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Multidimensional Impact of the Low-carbon European Strategy on Energy Security, and Socio-Economic Dimension up to 2050 Perspective

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Abstract: This report focuses on main trends in European energy policies, European uneven geographies of energy security and energy economics. It illustrates a review of European policies and strategies for a low carbon society and their implications on environmental and energy policies, and on national and continental performances. It also includes a geographical analysis of current economic, social and sustainability trends for EU Member States.

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Introduction

This third deliverable of the WP1 of the Milesecure-2050 project focuses on main trends in European energy policies, taking into account present trends and perspectives in terms of EU and single Member States capacity to reduce their dependency on external energy sources, to improve the energy mix favouring renewables, and to face climate change threats in order to achieve a sustainable development of both the economy, the society and the environment.

These challenges are even more crucial if we consider that main trends have been dramatically changed by the current economic crisis, which has forced to reshape growth scenarios and readapt expected societal changes.

European uneven geographies of energy security and energy economics are, in fact, to be highlighted with the review of European policies and strategies for a low carbon society and their implications on environmental and energy policies, and on national and continental performances. Current economic, social and sustainability trends for EU member states – in the framework of the aforementioned crisis – tend to represent challenges and constraints for both strategies and related policies that have, among other objectives, to make of the EU the part of the world with the smarter, more sustainable and more inclusive growth (the Europe 2020 strategy).

The analysis provides, to such extent:

1. a key-grid of policies, trends and scenarios concerning energy security and low carbon transition that Europe is experiencing and is likely to experience;
2. the definition of a set of indicators to assess the geographical differentiation among Member States in pursuing European policies and objectives towards a low carbon society;
3. a framework for the analysis of different geopolitical scenarios and spatial tensions originated by the investments in new technologies, infrastructures and politico-economic alliances. This framework has been applied to three Member States (Germany, Italy, Poland) with very different typologies of energy strategies, trends, policies and market situations.

The geographical analysis of current energy situation at the EU level and then with specific focus on three national case studies (the "focuses" on Germany, Italy, Poland) helps, in fact, to test the set of indicators for successive WPs, researches and analysis. The definition of an EU framework of energy strategies and policies, furthermore, will serve as a basis for the deliverable 1.4 on macro-regional geopolitics of energy security, taking into account potential tensions that could involve Europe in the global scenario.

The structure of this deliverable is organised around three sections:

- The first section, "Energy production and consumption in the European Union. Present trends, challenges and future perspectives", outline the current situation in the EU by highlighting: the relationship between energy consumption and provision; the uneven distribution of carbon emissions targets, policies and results; the general interrelation between sustainability issues and themes and the energy system. Trends and forecast are thus possible taking into account the balance between energy demand and consumption.

- The second section, “Existing EU energy and environmental strategies and related policies”, focuses on the main strategies that have been defined at the EU level in order to tackle the energy issue, especially in terms of renewable energy policy, energy efficiency policy, and environment and climate protection policy. Further attention is then paid to energy security, considering the achievement of markets integration, the feasibility and completion of energy networks in the EU space, specific actions aiming at achieving security of energy supply. This section reports also on EU approach towards more traditional energy sources (i.e. nuclear energy, coal and oil) in relation to low carbon transition perspectives. The last part is on the role of innovation, technology and related EU programming for 2014-2020 in sustaining and orienting changes in the energy system towards a low carbon transition.
- The third section, “Identification of energy and climate indicators to measure Member States performances and trends”, has a twofold objective: to provide a set of indicators through which evaluate current and future situations in Member States, a set of indicators that could be useful in the next steps of the research, and to use such indicators to analyse the situation of three Member States (Germany, Italy, Poland) that have been chosen because of their very different energy situation. This section is completed by full case studies reports on the three Member States.

1. Energy production and consumption in the European Union. Present trends, challenges and future perspectives

This section presents an overview of the present situation concerning energy production and consumption in the EU, and opens up some room for speculation on future perspectives on the matter. More in detail, it analyses facts, figures and hypothesis concerning energy sources, energy consumption, energy imports and exports, CO2 emissions, main trends and challenges, in order to get a meaningful picture of the current situation and potential scenarios.

The presented evidences are mainly based on the analysis of various statistical sources and scenarios developed by different international organizations. Particularly, the report is based on documents from Eurostat/EC (2011a, 2011b, 2013a; for scenario analyses also EC, 2003, 2006, 2008, 2010a), IPCC (2007, 2011), United Nations (2013), OECD (2013), International Energy Agency (IEA) (2013a, 2013b), Energy Information Administration (EIA, 2013). All these organization – arguably the main and most reliable organizations providing data and scenarios on a worldwide scale – publish periodical reports on the situation of global energy production and consumption, as well as scenarios. It has to be noted that, in many cases, the reports rely on the same data sources: what differs is the interpretation of the data and the methodology behind the construction of scenarios. In this light, section 1.4 presents a comparison between different trend scenarios. The report also considers data and projections proposed by a private company, British Petroleum (BP, 2013a and 2013b), proposing scenarios – largely based on IEA data – that constitute an alternative to those proposed in the abovementioned reports.

1.1 EU energy consumption and energy sources

EU's energy consumption, according to the latest statistics (EU, 2013a – referring to 2010) is about 12.765 Mtoe (gross inland consumption), that is 13,4% of total world consumption (figure 1). EU is therefore a relevant area for energy consumption, but emerging countries as China (19,3% of global energy consumption) and the USA (17,4%) are more energy-demanding economies.

The structure of energy consumption is represented in figure 2: the main share is used in the transport sector (365 Mtoe), followed by industry (287), households (273), services and others (155). It has to be noticed that transport has been the fastest-growing sector since 1990, and is now the largest consumer of final energy.

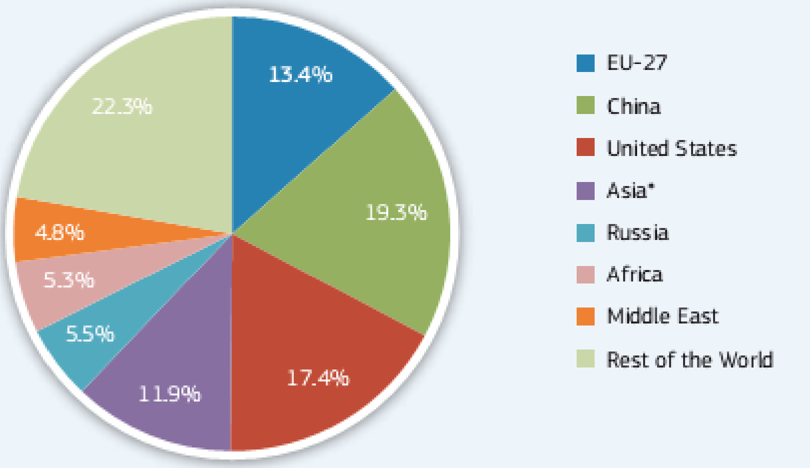
The main fuels used in the transport sector are reported in figure 3, while detailed figures on energy consumption in various industrial sectors are presented in figure 4 and 5. Finally, the ratio of energy sources for households' use is described in figure 6.

Fig. 1 - World gross inland consumption by region

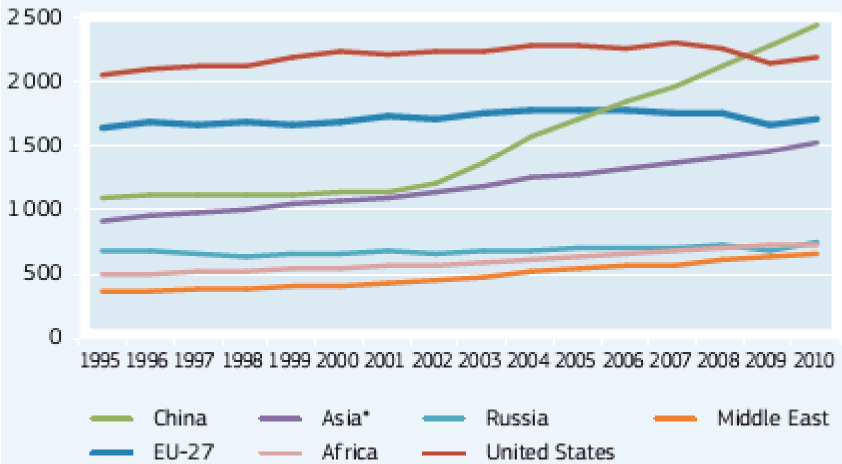
Mtoe	1995	2000	2005	2009	2010	2010 (%)
EU-27	1 637	1 685	1 780	1 654	1 714	13.4 %
China	1 058	1 108	1 709	2 301	2 469	19.3 %
United States	2 067	2 273	2 319	2 165	2 216	17.4 %
Asia*	880	1 052	1 259	1 461	1 524	11.9 %
Russia	637	619	652	647	702	5.5 %
Africa	438	496	596	676	682	5.3 %
Middle East	309	358	488	584	614	4.8 %
Rest of the World	2 209	2 418	2 649	2 684	2 844	22.3 %
World	9 235	10 009	11 452	12 172	12 765	100.0 %

World Gross Inland Consumption by Region (%)

Total 2010 = 12 765 Mtoe



World Gross Inland Consumption by Region (Mtoe)

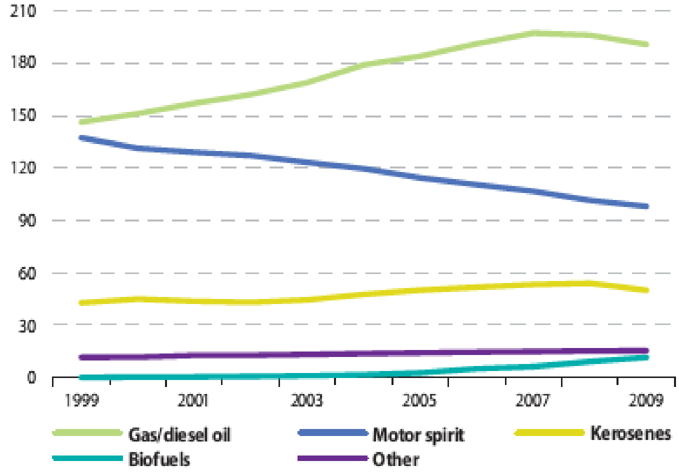


Source: EC (2013a), p. 16.

Fig. 2 - The EU energy flow

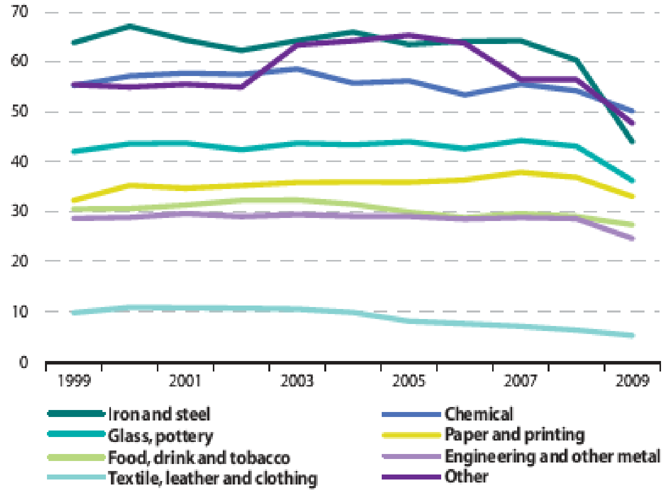
Source: EC (2013a), p. 19.

Fig. 3 - EU-27 final energy consumption in transport by fuel (Mtoe)



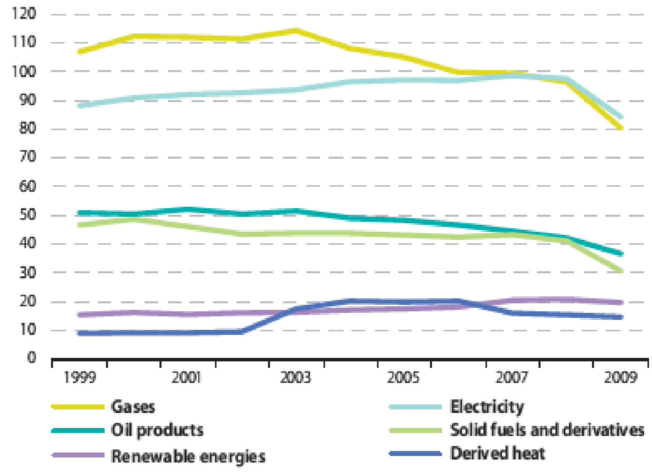
Source: Eurostat EC(2011a), p. 55.

Fig. 4 - EU-27 Final energy consumption in the industrial sector (Mtoe)



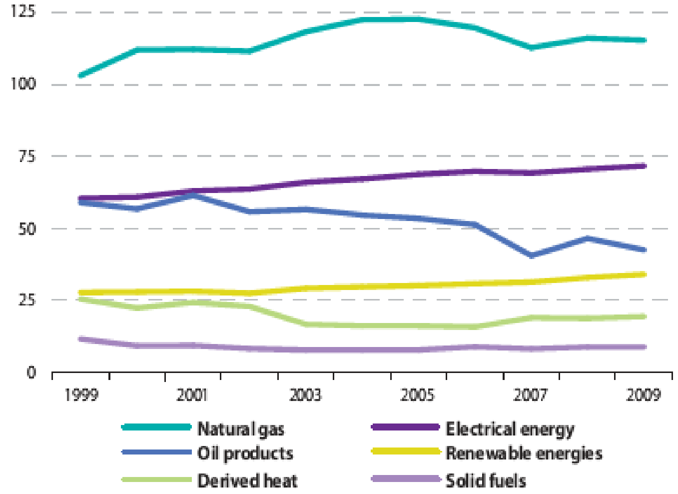
Source: Eurostat EC (2011a), p. 49

Fig. 5 - EU-27 final energy consumption in the industrial sector by fuel (Mtoe)



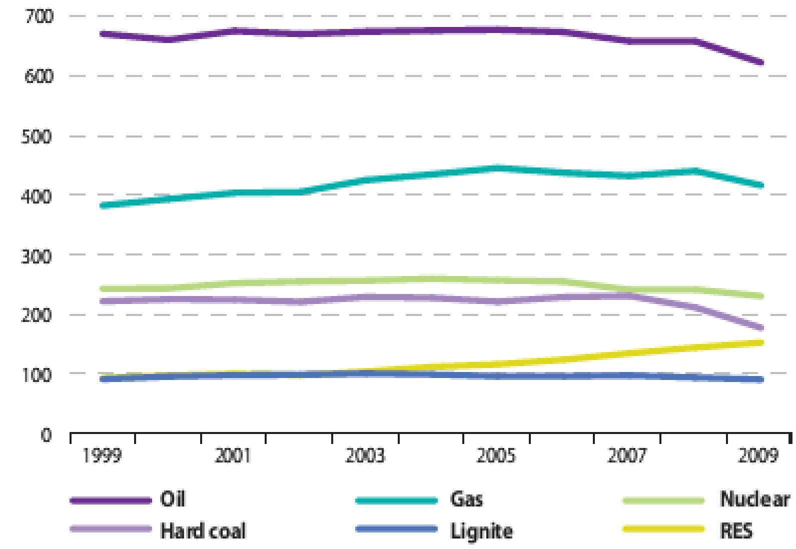
Souce: Eurostat EC (2011a), p. 51.

Fig. 6 - EU-27 final energy consumption in households by fuel (M-toe)



Souce: Eurostat EC (2011a), p. 57.

Fig. 7- EU energy mix: 1999-2009 trend

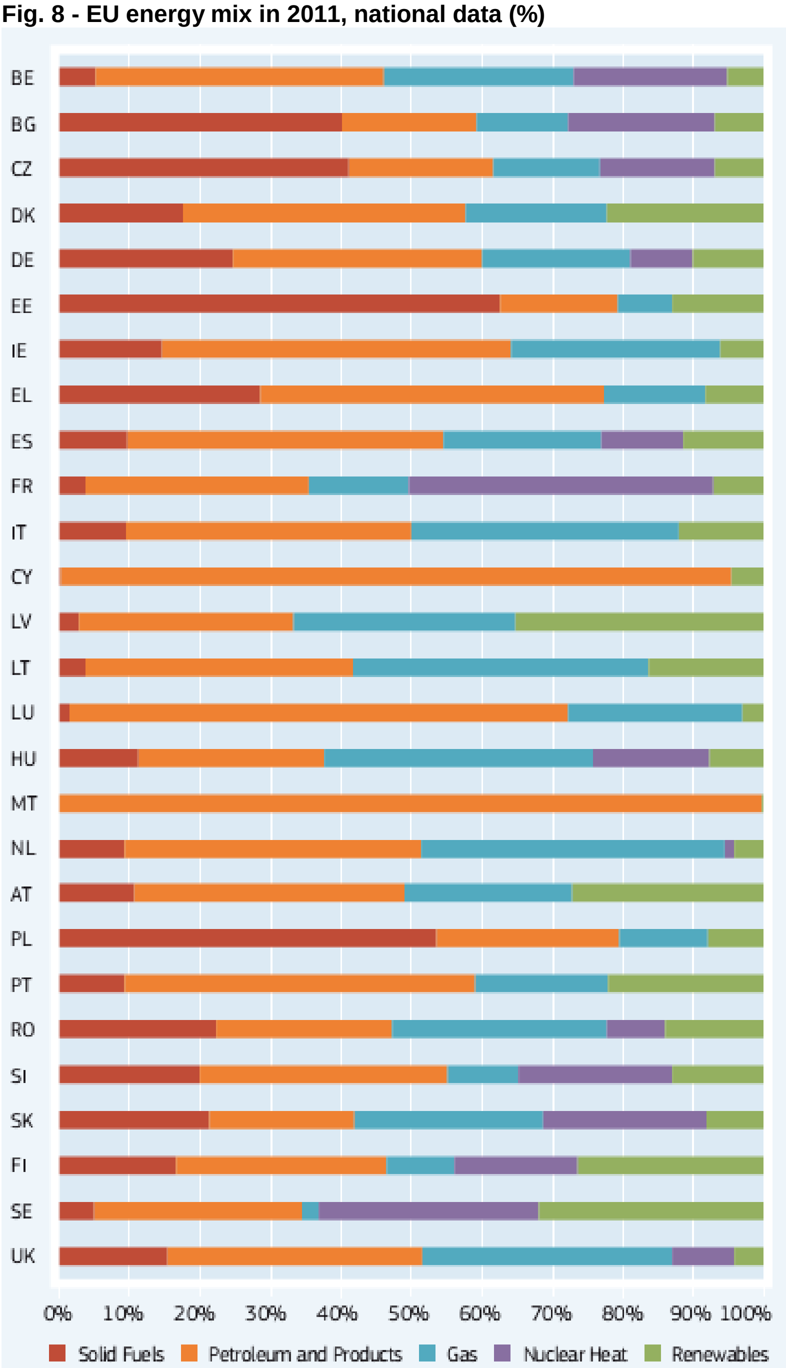


Source: Eurostat EC (2011a), p. 37

Basically, figures 3 to 6 emphasise two phenomena: different economic sectors rely on different energy sources, and each economic sector depends heavily on one or few energy sources. The outcome of these trends may be represented with the well-known concept of energy mix. As known, European energy mix (figures 7) shows a high dependence on oil consumption (35%), even if EU-27 general trends are the outcome of very different and uneven national performances (figure 8). In general, Germany had the highest level of gross inland consumption of primary energy in 2010, accounting for a 19.1 % share of the EU-27 total. France (15.3 %), the United Kingdom (12.1 %) and Italy (10.0 %) were the only other Member States to record double-digit shares; together these four countries accounted for 56.4 % of the EU-27's gross inland consumption.

Secondly, figure 4 emphasises a relevant problem of industrial competitiveness. European energy intensive industry sectors could be substantially disadvantaged in global competition in case a carbon constraint is imposed unilaterally on EU industries. While overall costs for the entire EU economy appear to be manageable (a reduction of GDP in 2020 by between 0.35% to 0.5% depending on the allocation of allowances; Eurostat EC, 2011a), the situation for certain energy intensive industries could be more dramatic. As an example, one of the adverse effects is "carbon leakage", that is the re-localisation of industrial production and emissions to countries outside the European Union due to increased production costs in Europe (Kuik and Hofkes, 2010; Eichner and Pethig, 2011).

Fig. 8 - EU energy mix in 2011, national data (%)

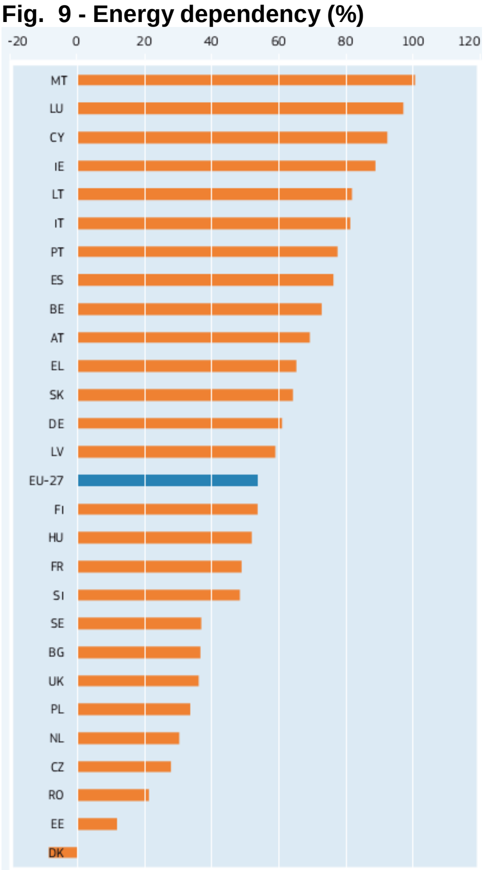


Source: EC (2013a), p. 21.

Looking at the energy mix during the period from 1999 to 2010, it is possible to observe a gradual decline in the share of crude oil and petroleum products, solid fuels, and nuclear energy. On the contrary, there has been an increase in the share of renewable energy sources and natural gas. The combined share of crude oil, petroleum products and solid fuels fell from 56.9 % of total consumption in 2000 to 51.0 % by 2010, reflecting a move away from the most polluting fossil fuels; there was also a modest decline in the share of nuclear energy (0.7 percentage points) although its share was relatively stable between 2007 and 2010. During the same period, the relative importance of natural gas rose by 2%, to account for one quarter (25.1 %) of the EU-27's gross inland consumption in 2010.
The biggest change in the energy mix refers to the progressive growth in the relative importance of renewable energy sources; their share of EU-27 gross inland consumption of primary energy increased by 4.2% between 2000 and 2010, to reach 9.8%. Renewable energy sources accounted for about one third of gross inland consumption of primary energy in Latvia and Sweden, and about one quarter in Austria and Finland.

Energy dependency varies meaningfully between Member States: on one extreme, countries as Malta, Luxembourg, Cyprus, Ireland and Italy depend heavily on imports; on the other extreme of the spectrum, Romania, Estonia and United Kingdom depends quite less heavily, and Denmark is the only European energy exporter. Worryingly however, EU-27 energy dependency has been growing progressively: in 1999 it was 45,1%, in 2004 it was 50,2%, in 2009 it was 53,0% (EU, 2011) – overall, an increase of 9% in ten years.

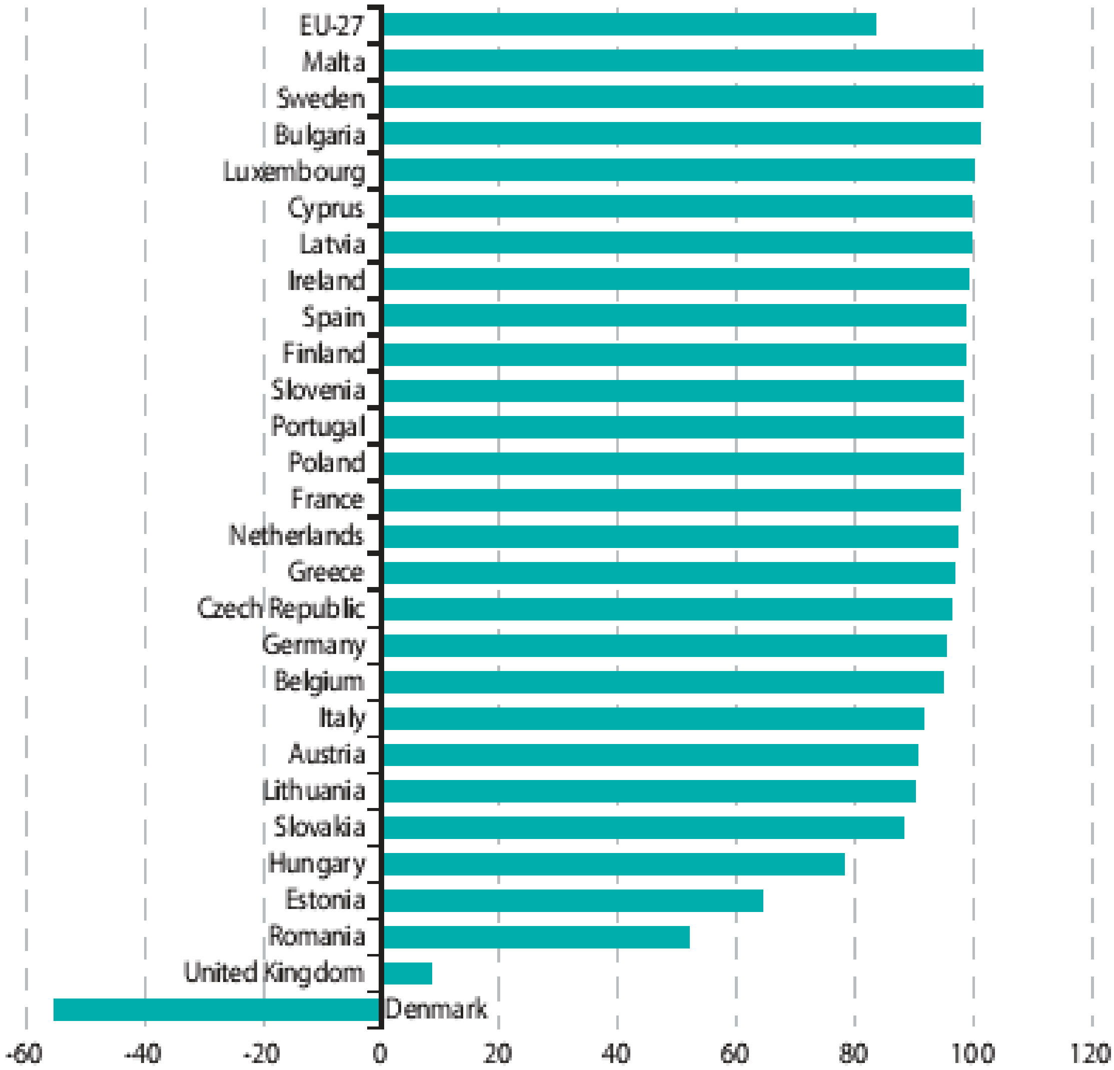
Fig. 9 - Energy dependency (%)



Source: EC (2013a), p. 23

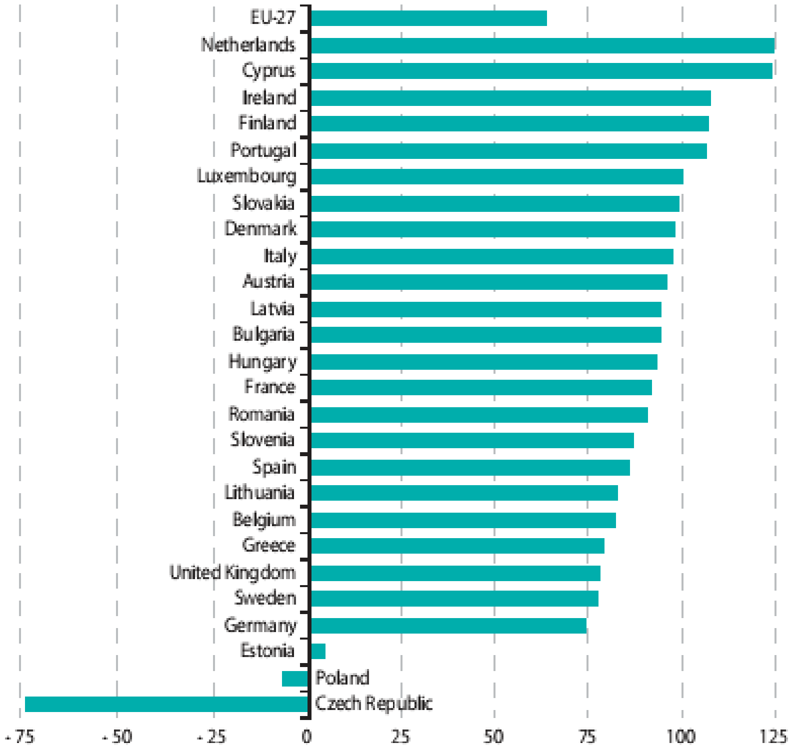
Different energy sources are characterized by different energy dependency ratios in different countries: the following figures (10-12) refer to oil, hard coal and derivates, and natural gas.

Fig. 10 - EU Member States' energy dependency (%): oil



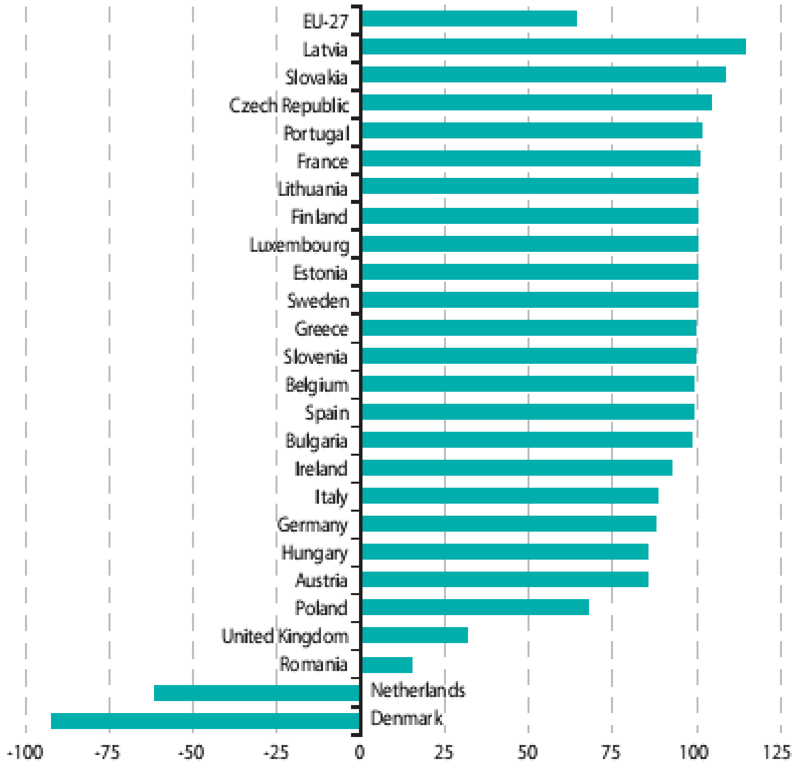
Source: Eurostat EC (2011a), p. 29.

Fig. 11 - EU Member States' energy dependency (%): hard coal and derivates



Source: Eurostat EC (2011a), p. 27.

Fig. 12 - EU Member States' energy dependency (%): natural gas



Source: Eurostat EC (2011a), p. 31.

The described heterogeneity notwithstanding, EU's energy dependency increased with time in relation to each of the mentioned sources. In all the three cases, EU's overall dependency has increased with time: in the case of oil from 72,9% in 1999 to 83,5% in 2009; in the case of hard coal and derivates from 38,6% in 1999 to 62,2% in 2009; in the case of natural gas from 47,9% in 1999 to 64,2% in 2009.
It obviously derives the main problem of EU energy security: the need to import energy sources from external countries (cf. Young, 2009, 2011). As it will be discussed, energy security may be defined in at least two ways:

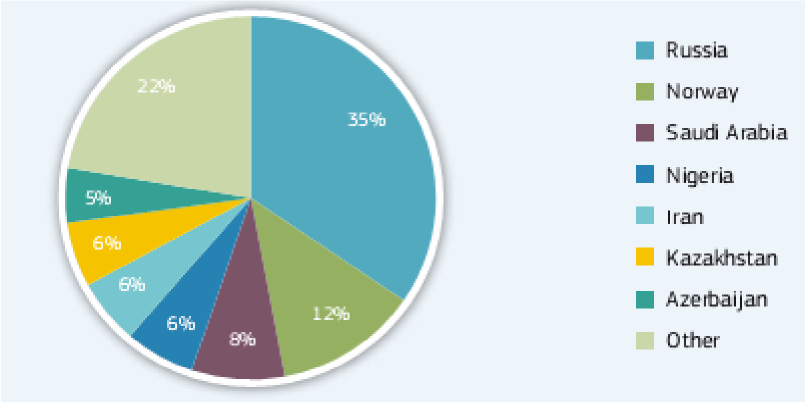
- "Energy security is the continuous availability of energy in varied forms, in sufficient quantities and at affordable prices" (UNDP, 2001).
- "Energy security, defined in general terms, means adequate and reliable supplies of energy at affordable prices" (IEA, 2007)

When confronting these definitions with the evidences presented in the previous paragraph, the main challenge related to EU energy security stands out clearly, i.e. the need to import energy sources from external countries and the related risks of a partial or total interruption of physical energy flow (*physical risk*) and/or a major shift in energy prices (*economic risk*) (Quemada, Garcia-Verdugo, Escribano, 2011). The high reliance on imports emphasise both these typologies of risks, for example because of the exposure to shortage of supplies in case of geopolitical conflicts or in case of technical problems on infrastructures, or because of the exposure to fluctuations in energy prices. This is the reason why the differentiation of energy sources and energy imports, and the promotion of self-reliance lay at the core of European energy strategies (see section 2 in this report for further details).

The problem of energy dependence poses a number of threats in terms of economic competitiveness. Taking a look at the evolution of fossil fuel prices from 2009 to 2012, the EU's import bill has gone up by €200 billion due to increasing fuel prices, and in 2012 the EU paid about 406 billion euro for oil and gas imports – 3.2% of its GDP. Of course it has to be considered that Europe is at the cutting edge of renewable energy technology and a world leader in wind energy (cf. Johnstone et al., 2010). Wind energy is already meeting 7% of the EU's electricity demand and it is hypothesised that the potential is still enormous (Kaldellis and Zafirakis, 2011).

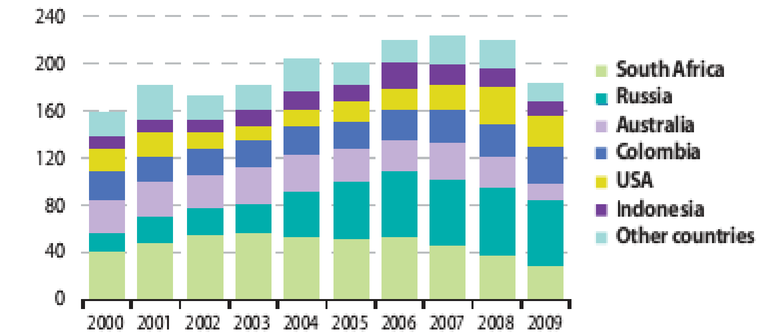
European imports of energy come from a limited number of key territories, whose relevance varies from source to source (see figures 13, 14 and 15 for imports of oil, hard coal and natural gas respectively).

Fig. 13 - EU imports of oil by country of origin (Mt)



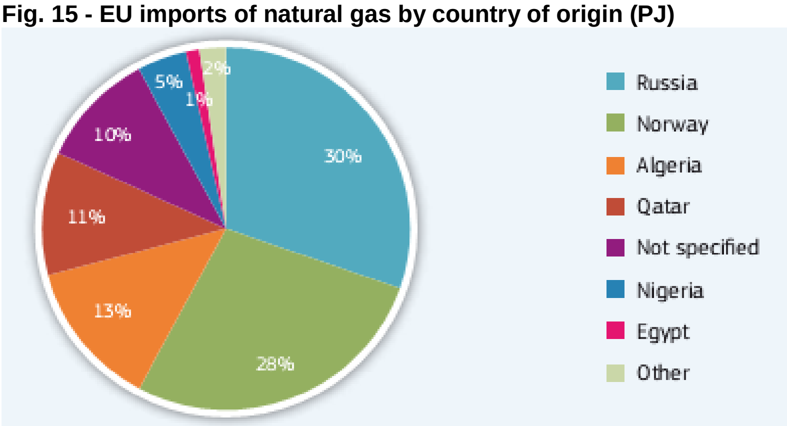
Source: EC (2013a), p. 24.

Fig. 14 - EU imports of hard coal by country of origin (Mt)



Source: Eurostat EC (2011a), p. 39.

Fig. 15 - EU imports of natural gas by country of origin (PJ)



Source: EC (2013a), p. 24.

The geography of European energy dependency shows the pivotal role of Russia as the one main partner providing oil, natural gas and solid fuels. This makes EU-Russia relations are considered highly strategic, as testified by the institutionalisation of the EU-Russia Energy Dialogue in Paris in the year 2000, with the remit of enabling "progress to be made in the definition of an EU-Russia energy partnership and arrangements for it" (cf. Averre, 2010, and the whole monographic issue on EU-Russia energy security in the journal *European Security*, v. 19, n .4, 2010). EU-

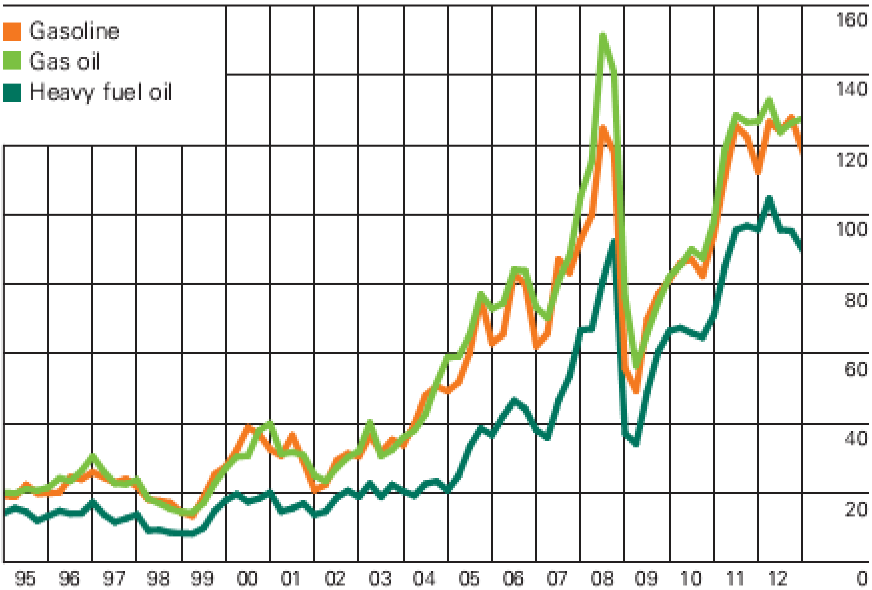
Russia Energy Dialogue has been both the first EU strategic energy policy Dialogue established with an external energy partner as well as the first sectoral Dialogue with Russia (EC, 2011c).

Secondly, it has to be considered that OPEC countries, all together, represent the region of origin of 36% on European oil imports, surpassing Russia (cf. EC, 2011d). High oil prices and uncertainty in oil markets have been encouraged, in many periods, by growth in oil demand and a reduction of spare capacity. In this context, the EU and OPEC have established in the second half of 2004 a bilateral dialogue to enhance producer-consumer relations. The EU aims at a more stable international oil markets and prices, an attractive investment climate, a more transparent market, a better market analysis and forecasts as well as, technological and international cooperation.

As a case for technical insecurity of infrastructures related to natural gas dependence, the January 2009 gas crisis constitutes a relevant example. As known, the Russia-Ukraine gas dispute of 2009 was basically a pricing dispute between Russia and Ukraine that occurred when Gazprom, the giant Russian natural gas company, refused to conclude a supply contract for 2009 unless Ukrainian gas company Naftogaz paid its debts. The dispute began in 2008 with a series of failed negotiations, and, on January 1, Russia cut off gas supplies to Ukraine. On January 7 the dispute turned to crisis when all Russian gas flows through Ukraine were halted for 13 days, completely cutting off supplies to South-Eastern Europe, and partially to other European countries. In synthesis, events exogenous to Europe, together with the lack of physical interconnections, a poor functioning of the EU internal market, resulted in several member States facing severe energy shortage for several days (Bilgin, 2009).

Similarly, figure 16 hints how the high volatility of energy prices may evidently affect and penalize European competitiveness and affect EU energy security. The price of energy in the EU depends on a range of different supply and demand conditions, including the geopolitical situation, import diversification, network costs, environmental protection costs, severe weather conditions, or levels of excise and taxation. In this sense, maintaining stable prices is a complex issue. At the same time, the price and reliability of energy supplies, electricity in particular, are key elements in a country’s energy supply strategy. Electricity prices are of particular importance for international competitiveness, as electricity usually represents a significant proportion of total energy costs for industrial and service-providing businesses. In contrast to the price of fossil fuels, which are usually traded on global markets with relatively uniform prices, there is a wider range of prices within the EU Member States for electricity or natural gas. The price of electricity and natural gas is also, to some degree, influenced by the price of primary fuels and, more recently, by the cost of carbon dioxide (CO2) emission certificates.

Fig. 16 - Fluctuations in energy prices, 1995-2012 (US dollars per barrel, Rotterdam product prices)



Source: BP (2013a), p. 14.

Moreover, one should notice that energy prices are not strictly connected only to phenomena taking place outside Europe. A relevant impact is exerted by the market distortion caused by different prices of energy in different countries, this being the reason for the EU aiming at the institution of a single, coherent energy market (see EC, 2012a). For instance, the difference source used for electricity generation and the fragmentation in a number of national economies results in very different final prices for end-users (figure 17).

The structure of national markets in the electricity sector contributes to market distortions and lack of competitiveness: figure 18 shows the market share of the largest electricity producers. Despite the growing liberalisation of the electricity sector, in some countries there is still a situation of oligopoly or even monopoly. But even the idea of monopoly, in the energy sector, may be controversial. This is the case of Electricité de France (EDF), the France state-owned electricity outfit, described by many French observers as a "national champion", but accused of unfair competition by other European observers. The case of Energias de Portugal (EDP), recently at the centre of a European dispute with antitrust, is also meaningful (Glachant and Lévêque, 2009).

Fig. 17 - Electricity prices, domestic consumers (Band DC: 2 500 kWh < Consumption < 5 000 kWh)

€/100 kWh 2nd Semester	2007	2008	2009	2010	2011	2012
EU-27	15.63	16.67	16.37	17.28	18.36	19.66
BE	16.83	21.52	18.64	19.74	21.19	22.23
BG	7.21	8.23	8.18	8.30	8.74	9.55
CZ	10.63	12.99	13.94	13.92	14.66	15.01
DK	24.01	27.85	25.53	27.08	29.75	29.72
DE	21.05	21.95	22.94	24.38	25.31	26.76
EE	7.86	8.50	9.20	10.04	10.42	11.23
IE	19.18	20.33	18.55	18.75	20.86	22.89
EL	9.84	10.99	10.32	12.11	12.38	14.18
ES	14.00	15.57	16.84	18.51	20.88	22.75
FR	12.22	12.03	12.07	13.50	14.23	14.50
IT	N/A	22.27	19.97	19.20	20.84	22.97
CY	15.73	20.40	16.42	20.21	24.13	29.09
LV	7.29	10.03	10.54	10.48	13.42	13.69
LT	8.70	8.65	9.26	12.16	12.21	12.68
LU	16.45	16.09	18.82	17.47	16.60	17.06
HU	12.96	15.53	16.62	15.74	15.53	15.57
MT	9.18	15.36	15.13	17.00	17.00	17.00
NL	17.20	17.80	18.41	16.96	17.73	18.95
AT	17.40	17.72	19.09	19.30	19.65	20.24
PL	13.80	12.95	12.91	13.82	13.51	15.29
PT	15.62	15.25	15.94	16.66	18.81	20.63
RO	11.41	11.03	9.79	10.52	10.85	10.75
SI	11.16	11.56	13.41	14.26	14.92	15.42
SK	13.70	15.26	15.60	16.37	17.10	17.22
FI	11.49	12.73	12.89	13.70	13.70	15.59
SE	16.13	17.46	16.46	19.58	20.44	20.83
UK	14.81	16.03	14.07	14.49	15.84	17.85

Source: EC (2013a), p. 118

In a similar way, variations in the final price of fuels between nations are meaningful and they mainly depend on the different taxation regimes (see the example in fig. 19). It has to be noticed that in 2011 the European Commission proposed to overcome the outdated rules on the taxation of energy products in the European Union, defining new rules aiming at restructuring the way energy products are taxed to remove current imbalances and take into account both their CO2 emissions and energy content. The logic is evidently to promote energy efficiency and consumption of more environmentally friendly products and to avoid distortions of competition in the Single Market.

Fig. 18 - Market share of the largest electricity producer

%	1999	2000	2005	2009	2010	2011
BE	92.3	91.1	85.0	77.7	79.1	70.7
BG						
CZ	71.0	69.2	72.0	73.7	73.0	69.4
DK	40.0	36.0	33.0	47.0	46.0	42.0
DE	28.1	34.0	31.0	26.0	28.4	
EE	93.0	91.0	92.0	90.0	89.0	87.0
IE	97.0	97.0	71.0	37.0	34.0	38.0
EL						
ES	51.8	42.4	35.0	32.9	24.0	23.5
FR	93.8	90.2	89.1	87.3	86.5	86.0
IT	71.1	46.7	38.6	29.8	28.0	27.0
CY	99.7	99.6	100.0	100.0	100.0	100.0
LV	96.5	95.8	92.7	87.0	88.0	86.0
LT	73.7	72.8	70.3	70.9	35.4	24.9
LU					85.4	82.0
HU	38.9	41.3	38.7	43.1	42.1	44.1
MT	100.0	100.0	100.0	100.0	100.0	100.0
NL						
AT	21.4	32.6				55.3
PL	20.8	19.5	18.5	18.1	17.4	17.8
PT	57.8	58.5	53.9	52.4	47.2	44.9
RO			36.4	29.3	33.6	26.0
SI			50.1	55.0	56.3	52.4
SK	83.6	85.1	83.6	81.7	80.9	77.7
FI	26.0	23.3	23.0	24.5	26.6	25.6
SE	52.8	49.5	47.0	44.0	42.0	41.0
UK	21.0	20.6	20.5	24.5	21.0	45.6

Source: EC (2013a), p. 85

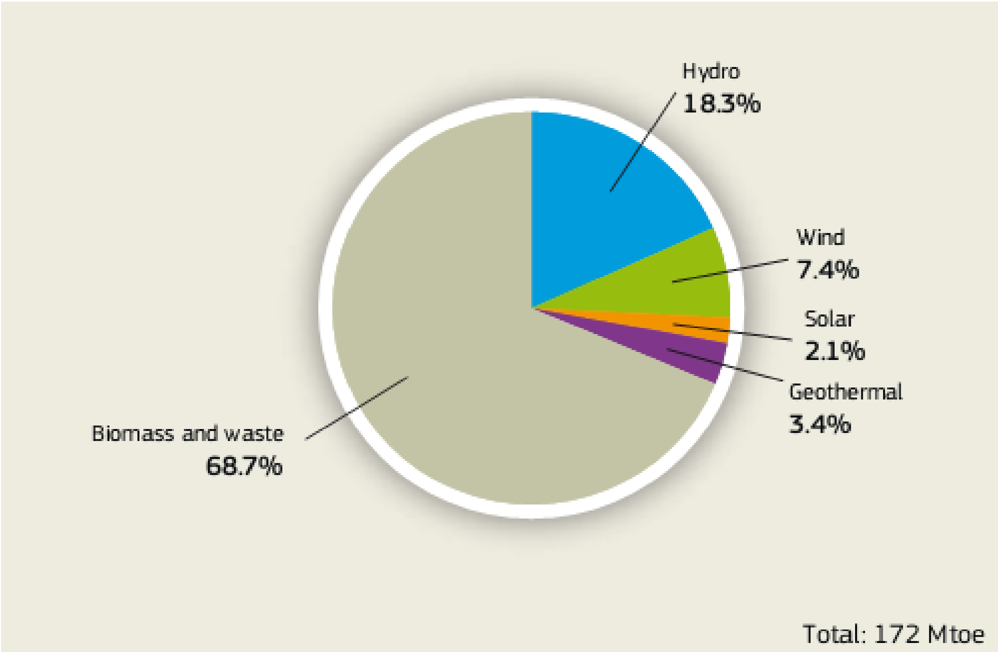
Fig. 19 - Price of of automotive diesel oil, all taxes included

Current Prices in € per litre	2005	2009	2010	2011	2012
EU-27*	1.03	1.01	1.17	1.37	1.50
BE	0.99	0.95	1.14	1.37	1.46
BG		0.84	0.98	1.17	1.27
CZ	0.93	0.99	1.21	1.39	1.45
DK	1.02	1.05	1.21	1.41	1.49
DE	1.06	1.07	1.20	1.38	1.49
EE	0.80	0.91	1.10	1.27	1.37
IE	1.03	1.02	1.22	1.41	1.55
EL	0.89	0.97	1.24	1.47	1.54
ES	0.90	0.91	1.07	1.27	1.37
FR	1.02	1.00	1.14	1.33	1.40
IT	1.11	1.08	1.21	1.44	1.71
CY	0.84	0.83	1.00	1.25	1.35
LV	0.80	0.92	1.06	1.27	1.37
LT	0.82	0.89	1.02	1.23	1.33
LU	0.84	0.85	0.99	1.17	1.26
HU	1.02	0.96	1.16	1.36	1.50
MT	0.88	0.96	1.04	1.30	1.37
NL	1.02	1.00	1.15	1.35	1.45
AT	0.95	0.97	1.10	1.33	1.41
PL	0.92	0.84	1.06	1.22	1.36
PT	0.93	1.00	1.15	1.37	1.45
RO		0.83	1.03	1.24	1.32
SI	0.91	1.01	1.15	1.24	1.36
SK	0.97	1.10	1.11	1.34	1.44
FI	0.97	0.99	1.13	1.37	1.55
SE	1.08	1.04	1.25	1.51	1.67
UK	1.33	1.17	1.39	1.60	1.76

Source: EC (2013a), p. 112

As it will be discussed later, a key strategy for both energy security and environmental sustainability is the promotion of renewable energy sources. Renewables include wind, solar, hydro-electric and tidal power as well as geothermal energy and biomass. More renewable energy will enable the EU to cut greenhouse emissions and make it less dependent on imported energy. Secondly, boosting the renewables industry it would encourage technological innovation and employment in Europe. As shown in figure 7, today European energy mix relies on renewable sources for 10%-13% (according to different statistical sources) of total energy consumption. Figure 20 describes the distribution of renewable sources.

Fig. 20 - Renewable energy sources: gross inland consumption of consumption by source as % of total Mtoe



Source: EC (2012a), p. 17.

1.2 EU geography of carbon emissions

The trend in carbon emission is obviously connected to the patterns in energy consumption described in the previous section. In the year 2010, the EU has contributed for 12,6% to global CO2 emissions (figure 21).

As shown in figure 22, EU's emissions have been relatively stable with time in absolute numbers, with a little decrease in the latest years, and particularly since 2008. However, when taking into account EU relative contribution to global CO2 emissions, a relevant decrease is observable[1].

The dynamics of CO2 emission, with details at the national scale, are presented in figure 22.

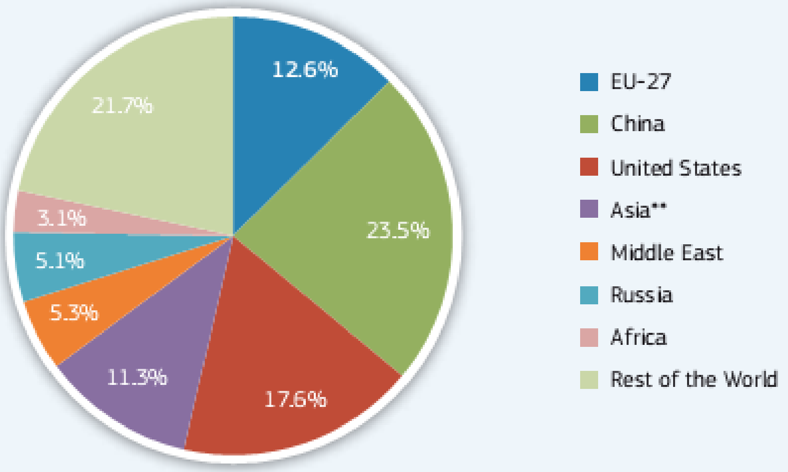
1 Various authors highlighted how this situation is directly correlated to the dynamics of the recent economic crisis, widely affecting "mature" economies such as Europe and North America, arguing that a EU recovery from the latter will plausibly result in an increase in emissions (Friedlingstein et al., 2010, Peters et al., 2012).

Fig. 21 - World CO2 emissions by region

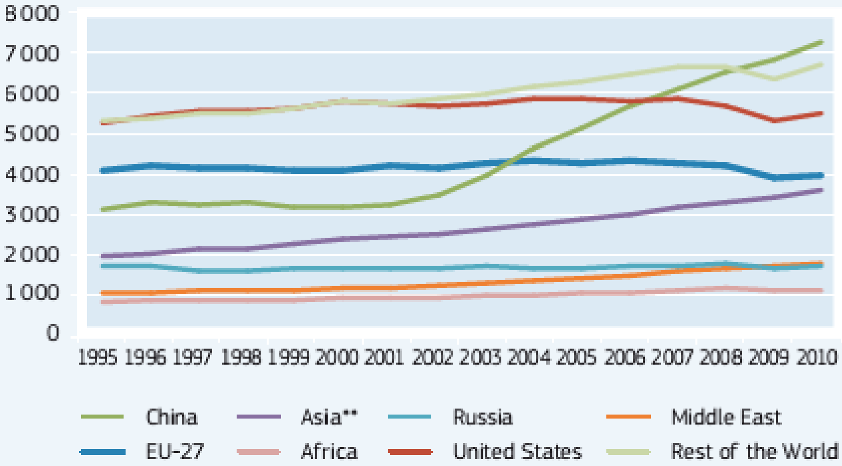
Mio ton CO_2 (Total)	1995	2000	2005	2009	2010	2010 (%)
EU-27	4 045	4 079	4 265	3 853	3 941	12.6 %
China	3 046	3 111	5 168	6 932	7 362	23.5 %
United States	5 275	5 844	5 922	5 325	5 516	17.6 %
Asia**	1 797	2 252	2 769	3 338	3 536	11.3 %
Middle East	846	982	1 279	1 577	1 648	5.3 %
Russia	1 589	1 519	1 531	1 538	1 605	5.1 %
Africa	635	719	863	968	967	3.1 %
Rest of the World	5 318	5 842	6 369	6 447	6 801	21.7 %
World	22 550	24 348	28 167	29 976	31 375	100.0 %

World CO_2 Emissions by Region (%)

Total 2010 = 31 375 Mio ton CO_2



World CO_2 Emissions by Region (Mio ton CO_2)



Source: EC (2013a), p. 17

Fig. 22 - EU-27 CO2 total emissions

Million ton CO_2	1995	2000	2005	2009	2010
EU-27	4 345	4 366	4 551	4 063	4 174
Index 1995	100 %	100 %	105 %	94 %	96 %
BE	139.9	145.6	153.8	135.2	140.3
BG	63.9	48.1	52.8	46.7	48.8
CZ	128.7	126.5	128.1	116.9	120.9
DK	67.7	60.2	55.9	52.2	53.3
DE	952.8	918.1	897.0	817.8	852.4
EE	18.3	15.5	17.0	15.0	19.0
IE	36.7	46.9	50.5	44.2	44.0
EL	100.7	117.1	124.9	115.4	108.2
ES	271.0	336.0	404.0	337.5	324.2
FR	410.6	434.5	446.9	398.5	406.3
IT	454.9	474.7	504.2	431.7	442.5
CY	7.1	8.6	9.7	9.9	9.5
LV	9.6	7.2	8.8	8.6	9.6
LT	15.9	12.4	14.8	13.5	14.5
LU	9.7	9.6	13.3	11.8	12.4
HU	62.2	59.4	61.4	51.3	52.1
MT	3.0	3.9	6.7	6.9	6.3
NL	213.7	222.4	240.9	226.0	234.6
AT	65.3	67.7	81.7	69.2	74.4
PL	360.6	317.8	319.8	314.4	334.4
PT	56.1	68.3	72.4	60.9	56.8
RO	135.9	101.4	108.9	89.1	87.8
SI	15.1	15.3	16.8	16.2	16.3
SK	45.0	41.4	42.8	36.2	38.2
FI	59.8	59.9	59.4	57.5	66.0
SE	63.8	60.8	61.9	56.0	61.7
UK	577.3	586.5	596.8	524.7	539.6

Source: EC (2013a) p. 153.

Of course, national data vary meaningful because of the different sizes of Member States. In order to provide a national comparison, it is useful to look at per-capita emission, reported in fig. 23.

Different living standards, different distributions of industrial activities, different energy mixes determine the huge differences between top-emitting countries (as Luxembourg, Malta, Estonia) and low-emitting countries (as Romania).

As a consequence of the so-called EU 20-20-20 strategy (see chapter 2.1 for further details) – aiming, among others, at a 20% reduction in EU greenhouse gas emissions from 1990 levels – the performances of the majority of the Member States in this concern is improving (see figure 24[2]).

[2] One should notice that the evidence presented in figure 30 does not take into account the launch of the European Union Emissions Trading System - EU ETS in 2005: see for example Grubb and Neuhoff, 2011).

Fig. 23 - CO2 emissions per capita

kg CO_2/cap	1995	2000	2005	2009	2010
EU-27	9 079	9 039	9 252	8 125	8 317
Index 1995	100 %	100 %	102 %	89 %	92 %
BE	13 804.2	14 214.9	14 680.0	12 527.3	12 889.1
BG	7 603.0	5 884.6	6 842.7	6 161.1	6 482.0
CZ	12 461.4	12 316.7	12 514.7	11 143.3	11 491.6
DK	12 954.0	11 274.5	10 321.9	9 447.8	9 606.9
DE	11 667.4	11 171.1	10 877.6	9 989.0	10 426.0
EE	12 629.4	11 329.4	12 586.0	11 186.8	14 198.4
IE	10 182.2	12 332.4	12 140.7	9 736.0	9 652.5
EL	9 465.8	10 722.9	11 245.7	10 226.4	9 569.2
ES	6 881.4	8 343.7	9 310.1	7 347.4	7 036.0
FR	6 914.6	7 155.2	7 097.7	6 181.3	6 267.5
IT	8 001.8	8 336.2	8 602.9	7 171.3	7 316.6
CY	10 943.7	12 379.5	13 110.0	12 225.0	11 443.2
LV	3 859.8	3 030.3	3 922.8	4 001.2	4 594.7
LT	4 372.8	3 555.0	4 467.3	4 271.0	4 669.9
LU	23 686.0	21 910.8	28 465.4	23 641.6	24 350.5
HU	6 022.4	5 813.1	6 083.5	5 116.5	5 207.3
MT	8 035.1	10 064.6	16 718.2	16 720.1	15 101.2
NL	13 823.7	13 966.0	14 765.4	13 672.6	14 122.0
AT	8 214.5	8 448.8	9 938.7	8 268.5	8 866.6
PL	9 420.5	8 307.2	8 380.6	8 242.0	8 682.8
PT	5 597.8	6 678.8	6 859.3	5 729.0	5 343.9
RO	5 994.1	4 519.2	5 034.0	4 148.7	4 095.7
SI	7 584.7	7 687.6	8 405.1	7 949.1	7 933.8
SK	8 386.9	7 667.9	7 935.7	6 677.1	7 028.0
FI	11 716.0	11 577.6	11 327.9	10 778.4	12 305.5
SE	7 226.9	6 856.3	6 850.2	6 017.1	6 574.6
UK	9 949.6	9 960.0	9 907.6	8 491.3	8 666.2

Source: EC (2013a), p. 158

Fig. 24 - Greenhouse gases emissions

Emissions Compared to 1990

Index 100=1990	1990	2000	2005	2005	2009	2010
EU-27	100	93	91	92	89	83
BE	100	105	102	100	95	87
BG	100	71	55	58	60	52
CZ	100	77	74	75	73	69
DK	100	111	99	93	93	88
DE	100	90	83	80	78	73
EE	100	49	42	45	48	40
IE	100	107	123	126	122	112
EL	100	105	121	129	125	119
ES	100	111	135	154	143	130
FR	100	99	101	101	96	92
IT	100	102	106	111	104	95
CY	100	155	156	171	176	172
LV	100	47	39	42	44	41
LT	100	44	39	46	49	40
LU	100	79	75	101	94	90
HU	100	81	79	82	75	69
MT	100	120	128	149	152	148
NL	100	105	101	100	96	94
AT	100	102	103	119	111	102
PL	100	95	84	85	88	83
PT	100	117	137	144	130	124
RO	100	72	55	59	58	49
SI	100	100	102	110	116	105
SK	100	74	69	71	70	62
FI	100	101	98	98	100	94
SE	100	102	95	93	87	82
UK	100	92	88	86	82	75

Source: EC (2013a), p. 29.

1.3 EU economic, social and environmental sustainability in relation to energy situation

It is well known that the concept of sustainability does not refer exclusively to the environment – considered through CO2 emissions, in this case – but to wider social and economic achievements. In this sense, the concept of sustainability is usually declined in the three spheres of economic sustainability, social sustainability and environmental sustainability.

This is exactly the approach at the basis of EU's analysis of sustainability. A key document is the 2006 EU Sustainable Development Strategy (SDS) (reviewed in 2009). The SDS describes how the EU will more effectively meet the challenge of sustainable development, with the aim to achieve a continuous improvement in the quality of life of citizens through sustainable communities that manage and use resources efficiently and promote ecological and social innovation, ensuring prosperity, environmental protection and social cohesion. This approach, therefore, closely mirrors the Lisbon strategy (that will be discussed in section 2).

The latest available resource is Eurostat European Commission (2011c; 2012), providing an extensive analysis of current situation and trends, in order to answer to the question "is EU on a sustainable development path"? Of course, it is not possible to give an absolute assessment of whether the EU is sustainable, as there is no political or scientific consensus on what this state of sustainability would be, or on the optimal levels for many of the indicators presented here. Rather, Eurostat European Commission (2011c) assesses the progress towards the objectives and targets of the SDS, which are intended to put the European Union on what has been implicitly defined as a path to sustainable development. The focus is therefore on 'sustainable development' rather than 'sustainability'

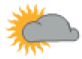
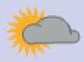
Eurostat European Commission (2011c) analyses more than a hundred statistical indicators. In order to provide a synthetic representation of EU's achievement of sustainable development, 11 indicators have been chosen and presented in fig. 25 (where SDI stands for sustainable development indicators).

It is possible to distinguish between different typologies:

- *Clearly favourable changes*. Recent developments can be considered as favourable for the headline indicator of the 'social inclusion' theme, with fewer and fewer people being at risk of poverty or social exclusion. Particularly relevant for this Report is the fact that changes can also be evaluated as clearly favourable for the two headline indicators related to 'climate change and energy'.
- *Moderately favourable changes* can be observed for the headline indicators related to 'socioeconomic development' and 'public health' as well as for one of the two 'natural resources' headline indicators.
- *Moderately unfavourable changes* refer to five of the eleven headline indicators, including those related to 'sustainable consumption and production', 'demographic changes', 'sustainable transport' and 'global

partnership' as well as one of the two headline indicators of the 'natural resources' theme.

Fig. 25 - EU Sustainable development: Evaluation of changes in the headline indicators since 2000.

SDI theme	Headline indicator	EU-27 evaluation of change
Socioeconomic development	Real GDP per capita	
Sustainable consumption and production	Resource productivity	
Social inclusion	Risk of poverty or social exclusion (*)	
Demographic changes	Employment rate of older workers	
Public health	Life expectancy and healthy life years (**)	
Climate change and energy	Greenhouse gas emissions	
	Consumption of renewables (***)	
Sustainable transport	Energy consumption of transport relative to GDP	
Natural resources	Abundance of common birds (****)	
	Conservation of fish stocks	
Global partnership	Official Development Assistance	
Good governance	*[No headline indicator]*	:

(*) From 2005.
(**) From 2002.
(***) From 2006.
(****) EU aggregate based on 19 Member States.

Source: Eurostat European Commission (2011c), p. 14

No headline indicator shows *clearly unfavourable changes*, suggesting that the European Union has made some progress along the path towards sustainable development. However, also Eurostat European Commission (2011c) specifies when additional indicators are taken into account, the overall picture may be less positive than the impression given by looking at the headline indicators in isolation. In this sense, Eurostat European Commission (2011c) presents more specific aggregations of data concerning the various sustainable development indicators (SDI themes) of figure 25.

For instance, when focussing on socioeconomic development, evidence shows that while some parameters are improving (reduction of regional disparities in GDP and employment, improvement of energy intensity), others are not (figure 26).

Fig. 26 - Evaluation of changes in the socioeconomic development theme (EU-27, since 2000)

Level 1	Level 2	Level 3
	Economic development	
 Real GDP per capita	 Investment	 Regional disparities in GDP
		 Household saving
	Competitiveness, innovation and eco-efficiency	
	 Labour productivity	 Research and development expenditure
		 Energy intensity
	Employment	
	 Employment	 Female Employment
		 Regional disparities in employment
		 Unemployment

Source: Eurostat European Commission (2011c), p. 47.

Similarly, also demographic change has a crucial role in influencing energy consumption. Here, a particularly problematic situation is represented by the growing share of elderly population (figure 27).

Fig. 27 focuses on one topic that is crucial for energy consumption that is demographic changes. As well known, a key problem for Europe is the growing share of elderly population. This demographic ageing is the outcome of a number of simultaneous demographic trends:

- the average number of children per woman, which stands at 1.5 children in the EU whereas the population replacement level is 2.1. The rate projected by the EU for 2030 is 1.6;
- the decline in fertility, known as ‘baby crash’, which followed the ‘baby boom’ is the cause of the large proportion of 45-65 year-olds in Europe's population, and poses a number of problems in terms of pension funding;
- life expectancy (which rose by eight years between 1960 and 2006) could continue to increase by a further five years between 2006 and 2050 and would thus result in a larger proportion of people surviving to the ages of 80 and 90 – an age when their health situation can often be delicate;
- immigration (1.8 million immigrants into the EU in 2004, 40 million in 2050 according to Eurostat European Commission) could offset the effects of low fertility and extended life expectancy.

These trends will slightly lower the total EU population, which will also become much older. The working-age population (15 to 64) in EU-25 will fall by 48 million between

2006 and 2050 and the dependency ratio is set to double, reaching 51% by 2050. This demographic change will also be accompanied by profound social changes (social protection, housing, employment) in all the countries confronted with the challenge of an ageing population.

Fig. 27– Evaluation of changes in the demographic changes theme (EU-27, since 2000)

Level 1	Level 2	Level 3
	Demography	
	Life expectancy at age 65 (men's) (*)	Fertility rate (*)
	Life expectancy at age 65 (women's) (*)	: Migration
		: Elderly population compared to working-age population
	Old-age income adequacy	
Employment rate of older workers	Income level of over-65s compared to before (**)	Risk of poverty for over-65s (**)
	Public finance sustainability	
	Public debt	Retirement age (***)
		: Expenditure on care for the elderly
		: The impact of ageing on public expenditure

(*) From 2002.
(**) From 2005.
(***) From 2001.

Source: Eurostat European Commission (2011c), p. 163.

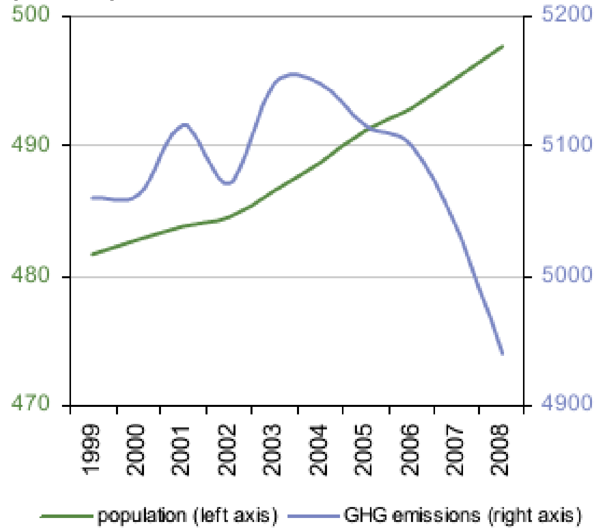
More in general, population can be one of the main driving forces of emissions in any high-carbon economy. The number of inhabitants drives consumption and subsequently different economic activities. A classical interpretative and qualitative formula from environmental studies is the I = PAT equation. The formula (of course simplistic) describes the impact of human activity on the environment:

$$I = P \times A \times T$$

In words: Human Impact (I) on the environment equals the product of P= Population, A= Affluence, T= Technology. This describes how our growing population, affluence, and technology contribute toward our environmental impact.

In the EU-27 the population grew by 3.3% from 1999 to 2008, i.e. 16 million people, by 2008, while GHG emissions declined (figure 29). Despite the long-term decrease, Eurostat European Commission projections forecast growing population midterm, an increase of about 22 million people by 2035 compared to 2008. Beyond that, as mentioned, the size of the population is expected to decrease.

Fig. 28 - EU-27 population and greenhouse gas emissions (million people, million tonnes of CO2 equivalent)



Source: Eurostat European Commission (2011b), p. 2.

Although a number of topics analysed by Eurostat European Commission analysis of EU sustainable development are strictly connected to energy security, an additional key theme directly connected to this topic is climate change (cf. Adelle et al., 2012) (figure 29).

Fig. 29 - Evaluation of changes in the climate change and energy theme (EU-27, since 2000)

Level 1	Level 2	Level 3
	Climate change	
	: Greenhouse gas emissions by sector	Greenhouse gas intensity of energy consumption
		: Global surface average temperature
	Energy	
Greenhouse gas emissions	Energy dependence	Gross inland energy consumption
Consumption of renewables (*)		Electricity generation from renewables
		Consumption of renewable energy in transport (*)
		Combined heat and power (**)
		Implicit tax rate on energy

(*) From 2006.
(**) From 2004.

Source: Eurostat European Commission (2011b), p. 218.

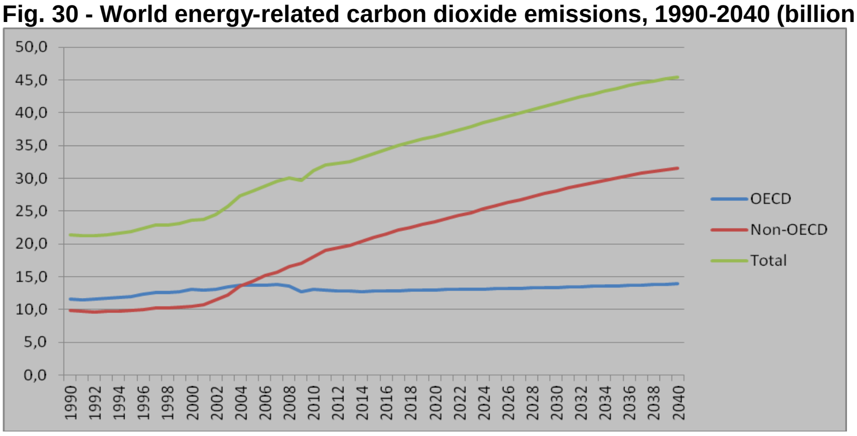
For the majority of the climate change and energy indicators progresses since 2000 have been relatively good, but unfavourable trends continue for some indicators. Although signs of a low-carbon transition are tangible, EU remains energy- and carbon-intensive (EC, 2010b). As most indicators linked to this theme are closely linked to economic growth, it is plausible to argue that the economic crisis has had a considerable impact on the achieved positive trends in terms of energy transition. In turn, the latter may be rather seen as temporary interruption of longer term trends then as the result of profound, structural changes.
All in all, however, one should notice that greenhouses gas emissions in the EU declined between 2000 and 2009, at a pace that may be sufficient to meet the 20% reduction target by 2020. Similarly, the EU is on the way to reach the target of 20% share of renewables in gross final energy consumption by the same year. Favourable developments can also be seen for the greenhouse gas intensity of energy consumption, in the use of renewable energy in transport, and in combined heat and power.

In contrast, the 2010 target of a 21% share of renewables in electricity production is unlikely to be met even though the share rose between 2000 and 2009. Also, as discussed in section 1.1, EU's dependence on energy imports has grown considerably since 2000, with about 54 % of energy consumption being met by imports from outside the EU. The implicit tax rate on energy has fallen since 2000, which is inconsistent with the EU objective of shifting the tax burden from labour to resource use. Finally, the development of cogeneration or combined heat and power which combines the production of useful heat with electricity generation has been steady but slow, reaching a share of 11.4 % of gross electricity generation in 2009.

1.4 Trends and forecast

Since the beginning of the debate on climate change, a number of forecasts of future trends and energy scenarios have been developed. With time, scenarios are adjusted and rearranged, producing very different outcomes. It is in fact evident that the production of a scenario for 2030 or 2040 implies the choice of a large number of hypothesis and assumptions concerning population growth, economic growth, prices, technologies, policies, etc.

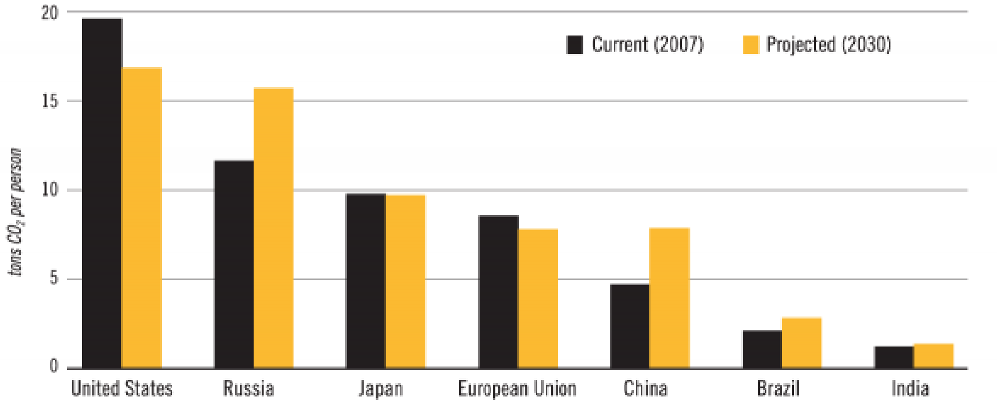
Fig. 30 - World energy-related carbon dioxide emissions, 1990-2040 (billion metric tons)



Source: personal elaboration based on EIA (2013) data.

According to EIA forecasts, often the most accredited in the production of scenarios, world emission will meaningfully grow in the next years. This increase will be almost entirely due to the growth of 'emerging countries' (non- OECD in the figure 30). Similarly, per capita emissions will increase mostly in the global South, while they are supposed to slightly diminish in Europe and Japan and to show a meaningful reduction in the US (fig. 31).

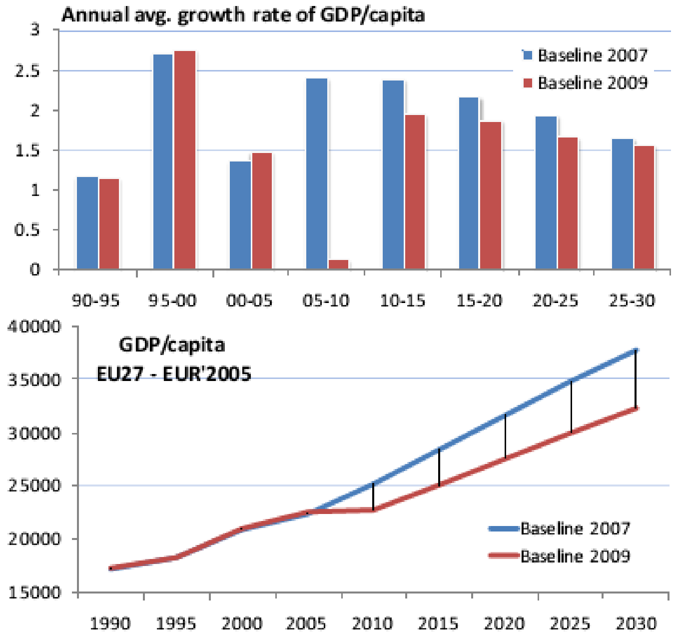
Fig. 31 - Per Capita CO2 Emissions for Select Major Emitters, 2007 and 2030 (Projected)



Sources: www.wri.org; notes: current: U.S. Energy Information Administration, 2009; projected: EIA, Annual Energy Outlook 2009. World Carbon Dioxide Emissions and Population by Region, Reference Case. DOE/EIA.

Concerning Europe, a number of projections and forecasts have been developed (see in particular: EC 2006, 2008 and 2010).

Fig. 32 - GDP growth: baseline 2007 and baseline 2009 scenarios



Source: EC (2010a), p. 15.

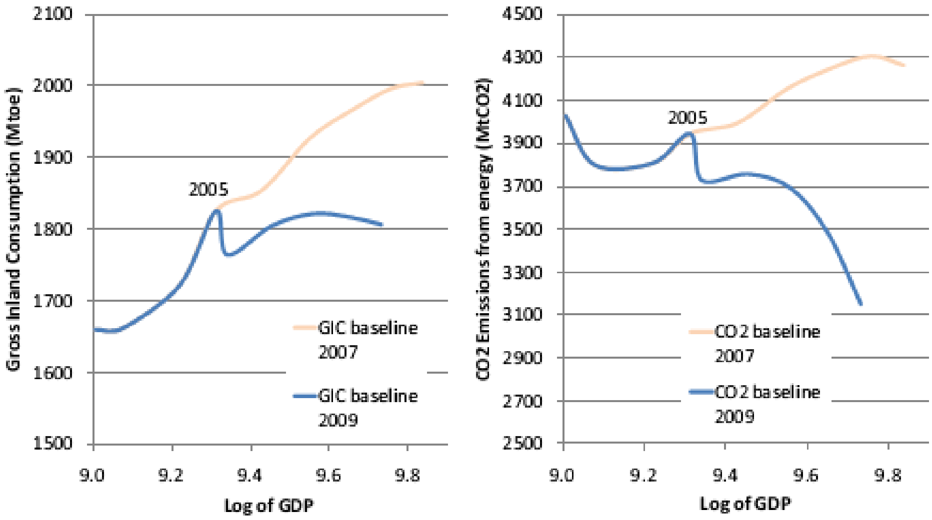
The most recent are proposed in EC (2010. See figure 32)[3]. The document presents two kinds of scenarios:

- *2009 Baseline*. The Baseline scenario determines the development of the EU energy system under current trends and policies[4]; it includes current trends on population and economic development including the recent economic downturn and takes into account the highly volatile energy import price environment of recent years. Economic decisions are driven by market forces and technology progress in the framework of concrete national and EU policies and measures implemented until April 2009. This includes the ETS and several energy efficiency measures but excludes the renewable energy target and the non-ETS targets.
- *Reference scenario*. The Reference scenario is based on the same macroeconomic, price, technology and policy assumptions as the baseline. In addition to the measures reflected in the baseline, it includes policies adopted between April 2009 and December 2009 and assumes that national targets under the Renewables directive 2009/28/EC and the GHG Effort sharing decision 2009/406/EC are achieved in 2020.

According to the *baseline scenario*, driven by the above mentioned policies and also because of the crisis, energy related CO2 emissions will decline continuously until 2030. The reduction attains 8.4% in 2020 from 1990 levels and 21.8% in 2030 (contrasting an increase in CO2 emissions, by 5.1% in 2020 and 5.4% in 2030 shown in the 2007 Baseline, see EC, 2008).

As shown in figure 33, it will be possible to have a considerable de-coupling of both energy consumption and carbon emissions from GDP growth.

Fig. 33 - Energy demand and CO2 emissions in relation to GDP – Baseline scenario

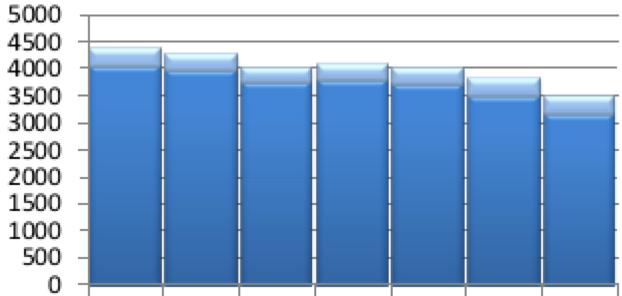


Source: EC (2010a), p. 24.

3 As the figure highlight, the previsions based on the so-called 'baseline 2009' scenario differ meaningfully from those based on the so-called 'baseline 2007 scenario' (EC, 2008), this being mostly due to the world economic crisis.
4 For a review of the latter, see section 3.

The net result will be a decrease in the total amount of CO_2 emissions, as shown in figure 34.

Fig. 34 - CO2 emissions, baseline scenario (Mt CO2)

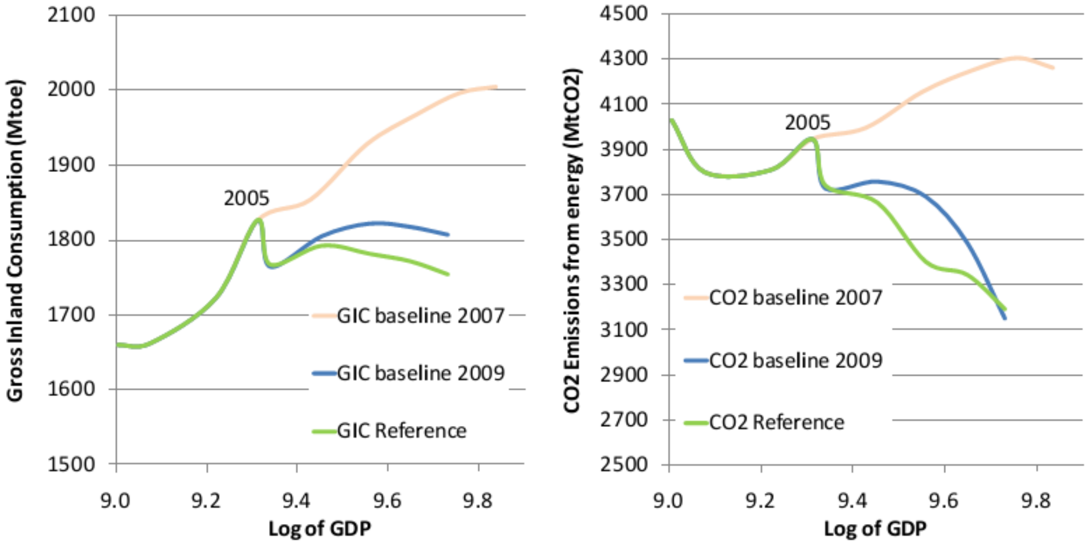


	1990	2005	2010	2015	2020	2025	2030
CO2 Emissions (non-energy related)	330	304	280	291	306	315	318
CO2 Emissions (energy related)	4031	3947	3728	3759	3692	3486	3152
All CO2	4360	4251	4008	4050	3998	3801	3470

Source: EC (2010), p. 32

Also in the case of the *reference scenario*, GDP growth and energy demand are decoupling. The additional polices of the reference case decrease primary energy requirements further. Gross inland consumption in the reference case is projected to be 9.5% lower in 2020 and 12.5% lower in 2030 than in the 2007 Baseline. Compared with the 2009 Baseline this represents a reduction of 2% in 2020 and of 3% in 2030 (figure 35).

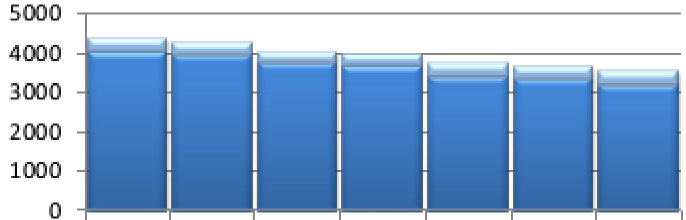
Fig. 35 - Energy demand and CO2 emissions in relation to GDP – Reference scenario



Source: EC (2010a), p. 40.

CO_2 emissions decrease faster than in the Baseline 2009 scenario up to 2020. After 2020, the decline becomes less steep resulting in a convergence of the carbon intensity of GDP in the Reference and Baseline 2009 scenarios by the year 2030[5] (figure 36).

Fig. 36 - CO2 emissions, reference scenario (Mt CO2)

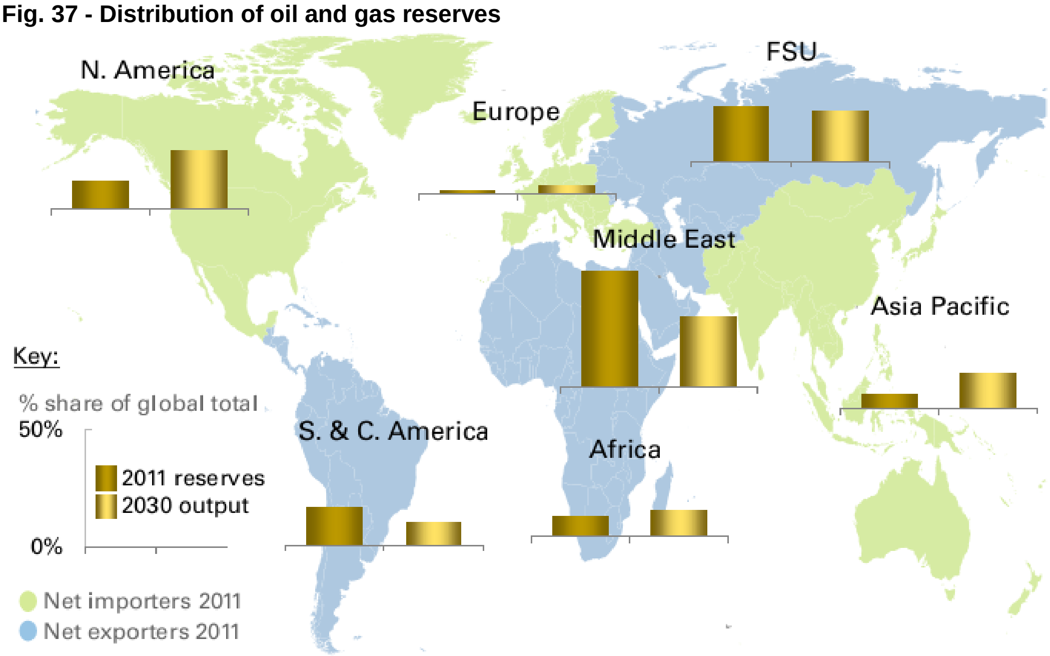


	1990	2005	2010	2015	2020	2025	2030
CO2 Emissions (non-energy related)	330	304	280	294	310	320	329
CO2 Emissions (energy related)	4031	3947	3740	3665	3403	3345	3194
All CO2	4360	4251	4021	3959	3714	3665	3522

Source: EC (2010a), p. 46.

Forecasts do not refer only to energy consumption and CO2 emissions: a number of previsions concerns variations in the distribution of oil and gas reserves, and consequently in the geography of imports and exports. Fig. 37 proposes a suggestive image from BP (2013), emphasising that the world's oil and gas importing regions – Asia Pacific, North America, and Europe – are expected to contribute a disproportional share of the world's oil and natural gas production to 2030.

Fig. 37 - Distribution of oil and gas reserves



Source: BP (2013b), p. 70.

5 Please note that given that greenhouse gasses concentrations matter for climate change, the development of cumulative emissions is decisive, and therefore the reference case is environmentally superior to the baseline.

2. Existing EU energy and environmental strategies and policies

2.1 EU general strategies and main policies

On March 2010, at the Spring Summit, EU Heads of State approved the European Commission's proposal for a *Europe 2020* economic strategy, the EU's growth strategy for the coming decade. Replacing the much-criticized Lisbon strategy, "Europe 2020. A European strategy for smart, green and inclusive growth" continues to promote EU growth based on knowledge and innovation, aiming at high-employment, but delivering social cohesion, and in a sustainable perspective (cf. Groenenberg et al., 2008; EC 20011e; Eurostat EC, 2013b). The goal of the strategy is to address the weaknesses of traditional EU growth model in order to create the conditions for a different kind of growth that is smarter (through more effective investments in education, research and innovation), more sustainable (thanks to a decisive move towards a low-carbon economy) and more inclusive (with a strong emphasis on job creation and poverty reduction).

To this end, the Strategy includes five headline targets to be reached by 2020. These cover employment; education; research and innovation; social inclusion and poverty reduction; climate and energy. Climate and energy issue are here tackled through measurable targets, known as the "20-20-20" targets, that the Member States have committed to reach by 2020 (da Graça Carvalho, 2012)[6]:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency.

According to the European Commission, these targets have to be realized through measures based on EU Emissions Trading System (EU ETS; Zhang and Wei, 2010), national targets for non-EU ETS Emissions (Effort Sharing Decision), national renewable energy targets and carbon capture and storage (Knudsen, 2012; Fisher, 2012).

The European Council, in line with positions of world leaders in the Copenhagen and the Cancun Agreements, has also defined a long-term strategy for decarbonisation. In order to keep climate change below 2ºC, the European Council reconfirmed in February 2011 the EU objective of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990, in line with Intergovernmental Panel on Climate Change recomendations (see also the long term perspectives set out by the Commission in 2011 in the "Roadmap for moving to a competitive low carbon economy in 2050", the "Energy Roadmap 2050" and the "Transport White Paper"; EC, 2012b).

The European document "Energy 2020. A strategy for competitive, sustainable and secure energy" (2011) puts forward ideas that could form the basis for a new

6 For a description of the main European strategies see par. 5.6 of the deliverable 1.1.

European energy strategy. It is based on the three core pillars already identified in the 2006 Green Paper “A European strategy for sustainable, competitive and secure energy” (Chester, 2010), that were:

- *sustainability*, to be achieved through actions including the development of competitive renewable energy sources, the diffusion of alternative transport fuels, the curbing of energy demand within Europe, the development of global actions to halt climate change and improve local air quality;

- *security of supplies*, that means tackling EU’s rising dependence on imported energy through integrated approaches. Possible approaches includes the promotion of demand reduction, the support for growing diversification of EU’s energy mix, with greater use of indigenous and renewable energy sources, the geographical differentiation of importers, the promotion of investments in energy-efficient technologies;

- *competitiveness*, implying the promotion of a functional, open and competitive internal energy market in order to allow improvements in the efficiency of energy grids, a decrease in energy prices, an increase in investments in clean energy production and energy efficiency, an overall improvement of EU economy in the global scenario.

In this perspective, the European Energy 2020 strategy focuses on five priorities that are:

1. *Achieving an energy-efficient Europe*. Efforts to improve energy efficiency should consider the whole energy chain, from energy generation and transformation to distribution and consumption (Solorio, 2011). Energy efficiency may be supported through technical innovations and investments, and it also concerns the empowerment of domestic and business consumers, their involvement in sustainable choices concerning energy savings, reduction of wastages and the switching to low-carbon technologies and fuels. Market instruments as emissions trading systems and taxation systems may be of great help in this framework (cf. Rio, 2012).

2. *Promoting a truly pan-European integrated energy market.* The hypothesis is that an integrated, interconnected and competitive market will lead to improvements in efficiency. Currently, Europe is largely fragmented into separate national energy markets characterized by monopoly or oligopoly (see Glachant and Lévêque, 2009; Meuss, 2011; Birchfield and Duffield, 2011). In order to promote market integration, the Commission has identified 12 priority corridors and areas, and 248 key energy infrastructure projects concerning energy transport networks (see the “Guideline for trans-European energy infrastructure” in chapter 3). Specific emphasis is posed on the Southern Gas Corridor, as natural gas will probably continue to play a key role in the EU’s energy mix in the coming years and gas can also gain importance as the back-up fuel for variable electricity generation (Finon, 2011; Bilgin, 2009). At the same time, smart meters and power grids are crucial for promoting renewable energies, energy savings and improvements in energy services (see the Communication “Smart Grids: from innovation to

deployment"; see Faruqui et al, 2010; Clastres, 2011). Finally, construction of new interconnections at Europe's borders should receive the same attention and policies as intra-EU projects in order to ensure the stability and security of supplies.

3. *Empowering consumers and achieving the highest level of safety and security.* It is crucial to guarantee trust, protect consumers and to help them play an active role (for a critical review see Kolk, 2012). As energy, in particular electricity, constitutes a substantial part of the total production costs of key European industries, it is crucial to provide affordable but cost-reflective and reliable supplies (see Bunse et al., 2011). Safety nets are also necessary, for example for vulnerable consumers. Promoting cooperation, competition and common regulation between Member States can also contribute to diversification of supply sources. The internal market is also hampered when Member States are not fully interlinked, such as in the Baltic States (Roos et al., 2012). Energy policy is also responsible for protecting European citizens from the risks of energy production and transport. For example, a controversial topic is nuclear power (Visschers et al., 2011): currently, mainstream EU position is that Europe must continue to be a world leader in developing systems for safe nuclear power, the transport of radioactive substances, as well as the management of nuclear waste (see Marrero, 2010; Dittmar, 2012). International collaboration on nuclear safeguards plays a major role in ensuring nuclear security and establishing a solid and robust non-proliferation regime (cf. Nuttall and Newbery, 2010). In the oil and gas exploitation and conversion sector, the EU legislative framework should guarantee the highest level of safety and an unequivocal liability regime for oil and gas installations.

4. *Extending Europe's leadership in energy technology and innovation.* Decarbonising is strictly connected to technological shifts (cf. Cox and Rigby, 2013; Shmidt et al., 2012; Nilsson and Rickne, 2012). The EU ETS is an important demand-side driver supporting the deployment of innovative low-carbon technologies (cf. Kemp and Pontoglio, 2011). New technologies will reach markets more quickly and more economically if they are developed through collaboration at the EU level. Europe-wide planning and management is therefore paramount for investment stability, business confidence and policy coherence. The Strategic Energy Technology (SET) Plan sets out a medium-term strategy. Main technologies to be developed concerns second-generation biofuels, smart grids, smart cities and intelligent networks, Carbon Capture and Storage, electricity storage and electro-mobility, next-generation nuclear, renewable heating and cooling (Fisher, 2012). The resources required in the next two decades for the development of these technologies are very significant, especially when seen in the context of the current economic crisis (Wüstenhagen and Menichetti, 2010; Schneider et al., 2010). The EU is facing fierce competition in international technology markets; countries such as China, Japan, South Korea and the USA are pursuing an ambitious industrial strategy in solar, wind and nuclear markets (Jänicke, 2012; Timilsina et al., 2012).

5. *Strengthening the external dimension of the EU energy market*. As emphasised in the Communication "The EU Energy Policy: Engaging with Partners beyond Our

Borders", the Commission supports intergovernmental energy agreements between Member States and third countries in order to pursue security of supply, competitiveness and sustainability (cf. Missiroli, 2010; Young, 2011). Both relations with producing and transit countries, and relations with large energy-consuming countries developing countries are of great importance. The EU already has a series of complementary and targeted frameworks ranging from specific energy provisions in bilateral agreements with third countries (Free Trade Agreements, Partnership and Cooperation Agreements, Association Agreements, etc.) and Memoranda of Understanding on energy cooperation, through to multilateral Treaties such as the Energy Community Treaty and participation in the Energy Charter Treaty. At the same time, more effective coordination at EU and Member State level is needed. Of course, the external dimension of EU energy policy must be coherent with other external dimensions concerning development, trade, climate and biodiversity, enlargement, Common Foreign and Security Policy, etc.

2.2 EU renewable energy and energy efficiency policy

2.2.1 Renewable energy policy

The existing EU energy and environmental policy package includes numerous strategies, directives and regulations (Kanellakis et al., 2013). The most significant of these are:

- Europe 2020 - a strategy for smart, sustainable and inclusive growth;
- A Roadmap for moving to a competitive low carbon economy in 2050;
- EU Emissions trading system;
- the security of supply directive;
- the third internal energy market package;
- renewable energy directive, the energy efficiency directive and carbon capture and geological storage directive.

Recently, a number of proposals relating to the EU energy sector have been put forward, including: a trans-European energy infrastructure regulation, the connecting Europe facility and guidance to Member States on state intervention in electricity markets.

To increase the use of energy from renewable sources is among the main objectives of EU energy policy. To develop renewable sector as well as to meet the energy objectives established in the Europe 2020 Energy strategy and in the Roadmap 2050, the EC adopted the directive 2009/28/EC focusing on the promotion of the use of energy from renewable energy sources (RES). The directive 2009/28/EC approved mandatory targets of a 20% share of energy from renewable sources in overall EU energy consumption by 2020 and a 10% target for each Member State regarding the share of renewable energy consumption in transport by 2020.

It must be emphasized that to access the grid is essential for renewable power plants. Therefore, the directive 2009/28/EC requires that transmission system operators[7] and distribution system operators[8] all over the EU guarantee the transmission and distribution of electricity produced from RES. When dispatching electricity, transmission system operators are to give priority to installations using RES so far as the secure operation of the national electricity system allows it. Additionally, steps towards the development of infrastructure for energy transmission and distribution, smart grids[9] and storage facilities must be taken, so as to facilitate a secure operation of the electricity system as it integrates electricity production from RES.

In addition, the directive establishes cooperation mechanisms by which Member States can join together to develop RES. Using such mechanisms aims at overcoming national approaches towards a joint European perspective to the development of renewable energy. They include:

a) statistical transfers whereby one Member State with a surplus of renewable energy can sell it statistically to another Member State, whose renewable energy sources may be more expensive. One Member State gains a revenue, at least covering the cost of developing the energy, the other gains a contribution towards its target at lower cost;
b) joint projects whereby a new renewable energy project in one Member State can be co-financed by another Member State and the production shared statistically between the two. Joint projects can also occur between a Member State and a third country, if the electricity produced is imported into the EU, (e.g. from North Africa);
c) joint support schemes whereby two or more Member States agree to harmonize all or part of their support schemes for developing renewable energy, to clearly integrate the energy into the single market, and share out the production according to a rule.

It should be highlighted that the Renewable Energy Directive also proposed to translate the EU 20% target into individual targets for each Member State. As a consequence, binding national targets for RES shares over final energy consumption have been introduced in each Member State. Moreover, to ensure that the mandatory national overall targets are achieved, Member States established National

7 A transmission system operator (TSO) is an entity entrusted with transporting energy in the form of natural gas or electrical power on a national or regional level, using fixed infrastructure.
8 Distribution system operator (DSO) means a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long term ability of the system to meet reasonable demands for the distribution of electricity or gas.
9 A smart grid is a modernized electrical grid that uses information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.

Renewable Energy Action Plans (NREAP) as well (Beurskens and Hekkenberg, 2011).

As shown in table 1, according to NREAP, Sweden, Latvia, Portugal, Finland, Denmark and Austria have a national target for the share of renewable energy in the year 2020 of 30-50%, meanwhile, Spain, Slovenia, Romania, Estonia, Greece, France, Lithuania have national target for the share of renewable sources in gross final consumption of energy in 2020 is higher than 20-25%, and rest fourteen EU Members (Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Hungary, Ireland, Italy, Luxembourg, Malta, Netherlands, Poland, Slovakia and United Kingdom) have renewable targets less that 20%.

Recently the EC estimates Member States' progress in the promotion and use of renewable energy along the trajectory towards the 2020 targets (EC, 2013). As seen in table 1, the most Member States have experienced significant growth in renewable energy. Austria, Finland, Latvia, Sweden have the highest share of renewables in their energy mix, between 30% and 45%; Denmark, Estonia, Lithuania, Portugal, Romania showing the penetration of renewable in total energy mix between 20% and 25%. Conversely, Belgium, Cyprus, Ireland, Luxembourg, Netherlands and United Kingdom have the lowest share of renewables in energy consumption (3-4%), while it is 0.4% for Malta.

Tab. 1 - Overview of Member States' renewable progress and target, %

Member State	RES share in gross final energy consumption		RES target established by the 2009/28/EC Directive	National targets established by NREAPs
	2005	2011		
Austria	23.8	30.9	34.0	34.2
Belgium	2.3	4.1	13.0	13.0
Bulgaria	9.2	13.8	16.0	18.8
Cyprus	2.6	5.4	13.0	13.0
Czech Republic	6.1	9.4	13.0	13.5
Denmark	16.0	23.1	30.0	30.5
Estonia	17.5	25.9	25.0	25.0
Finland	28.6	31.8	38.0	38.0
France	9.5	11.5	23.0	23.3
Germany	6.0	12.3	18.0	19.8
Greece	7.2	11.6	18.0	20.2
Hungary	4.5	9.1	13.0	14.7
Ireland	2.8	6.7	16.0	16.0
Italy	5.1	11.5	17.0	16.2
Latvia	32.3	33.1	40.0	40.0
Lithuania	17.0	20.3	23.0	24.2
Luxembourg	1.4	2.9	11.0	8.9
Malta	0.0	0.4	10.0	10.2
Netherlands	2.1	4.3	14.0	14.5
Poland	7.0	10.4	15.0	15.5
Portugal	19.8	24.9	31.0	31.0
Romania	17.6	21.4	24.0	24.0
Slovakia	6.6	9.7	14.0	15.3
Slovenia	16.0	18.8	25.0	25.3
Spain	8.4	15.1	20.0	22.7
Sweden	40.4	46.8	49.0	50.2
United Kingdom	1.4	3.8	15.0	15.0
EU - 27	8.5	13.0	20.0	-

Source: European Commission (2013), Communication from the Commission to the European Parliament and the Council, Renewable Energy progress report.

In spite of the fact that Member States have experienced growth in renewable energy, based on a variety of studies (EC, 2013; EREC, 2013) and relevant researches on evaluating EU renewable energy policy (Jacobsson et al., 2009; Klessmann et al., 2011; Kitzing et al., 2012;) the achievement of the ambitious 2020 and 2050 RES targets however is still hindered by numerous barriers:

a) *economic and market barriers* - RES not cost-competitive under current market conditions: high capital costs, unfavorable market pricing rules, subsidies for competing fuels, long reinvestment cycles of building-integrated technologies etc.; limited access to finance and high cost of capital due to high perceived risk; power markets are not prepared for RES; lack of access to the power markets, exercise of market power by large players, design not favourable for supply-driven RES, etc.

b) *legal barriers,* including inefficient administrative procedures (high number of authorities involved, lack of coordination among authorities, lack of transparent procedures, long lead times, high costs for applicants etc.); RES not or insufficiently considered in spatial planning; no or insufficient standards and codes for RES equipment (specifications not well defined, not expressed in EU and international standards, etc.); tenancy law and ownership law impede the development of building-integrated RES technologies.
c) *infrastructural and grid-related barriers* (mainly power grids, but also gas and district heat) - grid access is difficult to obtain (transmission system operator and distribution network operator not open to RES, lack of transparent procedures, long approval times, unfavorable cost allocation leading to high grid connection costs); lack of available grid capacity (weak grid environment, lack of interconnection capacity, no or slow grid reinforcement and/or extension, grid congestion leading to curtailment).
d) *lack of skilled labour* - lack of skilled labour (e.g. for planning and installation), problems with the guarantee and warranty and maintenance regime; lack or shortcomings of certification schemes for installers.
e) *supply chain bottlenecks* - restricted access to technologies (only a few technology providers, lack of production capacity, lack of R&D capacity), bottlenecks regarding feedstock supply (e.g. steel, silicon, etc.).
f) *information and social acceptance barriers* - lack of knowledge (about benefits of RES, about available support measures, etc.); lack of acceptance (not in my back yard opposition to RES plants and power lines, public concerns about sustainability of biofuels etc.).
g) *economic instability* - the changed economic climate has clearly an impact (fully or partially) on the development of new renewable energy projects and national renewable energy action plans commitments.

Another significant barrier is the insufficiency of investments in RES sector. Based on research studies (de Jager et al., 2011; Ragwitz et al., 2011a; Ragwitz et al., 2011b) in order to achieve the targeted 20% renewable energy production in EU, the annual investment volume should amount to 60-80 billion euro, compared to the current annual investment of 30-50 billion euro. The EU renewable energy markets currently do not trigger sufficient investment levels, even with the financial supports available from EC policy schemes as well in all Member States. Therefore, the EU energy policy must substantially increase the funding share for renewable energy technologies.

In addition to the abovementioned policy measures, the EC also established a series of tools aiming at supporting RES diffusion. Among them, a relevant role is played by the European Technology Platforms concerning Wind Energy, Photovoltaic Technology, Biofuels Technology, Electricity Networks, Renewable Heating and Cooling, Zero Emission Fossil Fuel Power Plants, Sustainable Nuclear Technology and the Fuel Cells and Hydrogen. These Platforms constitute as many supporting tools, whose mission is to develop a strategy and corresponding implementation plan for research and technology development, innovation and market deployment of renewable energy.

2.2.2 *Energy efficiency policy*

Aside from renewable energy target, the EC has committed to reach the objective of 20% primary energy savings in 2020 compared to a baseline. In order to meet these objectives, the EU has realized a variety of energy efficiency policies and directives. The most important initiatives relevant for energy efficiency include the Effort Sharing Decision 406/2009/EC, the Energy Performance of Buildings Directive 31/2010/EC, the Eco-design Directive 2009/125/EC, the Labeling Directive 2010/30/EC, Minimum standards for electric motors, Minimum standards for commercial lighting, the Energy Efficiency Plan, the Energy Efficiency Directive 2012/27/EU.

The Energy Efficiency Directive includes general energy efficiency policies and measures addressing specific energy consumption sectors as e.g. buildings, transport, industry, energy audits and management systems. The Energy Efficiency Directive also establishes a requirement for Member States to set indicative national energy efficiency targets for 2020, which are to be determined nationally and can be based on different indicators such as primary or final energy consumption, or primary or final energy savings, or energy intensity as shown in table 2.

In the case of energy efficiency in building sector, the EC adopted new Energy Performance of Buildings Directive. It introduced the following novelties: new buildings will have to consume nearly zero energy and use to a very large extent renewables in 2020; public authorities that own or occupy a new building should set an example by building, buying or renting nearly zero energy building; Member States shall develop measures to stimulate the refurbishment of buildings into very low energy buildings; minimum requirements for components are introduced for all replacements and renovations; a more detailed and rigorous procedure for issuing energy performance certificates with mandatory controls required to check their correctness; introduction of penalties for non-compliance.

In terms of the energy efficiency in transport sector, the EC adopted White Paper on transport focusing on passenger cars, vans and aviation. Specific energy efficiency policy in transport include: regulations setting CO_2 limits for new passenger cars and vans; regulations requiring gear shift indicators in new passenger cars; regulations requiring tyre pressure monitoring systems in new cars, the use of low rolling resistance tyres on new cars, and the introduction of a labeling scheme specifying the rolling resistance of tyres; inclusion of the aviation sector in the EU Emission trading scheme. Looking forward, the White Paper on transport has also set a target for the reduction of GHG emissions from transport, of 60% by 2050 from 1990 levels.

Tab. 2 - Overview of Member States' national energy efficiency targets for 2020

Member State	Indicative national energy efficiency targets for 2020	Absolute 2020 lelel of energy use [Mtoe]	
		Primary	Final
Austria	Final energy consumption of 1100 PJ	31.5	26.3
Belgium	Reducing primary energy consumption by 18% compared to projections for 2020	43.7	32.5
Bulgaria	Increase of energy efficiency by 25% until 2020 (5 Mtoe primary energy savings in 2020) and 50% energy intensity reduction by 2020 compared to 2005 levels	15.8	9.16
Cyprus	0.463 Mtoe energy savings in 2020 (14.4% reduction compared to BAU)	2.8	2.2
Czech Republic	Energy use shall be 20% more efficient by 2020	39.6	24.4
Denmark	Primary energy consumption of 744.4 PJ (17.781 Mtoe) in 2020	17.8	14.8
Estonia	Stabilisation of final energy consumption in 2020 at the level of 2010	6.5	2.8
Finland	310 TWh of final energy consumption in 2020	35.9	26.7
France	17.4% reduction of final energy consumption in 2020 compared to a baseline	236.3	131.4
Germany	Annual improvement of energy intensity by 2.1% pa. on average until 2020	276.6	194.3
Greece	Final energy consumption level of 20.5 Mtoe	27.1	20.5
Hungary	1113 PJ primary energy consumption in 2020 (236 PJ savings compared to business-as-usual), resulting in 760 PJ final energy consumption	26.6	18.2
Ireland	20% energy savings in 2020 along with a public sector energy saving target of 33%	13.9	11.7
Italy	20 Mtoe primary energy reduction by 2020, 15 Mtoe final energy reduction by 2020	158.0	126.0
Latvia	Primary energy savings in 2020 of 0.670 Mtoe (28 PJ)	5.37	4.47
Lithuania	17% reduction in final energy use compared to 2009 level (reduction of 740 ktoe)	-	5.4
Luxembourg	Energy use shall be 20% more efficient by 2020	4.48	4.24
Malta	22% energy or 237.019 toe savings target by 2020	0.825	0.493
Netherlands	1.5% energy savings per year(partial)	60.7	52.1
Poland	13.6 Mtoe primary energy savings in 2020	96.4	70.4
Portugal	Reduction of primary energy use in 2002 by 25%	22.5	17.4

	compared to projections		
Romania	Reduction of 10 Mtoe (19%) in the primary energy consumption	42.99	30.32
Slovakia	3.12 Mtoe of final energy savings for the period 2014-2020	16.2	10.4
Slovenia	10.809 GWh energy savings by 2020	-	-
Spain	20% energy savings to be achieved by 2020	121.6	82.9
Sweden	Energy use shall be 20% more efficient by 2020 compared with 2008 and a 20% reduction in energy intensity between 2008 and 2020	45.9	30.3
United Kingdom	Final energy consumption in 2020 of 129.2 Mtoe on a net calorific value basis	177.6	157.8

Source: Miladinova, G. (2011), "New EU energy efficiency policies and how to measure the progress?", Presentation DG Energy, European Commission

In view of energy efficiency progress, recently, the European Environment Agency conducted an evaluation of progress on energy efficiency (EEA, 2013), concluding in overall terms that, progress in energy efficiency in the last years across Member States was rather modest. As seen in table3, only four Member States (Bulgaria, Denmark, France and Germany) are making good progress in reducing energy consumption and primary energy intensity through well-balanced energy efficiency policy packages. The other Member States, however, did not make significant energy efficiency progress; the current energy efficiency policies are not sufficiently developed and implemented.

Tab. 3 - Overview of Member States' energy efficiency progress

Member State	Primary energy consumption (Mtoe)		Absolute change primary energy consumption	Final energy consumption (Mtoe)		Absolute change final energy consumption
	2005	2011	Index, 2005=100, %	2005	2011	Index, 2005=100, %
Austria	32.7	32.4	99.0	28.1	27.3	97.1
Belgium	51.5	52.0	101.1	36.6	38.9	106.3
Bulgaria	19.2	18.8	97.7	10.0	9.3	92.6
Cyprus	2.4	2.6	106.5	1.8	1.9	104.4
Czech Republic	42.3	40.7	96.3	26.0	24.6	94.7
Denmark	19.5	18.7	96.0	15.5	14.7	94.7
Estonia	5.4	6.1	113.8	2.9	2.8	99.2
Finland	33.7	34.4	102.0	25.5	25.2	98.7
France	260.3	245.4	94.3	162.4	148.1	91.2
Germany	314.7	286.4	91.0	229.5	207.1	90.2
Greece	30.6	27.0	88.3	20.8	18.8	90.5
Hungary	25.5	23.3	91.0	18.2	16.3	89.6
Ireland	14.8	13.6	91.7	12.5	10.8	86.3
Italy	179.9	161.9	90.0	134.6	122.3	90.9
Latvia	4.4	4.1	94.5	4.0	4.0	99.0
Lithuania	8.0	5.8	73.3	4.6	4.7	102.1
Luxembourg	4.8	4.6	95.2	4.4	4.3	96.3
Malta	0.9	1.1	118.1	0.4	0.4	114.7
Netherlands	69.5	67.4	96.9	52.3	50.7	96.9
Poland	88.5	97.3	109.9	58.2	64.7	111.2
Portugal	24.9	22.2	89.1	19.0	17.4	91.5
Romania	36.8	33.9	92.4	25.1	22.6	90.0
Slovakia	17.6	16.0	91.0	11.1	10.8	97.5
Slovenia	7.0	7.1	102.2	4.9	5.0	101.6
Spain	136.0	121.8	89.5	97.5	86.5	88.8
Sweden	49.4	47.6	96.2	33.6	32.2	95.7
United Kingdom	222.5	190.7	85.7	152.3	132.0	86.7
EU - 27	1711.0	1591.0	93.0	1198.2	1109.4	92.6

Source: Eurostat, 2011

According to relevant researches on the analysis of the existing energy efficiency policies (EC, 2009; Ecofys & Fraunhofer, 2010; de Vos, 2010 ; European Climate Foundation, 2011) there is however assumption that the EU will fail to reach the 20% energy savings target by 2020 due to various barriers.

Financing is perceived as the highest barrier. According to EC, to meet energy efficiency target, it will require 900 billion euro over the period 2010-2020. The uncertainty range is from 800-1200 billion euro. The breakdown of the 900 billion euro is as follows - buildings: 400 billion euro (uncertainty range 350-650 billion euro); transportation: 400 billion (uncertainty range 300-500 billion euro); industry: 100 billion euro.

The uncertainty in the investments numbers is highest in the buildings sector because it has a big impact on costs whether retrofit is carried out in conjunction to regular refurbishment or not. The study assumed that most of the energy efficient retrofitting can be done in connection to refurbishment that will occur anyhow. If this is not the case, costs will become higher, in particular when renovation rates are enhanced beyond the present level.

In order to overcome the abovementioned barriers, the EC has introduced some specific supporting tools. For instance, the Global Energy Efficiency and Renewable Energy Fund (GEEREF) aims at mobilizing private investments in energy efficiency and renewable energy projects (EC, 2006b). It establishes a public-private partnership by offering ways of risk sharing and co-financing for projects investing in energy efficiency and renewable energy. GEEREF participation ranges from between 25% and 50% for medium to high-risk operations to 15% for low-risk operations. Provision is also made for dedicated technical assistance funds.

2.3 Environment and climate protection policy

Climate protection is one of the strategic priorities of the EU in relation to sustainable development. The EU has made important efforts to develop the current environmental protection and climate change policy. In order to achieve stabilization of greenhouse-gas concentrations in the atmosphere, the EC on behalf of the Member States approved the Kyoto Protocol. As a part of the Kyoto protocol, the EU has made a unilateral commitment to reduce overall greenhouse gas emissions from its Member States by 20% compared to 1990 levels (30% if the conditions are right). For 2050, EU Members have also endorsed the objective of reducing Europe's greenhouse gas emissions by 80-95% compared to 1990 levels[10].

In order to achieve greater emissions reduction, the EC has developed the emissions trading system (ETS) (Böhringer and Lange, 2013) which has been in operation since 2005. It currently covers over 11.000 installations in the energy and industrial sectors which are collectively responsible for close to half of the EU's emissions of CO_2 and 45% of its total greenhouse gas emissions.

Independent studies at the regional and national levels (Kossoy and Ambrosi, 2010; Point Carbon, 2010; Brown et al., 2012; EC, 2012) have confirmed that the EU ETS is responsible for a significant share of emission reductions independent of complementary policies and the global economic recession. According to annual reports on progress towards achieving the Kyoto objectives (EC, 2012) in 2011, considerable progress has been made in the reduction of emissions. As shown in table 4 combined greenhouse gas emissions from all Member States were 18.4% below the 1990 level (even if it is not clear to what extent the economic downturn will impact on such progress).

[10] It must be recalled that, in addition to the 20-20-20 policy objectives adopted in 2008 by the EU (20% emissions reductions, 20% renewables in the total energy consumption of Europe, 20% energy savings by 2020), the “Europe 2020” strategy adopted in 2010 (COM (2010) 2020) sets five ambitious objectives on employment, innovation, education, social inclusion and climate/energy - to be reached by 2020. Furthermore, “The Roadmap for moving to a competitive low carbon economy in 2050” (COM/2011/112) adopted by the Commission proposes to extend these objectives to 2050 while the recent Green Paper (COM 169 2013) “A 2030 framework for climate and energy policies” proposes objectives to 2030.

Tab. 4 - Overview of Member States' greenhouse gas emissions progress

Member State	1990 (million tonnes)	Kyoto Protocol base year (million tonnes)	2011 (million tonnes)	Change 1990–2011, %
Austria	78.2	79.0	82.8	6.0
Belgium	143.1	145.7	120.2	-16.0
Bulgaria	109.5	132.6	66.1	-39.6
Cyprus	6.1	Not applicable	9.2	50.3
Czech Republic	196.0	194.2	133.5	-31.9
Denmark	68.7	69.3	56.2	-18.1
Estonia	40.5	42.6	21.0	-48.3
Finland	70.4	71.0	67.0	-4.9
France	556.4	563.9	485.5	-12.7
Germany	1250.3	1232.4	916.5	-26.7
Greece	104.6	107.0	115.0	10.0
Hungary	99.0	115.4	66.1	-33.2
Ireland	55.2	55.6	57.5	4.1
Italy	519.0	516.9	488.8	-5.8
Latvia	26.3	25.9	11.5	-56.3
Lithuania	48.8	49.4	21.6	-55.7
Luxembourg	12.9	13.2	12.1	-6.2
Malta	2.0	Not applicable	3.0	50.6
Netherlands	211.8	213.0	194.4	-8.8
Poland	457.0	563.4	399.4	-12.6
Portugal	61.0	60.1	70.0	14.8
Romania	244.4	278.2	123.3	-49.5
Slovakia	71.8	72.1	45.3	-36.9
Slovenia	18.4	20.4	19.5	5.8
Spain	282.8	289.8	350.5	23.9
Sweden	72.8	72.2	61.4	-15.5
United Kingdom	767.3	776.3	552.6	-28.0
EU - 27	5574.4	Not applicable	4550.2	-18.4

Note: As Cyprus, Malta and the EU27 do not have targets under the Kyoto Protocol's first commitment period; they do not have applicable Kyoto Protocol base years.
Source: EC, 2012c.

According to World Bank progress report on ETS effectiveness (Kossoy and Ambrosi, 2010), European factories and power companies have responded to the ETS and its complementary policies with a diverse range of profitable investments in low-carbon solutions; they have begun to fully integrate the cost of carbon into their investment decisions and include more low-carbon technologies, such as combined cycle gas turbines, high-efficiency coal and renewable energy in their future plan mix. The latest survey by Point Carbon (Point Carbon, 2013) also suggests that the EU ETS has been successful in reducing emissions: an outright majority of respondents in this survey said the EU ETS has caused emission reductions in the companies they represent.

The other significant element of the EU policy focusing on the reduction greenhouse gas emissions is Directive 2009/31/EC Carbon capture and geological storage (EC, 2009). The Directive provides extensive requirements for the selection of storage sites and storage permits. It also contains provisions on closure and post-closure obligations, and sets out criteria for the transfer of responsibility from the operator to the Member States.

Although Carbon capture and geological storage is technically workable and environmentally acceptable, there has been a regrettable lack of progress due to financial and political obstacles, as was emphasized by the EC in its recent Communication on the future of CCS in the EU (EC, 2013). The communication stresses that CCS is still only at the pre-demonstration stage, with repeated delays resulting in uncertainty. Therefore to deal with these challenges, the CCS policy requires a stable source of national and EU funding and a credible carbon price or regulatory approach. Such an approach could include a provisional target date for requiring CCS to be applied to any new fossil fuel power stations[11].

In view of the supporting tool, the EC established the European Climate Change Programme (EC, 2012) focusing on environmental protection and climate change policy. It involves all the relevant groups of stakeholders working together, including representatives from the Commission's different departments, the Member States, industry and environmental groups. The goal of Programme is to identify and develop all the necessary elements of the EU strategy to implement the Kyoto Protocol. Each of the EU Member States has also put in place its own domestic actions that build on the European Climate Change Programme measures or complement them.

2.4 Energy security policy

2.4.1 Market integration

The internal energy market has been at the centre of the EU energy initiatives[12]. The EC has established a series of directives for electricity and gas regulations, Directive 2009/72/EC concerning common rules for the internal market in electricity and Directive 2009/73/EC concerning common rules for the internal market in natural gas (EC 2009a, 2009b). These directives require designation of independent regulatory authorities for all Member States that must be legally distinct and functionally independent from any other public or private entity. The duties of these regulatory authorities are to oversee and monitor the whole electricity and gas market, facilitating their regular functioning and the rights and obligations of each of the legal entities and undertakings involved in the markets.

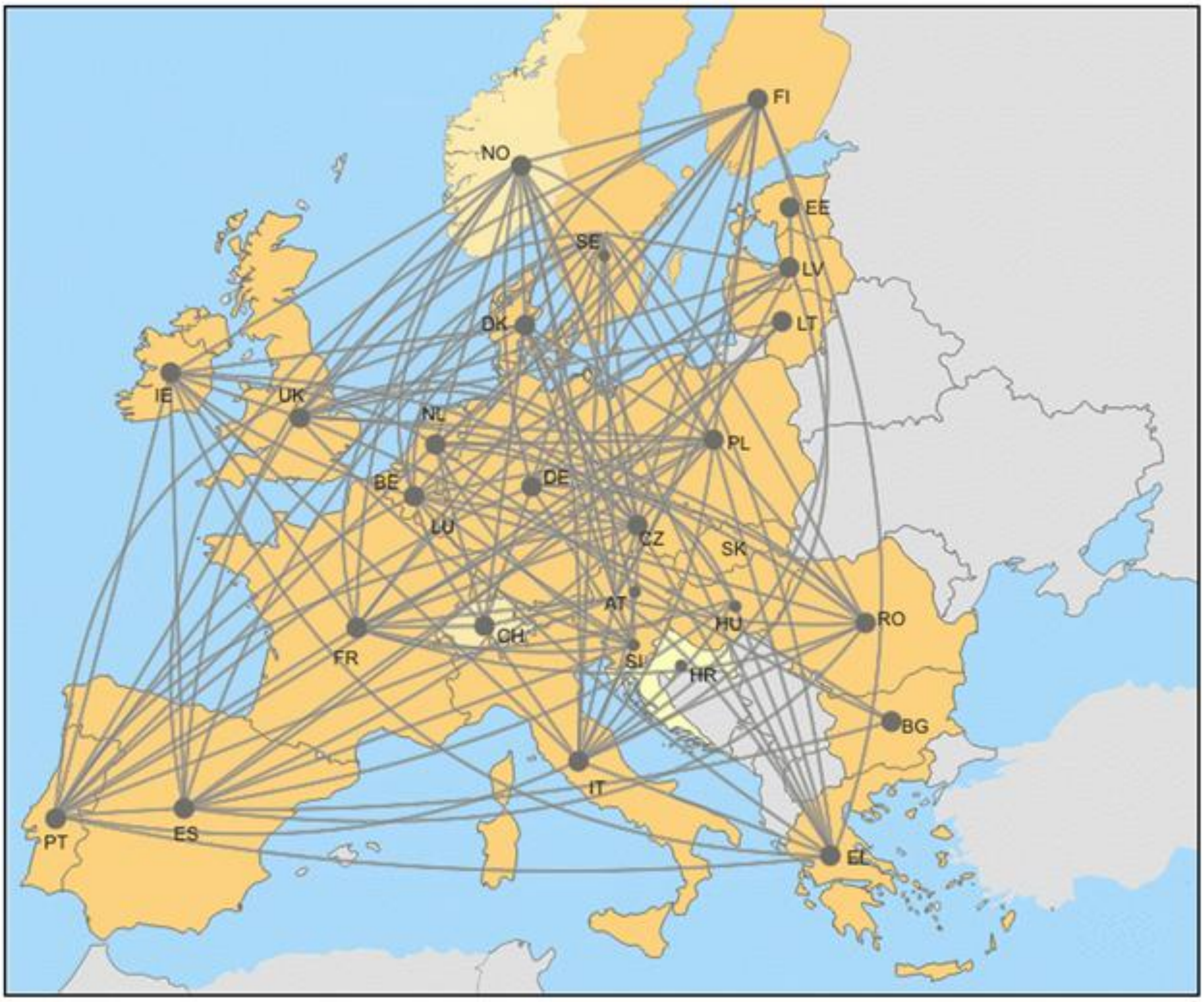
The Directives also require that Member States as well as their regulatory authorities shall cooperate with each other for the purpose of integrating their national markets at one and more regional levels. In particular, the regulatory authorities where

[11] The CCS demonstrators were supposed to be co-financed (NER300 programme) through the selling of ETS quotas. So far, only one project has been put forward reflecting the market uncertainty in the EU caused by low ETS carbon prices.

[12] For a more detailed focus on the energy market adequacy and transformations see Milesecure 2050 D1.1 "Report on key methodological approaches in multidimensional analysis" (esp. Chapter 2) and D1.2 "Report on global and macroregional key trends and scenarios" (with market analysis for specific energy sources).

Member States have so provided or Member States shall promote and facilitate the cooperation of transmission system operators at a regional level, including on cross-border issues with the aim of creating a competitive internal market in natural gas and electricity, fostering the consistency of their legal, regulatory and technical framework and facilitating the integration of the isolated systems.

Map 1 - European multinational electricity transmission system



Source: EC (2009). Directive 2009/72/EC of the European Parliament and of the Council, concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

Within these directives context, Member States shall establish transmission systems operators. Transmission system operators shall build sufficient cross-border capacity to integrate the European transmission infrastructure. Every year, they shall submit to the regulatory authority a ten-year network development plan indicating the main infrastructure that needs to be built or modernized as well as the investments to be executed over the next ten years.

Additionally, Member States shall designate distribution system operators. Distribution system operators are mainly responsible for ensuring the long-term capacity of the system in terms of the distribution of electricity and gas, operation, maintenance, development and environmental protection; ensuring transparency with respect to system users; providing system users with information; covering energy losses and maintaining reserve capacity.

However, in spite of existing supporting policy and fact that the EU Member states have endorsed 2014 as the target date for completing the EU's internal energy market (for this purposes, EC has also presented a Communication which gives guidance to Member States on how to make the most of public interventions, how to reform existing ones - especially renewable energy subsidy schemes - and how to effectively design new ones (EC, 2013), there is big concern that the goal of creating an integrated wholesale energy market is still some way off[13]. Based on studies assessing the EU policies addressing market integration (Jones at al., 2010; Brunekreeft et al., 2012) the prospect of a single market for energy will take even longer to achieve due to numerous barriers:

a) One of the biggest problems is the *lack of investments*. Achieving an integrated energy market will require enormous investment in new infrastructure, especially if the EU is to be able to increase the share of energy from renewable sources to the levels that are predicted. New flexible grids will need to be built to bring power from offshore wind to major population centres. More interconnectors will be needed to ensure that gas and electricity can flow freely within the EU's internal market.

b) The *economic challenges* are making it very difficult to raise the necessary investment. Several EU countries are unable to borrow funds for major capital projects from financial markets. At the same time, energy companies and investment banks are warning that there is a lack of certainty about the direction of EU energy policy after 2020 which makes it harder to justify investment decisions. The recent divisions among national governments over an energy roadmap for 2050 have not helped to set out a clear direction for energy policy.

c) One of the problems is *strong position of local and regional suppliers.* Market entry is also made less attractive for new and foreign companies because of the already strong position of established local and regional suppliers. On the one hand, some of these suppliers are subject to strong political influence and on the other hand they are able to establish a good position thanks to their regional proximity to their customers.

h) One of the challenges is *renewable energy integration in European electricity grids:* geographical distribution (the geographical distribution of renewable energy on the one hand and demand on the other hand often do not coincide, nor are renewables necessarily located close to current generation centres.

[13] More generally, the design of the current energy market is at stake. The current market co-ordination makes carbon prices ineffective at orienting investors towards low carbon technologies which are capital intensive: fossil fuel generation are preferred because their investment risks are much lower in the market regime, even with high but unstable carbon price. Long-term arrangements are required between the states and investors (UK provides long term contract guaranteeing a fixed electricity price for investors in nuclear energy or gaz plants). See Finon D. (2012), “The transition of the electricity system towards decarbonization: the need for change in the market regime”, *Climate Policy*, 13(2) (special number of LCRS-net); Finon, D. (2008), “Investment Risk Allocation in Decentralised Electricity Markets: The Need of Long-Term Contracts and Vertical Integration”, *OPEC Economic Review,* 32(2).

This is especially true for offshore wind parks and concentrated solar power deployed in desert areas); variability and intermittency (renewable power generation like wind and solar power is that it can be interrupted, and this variability affects the stability of the power produced); grid access is also difficult to obtain (transmission system operator and distribution network operator still not open to RES); one of the problems is also a lack of available grid capacity (weak grid environment, lack of interconnection capacity).

As a supporting tool, to overcome all barriers, the EC established the Agency for the Cooperation of Energy Regulators and the European Networks of Transmission System Operators, with the purpose of assisting regulatory authorities in exercising regulatory tasks performed in the Member States and, where necessary, to coordinate their action. The Agency is responsible for adopting, under certain conditions, individual decisions on technical issues. It may make recommendations with the aim of promoting the exchange of good practice between regulatory authorities and market players. It shall also provide a framework for cooperation between the national regulatory authorities.

2.4.2 Energy networks

Energy infrastructure is a top priority of the EU energy policy strategies; electricity transmission, gas and oil pipelines, smart grids, storage of energy and later on CO_2 transport are essential elements of EU present and future energy systems. Therefore, the EC has adopted the Energy Infrastructure Package (EC, 2010). As seen in table 5 and map 2, the Energy Infrastructure Package clearly identifies 12 priority corridors and areas where accelerated investments are needed to finalize the single energy market. These priorities cover different geographic regions or thematic areas in the field of electricity transmission and storage, gas transmission, storage and liquefied or compressed natural gas infrastructure, carbon dioxide transport and oil infrastructure (e.g. development of the North Sea offshore grid, North–South electricity interconnections in Central Eastern and South Eastern Europe, Southern Gas Corridor, oil supply connections in Central Eastern Europe).

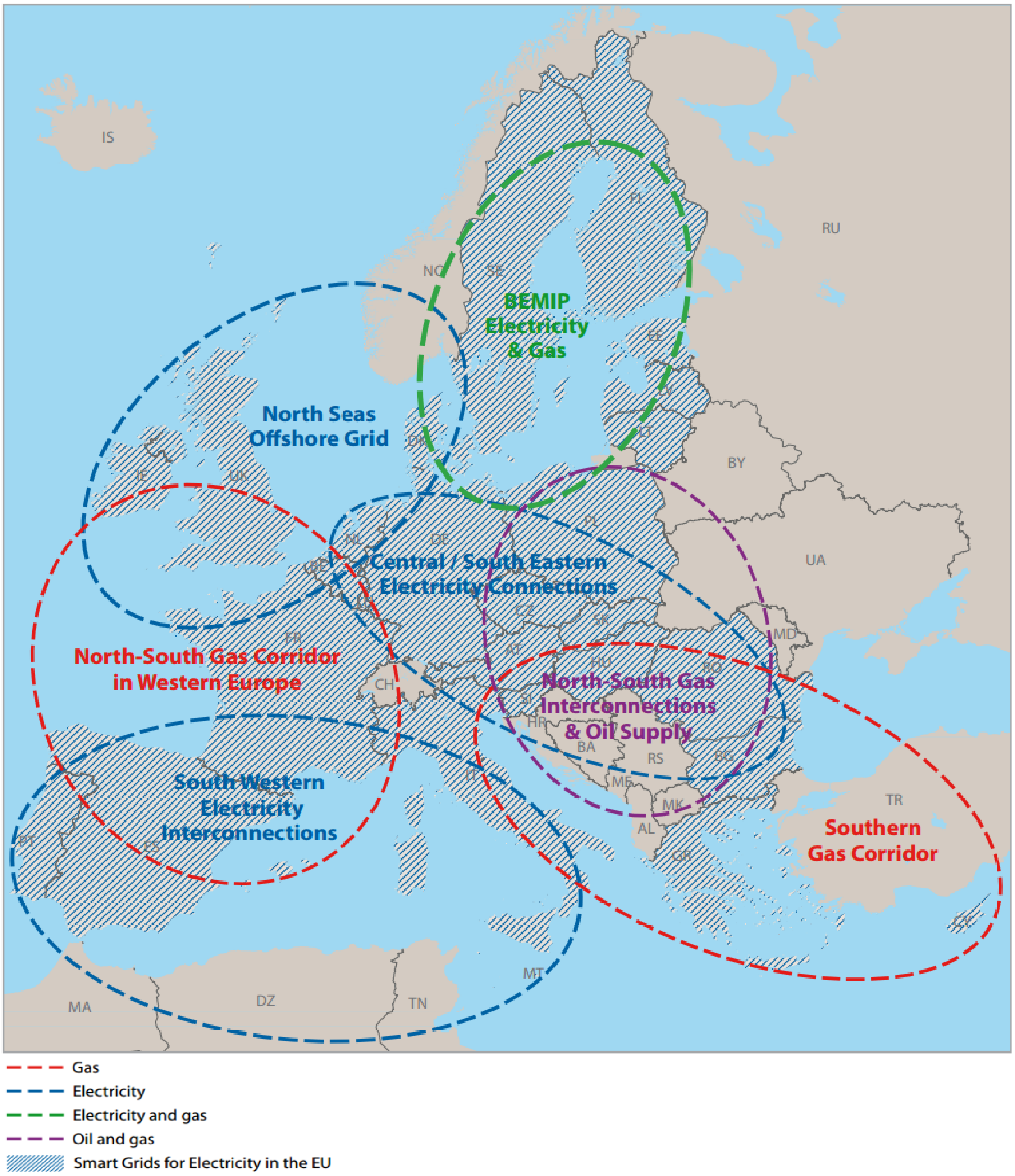
To find the best value-added investments, European regional groups propose projects with EU-level importance. The EC selects the projects of common interests (PCIs) and these selected projects will have an accelerated permitting procedure and financial assistance from EU funds. The concrete measures proposed by the EC provide appropriate answers to the infrastructure challenge of Europe by mitigating several types of risks associated with energy infrastructure development. A dedicated budget provided by the EU has been distributed between a limited numbers of projects with common interests, resulting in a significantly lower capital expenditure of the selected investments. Additionally, the acceleration of the permitting procedure reduces the risk of delays in the phase of project execution. Furthermore, the establishment of regional groups enhances regional cooperation among EU Member States.

Tab. 5 - Priority Trans-European Energy Networks

Priority corridors	Interconnections	Member States
Priority electricity corridors	Northern Seas offshore grid (NSOG): integrated offshore electricity grid in the North Sea, the Irish Sea, the English Channel, the Baltic Sea and neighbouring waters to transport electricity from renewable offshore energy sources to centres of consumption and storage and to increase cross-border electricity exchange.	Belgium, Denmark, France, Germany, Ireland, Luxemburg, the Netherlands, Sweden, the United Kingdom
	North-South electricity interconnections in Western Europe (NSI West Electricity): interconnections between Member States of the region and with Mediterranean third countries, notably to integrate electricity from renewable energy sources.	Belgium, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Malta, Portugal, Spain, the United Kingdom
	North-South electricity interconnections in Central Eastern and South Eastern Europe (NSI East Electricity): interconnections and internal lines in North-South and East-West directions to complete the internal market and integrate generation from renewable energy sources.	Austria, Bulgaria, Czech Republic, Cyprus, Germany, Greece, Hungary, Italy, Poland, Romania, Slovakia, Slovenia
	Baltic Energy Market Interconnection Plan in electricity (BEMIP Electricity): interconnections between Member States in the Baltic region and reinforcing internal grid infrastructures accordingly, to end isolation of the Baltic States and to foster market integration in the region.	Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Sweden
Priority gas corridors	North-South gas interconnections in Western Europe (NSI West Gas): interconnection capacities for North-South gas flows in Western Europe to further diversify routes of supply and increase short-term gas deliverability.	Belgium, France, Germany, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Spain, UK
	North-South gas interconnections in Central Eastern and South Eastern Europe (NSI East Gas): regional gas connections between the Baltic Sea region, the Adriatic and Aegean Seas and the Black Sea, notably to enhance diversification and security of gas supply.	Austria, Bulgaria, Cyprus, Czech Republic, Germany, Greece, Hungary, Italy, Poland, Romania, Slovakia, Slovenia
	Southern Gas Corridor (SGC): transmission of gas from the Caspian Basin, Central Asia, the Middle East and the Eastern Mediterranean Basin to the Union to enhance diversification of gas supply.	Austria, Bulgaria, Czech Republic, Cyprus, France, Germany, Hungary, Greece, Italy, Poland, Romania, Slovakia, Slovenia
	Baltic Energy Market Interconnection Plan in gas (BEMIP Gas): infrastructure to end the isolation of the three Baltic States and Finland and their single supplier dependency and to increase diversification of supplies in the Baltic Sea region.	Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Sweden.
Priority oil corridor	Oil supply connections in Central Eastern Europe (OSC): interoperability of the oil pipeline network in Central Eastern Europe to increase security of supply and reduce environmental risks.	Austria, Czech Republic, Germany, Hungary, Poland, Slovakia
Priority thematic areas	Smart grids deployment: adoption of smart grid technologies across the Union to efficiently integrate the behaviour and actions of all users connected to the electricity network, in particular the generation of large amounts of electricity from renewable or distributed energy sources and demand response by consumers.	Member States concerned: all.
	Electricity highways: first electricity highways by 2020, in view of building an electricity highways system across the Union.	Member States concerned: all.
	Cross-border carbon dioxide network: development of carbon dioxide transport infrastructure between Member States and with neighbouring third countries in view of the deployment of carbon dioxide capture and storage.	Member States concerned: all.

Source: (EC, 2010)

Map 2 - European priority corridors for electricity, gas and oil



Source: EC (2013), Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009.

However, as show relevant studies (Von Hirschhausen, 2013; Nyitrai, 2013; Tagliapietra, 2013) one of the biggest challenges for infrastructure development is financing the future trans-European energy infrastructures; the development and integration of new energy infrastructures requires substantial investment. According to the Energy Infrastructure Package, total investment needs in the electricity and gas sector between 2010 and 2020 is requiring over one trillion euro.

2.4.3 Security of energy supply

The security of supply has emerged as a central element of the EU policy, after the January 2009 gas crisis and now with the consequences of the Fukushima events. In order to deal with energy security challenges, the EC has established the extensive developments of the concept toward energy security mainly focusing on maintaining good relations with oil and gas producer countries as well as on prevention and crisis management, as a response to operational or technical disruptions and natural calamities, and to disruptions caused by temporary political conflicts.

EC has adopted a Directive 2009/119/EC (EC, 2009) imposing obligations on Member States aimed at ensuring a high level of security of oil supply in the Community through reliable and transparent mechanisms based on solidarity amongst Member States, maintaining minimum stocks of crude oil and petroleum products and putting in place the necessary procedural means to deal with a serious shortage.

Member States shall ensure that emergency stocks and specific stocks are available and physically accessible for the purposes of this Directive. They shall establish arrangements for the identification, accounting and control of those stocks so as to allow them to be verified at any time. This requirement also applies to any emergency stocks and specific stocks that are commingled with other stocks held by economic operators.

Member States shall take all necessary measures to prevent all obstacles and encumbrances that could hamper the availability of emergency stocks and specific stocks. Each Member State may set limits or additional conditions on the possibility of its emergency stocks and specific stocks being held outside its territory.

Additionally, Member States shall at all times have contingency plans to be implemented in the event of a major supply disruption. Upon request, Member States shall inform the Commission of their contingency plans and the corresponding organizational arrangements.

In the context of external relations, the EC has established a wide range of initiatives and strategic dialogues with Russia, Central Asia, Caspian Sea, the Mediterranean Sea, the Arab states on the Persian Gulf, and Turkey. All these initiatives call for new type of partnership in regulatory cooperation, energy security and safety, market access and investment protection, using appropriate cooperation instruments and agreements. Such partnerships should also extend to the efficient use of available resources, as well as joint assessment of long-term energy supply and demand perspectives (EC, 2012).

However, the potential threats to energy supply that have the capacity to negatively affect the European energy system still remain and will continue to exist and will increase (see D1.1; Matthes, 2004; Costantini et al., 2007; Umbach, 2010; IAEA, 2011; Mulle et al., 2013). Therefore EU security of supply and energy policy will require new energy policy tools as well as the active use of foreign policies and international cooperation. These involve, first of all, that EU policies in respect of external trade, foreign relations and security will become instrumental in securing the supply of oil and gas, by underpinning the political and economic stability in producer countries and maintaining good relations. In parallel, the EU should seek to build a dynamic foreign and trade policy towards North Africa, the Persian Gulf, the Caspian Sea region, Russia and Turkey, as neighbors and trading partners of the enlarged EU, focusing on long-term political and economic stability in these regions. This also includes bilateral cooperation and dialogue with other important consumer countries, particularly China, Japan and India in order to support a common approach concerning stability at the global oil and gas markets.

2.5 EU approach towards traditional energy sources in relation to low carbon perspectives

2.5.1 Nuclear energy

In terms of energy policy, there is not, and there never has been, common nuclear policy among Member States with regard to the role of nuclear energy; each EU Member States can decide whether it wants to include nuclear power in its energy mix. Some Member States consider the risks related to nuclear energy as unacceptable. Others continue to see nuclear energy as a secure, reliable and affordable source of low-carbon electricity generation. For example, after recent accident in Fukushima, Germany has announced the immediate closure of eight of its oldest reactors (built before 1980). It also announced a decision to close the rest by 2022. The Italians have voted overwhelmingly to keep their country non-nuclear. Switzerland has banned the construction of new reactors. Belgium is considering phasing out its nuclear plants, perhaps as early as 2015. Other EU countries have announced that their programs will continue, while emphasizing the need to take lessons from the Fukushima and Chernobyl accidents in order to make future plants safer. Poland, Bulgaria, Romania, Lithuania, the Netherlands are planning to build new reactors. France has defended its choice of nuclear power; at the same time it has proposed cutting nuclear power's electricity contribution by more than a third by 2025. The United Kingdom has announced that four nuclear reactors are due to enter service in 2018. Spain has announced a review of the security of its six plants and the launch of a study on the risk from earthquakes and flooding. The Czech Republic did not envisage the closure of its two plants and planned to build one new reactor. Finland simply committed itself to heeding the lessons of Fukushima.

Regarding its contribution to low-carbon energy future, nuclear remains a large scale low-carbon option. The analysis of the most studies (IEA, 2010; WNA, 2011; FORATOM, 2011; see also D1.2) show that nuclear energy would potentially play a key role alongside renewable technologies in achieving large reductions in CO_2 emissions while ensuring reliable and affordable energy supplies. However, many challenges to nuclear expansion remain. Decisions and actions in the next few years, or the lack of them, will have an important impact on the longer-term development of nuclear generating capacity.

The principal challenges for nuclear energy include:

a) The difficulties of financing the high capital costs of nuclear plants, especially given the risk of delays and cost overruns with first-of-a-kind plants and in countries with no recent experience of nuclear construction.

b) Overcoming current constraints on industrial capacities and human resources for the construction of nuclear plants.
c) Recovering pre-Fukushima levels of public acceptance of nuclear energy, by addressing people's concern over the safety of nuclear power.
d) Demonstrating the safe management of radioactive wastes, and implementing plans for the disposal of long-lived high-level waste.
e) Introducing nuclear capacity into additional countries while avoiding the proliferation of sensitive nuclear materials and technologies.
f) Increasing the supply of nuclear fuel in line with the expansion of nuclear capacity, and ensuring reliable f fuel supplies during reactor lifetimes of 60 years.

In the longer term, other issues may come to the fore. There is potential for nuclear energy to meet energy requirements beyond its established role in large-scale grid electricity supply. Designs for small modular reactors are being developed that could allow nuclear energy to be introduced in locations where existing grid infrastructure is inadequate for a large-scale plant, or in remote communities that are isolated from grid connections. In addition, some new designs will be capable of producing the high temperatures needed for direct use in industrial processes, such as in chemical plants, displacing fossil-fuel burning.

Another important factor that could affect the future of nuclear energy is public acceptance. Although concerns about security of energy supply and the threat of global climate change have tended in recent years to increase public recognition of the benefits of nuclear energy, several factors continue to weaken public support. These include concerns about nuclear safety, radioactive waste management and disposal, and the potential proliferation of nuclear weapons. Society at large is often reluctant to accept nuclear energy, mainly because its benefits are not perceived to outweigh its drawbacks.

There is an important role for state support for new energy technologies, including for research and development and for early deployment. However, as such technologies mature they should be increasingly exposed to competitive pressures. In the longer term, rather than governments choosing particular technologies to support, introducing technology-neutral carbon pricing or trading systems is likely to improve the cost-effectiveness of energy supply and CO_2 emissions reductions.

2.5.2 Traditional energy sources: coal, oil, gas

Regarding traditional energy sources, according to EU Energy roadmap 2050, gas will be critical for the transformation of the energy system. Substitution of coal (and oil) with gas in the short to medium term could help to reduce emissions with existing technologies until at least 2030 or 2035. Although gas demand in the residential sector, for example, might drop by a quarter by 2030 due to several renewables and energy efficiency measures in the housing sector, it will stay high in other sectors such as the power sector over a longer period. In the diversified supply technologies scenario for example, gas-fired power generation accounts for roughly 800 TWh in

2050, slightly higher than current levels. With evolving technologies, gas might play an increasing role in the future.

The gas market needs more integration, more liquidity, more diversity of supply sources and more storage capacity, for gas to maintain its competitive advantages as a fuel for electricity generation. Global gas markets are changing, notably through the development of shale gas in North America. With liquefied natural gas (LNG), markets have become increasingly global since transport has become more independent from pipelines. Shale gas and other unconventional gas sources have become potential important new sources of supply in or around EU. Together with internal market integration, these developments could relax concerns on gas import dependency. However, due to the early stage of exploration it is unclear when unconventional resources might become significant. As traditional gas production declines, EU will have to rely on significant gas imports in addition to domestic natural gas production and potential indigenous shale gas exploitation.

Coal in the EU adds to a diversified energy portfolio and contributes to security of supply. With the development of CCS and other emerging clean technologies, coal could continue to play an important role in a sustainable and secure supply in the future.

Oil is likely to remain in the energy mix even in 2050 and will mainly fuel parts of long-distance passenger and freight transport. The challenge for the oil sector is to adapt to changes in oil demand resulting from the switch to renewable and alternative fuels and uncertainties surrounding future supplies and prices. Maintaining a foothold in the global oil market and keeping a European presence in domestic refining - though one that is able to adapt capacity levels to the economic realities of a mature market - is important to the EU economy, to sectors that depend on refined products as feed stocks such as the petrochemical industry, and for security of supply.

However, it is also important to emphasize that the role of traditional energy sources in the future EU energy mix depends on the development of renewable energy technologies, market liberalization, fossil fuels prices and cost-effective application of carbon capture and storage technologies. According to most scenarios (Pacala and Socolow, 2004; IEA, 2012; Greenpeace, 2012;) in short-term and medium-term perspective, fossil fuels will continue to meet most of the energy needs. In World Energy Outlook (2012) scenarios for instance, fossil fuels, which represented 81% of the world primary fuel mix in 2010, remain the dominant sources of energy through 2035, although their share of the mix in 2035 varies markedly. Energy Technology Perspective (IEA, 2010) as well as Greenpeace (2012), GEA (2012) pictures almost similar trends with World Energy Outlook (2012) in terms of domination of fossil fuels and gradually penetration of renewables in the total energy mix. Under climate policies, a fundamental transformation of the energy sector is involved after 2030 through a decrease of fossil fuel, a strong penetration of RES (wind, solar, hydro), biomass, and a moderate increase of nuclear.

2.6 Energy technology and innovation policy

The energy innovation policy plays an essential role in the long-term transition of the energy system (in developing renewable technologies, improving energy efficiency, reducing emission, integrating energy market etc.) (Tavoni et al., 2012; Soriano and Mulatero, 2011; EC, 2009; EC, 2011). To provide technological support for low carbon transition, the energy research is implemented through the EU's general framework program for research such as European Strategic Energy Technology plan (SET-Plan) (Finger et al., 2013). The SET-Plan includes such innovative group as the European Wind Initiative (focus on large turbines and large systems validation and demonstration (relevant to on and off-shore applications); Solar Europe Initiative (focus on large-scale demonstration for photovoltaics and concentrated solar power); Bioenergy Europe Initiative (focus on next generation biofuels within the context of an overall bio-energy use strategy); European CO_2 capture, transport and storage initiative (focus on the whole system requirements, including efficiency, safety and public acceptance, to prove the viability of zero emission fossil fuel power plants at industrial scale); European electricity grid initiative (focus on the development of the smart electricity system, including storage, and on the creation of a European center to implement a research programme for the European transmission network); Sustainable nuclear fission initiative (focus on the development of new generation reactors technologies); the ERA-Net scheme (encouraging Member States to coordinate R&D programmes), the Networks of Excellence (giving research centers greater opportunity to work together), the Joint Technology Initiatives and Joint Programming as well as the Smart Cities and Communities program (aiming at pooling resources to support the demonstration of energy, transport and information and communication technologies in urban areas).

Recently, the EC has established Horizon 2020 (REN21, 2013), the EU’s new funding programme for research and innovation. Horizon 2020 brings together higher education institutions, research centers and businesses, all existing Union research and innovation funding, including the Framework Programme for Research, the innovation-related activities of the Competitiveness and Innovation Framework Programme and the European Institute of Innovation and Technology. Horizon 2020 focuses resources on three distinct, yet mutually reinforcing priorities:

i) generating excellent science (Part I). This part aims to reinforce and extend the excellence of the Union’s science base and to consolidate the European Research Area in order to make the Union’s research and innovation system more competitive on a global scale. In this context, the programme will support the best ideas, develop talent, provide researchers with access to priority research infrastructures, and make Europe an attractive location for the world's best researchers;
ii) fostering industrial leadership to support business, including small and medium-sized enterprises and innovation (Part II). Emphasis will be placed on funding of research and development in selected enabling and industrial technologies, enhanced access to risk finance for investing in research and innovation, as well as stimulation of innovation in small and medium-sized enterprises;
iii) tackling societal challenges, in order to respond directly to the challenges identified in the Europe 2020 strategy by supporting activities covering the entire spectrum from research to market (Part III). This part addresses major concerns

shared by citizens in Europe and elsewhere. A challenge-based approach will bring together resources and knowledge across different fields, technologies and disciplines, including social sciences and the humanities. This will cover activities from research to market with a focus on innovation-related activities, such as piloting, demonstration, test-beds, and support for public procurement and market uptake.

However, both SET-plan as well as Horizon 2020 is at risk of failing to deliver its objectives due to inadequacy of finance and uncertainty about the future policy framework (Lin, 2012). While EU level of investment in low carbon energy in 2011 was 94 billion US dollars, comparing favorably to the amount of 50 billion US dollars invested by each of the US and China, the EU’s level of investment was expected to be lower in future, due to constitutes economic recession in some EU Member States and a lack of sufficient investment. Obviously, so economic and investment uncertainties could impact on EU leadership in energy innovative sector on global market. China has already developed a strong base in the manufacture of renewable energy equipment, notably for the solar and wind industry EC, 2013; EURELECTRIC, 2013). Moreover, clean energy and energy efficiency technologies included in China’s most recent economic Five-Year Plan and determined as high priority. Therefore, to deal with inadequate funding of EU innovative programs, the EC must revise the both programs (SET Plan and Horizon 2020) with a view how these innovative programs will be financed. Such work must be undertaken in partnership with Member States as well as the private sector.

Furthermore, both SET-plan and Horizon 2020 is running out in 2020. A lack of clear beyond 2020 strategy impact on investors’ decision - investors are not able to make the substantial investments more comfortably. Therefore there is a need to re-consider current policies with revision framework programme for research and innovation, to give a clear and stable vision for post-2020, and, at the same time, to reinforce European competitiveness in low-carbon technology sectors on the global market, to reinforce innovative financial instruments for energy infrastructures, and to take into account the all economic, investment, public support, political, energy and technological and other changed context.

2.7 Low carbon energy investments in the programming period 2014-2020

The transition to low carbon energy system requires massive investment. According to Eurelectric study (EURELECTRIC, 2013), under the Power Choices scenario the total investment in power generation, during the period between 2010 and 2050, amounts to 1.75 trillion euro (in 2005 money terms). Total investment for the power grids is estimated to amount to 1.5 trillion euro for the period 2010-2050. Investment in energy savings and in energy efficiency improvement requires 20% of total energy system investment costs in cumulative terms over the period 2010-2050. According to the projection, end-users need to spend a total amount of 2.9 trillion euro for energy savings. They spend in addition 2 trillion euro for equipment replacement for standard energy uses and 5 trillion euro in the transport sector (accounting only for energy-related investment). The Power Choices scenario requires total energy system investment in the time period 2020-2050 that amounts to 350 billion euro per year. Total energy system investment during the time period 2010-2050 is estimated at 12.5 trillion euro.

The EC shows lower investment needs rate than Power Choices scenario. The EC indicates that, by 2020, investment of around 1 trillion euro would be required across the EU’s energy system (generation, transmission, distribution and demand) to replace obsolete capacity, modernize and adapt infrastructure and to cater for increasing and changing demand for low carbon energy. The total EC investments requires around 270 billion euro annually, about 1.5% of the EU GDP.

The needed investments will be partially provided by EU 2020 budget - known as the EU Multi-Annual Financial Framework - for the period 2014-2020 (Energy cities, 2011). This new budget has a strong focus on energy and climate related funding, as at least 20% of the budget will be spent on climate and energy-related actions including smart grids, passive housing, carbon capture and storage, advanced industrial processes and electrification of transport, energy storage technologies etc.

However, according to recent independent reviews (European Policy Centre, 2011) the mentioned 20% budget allocation on energy and climate projects is not ambitious enough and more EU funding should be allocated to meet Europe 2020’s energy and climate goals. There are also concerns that the budget proposal does not guarantee any support to local sustainable energy projects. The proposed EU budget does not contain any specific funding mechanisms triggering replication of sustainable energy (energy efficiency and renewable energy) projects at local level. The EU 2020 budget mainly concentrate on investment of large energy projects including energy priority corridors, cross border infrastructures, distribution and smart grids, integration renewables in national energy system.

As observed in reviews, public money for energy infrastructure investment and for low carbon energy innovation is insufficient. Therefore, in addition to the EU 2020 budget, the private investments are needed. However, currently EU private sector has a low interest due to debt problem, economic recession as well as energy and investment policy obstacles. Thus to unlock the private investment potential is a major challenge. There are needs to design clear medium-term 2030 investment policy framework, which take into account range of issues, which include: the necessary investment and costs; different energy sources; research and innovation; and issues of interconnection and energy security. The EC and EU Member States should also work urgently with investors, to ensure their awareness of the opportunities, to identify obstacles and to propose solutions, such as the development of instruments to allow the pooling of resources in order to mitigate risk and encourage investment.

3. Economic, social and environmental trends in EU and how they are related to new energy scenarios

The European Union has prioritized sustainable development and the transition to a low carbon economy as a goal for the year 2020 and beyond. The European Commission's Europe 2020 strategy highlights five major priorities to achieve, "smart, sustainable, and inclusive" growth leading up to 2020. With climate and energy as a primary focus, the plan seeks to reduce greenhouse gas (GHG) emissions to levels 20% lower than 1990, provide 20% of final energy from renewable sources, and increase energy efficiency by 20%[14] (defined as a reduction of primary energy consumption from 2005 "business as usual" growth projections, or a 13.5% reduction from 2005 levels[15]).

In order to discuss progress and trends in terms of economic, social and environmental development towards low carbon energy security, indicators will be necessary which are available, reliable and able to measure the transition. Therefore, we will investigate available indicators under the Europe 2020 strategy that are relevant for measuring progress towards low carbon energy security.

Furthermore, the EU Sustainable Development Strategy (SDS) focuses on addressing climate change adaptation, high energy consumption in the transportation sector, and reversing the current rate of natural resources loss[16]. Both the Europe 2020 and SDS strategies provide the EU backdrop for Member State efforts to decarbonise their economies and seek energy security.

In framing the analysis of current trends in European energy policies, energy indicators are introduced to provide a broad overview of three Member States with different energy profiles. This set of indicators enables the evaluation of transition progress towards low-carbon, energy-secure future scenarios.

The **Errore. Il segnalibro non è definito.** sections (**Errore. L'origine riferimento non è stata trovata.**) of the report show national focuses for the selected three Member States of Germany (DE), Italy (IT), and Poland (PL). These case studies highlight specific trends, new emerging phenomena not captured by the indicators, and current energy markets, policies, and challenges in IT, DE, and PL, respectively. Reflecting upon the indicators and case studies will reveal relevant lessons for the EU as it works towards its 20-20-20 energy and climate targets and as it looks beyond 2020 for long-term low-carbon energy security strategies.

[14] European Commission, "Europe 2020 Targets: Climate Change and Energy."
[15] Savona, *Europe 2020 Strategy – towards a Smarter, Greener and More Inclusive EU Economy?*.
[16] Eurostat, *Sustainable Development in the European Union: 2011 Monitoring Report of the EU Sustainable Development Strategy*.

3.1 Main trends and indicators

In analysing a country's low-carbon energy security, there are a number of factors that need to be taken into account. More than simply measuring carbon intensity and energy dependence, a thorough analysis should also include an examination of opportunities to increase energy security, efficiency, and low-carbon energy production. The following indicators are meant to offer insights into the current state of affairs and recent trends regarding these factors in Germany, Italy, and Poland.

Tab. 6 - Europe 2020 Targets for Discussed Member States and the EU

	Germany	**Italy**	**Poland**	**EU**
CO_2e emissions target (from 2005 levels)	-14,00%	-13,00%	14,00%	-20%*
Renewable Energy target (final energy consumption)	18,00%	17,00%	15,48%	20%
Energy Efficiency target (total 2020 primary energy consumption reduction from 2005 "business as usual" baseline energy projections through 2020, in Mtoe)	**38,30**	**27,90**	**14,00**	**368,00**

*(1990 levels)
Source: European Commission, "Europe 2020 Targets: Climate Change and Energy."

Particularly relevant indicators for evaluating progress towards a decarbonised society include Europe 2020 indicators (Table 6 above introduces these targets). This list includes CO_2 emissions reductions, renewable energy as a share of final energy, and overall energy efficiency. These indicators include[17]:

- Greenhouse Gas Emissions*
- Renewable Energy Generation*
- Primary Energy Consumption*

By selecting appropriate indicators for energy and climate from the set of Europe 2020 and EU SDS indicators, the following list of measurements was established:

[17] As regards indicators, in addition to Deliverable 1.2 (section 6), the literature on energy security indicators. For instance, in Kruyt et al (2009) four main indicators are selected: availabitily,accessibility, affordability, acceptability. Another point of view is of Chester L. (2010) that, building upon the aforementioned indicators, introduces the sustainability dimension and the indadequacy of energy production infrastructures. Socacool B. K. and Brown M. A. (2010) introduce the dimension of "environmental stewardship" (sustainability of policies that encompasses indicators that refer to certain pollutions such as sulphur dioxide and carbon emissions) and economic and energy efficiency.

Energy Indicators overview:

- Energy Dependence
- Change of Energy Dependence over Time
- Imported Energy Consumption
- Change of Imported Energy over Time
- Primary Energy Consumption*
- Final Energy Consumption
- Change of Final Energy Consumption over Time
- Energy Intensity of the Economy
- Change of Economy's Energy Intensity over Time
- Percentage of Household Expenditures on Energy
- Change of Household Expenditures on Energy over Time
- Combined Heat and Power Generation
- Change of Combined Heat and Power Generation over Time
- Renewable Energy Generation*
- Change of Renewable Energy Generation over Time

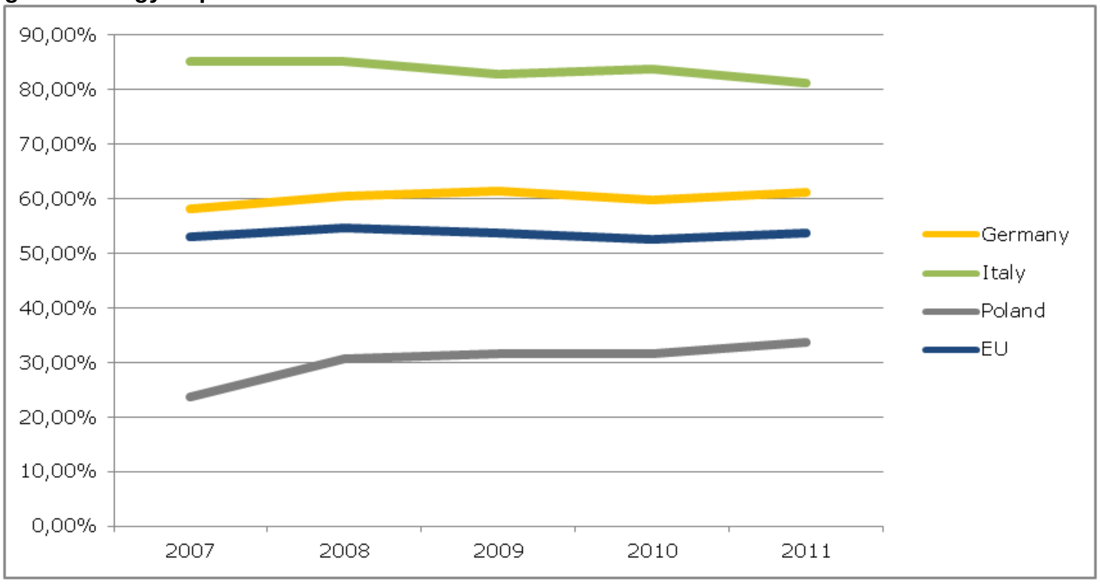
Climate Indicators overview:

- Greenhouse Gas Emissions*
- Per Capita CO_2 Emissions
- Change in Per Capita CO_2 Emissions over Time
- Emissions Intensity of the Economy
- Change of Economy's Emissions Intensity over Time
- Emissions Intensity of Energy compared to Baseline Year 2000
- Change of Energy Emissions Intensity over Time compared to Baseline Year 2000
- Greenhouse Gas Emissions from Transport
- Change in Transport Emissions over Time
- Transport Emissions Intensity of the Economy

3.2 Energy Indicators

The clearest indicator of a country's energy security is perhaps the percentage of energy which it must import either as raw fuel or directly as power in order to sustain itself. This number is calculated by dividing the country's net energy imports by their total energy consumption (including bunkers). Depending on the exact policies that are to be analysed, it can be quite helpful to look at the simple percentages over time, presented here:

Fig. 38 - Energy Dependence



These data indicate that Poland is the least energy dependent of the three countries, and that Italy is the most dependent upon energy imports.

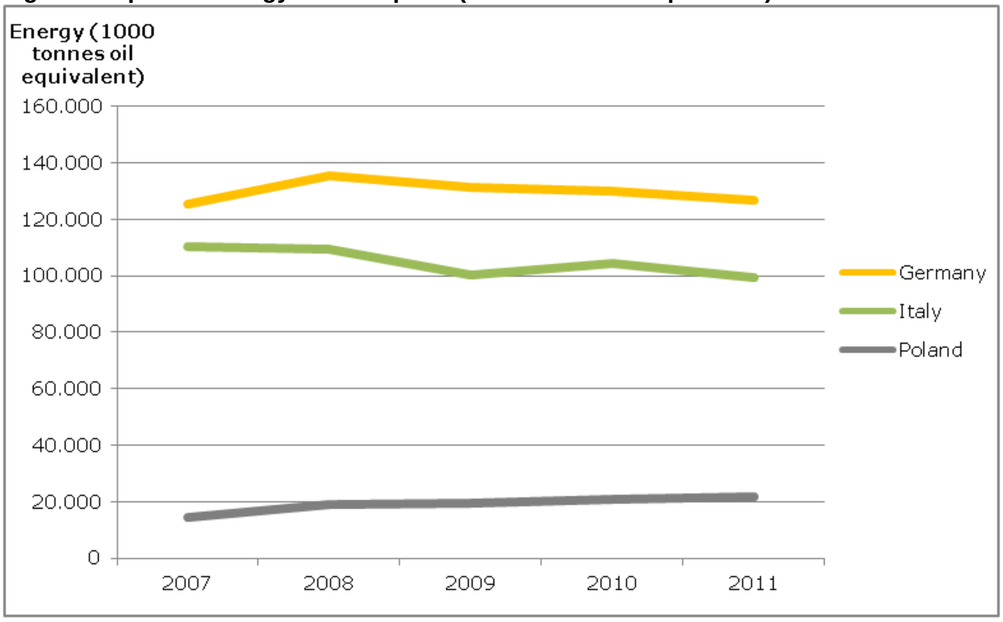
The first indicator covers annual data, a snapshot of the state of affairs is in a given year. Looking at these raw numbers can be problematic, though. As there is a large amount of inertia in complex economic systems, these data are highly dependent upon a country's initial position, i.e. how much energy it was importing before it began to implement new energy security policies. Therefore, it can be helpful to look at the trends in these data over time, to gauge how effective national policies are in increasing low carbon energy security. These trends can be used to measure countries' success at increasing energy security, regardless of the level at which they started. To calculate trends, one must simply take the difference between data for a given year and that for a previous year. The Annual change in energy dependence is given below, where a positive annual change signals an increase in energy dependence (net imports divided by total consumption):

Tab. 7 - Annual Change in Energy Dependence (%)

	Germany	Italy	Poland	EU
2008	2,4%	0,2%	7,0%	1,6%
2009	1,0%	-2,5%	1,1%	-0,8%
2010	-1,7%	1,0%	-0,1%	-1,2%
2011	1,3%	-2,5%	2,1%	1,2%

The presentation of energy dependence thus far only illustrates the share of each country's energy that must be imported, and does not indicate how large the energy markets are in these countries. It may be useful to look at the raw amount of energy that is being imported (i.e. the rate of dependence multiplied by the total final energy consumption) [18], presented here in units of tonnes oil equivalent:

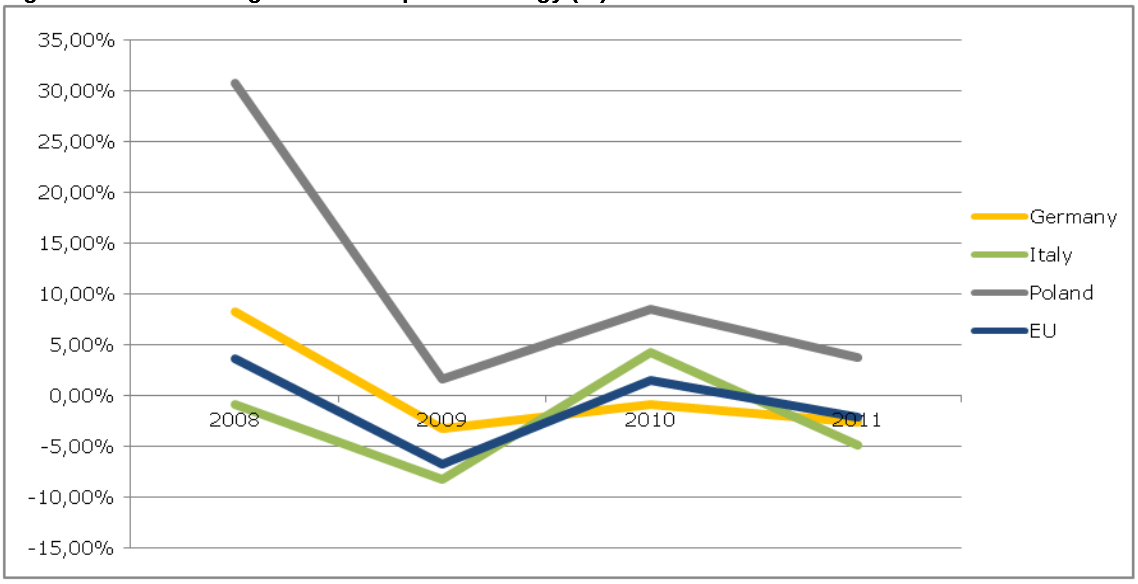
Fig. 39 - Imported Energy Consumption (1000 tonnes oil equivalent)



In this indicator, it is now Germany that seems to be the most dependent upon energy imports, as it imports about 25% more energy than Italy and about six times more than Poland. It is therefore possible that while Italy depends on imports for a greater percentage of their energy consumption mix, that Italy may be less impacted by changes to global energy supply or energy import prices than Germany because it might be more easily able to replace the imports. The change over time, again, is considered for imported energy, where a positive annual change signals an increase in imports, and percentages refer to the change in value from previous year statistics.

[18] Eurostat, "Final Energy Consumption, by Sector. tsdpc320."

Fig. 40 - Annual Change in Total Imported Energy (%)

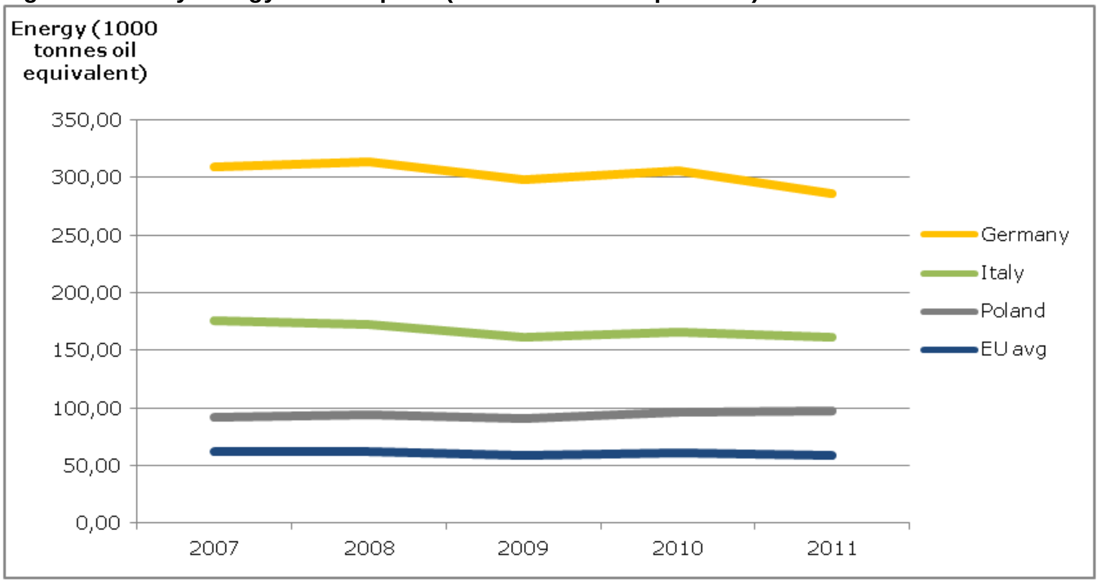


Looking at these trajectory data now illustrate yet a different story. While Italy is overall on a downward trend with regards to energy dependence, Germany's data are much more equivocal. Total imported energy has had a net increase within the years analysed, as has energy dependence. However, Germany's data also show an interesting phenomenon in 2009 and 2011, wherein total imported energy decreased while the percentage of energy dependence increased. This illustrates well the complexity of energy security. While raw imports may be down, if measures to reduce total consumption are even more effective, then it is possible that the percentage of energy that is imported will actually increase. Finally, Poland is shown to be on the worst trend, with increases in total energy imports every year and a large net increase in energy dependence.

Tracing the total amount of energy used over time by each country can be useful to address energy security, as reducing a country's reliance upon energy in the first place can greatly reduce dependency. Primary Energy is monitored first.[19]

[19] Eurostat, "Primary Energy Consumption. t2020_33."

Fig. 41 - Primary Energy Consumption (1000 tonnes oil equivalent)*



Primary energy refers to the total amount of energy in the system required to deliver energy services. Final energy refers to the amount of energy consumed at end use. Primary energy accounts for converting raw resources into services. Reducing primary energy consumption is a pillar of the Europe 2020 targets, but similarly relevant is an evaluation of final energy consumption. [20]

Tab. 8 - Final Energy Consumption (1000 tonnes oil equivalent)

	Germany	Italy	Poland	EU avg
2008	223.846	128.200	62.222	43.445
2009	213.165	121.148	61.027	41.116
2010	217.374	124.769	66.455	42.685
2011	207.093	122.312	64.689	40.861

The change over time for final energy consumption is considered, where a positive annual change signals an increase in consumption, and percentages are calculated based on previous year values.

[20] Eurostat, "Final Energy Consumption, by Sector. tsdpc320."

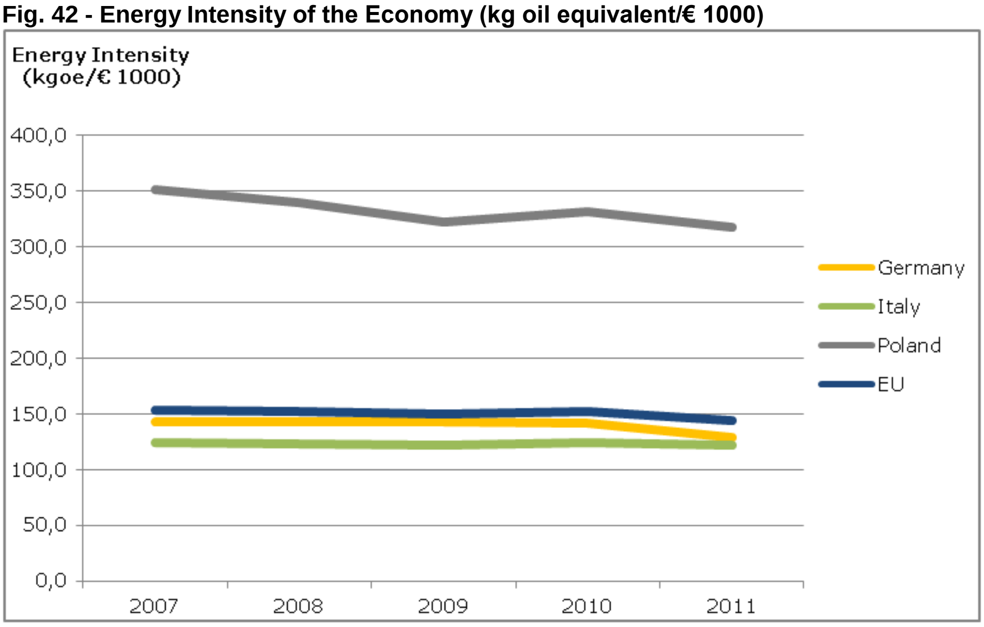
Tab. 9 - Final Energy Consumption Trend (%)

	Germany	Italy	Poland	EU
2008	3,92%	-1,11%	0,92%	0,66%
2009	-4,77%	-5,50%	-1,92%	-5,36%
2010	1,97%	2,99%	8,89%	3,82%
2011	-4,73%	-1,97%	-2,66%	-4,27%

These data illustrate that Germany and Italy have both decreased their energy consumption over this time period, while Poland's has increased. But in each case, the changes appear very small. However, as this number does not take into account population or GDP, but rather is a simple absolute value, it only has limited usefulness.

Eurostat also compiles data regarding the energy intensiveness of countries' economies (energy use relative to GDP).[21] Looking at this indicator, as well as the trends in it, help to show the relative energy efficiency of these countries' economies and the trajectories they are on.

Fig. 42 - Energy Intensity of the Economy (kg oil equivalent/€ 1000)



The change over time, again, is considered for energy intensity, where a positive annual change signals an increase in energy use per economic productivity, and percentages refer to the change in value from previous year statistics.

[21] Eurostat, "Energy Intensity of the Economy. tsdec360."

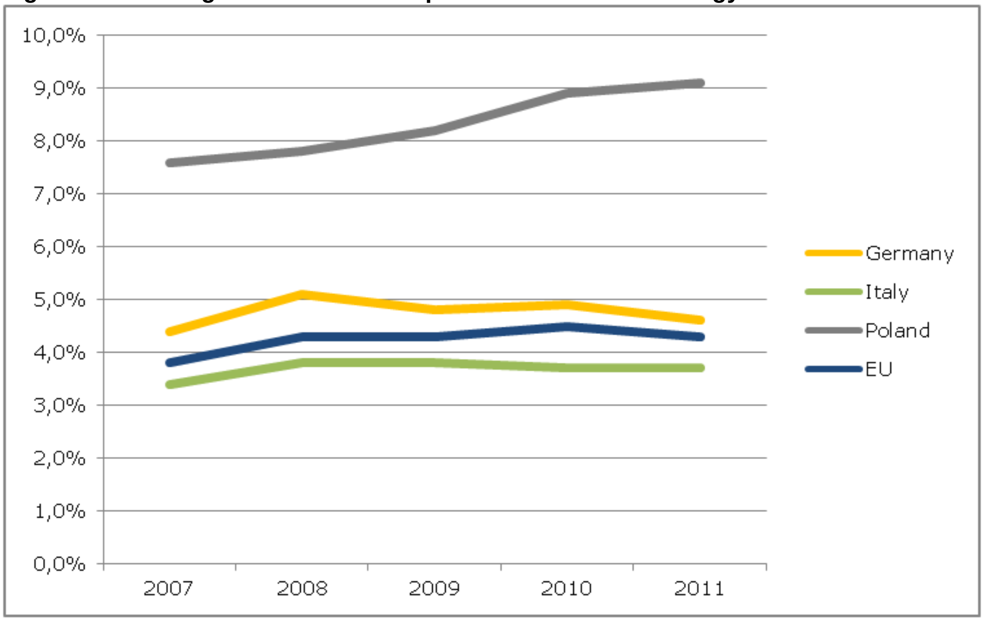
Tab. 10- Economy-wide Change in Energy Intensity Over Time (%)

	Germany	Italy	Poland	EU
2008	-0,14%	-0,73%	-3,33%	-0,85%
2009	0,35%	-0,97%	-5,27%	-0,99%
2010	-0,98%	1,56%	2,80%	1,27%
2011	-8,90%	-2,02%	-3,96%	-5,07%

While Poland is currently the least efficient of these economies, it is making the fastest improvement in this indicator, while both Italy and Germany are currently more efficient but are generally improving their efficiency at a slower rate.

Energy costs to consumers are particularly relevant to monitor a country's path to a low-carbon, energy-secure future. It can be very helpful to compare not only the effectiveness of certain policies in achieving their stated goals, but to also be able to assess how strategies might impact consumer affordability.[22]

Fig. 43 - Percentage of Household Expenditures Used for Energy



[22] Eurostat, "Final Consumption Expenditure of Households by Consumption Purpose - COICOP 3 Digit - Aggregates at Current Prices. nama_co3_c."

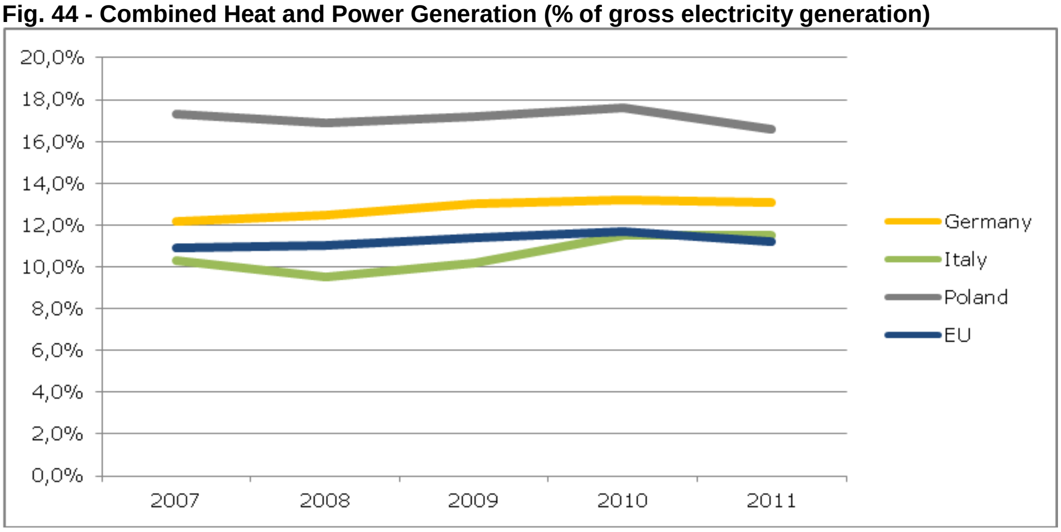
Tab. 11 - Annual Change in Percentage of Household Expenditures Used for Energy (%)

	Germany	Italy	Poland	EU
2008	0,70%	0,40%	0,20%	0,50%
2009	-0,30%	0,00%	0,40%	0,00%
2010	0,10%	-0,10%	0,70%	0,20%
2011	-0,30%	0,00%	0,20%	-0,20%

The major takeaway from comparing household expenditures on energy is that Germany and Italy have very stable, low energy expenses and that Poland's household energy expenses are significantly higher and on an upward trend. Household energy expenditures play a role when politicians consider new energy resources and delivery.

One large contributor to overall energy efficiency is the production of combined heat and power – i.e. capturing heat from electricity production processes to use for local heating needs. This avoids wasting heat that is being created anyways in power plants and then burning additional fuel in order simply to provide heat. Data provided by Eurostat. [23]

Fig. 44 - Combined Heat and Power Generation (% of gross electricity generation)



[23] Eurostat, "Combined Heat and Power Generation. tsdcc350."

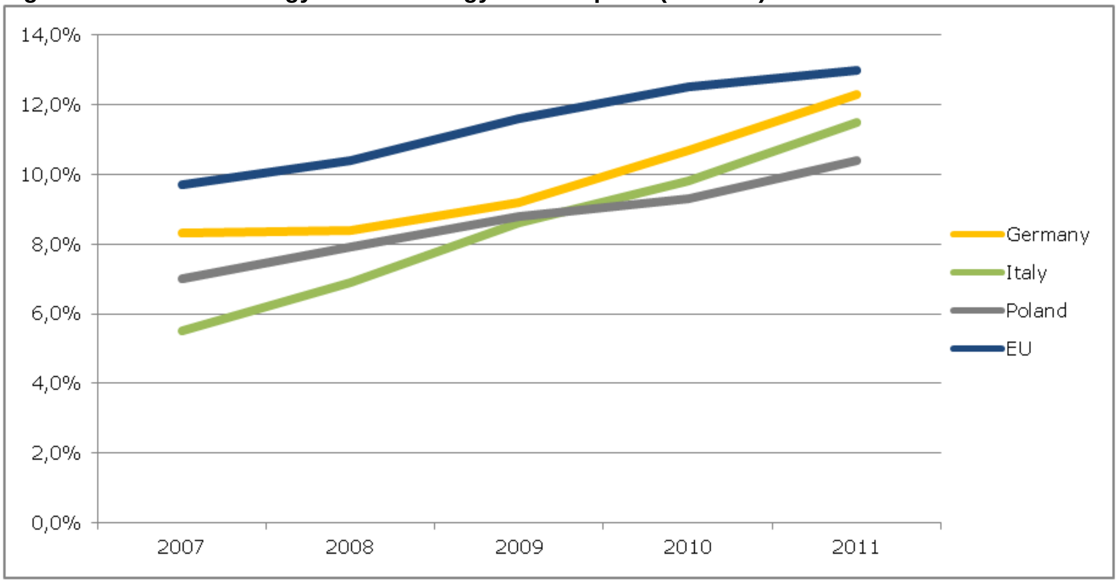
Tab. 12 - Annual Change in Combined Heat and Power Generation (% of gross electricity generation)

	Germany	Italy	Poland	EU
2008	0,30%	-0,80%	-0,40%	0,10%
2009	0,50%	0,70%	0,30%	0,40%
2010	0,20%	1,30%	0,40%	0,30%
2011	-0,10%	0,00%	-1,00%	-0,50%

Poland utilizes the highest percentage of its cogeneration potential, though Italy has had the fastest improvement rate in recent years.

An additional helpful indicator of the development of low-carbon energy security is the share of renewable energy in gross final energy consumption, [24] as it reveals the degree to which new carbon-free technologies have penetrated the energy sector, one of the largest sources of GHG.

Fig. 45 - Renewable Energy in Final Energy Consumption (% share)*



[24] Eurostat, "Share of Renewable Energy in Gross Final Energy Consumption. tsdcc110."

Tab. 13 - Annual Trend of Renewable Energy in Final Energy Consumption (% share)

	Germany	Italy	Poland	EU
2008	0,10%	25,45%	12,86%	7,22%
2009	9,52%	24,64%	11,39%	11,54%
2010	16,30%	13,95%	5,68%	7,76%
2011	14,95%	17,35%	11,83%	4,00%

Climate Indicators

To more directly address carbon intensity, i.e. the "low-carbon" part of energy security, it is important to find further indicators, as the data above only address energy consumption and importation, which could include energy sources of widely varying carbon intensity. The first step is to view an overview of GHG emission trends. [25]

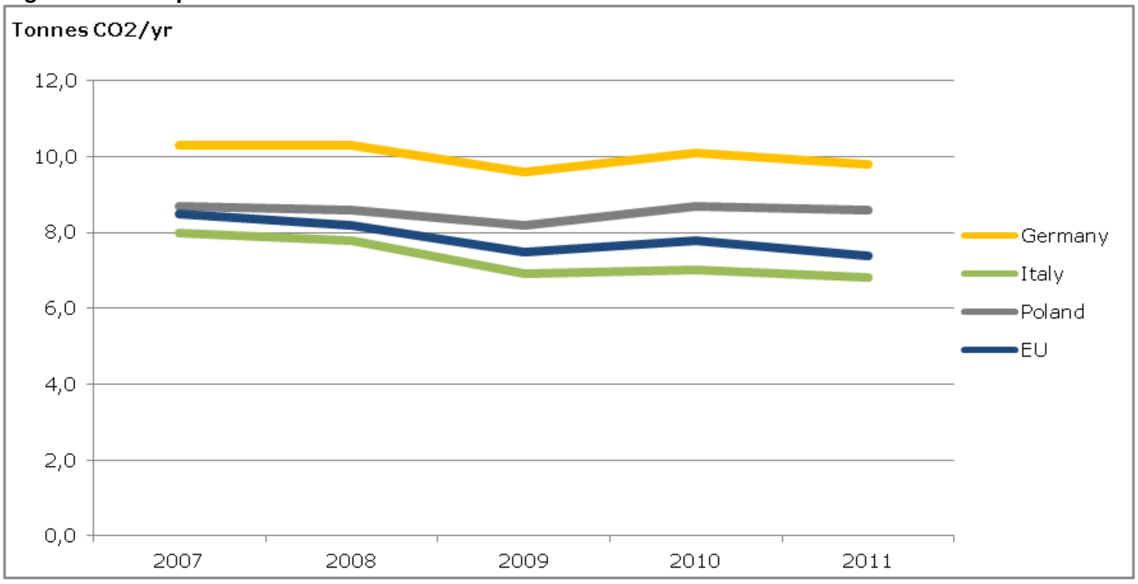
Tab. 14 - Total Greenhouse Gas Emissions (1000 tonnes CO_2e)*

	Germany	Italy	Poland
2008	974.993	541.177	400.214
2009	911.308	490.780	380.587
2010	943.518	500.314	401.670
2011	916.495	488.792	399.390

Analysing a country's per capita CO_2 emissions allows one to evaluate their relative carbon intensity, without giving influence to population size (as would be the case by looking at total national emissions) or economic strength (if one were to look at emissions relative to national GDP). The data below are primarily derived by calculating energy-related CO_2 sources, and do not include emissions from land use changes. [26] However, this data also does not include non-CO_2 GHG, no matter its source.

[25] Eurostat, "Greenhouse gas emissions by sector. tsdcc210."
[26] Eurostat, "CO2 Emissions per Inhabitant in the EU and in Developing Countries. tsdgp410."

Fig. 46 - Per Capita CO2 Emissions



These data show that Italy's per capita carbon intensity is significantly lower than that of Poland or Germany. The trends associated with these data are:

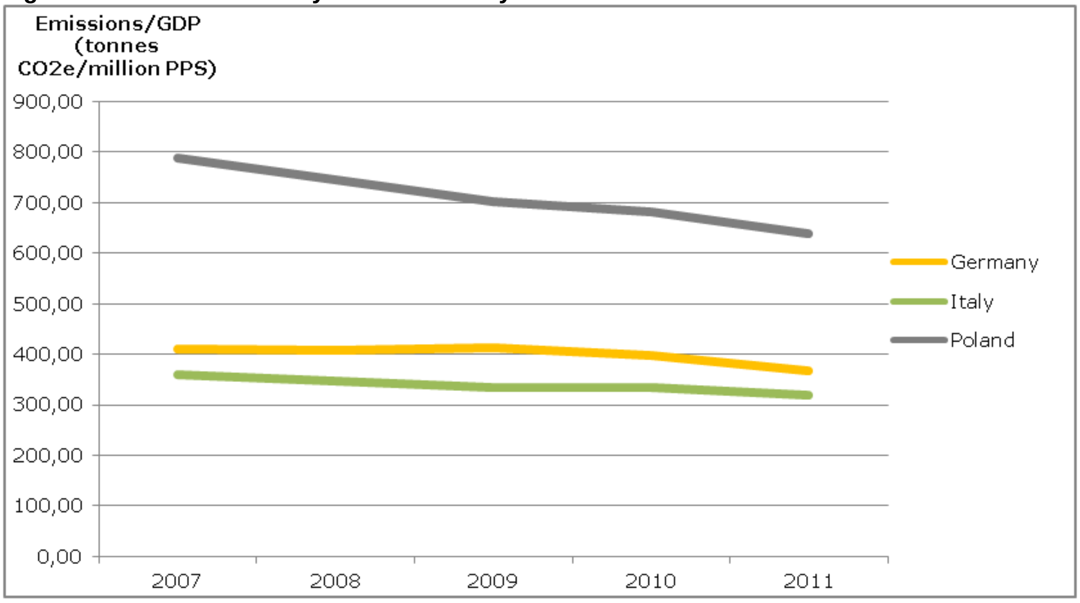
Tab. 1 - Per Capita CO_2 Emissions Change Over Time (%)

	Germany	Italy	Poland	EU
2008	0,00%	-2,50%	-1,15%	-3,53%
2009	-6,80%	-11,54%	-4,65%	-8,54%
2010	5,21%	1,45%	6,10%	4,00%
2011	-2,97%	-2,86%	-1,15%	-5,13%

These trends give yet another impression, allowing an analysis of the change in per capita emissions over time. These data highlight that not only are Italian emissions the lowest per capita, but that they have also had the greatest reductions over this time period, while Germany has effected modest reductions and Poland's per capita emissions have remained essentially stable. The EU's overall annual reductions seem to lie between Poland's and Italy's rates.

While it can be very valuable to look at per capita emissions, the carbon efficiency of a nation's economic system can be important to take into consideration as well. If per capita emissions are equal but one country is able to produce greater value in goods and services, then those produced goods and services have less climate impact. In order to analyse the efficiency of a country's economic system one should use look at (GHG) emissions relative to that country's gross domestic product (GDP).[27][28]

Fig. 47 - Emissions Intensity of the Economy



This indicator shows a rather wide variation in the amount of CO_2-equivalent GHG released by each country per unit GDP. It seems that Italy is consistently more efficient by this measurement than either Germany or Poland, and that Poland is significantly less efficient than either of the other two countries. As previously, it is important to also consider trends within these data, because these emissions levels are contingent upon a large number of historical, economic, societal, and geographical factors which may make these economies more or less likely to emit greenhouse gasses.

Tab. 216 - Change of Economy's Emissions Intensity over Time

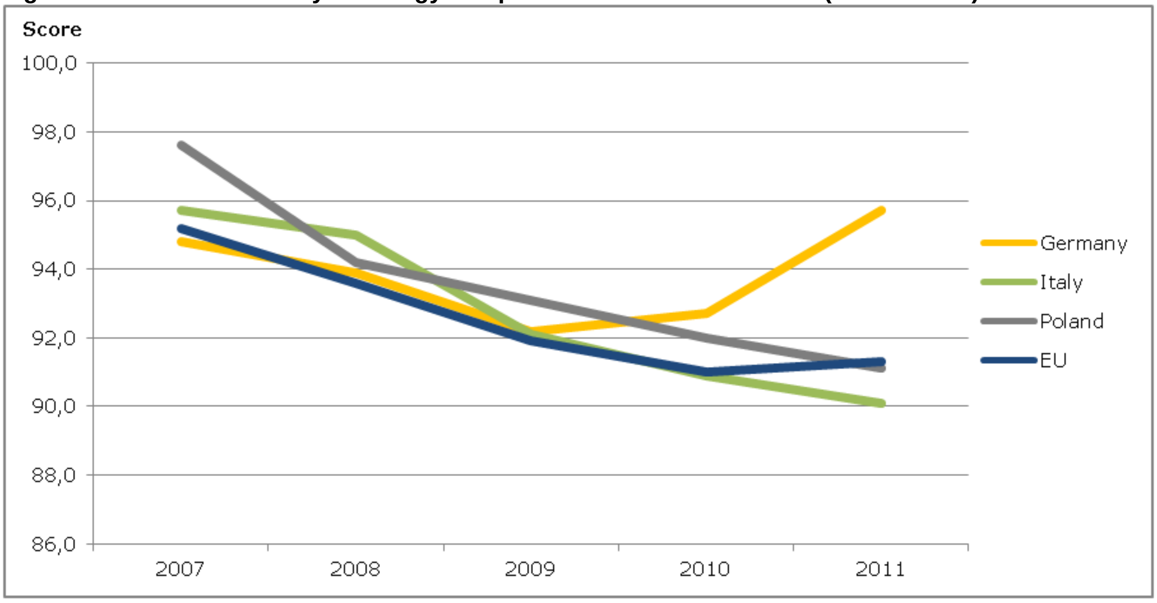
	Germany	Italy	Poland
2008	-0,46%	-3,57%	-5,30%
2009	0,83%	-3,56%	-5,92%
2010	-3,52%	0,12%	-2,78%
2011	-7,80%	-4,29%	-6,38%

These data give a much different impression from the raw emissions vs. GDP table. Whereas Poland has consistently had a much less efficient economy relative to GHG emissions, this table illustrates that Poland is becoming more efficient significantly faster than either Italy or Germany in every year where data is displayed. For their part, Germany and Italy are both becoming more efficient at a roughly equivalent rate.

[27] Eurostat, "Greenhouse Gas Emissions Intensity of Energy Consumption. tsdcc220."
[28] Eurostat, "Gross Domestic Product at Market Prices. tec00001."

In order to address efficiency more fully, there are a number of other indicators that should be analysed as well. Eurostat compiles an index of the GHG intensity of energy consumption in all European countries, relative to each country's baseline year of 2000.[29]

Fig. 48 - Emissions Intensity of Energy compared to Baseline Year 2000 (score of 100)



Tab. 17- Change of Energy Emissions Intensity over Time compared to Baseline Year 2000 (score of 100)

	Germany	Italy	Poland	EU
2008	-0,90	-0,70	-3,40	-1,60
2009	-1,70	-2,90	-1,10	-1,70
2010	0,50	-1,20	-1,10	-0,90
2011	3,00	-0,80	-0,90	0,30

This index indicates that all three countries have increased the efficiency of their energy supplies from the 2000 baseline. Italy has increased it the most, almost 10%, while Germany has increased it the least, just over 4%. Looking at the trend data, it is interesting to observe that both Poland and Italy have increased efficiency in every year analysed, while Germany decreased its efficiency in both 2010 and 2011. Reasons for this development will be analysed in more detail in the case study on Germany.

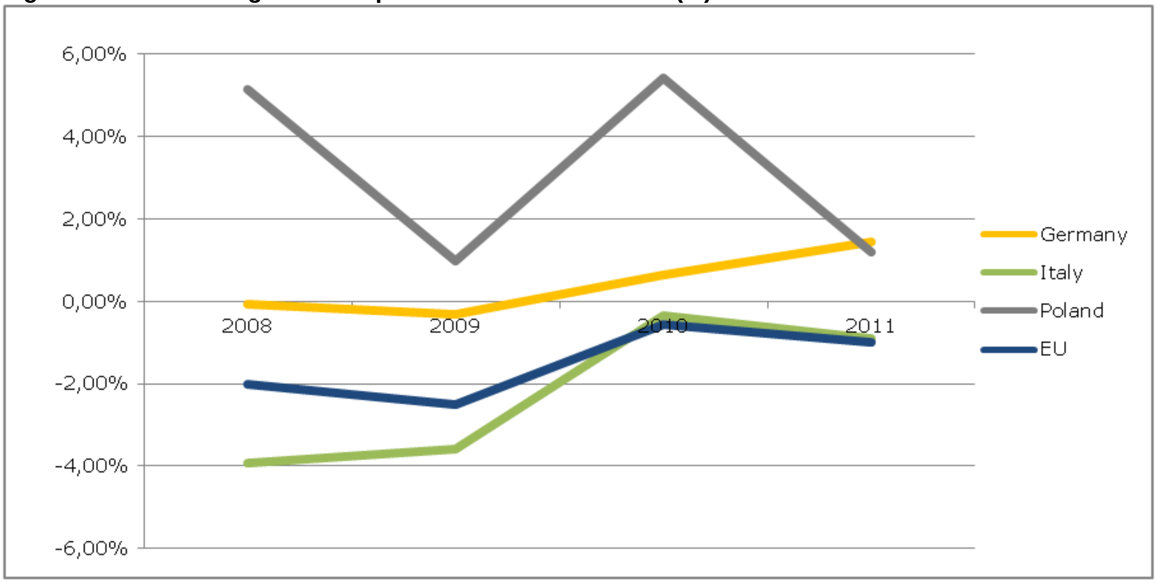
In order to analyse the GHG impact of the transport sector, it is important to look at both raw emissions data and data relative to GDP. [30]

[29] Eurostat, "Greenhouse Gas Emissions Intensity of Energy Consumption. tsdcc220."
[30] Eurostat, "Greenhouse Gas Emissions from Transport. tsdtr410."

Tab. 18 - Greenhouse Gas Emissions from Transport (1000 tonnes CO_2e)

	Germany	Italy	Poland
2008	154.447	123.776	45.201
2009	153.952	119.338	45.648
2010	154.956	118.911	48.114
2011	157.179	117.851	48.687

Fig. 49 - Annual Change in Transport Emissions over Time (%)



It seems that Italy has been successful in recent years cutting emissions from the transport sector, which will only continue as Italy implements its transport electrification plan.[31] On the other hand, Poland has seen a consistent rise in Transport GHG emissions.

Tab. 19 - Transport Emissions Intensity of the Economy (relative to GDP and compared to baseline year 2000, score of 100) [32]

	Germany	Italy	Poland	EU
2008	83,6	96,2	120,0	94,1
2009	88,5	97,6	119,9	95,7
2010	85,3	95,2	122,7	93,5
2011	83,1	94,9	118,5	91,7

[31] Dreblow, Eike et al. (2013), *Assessment of Climate Change Policies in the Context of the European Semester Country Reports*.
[32] Eurostat, "Energy Consumption of Transport Relative to GDP. tsdtr100."

Since 2000 it is quite clear that Germany has made economy-wide transportation GHG emissions reductions, although the bulk of that shift seems to have occurred earlier in the decade. On the other hand, Poland appears to have quickly increased the carbon intensity of transport after 2000, and in recent years has stabilized the transportation emissions relative to GDP.

3.3 Summary progress towards Europe 2020 energy targets

The national energy and climate targets under the Europe 2020 strategy are monitored in Table 20 below, which highlights current progress for the three Member States previously discussed.

Tab. 20 - Monitoring Member States on Europe 2020 Progress[33]

	Germany	Italy	Poland	EU
CO_2e emissions target (from 2005 levels)	**-14,00%**	**-13,00%**	**14,00%**	**-20,00%***
Change in CO_2e emissions (2011)	-8,16%	-14,91%	2,35%	-18,37%*
Renewable Energy target (final energy consumption)	**18,00%**	**17,00%**	**15,48%**	**20,00%**
Renewable Energy (2011)	12,30%	11,50%	10,40%	13,00%
Energy Efficiency target (total 2020 primary energy consumption reduction from 2005 "business as usual" baseline energy projections through 2020, in Mtoe)**	**38,30**	**27,90**	**14,00**	**368,00**
Primary Energy Consumption (2005, in Mtoe)	314,70	179,90	88,50	1702,80
Primary Energy Consumption (2011, in Mtoe)	286,40	161,90	97,30	1583,00

*From 1990 levels

**Comparing energy efficiency targets across countries is very difficult, based on unique, country-specific 1) growth dynamics, and 2) "business as usual" GHG projections through 2020. The table above presents Eurostat data for primary energy consumption in both 2005 and 2011 to chart how the Member States have progressed, but because of the many uncertainties associated with the unique "business as usual" scenarios, this table does not assess the extent to which the Member States are meeting their energy efficiency targets.

While the three Member States have some time before 2020, a striking conclusion is that Italy has already surpassed its 2020 CO_2e emissions reduction target. All three Member States have made progress toward reaching their Renewable Energy target shares.

[33] European Commission, "Europe 2020 Targets: Climate Change and Energy."

3.4 Focus on Italy

Introducing the Italian energy profile

In the absence of a significant domestic energy production, in terms of fossil fuels and nuclear energy generation, the Italian energy demand is largely satisfied by imports from abroad. Internal resources of fossil fuels, already quite limited, have declined in recent years, particularly with regard to natural gas. The increase in imports of natural gas, however, has not been affected by the economic crisis and its effect on industrial production that has reversed the trend in energy consumption. National energy policies instead strongly focus on the development of renewable sources whose contribution to the electricity sector has already reached the significant level of 26% (Eurostat 2010).

Regarding the logistics infrastructure for energy, critical factors are related to administrative issues, delays in authorization procedures and lack of investments, which constitute the main obstacle to a full transition to a low carbon economy.

National energy consumption and production

In 2011, the domestic production of natural gas and crude oil has been 8.3 billion Nm3 and 5.3 million tons, corresponding to 10% and 7.5% of the annual consumption of oil and gas, respectively (source: Italian Ministry of Economic Development, energy statistics).

With the onset of the global economic crisis, the increasing trend of energy consumption reversed its sign mainly due to the contraction of the industrial sector (Figure 50). In particular, during the period 2004-2011, energy consumption by the industrial sector dropped from around 188,5 Mtep to 173 Mtep.

Fig. 50 - Final energy consumption by sector in Italy, period 2004-2011

Source: ENEA elaboration on Eurostat data.

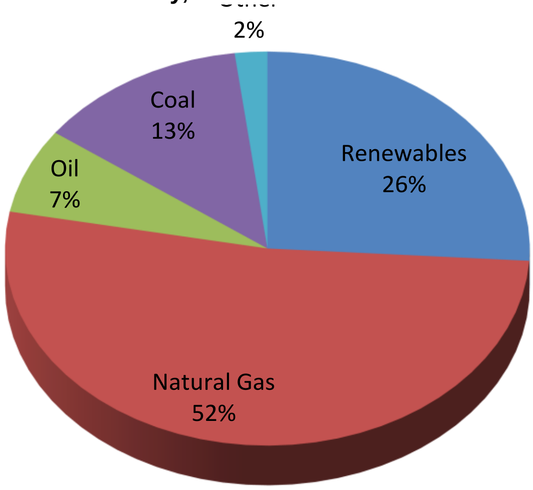
The Italian power system is facing a period of heavy transformation, represented by the progressive phasing out of fossil fuels. The shift from oil to natural gas, reducing oil's share in overall primary energy consumption from over 77% in 1973 to 41% of in 2011, is mainly due to the increased use of natural gas in power generation.

Changes in the energy mix are also reflected by the increasing share of renewable sources whose contribution in 2011 has reached 12% of national primary energy consumption.

Another peculiarity of the Italian energy system is represented by the absence of nuclear power, whose option has been definitively abandoned after two public consultations held in 1986 and 2010, after the Chernobyl and Fukushima events, respectively. Without the contribution of nuclear power, and in front of the reduction of oil products imports, the Italian energy strategy has gradually oriented towards natural gas, whose consumption increased from 58 to 68 Mtep in 10 years, and renewable energy sources whose consumption reached 18 Mtep in 2010. In spite of this, the degree of primary energy consumption covered by fossil fuels is still at the highest levels in Europe (88% of the overall primary energy consumption, 6% higher than the EU-27 average).

As for the electricity system, the total gross annual production of electricity has stabilized between 290 and 300 TWh. National production of electricity satisfies a very relevant share of domestic demand (86,6% in 2010; source: Terna). As of 2010, the largest share of electricity generation relies on natural gas (52%), followed by renewable energy sources with a share of 26%. Renewable energy sources electricity generation is mostly due to hydro and geothermal plants, but there has been a considerable growth in the last five years, especially in wind and solar photovoltaic thanks to the introduction of specific incentives. In 2011 wind power generation reached 9.0 billion kWh and PV production 1.9 billion kWh (+39.5% and +177%, respectively, with respect to 2010).

Fig. 51 - Electricity generation mix in Italy, 2010



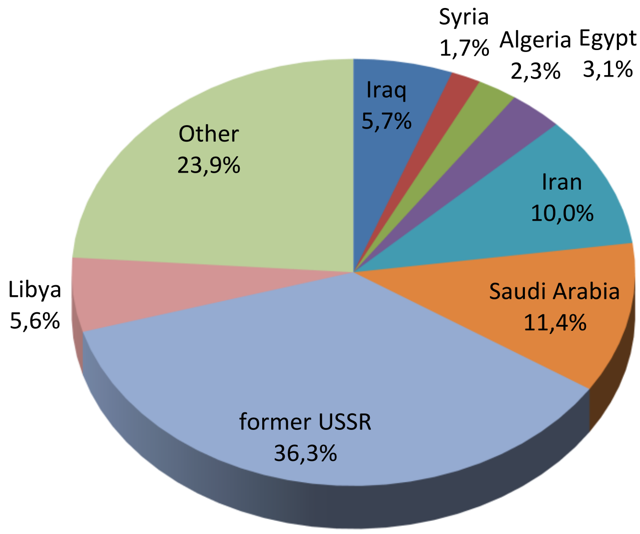
Source: Unione Petrolifera Italiana Databook, 2013

Energy imports

Italy has been paying for years a high energy bill resulting from heavy imports of fossil fuels. In 2011, net imports implied a cost of about 62 € billion.

Since the late 80s, natural gas has been considered as the main vehicle of the energy transition towards a new energy mix, less dependent on oil and foreign oil supplying countries. Such a fuel switch from oil to natural gas lead to a decrease in crude oil imports of about 20% with respect to 2005, especially from OPEC countries, some of which hardly affected by internal uprisings and some by change of government.[34]

Fig. 52 - Italian crude oil imports by country of origin, 2011



Source: Unione Petrolifera Italiana Databook, 2013

At the same time, however, the increase in net imports as well as the increase in consumption of natural gas is creating a new energy dependence of the Italian energy system from foreign imports. In 2010 the share of imported gas was the highest among European countries (90%), mostly originating from non-European countries (86%), in particular from Algeria (32%) and Russia (28%).[35]

Energy infrastructures

In line with the main objectives of the European energy policy, i.e., full integration of national energy markets, security of supply and diversification of energy sources, Italy can play a major role thanks to its geographical position, at the centre of the Mediterranean basin, standing as a platform exchange that can intercept the main North-South and East-West energy flows across Europe and from/to North Africa. In fact, considering the list of projects of common interest for trans-European energy infrastructure Italy is involved in 5 energy corridors, regarding electricity interconnections (North-South) and gas interconnections (North-South).[36]

The National Transmission Grid (NTG) is the backbone of the Italian **electricity system**, and consists of 63,500 kilometres of power lines managed by Terna, the

34 In 2011, for instance, the share of Italian crude oil imports from Libya, country that was in the middle of a civil war, dramatically collapsed to 7% while increasing the following year at beyond 20% (source: Unione Petrolifera).
35 Source: Unione Petrolifera 2013 Data Book and Agienergia.
36 COM(2010) 677 and "Guidelines for Trans-European Energy Infrastructure", REGULATION (EU) No 347/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 April 2013. NSI West Electricity e East Electricity, NSI West Gas, East Gas, e Southern Gas, http://ec.europa.eu/energy/infrastructure/pci/doc/com_2013_6766_en.pdf

Italian public holding that manages electricity transmission systems. The Italian transmission grid is interconnected with UCTE Power System by means of 22 interconnection lines, 12 with Switzerland, 4 with France, 2 with Slovenia, 2 with Corsica, 1 with Austria, and 1 with Greece.

The growing contribution of renewable energy sources to electricity generation puts pressure on the ability to accommodate into the grid decentralized and intermittent power generation plants with respect to traditional fossil-fuelled centralized power plants. Moreover, bottlenecks arise in the grid due to the fact that renewable energy sources electricity generation is mostly concentrated in the Southern Italian regions and in the Islands whereas most of the electricity demand comes from Northern regions where most of the industrial production takes place.

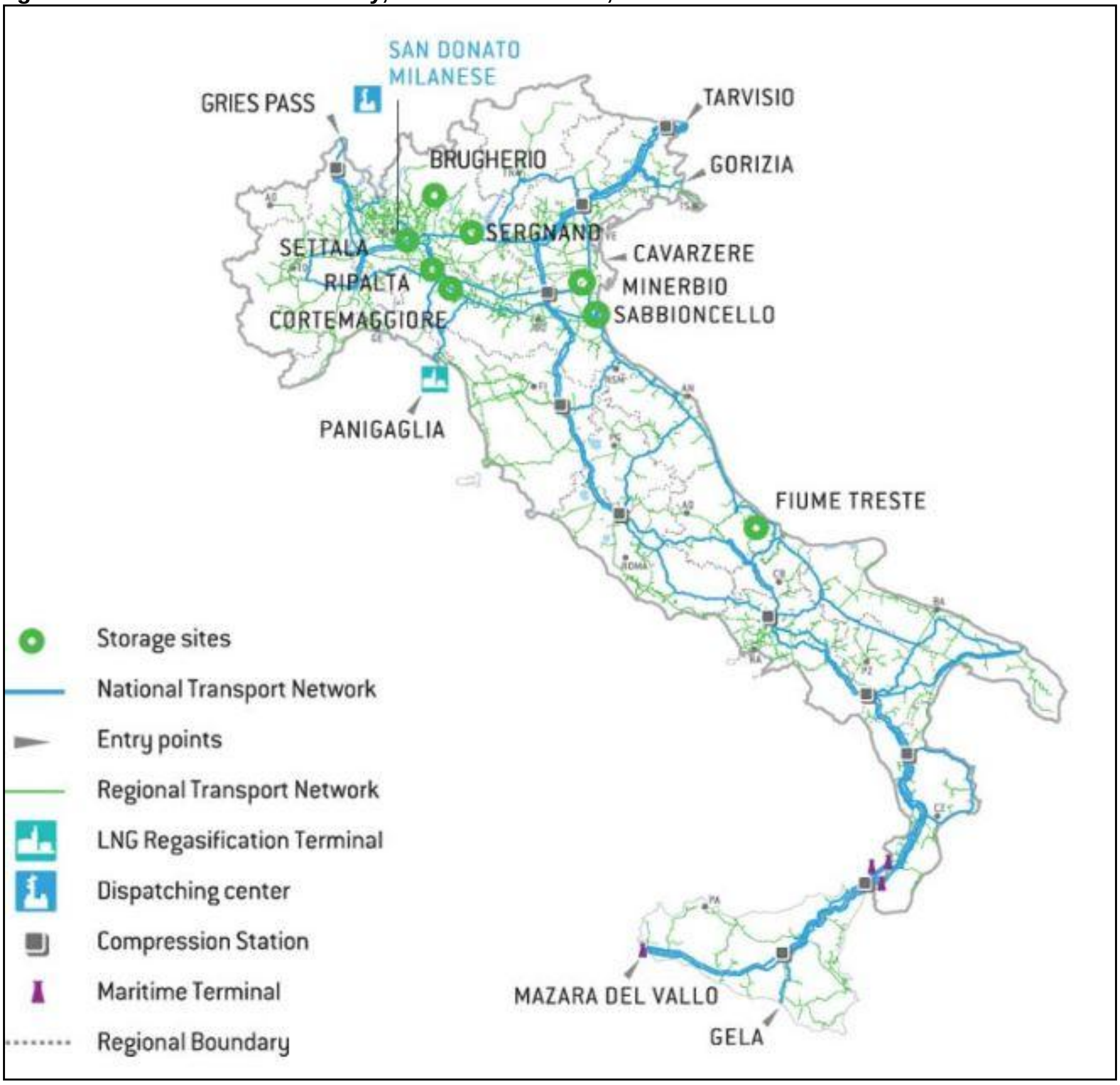
In order to modernize a grid that in recent years has also experienced episodes of severe disruption of energy provision, Terna began a series of investments aimed at realizing 2,500 km of new power lines and 84 new stations for strengthening national and international connections. As for the Northern interconnections, new lines are going to be realized with France, Austria and Slovenia. In the South of Italy, the power line "Sorgente-Rizziconi", scheduled to improve internal connection between Sicily and Calabria, could become a pillar to realize an Italian "electricity hub" of the Mediterranean. In fact, a number of projects, such as Desertec and Medgrid, are aimed at to promoting and developing a Euro-Mediterranean electricity network that would provide North Africa and Europe with renewable electricity, mostly from solar. Another relevant project is Elmed, an integrated project for energy production and transmission that includes a 1000 MW submarine connection between Italy and Tunisia.

The Italian **natural gas infrastructure** is one of the most extended and articulated in Europe. It consists of approximately 31,700 km of pipelines that are managed by Snam Rete Gas, a company of the Eni group that is in charge of transporting and dispatching natural gas. International connections are implemented through a network of pipelines divided into five main lines that carry natural gas at the border of the National Network, represented by two regasification terminals (located in Panigaglia and Rovigo).Ten storage facilities are planned to be realized in the Po Valley and in Central Italy. Three of them are currently under construction, and the other ones are under the authorization phase.

The interconnection projects through pipelines planned in the coming years include:

a) Southern Gas Corridor (TAP and IGI) that should allow to intercept the flow of natural gas in the Southern corridor, channelling resources from Azerbaijan, Iraq and Turkmenistan;
b) West Gas (Galsi) with the construction of an interconnection between Algeria Tuscany, via Sardinia;
c) East Gas (TGL), the construction of a two-way flow (reverse flow) between Italy, Austria and Germany, involving the markets of the Czech Republic and Slovakia.

Fig. 53 - Gas infrastructure in Italy, as of December 31, 2010



Source: Eni Fact Book 2010

The slow progress of these infrastructures highlights several administrative delays, related to the authorization procedures or to the granting of loans.

National energy market

The Third Energy Package has been implemented in Italy by the Legislative Decree n.93 of 01 June 2011.[37] Among the innovative measures introduced by the legislative decree the most relevant ones concern: (i) the definition of a national energy policy, (ii) public service obligations and consumer protection and (iii) duties and powers of the Authority. The Decree incorporates European Community regulations on unbundling

37 Italian Legislative Decree no. 93 of 1 June 2011 “Implementation of Directives 2009/72/EC, 2009/73/EC and 2008/92/EC in relation to common rules for the domestic market in electricity, natural gas market and a community procedure on the transparency of prices to the end industrial consumer of gas and electricity, in addition to repealing Directives 2003/54/EC and 2003/55/EC”.

the manager of the transmission system.

Regarding the electricity market, the model of ownership unbundling of transmission systems and transmission system operators ("TSOs") introduced by Directive 72/2009/EC was already in force in Italy pursuant to Legislative Decree no. 79 of 16 March 1999 (the so- called "Bersani decree"). The Italian legislator has therefore confirmed the existing model, entrusting TERNA with the operation of the transmission system and has forbidden the latter to carry out directly or indirectly any activity of production or supply of energy as well as to operate, even temporarily, electricity generating infrastructures or power plants. TERNA owns almost the entire national electricity transmission grid but there are also other smaller operators which owns some network elements (a few lines and substations).

Market integration with neighbouring markets is progressing, but Italy's interconnectors remain highly utilised. With more than 12.000 MW of interconnection capacity (8.000 MW of Net Transfer Capacity), Italy is one of the best interconnected systems in Europe, but the interconnectors are not always used as efficiently as they could be (e.g. there is no intraday capacity allocation) and internal congestion restricts their potential use.

Since 1 January 2011, integration of the Slovenian and Italian markets is based on market coupling for daily capacity allocation. Otherwise yearly, monthly and daily capacity is allocated through explicit auctions (from June 2012 intraday explicit auctions are in place). In April 2011, TERNA joined — together with other regional TSOs from the central-south region — the Capacity Allocation Service Company (CASC), the company organised by the TSOs of the central-west region to operate as a single auction platform for the region.

For the **gas sector**, the innovative measures introduced by the Decree n.93/2011 concern: (i) the unbundling of transmission systems and transmission system operators; (ii) access to modulation storage and obligations relating to strategic storage; and (iii) public service obligations and consumer protection.

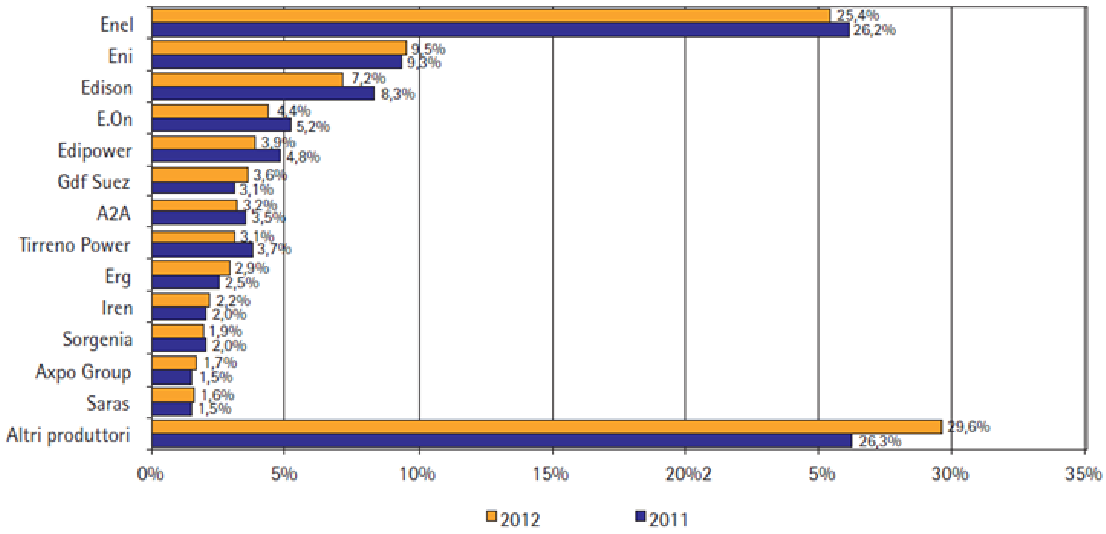
As for the unbundling between the activities relating to the operation of the transmission systems and those related to the production and supply of gas, the Legislative Decree no. 93/11 decided to apply the Independent Transmission Operator (ITO) model to the main transmission system operator, that is, Snam Rete Gas, while it left the choice between the remaining models to the other smaller network operators. Subsequently, Law no. 27 of 24 March 2012 reviewed the model chosen for Snam Rete Gas in favour of the ownership unbundling regime (TSO). Snam Rete Gas TSO is a subsidiary of SNAM S.p.A. which in 2011 was owned with a majority share of 52.5% by ENI, 5% by the government and the rest was privately owned.

Electricity market

In terms of electricity generation, the four largest producers together controlled slightly less than 50% of the Italian market in 2012. This value is due to a further reduction of ENEL's market share in electricity production, which has decreased from 26.2% in

2011 to 25.4% in 2012, following the trend of the previous years. ENEL's main competitors were ENI (9.5%), Edison (7.5%), E.On (4.4%) and Edipower (3.9%).

Fig. 54– Italian electricity production by company, 2011 and 2012



Source: AEEG[38], Annual Report on the State of Services and Regulatory Activities, 2013)

In the retail market as a whole, in terms of total sales, two different corporate groups registered market shares greater than 5% in 2011: Enel (37.8%) and Edison (8.1%). These were followed by the Acea group with a market share of 4.5% and Eni, whose share of 4.2% consisted almost exclusively of sales to non-residential customers. The top ten operators (corporate groups) covered roughly 75% of total sales.

In terms of prices, Italian households can benefit from regulated prices of electricity. In spite of that, household electricity prices place themselves among the highest ones across EU countries, exceeding 20 eurocent/kWh in 2011. The impact of taxes on the relative prices of electricity to households appears to be relevant in explaining this situation. The same can be said for industrial electricity prices that were slightly above 15 eurocent/kWh in 2011 with an upward trend with respect to the previous year.[39]

Natural gas market

The Italian gas market continues to be largely controlled by the ENI Group which still maintains control of the international gas pipeline capacity. The upstream sector is still dominated by Eni, which accounted for 83% of the gas produced in Italy in 2012.

38 Italian Regulatory Authority for Electricity and Gas.
39 Source: ACER/CEER, Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2011.

Fig. 55 - Natural gas production in Italy by company, 2012

Company	Quantity Mm3	Share
Eni	6.815	82,6%
Edison	608	7,4%
Royal Dutch Shell	596	7,2%
Gas Plus	200	2,4%
Others	32	0,4%
Total	8.251	100%
Production (Ministry of Economic Development)	8.605	-

Source: AEEG, Annual Report on the State of Services and Regulatory Activities, 2013

The number of retailers in the natural gas market has grown in 2011 reaching a total of 308 players. The retail market continues to exhibit the high concentration noted previously: the top three groups' overall share is equal to 49.5%. This share is now increasing for the first time after several years of decline, and was equal to 47.8% in 2010. As in the case of the wholesale market, the incumbent's (Eni) share is increasing in the retail market, climbing up from 24.7% in 2010 to 26.8% in 2011. The incumbent Eni is consolidating its position, with the share of the second operator (Enel) being equal to a share of 11.8%.

As in the case of electricity, Italian households can benefit from regulated prices of natural gas. In spite of that, household gas prices place themselves at the third place across EU countries (after Sweden and Denmark), slightly below 8 eurocent/kWh in 2011. In this case, however, the impact of taxes by itself cannot explain this result which is closely related to the heavy degree of natural gas import dependency from abroad. This is also due to the fact that companies which sell gas on the households market have signed long-term contracts indexed on oil prices with the major foreign suppliers. By contrast, industrial natural gas prices do not seem to be affected in the same way as household prices by this situation and place themselves slightly below the EU-27 average (3.25 eurocent/kWh in 2011).[40]

Research and innovation in the energy sector

In 2011, national public funding for energy R&D and demonstration was approximately 400 € million. Considering the government budgets on energy R&D per thousand units of GDP, the value for Italy has slightly increased in 2011 with respect to 2010 from 0.20 to 0.25.[41]

The budget structure has changed in recent years, with a marked shift towards energy efficiency and renewable energy sources, in particular, solar (24% and 17% of the total budget, respectively), while nuclear power R&D has lost ground (23% in 2011 compared to 40 % in 2000), consistently with the public opinion position expressed in

40 Source: ACER/CEER, Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2011.
41 Total RD&D expenditures in nominal national currencies divided by GDP in nominal national currencies at market prices and volumes, expressed in thousand units of GDP: Source: IEA RD&D Budget/Expenditures Statistics.

the 1986 and 2011 referendums against this form of energy within the Italian national borders. Among renewable energy sources, the Concentrated Solar Power (CSP) sector has received roughly between 21% and 22% of the total national RES R&D budget in the last two years, corresponding to a total expenditure of around EUR 12 million in 2010 and EUR 15 million in 2011.

Eni, the main Italian oil and gas company, and Enel, the formerly state-owned Italian electricity utility are large investors in R&D programmes, both in Italy and abroad. In 2007, Eni invested over 208 € million in its R&D programme, 47% of which was directed to energy exploration and production. The Eni “Along-with-petroleum” initiative addresses innovation in the fields of renewable energy sources and systems for efficient energy use. In 2007 the fund financed projects in the area of innovative photovoltaic systems (12 € million) and biofuels (7 € million). In the subsequent four years, Eni invested approximately 1.7 € billion to implement its technological innovation strategy.

Enel is also a significant investor in R&D activities. In 2007, the company launched a number of new initiatives aimed at developing and demonstrating innovative technologies in the field of carbon capture and storage (CCS), electricity generation from renewable energy sources, distributed power generation and energy efficiency. Investments of some 800 € million were planned for a period of 5 years.[42]

National energy policies

On March 8, 2013, the Italian Ministry of Economic Development jointly with the Ministry of the Environment approved the document containing the new National Energy Strategy (“Strategia Energetica Nazionale”, SEN). The final version of the document is the result of a wide public consultation that started in October 2012. It outlines the most relevant strategic objectives for the national energy sector from a medium (2020) to long-term (2050) perspective. The actions proposed aim at defining a low-carbon growth path for the national economy while reinforcing the country’s security of supply. In particular, energy efficiency, the sustainable development of renewable energy sources and the deployment of smart grids for electricity distribution are among the main priorities listed in the document.[43]

National low-carbon energy policies

In order to achieve the targets on GHG emission reduction and decarbonisation of the energy sector defined at the EU level, Italy has adopted a series of measures and policies at different levels and covering different sectors with the aim of: i) completing the liberalization process of the electricity and gas markets; ii) promoting energy efficiency; and iii) fully deploy the potential of renewable energy sources to diversify the national energy mix.

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42 Source: International Energy Agency, “Energy policies of IEA countries – Italy 2009 review”, 2009.

43 For additional information and the full text of the document, see http://www.sviluppoeconomico.gov.it

Energy efficiency, in particular, is often claimed to be one of the most cost effective ways to enhance security of energy supply, and to reduce emissions of greenhouse gases and other pollutants. In the case of Italy, the residential and tertiary buildings sector showed important results in terms of energy efficiency improvements over the period 1990-2010,[44] and the major role of the national policy framework is often recognized to be an explanation of these results.[45] The principles and the methods to improve the energy efficiency in households and tertiary buildings are settled by the Legislative Decree n.192/2005, amended by the L. D. n.311/2006 and complemented by L.D.115/2008: mandatory minimum energy performance standards addressing the primary energy demand for new houses and for existing buildings undergoing major renovation; energy performance certificates; measures aimed at favouring the use of renewable energy sources for electricity generation. At the same time, financial support schemes like the 55% tax allowances for the costs incurred for energy efficiency interventions in buildings (high efficiency boilers, high efficiency fixtures, installation of solar panels, thermal insulation and retrofitting) certainly contributed to the positive energy efficiency trend in this sector.

The more recent national policies for energy efficiency improvements and the deployment of renewable energy sources adopt the corresponding EU Directives in the field. To this end, a set of energy planning measures and tools have been set up. Notably, two National Energy Efficiency Action Plans (NEEAPs; in Italian: Piano di azione per l'Efficienza energetica, PAEE), and the National Action Plan for the deployment of Renewable Energy Sources (in Italian, Piano di Azione Nazionale per le energie rinnovabili, PAN).

NEEAPs implement the Directive 2006/32/CE that came into force in 2008 and established for EU Member States an approximate energy saving target of 9% by 2016 to be achieved by means of end-use energy services and measures for energy efficiency improvements.

The first NEEAP (2007) envisaged the attainment of a target slightly higher than the one defined by the Commission, notably 9.6% energy savings by 2016. More than 80% of the overall energy saving obtained in the period 2007-2010 (mostly attributable to the residential sector) concerns interventions realised under two policy measures: the energy performance minimum standards for residential buildings (L.D. 192/05) and the mechanism for the acknowledgement of energy efficiency titles (the so called "white certificates"[46]). The most relevant interventions to the achievement of the national target were: the installation of efficient heating systems in the residential sector; the adoption of minimum energy performance standards in the tertiary sector; the installation of high efficiency cogeneration plants, high efficiency electrical engines and heat recovery in the industrial sector; and the eco-sustainable renovation of the car park in the transport sector.

In July 2011, the second NEEAP was released. This plan has a wider vision than the

44 See http://www.odyssee-indicators.org/publications/country_profiles_PDF/ita.pdf

45 http://www.energy-efficiency-atch.org/fileadmin/eew_documents/Documents/EEW2/Italy.pdf

46 For a cost analysis of different white certificates schemes in Europe see Giraudet, L.G., Bodineau L., Finon D., (2012), "The costs and benefits of white certificates schemes", *Energy Efficiency*, 5(2), pp.179-199.

preceding one and clearly highlights the need to assess the impact of energy consumption reduction policies at a system level. The measures identified to achieve the 2016 national target can be potentially extended to 2020 and include the use of renewable energy technologies as a means to achieve energy efficiency improvements, in particular for thermal generation (solar thermal collectors for hot water production, high efficiency heat pumps, low-enthalpy geothermal plants, etc.)

The National Action Plan for the deployment of Renewable Energy Sources (PAN) implements the Directive 2009/28/CE, that established a common framework to promote renewable energy sources and fixed binding national targets for the overall share of renewable energy over gross final energy consumption and in the transport sector. The Italian national targets amount to 17% and 20% by 2020, respectively. The PAN, issued in June 2010, defines sector targets and the measures aimed at achieving them, and takes into account the possible interactions and synergies with energy efficiency measures. More specifically, the PAN defines the following targets to be satisfied by renewable energy sources by 2020:

- 10% of the energy consumption in the transport sector, thanks to higher contribution of biofuels and other kind of interventions aimed at deploying the electric vehicles sector;
- 26% of the energy consumption in the electricity sector, by means of energy storage systems, improvements in the distribution networks and the realisation of smart grids;
- 17% of air-conditioning consumption, through actions aimed at deploying district heating and cogeneration and at inserting biogas in the natural gas distribution network.

A number of measures are currently in place in Italy to incentivize electricity generation through renewable energy sources:

- the “green certificates” system, based on a compulsory share of additional electricity generation by means of renewable energy technologies;
- feed-in tariffs for the electricity produced and put into the grid by renewable sources plants with a capacity below 1MW (200 kW for wind), as an alternative to the green certificates;
- dedicated incentives to photovoltaic and solar thermodynamic plants through the “Conto Energia” mechanism;
- simplified selling procedures for electricity produced by renewable energy plants (“ritiro dedicato”).

As for the incentives to thermal energy production by means of renewable sources, most of the measures overlap with those for energy efficiency improvements:

- 55% tax allowances for the expenditures incurred to install heat pumps, and solar thermal and biomass plants at home;
- obligation (not fully operational yet) for new buildings to cover 50% of energy needs for hot water by renewable energy technologies, and to use renewable sources plants for electricity generation;

- fiscal incentives for (geothermal or biomass) district heating users;
- energy efficiency titles for solar thermal plants and other renewable energy technologies;
- tax exemption for solid biomass used in domestic boilers;
- Kyoto rotation fund, a financing mechanism aimed at promoting public and private small-scale investments in energy efficiency actions and for the use of renewable energy sources.

Regional Low-Carbon Energy Policies

Consistently with EU Directives, the planning and decision-making processes in the energy sector involve a large number of public and private stakeholders. This is also related to the recent progress in the liberalization of the energy market and to the decentralization of duties and administrative functions in the field of energy from the State level to the Regions and to local authorities.

Italian regions have a high degree of autonomy in relation to the planning and development of their own innovation and industrial support programmes. Moreover, the regions and the autonomous provinces have coordinating functions in energy matters. In particular, the regions are charged with the responsibility of drawing specific regional energy plans including renewables potential (Piani Energetici Regionali, PER), identifying the goals to comply with under the Kyoto Protocol and the European Union’s climate and energy package (IEA, 2009).

According to the Legislative Decree n.28/2011, the regional “Burden Sharing” agreement splits among the regions and the autonomous provinces the minimum share of increase of energy produced by renewable energy sources in order to attain the 2020 national target of 17% of gross final energy consumption. The Ministry of Economic Development Decree of March 15, 2012, besides specifying intermediary and final target shares for each region (based on the current level of renewable energy production in the region), contains also monitoring tools and procedures in case of non-fulfilment.[47]

Some Italian regions have been active in defining regional measures for energy efficiency in buildings. For example, in March 2008, the Emilia Romagna regional council deliberation resulted in standards and other measures aimed at improving the energy performance of buildings (development of a standard on the energy performance of buildings, including a calculation methodology, determination of energy classes and limit values, as well as minimum requirements for energy performance).[48]

47 Decreto del Ministero dello Sviluppo Economico, 15 marzo 2012, recante “Definizione e qualificazione degli obiettivi regionali in materia di fonti rinnovabili e definizione della modalità di gestione dei casi di mancato raggiungimento degli obiettivi da parte delle regioni e delle provincie autonome”, Gazzetta Ufficiale n. 78 del 2 aprile 2012.

48 Source: IEA, Addressing climate change: policies and measures database http://www.iea.org/policiesandmeasures/climatechange/?country=Italy

Local Low-Carbon Energy Policies

Italy is the European country that has by far the largest number of signatories of the Covenant of Mayors initiative. In fact, Italian cities and municipalities account for half of the total number of signatories. The Covenant of Mayors is the mainstream European movement involving local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories. By their commitment, Covenant signatories aim to meet and exceed the European Union 20% CO_2 reduction objective by 2020. For its unique characteristics - being the only movement of its kind mobilising local and regional actors around the fulfilment of EU objectives - the Covenant of Mayors has been portrayed by European institutions as an exceptional model of multi-level governance.

After the adoption, in 2008, of the EU Climate and Energy Package, the European Commission launched the Covenant of Mayors to endorse and support the efforts deployed by local authorities in the implementation of sustainable energy policies. Indeed, local governments play a crucial role in mitigating the effects of climate change, all the more so when considering that 80% of energy consumption and CO_2 emissions is associated with urban activity.

In order to translate their political commitment into concrete measures and projects, Covenant signatories notably undertake to prepare a Baseline Emission Inventory and submit, within the year following their signature, a Sustainable Energy Action Plan outlining the key actions they plan to undertake.

The different types of actions implemented by Covenant signatories as well as key measures of approved Sustainable Energy Action Plans serve as examples for others to follow. The Italian experiences of Milan congestion charge and the Province of La Spezia program for energy-efficient buildings are included among the successful initiatives and policies in terms of sustainable local development.

The objective of Milan congestion charge – according to which drivers entering the ‘Cerchia dei Bastioni’ (city centre, also referred to as ‘Area C’) of Milan with certain categories of vehicles are required to pay a fee – is to reduce road traffic in the city centre by 20 to 30%, CO_2 emissions by 20 to 25% and to use the revenue for improving the public transport network, expanding cycle lanes, pedestrian zones and 30kph zones. The congestion charge is part of Milan’s Sustainable Energy Action Plan and has secured public acceptance with 76.6% of the vote in favour of the scheme at a local referendum.

The main focus of the Province of La Spezia – composed by 32 municipalities, all of them Covenant Signatories – is to reduce the CO_2 emissions produced by municipal buildings. To this end an ambitious energy audit was launched in 2008 to evaluate 250 public buildings. Each building is identified by an “energy card” that gathers the building’s most important data, such as surface, volume, heating system, thermal and electrical consumption, among other information. The audit points out the building’s technical deficiencies from an energy point of view, analyses the construction quality and performance, and ultimately identifies the energy-efficient measures that are achievable with a quantification of the costs. The audit process is supported and directly financed by the Province and it is carried out by a joint network within which the university and public employees cooperate simultaneously.

At the same time, the Province of La Spezia has developed a web-based platform "AuditGIS" to make all the information collected from energy audits publicly available through interactive maps. The application makes it possible to monitor energy consumption and CO2 emissions, and to manage all the data at the municipal level. It also simulates various possible interventions and follows the evolution of the consumption and emissions over time. The tool has been instrumental for the development of the SEAPs of the municipalities of La Spezia.

Energy and sustainability challenges

The National Energy Strategy (SEN) approved in March this year outlines the most relevant challenges and strategic objectives for the national energy sector from a medium (2020) to long-term (2050) perspective.

While the economic crisis lead to a substantial contraction of industrial production in the second manufacturing country in the European Union, the rapid deployment of renewable energy sources and the exponential growth in installed capacity of solar and wind power pushed by generous incentives have changed the national energy market and system in recent years. As a result, the 2020 objectives – in terms of CO_2 emission reductions as well – appear to be actually achievable. The SEN takes this into account and aims at directing efforts to a substantial improvement of the competitiveness of the energy system together with the pursuit of environmental sustainability. This goal consists of four main objectives by 2020:

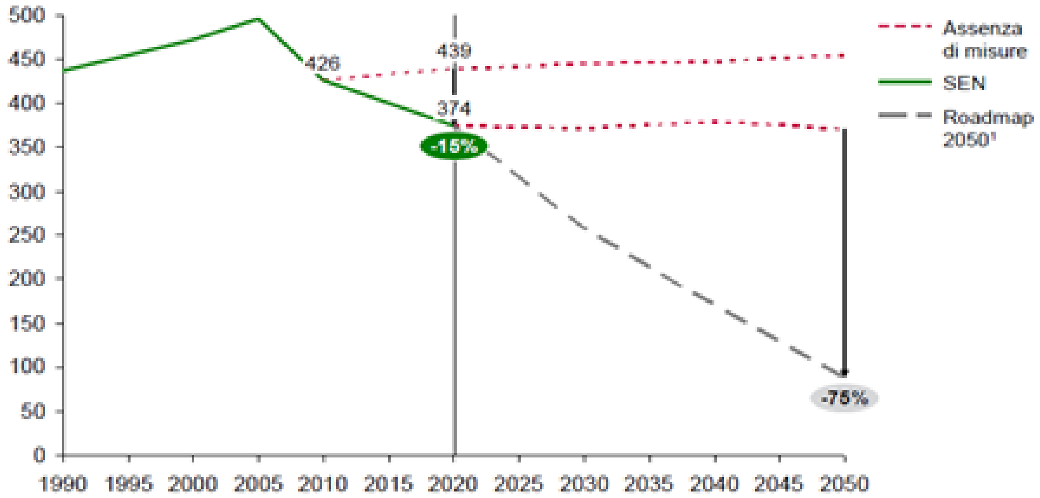
1) reducing energy costs for households and the industry with the alignment of prices to European levels;
2) exceeding the targets defined by the European Climate and Energy Package 2020;
3) greater security of supply, with a reduction of the foreign energy bill for the country;
4) growth and employment with investments both in traditional and in the green economy (renewable energy sources and energy efficiency) sectors.

In the medium term, the SEN identifies seven priorities with the corresponding goals and measures of support:

- sustainable development of renewable energy;
- energy efficiency;
- development of a competitive gas market and of the south-European gas hub;
- sustainable production and exploitation of national hydrocarbons ;
- deployment of smart grids for electricity distribution;
- restructuring of the refining and fuel distribution network;
- modernization of the governance system.

The measures planned by the SEN will need relevant investments, in the order of €180 billion by 2020, both in the traditional energy sectors (electricity and gas networks, LNG terminals, storage facilities, etc.) and in the renewables and energy efficiency ones, with the concrete involvement of private investors, partly supported by public incentives. This will have an expected positive return for the energy system as a whole, in particular with respect to energy imports: the expected reduction of imports will be equivalent to almost 1% of additional GDP and bring about €14 billion yearly savings on the foreign energy bill, with a decrease from 84% to 67% dependence on foreign supplies.

Fig. 56 - Primary energy consumption in the Reference scenario (no measures)



Source: SEN Scenario, Roadmap 2050 Scenario for Italy (Mtoe)

The SEN also highlights the role of research and innovation to face long-term energy and sustainability challenges and identifies priority areas in the energy sector:

- research on innovative renewable technologies;
- research on intelligent networks (notably, smart grids to facilitate the effective implementation of distributed generation) and storage systems (also with a view to sustainable mobility);
- research on materials and energy efficiency solutions and their technology transfer from labs to industry;
- development of projects for capture and confinement of CO_2.

Although the actions indicated by the SEN can contribute to reducing CO_2 emissions to 2020 and 2050, they will hardly be sufficient to allow Italy emission reductions in the order of 80%, as assumed by the EU Energy Roadmap 2050. On the contrary, the efforts needed are likely to be very important, leading to substantial changes in the structure of the energy system, through investment in energy infrastructure, research on new low-carbon technologies, and energy savings resulting from individual and societal behavioural change.

3.5 Focus on Germany

Introduction to German Energy Profile

With the largest economy in the EU, Germany has committed to developing a low-carbon energy system based on renewable sources by the year 2050. This energy transition will achieve greenhouse gas emission (GHG) reductions of 80-95%, compared to the reference year of 1990 (BMU and BMWi 2010). The energy sector is at present the largest emitter of GHGs in Germany with a share of 40% of total emissions (UNFCCC inventory 1990-2011).

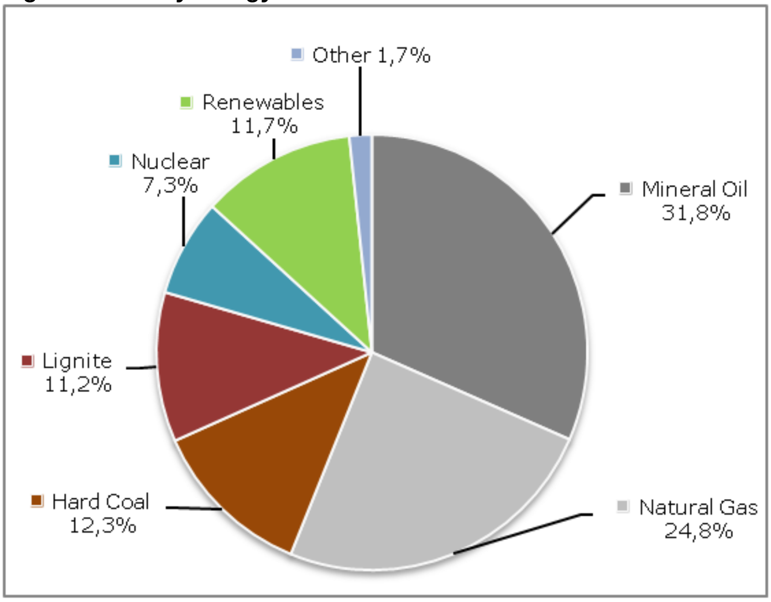
The basic document outlining the energy transition is the "Energy Concept" which was adopted in 2010. It provides a long-term strategy for German energy policy and includes 180 different measures. The *"Energiewende,"* or 'energy transition,' refers to this nationwide shift toward renewable energy and energy efficiency. The principal objective of the Energy Concept is to secure a reliable, economically viable and environmentally sound energy supply and to turn Germany into a 'Green Economy' (BMU 2013a).

The German government set a goal for a predominantly renewable energy supply by 2050 and the plan calls for a reduction in primary energy consumption in all sectors. The first version of the Energy Concept, which calls for a predominantly renewable energy supply by 2050 and the plan calls for a reduction in primary energy consumption in all sectors named nuclear energy as a bridging technology. However, in 2011, following the Fukushima nuclear accident, the environment ministry announced the permanent phase out of nuclear power (8.4 GW capacity) in Germany by the year 2022 (BMU and BMWi 2010).

Even in light of the nuclear phase-out, Germany has produced (on an annual basis) a surplus of electricity domestically, thanks to significant wind and solar energy capacity, regional power interconnections and backup thermal power plant capacity (IEA 2013). The announcement of the nuclear phase-out has accelerated the procurement of renewable projects as well as coincided with the construction of several new large coal plants (many of which will replace older, highly polluting plants that will be decommissioned following the EU Large Combustion Plant Directive). These coal plants may put the 80-95% GHG emissions reduction target from the Energy Concept at risk.

In December 2012, the government presented its first annual monitoring report on the progress of the Energy Concept (BMU/BMWi 2012). The report's complimentary expert statement stated that in order to meet the goals of the Energy Concept, increased action in the field of energy efficiency and in the expansion of the electricity grid would be necessary (Löschel et, al. 2012).

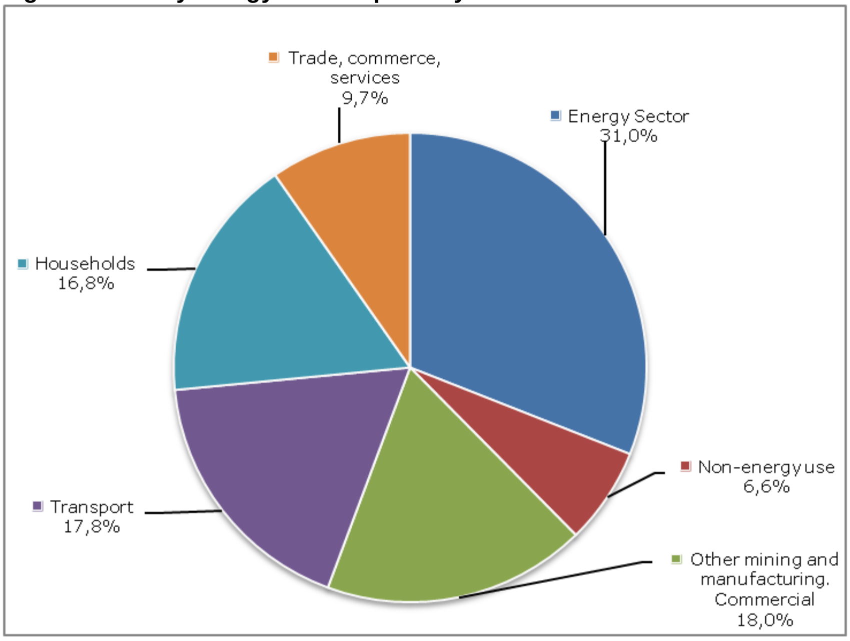
Fig. 57 - Primary energy use data for first half of 2013. Note that 0.8% of gross energy is exported.



Source: AG Energiebilanzen e.V. 2013

Energy use in the German economy can be broken down by sector. Figure 58 shows the current distribution. Each sector may consume different energy sources. For example, energy consumption in the Transport sector is dominated by fuels like oil, but increasingly will incorporate electricity that may come from a combination of coal, gas, and renewables.

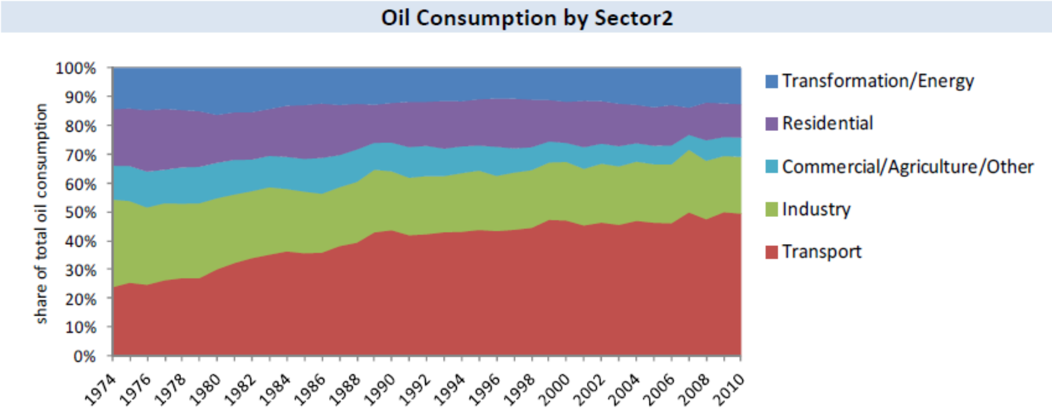
Fig. 58 - Primary energy consumption by sector



Source: AG Energiebilanzen e.V. 2013

The primary source of energy in Germany is still **oil** at 32% of total German primary energy use (AG Energiebilanzen e.V. 2013), with 53% of oil consumption dedicated to the transportation sector in the form of gasoline and diesel fuel (IEA 2012). However, oil´s share in the energy balance is declining. The share of **coal** has also declined significantly from 42% in the early 1970s to 23% in 2013 (IEA 2012 and AG Energiebilanzen e.V. 2013). Oil and coal have been replaced over time in the different sectors by a combination of natural gas, renewables, and nuclear (IEA 2012). However, in 2012 and 2013 coal and lignite based electricity generation increased again (UBA 2013), mainly due to new lignite capacities, a low coal price and hardly any price incentive from the EU emission trading scheme that would support a fuel switch to natural gas (Dreblow, et al 2013).

Fig. 59 - German domestic oil consumption broken down by sector



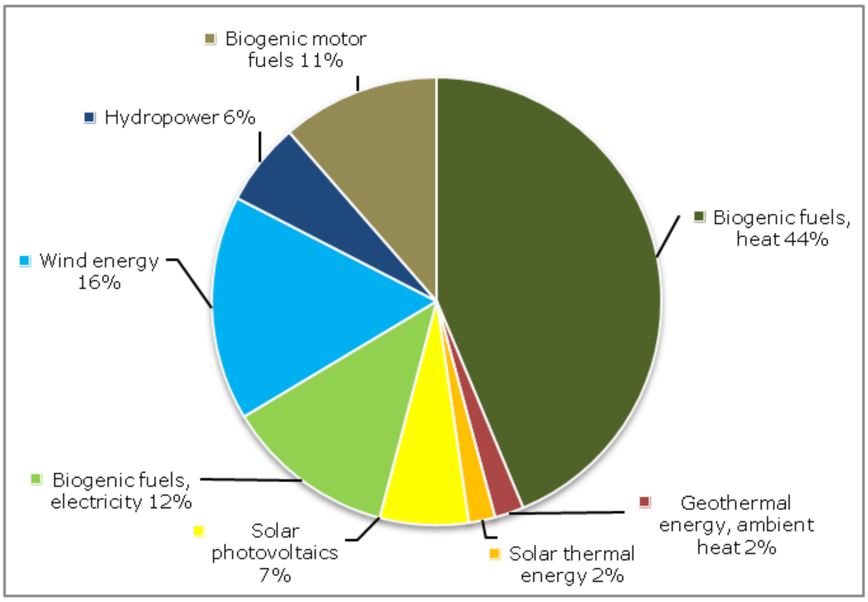
Source: IEA 2012

Natural gas accounts for 25% of gross primary energy use (AG Energiebilanzen e.V. 2013), and is the second-largest energy source in Germany, with significant chunks directed towards use in industrial, residential, and electricity conversion settings (IEA 2012). The total consumption of natural gas in Germany is projected to decline over the long term due to increased use of district heating and energy efficiency improvements. However the share of natural gas in Germany´s total primary energy supply is expected to rise in the coming years, as new natural gas plants are expected to come online in order to provide back-up for renewable electricity generation (IEA 2012).

In 2011, **renewable energy** (heat, fuels, and electricity) provided for 12% of final energy consumption in Germany. The share of renewable electricity in final electricity consumption doubled from 10% to 20% between 2005 and 2011 (Eurostat 2013). While the production of renewable energy has significantly increased in Germany over the last decade, in order to meet its target of 18% renewable energy in final energy consumption by 2020, Germany will need to continue to add significant renewable energy generation capacity.

Biomass (solid, liquid, and gas) provides for around 8.2% of final energy consumption, which is the most of any renewable energy source (65% of renewables contributions) (BMU 2013b). In 2012, wind energy accounted for 1.7% of final energy consumption, while solar photovoltaics contributed 1.0% of final energy consumption (BMU 2013c). Figure 60 below includes a breakdown of how each renewable energy source (electricity, heat, fuel) contributes to the total pie of renewable energy supply.

Fig. 60 - German renewable energy supply characteristics

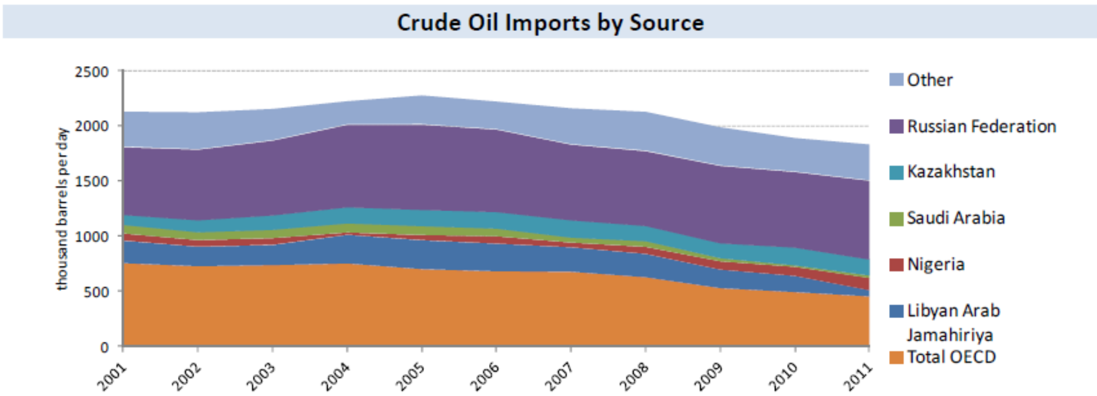


Source: BMU 2013c

Imports, Exports, and Energy Security

Germany relies on **oil** imports due to very little domestic production. Germany´s domestic oil production accounted for only 2% of consumption in 2010 and the number is expected to decline further (IEA 2012). Countries from the former USSR (non-OECD) accounted for 50.8% of oil imports, while OECD sources delivered another 25% (IEA 2012).

Fig. 61 - Germany's crude oil supply by source



Source: IEA 2012

Germany is the eighth largest producer of **coal** in the world, and the sixth largest importer, consuming 18.6% of global coal imports (World Coal Association 2012). The source of German coal imports has shifted in recent years, as imports from the USA have increased by 150% and South African imports have been reduced by 66% (United States Energy Information Agency 2013).

Like with oil, Germany is dependent on **natural gas** imports. Domestic gas production accounts for 12% of consumption (BMWi 2013), and is expected to decline by 5% per year, annually in the near future (IEA 2012). Roughly 40% of natural gas imported into Germany comes from Russia. This figure could increase in the future due to declining gas production in Western Europe (e.g. the Netherlands, Norway, etc) (IEA 2012).

In contrast to other energy sources, natural gas poses unique energy security challenges, because of its relatively rigid transit structures and delivery options (BMWi 2012). German dependency on imported oil and natural gas forms the backdrop for policy concerns about energy security and supply. As Germany's primary supplier of crude oil and natural gas, Russia's role is key. Reliance upon a small number of partners for a relatively large proportion of Germany's primary energy supply can leave that supply vulnerable to shocks and instability, depending on the political relationships among the parties (Eurostat 2012b).

Germany is a net exporter of **electricity**, sending a surplus of 22.8 terawatt hours (TWh) mostly to the Netherlands (22.6 TWh), Austria (15.8 TWh), and Switzerland (12.7 TWh) in 2012 (Destatis 2013). 2013 is expected to be another year of surplus, with most exports occurring in winter months and at times of high demand, and with imports occurring during cheap, low-demand periods (Fraunhofer 2013). With the recent expansion of renewables, Germany has significant generating capacity; therefore, imports and exports depend primarily on market price and available cross-country connections.

Energy Infrastructure

The **oil** supply infrastructure is currently well developed, and therefore does not require the same substantial investment as the electrical grid. Germany maintains four cross-border crude oil pipelines, and four oil ports that transport crude oil to refineries (IEA 2012). Germany is one of the largest oil refiners in the world, with 14 refineries and a crude oil refining capacity in 2011 of 2,364.4 kb/d (IEA 2012).

Natural gas deliveries are well-diversified. For example, most gas is imported via four pipelines (or interconnections) with the Netherlands, three Norwegian pipelines, or three Russian/Ukrainian pipelines (IEA 2012). There are currently 17 gas transmission companies and various distribution and storage system operators (BMWi 2013b). In order to maintain and strengthen the gas network, in 2012 the transmission system operators began working with the Federal Network Agency to craft a ten-year gas grid development strategy (IEA 2013).

The **electrical grid** in Germany was designed for large, centralised thermal power plants distributing electricity to industrial and population centres. The *Energiewende*'s transition to smaller, decentralised, and intermittent renewable resources will require significant upgrades, design innovations, and physical expansions to the grid in order to balance the domestic electrical needs. One of the largest hurdles in matching instantaneous demand with supply is transporting significant volumes of electricity from areas near the North and Baltic Seas, where large wind capacities were installed, to the southern and western population centres. Formerly, power plants were located regional to the points of demand (the South is also home to energy-intensive industry like the BMW and Mercedes plants), but the move to renewables is expected to increase domestic as well as cross-country, long-distance transfers of electricity (IEEE 2013). Currently at times with high wind energy generation in northeast Germany, electricity deliveries to Bavaria flow through Poland and the Czech Republic, straining the Polish and Czech electrical grids (IEEE 2013).

The 2009 Power Grid Expansion Act is one of many recent policies the German government adopted to address these challenges (Bundesnetzagentur 2012). Thanks to regional electrical interconnections with France, Belgium, and the Netherlands, through the Central Western Europe Market Coupling (CWE), Germany and other CWE nations benefit from lower prices, and a wider range of importation and exportation capabilities (Elia 2012).

National Energy Market

Energy Market Structure

The German oil market is entirely privatised, with a wide swath of companies participating in domestic production, refining, and retail sales. However, in 2011, the Federal Cartel Agency released a report warning against an oligopoly and price-fixing activities among petrol station operators BP (Aral), ConocoPhilipps (Jet), ExxonMobil (Esso), Shell and Total (Bundeskartellamt 2011).

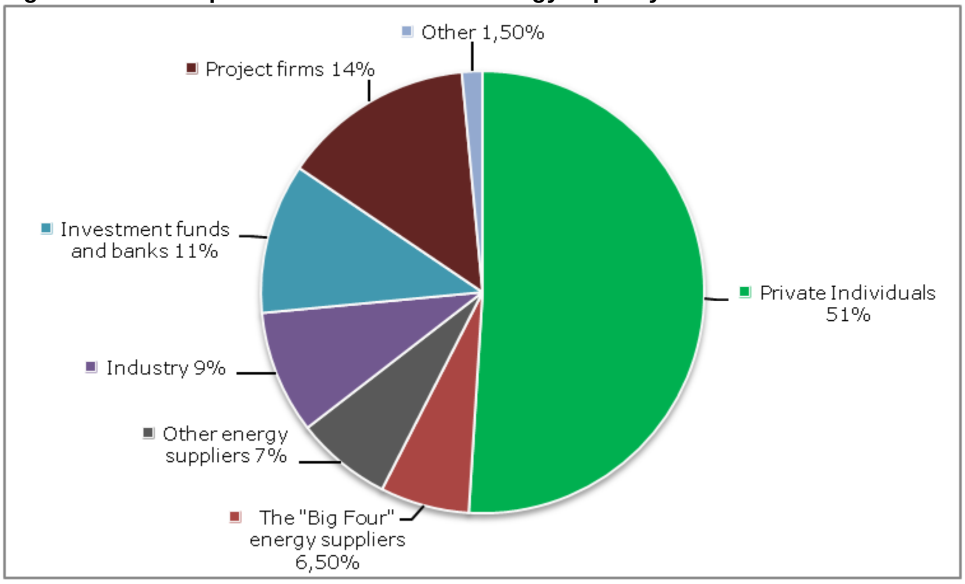
There are currently two natural gas market areas (NetConnect Germany and Gaspool) in Germany. Both market areas manage gas network access and coordination among market players. Under EU law, natural gas suppliers and operators of natural gas storage facilities are legally separated to promote competition (BMWi 2013b). Major energy producers historically have had gas prices fixed to oil prices in their long-term delivery contracts (Deutsche Bank Research 2012). The Federal Network Agency (access fees) and the Bundesländer authorities (licensing and installation fees) are responsible for regulating the electricity and gas networks.

The major players in German electricity markets have historically been the oligopoly of the “Big Four” (RWE, E.ON, EnBW and Vattenfall), which owned both the transmission grid and most of the generation capacity (resources consisted of hydro, nuclear, gas, and coal). The Big Four were able to cross-subsidize costs of transmission and generation until the EU Internal Market design Directive (96/92/EC and subsequently repealed by 2003/54/EC). The Directive required the unbundling of transmission grid and generation ownership, and led to market liberalisation, which allowed citizens to freely choose electricity providers (European Commission 2003). This change pressured utilities to privatise and sell off assets, based on new competition. With the 2000 Renewable Energy Sources Act (EEG), municipalities increasingly became local suppliers and smaller plants for electricity generation, reasserting municipal utility authority (Deutsche Bank Research 2012). In addition, the EEG opened up the market to a large share of small private investors that often gathered together to invest and build-up renewable generation capacities (Paulitz 2013).

Electricity production in Germany has increasingly diversified in recent years. Considering non-renewable generators larger than 10 MW, there are currently 126 independent power plant operators (Bundesnetzagentur 2013a). The Big Four have lost market share in recent years, due to a combination of selling generator assets, substantial increases in renewable electricity generation by competitors (22% of German demand in 2012, according to the environment ministry), the shutdown of 8,400 MW of nuclear capacity following the environment ministry's 2011 decision, and the rise in market electricity exchanges, through the CWE (Bundesverband der Energie- und Wasserwirtschaft 2012).

The EEG (2000) intensified the push toward decentralised and rather small-scale renewable energy in Germany (Paulitz 2013). The priority access of renewable electricity generation as regulated under the EEG electricity continues to favour local suppliers, as opposed to the large centralised fossil and nuclear plants (German Energy Transition 2012).

Fig. 62 - Ownership of German renewable energy capacity as of 2010



Source: German Energy Transition 2012 via Agentur für Erneurbare Energie

The Central Western Europe Market Coupling (CWE) was launched in November of 2010 and has led to price convergence and greater competition in the CWE region (Bundesverband der Energie- und Wasserwirtschaft 2012). In November 2013, the CWE introduced a "flow-based" algorithm to improve market coupling. The new system takes more sophisticated grid modelling to "optimise commercial flows on the electrical interconnections of meshed networks" (Amprion 2011), with the goal of utilizing the grid's physical capacities to maximise market welfare in the CWE (Tennet 2013). The CWE highlights a movement toward a regional integrated electricity market.

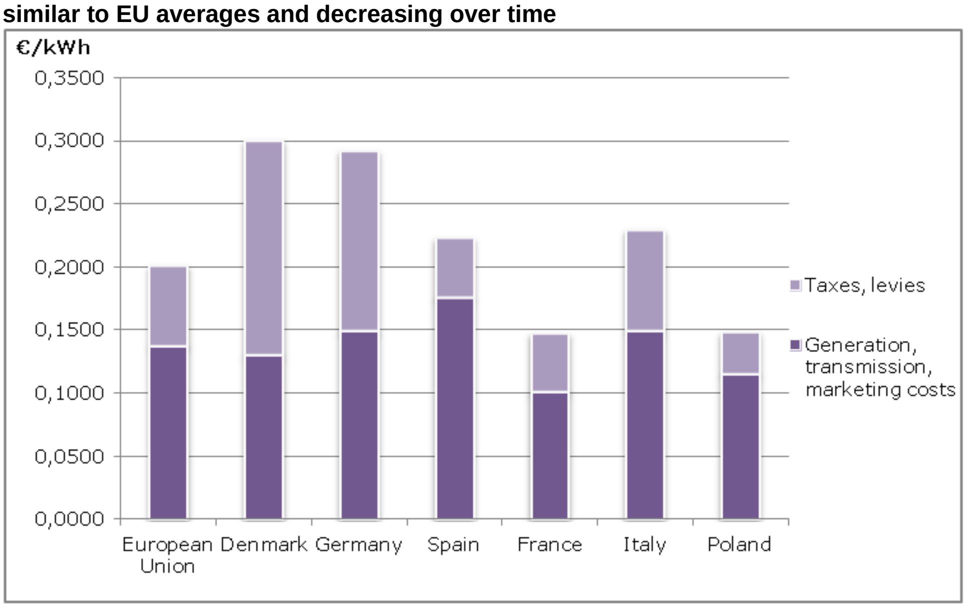
Retail Gas and Electricity Markets

From 2008 to 2010, household customers in Germany saw the number of electricity and gas suppliers substantially increase due to liberalisation (Bundesverband der Energie- und Wasserwirtschaft 2012). In 2010, most customers could choose among dozens of gas suppliers, sharply contrasting with the previous standard of 1-5 (Bundesverband der Energie- und Wasserwirtschaft 2012). “On 31 December 2010, there was an average of 147 [electricity] suppliers per network area, weighted by the number of inhabitants,” (Bundesnetzagentur, 2011). Thus, due to increasing competition in the sector, as well as customers switching providers and changing contracts, public utilities have continuously lost market share in the electricity and gas sector since 1998 (Bundesverband der Energie- und Wasserwirtschaft 2012).

Gas prices have trended upward for both residential and industrial customers between 2010 and 2012 in Germany, as well (Eurostat 2013), but Germany’s geographic location and role in the European natural gas market keep prices closer to EU averages. The Federal Network Agency (Bundesnetzagentur) implemented a decoupled entry - exit tariff model for gas trade, which reduced the number of market areas (Backes). Combined with new gas supply routes, such as the Nord Stream pipeline, the German natural gas markets meet supply needs of the resource (IEA 2013).

Both the industrial and residential sectors have seen electricity prices steadily increase over the past several years. Germany holds the third-highest average electricity price (per kWh) in the EU27 for both residential and industrial sectors (Eurostat 2013). Consumer electricity bills in Germany include an EEG surcharge, transmission and distribution grid expansion costs, and energy technology research and development (R&D) fees that have risen over the past years (IEA 2013).

Fig. 63 - EU 2013 household electricity price breakdown. Prices in Germany, before taxes, are similar to EU averages and decreasing over time



Source: Eurostat 2013

The EEG surcharge increases have led to public debates in Germany. However, it must be noted, that the levy is calculated by the difference between the spot market price and the feed-in tariff at a given time. The spot market price has decreased in recent years due to the increasing share of renewable electricity generation – in 2013 thus far, the average intraday spot market price has been below €0,05/kWh all but four weeks (Dreblow, et al 2013 and Mayer 2013). Therefore, the surcharge covers expenditures beyond the new capacity additions. Furthermore, companies can apply for an exemption from the surcharge when consuming more than 1 GWh, for which electricity costs account for more than 14% of the gross value added. In this regard, households and small companies are forced to carry an even higher surcharge (Dreblow, et al 2013).

However, the overall costs for electricity for the whole economy did not rise as dramatically as discussed in the media: The share of payments for electricity compared to nominal GDP was 2.5% in 2011 (as well as in 2009 and 2010) which is the same level as in 1991 (Löschel et al. 2012). Similarly, if German household energy expenditures are normalized over income and compared to EU averages (as done in the indicators section at the beginning of this chapter), the figures are very close (4.6% vs. 4.3%) (Eurostat 2013).

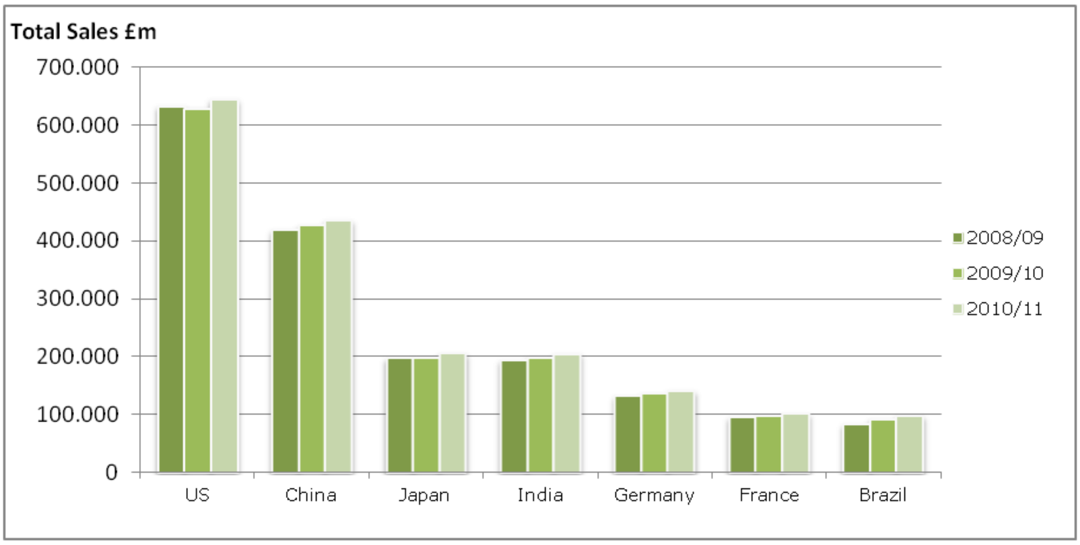
Innovation in Energy

The German federal government is proactively crafting policies and incentives to facilitate innovation in renewable technologies in order to meet the goals of the *Energiewende*. R&D programmes are becoming increasingly important for companies in the clean technology sector. From 2005 to 2008, private R&D investments rose by approximately 19 percent (BMBF 2010). Typically federal energy technology grants cover in the range of 50 percent of total project costs but can be greater when promoting small or medium enterprise (SME) involvement or cooperative projects (German Trade and Invest 2012).

In August 2011, the federal cabinet announced the Sixth Energy Research Programme, a multiple ministry project aimed at “forward-looking energy technologies” (BMWi 2011). The Programme increases the budget for energy research and development (R&D), including projects related to renewable energy, energy efficiency, energy storage, and grid technologies. The budget has increased 75% from the previous budget to €3.4 billion annually (BMWi 2011). Germany has also unveiled a “High-Tech Strategy 2020” research innovation programme, which offers grants for R&D projects in different sectors to tackle global problems. Climate and Energy is a priority in the strategy (BMBF 2010). Additionally, each of the 16 German Länder governments offer varying regional research and innovation incentives (German Trade and Invest 2012).

German research produces a significant number of climate protection patents, only second to Japan in percentage and closely behind the USA in volume. Around 30% of these lie in the field of renewable energy, 20% in energy efficient buildings, and another 20% in transportation efficiency (Rave 2013). The U.K. Department for Business Innovation & Skills releases an annual report on “Low Carbon Environmental Goods and Services,” (LCEGS) which defines the “green sector” to include low-carbon, renewable energies, and environmental services and activities. The 2013 report ranks Germany fifth overall, based on contributing 4.2% to total worldwide LCEGS value, and specifically increasing sector growth 3.5% from 2010/2011 – 2011/2012 (U.K. Department for Business Innovation & Skills 2013).

Fig. 64 - Gross size of "green" sector of economy (U.K. Department for Business Innovation & Skills 2013[49]



Source: U.K. Department for Business Innovation & Skills 2013

2012 clean energy investment in Germany was estimated to total $22.8 billion (Pew Environment Group 2013). In the second half of 2012, Germany led Europe with the investment of $4.34 billion in renewable energy projects and assets financing. Meanwhile, venture capital investments totalled less than $40 million over the same period (Taylor Wessing 2013). As outlined above, much of the investment in renewable energy installations comes from the civilian population.

National Energy Policies

The “Energy Concept” of 2010 created a long-term strategy for German energy policy while reducing GHG emissions by 80-95% by 2050 (BMU and BMWi 2010) (see also above). The national action is embedded in the EU framework: of relevance to Germany is the EU 20-20-20 climate and energy package (20% EU GHG emissions reduction, 20% EU renewable energy consumption, 20% improvement in EU energy efficiency). For Germany, this translates into:

1) a reduction of non-ETS emissions by 2020 of 14%, based on 2005 levels(Decision No. 406/2009/EC);

2) increasing the share of renewable energy to 18% of primary energy consumption (Directive 2009/28/EC);

3) implementing a legal body and framework to monitor the environmentally safe use of carbon capture and sequestration (Decision No. 2011/92/EU); and

4) an annual energy efficiency improvement target of 2.1% per year (Bundesregierung 2013).

[49] US through Germany presented in order of top five green economies. France and Brazil presented as notable comparisons.

Tab. 21 - Comparison of national climate and energy targets with EU targets

Germany national targets	EU targets for Germany
GHG Emissions	
-40% GHG emissions by 2020 (based on 1990 levels) (Energy Concept)	**-14% non-ETS GHG emissions by 2020** (based on 2005 levels) (Effort Sharing Decision)
Renewable Energies	
18% share of gross final energy consumption by 2020 (60% by 2050) (Energy Concept)	**18% share of gross final energy consumption by 2020** (Europe 2020)
35% share of gross electricity consumption by 2020 (80% by 2050) (Energy Concept)	**n/a**
Energy Efficiency	
Increase of 2.1% per year in energy productivity (compared to final energy consumption) (Energy Concept)	**Reduction of 38.30 Mtoe in primary energy consumption** (from 2005 "business as usual" baseline energy projections through 2020) (Europe 2020)

Source: Löschel et, al. 2012

In order to achieve these targets, the government has implemented a range of policies and measures outlined below.

National Low-Carbon Energy Policies

Renewable Energy

In meeting the internal German target of a 35% share of renewables in total electricity production by 2020, Germany has bolstered the Renewable Energy Sources Act (EEG). The EEG guarantees fixed feed-in tariffs for solar energy to incentivise development up until a national capacity of 52 GW has been reached, at which point the government will stop supporting new projects. The EEG was amended in June 2012 to reduce the feed-in tariff over time in an effort to prevent over-subsidization of solar photovoltaic (PV) generators. Consumers pay for the policy via an EEG levy on their electricity bill (Bundesnetzagentur 2013b). In encouraging the economic competitiveness of renewables, the German government is currently phasing out subsidies for high-carbon resource infrastructure, like coal (Aachen University 2012).

Germany has set renewable energy goals in heating energy. In the building sector, Germany has set a target of 14% renewable energy in heating by 2020. The Ministry for the Environment oversees the implementation of 2008 Renewable Energies Heat Act (EEWärmeG), which requires heat in public or new buildings to come from renewable energy, waste heat, or high efficiency cogeneration plants (AGFW 2013).

Relating to transport, the Cabinet of Ministers adopted the Federal Ministry of Transport, Building and Urban Development's fuel strategy in 2013. This 'learning strategy' seeks to develop a national biofuel strategy, among other targets (BMVBS

2013). Environmental regulations like the Tenth Federal Pollution Control Act require ethanol mixed into retail fuels (BMWi 2013a).

Carbon Capture and Storage

In August 2012, Germany responded to EU Decision No. 2011/92/EU and implemented EU Directive 2009/31 through a Carbon Capture and Sequestration (CCS) Act (2012 Nr. 38 23.08.2012 S. 1726), after legislative approval. The Länder also have the ability to decide where projects can be developed. The law allows for an annual maximum of 1.3 million tonnes of CO2 per project and a yearly limit of 4 million tonnes of CO2 to be stored in Germany for the technology in testing phases (2012 Nr. 38 23.08.2012 S. 1726).

Energy Efficiency (buildings, industry, transport)

Energy intensity in Germany declined by 17% from 2005 to 2011 and Germany's economy is currently the 6th least-energy-intensive economy in the EU (Eurostat 2013). Germany has introduced several energy efficiency regulations and incentive programmes for buildings (OECD 2012). The Energy Saving Ordinance of 2002 (BMVBS 2012a), requires strict minimum energy performance of new buildings and introduces energy performance certificates. A draft amendment to the ordinance was introduced in February 2013, which would require primary energy demand of new buildings to decrease by 12.5% annually between 2014 and 2016, and the design of new, roughly zero-energy buildings by 2019 for the public sector, and by 2021 for other sectors (BMVBS 2012a). The 2006 CO2 Building Modernisation Programme provides funds both to new, efficient structures and energy efficient refurbishment projects. The programme, which distributes money from the German Energy and Climate Fund, delivered €9.3 billion between 2006 and 2012 for the refurbishment or efficient construction of 3 million flats and 1,400 municipal buildings (BMVBS 2012b). Finally, another major goal is to reduce heat use through policies like the Combined Heat and Power Act (KWKModG), which provides support for combined heat and power plants and subsidizes the installation of district heat networks (AGFW 2011).

In the industrial sector, efficiency measures are incentives-based rather than mandatory. For example, a national energy efficiency fund (based on EU ETS revenues) provides grants for industrial investment in energy management systems and the deployment of new and efficient technologies (BMWi 2013). Effective as of 2013, energy-intensive companies must implement certain energy management systems, in order to receive the benefits of the eco tax relief program (Odyssee 2012).

In June 2013, the EU Parliament announced a revised transportation agreement for new car CO2 emissions. The proposal, pending final confirmation, reduces fleet-wide average new vehicle CO2 emissions to 95g per kilometre by 2020, a 40% cut from the mandatory 2015 target of 130g/km (European Commission 2013b) (although as of November 2013, with the support of other member States, Germany is seeking to delay the regulation compliance period to 2024 (Ends Europe 2013)).
In order to incentivise efficient fuel use in Germany, a tax applies to fuels, which is currently (without Value Added Tax (VAT)) €0.65 per litre for petrol and €0.47 per litre

for diesel (Turan, et al. 2012). Currently, average emissions of newly registered cars are at 141.5 g CO2/km, 8th highest in the EU (Eurostat 2013). In order to bridge the gap, and address the 2010 Energy Concept's transportation sector emission reduction goals of 10% by 2020 and 40% by 2050 (based on 2005 levels), the German government has developed several programmes. As mentioned above, the 2013 Ministry of Transport, Building and Urban Development's fuel strategy will also reduce energy use in the transport sector by investing in new vehicle technologies, and pushing for electric mobility (BMVBS 2013).

The government also announced a Programme for Electric Mobility in 2011. Its target is 1 million electric vehicles in use by 2020 (10.651 electric cars were registered in Germany in August 2013 (Tagesschau 2013)). Accordingly, the government will: increase funding for R&D, transition the government fleet of vehicles to electric cars, and demonstrate prototypes regionally. Parliament has implemented a ten-year tax exemption for cars with less than 50g/km emissions, as of December 2012 (2012 Nr. 57 11.12.2012 S. 2431). The Programme for Electric Mobility led to the April 2012 Showcases Electric Mobility Programme, which selected regions to receive €180 million for demonstration projects (BMVBS 2012c). The government supports a National Innovation Programme for Hydrogen and Fuel Cell Technology with a total of €1.4 billion until 2016 (Dreblow, et al 2013).

Regional Low Carbon Energy Policies

Almost all of the Bundesländer have their own support programmes for implementing low-carbon energy policies. Baden-Württemberg has been implemented a law to require residential use of renewable heat energy via solar thermal, geothermal, biomass, and ground source heat pump technologies, while also permitting the use cogeneration heat and district heating. The law applies both to existing residential buildings and new constructions, in an effort to achieve 16% renewable heat energy across Baden-Württemberg by 2020 (Baden Württemberg Ministry for Environment 2007).

The Bundesland of Nordrhein-Westfalen has chosen to promote heat pumps through a combination of loans, subsidies, and other funding structures for new homes, refurbishments, and non-residential buildings alike. Ground source heat pumps save energy by using the relatively stable temperatures below the earth to provide heat in the winter and cooling in the summer. Programme funding depends on the type of building, type and size of heat pump, etc (Energieagentur Nordrhein-Westhafen 2013). Currently more than 20 percent of new buildings in the state use heat pumps and Nordrhein-Westfalen seeks to increase the number from 80,000 to over 200,000 by the year 2020 (EnergieRegion.NRW 2011).

Local Low Carbon Energy Policies

Freiburg im Breisgau, a southwestern German city, recently adopted its Climate Protection Strategy 2030, aiming for a CO2 reduction of 40% by 2030 (based on 1992 levels). In 2007, the City Council chose an aggressive implementation plan to rapidly achieve this target. The four major municipal policies adopted include: building combined heat and power plants (fuel from landfill methane or woodchips) to achieve 50% cogeneration for electricity and heating; installing photovoltaic and solar thermal heating systems on high profile public and private buildings; investing in integrated sustainable transportation by building pedestrian and cycling infrastructure to link to public transit options, while disincentivising driving through parking fees; and developing low-energy neighbourhoods (Vauban and Rieselfeld) that employ passive solar building design (ICLEI 2009). Freiburg played an early leader in city climate strategies, and since 2007, smaller German municipalities like Moers, Mönchengladbach, and Bad Hersfeld have developed similar plans (Pro:21 2013, Wuppertal Institute 2009).

The north lying city of Flensburg (of Schleswig-Holstein) has also adopted ambitious GHG reduction targets. The mid-term objective is a CO2 reduction of 30% by 2020 (based on 1990 levels) and the long-term goal is carbon neutrality by 2050, with a 50% reduction in primary energy use in the same timeframe (Beer, et al 2013). One of the key features of the integrated climate protection concept, led by Klimapakt Flensburg ("Climate Compact club Flensburg"), is the central role of community working groups that will evaluate and guide implementation of the low-carbon measures (Ziesing 2013). The University of Flensburg has recommended as early measures of the plan mobility management programs for businesses and a climate-labelling scheme for small and medium enterprises (Beer, et al 2013).

Energy and Sustainability Challenges

Key Messages

- ***Markets:*** *The impact of renewable energy incentives on consumers suggests the need to refinance electricity generation investments in the current market design.*
- ***Policy:*** *Measures have been taken in all relevant sectors, but increased action is necessary in energy efficiency and transportation programmes.*
- ***Sustainability Challenges:*** *Additional domestic policies are necessary for Germany to meet its national and EU GHG targets. Further physical grid infrastructural investment will be critical to the integration of more renewable energy onto the electrical grid.*

With the largest population in the EU, Germany emits the most GHGs at an annual rate of 917 Mt CO2eq (UNFCCC inventory 2011), and the seventh-most per capita (Dreblow, et al 2013). Germany, however, has made significant progress reducing emissions by 26% from 1990 levels, largely from improved energy efficiency and building insulation measures in the former East Germany, and a power sector shift towards natural gas and renewable generation. Therefore, since the Kyoto Protocol's emission target was -21% annually from 1990 levels for 2008-2012, the latest set of data shows that Germany is on track to meet the target (EEA 2013a).

With regard to the GHG emissions not covered by the ETS, Germany's target is -14% annually from 2005 levels for the year 2020. It is expected that Germany will struggle to reach this 2020 ESD target without additional measures, based on current national projections (EEA 2013b). Tab.Table 21 shows Germany's non-ETS emissions trends and targets up through 2020.

Tab. 22 - GHG emission developments, ESD-targets and projections (in Mt CO_2eq) (adapted from Dreblow, et al *(2013).*

					ESD target**		2020 Projections***	
	1990	2005	2011	2012*	2013	2020	WEM	WAM
Total	1,250.3	997.9	916.5	931.1				
Non-ETS		508.8	466.2	476.7	487.1	417.2	421	400
(% from 2005)				-6%	-4%	-14%	-13%	-18%

Source: UNFCCC inventories; EEA (2013b); Calculations provided by the EEA and Ecologic Institute (2013). * proxies for 2012 emissions ** The ESD target for 2013 and for 2020 refer to different scopes of the ETS: the 2013 target is compared with 2012 data and is therefore consistent with the scope of the ETS from 2008-2012; the 2020 target is compared to 2020 projections and is therefore consistent with the adjusted scope of the ETS from 2013-2020. 2005 non-ETS emissions for the scope of the ETS from 2013-2020 amounted to 485 Mt CO2eq. *** Projections with existing measures, "WEM," or with additional measures, "WAM." Legend for colour coding: green = target is met, orange = not on track to meet target Total greenhouse gas emissions (GHG) and shares of GHG do not include emissions and removals from LULUCF (carbon sinks) and emissions from international aviation and international maritime transport.

Member States are required to prepare emissions projections every two years (Decision 280/2004/EC), based on existing measures/policies and planned or expected measures/policies. The following table summarises existing policies outlined by Germany as basis for their 2011 projections, with a focus on instruments expected to reduce emissions the most ([50]).

Tab. 23 - Existing measures as stated in the 2013 GHG projections (adapted from Dreblow, et al *(2013).*

Existing Domestic Measures ("WEM")	
Energy	Renewable Energy Source Act (EEG): Guaranteed feed-in tariffs and grid access
	Market Incentive Programme (Solar, Biomass, Heat pumps, Storage capacities): Incentives for building owners and investors
	Renewable Energies Heat Act (EEWärmeG): Building code which sets minimum standards for new buildings
	Environment Tax 99-03: Tax on electricity, mineral oil, natural gas consumption
Energy Efficiency	KfW incentives and grants: Incentives for investors for energetic rehabilitation of buildings, or low-energy new buildings.
	Special fund for energy efficiency in SMEs: coupling of financial

50 Policies that address other EU Directives have only been considered if they have been outlined in the Member State projections as a primary instrument to reduce GHG emissions.

	incentives for energy audits with low interest loans for investments in energy efficiency. The Federal Office of Economics and Export Control (BAFA) administers the programme.
	Energy Efficiency Ordinance: Building code which sets minimum standards for buildings; New code was passed in Oct and will enter into force on 16 April 2014.
	Heating costs ordinance (HeizkostenV): Building code which sets minimum standards for buildings
	CHP Act: Payments for use of electricity from modernised or new CHP plants
Transport	Redistribution of Highway toll for heavy duty vehicles: Highway toll revision to account for CO_2 emissions
	Mandatory biofuel quotas
	Mandatory efficiency standards for new cars
	Taxation of autos based on CO_2 emissions

Member State report information in accordance with Decision No 280/2004/EC (EEA 2013b).

The following table summarises additional measures outlined by Germany as basis for reaching their 2020 targets ([51]).

Tab. 24 - Additional measures as stated in the 2013 GHG projections (adapted from Dreblow, et al *(Ecologic Institute and eclareon 2013).*

Additional Domestic Measures ("WAM")	
Energy	Promotion of hard coal extraction expires, end of black coal extraction in 2018
Energy Efficiency	Renewable energies Heat act (large solar thermal and heat pump appliances) (EEWärmeG)
	Common procurement of energy-efficient products*
	Tax abatement (Reduce VAT) for investments in energetic rehabilitation of buildings*
	White certificates (Industry sector): Creation of an additional market for energy efficiency measures*
Transport	VAT for Aviation (LuftVStG)
	Revision of fuel taxation*
	Removal of Tax for electricity used by railways*
	Funding programme for electric mobility (part II)*
Other non-ETS sectors	Full SF6 substitution in Magnesium production*
	HFC substitution in many application sectors*

*Measures noted with an asterisk indicate those that have not been implemented. A draft law of the Tax abatement measure was submitted to the Bundesrat for discussion in May 2013. Member State report information in accordance with Decision No 280/2004/EC (EEA 2013b).

51 Policies that address other EU Directives have only been considered if they have been outlined in the Member State projections as a primary instrument to reduce GHG emissions.

Further Challenges

Transport

Beyond the aforementioned electric mobility policies, the German government can reduce transportation emissions by tackling current fuel usage with other policy tools.

One particular area with significant room for improvement is the company car incentive structure. In Germany, the purchase and operating costs of company cars are tax deductible (Dreblow, et al 2013). Annual car registrations for commercial use have exceeded the number of cars registered for private use since 2001 (Federal Motor Transport Authority 2013), especially fuel-intensive vehicles (Graus and Worrell 2008). One strategy to address the current structure is to peg the tax deductibility of costs on CO2 emissions, like Belgium, Ireland, and the United Kingdom already have done (Veitch and Underdown 2007 and Dreblow, et al 2013). Companies would then be incentivised to choose low-emission cars, and additional revenues from a revised company car taxation program could be directed toward public transit infrastructure, which is expected to require €3 billion before 2016 in maintenance and renovation (Dreblow, et al 2013).

Energy Infrastructure

Bringing all the geographically disperse renewable resources required by the *Energiewende* onto the grid will pose infrastructural, distribution, and supply flexibility challenges. By focussing on grid interconnections and a common regulatory framework with neighbouring countries, particularly those in Scandinavia, Germany can increase competition in electricity markets and ensure affordable prices to consumers (Dreblow, et al 2013). It is expected that the German electrical transmission and distribution network will need funding up to €42.5 billion by 2030 (DENA 2012).

As mentioned above, delivering renewable electricity from generation sites in the north to population centres in the south requires domestic distribution improvements (IEEE 2013). And low marginal costs of renewable energy (no fuel expenses) make it difficult to justify investments in storage facilities that might benefit grid operators in their delivery of variable renewable electricity. Federal efforts, like the 2011 Grid Expansion Acceleration Act (NABEG), have produced grid development plans through collaboration by the four German grid operators and Federal Network Agency. The second version of the plan in 2013 identified 2,700 km of additional lines and 2,300 km of lines that require further upgrades (Bundesnetzagentur 2013c). This included for the first time an offshore grid development plan, reflecting the November 2012 amendment to the Energy Industry Act (EnWG) (Bundesnetzagentur 2013c).

Additionally in 2013, the Federal Plan (Bundesbedarfsplangesetz) prioritised lines for grid development over the next 10 years (BMWi 2012). Implementation of grid expansion projects, on the other hand, has faced delay. Only 214 km of the planned 1834 km of power lines, determined by 2009's Power Grid Expansion Act (EnLAG), had been built in 2012. Construction is often delayed when lines cross several Länder (Bundesnetzagentur 2012). The Federal Network Agency posts online updates on the progress of the 36 current projects.

3.6 Focus on Poland

Introducing to the Polish national energy profile

According to Policy and legal Acts, the objective of the state energy policy is to ensure the energy security of the country, to increase the competitiveness of the economy and its energy efficiency as well as to protect the environment and mitigate climate change. Polish energy legislation clearly settles that public authorities should balance the interests of energy enterprises and energy customers. In practice, central and local authorities are obligate to ensure stable fuels and energy supply required domestic needs at prices acceptable for the society and national economy, assuming the optimal use of domestic deposits of energy resources, and by diversification of fuel mix, and supply routes of crude oil and oil products, natural gas, and power grid transnational interconnections.

Oil and natural gas

In both the natural gas and crude oil sectors, it is essential to increase transmission capacity of gas transport and storage systems and of oil and fuel pipelines, as well as their transshipment and storage infrastructure, including cavities in salt structures.

These activities are extremely important because near 95% of imported crude oil and 80% of natural gas comes from Russia or shipped by pipelines of the Russian territory.

Moreover, in the oil sector, the government supports the extension of the Odessa- Brody pipeline from Ukraine to the Polish refineries in Plock and Gdansk as part of the larger regional initiative to transport Caspian oil to Europe[52]. In 2012 was refined more than 25 Mt of oil delivered by direct pipeline from Russia and marine supply via Gdansk. Import of oil product was slightly less than export (-0,7 Mt).

In the gas sector, the key elements of Poland’s policy include building an LNG terminal[53] in Swinoujscie (very close to German border) to diversify supply gas routes, expanding underground storage capacity, extending the transmission and distribution system and increasing domestic gas production.

In 2012 the total consumption of natural gas in Poland amounted to 15,44 bcm[54]. Gas produced from domestic sources, amounted of 4,317 bcm, constituted almost 27% of the total national gas supply. The majority of the consumed gas came from abroad - the supply volume amounted in 2012 to 11,266 bcm. All foreign gas supplies in 2012 comprised the import from the Eastern direction as well as intra-Community supplies from Germany and the Czech Republic. The import from the Eastern direction was conducted under a long-term contract concluded between PGNiG and OOO Gazprom Export in 1996. The amount of gas imports by Yamal pipeline amounted to 9,08 bcm, what constituted around 82% of the total gas supply to Poland. The remaining 18% of the total supply volume came from Germany and the Czech Republic. Total volume of

52 See Long-term infrastructure vision for Europe and beyond. COM(2013) 711 final, 14.10.2013, Brussels, Annex 1 – Energy Infrastructure priority corridors and areas (electricity, gas, oil and areas)
53 Starts with 5 bcm/a capacity in 2014, and extending up to 7,5 bcm/a near 2020.
54 Bcm – bilion cubic metres – 109 m3 in normal conditions

these supplies amounted in 2012 to 1,983 bcm. At the end of 2012, the active gas storage capacity in Poland amounted to 1,8 bcm for high-methane gas and 0,23 bcm for nitrogen gas (delivered to final consumers by separate pipeline system).

Coal

Coal (steam coal and lignite) remains a base source of primary fuel used for electricity and heat production (power and CHP utilities), ~39 Mt of steam coal and 63 Mt of lignite, in district heating plants (HoB – heat only boilers) -~5,6 Mt, and in coke-oven plants – around of 12 Mt coking coal.

Poland's generating capacities are ageing so it needs to be deeply modernized or repowered. There is a need for better and more stable environment enabling the replacement of existing power plants by new more efficient units. Poland by the recent amendment of Energy Act[55] has fully transposed the Third Energy Package Directive liberalizing the electricity and gas markets, and transposed into Polish Law the RES Directive (2009/28/EC). Loop flows remain an important problem which needs to be solved by identifying appropriate short and long term solution with its neighbours. Until now the electricity tariffs for household consumers are still regulated, but the last Energy Law amendments introduced supporting mechanism for vulnerable customers, and it is expected that regulated tariffs will be released.

Electricity and district heating (CHP)

In 2012 the national gross electricity consumption decreased by 0.6% in comparison to the year 2011, mainly due to downturn in the economy, and amounted to 159,3 TWh. The volume of national gross electricity production amounted to 162,14 GWh in 2012 and was ~ 1% smaller than in the previous year. The surplus of the electricity production over its national consumption is a result of an upturn in the cross-border electricity trade. The net export amounted to 2,84 TWh in 2012 but this value was lower than in 2011 (5,24 TWh, and significantly lower than in 2005 (11,2 TWh).

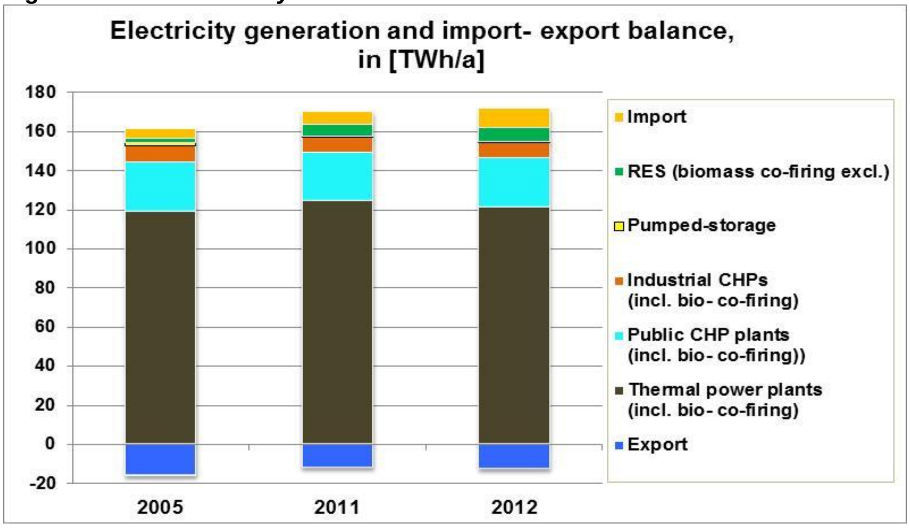
Similarly to 2011, the volume of installed capacity was maintained in 2012 on a relatively high level exceeding 37 GW. Moreover, its growth by over 1.8% could be observed in 2012. The available capacity and power reserves in the National Electricity System (NES) remained in 2012 on the adequate level from the point of view of its current operational security. The average annual demand for power amounted to 21,81 GW with a maximum load demand of 25,85 GW. The relation between available and total generation capacity in 2012 slightly fall down in comparison to the year 2011 - from 73,45% to 71,68%. It should be underlined that in the previous years the level of the available reserves of capacity had been systematically falling. The structure of electricity generation did not changed significantly. The two fuels - hard coal and lignite – were dominant sources for electricity production and their share in generation amounted to ~88% in 2012. There was also a rise by almost 35% of the installed and available generation capacity of renewable energy sources in comparison with 2011.

55 The Act on 26 July 2013 on Energy Law amendment and other Acts (Journal of Law 2013 item 984, came into force on 11 Sept. 2013

Similarly, to the previous years, Poland was a net exporter of electricity in 2012. The biggest volume of actual flows was directed from the NES to the Czech Republic and Slovakia, while most of the physical flows came from Germany (so called loop flow).

In Poland in 2012 total electricity generation was 162,1 TWh and gross consumption 159,3 TWh, what is shown on figure below.

Fig. 65 - Gross electricity balances of Poland



Source: Polish Power Statistics, ARE-2013

District heating systems (DH)

Poland has widely developed district heating systems supplying households' consumers with a relatively cheap, comfortable, and safe heat used mainly for space heating and hot water for individual (sanitary) needs. Almost all large cities in Poland are equipped with district heating systems, which are supplied by highly efficient CHP plants (see below fig. 63 - 65).

Fig. 66 Electricity generation in CHP plant - Poland and other EU states

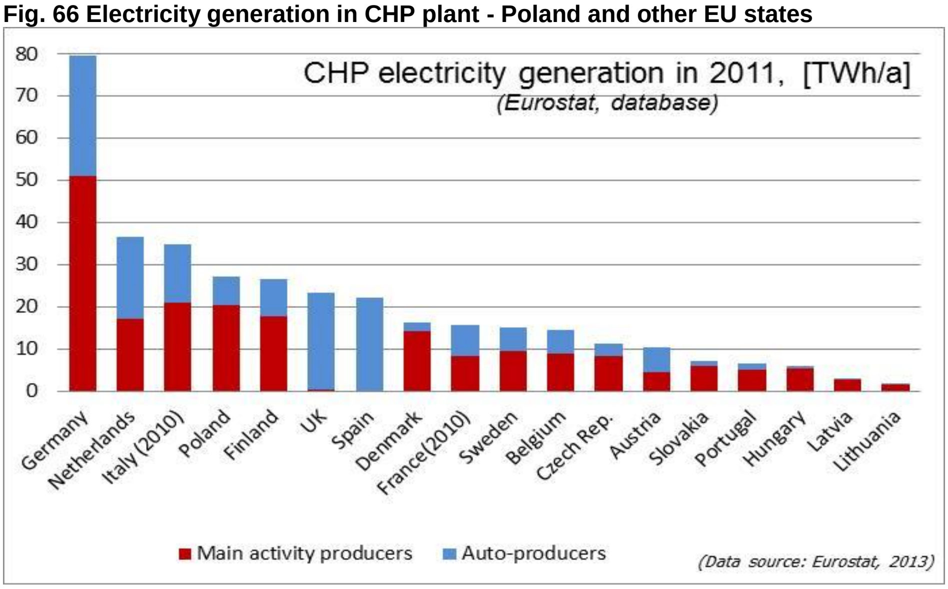
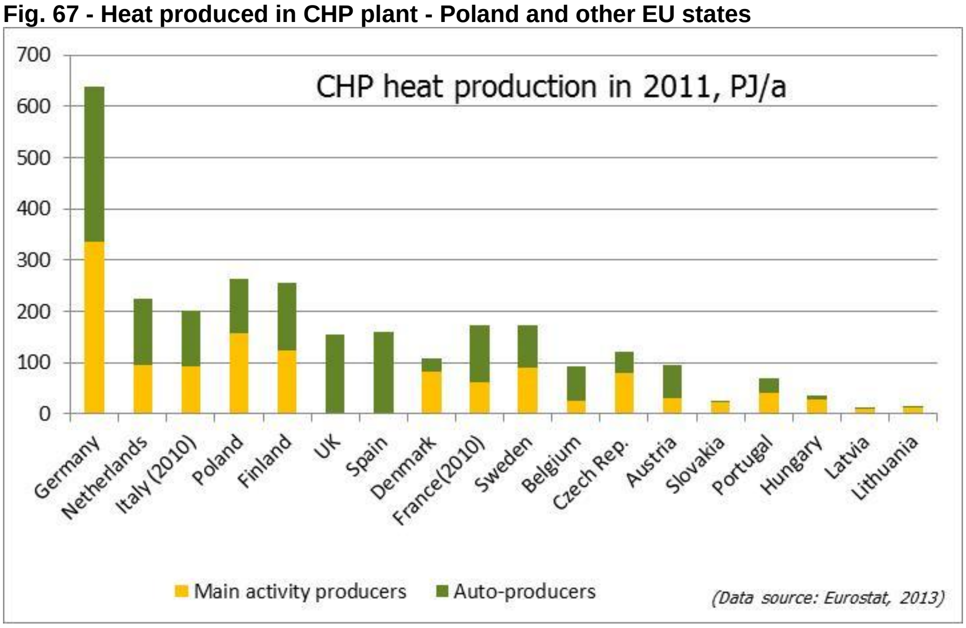


Fig. 62 and 63 illustrate the production of electricity and heat generated in CHP utility plants (main activity producers, state or municipality owned) and the production generated in industrial CHP (CHP auto-producers) and then sold to a national electricity system (NES) and i district heating system in cities.

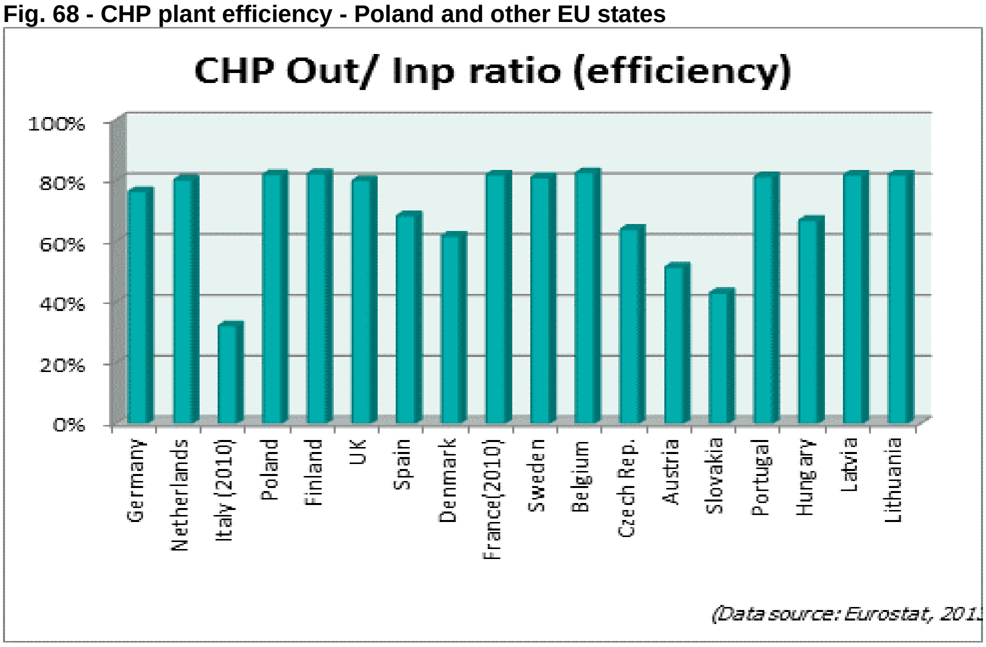
Fig. 67 - Heat produced in CHP plant - Poland and other EU states



As shown on fig. 62 and 63 Germany, the Netherlands and Italy have generated more electricity than Poland, however in the case of district heat production only Germany is ahead of Poland.

Fig. 64 presents the relation between outputs - electricity and heat generated in cogeneration, and inputs – fuels used for this generation.

Fig. 68 - CHP plant efficiency - Poland and other EU states



The fig. 65 shows that in Poland, despite a very high share of coal in CHP (about 72% of fuel input) their efficiency is among the highest in the EU. It is comparable to the efficiency of CHP with a very large share of natural gas (the Netherlands, UK, Belgium, Lithuania), or fired with renewable fuels (RES) as in Sweden or Finland.

Important conclusions can be drawn from charts 66, 67 and 68 - showing significantly different characteristics of the production system and use of energy (specific) in Poland, in comparison with most EU 15 countries. Some similarities to Poland concerning the development of district heating system (DH - district heating) can be also observed in Nordic countries (DK, SE, FI) – as illustrated on chart 67. They inform jointly about potential hazards and at the same time challenges of the transformation of Polish heating system regarding social reasons, for both the resignation of coal (over 70% share in DH, not taking into account around 10 Mt of coal fired directly in individual heating boilers (furnaces), especially in rural regions.

Changing this, undoubtedly health harmful, coal combustion for individual heating is very expensive and takes time. For example, it has been calculated that replacing coal heating (and for biomass) in Krakow's individual furnaces, what is planned to be eliminated by the city and voivodship (province) council, will cost additional 2 billion PLN/ a (~ 500 M €/a) per year, as a payment for fuel gas, replacement of furnaces and modernization of infrastructure.

This problem increases due to a large Polish dependence on natural gas imports from Russia and at the same time, the EU has tightened requirements for the exploration and exploitation of shale gas.

In total, this creates an immense challenge for the Polish society, which should be taken into consideration by both Poland and – hopefully EU energy transformation policy until 2020 and in 2050 perspective.

Fig. 69 - CHP fuels input for electricity and district heat production

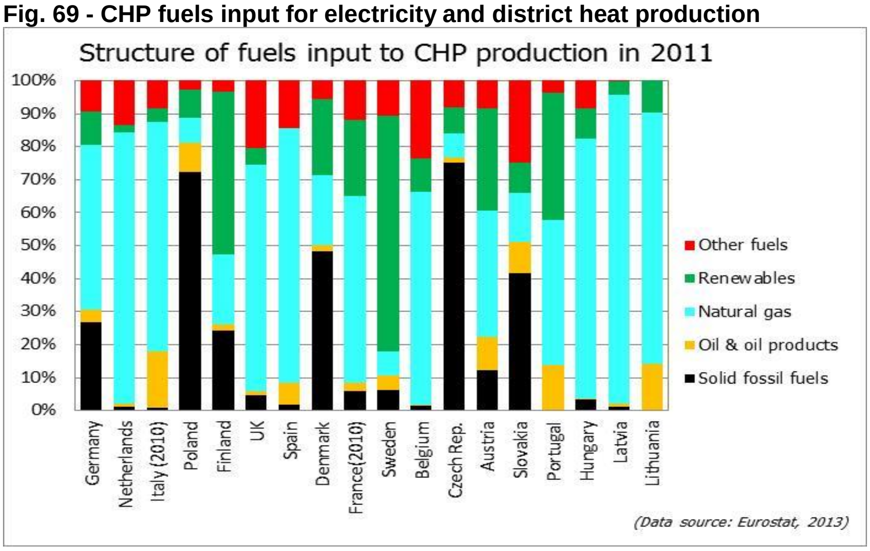


Fig. 70 Citizens proportion supplied by DH in 2009 (counted to population)

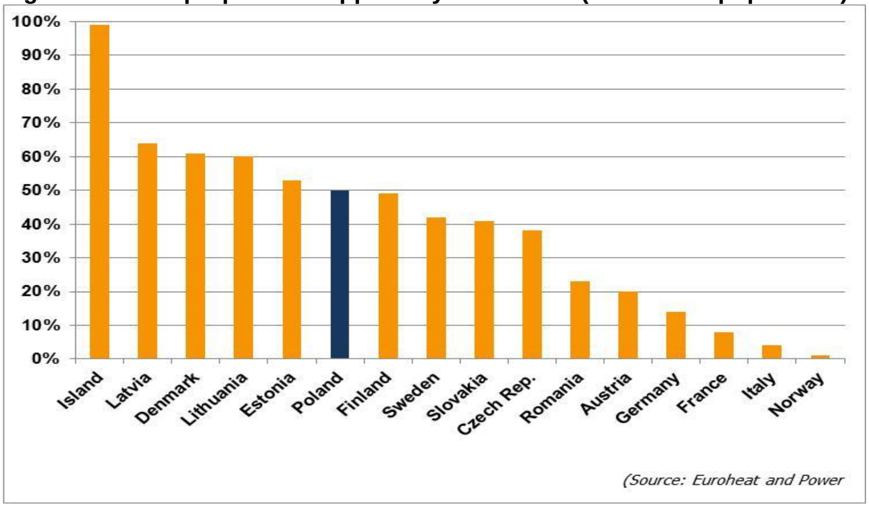
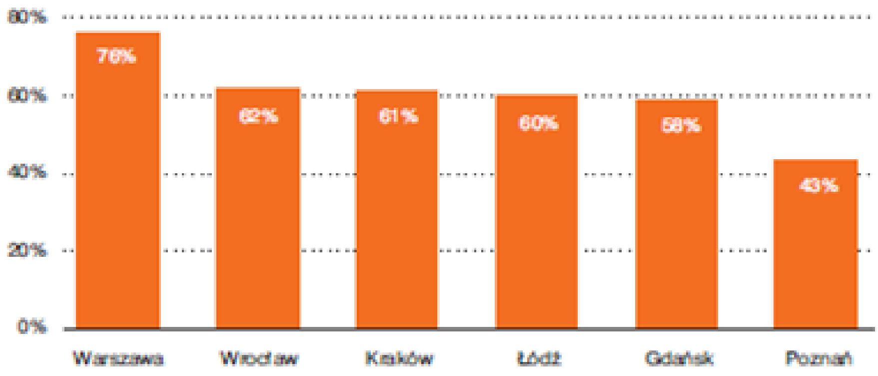


Fig. 71 Shares of DH supply in Polish largest cities to total heat consumption



Source: pwc report, 2012[56]

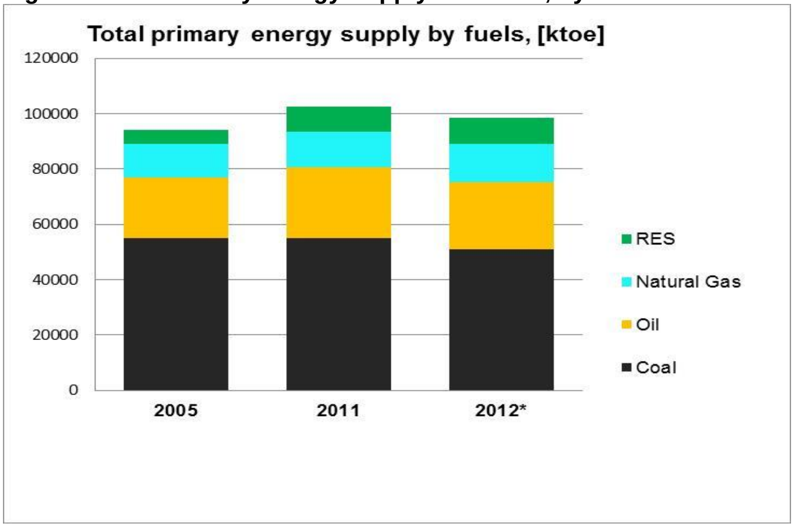
Primary and final energy balance of Poland - key aspects

Solid fuels of which 75% is hard coal and 25% lignite, continues to play a major role in Poland's primary energy supply in 2012. Solid fuel accounts for 52% of the country's energy consumption mix and nearly 88% in electricity generation. Out of 162.1 TWh of electricity produced in Poland, 10,4% came from renewable energy in 2012 (see chart 69). RES consumption balances more detailed have been discussed in section 2.5.6, together with issues of 'energy and sustainability challenges'.

Chart 70 presents the energy balance taking into account directions of primary energy supply from a domestic production as well as import and export, including changes in inventories.

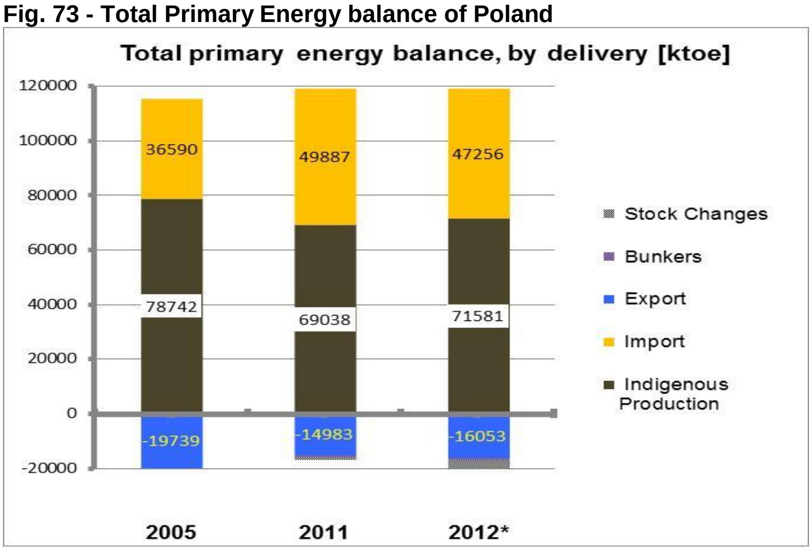
56 Heat market in Poland; PriceWaterhouseCoopers Report, October 2012

Fig. 72 - Total Primary Energy Supply of Poland, by fuels



Source: Energy balances according to OECD classification, GUS, 2013 (2012 – preliminary data)

Fig. 73 - Total Primary Energy balance of Poland



Source: Energy balances according to OECD classification, GUS, 2013 (2012 – preliminary data)

Chart 70 shows a very significant increase in fuels import, with the largest share of oil and natural gas, as well as in the last two years, coal imports from Russia, about 8 - 10 Mt /a. On the contrary - there was a significant decline in domestic production of coal, which is associated with the rationalization of its consumption, and the reduction of a production cost in coalmines. This process is partially due to gradual implementation of Polish climate policy aiming at a more sustainable and less environmentally harmful 'energy mix'. However, this is a long-term process - mainly for social reasons.

Chart 71 presents the balance of final energy consumption in 2012, distinguishing amounts of fuels used in respective business sectors of the national economy and in a residential sector, in majority including households.

Fig. 74 - Final Energy Consumption of Poland in 2012

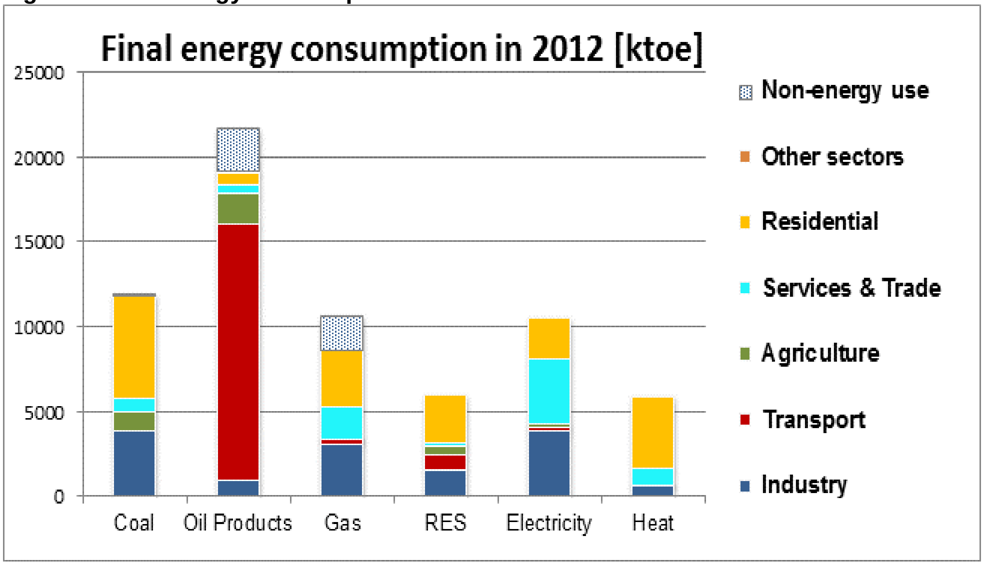


Figure 71 illustrates, among others, that large amounts of coal and its products (coal briquette + coke) as well as district heating (DH) are used for example in a residential sector, with a very low consumption of oil products, all of which are accounted for in transport (in a residential sector only LHO - light heating oil).

In reality for space heating in residential sector are used: the entire coal and RES, and ~80% of gas, and about 6-7% of electricity, and finally all district heat it occurs that this social needs constitutes 85% of total final energy consumption in a residential sector. The remaining 15% is mainly the need to prepare meals, lighting and to use mass appliances, computers, accessories, etc. It is also visible that the biggest consumers of electricity are sectors of industry, services, and trade.

Energy cross-border infrastructure

Electricity interconnections

In year 2012 Poland was a net exporter (import minus export) of electrical energy, with cross-border exchange amounted to 2837 GWh. The largest amount of power volume flow was directed from Germany into Poland, and then outflow to the Czech Republic and Slovakia, and though Austria go back to Germany. These physical inflows create loop flow of power which strongly distorting of normal trans-border trade of capacities (explicit auction) and/or capacity and energy jointly (implicit auction).

Since 16th of December 2010 Poland has a 600 MW direct current interconnector with Sweden - Swe-Pol link, made available on the basis of free market rules. Its capacity is available through POLPX (Polish Power Exchange) and Nord Pool Spot power exchanges, in a day–ahead mechanism. The congestion management is conducted in an implicit auction through a market coupling mechanism. In 2012, the average daily capacity available respectively for export and import equalled of 110,5 MW and 394,0 MW. The average daily flow was equal 14,3 MW from Poland to Sweden direction and from Sweden to Poland 304,3 MW. The exports from Poland to Sweden in 2012 amounted to 187,8 GWh and import 1686,1 GWh[57].

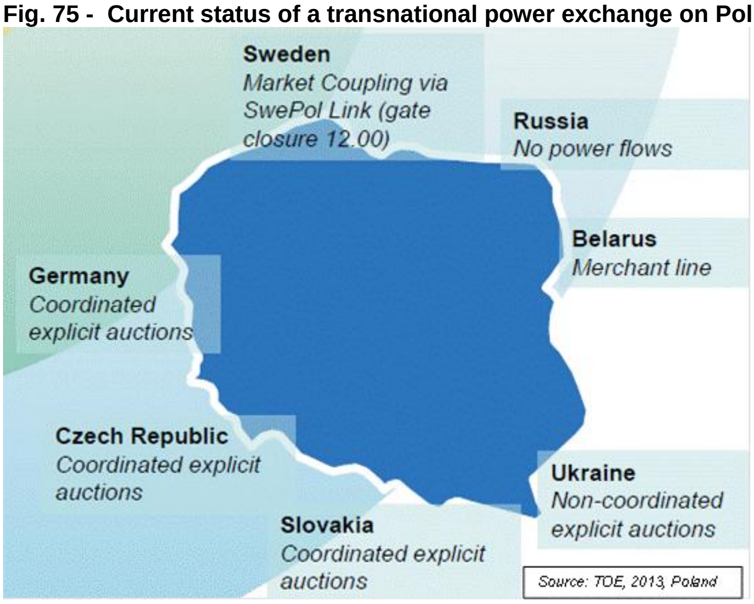
Regarding the connections to the third countries, Poland has one active connection to the Ukrainian system. It consists of a single-track 220 kV line connecting two local high voltage grid nodes (Zamosc and Dobrotwor).

The capacity is provided in a direction from Ukraine to Poland and allocated to the market participants by means of explicit monthly auctions. These are uncoordinated (unilateral) auctions.

Plan for a development of cross-border connections prioritises the power integration with the Baltic States (Lithuania, Latvia and Estonia), what includes the construction of the power connection with Lithuania, expansion of the power system in North-Eastern Poland and also construction of a new interconnections with Germany[58].

A recently published EC Communicate on the Projects of Common Interest (PCI) includes a detailed list and expected time-schedule of their realisation. A current state of Polish cross-border connections is shown on the figure below. Its expansion will proceed according to COM (2013) 711 final52 - two priority corridors *(citation from page 9 of the COM)*: (a) North-South electricity interconnections in Central Eastern and South Eastern Europe ("NSI East Electricity"), and (b) the Baltic Energy Market Interconnection Plan in electricity ('BEMIP Electricity') interconnections between Member States in the Baltic region. These reinforcing internal grid infrastructures accordingly, to end isolation of Baltic States and foster market integration, inter alia, by working towards the integration of renewable energy in the region.

Fig. 75 - Current status of a transnational power exchange on Polish border



Source TOE presentation Warsaw, August 2013[59]

57 Source: National report of President of ERO (in Polish, 2013)
58 Source: Polskie Sieci Elektroenergetyczne Polska Spółka Akcyjna: Development Plan within the scope of meeting present and future demand for electricity for the period 2010-2025, Update for the period 2013-2017. Abstract, Konstancin-Jeziorna, Maj 2013
59 TOE - Association of Energy Trading, Poland

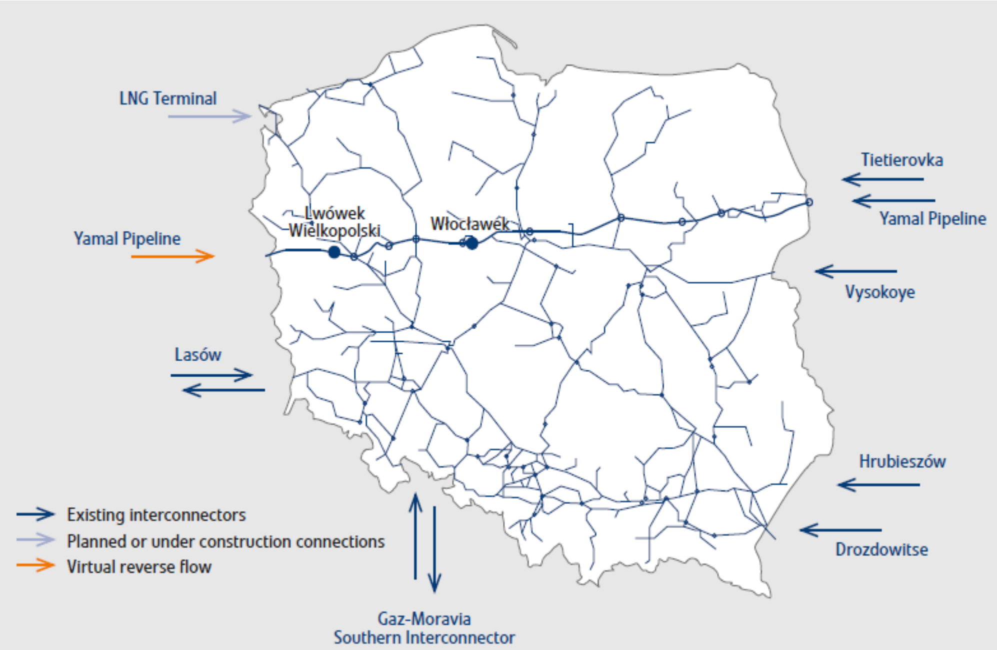
Natural gas interconnections

In 2010, 70% of annual gas inland consumption, in amount of 10,1 bcm came from import. 90% of it was delivered from Russia under a long-term agreement signed between the Polish Oil and Gas Company (PGNiG SA) and Gazprom (Russia), and the rest 10% was imported from Germany.

In 2012 the total cross-border transmission capacity has decreased slightly to 17,85 bcm/year comparing to year 2011 when it reached 18,13 bcm/year. The transmission system operator – company fully state owned named "Gaz-System SA", cooperated with the TSO's of Belarus, Ukraine and Germany based on the concluded inter-operators' agreements. Those agreements concern the cooperation in reference to controlling the gas flows at links at Drozdowicze (Ukraine), Wysokoje and Tietierowka (Byelorussia), Lasów, Gubin and Kamminke (Germany) and Cieszyn (the Czech Republic). Since October 2012 there is an available new connection towards Ukraine. The physical flow of 4,8 mcm/day is offered and most probably before the end of 2013 gas flow will go into Ukraine.

The works conducted by TSO in 2012, aiming at introduction of the bundled capacity at the Lasów[60] interconnection point, may lead the earliest in 2014 to offering the capacity of maximally 5200 mcm /hour.

Fig. 76 - Existing and under construction and/or expansion sources of natural gas supply into Poland



Source: Report- PGNiG in Numbers 201261

The gas transmission capacity at a Polish – Czech interconnection in Cieszyn in 2012 (Gas-Moravia, see map below) was provided on a day-ahead basis. Since 2013 it has changed and transmission services are offered on a affirm basis. The capacity volume in offer is set in a dynamic way based on the flows in the both systems. In 2012 the

60 Located close to German border (see map)
61 PGNiG SA – Polish Oil and Gas Company Joint Stock, State Owned, dominated on natural gas market 97% of wholesale and retail ~markets. Annual report published in 2013.

President of ERO monitored also the rules of managing and allocating capacity on the Polish section of Yamal-West Europe pipeline (see map).

The expansion of Polish gas interconnections will proceed in accordance with guidelines COM (2013) 711 final52, concerning Projects of Common Interest/ Cluster of PCIs- fully explained in its Annex 1).

National Energy Markets

Electricity

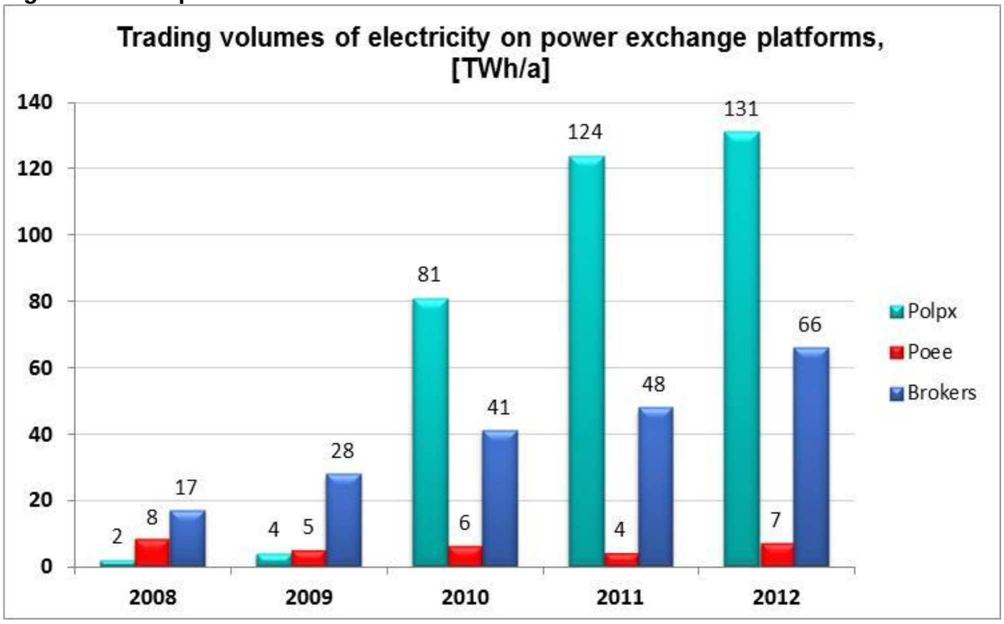
In Poland the wholesale electricity market is permanently growing, and confirmed by a number of completed commercial transactions and turnovers evidence. The economic situation caused a fall of prices on the wholesale market. On the electricity retail market a further increase in the number of consumers to which the energy was supplied on the basis of the free-market rules was observed. The total number of consumers, who in 2012 switched the supplier, increased in comparison to 2011 almost four times. It should be noticed that similarly to 2011, the share of households switching the supplier grew to a much bigger extent than in the case of industrial and commercial consumers.

Wholesale market

In 2012 the biggest share in the production subsector was maintained by the capital group PGE Polska Grupa Energetyczna SA and in the supply to the end-users by the TAURON Polska Energia SA. Existences of vertically integrated capital groups make the markets of electricity generation and trade highly centralised.

The competitiveness on the electricity market is illustrated by the indexes measuring the level of concentration. The index of market share which is measured with the power fed into the network amounted in 2012 on the level of 64.3%. More than a half of installed capacity was kept by three the biggest companies, operating within the following capital groups: PGE Polska Grupa Energetyczna SA, TAURON Polska Energia SA and EDF. They were also responsible for production of over 60% electricity in the country. In 2012, the number of commercial transactions carried out through the power exchange increased to 61.8 % share of the volume of electricity sold by the generation companies. The share of bilateral contracts has diminished to 33% (in comparison in 2010 it was as much as 89.9%). The rest of sales was conducted on a balancing market and to a small extend was sold abroad. Since 2011 there can be also observed an increase of electricity purchases to power exchange instead of trading companies, which were dominating by 2010. Development of power wholesale market in Poland is illustrated on chart below.

Fig. 77 - Development of Power wholesale market in Poland



Source TOE presentation Warsaw, August 2013

The share of electricity sold by power generators to the end users amounted to 1.3% in 2012. The average price at which the generation companies were selling the electricity amounted to 203,44 PLN/MWh and was higher by 2.1% than the price in 2011. The price of electricity sold by the trade entities amounted to 210,08 PLN/MWh and was lower by 7.6% than the price in 2011.These prices cover all of supporting mechanism for electricity generation based on RES and in highly efficient co-generation (different technologies by capacities and fuels fired).

In 2013 on the wholesale electricity market there can be observed the phenomenon of price war of energy companies (the four major vertically integrated companies with a significant part shares hold by State Treasury).

Main reasons are as follows:

a) a slight increase in demand for energy in the country
b) an accumulated surplus of green certificates allowing to obtain additional incomes
c) a significant share of fully depreciated old units working on variable cost only
d) around 10% share of installed RES capacities, including the wind farms of over 3 GW capacity, and producing with near zero variable costs (highly remunerated by green certificates)
e) handing into operation a new very modern and efficient energy block lignite fired of 858 MW capacity producing relatively cheaper electricity
f) green certificates breakdown of market prices on a secondary trade platform, and bankruptcy of small biomass suppliers; finally biomass prices significantly decreased.

It is forecasted that the price war of energy companies could last until the first half of 2014. Companies have in their capital groups, distribution companies, and trading companies, which allow them to endure the inconvenient terms of a price war - compared with manufacturers not conducting network or commercial activities (energy trading).

It is worth stressing that for political reasons declines in energy prices on a wholesale market are favorable in the short-term for both consumers as well as the government coalition, and therefore there is no strong pressure on the regulator to normalize the situation, which threatening the security of supply in a medium and long term (beyond 2020).

Retail Market

In 2012 the electricity prices for households, who decided not to switch the electricity supplier (non-TPA consumers) were set in tariffs, calculated by the energy companies and approved by the President of ERO. Similarly to the previous years, the biggest amount of electricity sold to end user, came from incumbent suppliers, remaining the party to the common service agreements after the distribution network unbundling, who perform a function of the default suppliers. There were 82 active suppliers operating on the electricity market in 2012. The total number of entities licensed to trade electricity equalled 360, majority of which consisted of vertically integrated power companies. As of the end of September 2012 there were six main DSO's operating on the market, but after the consolidation of TAURON Dystrybucja SA and TAURON Dystrybucja GZE SA[62] on the 1st of October 2012, this number decreased to five. Number of electricity end-users equals 16,7 millions of customers (President of ERO data), out of which around 90% consists of households. The volume of electricity supplied to this group amounts to around 23% of the electricity supplied to all final users.

Tab. 25 - Polish electricity market in number 2012

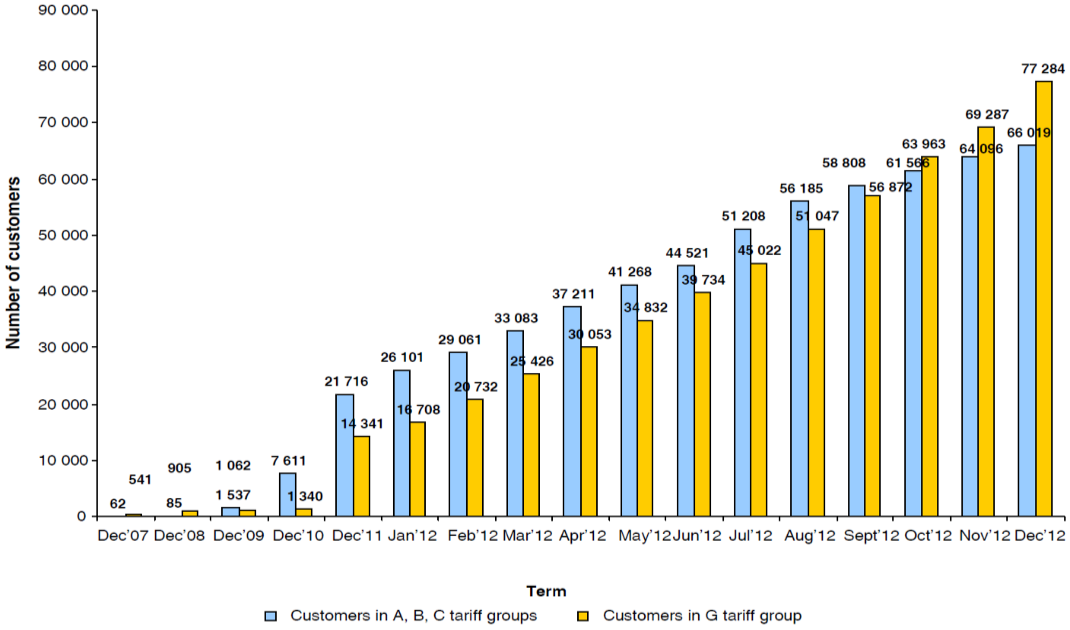
Number of energy end-users	16,7 million
Generation capacity (installed, end of year)	38203 MW
Disposable capacity (for TSO – dispatching centre)	26567 MW
Gross electricity production:	162,14 TWh
- Import (real flow)	9,80 TWh
- Export (real flow	12,64 TWh
Total electricity consumption	159,3 TWh
Max load (day 7/02/2012)	25 845 MW
Min load (day 17/06/2012)	16 178 MW

Source : Polish Electricity Statistics 2012, published by ARE, 2013 and TSO data

TPA indexes are growing but the relatives number of consumers that switched the electricity supplier in 2012 is still relatively small (around 0,86%). On the other hand it was still a significant rise in comparison to year 2012, when this index was at the level of 0.23%. Below there is one chart showing how the opening of the Polish energy market has been proceeding, since the year 2007, when the TPA rule was applied for the first time.

62 Buy from Vattenfall company which decided to withdraw of its activity on Polish energy market

Fig. 78 - Application of TPA rule, years 2007 - 2012



Source: National Report The President of the Energy Regulatory Office in Poland 2013

Natural Gas

In 2012 the gas market in Poland was still fully regulated, but the efforts made to liberalise it, undertaken by the President of ERO, resulted in approval of a new Transmission Grid Code and Distribution Grid Code. The changes included there enabled launching a gas exchange at the end of a year 2012.

Wholesale market

In 2012, the wholesale gas market was dominated by one entity – PGNiG SA. The trade of natural gas was conducted only by means of bilateral contracts. There were 97 entities entitled to trading in gas. Companies from outside PGNiG Capital Group obtained around 50% of gas from PGNiG SA and 50% from direct import. The volume of gas they sold in 2012 constituted to more than 5% of total sales, which equalled 707,5 mcm. The prices for natural gas were regulated by tariffs, unless the trading company was buying it directly from the domestic gas mines, in which case the price was set in bilateral contract.

In September 2013, come into force the Act of 26 July 2013 amending the Energy Law (JoL, 2013 item 984). According to article 25 of the new Act the natural gas, wholesale market opening has been obligatory introduced as follow:

- 30 % - up to the end of 2013
- 40 % - in 2014
- 55 % - from January 2015 – all proportions calculated as fraction of total natural gas feed into gas transmission system (network).

Above shares are calculated for high methane natural gas volumes feed into gas transmission pipelines managed by nominated and certified TSO (Gaz-System), with some exceptions justified by safety and emergency reasons (cases), according to EC recommendations.

Retail market

The retail market concentration is very similar to the wholesale one. Polish gas market is dominated by incumbent PGNiG SA, which conducts around 94,64% of the natural gas sales, while the remains are sold by other entities. Households form 96,9% of the total number of PGNiG consumers, the volume of gas sold to them in 2012 equalled 26,1%. Industrial consumers such as chemical utilities, electricity and combined heat and power plants had the biggest share in the sale of natural gas, equalled 60.2%. On the retail gas market there exist also companies from outside PGNiG Capital Group, which activities is based on resale of natural gas acquired through intra-Community purchases or from PGNiG SA. These companies delivered in 2012 51 mcm of natural gas, mainly through local distribution networks.

Slow process of opening gas retail market can be observed. Since 2011, there has been a constant growth in the number of trading companies selling gas to the end-users. In 2012 thirteen biggest trading companies, from outside of PGNiG SA, sold in total around 1336,52 mcm of gas to 141 240 consumers. Despite mentioned positive changes, the lack of competition on the Polish gas market creates a situation in which the gas prices for all groups of consumers still has to be regulated. The Polish gas market stakeholders are waiting for positive results of the new Act implementation, amending Energy Law and introducing gas time-schedule opening, as shortly described in previous item (2.5.4.2.1).

Tab. 26 - Polish Gas Market key figures, 2012

Categories	Unit	Value
Total gas supply	$10^9 m^3$	**15,318**
Total import	$10^9 m^3$	11,000
Total import from Eastern direction	$10^9 m^3$	9,018
Total import from Western direction	$10^9 m^3$	1,427
Total import from Northern direction	$10^9 m^3$	0,0
Total import from Southern direction	$10^9 m^3$	0,556
Domestic production	$10^9 m^3$	4,317
Number of natural gas end-users	Million	6,7
Number of TSO (Transmission System Operator) (Gaz-System SA)		1
Number of DSO (Distribution System Operator)		1
Total gas consumption	10^9 m3	15,430
Percentage of gas volume consumed by end-user group:		
Industrial consumers (incl. non-energy gas use, mainly chemistry)	%	48,3
Households		31,6
Others		13,7

Source: Report PGNiG in numbers 2012. Published in 2013)

In 2012 new suppliers started activity in the gas retail market, what contributed rise in the number of switching suppliers. The growing trend of suppliers switching was positively influenced by distribution service agreement – “framework agreement”. The increase in the number of that agreement is directly proportional to the number gas supplier switching grow. The table below present the gas retail market development applying TPA rule.

Tab. 27 - Number of customers changed of gas suppliers (under TPA rules)

Year 2011	Q_1 2012	Q_2 2012	Q_3 2012	Q_4 2012
4	6	19	17	168
SUM for year 2012	**210**			

Source: National Report of President of ERO, 2013 (in Polish)

Electricity and natural gas prices

Electricity prices

In the year 2012 the electricity tariffs for the group “G” (households consumers only), who are connected to the DSOs networks and has not switched the supplier, continuously had to be approved by the President of ERO. The prices for other groups based on market rules.

Below on three next charts are presented prices of electricity charged to the following groups of final consumers:

i. Medium size households consumers (consumption 2500 - 5000 kWh/a) - chart 76
ii. Small size industrial consumers (annual consumption below 20 MWh/a) - chart 77
iii. Medium size industrial consumers (annual consumption between 500 and 2000 MWh) - chart 78

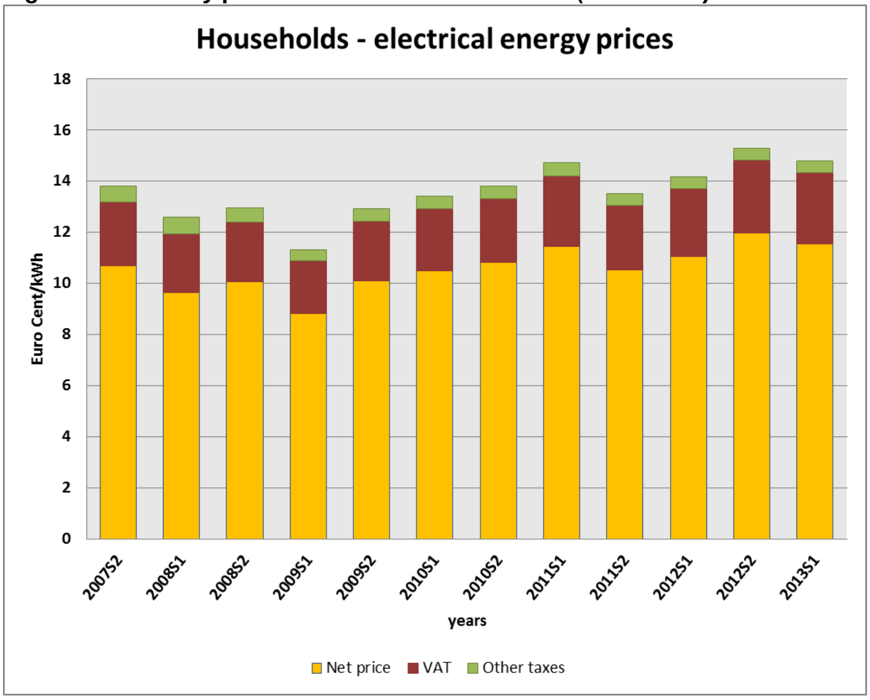
Prices presented on charts below are taken from Eurostat database registering half-year (semester) national markets changes, and prices for S1 means value established on the1st of January, and S2 as valid on the 1st of July of an analysed year. When Eurostat publishes only annual data on prices it applies price values for the second semester of a current year (S2).

Also the charts 76 -78 show end-users pricing components e.g. net price of electricity plus grid costs (transmission and distribution) plus supporting mechanism charges (RES and CHP promotions), and different taxes (refundable and not-repayable, e.g. excise tax).

On all charts is visible that the latest prices are slightly lowering due to lowering wholesale prices of electricity, and the same decreasing of Polish currency exchange rate.

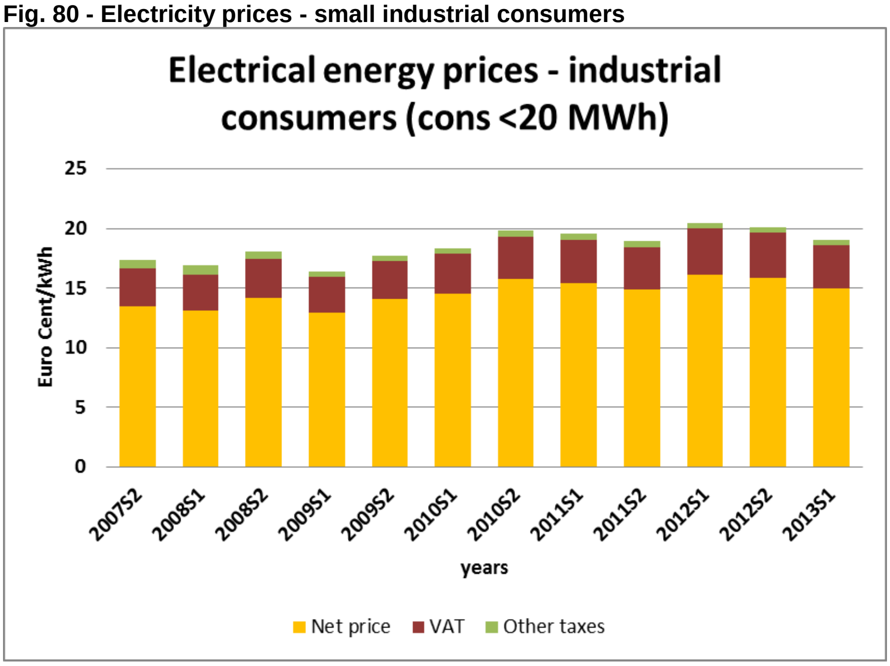
It is worth to mention that additional decrease of wholesale prices is due to significant lowering of variable costs of RES electricity, parallel with significant decrease of certificate premium to green energy and expire of CHP supports (renewed Energy Law is under the EC notification). In addition, start-up of new very modern power plant lignite fired (858 MW electric capacity) has influenced price lowering.

Fig. 79 - Electricity prices of domestic consumers ('G"- tariffs)



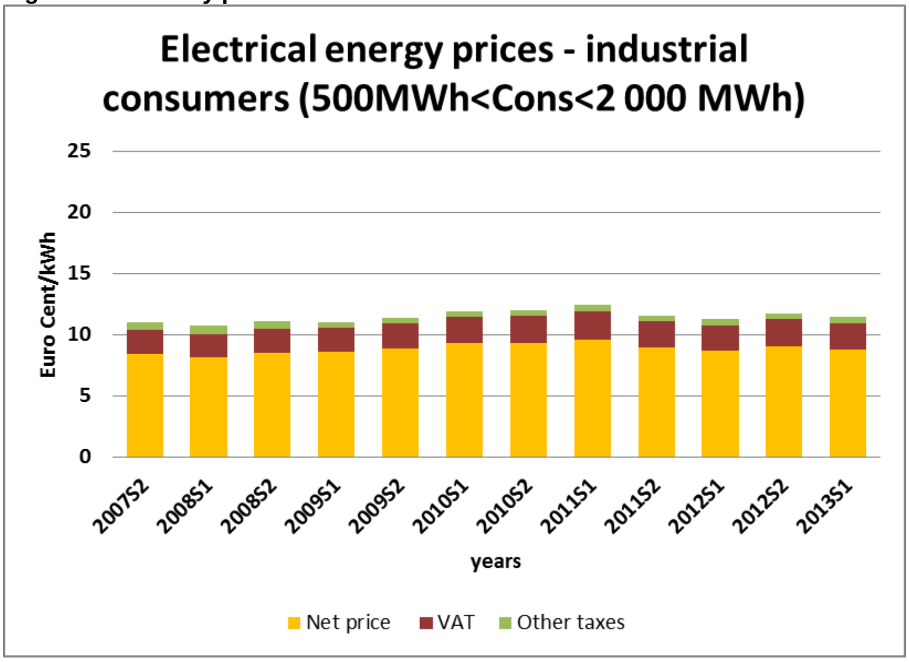
Source: Eurostat data base

Fig. 80 - Electricity prices - small industrial consumers



Source: Eurostat data base

Fig. 81 - Electricity prices - medium sized industrial consumers



Source: Eurostat data base

Natural gas prices

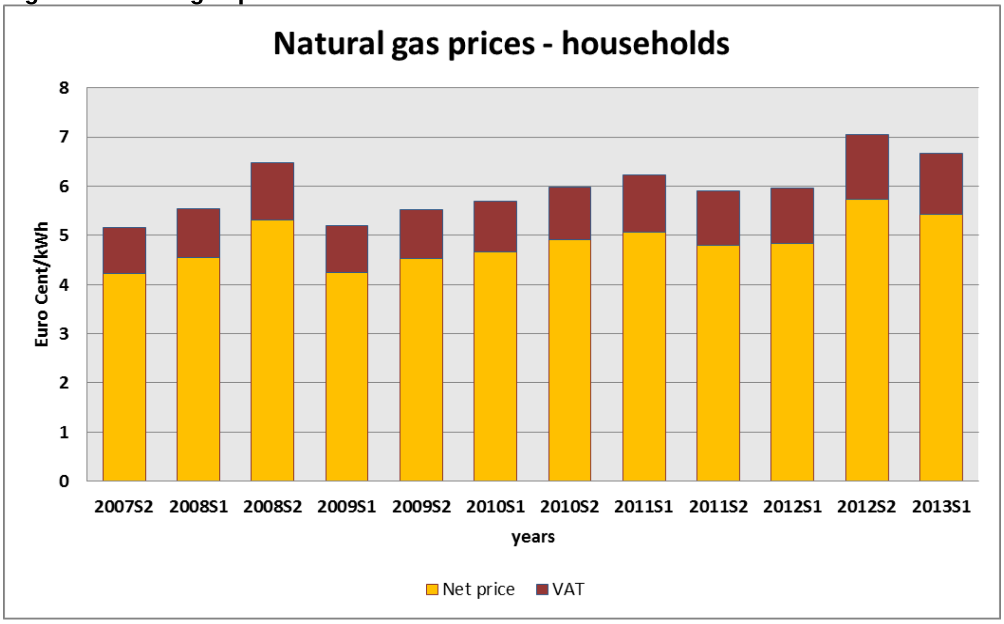
According to the Energy Law and secondary legislations (ordinances issued by ministers), the gas tariffs, set by the energy companies shall cover all planned and justified costs of the business activity together with the fair return on capital employed in this activity. Inter-annual cost deviations, from costs being the base for the tariff's approval, are not included in tariffs, as long as they are not in the nature of changes possibly threatening of provider's financial security - PGNiG SA company.

Below there are presented charts showing natural gas prices expressed in current Euro, charged to the three following groups of final consumers:

i. Domestic consumers (households), with annual consumption not exceeding 20 GJ (~500 cm/a; gas used for cooking and hot water preparation)
ii. Small industrial consumers, with annual consumption not exceeding 1000 GJ (<25 000 cm/a)
iii. Medium size industrial consumer, with annual consumption between 10 000 and 100 000GJ (< 2 500 000 cm/a)

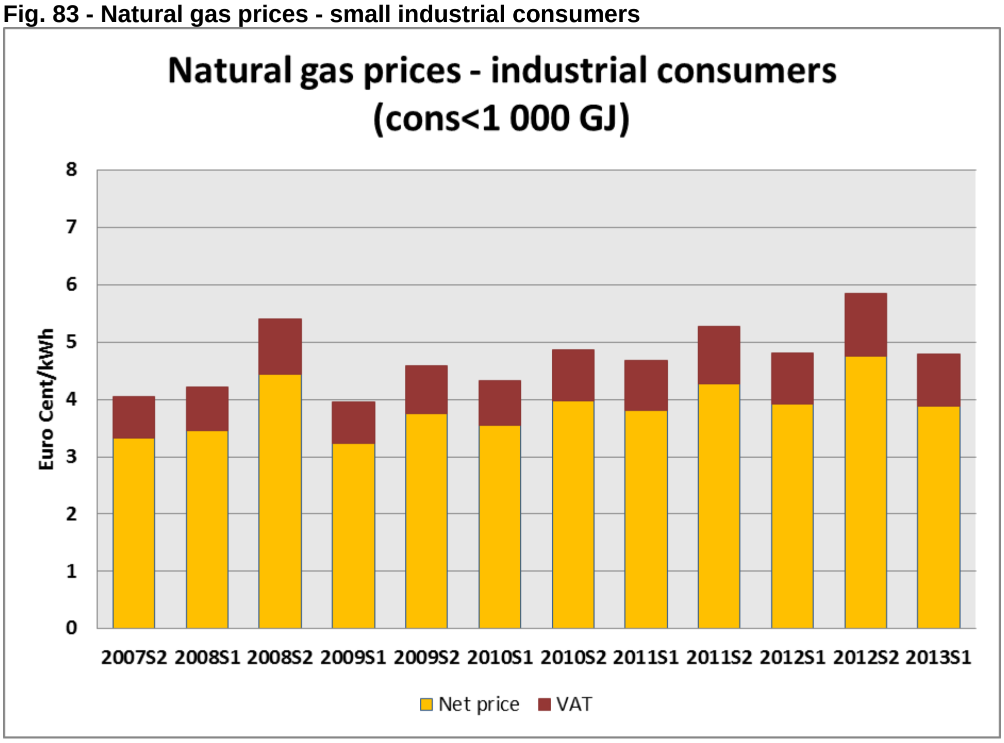
Prices presented in graphs take into account all fiscal charges existing in Poland that must be paid by household and industry customers. In fact, in 2013 in Poland, the only tax that was charged in gas consumption was a VAT in the same value of 23%. For industrial customers, VAT is accounted for according to international accounting standards.

Fig. 82 - Natural gas prices - households



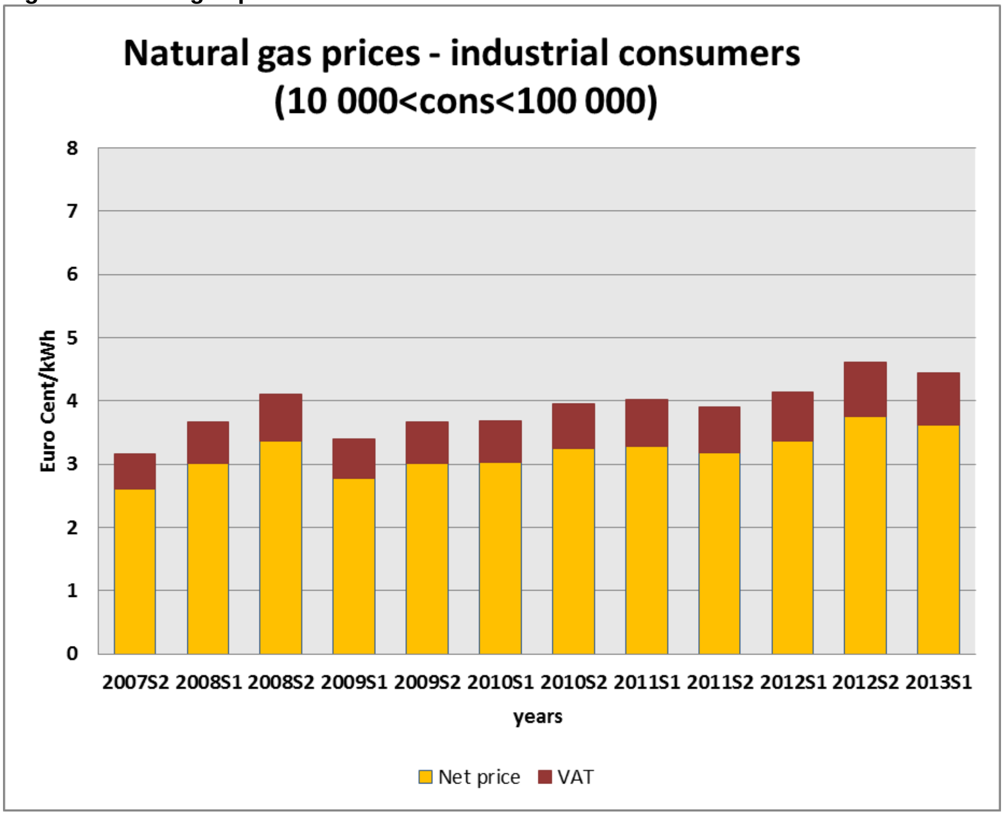
Source: Eurostat

Fig. 83 - Natural gas prices - small industrial consumers



Source : Eurostat

Fig. 84 - Natural gas prices - medium industrial consumers



Source: Eurostat

Data on figures 79 - 81 quite well indicate the dependence of gas tariffs from changes in gas prices purchased at the main supplier - Russia, primarily under long-term contract with Gazprom Yamal.

It is worth noting that Poland buys a natural gas in Russia at a quite significantly higher price than the one paid by Germany, Italy and several other EU countries, which can only partly be explained by much higher volume of gas purchased by Germany for example. This situation is not easy to release gas prices from the President of ERO tariffs' regulation, as they could increase significantly. It is very probable because the dominating company on a domestic market - PGNiG SA (~97% share of gas wholesale and retail markets) would be willing to raise the price of gas produced in Poland to the level corresponding to prices of imported gas (the share of domestic gas production is about 30% of a national consumption).

National Energy Policy

Regulatory framework

The rules of functioning of the natural gas and electricity market are regulated by the act - Energy Law. In 2012 there were still conducted legislative works (started in 2011), aimed at introduction of significant changes implementing the directives included in the third EU energy package into the Polish law. This governmental and Parliamentary process and procedures, incl. public hearing has been concluded, and the new Act amending Energy Law come into force in 11 September 2013 (Act of 26 July 2013, promulgated in Journal of Law 2013 item 984). The new Act regarded mainly to remove of market shortcomings related to liberalisation of electricity and gas markets, incl. effective protection of vulnerable customers and phasing out retail price regulation.

Moreover, the wholesale gas market platform has been established incl. time-schedule of gas market opening. In addition, the key regulations concerns implementation of RES directive (2009/28/|EC) has been fairly introduced, incl. National Action Plan for RES development on-time performance.

Unbundling

According to the Polish Energy law, only electricity TSO shall operate on the Polish territory, in the form of joint-stock company with a single stakeholder – the State Treasury. Moreover this function can be performed by a transmission network operator acts on agreement with the grid owner, and subordinate to another governmental body. In Poland, it is the Minister of Economy independent from the Minister of State Treasury decisions. According to the above at the end of 2012, there was a single TSO on the Polish territory, namely PSE SA, who had certified by ERO. In the natural gas sector, the TSO is a state owned Gaz-System Company (100%) and its certification process is ongoing, and should be concluded soon.

Unbundling of distribution system operators

The obligations of distribution system operators (DSOs) are also stated in the Energy Law. DSOs, which act within vertically integrated energy groups and serve over 100 000 customers have to be independent in terms of legal structure, organization, and decision-making. They must not be connecting with other types of activities linked to either transmission or distribution of both the electricity and gas activities (test of independency).

It is worth to mention that before 2012 distributed natural gas market has been served by six local DSO's – subsidiaries of PGNiG SA (Polish Oil and Gas Company). Currently PGNiG performs the consolidation process of these six companies into one DSO brand name “Polska Grupa Gazownicza” Ltd.

Energy and sustainability challenges

In Poland installed capacity of wind farms at the end of 2012 equals around 2,5 GW, and now (November 2013 it is more then 3,0 GW), what is a quite significant share in the total installed capacity in the NES (37 GW). Also at the end of 2012, there were additional 20 GW of capacity waiting to be connected to the public grid (TSO registering and managing this process). It should be noted that the amount of already installed amount of renewables in the NES might have a negative influence on the power system balancing.

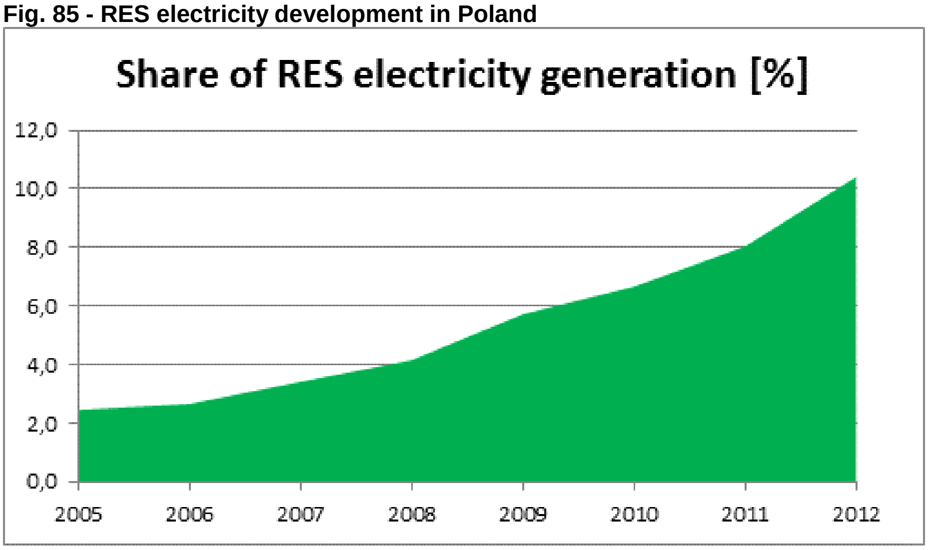
Regarding the RES power connection to the grid, as it is stated in the Energy Law, in the case of the power units with installed capacity less than 5 MW and/or cogeneration units below 1 MW the grid connection fee is reduced by 50% of real connecting costs.

In addition, those units give preferential treatment in the case of connection to the grid and purchase of electricity and/or preferential transmission and distribution TSO/DSO services, while preserving the reliability and security of the NES (national electricity system). The default (last resort) supplier is also obliged to purchase electricity generated from RES units connected to the distribution or transmission grid. The energy shall be bought at an average price for electricity on the competitive market in the previous year, announced annually by the President of ERO.

Moreover, the last Energy Law amendment defined micro-generation and micro-cogeneration units and granted them special preferences like, grid connection free of charge or a few other handling charges or administrative permissions, incl. licenses and/or concessions required from bigger units. In addition, guarantee of origin separated from certificates supporting the scheme and allowable RES statistical transfers has been introduced into law.

These legal frameworks together with very stimulus supporting schemes (quota systems and tradable certificates represent property rights) create good conditions for RES development in Poland, as illustrated on the two charts below.
It should be clearly emphasized that the system for supporting 'green electricity' using tradable certificates scheme worked well in Poland until 2012. Unfortunately, this year mechanisms of control and market surveillance failed and consequently the prices of green certificates have fallen quite dramatically in secondary market transactions. This led, on the one hand, to 'the purification' of the market from an excess certificates' speculations, but on the other hand resulted in quite a large number of bankruptcies, particularly small producers, and suppliers of biomass. Some of them were merge by huge energy companies, which may result positively by more stable price of biomass supply in the next few years, and negatively – higher market concentration.

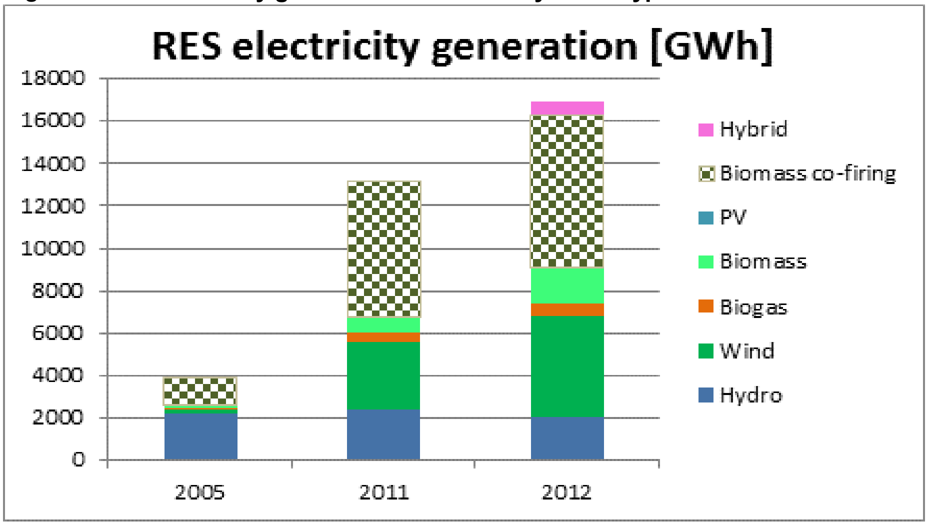
Fig. 85 - RES electricity development in Poland



Source: Polish energy statistics by GUS/ ARE and own calculations

The analysis of chart 83 proves that wind farms have a key significance on a Polish RES market and above all biomass co-combustion, mainly with carbon. This situation has been considered invalid and in the next amendment of the Polish law the system of support for biomass co-firing will be greatly reduced (to approximately 50 % of the present value of supplements to 1 MWh of 'green electricity'). Unfortunately, in Poland there is still no support system for the production of 'green' district heating. But in the National Action Plan for RES energy development (NAP- RES) formally approved by the Polish government in 2010, it has been settled that district heating and cooling sector should cover about 17 % of 'green' heat from RES (in 2010-2011 the share was approximately 12.5%). According to the plan (NAP -RES) the share of 'green' electricity in 2020 should be more than 19 %, while in transport (liquid fuels) about 10%. Jointly these shares will allow Poland to meet their commitments of RES 15% share - in accordance with objectives of the climate and energy package (3*20%).

Fig. 86 - RES electricity generation in Poland by units' type



Source: Polish power statistics by ARE and own calculations

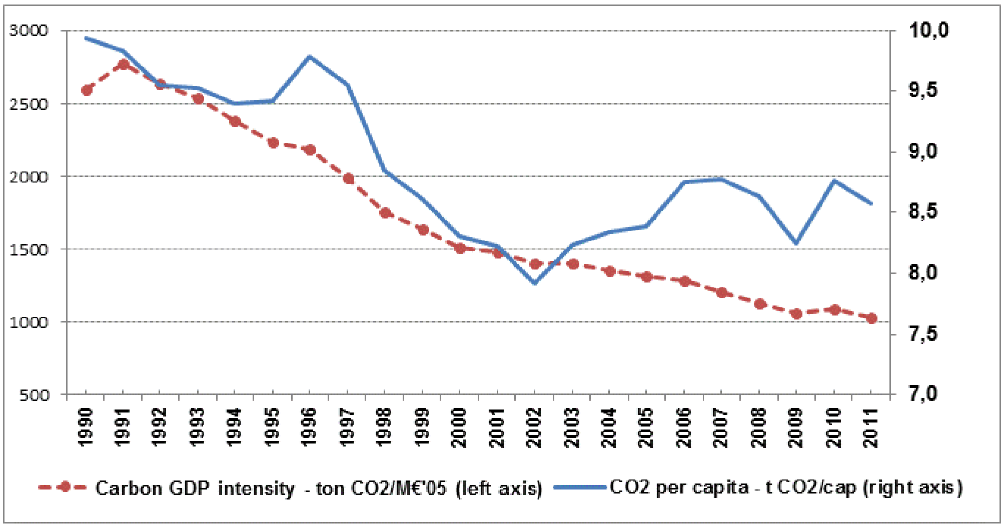
CO2 and GHG emissions

Poland undertakes a number of activities aiming at reducing greenhouse gas emissions in order to fulfill the objective of a 20% reduction of GHG emissions in 2020. There has been prepared the strategic adaptation plan for sectors and areas vulnerable to climate changes by 2020[63], which will be gradually implemented in the coming years.

The below chart illustrates the effects of actions and measures implemented, indicating both the continuous decline in carbon intensity of GDP (left axis), as an effect of GDP growth, as well as the physical reduction of emissions from many sectors of the economy, largely from energy sector. In the last 3 years this process has weakened due to the world financial crisis and problems of the euro zone (Mainly Mediterranean countries), which were also reflected in the Polish economy. In addition, relatively expensive natural gas, in combination with the completion of a national support scheme (end of 2012) for highly-efficient cogeneration based on natural gas (so called yellow certificates scheme) caused that modern gas-fired CHP limit the production, or are simply disposed of to a cold reserve .

63 Strategic Plan for sectoral and sensitive areas adaptation to climate changes up to 2020, and perspective until 2030 (in Polish). Ministry of Environment, October 2013

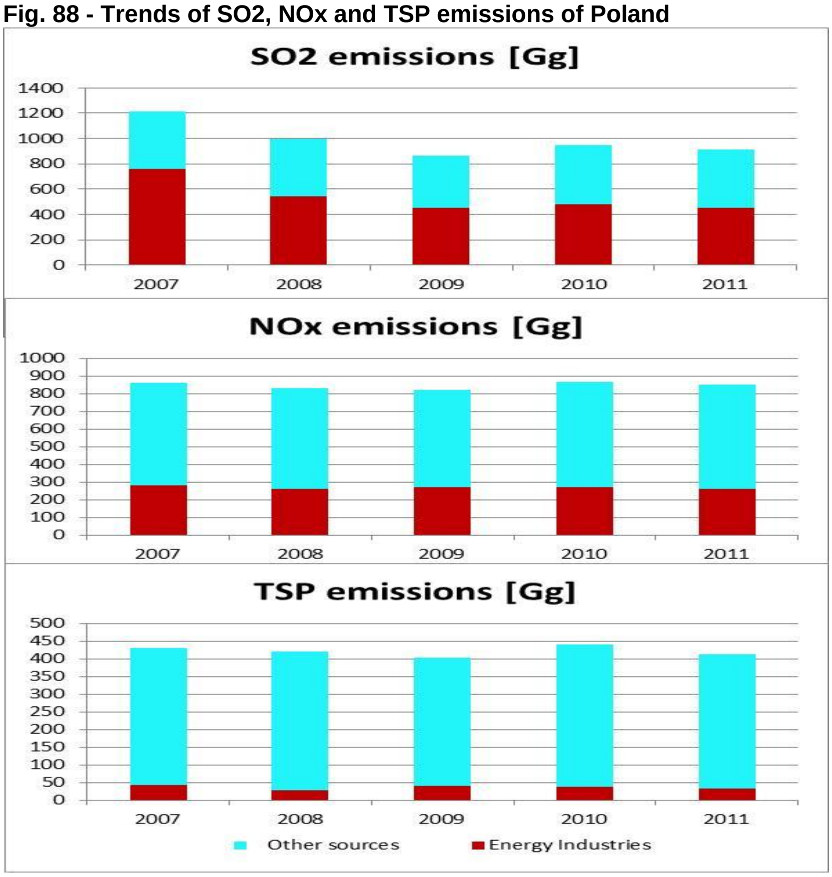
Fig. 87 - Historical trends of CO2 emission key indicators



Source: Eurostat & Polish National GHG reports and own calculations

For Poland as a coal-wide use country, the key issues are still linked with SO2, NOx, and PM emission reduction. Below charts show trends of these emissions observed in last few years. It is quite clearly visible that for Poland low emissions prevail emissions come from energy sector's units.

Fig. 88 - Trends of SO2, NOx and TSP emissions of Poland



Source: Polish National Inventory reports and own calculations

Energy efficiency[64]

Since joining the European Union, Poland has been making efforts to implement European regulations concerning energy law and energy efficiency. According to the report prepared by Odysse-Mure 2010: *Energy Efficiency Policies and Measure in Poland*, the country has made a significant progress in achieving energy savings stated as an indicative target set by Directive 2006/32/EC – of achieving 9% of energy saving compared to 2001-2005 average use of final energy.

In April 2012 the Second National Energy Efficiency Action Plan for Poland (NEEAP2) was prepared to fulfil the obligation of the 2006/32/EC Directive (Journal of Law L 114 from 27 April 2006, page 64) as well as the directive on energy performance in buildings, 2010/31/EC (Journal of Law L 153 from 18 June 2010, page 13). The NEEAP2 was developed based on article 6 of Act 15th of April 2011 “On energy efficiency” (Journal of Law No. 94, pos. 551), implementing regulations of directive 2006/32/EC and cogeneration directive (2004/8/EC). The document also contains a list of current and planned measures and instruments including financial and supporting actions on energy saving in buildings in accordance with article 10 of directive 2010/31/EC (so called ‘building directive’).

The second NEEAP2 documents and summarizes the established and implemented energy savings objectives determined in Directive 2006/32/EU for 2010. For the Poland the objective was set on 2%, i.e. 11 878 GWh of final energy (~1,02 Mtoe), and reached 35 320 GWh, i.e. 3 times higher savings. The highest savings achieved in the households sector, around 13 816 GWh, while in the industrial sector around 11 851 GWh. These results allow to highly anticipating the realisation of expected objective for 2016, as well as 20% reduction in consumption (compared to the base-line) in 2020.

NEEAP2 contains descriptions of energy efficiency improving measures and expectations until 2016 according to the requirements of the EU directives.

While developing NEEAP2 the following assumptions applied:

- ✓ the proposed measures will be maximally based on market mechanisms and minimally on a state budget
- ✓ objectives will be accomplished according to the lowest cost rules with maximal use of existing mechanisms and organizational infrastructure
- ✓ participation of all parties in the exploitation of the total national energy efficiency potential.

Monitored and reported energy savings accordingly to the second NEEAP are presented in the table below. There is energy savings calculated for activities and implemented measures as indicated in the table.

64 Based on: Central Statistical Office The Polish National Energy Conservation Agency: Energy Efficiency Policies and Measure in Poland ODYSSEE&MURE 2010 Monitoring of EU and national energy efficiency targets, Warsaw, October 2012

Tab. 28 - Energy savings expected results of Poland for year 2016[64]

Energy efficiency activity, by sectors	GWh	Mtoe
Target for 2016 accordingly the second NEEAP	67211	5.779
Energy use sectors:		
1. Households		
Thermal Modernisation Fund	8121	0.698
2. Services - public		
System of green investments (1)	1950	0.168
Operational Programme Infrastructure and Environment (Activity 9.3)	320	0.028
3. Industry and SMEs		
Effective energy use (Part 2)	2900	0.249
Operational Programme Infrastructure and Environment (Activity 9.2 – Effective energy distribution)	498	0.043
Operational Programme Infrastructure and Environment (Activity 9.1- High efficient electricity generation)	3100	0.267
4. Transport		
Transport management system	13360	1.149
Fleet replacement	2500	0.215
5. General Cross-Cutting		
White certificates system	25586	2.200
National information campaign	12793	1.100
Total		6.116

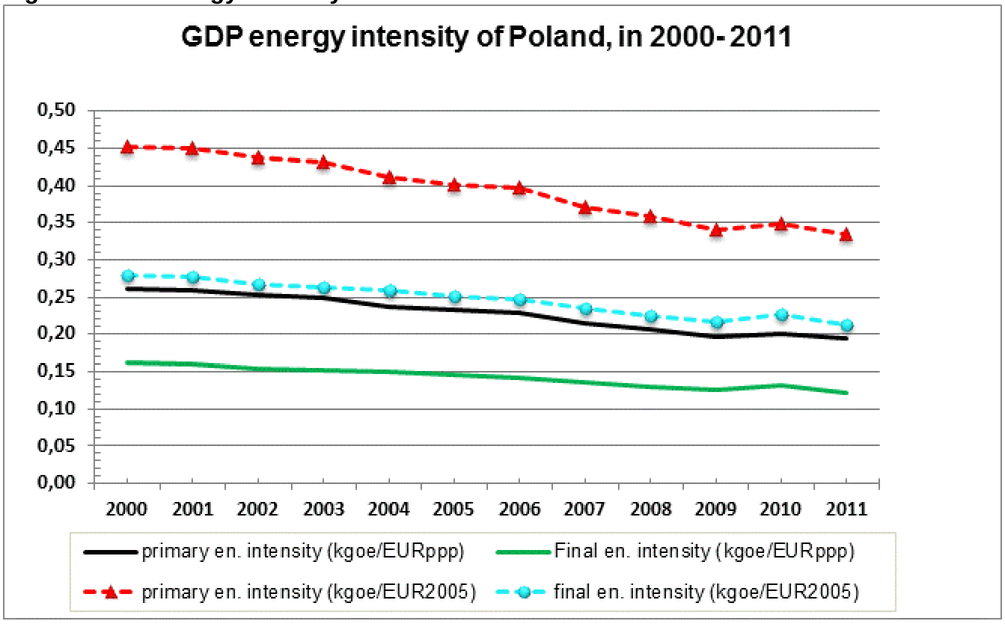
The total energy saving effects of specific measures indicated in the table are even higher than the ones assumed for 2016 Poland's targeting. The authors of monitoring report suggest strengthening the role of bottom-up calculations in evaluations of specific energy savings measures results.

GDP of Poland increases faster than energy consumption, what is observed as the decrease of primary and final intensity of GDP. These trends are shown in the chart below. There are four cases presented:

i. Primary energy consumption in constant EURO'2005 prices adjusted to purchase power parities (ppp)
ii. Final energy consumption in constant EURO'2005 prices adjusted to purchase power parities (ppp)
iii. Primary energy consumption in constant EURO'2005 prices
iv. Final energy consumption in constant EURO'2005 prices.

The chart is based on the calculation conducted within preparing the statutory work of the Institute of Power Engineering: Energy efficiency - mechanisms and instruments of implementation in the EU and the U.S. – the conclusions and recommendations for Poland.

Fig. 89 - GDP energy intensity trends within 2000 – 2011



Source : Eurostat and World Ban

In the last two decades, Poland has obtained one of the greatest progresses in terms of an efficient energy use. The main contribution was achieved by the industrial sector due to structural changes and privatization. Actions aiming at improving energy efficiency are also constantly performed in household, services, and transport.

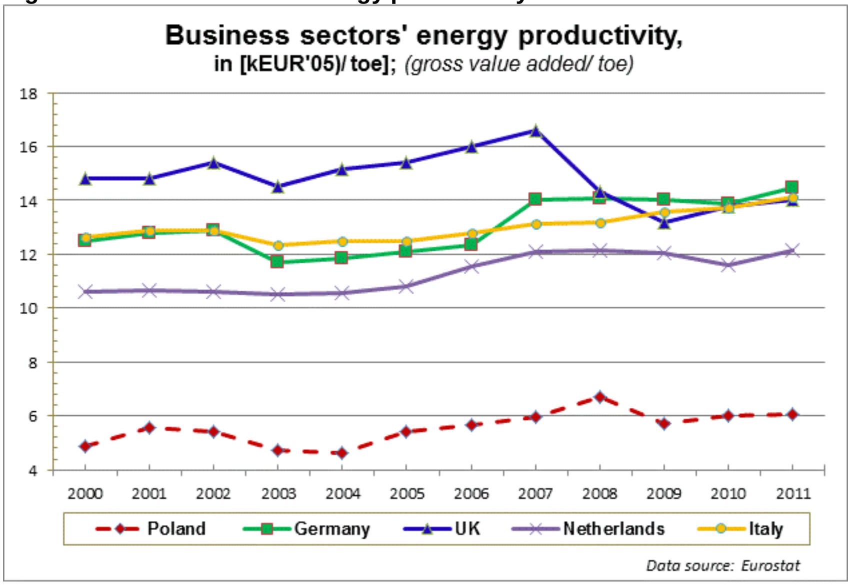
Below there is presented the productivity of Polish business sector (defined as overall final energy use in Poland minus energy consumed by households). The results achieved are compared with other EU countries.[65]

Currently the issue of energy efficiency is prioritized when applying changes to the Polish energy policy. The main objectives in this area are recognized as:

i. “zero-energy” economic growth;
ii. Decreasing the energy intensity of Polish economy to the level of EU-15
i. Implementing efficiently and effectively all obligations resulting from new Energy Efficiency Directive (EED)[66] ;

65 Results presented on figure are based on Authors’ statutory project entitled ”Energy efficiency - mechanisms and instruments of implementation in the EU and the U.S. – the conclusions and recommendations for Poland”, which ends in 2013.
66 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EC and repealing Directives 2004/8/EC and 2006/32/EC. OJ of the EU L 315, published 14.11.2012.

Fig. 90 - Business sectors energy productivity within 2000 – 2011 in the EU countries analysed



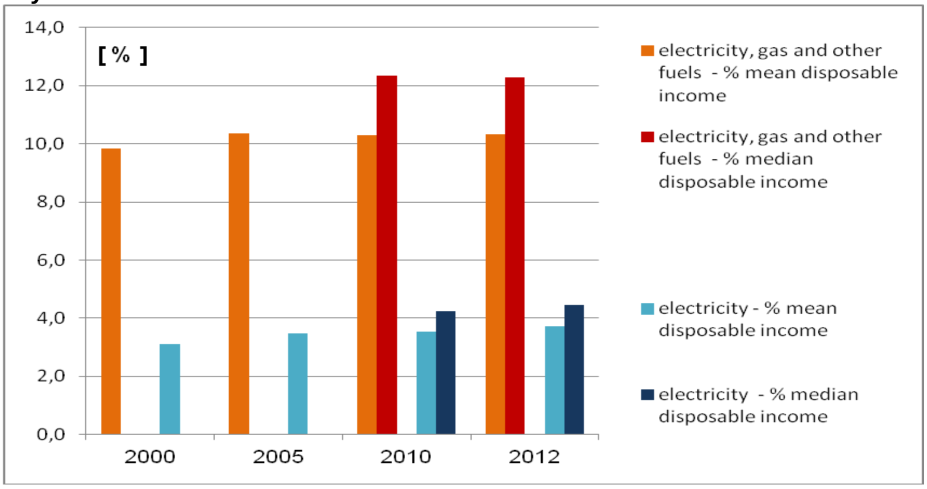
Source : Eurostat and IEn own calculations

Social aspects

In the case of Poland's energy transformation based largely on a relatively cheap coal it is important to continuously analyze and evaluate social and economic impacts that decide about the success of a planned transformation. Too ambitious reduction targets under the primacy of climate policy over energy, and similarly safety and protection of vulnerable customers may fail either due to public protests, or because of the threat to energy security. Security understood as the reliability of energy supply to households and economic sectors. Economic sectors must remain competitive, which in the case of energy-intensive industries heavily depend on energy costs. The loss of industrial competitiveness will threaten many jobs and will result in the households' lack of ability to purchase energy necessary for fundamental needs i.e. district heating and electricity. The ways in which shares of energy costs are formed in Poland are shown in the following three charts. They show quite clearly that they are very large, excessing the 10% threshold adopted in the EU as a fuel poverty threshold for households.

Chart 88 presents shares of energy costs spend for households' residential needs only, excluding individual transport motor fuels costs (according to Eurostat methodology used).

Fig. 91 - Energy annual expenditures paid by Polish households, as % of their disposable income in years 2005-2012

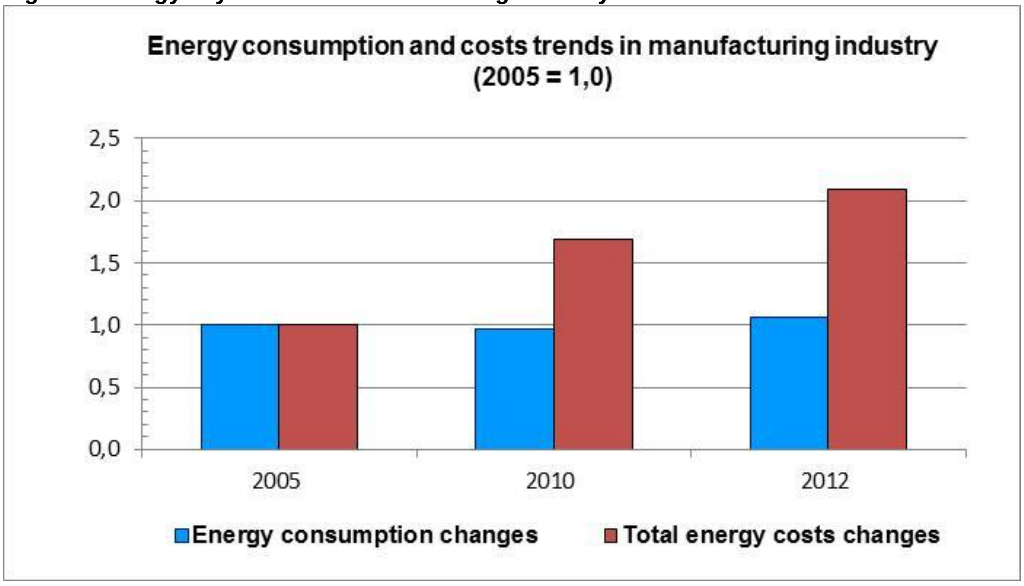


Source: GUS- Central Statistical Office and EnergSys own calculations

Manufacturing industry

As regards manufacturing industry – share of energy costs already exceeds the achieved 'net financial outcome' already indicating the seriousness of this situation. In addition, it reflects currently achieved energy prices and production costs.

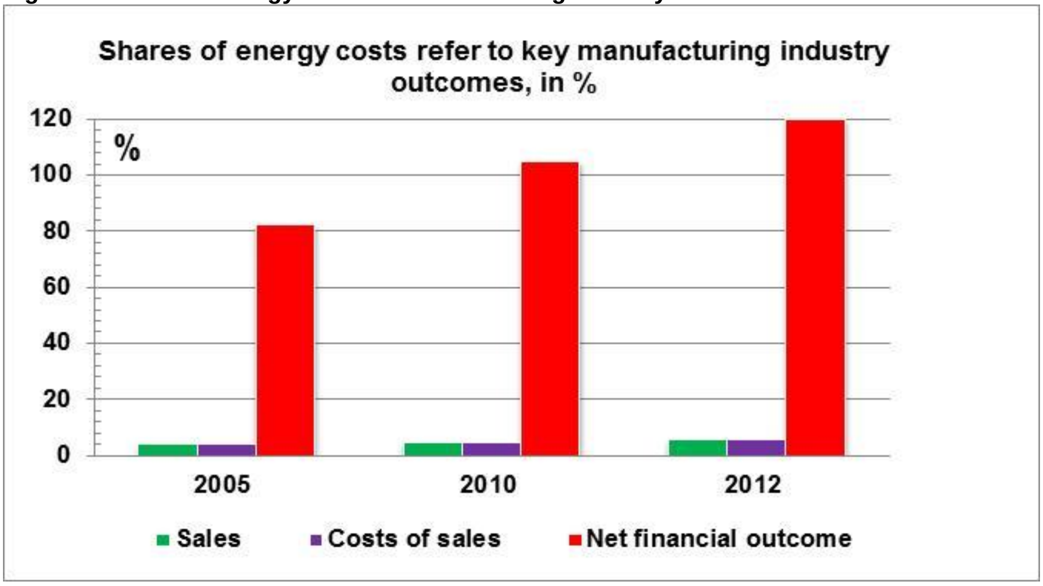
Fig. 92 - Energy key trends in manufacturing industry of Poland



Source: GUS- Central Statistical Office and EnergSys own calculations

The chart 90 clearly illustrates that from the year of 2010 energy costs prevailed net financial outcome of total manufacturing industry (section C of NACE classification).

Fig. 93 - Shares of energy costs in manufacturing industry of Poland



Source: GUS- Central Statistical Office and EnergSys own calculations

Focuses Conclusions

Key Strengths

Germany	Italy	Poland
Overall Profile		
Positioning a green economy: Germany's economy has reduced energy usage per output while continuing to grow. Federal and private sector efforts have created a business environment supportive of green industries.	***Achieving GHG emissions reductions:*** Italy has already surpassed its 2020 target of reducing CO_2e emissions by 13% from 2005 levels, and plans to push further with its National Energy Strategy.	***Reducing carbon intensity of the economy***: The growth of Poland's economy has been efficient. GDP has increased faster than energy consumption, and so Poland has been successful in greatly reducing emissions per GDP.
Energy Policy		
Ramping up renewable electricity: The Renewable Energy Sources Act has incentivised the doubling of renewable electricity in Germany from 10% to 20% between 2005 and 2011, in part due to the feed-in tariff. Similarly, federal R&D opportunities and commercial incentives of the feed-in tariff have created a business environment supportive of green industries.	***Keeping costs down with energy efficiency:*** Italian energy costs per household are lower than EU averages and decreasing, thanks in part to aggressive residential energy efficiency and renewables programmes like Legislative Decree 115/2008, which subsidises efficiency measures, sets minimum performance standards, and incentivises solar installations.	***Implementing highly efficient CHP systems***: Via well-developed networks, Poland produces a significant fraction of heat and electricity (much higher than EU averages) via efficient CHP and district heating systems.
Encouraging public buy-in for renewables: Through citizen cooperatives and investments, over 51% of renewable energy capacity is owned by private citizens, and only 6.5% by the "Big Four" energy companies. To support public awareness, the German Energy Transition website also communicates *Energiewende* lessons learned to the broader international community.	***Leading with local programmes***: With the most signatories of the European Covenant of Mayors initiative, Italian municipalities are successfully implementing sustainable energy policies aimed toward reducing transportation emissions through congestion fees and also improving the efficiency of buildings with strategic audits and analyses.	***Focussing on Energy Efficiency:*** Under its National Energy Efficiency Action Plan, Poland achieved efficiency savings three times higher than expected by the European Commission in Directive 2006/32/EU, due in part to industrial sector privatization and implementing obligations on the Energy Efficiency Directive.

Key Challenges

Germany	Italy	Poland
Overall Profile		
***Reversing the trend of emissions intensity*: The carbon intensity of energy consumption has increased in Germany since 2009, and only represents a 4% decrease from 2000 levels. Phasing out high-carbon energy resources can upend the trend.	***Reducing dependence on foreign imports:*** Despite decreasing dependency in recent years, Italy still imports over 81% of final energy consumed, significantly higher than the EU average and leaving Italy vulnerable in terms of energy security.	***Decreasing Primary Energy Consumption*:** While Poland's economy has reduced energy use per unit growth, a next challenge will be continued growth and an economy-wide energy reduction, since Poland has increased primary energy use steadily since 2005.
Energy Policy		
***Increasing efforts in the field of energy efficiency*:** Measures have been taken in all relevant sectors, but further programmes are necessary in energy efficiency and transportation in order for Germany to meet its Effort Sharing Decision emissions reduction target, based on current projections.	***Rebuilding a green economy:*** Following the contraction of the Italian manufacturing sector during the recent economic crisis, one of the National Energy Strategy's priorities is to increase employment and investments in both traditional and "green" (renewable/energy efficiency) sectors.	***Keeping household energy costs down while decarbonising*:** Household energy costs are already significantly higher in Poland than the EU average, and have only increased in recent years. Providing low-carbon, affordable energy becomes critical for consumers.
***Addressing harmful subsidies across sectors*:** As an example, Germany can reduce transportation emissions by changing tax incentives for company cars by tying cost deductibility to CO_2 emissions. Aligning incentives with infrastructure investments would also benefit Germany.	***Balancing energy security priorities with decarbonisation goals:*** The National Energy Strategy seeks to enhance traditional energy sector infrastructure, exploit hydrocarbons, and transform Italy into a south-European gas hub. Prioritising these efforts alongside the promotion of renewables may prove challenging.	***Shifting away from coal on domestic heat:*** Transitioning to natural gas for heating poses energy security questions for Poland, a nation importing 80% of its gas from Russia and currently facing limited domestic gas exploration opportunities.

Shared Strengths

- ***Renewable energy progress:*** *All three Member States are on track to reach prescribed Europe 2020 renewable energy targets, and are doing so with different renewable energy sources. The "Energy Concept" (DE), "National Energy Strategy" (IT), and "National Action Plan for RES" (PL) are the broad governmental plans guiding these Member State transitions.*
- ***Use of CHP and district heating:*** *Poland derives a significant fraction of energy from efficient CHP, Germany holds a large capacity for the technology, and Italy has increased its fraction of energy from CHP and district heating in recent years. All three Member States outperform the EU average usage of CHP.*
- ***Energy efficient economies:*** *Germany and Italy are below the EU average energy intensity per unit GDP, while Poland is quickly improving its position on this metric.*

Shared Challenges

- ***Grid Integration/Infrastructure:*** *In Germany, alongside the installation of physical infrastructure, interconnections with Scandinavia and the development of a new offshore grid could aid in the delivery of renewable power to the population centres. In Italy, the National Transmission Grid faces transmission and delivery bottlenecks. Italy plans to lay new power lines, open new interconnections with France, Austria, and Slovenia, and develop a Euro-Mediterranean grid to take advantage of the ample solar resource. In Poland, the European Commission has identified priority grid expansion corridors of a North-South link of Central and Southern Eastern Europe, along with a Baltic region interconnection, in efforts to foster market integration and the integration of renewable electricity in the region.*
- ***Emissions in the transportation sector:*** *In recent years, Poland and Germany have increased emissions in the transportation sector, while Italy has maintained one of the highest rates of vehicles per capita in the EU. Decarbonising and reducing energy use in the transportation sector is key to achieving Europe 2020 goals. Thus, transport infrastructure promoting a modal shift, alternative mobility and electromobility programmes, tax incentive restructurings, and increased funding for mass transit would be mutually shared goals for Germany, Italy, and Poland.*
- ***2050 GHG targets:*** *The EU Energy Roadmap 2050 proposes a goal for 80% CO_2e reductions across the EU by 2050. While the Energy Concept (DE) and National Energy Strategy (IT) are examples of frameworks that work towards this goal, deep fundamental changes will be required in energy infrastructure, economic priorities, and consumer behaviour to achieve the ambitious 80% target.*

4. Conclusions

The main message that can be synthetized from the previous chapters is that there are at least three keywords and an alert that can describe the current situation of EU and single Member States in the field of energy security and low carbon transition strategies. The keywords are: dependency, consumption, and integration. The alert refers to the current economic crisis.

Dependency is a major keyword to describe EU energy scenario because both in terms of trends (i.e. all those market, societal, economic and geopolitical features) and of strategies (i.e. the directions to take in order to achieve expected results) it seems that on one hand EU is and will be depending from imports for the vast majority of its energy needs (with an increasing dependency rate of 9% from 1999 to 2009), while on the other the possibility that a fair degree of energy independence could be achieved rely both on much higher investments on renewables and on the use of less sustainable energy sources (as in the case of nuclear energy, coal, oil). To this extent, the whole EU seems to be moving away both from fossil fuels (-5,9% in 10 years since 2000) and from nuclear energy (a more modest 0,7%), but the situation varies dramatically in the different Member States, with only Latvia and Sweden that can account to renewables for one third of their gross inland primary consumption.

Plus, there is an internal issue of dependency within the EU because Member States act differently on the market (there is not anything such as a “single EU buyer”), have different national/internal resources (as in the case of the oil available to countries facing the North Sea), have different policies regarding the balance between traditional and renewable energy sources notwithstanding the role of EU addresses and directives, have to face market and societal inertia that may hamper efforts towards change. The three national focuses presented in this deliverable show, in fact, how diverse the situation is in each Member State.

Consumption seems like the other face of the coin, at least because it seems to exacerbate the dependency of EU (and of some Member States more than others) from certain level of provision that may require increasing expenditures (as in case of market fluctuations) or complex energy mixes (as in the case of those countries that have to rely almost totally on energy import). EU, in fact, according to the latest available data (2010) was the third major global consumer (13,4% of the total world consumption, behind China and USA), but what is more worrying is that different economic sectors rely on different energy sources and that each sector depends heavily on one or few energy sources: that is almost the contrary of what should be expected in terms of consumption to avoid an excessive dependency rate.

Again, also in this case there is a consumption issue at EU level but national situations may vary consistently. To be more specific, consumption calls for a closer look at lifestyles, societal organisation in the energy field, different patterns according to local environmental and cultural conditions, etc. At the local level, for instance, is possible to see the perverse effects of a missing consumption policy in terms of industrial competitiveness and the related phenomenon of the “carbon leakage”, that is re-localisation because of increased production costs in the EU.

Integration calls for a better harmonisation of policies and interventions at different levels, from the local to the EU and beyond. It seems, in fact, that the issues that have been raised in terms of dependency and consumption would greatly benefit by a coherent strategy able to develop into coherent policies in the whole EU. Differentiation of energy sources and energy imports and the promotion of self-reliance are at the core of EU energy strategies but the filtering down of directives to Member States and regions seems to weaken the effort. For instance, the need for a single, coherent energy market has been made explicit (EC, 2012a) but still the process is in the making.

A second dimension of integration would be related, of course, to the energy mix that – in order to be part of a successful transition towards low carbon societies – needs to be oriented towards a more sustainable use of traditional energy sources and to an increasing role of renewables.

The alert, finally, is on the *crisis* in terms of an effective analysis of the current situation. Data are, in fact, somehow misrepresented because of (i) their availability that often is up to the first years of the crisis thus not fully comprehending its impact, and (ii) the possibility that such a deep and long crisis will permanently produce changes in the way single citizens and the whole society relates to energy consumption. These factors will surely be taken into account in the following phases of the MILESECURE-2050 project, especially as regards next WPs (WP2 “Analysis of concrete anticipatory experiences on energy transition at the local level” and WP3 “Societal processes for energy transition”) but of course with relevance also for the modelling approach and the definition of a model of governance of the transition energy process.

This deliverable has also promoted the definition of a basic set of energy and climate related indicators to measure Member States performances and trends. The first test has been prepared with the three Member States that have been analysed as case studies: Germany, Italy, and Poland. These countries represent diverse situations and geographical parts of Europe and have been considered as the litmus test for the indicators.

The set of indicators considers (7) energy and (6) climate indicators and for each the annual change or trend is considered to understand how the situation is changing. These indicators are then completed by the monitoring of the Member States performances and progress according to the EU 20-20-20 objectives (6 more indicators).

The synthetic picture that is possible to have by using the set of indicators can thus complete the in-depth analysis of the three national focuses.

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