) Swedish Energy Markets Inspectorate (2012).
([237]) World Nuclear Association, Nuclear Power in Sweden, www.world-nuclear.org

9.1.1.3. Oil

Oil is the third largest energy source used in Sweden. It accounted for 27% of gross inland energy consumption in 2008-2012, 8 pp below the EU average. There is no domestic oil production in Sweden. The country's crude oil imports are rather well diversified. The most important suppliers in 2012 were Russia (42%), Norway (25%), Denmark (15%), Nigeria (6%) and the UK (5%).

Graph II.9.4: **Sweden - Non-EEA share of imports**



Source: Eurostat

Sweden has five oil refineries with a distillation capacity around 30 million ton crude oil per year. The major refineries are located on the west coast, close to Gothenburg. Crude oil is thus delivered by ship. Sweden is a net exporter of processed petroleum products, and the main trading partners are Norway, Denmark and the UK.

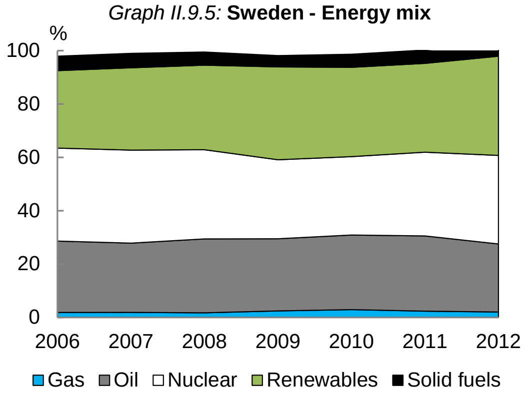
9.1.1.4. Solid fuels

The fourth energy source in Sweden is solid fuels. In contrast to the other sources of energy, solid fuels only account for 5% of the country's energy mix in 2008-2012, much below the EU average of 17%. The share of coal in the energy has been rather stable, but a slowly decreasing trend can be observed since 2007.

Sweden has no indigenous coal resources, and thus all solid fossil fuels are imported. Sweden's coal imports are well diversified. In 2012, 25% of solid fuels were sourced from the Australia, 19% from the United States, 18% from Russia, followed by 11% from Latvia and 8% from Poland.

In Sweden, coal is now mainly used in the industry, which account for 72% of the domestic use. Combined heat and power production account for the reminder. The energy tax system, including carbon taxation, has provided a strong incentive to switch to biomass and waste in the energy sector since the early 1990's. As a result, the use of coal in this sector has decreased by 39% compared to 1990.

Graph II.9.5: **Sweden - Energy mix**



Source: Eurostat

9.1.1.5. Gas

The least used source of energy in Sweden is gas. It accounted for 2% of gross inland energy consumption in 2008-2012, which is considerably below the EU average of 24%. Sweden has the lowest share of gas use in the EU, with the exception of the two islands without gas networks (Malta and Cyprus). Sweden imports all the used gas as there is no domestic gas production.

All natural gas supplies enter the Swedish system via one single interconnector from Denmark. As a result, Sweden relies fully on Denmark for its supply of gas in terms of gas import, even if a large share of this gas is sourced from Germany and transited through Denmark by E.ON. The level of diversification of gas imports by country of origin, measured by HHI index, belongs thereby to the lowest among Member States. As Denmark is part of EEA, the share of EEA countries in gas imports to Sweden is 100%.

The only gas interconnector makes the system vulnerable to interruptions. Sweden is currently exempted from the N-1 regulation (Regulation 994/2010) to safeguard the security of gas supply. There are currently no significant storage facilities, and Sweden has to rely on Denmark to balance seasonal swings in demand. A new LNG terminal is currently being constructed in the Port of Gothenburg to increase security of supply, but it will also add flexibility to the market. The first construction phase is intended to primarily supply the transport sector with LNG, while in time the terminal will also be connected to the grid ([238]).

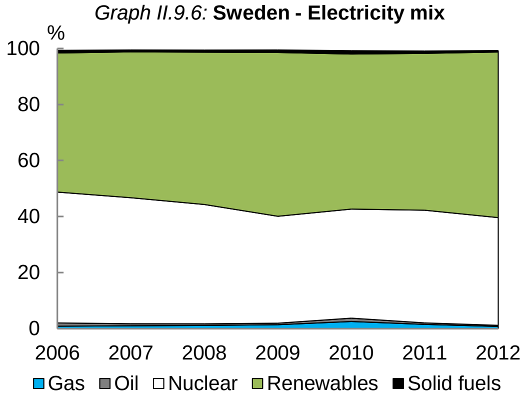
The Swedish network operates as a distribution system for gas consumers. At a wholesale level, two major suppliers operate on the market, i.e. E.ON Sverige and Dong. The Swedish entry point is located in Denmark, where shippers gain access to capacity according to EU rules on capacity allocation. Thus, to gain access transmission capacity has to be acquired on the Danish interconnector. There is currently no congestion on the grid, nationally or on the import link from Denmark. At retail level, the three biggest suppliers (E.ON, Dong Energy and Göteborg Energi) cover around 90% of the market ([239]). Final gas prices, including taxes and levies, are among the highest in the EU both in nominal terms and when adjusted for purchasing power. Prices before taxes are also high.

9.1.2. Secondary Energy Sources

Sweden's net trade position in electricity varies and depends on the hydrological situation as well as the operational capacity of the nuclear plants. In the 2006-2012, Sweden was a net exporter in three years of this seven-year period. In 2012, the export represented close to 14% of consumption while other years exhibit a share of around 5%. The greatest import share was around 4%. The Swedish system is often acting as a net exporter to Poland and Denmark, while it is a net importer from Norway. However, the situation fluctuates over the years.

([238]) Swedgas (TSO), www.swedgas.com
([239]) European Commission (2012).

Graph II.9.6: **Sweden - Electricity mix**



Source: Eurostat

Sweden's electricity mix in 2012 was dominated by renewable power (with 59% share) and nuclear (38%). The role of gas, oil and solid fuels in power production is marginal (1%). The share of renewable power is growing as Sweden aims to increase the use of co-generation, wind and other renewable production to reduce vulnerability and increase security of supply in the long-term. The large degree of hydro power in the system also results in a high degree of variability, e.g. hydro power accounted for 42% of domestic consumption in 2006 versus a 59% in 2012.

Good electricity interconnections and adequate domestic transmission capacity are important to ensure a good balance in the system in view of the variable production as well as to enable further integration of renewable power. A well-functioning electricity market should provide competitive prices and proper incentives for necessary investments. Svenska Kraftnät is the TSO, which is fully owned by the Swedish government. It has been certified as unbundled. The 170 district system operators are considered functionally unbundled.

The Swedish wholesale market is well connected and integrated with the other Nordic markets. A share of 91% of the Swedish electricity production is traded on the NordPool Spot. The corresponding share of the Nordic electricity production amounts to 77%. 358 actors are active on the spot market, while the balancing market has 121 traders. Further investments are on-going to enhance the interconnecting capacity. NordBalt will connect Sweden and Lithuania, and is estimated to be operational in 2015/2016. Investment in Sydvästlänken is also on-going to address congestion in the grid between the south and central parts of Sweden, and is expected to be completed in 2015/2016 ([240]). The Swedish electricity market is divided into four price zones since 2011. The aim was to improve the management of congestions within the Swedish network by improving incentives for additional investments in internal connection capacity and better location of new generation capacity. The Nordic market is coupled to the continental markets. Moreover, since February 2014 a pilot project is on-going to extend the market and couple 14 markets in North West Europe.

The Swedish wholesale market is dominated by three companies, i.e. Vattenfall (44%), Fortum (18%) and E.ON (17%). Thus, they control jointly 80% of the electricity production. As nearly the whole wholesale production is traded on the well-integrated Nordic spot market (see above), this high degree of market concentration is not regarded as major competition issue.

In the end of 2012, there were 121 electricity retailers of which 97 served the whole country. However, more than half of them are part of business groups and as a result, the same three incumbents control around half of the retail market. The rate of switching was around 10% both in 2011 and 2012. Moreover, 37% of household customers were active on the market in 2012. Most of them re-negotiated their contract with the current retailer ([241]).

Electricity retail prices for domestic consumers are close to the EU average before taxation, but once taxes and levies are included they are above average. Taking into account differences in purchasing power, prices are on the other hand lower than the EU average. Prices for industrial consumers are, in contrast, both lower before and after taxes and levies, as well as after adjusting for purchasing powers.

9.1.3. Conclusions

Sweden's has a rather low dependence on imported energy sources (imports cover 35% of total country's energy needs versus an EU average of 54%) due to the country's energy mix relying

([240]) Swedish Energy Markets Inspectorate (2012)
([241]) Ibid.

mainly on oil, renewables and nuclear energy. The oil is imported, but the import sources are relatively well diversified. The political ambition to increase the share of renewable energy could further decrease the import dependence, but might also result in increased import of biomass and biofuels. Another uncertainty is the future policy concerning new nuclear capacity replacing ageing capacity, as the nuclear policy has shifted in the past.

9.2. ENERGY AND CARBON INTENSITY

Sweden's energy intensity is slightly above the EU average, which implies that it is relatively high compared to many "old" Member-States (EU-15). Energy intensity has declined steadily between 2000 and 2009, it increased in 2010 as the economy picked up after the downturn, but has since then decline again in 2011 and 2012 and is now at an all-time low. Over the period 2001-2012, energy intensity of the economy fell by 23%.

The energy savings targets notified by Sweden in the context of the second National Energy Efficiency Action Plan amounts to 9% (33.2 TWh) energy savings by 2016 as compared to the average final energy consumption in the 2001-2005 period. An interim target of 6.5% (24 Twh) is set for 2010. The provided projections indicated that these savings should be reached with a margin ([242]).

In addition, Sweden has set and notified to the European Commission an **indicative energy efficiency target of 20% more efficient energy use and a 20% reduction in the energy intensity by 2020 compared to 2008.** This means energy savings equal to 106 TWh. According to Sweden's notification ([243]), energy savings are expected to be achieved by a range of measures including e.g. energy taxation, municipal energy and climate advice, regional climate and energy strategies, energy audit checks, programme for energy efficiency in electricity intensive industry, technology procurement, and information initiatives.

Sweden's carbon intensity (greenhouse gas emissions per tonne of oil equivalent) **is the lowest in the EU, and amounts to about 40% of the EU average.** Moreover, the carbon intensity of the economy has fallen by nearly 7% over the 2008-2012 period.

In 2010, CO2 was the main source of greenhouse gas (GHG) emissions representing around 80% of total emissions, excluding LULUCF and international bunkers. The transport sector accounted for close to a third of emissions (31%), followed by energy use (22%) and energy production (21%).

Under the Kyoto protocol, Sweden was allowed to increase GHG emissions to an average of 4% for the 2008-2012 period, above the level recorded in 1990. Sweden also has a national target of decreasing GHG emissions to an average of minus 4% for the 2008-2012 period. According to the European Environmental Agency, Sweden is likely to achieve its targets. The average GHG emissions were 13% below the 1990 level in 2008-2012, which correspond to an overachievement of 16% in relation to the Kyoto target. ([244])

According to the EU effort sharing agreement, Sweden has a legally binding obligation to reduce GHG emissions not covered by the Emission Trading System (ETS) by 17%, with 2005 as a base year. The latest assessment indicates that Sweden is on track to fulfil its target with the existing measures. The emissions were approximated to be 13% below the 2005 level in 2012. ([245]) Sweden also has a national target for 2020 of decreasing emissions by 40 % in the non-ETS sector compared to 1990. The reduction should be achieved through domestic action, investments in other EU countries or through flexible mechanisms, such as CDM.

([242]) Sveriges andra nationella handlingsplan för energieffektivisering, 30 juni 2011.
([243]) Ministry of Enterprise, Energy and Communications, Plan for implementation of Article 7 of the Energy and Efficiency Directive, N2013/5035E (partial).
([244]) European Environment Agency (2012).
([245]) European Commission (2014).

Table II.9.1:
Energy and carbon intensity

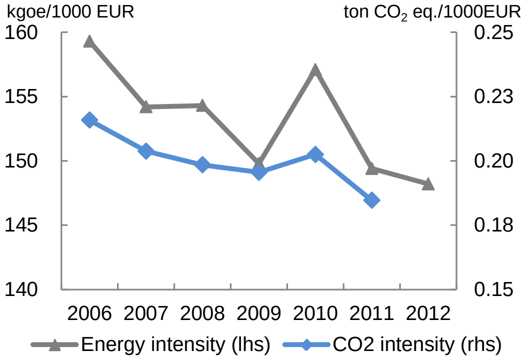
	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	148	-4.0
CO2 intensity of the economy 2)	0.18	-7.0
Share of energy intensive sectors in Gross Value Added 3)		
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

The share of GHG emissions falling under the ETS was equal to 31% in 2012. In 2012, the annual allowances covered 82% of the verified ETS emissions, which equivalent to the level recorded in 2011. During the third phase of the ETS-scheme, starting in 2013, allowances will be auctioned, while previously they were allocated for free. This will tend to increase energy costs of companies, which are likely to pass them on to consumers. Special provisions, with free allocation based on technology benchmarking, are in place for energy intensive and trade exposed industries.

Sweden has slightly higher share of **environmental taxation** amounting to 2.5% of GDP than the EU-average of 2.4% in 2011. Most of this revenue comes from the energy taxation (2.0% of GDP), while the taxes on transport excl. fuel (0.4% of GDP) play a more minor role. The tax rates on energy products remain comparably high in relation to the average level in the EU, and the taxes are regarded as an important element in the energy efficiency policy. In particular, fuels used for heating is taxed heavily in Sweden compared to other Member States. The energy tax system is differentiated, and tends to tax industry, and in particular energy intensive sectors, exposed to competition less than e.g. households and service sectors.

Graph II.9.7: **Sweden - Energy and carbon intensity of the economy**



Source: Eurostat

Reforms were initiated in 2011 to streamline the energy tax system, and to align it better to the 2020 climate and energy policy objectives. The structure of the rates has reviewed and rates increased. Various reduced tax rates have been increased or phased out, e.g. for greenhouses and sectors outside the ETS. The policy aims at using the CO2-tax to ensure that the policy objectives will be achieved, which will result in future revisions of the tax rate. An assessment of the reforms is scheduled for 2015 ([246]).

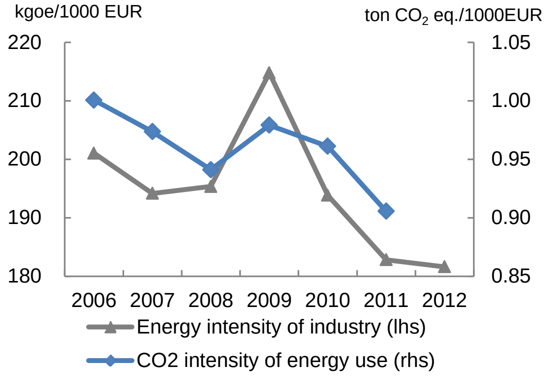
9.2.1. Industry

The energy intensity of Swedish industry is 34% above the EU average, and it ranks 14th in the EU-28. The energy intensity in this sector has improved by 6% in the 2008 and 2012 period.

([246]) Prop. 2009/10:41

The relatively high energy intensity of the industry may be explained by a relatively large manufacturing and energy intensive industrial sector. Of the energy intensive sectors, chemical and non-metallic mineral sectors perform well in terms of energy intensity vis-à-vis the European average according to data from 2009. The mining and quarrying, the iron and steel and the pulp and paper sector are, in contrast, more energy intensive than the average. ([247])

Graph II.9.8: **Sweden - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

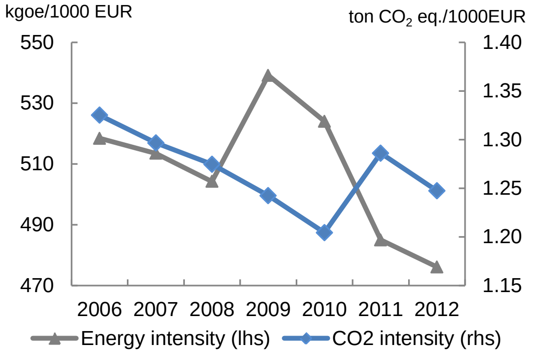
Efforts to improve the energy efficiency of the energy intensive industry rely mainly on the Programme for Energy Efficiency in Energy Intensive Industry (PFE). Companies are exempted from the EU minimum tax on electricity, and will in return commit to an energy management system, energy audits, and other measures to increase efficiency. In the period 2009-2014, the programme is estimated to save 1.45 TWh. The PFE programme expired in 2013, and the last participants will exit the programme in 2017.

Other measures in the industry sector include energy audit support schemes for SMEs. National networks have also been created to enhance energy efficiency for both SMEs and energy intensive industries, while network has been created at regional and local level to cover all enterprises ([248]).

9.2.2. Transport

The energy intensity of the transport sector is 31% below the EU average, the 3rd lowest in the EU. It has also fallen by 9% in the 2008-20012 period. **The carbon intensity of transport in Sweden is also low.** One of the reasons for this is relatively advantageous modal split in freight; road accounted in 2011 for 62% of total inland tonne-km, against 76% on average in the EU, while rail accounted for 38% versus an average of 17%. The modal share of cars for passenger transport is, in contrast, in line with the European average of 83%.

Graph II.9.9: **Sweden - Energy and carbon intensity of transport**



Source: Eurostat

Sweden has set a target to achieve a carbon independent vehicle stock by 2030. Since 2009, tax breaks are provided to environmentally friendly vehicles during the first five years. An additional tax rebate was introduced in 2012 to super environmentally friendly cars that emit less than 50 mg CO2 per km or less. The ambition to achieve a carbon free transport sector by 2030 will require further measures in this area. Efforts to shift freight from road to rail have been made, but the additional potential is limited. Public transport is supported, as well as infrastructure for bicycling ([249]).

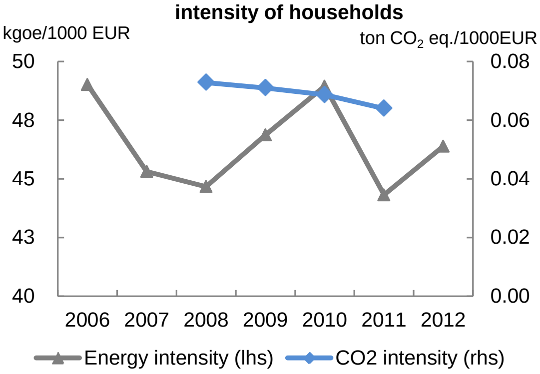
9.2.3. Households

Swedish households' energy intensity is only slightly above the EU average, despite its geographical location with adverse climate conditions. The energy intensity in Sweden was about a fourth lower than in Finland, and only slightly higher than in Denmark in the 2008-2012

([247]) European Commission (2013). .
([248]) International Energy Agency (2013)
([249]) Ibid.

period. Energy efficiency improvement has also reduced the energy intensity in households to some extent, as it fell by 2% in the 2008-2012 period.

Graph II.9.10: **Sweden - Energy and carbon intensity of households**



Source: Eurostat

Due to the low rate of new construction, the energy efficiency efforts for building will have to mainly rely on renovation efforts. In addition to the energy taxation of heating fuels and electricity, Sweden promotes awareness of energy efficiency in the building sector. In line with the EU Directive on the Energy Performance of Buildings, energy performance certificate is required when buildings are sold, rented or constructed. Energy performance requirements are in place in the building code for new and renovated residential, commercial and public buildings. In terms of appliances, the EU regulations are implemented and additional measures aim at creating awareness, provide advice and conduct market surveillance ([250]).

9.2.4. Conclusions

Sweden's overall energy intensity is only slightly above the EU average despite its geographical location. The energy intensity for the industrial sector is above average pointing at a relatively energy intensive industrial structure. The energy intensity of the household sector is slightly above the EU average, while the intensity in the transport sector is well below. Sweden has worked actively with energy efficiency policy since the 1970's. IEA assesses the Swedish performance as overall exemplary, but improvements can be made by evaluating results and synergies in order to scale up activities according to their potential in a cost-efficient manner.

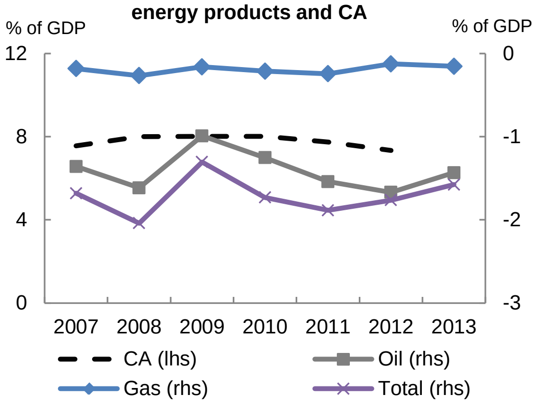
Sweden's carbon intensity is only a third of the EU average, which can be explained by low carbon intensity in both the energy and transport sectors as well as in the households' energy use. Sweden is also on track to meet their greenhouse emission target according to the effort sharing decision and has already committed to ambitious polices for the period beyond 2020.

9.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

9.3.1. Net energy trade balance

Sweden had an average energy trade deficit of 1.7% of GDP in 2009-2013. This was the second lowest deficit after the UK, apart from Denmark which is a net exporter. Between 2007 and 2009, it actually deteriorated from 1.3% to 1.9% of GDP, before improving to 1.6% of GDP in 2013.

Graph II.9.11: **Sweden - Trade balance of energy products and CA**



Source: Eurostat

The deficit can mainly be attributed to the trade in oil and petroleum products with 1.4% and in natural gas with 0.2% of GDP in 2009-2013.

The size of Sweden's energy trade deficit should be seen against the background of its current account balance, which is in surplus averaging 7.3% of GDP during the same period. Hence, the net energy trade balance does not constitute a major concern for the Swedish economy.

([250]) Ibid.

Table II.9.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-1.3	-1.7	-1.9	-1.8	-1.6
Relative trade balance (%)	-23.8	-25.3	-25.3	-21.0	-23.7
Share of energy in total trade (%)	8.9	10.3	11.0	13.0	11.3
Macro trade openness (% GDP)	61.4	66.3	67.8	64.3	58.7

Source : Eurostat

9.3.2. Decomposition of the net energy trade

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade and the macro openness to trade (i.e. the ratio of total trade to GDP).

Sweden has currently a rather low share of energy trade in total trade in relation to other Member States of the EU. The country increased its energy trade deficit slightly between 2009 and 2011, before deteriorating slightly in 2013. This is consistent with the fact that the share of energy in total trade increased during the same period and amounted to 12% in 2012, before falling back to 11% in 2013. However, over the same period Sweden also reduced it macro openness to trade, as the ratio of total trade to GDP fell.

Sweden's relative trade deficit for energy products decreased from 30.7% in 2007 to 23.7% in 2013, but this development appears rather volatile.

9.3.3. Conclusions

Sweden's energy trade deficit indicates low vulnerability concerns as it is among the lowest in the EU. It should be seen against the background of its current account surplus, in combination with a low relative energy trade balance. The low energy trade deficit and that fact that the share of energy products in trade is quite low suggests that the impacts of energy price shocks on the economy may be rather limited.

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10. THE UNITED KINGDOM

Key Insights

Security of Energy Supply

- The UK overall import dependence is low; therefore the vulnerability of the country to external energy supply disruption appears limited. Its increasing trend poses nonetheless some challenges for the future. The development of domestic sources such as renewables, still limited, is growing while the prospects for shale gas extractions appear promising, but are still at an initial stage.

- The growing share of coal in the energy and electricity mix might undermine the achievement of climate targets. Renewed efforts to improve electricity generation capacity and interconnections will therefore be essential to enable a transition to low carbon energy sources.

Energy and Carbon Intensity

- The UK displays some of the lowest levels of energy and carbon intensities across all economic sectors. The only exception is the carbon intensity of the energy sector, where a low uptake of renewables and an increasing share of coal are undermining the performances of the sector.

- A particular challenge appears to be the growing importance of energy items in the consumers' basket. This will require maintaining a balanced and cost-effective approach to the transition to a low carbon economy.

Trade balance for energy products

- The overall energy trade deficit is among the smallest in the EU, mainly due to comparatively small relative energy trade deficit and macro trade openness.

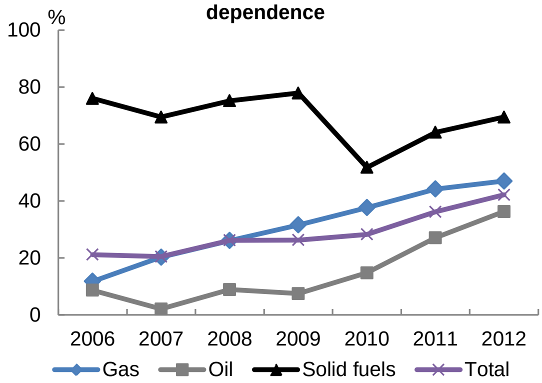
- The UK displays, however, a clearly deteriorating pattern across all the energy-related trade dimensions. A close monitoring of the future evolution is therefore warranted, especially in light of the persistently negative current account balance.

10.1. SECURITY OF ENERGY SUPPLY

The UK's import dependence has been far below the EU-28 average over the period 2008-2012. It increased over the period, from 26% in 2008 to 42% in 2012, whereas the EU average decreased marginally.

At the same time the country's energy mix is not particularly diversified, relying largely on oil and gas. However a certain increase in diversification can be observed between 2008 and 2012 mainly due to the increased share of renewables and solid fuels.

Graph II.10.1: **United Kingdom - Import dependence**



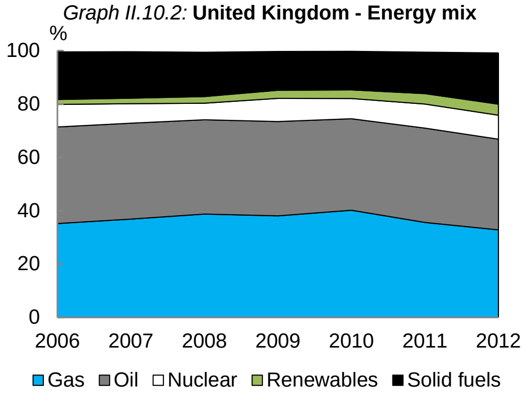
Source: Eurostat

10.1.1. Primary Energy Sources

10.1.1.1. Gas

Gas is the largest source of primary energy in the UK, accounting for around 33% of the UK's primary energy supply in 2012 (compared to 39% in 2008). This represents one of the highest shares of gas in a Member State's energy mix in the EU.

Graph II.10.2: **United Kingdom - Energy mix**



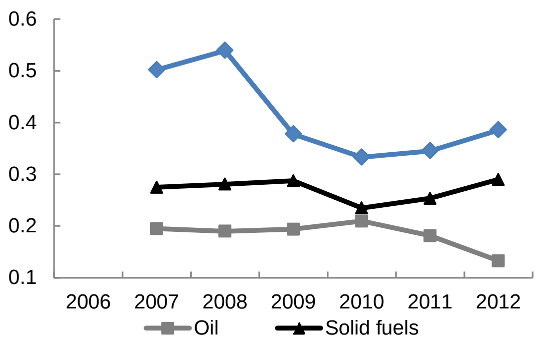
Source: Eurostat

The UK imported around 47% of its gas consumption in 2012, which rose dramatically from around 26% in 2008. Although it is still 29% below the EU average, the figure is projected to keep rising as domestic production from the UK Continental Shelf (UKCS) continues its rapid decline ([251]). Despite its rising import dependence, significant interconnections and import infrastructure have meant the UK enjoys a relatively diversified import source mix, with the largest supplies sourced via the Langeled pipeline from Norway and LNG from Qatar. The interconnection with the Netherlands has also proven significant, with increasing quantities expected to come via this route up to and in the early 2020s.

Despite the UK's rising reliance on imported gas, the government is taking various measures to revive extraction and production of indigenous gas supplies. Targeted tax allowances for North Sea drilling companies have increased investment in further field developments in the UKCS to a projected GBP 14 billion this year. The Energy Minister has also undertaken an independent review into the North Sea oil and gas industry to identify ways to boost extraction and production rates in the North Sea, and it presented its findings in February 2014 (see also the next section on oil). ([252])

Moreover, hopes of a US-style shale gas boom in the UK remain strong following increasingly positive signals from the government. A recent report by the British Geological Survey revealed around 1 300 tn cubic feet of gas may be located in Bowland Shale, in northern and central England. The government has also announced a package of community incentives, including a requirement for shale companies to pay GBP 100,000 per gas where hydraulic fracturing ("fracking") is applied and 1% of revenues once production starts, in order to overcome the often strong local opposition to fracking. Measures were also announced "to make the approval process for fracking clearer and more streamlined", and, following a consultation, tax measures to facilitate shale exploration have been introduced ([253]).

Graph II.10.3: **United Kingdom - HHI index energy imports**



Source: Eurostat

A well-functioning and interconnected gas market with competitive and market-based prices should provide the correct incentives for further investments and signals to consumers for an efficient and sustainable use of the resources. Both elements are conducive to reduce the vulnerability of the country to energy-related shocks. The UK is distinguished in this respect, having adopted a liberalised market model very early on relative to other EU members. The UK's gas market has been liberalised since the 1990s, and it has the least concentrated wholesale market among the larger EU countries ([254]). This early

([251]) Ofgem (2012): the UK sourced its gas needs almost wholly from the North Sea as recently as 2000, and it was a net exporter of gas until 2003.

([252]) Wood, I. (2014)
([253]) UK has far more shale gas than previously thought 2013
([254]) European Commission (2011).

liberalisation has helped attract large investments in gas import and transport infrastructure, resulting in a five-fold increase in the UK's import capacity between 2000 and 2010 ([255]). Good pipeline interconnections with Norway, Belgium and the Netherlands have opened up direct access to gas from the Norwegian continental shelf, from Europe and from further afield e.g. Russia. The UK energy regulator, Ofgem, has recently launched a joint project with Belgian and Dutch regulators to assess the efficiency of interconnectors between the UK and continental Europe. Three LNG facilities are also in operation, making the UK the third largest importer of LNG in 2011, following Japan and South Korea ([256]). LNG imports are expected to play an increasingly important role in satisfying annual gas demand over the next decades.

While a liberalised market-based approach has managed to mobilise sufficient investment in import capacity, it has failed to attract equally significant investment in gas storage. Due to its historical position as a gas producer, the UK is an outlier among the EU countries (along with Spain) in having a very low level of storage capacity relative to annual gas demand. This, combined with rising import dependence and a relatively low proportion of long term contracts, could expose the UK to international gas price volatility to a greater extent. Concerns regarding the inadequacy of market forces have driven some national players to advocate direct government support for the development of gas storage facilities, under a regulated regime ([257]).

Despite the early adoption of a liberalised market model in the sector, it still displays moderate levels of market concentration in production: the 3 largest gas producers accounted for 50% of the market in terms of available gas in 2010. Nevertheless, the UK has the most liquid wholesale trading hub in Europe – the virtual NBP. Both household and industrial natural gas prices were below the EU average in 2013 ([258]).

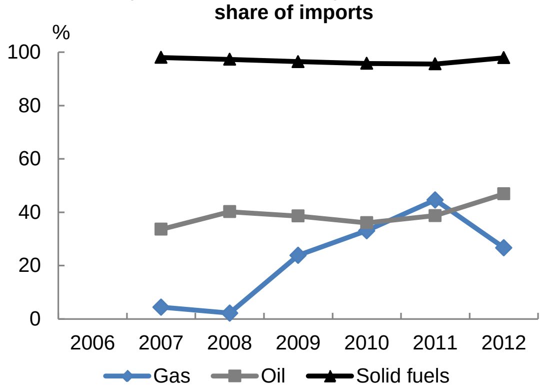
([255]) DECC (2010)
([256]) Ofgem (2012)
([257]) Ofgem (2012)
([258]) Eurostat

10.1.1.2. Oil

The second source of energy in the UK is oil. It accounted for 34% of the country's gross inland consumption in 2012, equal to the EU average, and this share has been relatively stable since 2008, increasing by just one percentage point.

The UK remains the largest crude oil producer in the EU, despite large declines in production over recent years. It exported around 28 million tonnes of crude oil in 2012 while it was 68 million tonnes in 2003, about 77% of its exports go to other EU Member States. The Netherlands and Germany were the two largest export markets for UK oil, accounting respectively for 44% and 22% of all exports in 2012. The vast majority of the UK's oil reserves are located in the UK Continental Shelf (UKCS); as of January 2013, the UK had 3.1 bn barrels of proven crude oil reserves.

Graph II.10.4: **United Kingdom - Non-EEA share of imports**



Source: Eurostat

The oil industry represents a significant economic sector in the UK. Along with gas, it is the biggest sector of industrial investment in the UK. Moreover, Corporation and Supplementary Tax income from the sector accounts for around 25% of UK corporate tax receipts. The UK has significant refinery capacity, with 7 major refineries and 1.7 bn barrels per day of refining capacity in January 2013.

Oil production has nevertheless declined rapidly in recent years, as the discovery of new reserves sand new production have struggled to keep pace with the maturation of existing fields. After years of strong exports, the UK became a net importer of crude oil in 2005, with a majority share of its imports (45%) coming from Norway in 2012.

The Coalition government has stated its commitment to a tax regime that encourages investment and innovation, ([259]) fiscal changes from the 2011 Budget increased the tax burden of UKCS projects. Rising operating costs decreased investment in existing fields and new exploration.

To counter these developments, the government has introduced a range of measures to encourage the continued development of the oil and gas sectors. The Oil and Gas Strategy of March 2013 includes initiatives to increase certainty over the availability of decommissioning tax relief, new field allowance regime changes to encourage investment in commercially marginal oil and gas projects, and measures for workforce skills development ([260]). A new round of offshore licencing was also launched in May 2012, leading to a first batch of 164 awarded licences.

The Government's introduction of field allowances and providing decommissioning relief helped generate investments for GBP 14.4 bn last year, and industry estimates that GBP 7 bn of this was incentivised by the government's allowances ([261]). At Budget 2014, the government announced it would conduct a review of the entire oil/gas tax regime, to ensure it continues to incentivise economic recovery as the basin matures. It also announced a new allowance to support investment in ultra-high pressure, high temperature clusters in the central North Sea. It commissioned an independent review into increasing oil and gas production, which was published in February 2014 ([262]). The government has accepted all its recommendations – including the introduction of a new arm's length body which will be tasked with maximising economic recovery in the UK.

Although the UK's demand for oil is set to decline over the longer term given its commitment to decarbonisation, oil is expected to remain a part of the UK's energy mix, both as an important economic input and for security of supply and diversification reasons. It is likely to remain an important fuel for transport and heating, and a crucial feedstock in the petrochemicals, industrial and construction industries. The production side is also likely to remain afloat. Following a number of small new field developments in 2012 and expected in 2013, two large new developments owned by Statoil and Chevron are expected to be operational around 2015. The latest round of offshore licencing launched in 2012 also received the highest number of applications since licencing began in 1964.

([259]) DECC (2012)
([260]) UK (2013)
([261]) Oil and gas UK (2014)
([262]) Wood, Ian (2014)

10.1.1.3. Solid Fuels

The third energy source in the UK is solid fuels, which accounted for 19% of the UK's energy mix in 2012, up of two percentage points since 2008, above the EU average of 16% and also above its previous historical peak of 17.8% in 2006. Among the solid fuels, coal production has been declining steadily since the 1990s, driven by decreasing domestic consumption and increasing lower cost imports. In 2012, the UK imported around 70% of its total coal consumption. Of this, 40% was sourced from Russia, 26% from Colombia and 24% from US (a share that is rapidly growing). The relatively low price of coal, driven at least in part by the shale revolution in the US and the subsequent fuel-switching from natural gas to coal, has also hit the profitability of the UK coal industry. Given coal's high carbon intensity relative to other fossil fuels, domestic demand for the fuel is set to decline, as the UK makes progress towards its carbon-reduction commitments for 2020 and beyond.

In 2012, coal accounted for 39% of total electricity generation. There was resurgence in the use of coal for power generation in the UK between 2011 and 2012, with its usage up nearly 50%. This is again a likely product of the relatively low world coal prices following the shale revolution and subsequent decrease in demand for coal in the US over the last few years.

The UK government nevertheless acknowledges that it cannot sustain investment in new coal power plants, unless they are equipped with CCS or other emission-abating technologies, if it is to meet its decarbonisation objectives up to 2050. The Emissions Performance Standard under the new Energy Bill, which limits the amount of emissions a new fossil fuel power station can emit, helps deliver on this objective.

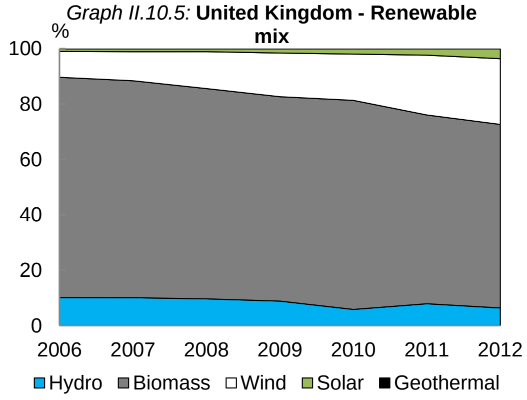
A gradual phase out of coal-fired power plants in the UK is taking place due to a mix of EU and national legislation. The EU's Industrial Emissions Directive (IED) requires that power plants that remain operational beyond 2023 adhere to stricter pollution standards. This essentially gives the UK's coal power industry three choices: make necessary investments in pollution abatement technologies to meet the IED requirements, convert their coal-burning plants to cleaner biomass, or close the plants down by 2023. Out of the 19 coal-fired plants in operation in 2011, 6 were due to close or be converted to biomass by 2015, and the remaining 13 will had to decide their choice of compliance by the end of 2013 ([263]). After submitting the compliance plan, RWE-npower stated the intention to proceed to a probable shutdown of seven plants by 2023 ([264]). The power plant at Tilbury is the first coal-fired plant in the UK to have been converted to biomass. There are expectations that all existing coal plants will opt to close by 2023 or convert to biomass, rather than making the necessary investments to comply with the IED, due to the impact of the new carbon price floor and the substantial biomass subsidies that have been implemented in the UK. The carbon price floor essentially places an extra tax on carbon emitters, to compensate for low EU ETS allowance prices, and will make it highly uneconomical to invest in the new technologies required for coal-fired plants to meet the IED requirements. Conversion to burning biomass is also more attractive given the government subsidies.

Coal is, however, an important component of the UK energy mix to ensure diversification and security of energy supply. The use of CCS alongside coal generation has been recognised by the government as an attractive proposition ([265]). However, CCS is unlikely to be commercially ready until well into the 2020s. The Capacity Market mechanism under the new Energy Bill, to be run by the government from 2014 onwards, may also provide a means for coal plants to remain afloat by supplying back-up power ([266]). It is designed to offer power plants incentives to run as guaranteed back-up capacity, even during peak demand, to ensure a secure electricity supply. These capacity payments may offset the impact of the carbon tax and make it worthwhile for plants to invest in meeting the IED requirements, decrease their emissions, and avoid closure by 2023.

10.1.1.4. Renewables

Renewable energy accounted for just 4.2% of the UK's energy mix in 2012, up from 2% in 2008. ([267]) However, renewables accounted for 10.8% of electricity generation. ([268]) The UK's First Renewable Energy Roadmap in 2011 estimated that the country's consumption of renewable energy will need to increase by 17% per annum from 2010 levels to achieve its binding target of a 15% renewables' share in its energy mix by 2020, as required by the renewables directive. The Roadmap, and its update in 2012 and 2013, sets out clear measures to accelerate the deployment of renewable energies, and identifies specific technologies for policy focus based on their long term potential and cost-effectiveness. These include onshore and offshore wind, marine energy, solar photovoltaics, and biomass electricity and heat.

Graph II.10.5: **United Kingdom - Renewable mix**



Source: Eurostat

Biomass, wind and hydro accounted for the largest shares in the UK's primary production of renewable energy in 2011, and hold the

([263]) London Mining Network: 2013 – A crunch year for coal and the UK coal industry
([264]) World coal (2014), RWE npower to close UK coal plants.
([265]) DECC (2012)
([266]) The Telegraph: Coal's final chapter is not written yet.
([267]) The share of renewables in the energy consumption is here defined as the share of renewable energy in gross inland energy consumption. On the other hand, EU and Member States' renewable targets for 2020 under Directive 2009/28/EC are expressed as a share of renewable sources in gross final energy consumption, i.e. excluding transmission, distribution and transformation losses.
([268]) This has provisionally increased to 13.8% in 2013. UK Energy Trends, March 2014 (Section 6)

largest potential for the deployment of renewable energy up to 2020. Biomass was the largest source of renewable heat and electricity in 2010, while wind energy held the second highest share in renewable electricity. The UK is a world leader in offshore wind, and was the largest offshore wind electricity producer in the EU in 2010. It is also accelerating the deployment of onshore wind, which remains the most deployed renewable electricity technology in capacity terms. Solar PV has seen the fastest growth among renewable technologies in recent years, with more than a five-fold increase in installed capacity between June 2011 and June 2012. This was largely driven by a rapid fall in the cost of solar PV, with costs estimated to have fallen by up to 50% between 2011 and 2012, and the introduction of a Feed-In-Tariff (FIT) subsidy for small-scale installations in April 2010.

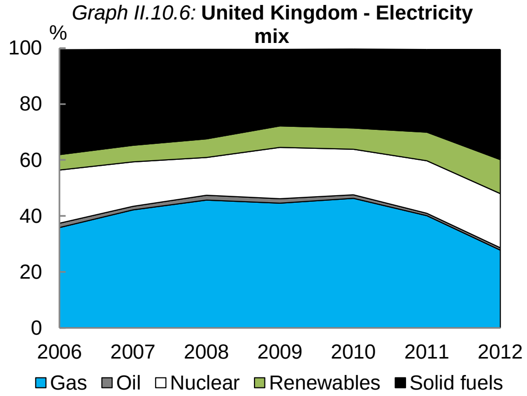
The share of RES in electricity generation was 12% in 2012, up from 6% in 2006. This share is expected to rise rapidly following the introduction of Feed-In-Tariffs with Contracts for Difference in 2014 under the recent Energy Bill. The incentive scheme guarantees a strike price for low-carbon generators that is proportional to their construction and equipment costs, under long-term power contracts. Renewables accounted for just 2.2% of total heat demand in 2011. Nevertheless, the launch of the world's first Renewable Heat Incentive (RHI) in November 2011, along with the Renewable Heat Premium Payment (RHPP), are expected to boost these figures. In road transport, the share of biofuels in 2009/2010 was 3.33% ([269]), up from 2.7% in 2008/2009, and slightly higher than the target 3.35% set by the Renewable Transport Fuels Obligation (RTFO) ([270]).

The key support instrument for renewable electricity production is a quota obligation system with tradable green certificates (TGC), combined with feed-in-tariffs (FIT) for small scale installations since 2010. The level of support under the TGC substantially exceeds generation costs in the wind and solid biomass power sectors, and is relatively high in the hydropower sector. Other support measures include the Green Deal, which covers small-scale installations of renewable energy technologies e.g solar panels, and removes the need for households and businesses to pay all costs of installation up front. The RHI currently provides long term financial support for renewable heat installations in the non-domestic sector, and this will be extended to the domestic sector in Spring 2014 to replace the RHPP. In transport, Renewable Transport Fuel Certificates (RTFC) under the RTFO aims to incentivise the supply of sustainable biofuels.

10.1.2. Secondary Energy Sources

In 2012, solid fuels were the main source of power generation with a share of 39% against a share of 28% for gas. However, previously, the UK's electricity generation fuel mix had been dominated by natural gas which accounted for around 41% of total generation, and solid fuels, which made up 31% over the 2008-2012 period. This change is most likely due to the relatively higher price of natural gas in the UK. The gradual reduction in coal generation, which is expected over the next decade will nevertheless increase the UK's reliance on increasingly imported natural gas in the near term. This could raise the exposure of UK electricity prices to fluctuations in natural gas prices and supply. In 2012, the UK covered around 4% of its electricity consumption via imports, and this share has remained broadly constant since 2008. Nuclear accounted in 2012 for 19% of electricity generation while RES accounted for 12%.

Graph II.10.6: **United Kingdom - Electricity mix**



Source: Eurostat

Good electricity interconnections and adequate domestic infrastructure capacity are important to shelter the country from supply shocks and

([269]) Renewable Fuel Agency Report (2010)
([270]) Under the Renewable Transport Fuels Obligation of 2008, fuel suppliers must provide 5% of transport fuels from renewable sources in 2013/2014.

to enable a proper absorption of renewables. A competitive and dynamic electricity market should cater the necessary investment incentives and provide the right price signals to consumers.

The UK has a significant need to improve the capacity of its network infrastructure and establish additional interconnectors with continental Europe. The infrastructure investment costs for projects of "pan-European significance" between 2012 and 2022 are estimated to be around EUR 19 bn for the UK, which is second only to the estimated needs of Germany (30 bn) ([271]). The UK currently has the East-West Interconnector with Ireland, which became operational in 2012 and has doubled the interconnection capacity between the two countries, as well as HVDC links with France and the Netherlands. To boost interconnections with continental Europe, OFGEM, the UK energy regulator, is currently developing a new regulatory framework to support cross-border links.

The UK also needs substantial investment in its electricity generation capacity, to facilitate its transition to a low carbon economy and to offset the retirement of a significant share of its existing generation capacity over the next decade. The Electricity Market Reform (EMR) measures, as part of the 2013 Energy Bill, aim to address this shortfall. Its measures include Feed-In-Tariffs (FIT) with Contracts for Difference to provide a stable and predictable strike price for companies to invest in low-carbon generation, a capacity market to ensure greater security of electricity supply, liquidity and power purchase agreements to sustain a competitive wholesale market, and the Emissions Performance Standard (EPS) to limit the emissions of new fossil fuel power plants ([272]).

Another measure to incentivise investment in low carbon generation is the carbon price support, which is essentially a carbon price floor, implemented in 2013, There are concerns at the EU level that such measures may conflict with progress towards the internal electricity market. The Commission has stressed that they must be compatible with the internal market and EU state aid rules, and that any resulting market distortions should be minimised ([273]).

The UK has a fully privatised wholesale and retail electricity sector, with moderate levels of market concentration and ownership unbundled TSO and DSO networks. The largest power producer in the UK is EDF Energy, while other important companies include E.ON UK, RWE, Drax, Scottish and Southern Energy (SSE), and Scottish Power. The cumulative market share of the 3 largest utilities at the generation level was 44% in 2011. The domestic retail market is dominated by the 6 vertically integrated suppliers, which have a 99% combined market share. Among these, the 3 largest companies accounted for 61% of the market. Despite this dominance, customer switching rates in the UK were among the highest in Europe in 2011 (15%). The UK also has 3 liberalised power exchanges: APX UK, the Nasdaq OMX N2EX, and the Intercontinental Exchange (ICE). Nevertheless, only 8.5% of power trading was carried out on these exchanges in 2011; the majority was conducted over-the counter (OTC) ([274]).

Average daily wholesale electricity prices in the UK were higher than in other continental European countries in 2013 ([275]). This contributes to explain the high share of energy and supply costs in retail electricity prices (excl. taxes) in the same year, the third highest level after Malta and Cyprus - energy and supply costs accounted for 78.9% of end user prices in 2013. Wholesale electricity prices can be expected to continue to mostly be driven by movements in natural gas prices over the medium term, given the major role gas-fired generation plays in setting prices. Household electricity prices were below the EU average in 2013 and industrial prices were in line with the average ([276]).

10.1.3. Conclusions

UK overall import dependence is low; therefore the vulnerability of the country to external energy supply disruptions appears limited. Its increasing trend poses nonetheless some challenges for the

([271]) ENTSO-E (2012)
([272]) DECC (2013)
([273]) European Commission (2012a)
([274]) European Commission (2012a). OTC are bilateral contracts between two entities.
([275]) DG ENER (2013)
([276]) Eurostat

future. The development of domestic sources such as renewables is still limited but it is growing and the UK retains an ambition for over 30% of electricity to come from renewable sources by 2020. The prospects for shale gas extractions appear promising, but a still at an initial stage.

The growing share of coal in the energy and electricity mix might undermine the achievement of climate targets, but it may be a temporary factor. Renewed effort to improve electricity generation capacity and interconnections will therefore be essential to enable a transition to low carbon energy source.

10.2. ENERGY AND CARBON INTENSITY

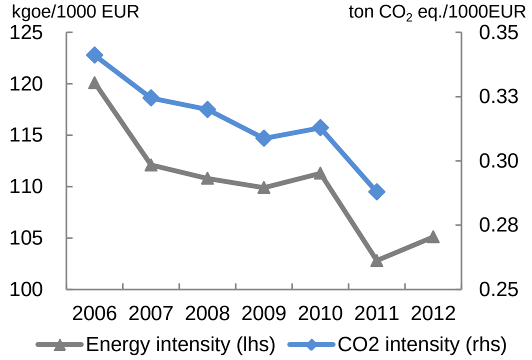
In 2012, the UK's energy intensity of the economy was among the lowest in the EU, outperformed only by Ireland and Denmark. It declined steadily between 2000 and 2009, and picked up only marginally in 2010 as economic activity recovered slightly following the global financial crisis, but declined again in 2011 and broadly stabilized in 2012. Over the period 2000-2012, energy intensity of the economy fell by 25% in the UK.

The National Energy Efficiency Action Plan (NEEAP) runs for the period 2008-2016. According to the Energy End-Use Efficiency and Energy Services Directive of 2006, the savings target to be reached by 2016 is an overall decrease in final energy consumption (FEC) by 9% compared to the baseline level, which in the UK amounts to around 137 TWh ([277]). In its first NEEAP, the UK committed to reaching the full 9% of energy savings in its interim target to the end of 2010. According to latest projections, the UK is expected to achieve 14% of savings against the baseline by 2016, exceeding the necessary 9% reduction.

Under the Energy Efficiency Directive, the UK has reported an indicative target for 2020 of 129.2 Mtoe, which corresponds to a reduction of 18% of final energy consumption compared to business as usual projections. The target reflects the policy package on energy efficiency that was put in place in 2007. The latest available projection indicates that the UK is on track to meet the target. ([278])

The carbon intensity of the UK economy was well below the EU average in 2011, and had fallen by around 17% between 2006 and 2011. As with energy intensity, the carbon intensity of the economy has been decreasing steadily over the period 2000-2009, followed by a slight increase between 2009 and 2010 and then it decreased again in 2011.

Graph II.10.7: **United Kingdom - Energy and carbon intensity of the economy**



Source: Eurostat

Total GHG emissions in 2011 had fallen by 15% since 2006. Emissions dropped dramatically between 2008 and 2009, most likely due to depressed economic activity during the financial crisis, and increased slightly between 2009 and 2010, only to drop again in 2011**.** Despite these steady decreases, the UK was still one of the largest emitters in the EU-28 in 2011. The UK and Germany together accounted for around a third of total EU-28 GHG emissions that year ([279]). However, both countries achieved significant reductions in emissions relative to 1990 levels, which in the UK was largely due to the effects of liberalising the energy markets and the fuel switching from oil and coal to natural gas in electricity production. Since 1990, the UK has been one of the countries with the largest reductions in emissions per capita among the EU-28 ([280]). In more recent years, the UK has also adopted some of the most stringent climate legislation in the world. The 2008 Climate Change

([277]) The baseline is the average annual final energy consumption over the period 2001-2005.

([278]) UK's indicative national energy efficiency target for 2020 under Article 3 of EDD, (2014).
([279]) European Commission (2012b)
([280]) European Commission (2012b)

Table II.10.1:
Energy and carbon intensity

	2012	percentage change 2008 - 2012
Energy intensity of the economy 1)	105	-5.1
CO2 intensity of the economy 2)	0.29	-10.0
Share of energy intensive sectors in Gross Value Added 3)	7.1	-1.0
memo items: EU28		
Energy intensity of the economy 1)	143	-5.2
CO2 intensity of the economy 2)	0.53	-10.3
Share of energy intensive sectors in Gross Value Added 3)	9.0	-0.4

Source : Eurostat
Notes: 1) Kg of oil equivalent per 1000 EUR, changes in percent; 2) Tonnes of CO_2 equivalent per 1000 EUR, changes in percent, latest data refer to the year 2011; 3) percent of total gross value added, changes in percentage points.

Act set legally-binding emission-reduction targets for 2050, with an obligation to reduce GHG emissions by 80% relative to 1990 levels. So far, the UK is the only EU Member State to have adopted legally-binding long-term targets to 2050. The Climate Change Act moreover provides a framework for achieving this long-term target through five-year legally-binding interim targets under the Carbon Budgets ([281]).

The UK is also expected to have exceeded its Kyoto Protocol obligations for the period 2008-2012 ([282]). Against the Kyoto requirement for GHG reductions of 12.5% below base year levels over the 2008-2012 period, provisional estimates reveal that emissions may have been 27% below the baseline in 2012.

In the context of the Effort Sharing Decision ([283]), the UK has committed to reduce emissions in non-ETS sectors by 16% relative to 2005 levels by 2020. Current projections show that the country had already exceeded the target in 2012 ([284]). The UK is expected to reach and most likely exceed its 2020 non-ETS target with existing policies and measures.

With regards to the ETS sectors, the share of emissions falling under the ETS is 40% ([285]). Since the third phase of the scheme started in 2013, there has been an EU-wide emissions cap and emission allowances are auctioned, while so far they had been granted for free. This is expected to impact on the energy costs of industries, though the extent to which these might be passed on to consumers depends on a number of factors (which are likely to vary across and within sectors), including the exposure to international competition, and the degree of competition on non-price characteristics (e.g. quality).The UK has put in place measures to compensate energy intensive industries for the indirect costs of the EU ETS and the Carbon Price Floor. The effects of the auctioning on the British economy will largely depend on the carbon price, which is currently very low, and on the ability of the UK energy system to decarbonize itself. The decarbonisation process may also be hampered in the short term by the very competitive prices of coal, which has increased its share in the energy mix.

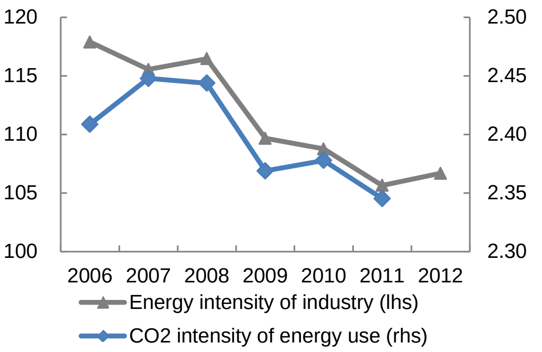
10.2.1. Industry

In 2012 the energy intensity of the UK industry was among the lowest in the EU. A slight decline of the energy intensity can be observed compared to 2008.

In the second National Energy Efficiency Action Plan of the UK the industrial sector is considered in combination with the public sector. Their combined share of annual energy saving in relation to total annual energy savings to be achieved by 2016 and by 2020 is approximately 20%. By 2010 these sectors have already achieved about 40% of their total expected savings.

([281]) Frankhauser, S. et al. (2009)
([282]) European Commission (2012b)
([283]) Decision (2009)
([284]) European Commission (2012b)
([285]) European Commission (2012b)

Graph II.10.8: **United Kingdom - Energy intensity of industry, carbon intensity of energy use**



Source: Eurostat

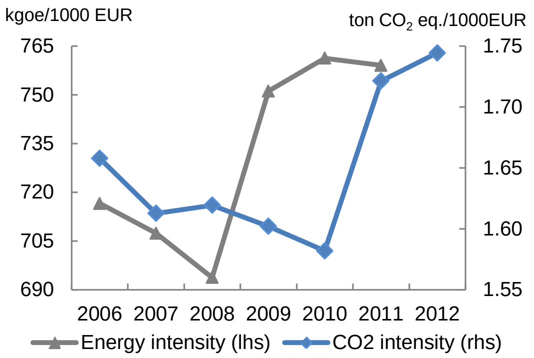
To date energy intensive industries with Climate Change agreements have made significant savings. Looking ahead the relative importance of these measures is expected to decrease. Subsequently, the largest contribution to the savings should come through carbon reduction commitments and product policies. The former is a mandatory scheme for large organisations outside of the EU Emissions Trading System that requires energy to be reported and allowance purchased to cover the emissions from it. A number of product policies aimed at improving the energy efficiency of products purchased and used in homes, businesses and the public sector are also foreseen ([286]).

The UK displays a moderate level of carbon intensity of energy use, which has declined marginally by 4.1% between 2008 and 2012. Nevertheless, the UK fails to outperform the EU due to a relatively low share of renewables in its energy mix, and the still substantial reliance on oil, especially in the transport sector. Carbon intensity of energy use can be expected to fall over time in the UK however, with the country's stringent climate policies, the plans for renewables deployment and the growing reliance on natural gas in the short-to-medium term.

10.2.2. Transport

After a period of steady decline, the energy intensity of the UK transport sector has been increasing between 2008 and 2011, reaching its peak since 2001. Energy intensity levels have been below the EU performance until 2010. The final energy consumption (FEC) of the UK transport sector has been the second highest in the EU over the past decade, preceded only by Germany. The actual level of transport FEC was around the same level in 2010 as it was in 2000, although transport's share in total UK FEC has been rising over the past decade, displacing industry's share to some extent. How the UK transport sector managed to sustain energy intensity levels below the EU performance despite very high levels of FEC, can be explained by the dynamics of transport GVA: for each year in the period 2000-2009, the UK had either the highest or the second highest transport sector GVA, which would have helped offset the negative effect of high FEC on the energy intensity of the sector. However between 2010 and 2011 the GVA of the sector sharply declined.

Graph II.10.9: **United Kingdom - Energy and carbon intensity of transport**



Source: Eurostat

According to the second NEEAP ([287]), the transport sector accounts for around 18% of expected FEC savings by 2016, which is much lower than the sector's share in total UK FEC in 2010 (37%). This indicates that transport has an energy savings burden that is disproportionally smaller than its actual contribution to total energy consumption in the UK. The savings estimates are based on expected savings from implemented or planned efficiency measures in the sector. These measures include two mandatory EU targets for new car fuel efficiency standards by 2012 and 2020. They also include UK and EU policies and regulations to encourage the use of sustainable biofuels in transport, as well as policies to encourage the introduction of low carbon buses. The largest savings in the sector to 2016 and 2020

([286]) UK (2011b).

([287]) UK (2011b)

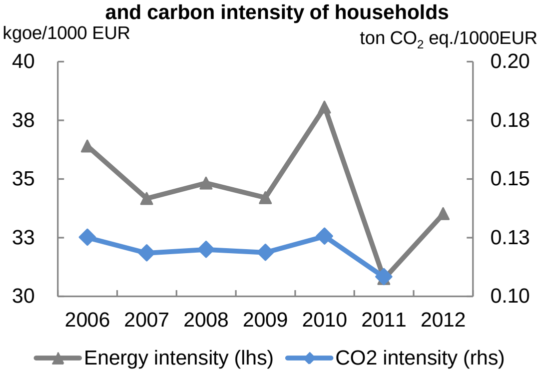
are expected to come from the EU-led agreement and two mandatory targets on new car fuel efficiency in the UK.

The carbon intensity of the transport sector was below the EU performance for all years 2007-2011. This was despite the high carbon intensity of transport's energy use: in 2010, transport's FEC was dominated by petroleum, and the sector accounted for 85% of petroleum use and only 15% of gas use in the UK economy. Nevertheless, the relatively low carbon intensity of transport can be explained by the sector's high GVA in the UK economy, which offsets the impact of the sector's high carbon emissions on its carbon intensity.

10.2.3. Households

UK households' energy intensity was among the lowest in the EU over the period 2000-2012. Between 2000 and 2012, energy consumption per UK household fell by 25%, mainly driven by the fall in household consumption of space heating. Despite this reduction, space heating still accounted for around 60% of household's FEC in 2009 ([288]). Household FEC is also dominated by gas use, and in 2010 the household sector accounted for 65% of the UK's gas usage.

Graph II.10.10: **United Kingdom - Energy and carbon intensity of households**



Source: Eurostat

The household sector is expected to be the biggest contributor to the forecasted 14% overall FEC savings in the UK economy, relative to the baseline, by 2016. The sector is expected to account for around 61% of total savings. Measures to facilitate these energy savings include the Green Deal, to help finance energy efficient home improvements. From 2016, all new homes in England will also be required to be built to a zero carbon standard. The Warm Front scheme is one of several initiatives designed to tackle household fuel poverty in the UK through energy efficiency measures. Moreover, the mass roll-out of smart meters from 2014 onwards will also enable households to better monitor and manage their energy consumption, and this is expected to allow the average household with gas and electricity to save an average of GBP 26 a year on their energy bills by 2020 ([289])

The largest annual savings up to 2016 and 2020 are expected to come from building regulations, relating to improving the energy efficiency standards of existing and new homes (including the zero carbon standard for new home builds from 2016), and supplier obligations, especially those related to tackling fuel poverty in households. The latter measure includes initiatives like the Carbon Emissions Reduction Target (CERT), which requires large energy suppliers to help households reduce their carbon footprint, and the Community Energy Savings Programme (CESP), which targets low income communities and provides whole house retrofits with a range of energy saving renovations. The energy savings potential in UK homes is significant: in 2011, 41% of UK households with cavity walls did not have them insulated, and 99% of UK homes with solid walls did not have solid wall insulation ([290]). The EEDO estimates that if all households with cavity walls had them insulated, this would save around GBP 83 m in consumer gas bills each year.

The carbon intensity of UK households fell by 15% between 2006 and 2011, and has remained consistently below the EU average. Its development appears to some extent more stable than the energy intensity, but follows largely the same pattern.

10.2.4. Conclusions

The UK displays some of the lowest levels of energy and carbon intensities in the EU across all economic sectors. The only relative exception is the carbon intensity of the energy where a low

([288]) EEDO (2012)

([289]) UK (2011b); and UK(2014)

([290]) EEDO (2012)

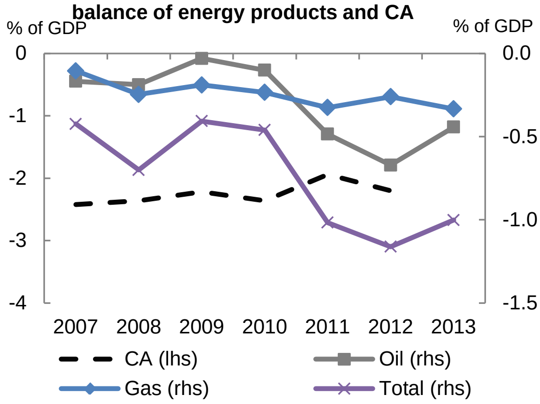
uptake of renewables and an increasing share of coal are undermining the performances of power sector.

10.3. CONTRIBUTION OF ENERGY PRODUCTS TO TRADE

10.3.1. Net energy trade balance

Between 2001 and 2013, the UK's energy trade balance deteriorated from a surplus of 0.5% to a deficit of 1%. Despite this, the UK has consistently performed better than the EU average. In 2013, the UK had the smallest trade deficit among the EU-28, outperformed only by Denmark which was the only Member State to register a trade surplus that year.

Graph II.10.11: **United Kingdom - Trade balance of energy products and CA**



Source: Eurostat

In terms of the different product categories, the oil trade balance has pretty much mirrored the dynamics of the energy trade balance, moving from a surplus of 0.5% in 2001 to a deficit of 0.4% in 2013. The gas trade balance has also gone from a surplus to a deficit over the decade, although it has remained relatively more stable than the oil or the total energy trade balance.

The size of the energy trade deficit should be seen against the background of the country's current account balance. The current account has been in deficit between 2001 and 2013, but the size of this deficit has been fluctuating: between 2006 and 2008, the size of the deficit fell by 59%, and over the course of a single year between 2009 and 2010 and between 2011 and 2012, it more than doubled. It seems that in recent years, the growing energy trade deficit can have been as one contributing factor to the current account deficit.

10.3.2. Decomposition of the net energy trade balance

The energy trade balance can be decomposed into three multiplicative factors, namely the relative energy trade balance (i.e. the share of net exports in energy products in total cross-border energy trade), the share of energy in total trade, and the ratio of total trade to GDP (macro openness to trade).

The UK's relative energy trade balance also closely mirrored the movement of the net energy trade balance, moving from a surplus of 21.2% in 2001 to a deficit of 16.7% in 2013. In all years over the decade, it performed significantly better than the EU average. The share of energy in total trade, on the other hand, has been increasing steadily over the period 2007-2013, rising by over 28%. This share has also been consistently higher than the EU average. Macro openness to trade has increased by about 20% on net over the same period, although it has been fluctuating more than the share of energy in total trade. It appears that the dynamics of all these three components jointly explain the gradual worsening of the energy trade balance in the UK over the past decade.

Table II.10.2:
Decomposition of Energy Trade Balance

	2009	2010	2011	2012	2013
Energy trade balance (% GDP)	-0.4	-0.5	-1.0	-1.2	-1.0
Relative trade balance (%)	-10.0	-9.1	-16.0	-17.7	-16.7
Share of energy in total trade (%)	10.3	11.5	13.3	13.9	12.6
Macro trade openness (% GDP)	39.4	43.9	48.0	47.1	47.4

Source : Eurostat

10.3.3. Conclusions

The UK is not among the most vulnerable Member States in terms of the contribution of energy to trade. The overall energy trade deficit is among the smallest in the EU and this is due mainly to comparatively small relative energy trade deficit and macro trade openness. At the same time the share of energy in total trade places the UK in the broad middle of the EU ranks.

Nonetheless the UK displays a clearly deteriorating pattern across all the energy-related trade dimensions. A close monitoring of the future evolution is therefore warranted, especially in light of the persistently negative current account balance.

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