

# Energy and environment report 2008

Executive summary





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This report assesses the key drivers, environmental pressures and some impacts from the production and consumption of energy, taking into account the main objectives of the European policy on energy and environment including: security of supply, competitiveness, increased energy efficiency and renewable energy, and environmental sustainability. The report addresses six main policy questions and presents trends existing within the EU compared to other countries.

## 1 What is the impact of energy production and use on the environment?

The production and consumption of energy places a wide range of pressures on the environment and on public health, some of which have been decreasing. Following are the key trends observed in Europe.

1. Energy-related greenhouse gas (GHG) emissions remain dominant, accounting for 80 % of the total emissions, with the largest emitting sector being electricity and heat production, followed by transport.
2. Between 1990 and 2005, energy-related GHG emissions in the EU-27 fell by 4.4 % but a significant part of this occurred in the beginning of the 1990s due to structural changes taking place in the economies of the EU-12 Member States <sup>(1)</sup>. The intensity of CO<sub>2</sub> emissions from public conventional thermal power plants in the EU-27 decreased by 27 % due to efficiency improvements and the replacement of coal with gas in the power sector.
3. Between 1990 and 2005, energy-related emissions of acidifying substances, tropospheric ozone precursors and particles in the EU-27 decreased by 59 %, 45 % and 53 %, respectively, mainly due to the introduction of

abatement technologies in power plants and the use of catalytic converters in road transport. Improvements in reducing air pollution (e.g. SO<sub>2</sub> and NO<sub>x</sub>) recently showed a tendency to slow down due to the increased use of coal in power and heat generation.

4. The annual quantity of spent fuel from nuclear power generation declined by 5 % over the period of 1990–2006 despite a 20 % increase in electricity production. However, the high-level waste continues to accumulate, exceeding a total of 30 000 tonnes of heavy metal in 2006. Currently, there are no commercially available facilities for permanent storage of this waste.
5. Since the 1990s, oil discharges from installations and accidental spills from tankers have diminished due to a decrease in large tanker accidents. Improved safety measures, such as double-hulled tankers, also contributed to this trend.

Baseline (reference) scenarios taken from POLES, WEM and PRIMES models indicate that by 2030 primary energy consumption is likely to increase by 10–26 % compared to 2005, with fossil fuels maintaining a high share in all cases. Under these assumptions, environmental pressures from energy production and consumption are also likely to increase in the future. It is only under scenarios involving more stringent policies for energy and climate change <sup>(2)</sup> that the absolute increase in primary energy consumption slows down and, actually starts to decline between 2020 and 2030, primarily due to greater improvements in energy efficiency. Under these scenarios, the positive trend of declining environmental pressures associated with the consumption and production of energy continues, due to significant reductions in primary energy demand and higher penetration rates for renewable energy. For instance, it is possible to achieve, by 2030, reductions in CO<sub>2</sub> emissions of about 20 to 30 % compared to 2005.

<sup>(1)</sup> Member States that joined the EU from 2004 onwards: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

<sup>(2)</sup> For example, the POLES GHG reduction scenario is based on a possible emissions trajectory to 2050, which can lead to the EU's objective of limiting global temperature rise to 2 °C. More details of the scenarios are given in Appendix I to this report.

Taking a long-term perspective, it is also important to consider the potential impact of climate change on energy production and consumption.

1. Climate change will alter energy demand patterns. Electricity consumption in southern Europe and the Mediterranean region will increase due to projected temperature increases and the associated increasing demand for space cooling. Energy demand for space heating in northern Europe will decrease, but the net effect across Europe is difficult to predict.
2. Climate change will affect power production. Due to projected changes in river runoff, hydropower production will increase in northern Europe and decrease in the south. Furthermore, across Europe, summer droughts are projected to be more severe, limiting the availability of cooling water and thus reducing the efficiency of thermal power plants.
3. Both types of impacts may lead to changes in emissions of air pollutants and greenhouse gases from energy, which are, however, difficult to estimate at present.

## 2 What are the trends concerning the energy mix in Europe and what are its related environmental consequences?

The concept of energy security in Europe encompasses a wide range of issues including energy efficiency, diversification of energy supply, increased transparency of energy demand and supply offers, solidarity among the EU Member States, infrastructure and external relations. Together with the energy efficiency, the energy import dependency aspect of security of supply has direct environmental consequences. Some of the links between the environment and the energy import dependency are determined by the fuel mix used to deliver energy services, the level of demand for those services and the speed with which these services have to be delivered. Reducing energy import dependency can have positive or negative effects on the environment, both within the EU and outside its borders, depending on the energy sources imported and the ones being replaced. In Europe, a higher penetration of renewable energy sources in the energy mix, coupled with a switch from coal to gas, resulted in reduced energy-related GHG emissions and air pollution but also in increased dependency on gas imports. However, these environmental benefits were partially offset by increasing energy consumption and, more recently, by the tendency to increase the use of coal in

electricity generation due to concerns about security of supply as well as concerns over high and volatile prices for imported fossil fuels.

1. The current energy system within the EU is heavily dependent on fossil fuels. The share of fossil fuels in total energy consumption declined only slightly between 1990 and 2005: from around 83 % to 79 %.
2. Over 54 % of primary energy consumption in 2005 was imported, and this dependence on imported fossil fuel has been rising steadily (from 51 % in 2000).
3. Dependence is increasing rapidly for natural gas and coal. Natural gas imports accounted for some 59 % of the total gas-based primary energy consumption in 2005, while for hard coal based primary energy, imports accounted for 42 %. Oil imports accounted for as much as 87 % in 2005 — up from 84 % in 2000 — driven by substantial increases in demand from the transport sector, reflecting a lack of real alternatives in this sector and low EU oil reserves.
4. The largest single energy exporter to the EU is Russia, having supplied 18.1 % of the EU-27 total primary energy consumption in 2005 (up from 13.3 % in 2000). Russia supplies 24 % of the natural gas imports, 28 % of the oil imports and is the second largest supplier of coal after South Africa, with 10 % of imports in 2005.
5. Between 1990 and 2005, the final electricity consumption increased on average, by 1.7 % a year, whereas final energy consumption increased only by 0.6 % a year.
6. A change in the energy mix is taking place in Europe. Renewable energy has the highest annual growth rate in total primary energy consumption, with an average of 3.4 % between 1990 and 2005. Second comes natural gas, with an annual average growth rate of 2.8 % over the same period. The annual growth rate of oil consumption slowed down, particularly in recent years due to its partial replacement in power generation by gas and coal.
7. The switch to gas due to environmental constraints (including concerns over climate change) and a rapid increase in electricity demand brought about some environmental benefits (reduction of CO<sub>2</sub> emissions) but increased dependency on gas imports. Natural gas consumption increased, between 1990 and 2005, by over 30 %.

Baseline (reference) scenarios from POLES, WEM and PRIMES models show a rising dependence on imports of fossil fuels. This is particularly true for gas, with imports (as a percentage of gas-based

primary energy consumption) rising from around 59 % in 2005 to up to 84 % by 2030. Even in scenarios built on the assumption of a more stringent policy for energy and climate the import share of all fossil fuels still rises. In these scenarios, improvements in energy efficiency and the penetration of renewables occur more rapidly but the positive effect is more than offset by the decline in the EU's indigenous fossil production (and consequently, increased imports of fossil fuels required to meet the growing energy demand).

### 3 How rapidly are renewable technologies being implemented?

Renewable energy technologies usually have less environmental impacts than fossil fuel, although some concerns exist with respect to the environmental sustainability of particular types of biofuels. In recent years, they have accomplished high rates of growth but further action is necessary to achieve the proposed 2020 goals.

1. In 2005, renewable energy accounted, for 6.7 % of total primary energy consumption in the EU-27 — compared to a share of 4.4 % in 1990. Over the period, the share of renewable energy in final consumption has also increased from 6.3 % in 1991 to 8.6 % in 2005.
2. Wind power remains dominant, representing 75 % of the total installed renewable capacity in 2006 (excluding electricity from large hydropower plants and from biomass). The strongest growth took place in Germany, Spain and Denmark — which accounted for 74 % of all installed wind capacity in the EU-27 in that year. In the same year, Germany alone accounted for 89 % and 42 % of the installed solar photovoltaics and the solar thermal systems, respectively.
3. The share of renewables in the final energy consumption varies significantly across countries: from over 25 % in Sweden, Latvia and Finland to less than 2% in the United Kingdom, Luxembourg and Malta. Newer Member States showed the most rapid growth in shares, with increases of over 10 percentage points in Estonia, Romania, Lithuania and Latvia.
4. From 1990 to 2005, electricity production from renewables increased in absolute terms (an average of 2.7 % annually), but a significant growth in electricity consumption partially offset the positive achievement limiting the RES share in gross electricity consumption to only 14.0 % in 2005.

Baseline (reference) scenarios from POLES, WEM and PRIMES models show that the share of renewables in primary energy consumption is expected to increase, to a value between 10 % in 2020 and 18 % in 2030. In scenarios where more stringent policies to reduce GHG emissions, and promotion of RES and energy efficiency are assumed, higher shares of renewables in primary energy consumption are envisaged ranging from 13 % in 2020 to over 24 % in 2030. The rising share is also supported by more rapid improvements in energy efficiency, which reduces the absolute level of energy consumption. The estimations vary significantly depending on the model used and the specific scenario chosen, since various scenarios make different assumptions about costs for the various technologies, the carbon prices and the speed of improvements in energy efficiency.

Achieving the proposed new target for renewable energy will require a substantial effort, to fill the gap between the current levels (8.5 % in the final energy consumption in 2005) and the objective of 20 % of renewable energy in the final energy consumption in 2020. To meet the proposed targets, 15 Member States will have to increase their national share of renewables in the final energy consumption by more than 10 percentage points compared to 2005 levels. Substantially reducing final demand for energy will help Europe achieve the target for renewables.

### 4 Is the European energy production system becoming more efficient?

Increasing the European energy system's efficiency can reduce environmental effects and dependence on fossil fuels and can contribute to limit the increase in energy costs. Whilst in recent years, the efficiency of energy production has increased, the potential for further improvement is still significant — for example, through a greater use of combined heat and power and other energy-related efficient technologies that are already available or close to commercialisation.

1. Between 1990 and 2005, the total energy intensity (total energy divided by GDP) in the EU-27 decreased by an estimated 1.3 % per annum. The energy intensity decreased three times faster in the new Member States.
2. Over the period of 1990–2005, the average level of efficiency in the production of electricity and heat by conventional public thermal plants improved by around 4.2 percentage points, reaching 46.9 % (48.5 %, if district heating is also included) in 2005.

3. Some 25 % of the primary energy is lost in generation, transport and distribution of energy. The largest share in the energy losses occurs in generation (around 3/4 of total losses), hence, the urgent need to deploy available state-of-the-art technologies.
4. In 2005, the share of electricity generated from combined heat and power (CHP) plants, in total gross electricity production in the EU-27, was 11.1 %. CHP can be a cost-effective option to improve energy efficiency and reduce CO<sub>2</sub> emissions. It could be further enhanced in the EU.

## 5 Are environmental costs reflected adequately in the energy price?

Current energy prices vary significantly among the EU Member States due to differences in tax levels and structures, subsidies for different forms of energy generation and different market structures. Including all relevant externalities to establish the true costs of energy use will help provide the correct price signals for future investment decisions in energy supply and demand. It is difficult to identify within current energy price structures the share attributed to the adverse external impacts of energy production and consumption on public health and the environment.

1. In 2007, the nominal end-user electricity price for households increased, on average, by 17 % compared to 1995 levels. This was due to a combination of factors including a certain level of internalisation of environmental externalities (via increased taxation and effects of other environmental policies, such as the EU Emissions Trading Scheme), increased energy commodity prices (particularly coal and gas), and other market factors stemming from the liberalisation process. Significant increases (around 50 %, compared to 1995 levels) occurred in Romania, the United Kingdom, Poland and Ireland.
2. In 2007, nominal end-user gas prices for households increased, on average, by 75 % compared to 1995 levels, mainly because of increasing world commodity prices. Increases above the average level occurred in Romania, the United Kingdom, Latvia and Poland.
3. Overall, in 2005, the external costs of electricity production in the EU-27 were estimated to be about 0.6 to 2 % of the GDP. The external costs decreased, between 1990 and 2005, by 4.9 to 14.5 eurocents/kWh and reached an average value of 1.8 to 5.9 eurocents/kWh (depending

on whether high or low estimates for external costs are used) in 2005. Among factors that contributed to this downward trend are the replacement of coal and oil with natural gas, the increased efficiency of transformation and the introduction of air pollution abatement technologies. Further efforts are needed to develop methodologies to better quantify these externalities.

## 6 What is the role of the household sector in addressing the need to reduce the final energy consumption and what are the observed trends?

End-use energy efficiency measures should be implemented in the residential sector to ensure that energy services (i.e. heating, cooling, and lighting) remain affordable. At the same time, improved energy efficiency will also deliver environmental and social benefits. Despite the significant potential for cost effective savings, energy consumption in the household sector continues to rise.

1. In 2005, the residential sector in Europe accounted for 26.6 % of the final energy consumption. It is one of the sectors with the highest potential for energy efficiency. Measures to reduce the heating/cooling demand in buildings represent a significant part of this potential. In Ireland and Latvia, measures in the residential sector account for over 77 % of the overall national target under the Energy Services Directive, while in the United Kingdom, the proportion is just over 50 %. Cyprus estimates that the residential sector can deliver savings of more than 240 ktoe, 1.3 times the national target set for 2016 (185 ktoe, representing 10 % of the final inland consumption – calculated in accordance with the requirements of the directive).
2. Between 1990 and 2005, the absolute level of final household energy consumption in the EU-27 rose by an average of 1.0 % a year.
3. Final household electricity consumption increased at a faster rate attaining an annual average of 2.1 %.
4. Final energy consumption of households per m<sup>2</sup> decreased annually by about 0.4 %.
5. Two key factors influence the overall household energy consumption: fewer people living in larger homes and the increasing number of electrical appliances. Together, they contribute to a rise in the household consumption of 0.4 % a year.

## 7 EU trends compared to other countries

During the 13th Conference of Parties to the UN Climate Convention, parties agreed that there exists a need for a shared view on how to deal with climate change in the long-term perspective. Alongside a shared view, there should also be a shared responsibility for action — given both historic and current trends in generating global GHG (particularly CO<sub>2</sub>) emissions. These trends vary from country to country. In the EU and in countries such as China and the United States of America, there is a growing recognition that it is crucial to improve the energy efficiency and expand renewable energy — not only because of the current global context of rising energy demand and energy prices, but also because these are important measures to reduce CO<sub>2</sub> emissions. Experience accumulated in the EU-27 shows that the consistent implementation over time of environmental and energy policies can be effective but much more has to be accomplished in the near future to ensure the substantial reductions in the level of CO<sub>2</sub> emissions that are necessary to avoid irreversible effects of climate change.

1. Between 1990 and 2005, the EU-27 experienced an average GDP growth rate of 2.1 %, while reducing its energy-related CO<sub>2</sub> emissions by a total of about 3 %. During the same period, CO<sub>2</sub> emissions increased by 20 % in the US and doubled in China. Energy-related CO<sub>2</sub> emissions in Russia decreased by 30 % due to economic restructuring.
2. From 1990 to 2005, the EU's per capita CO<sub>2</sub> emissions decreased by 6.7 %, having become less than half of those in USA and about 25 % lower than per capita emissions in Russia. Per capita emissions in China are now 52 % below the EU level but they are growing fast due to the pace of economic development and the increase in the use of coal for power production.
3. Between 1990 and 2005, the CO<sub>2</sub> emissions intensity of the public electricity and heat production in the EU-27 decreased by 18.2 % while in many other parts of the world, including Russia, the opposite is true. A slight decrease occurred in China and the US (0.8 % and 2.5 %, respectively), partly because of changes in the renewable production (less hydroelectricity due to less rainfall) which

offset improvements resulting from the implementation, in recent years and particularly after 2004, of energy efficiency policies.

4. Policies for energy efficiency and renewable energy are being implemented in the EU-27, the US and China, but the overall objectives of these policies may differ. For instance, in the EU-27 and the US, environmental protection is one of the key stated policy objectives, while China needs to find a balance between the enormous increase in its energy demand and the subsequent environmental consequences (e.g. increased air pollution). Enhancing security of energy supply is a driver everywhere.

In all countries, efforts are being made (and are expected to continue) to boost the renewable energy. Under the WEM (IEA) baseline scenario, by 2030, electricity produced in the EU-27 member states from renewable energy could account for as much as 18 % of the global total, followed by China — with 17 %, and USA — with a share of 12 %. Under the WEM alternative scenario, electricity generated by China from renewables, could represent as much as 20 % of the global total, followed by the EU-27 — with 16 %, and USA — with 11 %. The shares of the EU-27 and USA in the global total appear to decrease, because in this scenario all countries are expected to step up their efforts to increase the share of renewables in their energy mix.

Looking at the WEM baseline and alternative scenarios (concerning the possible evolution of the global total of CO<sub>2</sub> emissions), it is clear that in the EU-27, as well as in other countries — such as China and USA, it is still imperative to take measures to decrease the energy intensity of the economy and to deploy renewable energy faster. According to the WEM baseline scenario, by 2030, China's share of the total CO<sub>2</sub> emissions in the global total could be as high as 27 %, surpassing the US and the EU-27 — with a share of 16 % and 10 %, respectively. Even considering a more stringent energy and climate policies, China's share in the global total CO<sub>2</sub> emissions remains significant (26 %), and so does that of the US (18 %), followed by the EU-27 (with 10 %). Under the alternative scenario, all countries are expected to reduce their total CO<sub>2</sub> emissions, which explains why the share of the US appears to be higher and the EU-27 appears to remain at a constant level.



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