European Foundation for the Improvement of Living and Working Conditions

Trends and drivers of change in the European energy sector: Mapping report

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Introduction

The energy sector is one of the central pillars of economic growth and competitiveness, and of social and territorial cohesion in Europe. Furthermore, the sector plays a crucial role in overcoming the challenges of climate change. In light of this, the sector must be regarded as one of the most vital in the EU.

The founding Member States of the European Union were aware of the importance of the energy sector and the need to take a common approach to energy that could bond together the former rival nations of Europe. The signing of the Coal and Steel Treaty in 1951 and the European Atomic Energy Treaty in 1957 marked the significance of the energy sector throughout Europe and became the vital building blocks of the EU in its current shape.

The oil crisis in the 1970s brought energy and the energy sector into focus once more; this was a serious warning of the possible consequences of EU dependence on external fossil energy sources. In response, the International Energy Agency (IEA) was created and renewable energy became, although slowly and to a minor extent, part of the ongoing energy debate.

In 1996, the energy sector was again put high on the political agenda when the EU Commission presented its Green Paper *Towards a European strategy for energy security and supply*. The document stated that Europe, because of its increased dependence on external energy sources and the emergent climate changes, faces serious challenges concerning energy. At the same time, the major liberalisation process of the former heavily monopolised and nationally regulated gas and electricity sector commenced, in order to create a competitive and effective internal European market for energy.

All of these developments have led to profound changes in the energy sector regarding supply chains, company structures and employment issues. In March 2007, one of the most important turning points in EU energy policies was made when the EU agreed on the legally binding targets of reducing greenhouse gases by 20% in 2020 and raising renewables' share of energy consumption to 20%, also by 2020. This was followed by a communication from the European Commission, '20 20 by 2020', released in January 2008, which referred to the extension of the Trading Emission Scheme, improvements in energy efficiency and carbon capture storage as tools to reach the goals.

With its crucial importance for economic growth and social stability in the EU and the required transition to a low carbon economy, the sector also faces major challenges and changes in the near future.

Definitions and terminology

Since the energy sector is relatively complex and is closely interconnected with many other business sectors, it is necessary to define the parts of the energy sector covered in this report.

The elements covered in the report follow the definition of the energy sector applied by the European Monitoring Centre on Change (EMCC) – 'Electricity, gas, steam and air conditioning supply'. This falls within category E – 'Electricity, gas and water supply – of the Statistical Classification of Economic Activities in the European Community (NACE) and, more specifically, is covered by category E40 of the NACE classification relating to 'Electricity, gas, steam and hot water supply'. The report also looks at innovative sources and storage of energy such as hydrogen and fuel cell technologies.

- The report covers areas such as the provision of electric power, natural gas, steam and hot water supply, through a permanent infrastructure (network) of lines, mains and pipes. It is worthwhile noting that the extension of the network is not decisive concerning its inclusion in the analysis. The research also includes an analysis of the distribution of electricity, gas, steam and hot water in industrial parks or residential buildings.

- The report therefore examines the operation of electric and gas utilities, which generate control and distribute electric power or gas. The provision of steam and air conditioning supply is also investigated.
- On the other hand, the research excludes the operation of water and sewerage utilities, as well as the typically long-distance transport of gas through pipelines.

It should be noted that statistics on production, consumption, exports and imports of energy, which are also referred to occasionally in this report, most often include fossil fuels such as coal, oil and gas. Under normal circumstances, oil is not directly relevant to the parts of the energy sector concerned in this study, since it has almost been phased out of electricity, steam and hot water production.

Some of the statistics, reports and articles published only focus on the 'electricity sector'. However, in the analysis presented here, it is important to note that most of the activities of the major electricity generation and distribution companies also include the production and distribution of gas, as well as steam and hot water supply.

Methodology and sources of information

Data for this report have been collected through comprehensive desk research and literature studies of reports, surveys, analyses, statistics and relevant web pages related to the energy sector.

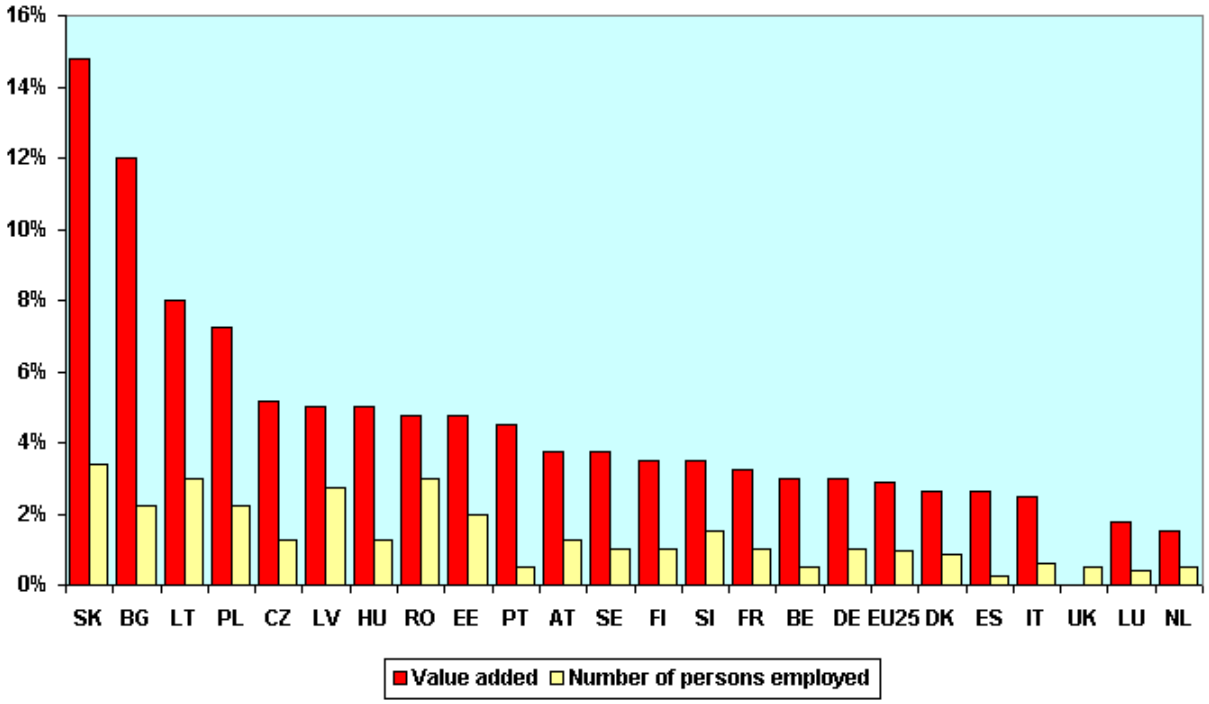
To complement desk-based research, a group of selected energy experts have been interviewed and consulted during the data collection process. The chosen experts represent different stakeholders within the energy sector: enterprises, trade unions and industry associations, cluster organisations and research centres. A complete list of the experts involved in this research is presented in the annex to this report.

Overview of the sector

In 2003, the EU energy sector generated a turnover of about €535 billion. Moreover, it was the main activity of 16,000 enterprises, which employed slightly over a total of 1.1 million people. Its share of the non-financial business economy in the 25 Member States of the European Union (EU25 – the former EU15 and the 10 new Member States (EU10) that joined the EU in 2004) prior to enlargement in 2007 was 2.9% in terms of added value and 1% regarding employment.

The energy sector is represented in all EU Member States, although its importance varies between individual states. Slovakia is by far the most specialised energy producer since the energy sector represents 14.8% of the added value and 3.4% of the employment of the country's non-financial business economy. Main contributors to the EU energy sector are France and Germany, respectively contributing 16% and 23% of the total added value, and together employing more than 30% of the sector's total workforce in Europe (Eurostat, 2006). Figure 1 shows the energy sector's share of employment and the added value of the non-financial business economy in selected EU Member States.

Figure 1: *Energy sector's share of non-financial business economy, by country, 2006 (%)*



Source: *Eurostat, 2006*

The energy sector in Europe is divided into three subsectors – electricity, gas, and steam and hot water supply – with each including branches of production or manufacturing, distribution and sales. Table 1 shows the size of the three subsectors in terms of persons employed, number of enterprises, and their percentage of the total energy sector's added value. The different subsectors are closely intertwined, and many of the major energy companies today operate in all of the subsectors.

Table 1: *Size of EU energy subsectors*

Sector	Persons employed	No. of companies	Value added (% of energy sector total)
Electricity	867,000	11,000	77
Gas	152,000	1,300	18
Steam and hot water	165,000	3,800	5

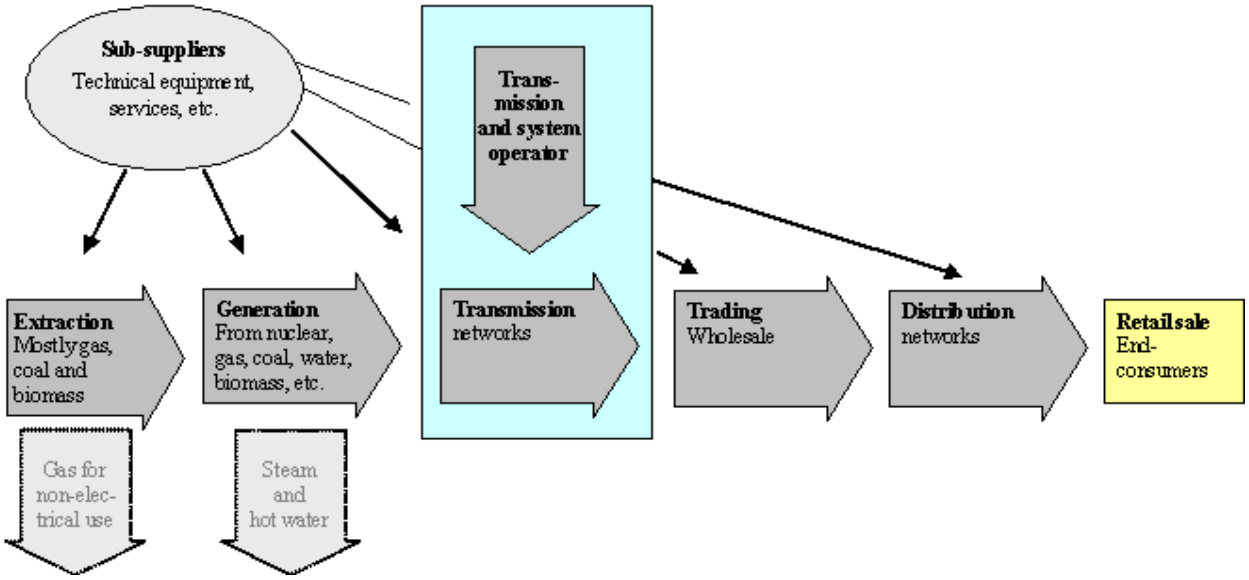
Source: *Eurostat, 2006 and 2007*

Electricity subsector

The electricity subsector is, by far, the largest of the three subsectors within the EU energy sector. It is comprised of almost 11,000 companies, employs more than 867,000 persons and accounts for 77% of the energy sector's total added value (Eurostat, 2006 and 2007). Although the demand for both gas and hot water supply is also increasing rapidly, many experts within the sector forecast that the electricity sector will experience the biggest growth rates in the long run. Energy efficiency in electricity is very high at the point of use; moreover, new developments in renewable electricity sources, as well as cleaning and filtration technologies, make electricity the cleanest energy form available in huge quantities and at reasonable prices. Total electricity consumption rose by 22% from 1990 to 2004 in the EU25 (EEA, 2007). Furthermore, the development of new types of electrical vehicles seems to make greater use of electricity in the transport sector possible, thereby, increasing the demand for electricity.

The electricity subsector can be divided into the following branches: generation, transmission, distribution, and retail sale to consumers. Figure 2 shows the value chain of the electricity sector and its interconnections with the gas and the hot water supply subsectors. Many companies operate in all of the branches except transmission networks, which have been monopolised or are run completely by the state in many EU Member States.

Figure 2: *Electricity sector value chain*

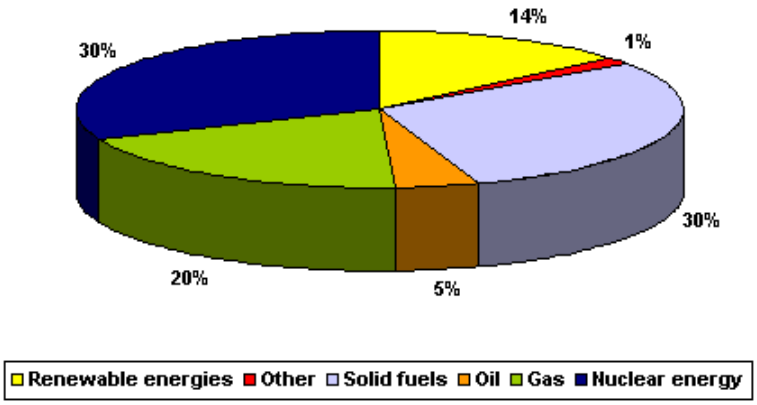


Source: *Oxford Research, 2007*

Electricity in the EU is generated from varied sources, of which nuclear and solid fuels (mostly coal) are the most important ones – both having equal shares of 30% of electricity generation. Natural gas is also highly important since it accounts for 20% of electricity generation. Figure 3 shows the proportion of the different energy sources in the European electricity production.

Electricity generation companies typically have a diversified mixture of most of the energy sources, in order to secure supply and to be flexible in case of price fluctuations of the different sources.

Figure 3: *Energy sources in EU25 electricity generation*



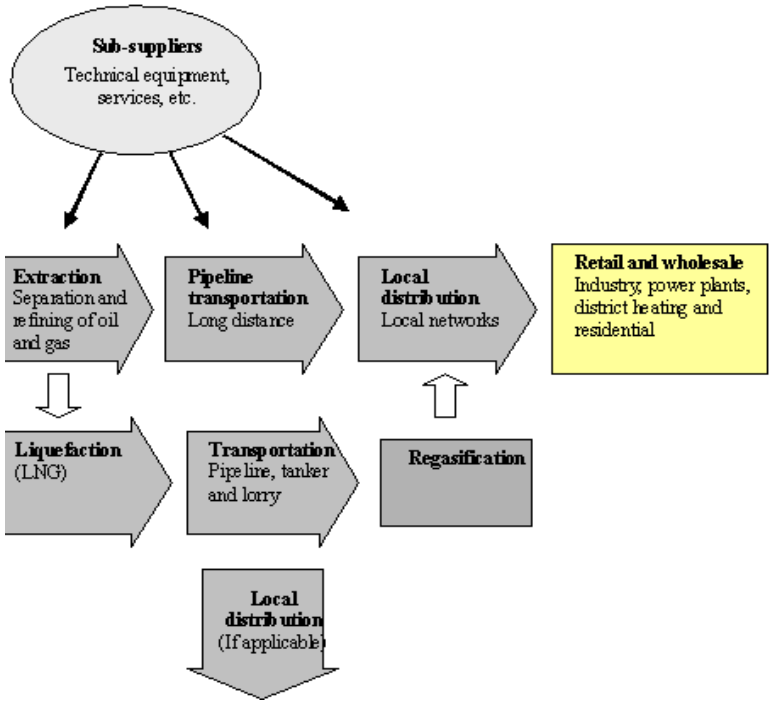
Source: *European Commission, 2006*

Gas sector

Natural gas is the second largest primary energy source in the EU in terms of added value. Moreover, the gas market is projected to grow rapidly in the coming years due to the demand for cleaner energy sources (IEA, 2004). Gas is less carbon intensive than coal and oil, and releases less particles. It is mostly used in heating, electricity generation and industrial processes. In 2003, the gas sector was composed of about 1,300 companies and employed approximately 152,000 persons (Eurostat, 2007).

The gas sector can be divided into the following branches: extraction, manufacturing, transportation through long-distance pipelines, distribution and sales. Another sectoral branch with increasing importance is production and handling of liquefied natural gases (LNG). By pressure and cooling processes, natural gas can be liquefied and transported by ship and road. Before distribution, liquids have to be regasified (Centre for Liquefied Natural Gas, 2007). Today, LNG accounts for 10% of EU gas imports, which is expected to increase to 35% by 2030, according to a statement by EU Energy Commissioner Andris Piebalgs. Figure 4 shows the gas sector value chain with LNG branches.

Figure 4: *Gas sector value chain*



Source: *Oxford Research, 2007*

Gas is highly important in electricity generation and accounts for about 20% of the total EU25 electricity production. As a result, many of the European electricity companies diversified into the gas sector and, today, electricity companies, such as EDF in France, E.ON in Germany, Enel in Italy, Iberdrola in Spain and DONG Energy in Denmark, have branches operating within the gas sector.

The EU is greatly dependent on gas imports. Furthermore, the rising importance of gas has also made it a sensitive geopolitical topic as illustrated by the so-called 'pipeline war' between Russia and the Ukraine that threatened EU gas supply in recent years.

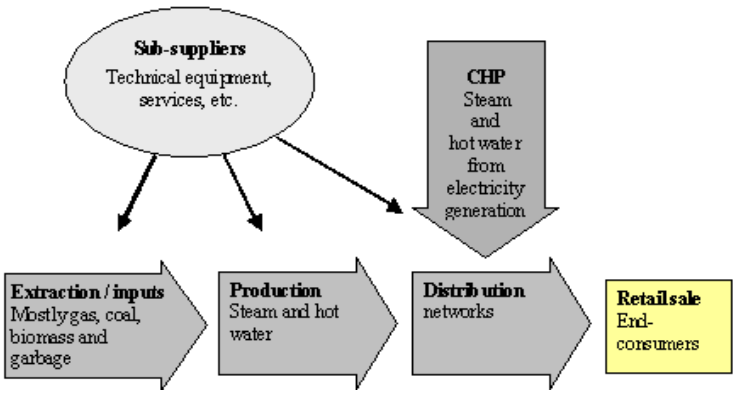
Steam and hot water supply sector

The steam and hot water supply – air conditioning supply – sector employed just over 165,000 persons in 2003, with around 3,800 companies having their main business activities in the sector (Eurostat, 2007). Although bigger than the gas sector in terms of the number of companies and employees, it is the smallest of the three energy subsectors in economic terms, since it only accounts for 5% of the energy sector's added value. Steam and hot water are mostly used for industrial purposes and district heating – a distribution system for heat generated in a centralised location for residential and commercial heating requirements. The market for district heating has increased rapidly in recent years due to high energy efficiency in district heating systems. The heat is often obtained from burning fossil fuels, but increasingly from burning biomass, such as biodegradable waste. The four largest markets for district heating include the Czech Republic, Germany, Poland and Sweden, according to data from the **International Energy Agency (IEA)-District Heating and Cooling (DHC)**[1] and the Swedish energy company **Vattenfall**[2] in 2007.

Many electricity generation plants produce hot water for district heating through a process called combined heat and power generation (CHP) or cogeneration. Hot water is a natural waste product of electricity generation; therefore, CHP plants increase energy efficiency. Despite the fact that the EU promotes the increase of CHP, consulted energy experts have underlined that liberalisation of the electricity markets has made CHP less attractive to electricity generating companies, since demand and therefore prices of electricity and hot water have different fluctuation rates.

The steam and hot water supply subsector can be divided into the following three branches: production and generation, distribution and sales. The market for hot water supply to district heating has not been liberalised; hence, production companies also own and control distribution networks and retail sale. Figure 5 shows the organisation of the subsector and its interconnection with the electricity sector.

Figure 5: *Steam and hot water supply sector value chain*



Source: *Oxford Research, 2007*

Company concentration in the energy sector

The European energy sector is characterised by a significant degree of company concentration. Small and medium-sized enterprises (SMEs) – enterprises with less than 250 employees – only account for around 20% of the EU25 added value, and only a small number of companies have reached a size and position today that makes them dominant in the European energy market. These increasingly dominant companies are called 'the seven brothers' and consist of the E.ON Group,

[1] **http://www.iea-dhc.org**

[2] **http://www.vattenfall.com**

the EDF Group, the German-based RWE, Iberdrola, French GDF-Suez, Enel and Vattenfall. Together, they generate turnover of more than €262 billion, which makes up more than half of the total turnover of the EU25 energy sector (Eurostat, 2006; Thomas, 2007).

Widespread agreement exists that liberalisation of the gas and electricity markets have led to a remarkable degree of company concentration in the energy sector (Thomas, 2007). Companies now compete in the international market and must maximise business profits in order to meet shareholders' demands; hence, large-scale operations become favourable. However, since most European energy markets are saturated, the only way of expanding operations is through mergers and acquisitions. This again has become a possible option due to the liberalisation of energy companies' ownership.

Trade patterns and dynamics

The EU is currently the second largest energy market in the world behind the USA and is heavily dependent on imports of fossil fuels. EU energy import dependency currently stands at about 50%. Dependence is growing steadily and is expected to reach 70% in the next 20–30 years. At present, all EU Member States, except Denmark, are net importers of energy – this means that the value of imported energy is higher in these countries than its export value (IEA, 2006; European Commission, 2006; Eurostat, 2006b).

The largest share of EU energy consumption and imports come from crude oil, which is only used to a small extent in the energy sector concerned. The EU is also relatively dependent on imports of natural gases, since gas accounts for almost 24% of the total energy consumption in the EU. More than 70% of EU gas imports come from just three countries – Algeria, Norway and Russia. Within the EU, the biggest exporter of natural gases is the Netherlands and the biggest net importer is Germany (European Commission, 2006). In terms of shares of energy consumption, some of the new EU Member States such as Hungary, Lithuania and Slovakia are the biggest consumers of natural gas (European Commission, 2006b). These countries are therefore highly dependent on imports, especially from Russia; it also places them in a fragile and difficult position when trying to move between securing energy supply and taking a stance in the disputes over gas supply and pipelines involving Russia, the Ukraine, Belarus and the EU.

Demand for and generation of electricity in the EU are generally balanced with only a small net export. The lack of transition networks between the EU and non-EU countries makes large-scale global electricity trading impossible. However, neighbouring countries to the EU, such as Norway and Switzerland, are connected to the EU electricity infrastructure.

Within the EU, countries like the Czech Republic, France and Germany are the biggest electricity exporters. The biggest importers of electricity are Germany and Italy, thereby making Germany only a small net exporter.

The European electricity and gas market can be divided into eight market areas: eastern Europe, northern Europe (including Norway), the Iberian Peninsula (Portugal and Spain), the Benelux countries (Belgium, Luxembourg and the Netherlands), the UK, France, Germany and Italy (Thomas, 2007). Within these markets, trading between these countries and regions is possible; therefore, prices vary little between these countries. Prices are set according to supply and demand in each of the market's electricity exchange. Limitations in transmission volume between the markets hinder the complete integration of a single and equally-priced European energy market.

The market for district heating is localised. Networks for delivering steam and hot water are not connected to an interregional or international network enabling international trade. As such, prices vary significantly from country to country.

Carbon dioxide quotas

As a tool to complete the commitments made by the EU in the Kyoto protocol – an amendment to the international treaty on climate change, which assigns mandatory targets for the reduction of greenhouse gas emissions to signatory nations – to lower carbon dioxide (CO_2) emissions by 8% not later than 2012, the CO_2 quota-trading system was introduced in January 2005 (Figure 6).

Figure 6: CO_2 *allocation and trading system*

Source: *Vattenfall website, 2007*

CO_2 emission allowances are limited to certain quotas for power plants and various so-called 'heavy' industries, such as the metalworking and chemicals industries. Following national CO_2 quotas, power plants are allocated a certain amount of CO_2 quotas by their national authorities. Allocated quotas can then be traded on the international market. If a power plant needs an increase in CO_2 quotas, it will have to buy these on the international market. At the same time, a power plant has the opportunity to sell redundant quotas on the international market if the need arises. The market sets the price according to demand and supply. This should motivate power plants to cut down on CO_2 emissions.

The CO_2 allocation and the trading of quotas do not seem to have led to remarkable changes in the energy sector as yet. A survey carried out by the European Commission's Directorate General (DG) for the Environment showed that the price setting of electricity generating companies is clearly influenced by the CO_2 allocation system, but more future-oriented decisions on, for example, innovation matters, are only influenced to a minor extent. Still, if prices for quotas increase, CO_2 trading could become one of the most important drivers of change in the energy market and eventually in the entire sector (European Commission, 2005).

A new Emission Trading Scheme was proposed by the European Commission in January 2008. The scope of the system will be expanded to also include other greenhouse gases than CO_2 and all major industrial emitters. Furthermore, the trading system will be harmonised and national allocation plans replaced by auctioning or free allocation through single EU-wide rules (European Commission, 2008).

Liberalisation of the energy market

In the mid-1990s, the EU began the process of creating an internal liberalised energy market for gas and electricity in order to secure low prices and supply security. As of 1 July 2007, all consumers, in principle, should be able to freely choose their electricity and gas suppliers. Liberalisation of the gas and electricity market consists of several elements:

- prices should no longer be regulated by authorities but should follow demand and supply;
- consumers should be able to choose among suppliers;
- ownership of generation companies and network operators should be unbundled.

Although the Commission does not propose privatisation of generation companies directly, this has happened in several Member States. Another important element has been the creation of cross-border transition networks and infrastructure in order to facilitate international and interregional trade of gas and electricity.

The first European gas and electricity directives were adopted in 1996 and 1998, respectively: **Council Directive 96/92/EC**[3] concerning common rules for the internal market in electricity and Council Directive 98/30/EC concerning common rules for the internal market in natural gas which was repealed through **Council Directive 2003/55/EC**[4]. However, the implementation process of both directives has been slow and many EU Member States have thus been postponing liberalisation initiatives and integration processes of cross-border markets (Thomas, 2006). Even in Member States with a high degree of liberalisation, like the UK, energy is still a highly regulated market compared with other sectors of the economy. In this way, the energy market falls between free market forces and public regulations and monopoly. Experts are convinced that this situation will prevail, due to the absolute necessity of energy and its geopolitical importance.

One of the major aims of liberalising the energy market is to create entry possibilities for new companies in order to ensure competition. From 1999 to 2003, the number of companies active in the European energy sector grew by 18%. However, only a relatively small proportion of these companies has reached a notable size and market share. This is also highlighted by the significant degree of company concentration in the sector (Eurostat, 2006). Table 2 outlines the extent of liberalisation in the EU25 Member States in 2001 and in 2005.

[3] **http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&numdoc=396L0092&model=guichett&lg=en**

[4] **http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32003L0055:EN:HTML**

Table 2: *Development of energy market liberalisation, by energy subsector, EU25, 2001 and 2005 (%)*

Country	Electricity		Gas	
	2001	2005	2001	2005
AT	100	100	49	100
BE	35	90	59	90
CY	-	35	-	-
CZ	-	74	-	25
DE	100	100	100	100
DK	90	100	30	100
EE	-	12	-	95
EL	30	62	-	-
ES	45	100	72	100
FI	100	100	100	-
FR	30	70	20	70
HU	-	67	-	66
IE	30	100	75	86
IT	45	79	65	100
LT	-	74	-	90
LU	-	84	51	80
LV	-	76	-	0
MT	-	0	-	-
NL	33	100	45	100
PL	-	80	-	72
PT	30	100	-	-
SE	100	100	47	95
SI	-	77	-	91
SK	-	79	-	72
UK	100	100	100	100

Source: *Eurostat, 2006*

According to the Principal of the Commission's DG for Energy and Transport, Christine Jenkins, allowing more and larger entries to the energy sector will be a high priority area of the European Commission. Wider entry possibilities will mostly be ensured by 'unbundling', which means that energy companies will be forced to judicially split up activities related to generation, operation of distribution networks and sales.

On 19 September 2007, the Commission released its proposal for a third package of directives to strengthen the liberalisation process and functioning of the internal electricity and gas markets (European Commission, 2007c). This move mainly focuses on further unbundling activities, thus hindering companies from owning both transmission and energy production or supply activities. In particular, this should increase competition in electricity and gas retail.

At the same time, the Commission proposes to create a strong EU surveillance and cooperation body aimed at ensuring the opening of markets in all EU countries and at monitoring large energy companies, thereby preventing them from abusing their monopolistic status in the market.

In the long term, it will also be interesting to follow the consequences of consumers being able to freely choose electricity and gas suppliers. This could become a major driver of change, as customers become more aware of the possibilities in relation to energy supply and demand more from their energy suppliers. Today, energy companies have already started focusing not only on delivering different forms of energy but also on services and other 'add-ons' or additional services, but this market is only just emerging.

Competitiveness of the energy sector

Formerly, the energy sector was characterised by over-investment in infrastructure and little awareness of labour productivity and effectiveness. At present, liberalisation and the creation of an internal market have encouraged energy companies to be much more effective and competitive; thus, in 2003, labour productivity in the energy sector reached €122,400 (with added value per employee), which corresponds to 2.5 times the industrial average in the EU25 (Eurostat, 2006).

Personnel costs per employee is a third higher in the energy sector compared with the EU25 industrial average, but labour productivity adjusted by wage is still twice as high in the energy sector compared with the industrial average. EU Member States with the highest wage-adjusted labour productivity in the energy sector include Denmark, Slovakia and Spain, with the lowest being France, Germany and Romania (ibid).

Between 1999 and 2003, total turnover in the energy sector increased by more than 29%, which is much higher than the average industrial growth rate of 13.2% in the same period. Added value in the energy sector rose by 10% in the period between 2000 and 2002. In the same period, the average industrial added value stagnated.

In comparison with other European economic sectors, the energy sector appears to be competitive and highly effective. Concerning the competition and function of the market, it should be noted that energy is still a very special case. Free competition is still limited due to lack of sufficient cross-border transmission networks and government intervention in price setting in some Member States. Electricity, hot water and retail of gas are not markets directly influenced by global competition, since closeness and access to EU transmission and distribution networks are an absolute necessity for companies to operate in the EU energy market; hence, electricity, distribution, and retail of gas and hot water supply still remain mostly nationally contained markets (Euractiv, 13 November 2007).

Although direct foreign competition is not possible in the energy market, it is a major concern at EU level that foreign, state-controlled energy companies, like Gazprom in Russia, could come to possess a leading position in the liberalised EU energy market through acquisitions; thus, the European Commission's newly-proposed directives would make it impossible for non-EU companies to own majority stakes in gas pipelines or electricity transmission and distribution grids, unless their home countries sign an agreement giving EU companies access to their energy markets.

Energy prices and competitiveness

Despite increased competition and a highly cost-effective sector, consumer prices have increased in recent years. Experts and energy companies interviewed in connection with this study explain that the rising prices are a result of increasing energy demand and a rise in cost-intensive environmental requirements and regulations. Many are also convinced that energy prices will continue to rise over the next 30–50 years.

Electricity and gas prices are a significant player in terms of overall EU competitiveness, although mostly for energy-intensive sectors. The steady rise in electricity prices has already resulted in job losses for the EU's most energy-intensive industries such as iron, steel and paper production. Interviewed experts have also commented on the consequences of outsourcing production utilities among paper and steel companies. Rising gas prices are mostly a problem for the chemical industry, which also claims to suffer from the unstable supply of gas. Experts foresee more job losses in energy-intensive industries, since many more of these industries will choose to outsource production utilities in the coming years following the projected rise in European electricity and gas prices. Job losses and competitive consequences of rising energy prices are likely to be most significant in the EU10, where energy-intensive industries account for a large proportion of the economy (European Commission, 2007b; The Alliance of Energy Intensive Industries, 2006).

Security of energy supply

The security of energy supply is highly important for the EU economy to function effectively. The rise in energy prices, and especially the uncertainties concerning security of supply, has already caused hesitation among some investors in energy-intensive sectors to make the long-term investments necessary to maintain the competitiveness of the industries (Alliance of Energy-Intensive Industries, 2006).

A major problem associated with EU energy security is the dependence on external energy sources. In the electricity, gas and hot water sectors, EU dependence especially on gas imports is a major concern. With the majority of gas imports coming from only three countries – Russia (36%), Norway (16.4%) and Algeria (11.1%) – the EU is at a disadvantage regarding negotiations with suppliers. As a result, conflicts with these countries could lead to a serious energy supply crisis (European Commission, 2006).

Additionally, EU energy supply is threatened by an outdated energy infrastructure, which will need extensive investments in the next 20 years in order to keep up to date with energy demands. Moreover, the transformation to a low carbon economy provides many challenges, since renewable energies relying on weather conditions, such as wind and water power, have very little supply security.

To secure future energy supply, Europe needs to create a highly effective and flexible energy market and develop a varied range of alternatives to imported fossil fuels. The Commission and many of the interviewed experts are convinced that this will most likely be achieved through the completion of an internal and liberalised energy market. A competitive and well-functioning market will ensure the needed private investment in infrastructure and development of new energy technologies (European Commission, 2007c).

Securing energy supply through renewable sources

The increase of renewable energies in electricity production is considered an important part of securing energy supply in the EU. In 2001, the EU agreed that the share of renewable energy sources should contribute 21% of the total EU electricity production by 2010 (European Commission, 2006) and in March 2007 EU agreed to set up a legal binding target of increasing renewables' share of energy consumption to 20% by 2020 (European Commission, 2008).

Currently, the share of renewable sources in the overall EU25 electricity production stands at about 14%, but the majority of this – up to 70% – comes from hydropower (European Commission, 2006b). The potential of hydropower is almost completely exploited in Europe; thus, the increase in renewable energies has to come from other sources such as wind power, biomass, and photovoltaic solar power. On the positive side, all major energy companies operating within Europe are increasingly focusing on renewable energy both in terms of research and development (R&D) and in the construction of utilities based on renewable sources. Installed capacity – the total maximum generating capacity – in renewable

energy sources in the former EU15 countries only reached 11.8 giga-watts (GW) from 1996 to 2000. This rate almost tripled between 2001 and 2005 when 30 GW were installed (European Renewable Energy Council, 2007).

The main challenge associated with the dominant renewable energy sources such as wind and hydropower is that they all heavily rely on weather conditions; therefore, in reality, they provide little energy security if not mixed with other types of energy production. According to several consulted experts and companies, energy security can only be reached in the next 30–50 years by combining the increased use of renewable sources with energy efficiency initiatives and improvements in traditional electricity production methods.

Some important stakeholders in the European energy sector, such as the European Renewable Energy Council (EREC), are rather doubtful that the EU will reach its target of 20% use of renewables as a proportion of total energy consumption by 2010. Although progress in this direction is speeding up, it is still not fast enough, according to various stakeholders (ibid).

Many of the EU10 are especially lagging behind in relation to increasing renewable energy sources. However, in terms of simple energy security, some of the EU10 countries such as the Czech Republic and Poland are in a better position than the former EU15, since their electricity productions mainly rely on hard coal and nuclear power and only to a minor extent on gas imports. Moreover, these countries have a significant domestic production of hard coal (Eurostat, 2007). In many EU10 countries, problems in energy supply are mostly related to lack of capacity and infrastructure, which again is connected partly to ineffective and less liberalised energy markets. Some of the EU10 – such as Hungary, Lithuania and Slovakia – are, however, heavily dependent on fossil fuel imports, in particular natural gas from Russia.

Importance of oil in the sector

After the oil crisis in the 1970s, the electricity and hot water supply subsector has almost phased out oil completely from generation and production. Today, oil only produces 5% of the EU's electricity (European Commission, 2006). Still electricity prices are influenced by oil prices, since other energy sources such as gas and coal most often follows fluctuations in the price of oil.

Therefore, fluctuations in oil prices in general do not influence the energy sector directly. In the near future, oil prices may have another and new effect on the electricity sector. If oil prices continue to rise, electrical cars such as hybrid plug-in cars will become economically favourable to regular gasoline or diesel-driven vehicles. This will result in a significant rise in demand for electricity, as well as in the need for substantial investments in expansion and adaptation of the electricity infrastructure. Most of the consulted energy experts for this research are confident that this development will take place during the next 20 years.

Research and Development

Since a relatively high technological level in both production and distribution characterises the energy sector, developments of new technologies are of particular importance. The transition to new renewable technologies is already changing the sector. Breakthroughs in, for example CO_2 storage technologies, would have significant importance in enabling prolonged use of coal and gas-powered generation utilities. Furthermore, the development of an effective plug-in car, at a reasonable price, could revolutionise the whole energy sector by requiring huge extensions and adaptations of the electricity infrastructure.

Despite these efforts, R&D investments and the pace of innovations are, according to several experts within the sector (see Box 1), still very low when comparing the energy sector with other European economic sectors.

Text box 1: Expert opinion on R&D investment and innovation

'*Frankly, I think that the pace of innovation has been too slow, especially in the power plant sector. We simply haven't been good enough. Luckily, much is done from political side to increase the pace of innovation and developments in the energy sector. The pace is increasing, but it is still not fast enough.*'

Torkil Bentzen, Former Executive Vice-President of DONG Energy and CEO of Energi E2

The inertia of the energy sector concerning R&D and the implementation of new technologies are the result of the high level of long-term investments that characterise the sector. Building power plants and infrastructure requires huge investments and often has 'payback times' lasting more than 20 years. This means that changing systems and technologies too often will have serious economic consequences.

However, the increased political pressure and the CO_2 quota system will probably speed up innovations and developments within the energy sector. Some of the renewable technologies such as solar power can be effectively used in small-scale utilities resulting in more flexibility and short-term investments. This could also speed up continuous implementation of new innovative technologies and energy solutions.

Possibility of a hydrogen economy

Hydrogen is not a primary energy source but an energy storage medium. It does not exist in pure form naturally, which means that is has to be extracted, for example from water, through electrolysis – a process which involves separating chemically bonded elements and compounds by passing an electric current through them. The vision of a hydrogen-based economy relies on the expectations that hydrogen can be produced from cost and environmentally-effective sources and that applications using hydrogen, such as fuel cell vehicles (FCVs), will be effective and affordable enough to gain leading market shares.

Advocates of a hydrogen economy argue that hydrogen can be a highly environmentally-friendly energy medium, particularly in vehicles and transport applications, since hydrogen does not release any particles or CO_2 at end use. Some analyses and research have also concluded that the hydrogen supply chain would overall emit far less CO_2 than gasoline-driven cars.

However, the possibility of a world economy fuelled by hydrogen is a highly debatable matter and many experts doubt that it will happen. Technology is still far from being able to extract, distribute and store hydrogen in cost-effective and safe ways. With the technology available at present, the potential extension of a hydrogen economy seems limited. To build the required distribution networks and storage facilities will be much more complicated and expensive than, for example, extending and developing the electricity network and electric utilities such as plug-in cars (Committee on Alternatives and Strategies for Future Hydrogen Production and Use, 2004).

Nevertheless, a breakthrough in hydrogen technologies could result in major changes in the energy sector. First, hydrogen could change the transport sector which is currently heavily dependent on expensive and insecure fossil energy sources (see Box 2). Secondly, developments might also enable hydrogen use in power generation facilities. This would make small-scale generation utilities much more effective, and thereby, change the electricity sector dramatically.

Text box 2: Series production series of hydrogen vehicles

In early September 2007, Mercedes – the first car-producing company ever – announced that it will start the series production of hydrogen fuel cell vehicles. Low volume production will begin in 2010.

The vehicle for manufacturing is a so called 'B-Class' model and has a range of up to 400 kilometres. So far, 30 of these cars have come onto the market in Europe and North America.

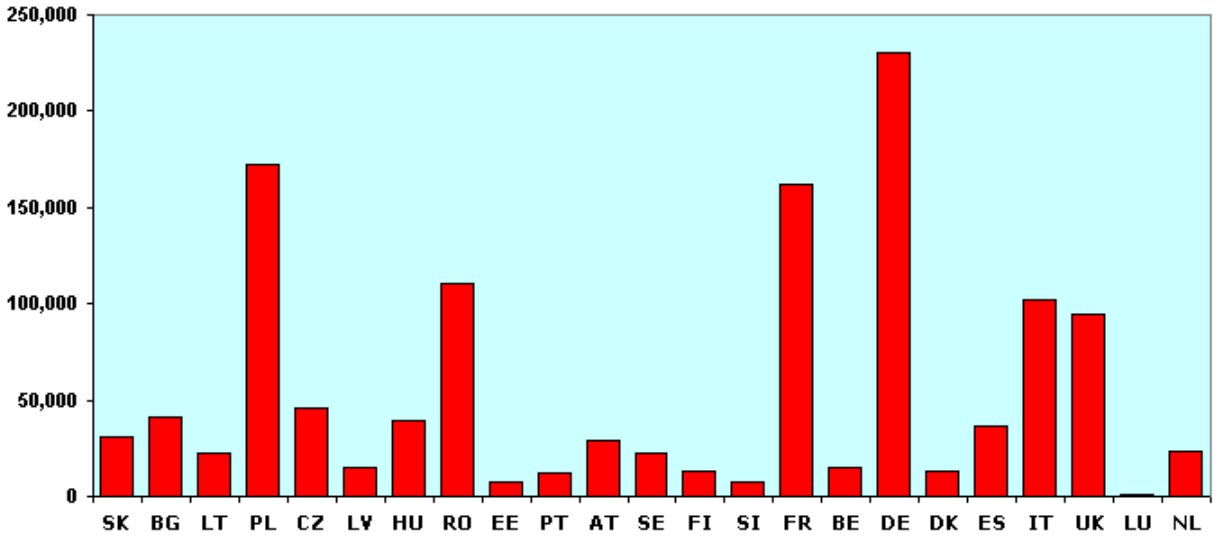
Source: **http://www.h2euro.org 2007**

According to the President of the European Hydrogen Association (**EHA**[5]), Lars Sjunneson, hydrogen will play a role in the energy sector in 20–30 years' time, but today he cannot say exactly to what extent this will be possible. A significant sum of money has already been invested in developing hydrogen and fuel cell technologies, which many companies and stakeholders simply cannot afford to ignore. Regarding labour issues, Mr Sjunneson is convinced that a breakthrough leading to the development of efficient hydrogen technologies would lead to the creation of many jobs. Construction of a hydrogen infrastructure and further R&D would result in a great need for skilled labour.

Employment and human resources

Employing a total of 1.1 million workers, the energy sector represents an important part of the European labour market. The sector creates a considerable number of jobs in all EU countries, although employment in total numbers is concentrated in the larger Member States, such as France, Germany, Italy, Poland, Romania and the UK. Figure 7 shows the number of employees in the energy sector in selected Member States.

Figure 7: *Energy sector employment in selected EU Member States, 2006*



Source: *Eurostat, 2006*

[5] **http://www.h2euro.org/**

The German energy sector employs more than 230,000 employees, representing the largest share of the total EU energy sector employment. However, in terms of employment, the energy sector is most important in many of the EU10. In Slovakia, Bulgaria, Lithuania, Romania and Poland, employment in the energy sector accounts for around 2.5% of total non-financial employment compared with the EU25 average of only 1% (Eurostat, 2006).

The energy sector's workforce is characterised by a high number of technically and highly educated employees; however, no exact figures are available on EU employment and education at sectoral level. The sector employs many engineers, but the liberalisation process, resulting in a higher focus on services, communication, product development and project management, has also attracted new educational and occupational profiles to the sector (European Commission, 2007b).

With regard to employment and human resources (HR), one of the biggest developments in the energy sector has been the changing view on personnel management and HR. In the former monopolistic energy enterprises, personnel management was mostly a matter of administration rights, while rules and trends in human resource management (HRM) have had little influence. According to the experts and management of energy companies interviewed for this research, the opening of the markets and – in some cases – the privatisation of ownership have been a revelation for the energy sector's personnel management. Today, human resource and personnel management issues are considered highly strategic matters and chief personnel officers are often represented in energy companies' top management. This has also resulted in a higher focus on gender and equality issues.

The entire liberalisation process has, in many ways, presented great challenges for HRM in the energy companies' shift from being simple energy providers to multi-utility and multinational 'energy giants'. New skills required by the energy sector's employers seem to include flexibility, adaptability, customer-focused sales skills and regulatory expertise (European Commission, 2007b).

Dramatic decline in employees

Since the mid-1990s, the energy sector has experienced a dramatic decline in the number of workers employed. Research shows that in the former EU15, almost 250,000 jobs were lost in the electricity sector alone since 1995 – a decline of nearly 25% in the sector's total workforce. For the EU10 and the two newest Member States to join the EU in 2007 (Bulgaria and Romania), job losses in the same period amounted to about 50,000 places, representing approximately 15% of the energy sector workforce (European Commission, 2007b).

The gas sector has also experienced substantial job losses, although less severe than in the electricity sector. Since gas is mostly supplied from outside the EU, employment in the sector is also much more marginal than in the electricity industry. Still, employment declined by 12%–13% from 2000 to 2004 (European Commission, 2007b).

Employment issues in the hot water supply sector are not thoroughly described, but experts within the sector estimate that employment decline in this subsector has been relatively low. The hot water supply sector has not been liberalised and is a locally-contained market dominated by many small locally-based suppliers.

Looking at the overall EU25 energy sector, employment decline has been significant in recent years. Between 2000 and 2004, more than 160,000 jobs – or 13% of all jobs – were lost in the sector. Table 3 shows the decline in the number of employees in the EU25 energy sector from 2000 to 2004.

Table 3: *Employment in the EU25 energy sector, 2000–2004*

	2000	2001	2002	2003	2004
Persons employed	1,260,300	1,204,600	1,180,700	1,136,400	1,100,000

Source: *Eurostat, 2007*

Groups most affected by job losses

The employment decline in the energy sector has had different impacts on skills, activities, genders and age groups. In the liberalised energy market, which is highly focused on competitiveness, effectiveness and development, demand seems to be higher for more educated and highly skilled workers. This means that job losses have been most pronounced among lower skilled personnel, especially in maintenance and administrative occupations.

Female workers have been less affected by job losses than male workers. This is most likely a result of the fact that male workers, on average, are less educated than their female counterparts and that maintenance, which has been almost completely dominated by men, has been struck hard by rationalisation processes. Some of the new emerging jobs in services and communications occupations also seem to be more attractive to women.

Finally, job losses have mostly hit the oldest and the youngest members of the workforce. Many companies have used early retirement schemes as a rationalisation instrument which affects older workers, while young workers and graduates have experienced employment and training possibilities disappearing following reductions in employment (European Commission, 2007b).

Factors influencing job losses

Most experts and reports on the subject conclude that liberalisation of the electricity and gas markets seems to be the most important cause of the decline in employment. Liberalisation resulting in increased competition has forced companies to become more effective; hence, they are also starting rationalisation processes (Thomas, 2007; Feickert, 2006; European Commission, 2007b).

Many mergers and acquisitions have also their part to play in employment decline with large-scale operations rendering many employees redundant.

Whereas the ongoing company concentration is most likely further reducing the number of employees through rationalisation measures, it is not necessarily worsening working conditions in the sector. Large companies are normally better than SMEs in fulfilling working conditions obligations, and it is easier for trade union organisations to put pressure on large companies.

Bigger companies, however, can pose a democratic problem – sometimes making a decent level of communication and consultation with employees difficult. The new multinational energy companies can also pose a challenge to the nationally anchored associations representing workers (Thomas, 2007).

Liberalisation is not the only driver affecting employment in the energy sector. Technological developments have also had an impact. In this case, one example is the increased use of new gas-powered electricity plants which require fewer employees as handling gas is significantly less labour intensive than handling coal. Another point to note is that certain trends, such as privatisation, commercialisation and increased competitiveness, are partly the results of liberalisation processes. They would most likely occur as major drivers contained in the process of globalisation (European Commission, 2007b).

Future needs of skills and labour

During the last decade, the European energy sector has experienced processes of rationalisations resulting in significant employment losses. However, several experts and companies interviewed in connection with this study foresee that the employment decline has come to an end and a lack of skilled workers is emerging (see also Fairbrother, 2003).

Although the interviewees from the various energy companies have a strong focus on upgrading and training their employees, they do not see this as the major challenge concerning employment. The overall problem will be in recruiting young and new employees to meet the rising energy demand and in dealing with the challenges of an ageing workforce. The need will especially be for engineers specialising in the different branches of the electricity and gas sector.

For many years, technical education courses on energy-related issues have had difficulty in attracting potential students. The unattractive images of cables, coal and heavy power plants have been difficult to make attractive to potential students. Some experts and companies within the sector also criticise their own efforts, being too weak or too late in spicing up the image of the energy sector and making it more attractive for young people. Today, energy companies hope that the increased public and political focus on energy and climate change will result in renewed interest in education and jobs within the energy sector.

The tasks of renewing and extending the European energy infrastructure also pose an enormous challenge concerning the sector's workforce. The staff needed will have to receive extensive training and skills upgrading, since know-how on the construction of energy infrastructure is currently lacking among the energy workforce. The reason for this significant skills gap is clear: in the last 20–30 years, no extensive construction of energy infrastructure has been carried out in Europe, and the workers who possessed the specialised knowledge for jobs in this area are now retired. One of the experts interviewed argues that it will be necessary to bring in workers with the required know-how and other skilled workers from India and China, where the construction and extention of energy networks is currently being carried out.

Emerging jobs in renewable energy sources

At present, renewable energy technologies already employ around 300,000 people across the EU and generate a turnover of about €20 billion annually (European Commission, 2007). Studies on renewable energy show that renewable resources have the potential to create further employment opportunities in the near future.

Renewable energy sources are more labour intensive than nuclear and fossil fuels, and the EU climate policy, among other issues, with the signing of the Kyoto protocol, has kick-started interest in increasing the share of renewable energy as a proportion of total energy production. In the coming years, the projected investments in renewable sources will most likely create jobs, particularly in connection with research, innovation and development activities. Table 4 shows the estimated number of jobs that could potentially be created in the renewable energy sectors.

Table 4: *Estimated jobs in the production of renewable energy sources, by 2010*

Sector	Estimated number of employees
Wind	190,000–320,000
Biomass	1,000,000
Solar photovoltaic	100,000
Solar thermal	250,000
Total	**1,670,000**

Source: *ECOTEC, 1999*

Most jobs will not be created in the primary energy sector but in the supplying subsectors such as manufacturing industries. The estimates of Table 4 include subsectors and suppliers.

Within the European market, biomass and wind power are particularly booming renewable energy sources. In the EU, the fastest growing power source is wind energy, increasing by an average of 32% a year from 1995 to 2005. During the last five years, 30% of all newly installed electricity production capacity has been wind power. European wind system manufacturers hold 80% of the global market – a market that grew by 40% in 2005. The European wind power sector today employs around 150,000 people, most of whom work in Germany, Denmark and Spain (EREC, 2007).

Biomass is mostly used in combined heat and power (CHP) utilities; however, EU25 electricity production from biomass still increased by 19% in 2004 and 23% in 2005 (ibid). Biomass production is particularly labour intensive; hence, it will most probably be the energy sector creating the most number of new jobs in the near future.

EU electricity production from photovoltaic solar power is still relatively marginal compared with wind and biomass, but the market has started developing rapidly. Within Europe, the market has mostly been driven by Germany and some of the Mediterranean countries. Worldwide, the potential for this market has been greater, with the solar power industry growing by an average of 40% between 2000 and 2005. The EU solar power sector currently employs about 70,000 people (ibid).

Due to the fast expanding internal market, European companies today are leading players in the market for renewable energy technologies and hold 60% of world market shares (European Commission, 2007). This gives many EU companies a basis for extending activities to the global market.

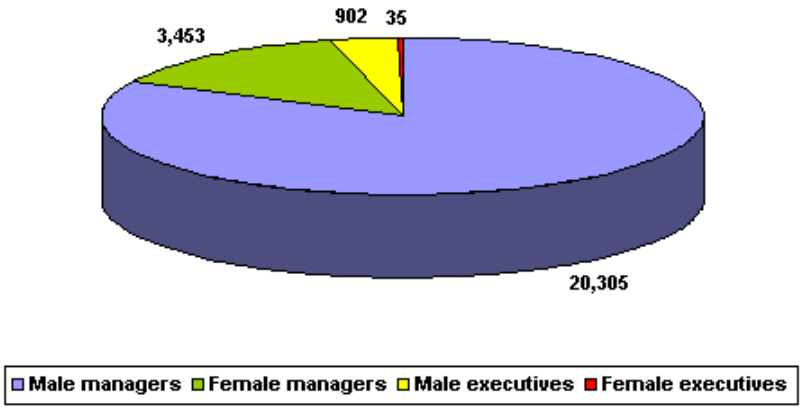
In current markets, Japan, the USA and Canada are important markets for European renewable technologies. But markets in developing countries also contain great possibilities for further European exports of both knowledge and technical utilities. Whereas the market drivers for renewable energy are environmentally and politically regulated in developed countries, it is the shortage of energy that drives markets in developing countries (ECOTEC, 1999).

Gender and equality issues

The European energy sector mainly employs men. Women represent only 15% of the total workforce, and in some countries, their proportion is as low as 8%. The highest percentage of female energy workers seems to be in northern European countries, where women in general have a high employment rate (ECOTEC, 2002). Female workers are concentrated in only a few occupational categories, such as secretarial, clerical and customer services posts.

Moreover, significantly few women hold management positions. Figure 8 shows the divisions of male and female managers and executives at the French electricity and energy company EDF. With its 131,000 employees, EDF is the single biggest employer in the European energy sector.

Figure 8: *Male and female managers and executives working at EDF*



Source: *ECOTEC, 2002*

Although research concludes that female employees have been less affected by restructuring in the energy sector, the share of women working in the sector has not been rising. The inability to attract female workers could make the emerging lack of skilled workers even more urgent, and it could also make the recruitment of young men more difficult in the future. Progressive companies with more equal gender rates seem to be more attractive to work for among both young male and female workers. In addition, energy companies could become less competitive and innovative in order to meet the varying demands of female and male customers (ECOTEC, 2002).

Experts explain the low percentages of women in the sector by the fact that the energy sector has for a long time had an image of being a 'technical, heavy industry sector' – a description quite unattractive to women. Engineers and technical workers are in high demand in the sector and fewer women choose to explore such technical careers.

Interviews with experts and management of companies within the energy sector revealed that gender issues have been put in focus only recently. So far, little has been done to make jobs in the energy sector more attractive to women.

A report on the impact of restructuring in the electricity industry on women concludes that initiatives in the areas of flexible working time, equal pay for equal work, mentoring schemes, and gender-focused recruitment have to be carried out in order to attract more female workers and managers to the electricity industry (ECOTEC, 2002).

Ethnicity, age and other equality issues

Where the focus on gender-related issues seems to be increasing, equal opportunity policies and initiatives in relation to other areas such as age, ethnicity and religion are common. Some companies have carried out projects addressing equality issues among different social groups. However, there seems to be a lack of evidence in relation to the mainstreaming of these measures and initiatives. They typically seem to focus on a specific social group and are not part of an integrated equal opportunity policy (Fairbrother, 2005).

The energy sector also seems to face difficulties in attracting employees from outside the EU. In Denmark, the energy sector has been carrying out a campaign aimed at attracting more immigrants and persons of ethnic backgrounds other than Danish. Still the share of employees coming from different backgrounds continues to be quite marginal.

The Swedish energy company Vattenfall also reported having problems attracting employees from different ethnic backgrounds to the company. The company explains this by the fact that Vattenfall, for many years, has been closely

associated with the Swedish state, which owns 100% of the company's shares. Therefore, working for Vattenfall has been associated with working for the Swedish state. Furthermore, there has been a tradition of 'family employment' in the company, where a father or another relative working for Vattenfall facilitated other relatives in obtaining a job in the company, thereby making it harder for newcomers to enter the company.

Key trends and drivers of change

This section summarises the findings and conclusions of this study on the energy sector in terms of electricity, gas, steam and hot water supply. First, a SWOT analysis – measuring strengths, weaknesses, opportunities and threats – of the energy sector is outlined and, secondly, the most important drivers of change in the sector will be summarised.

Strengths, weaknesses, opportunities and threats

This SWOT analysis gives a short but concise overview of the strengths, weaknesses, opportunities and threats challenging the European energy sector. Strengths and weaknesses are characterised as internal sectoral factors, whereas opportunities and threats refer to the external factors and developments facing the sector.

Table 5: *Energy sector SWOT analysis*

Strengths	Opportunities
• **Indispensability** of energy: No substitute for energy exists; hence, consumers will not 'turn their back' on energy. • An **ever-increasing demand**: When looking at the history, energy demand has been rising with almost no exceptions. • **Diversity** of sources: Energy production today comes from varied sources. This makes the energy sector less vulnerable than, for example, the transport sector, which is almost completely dependent on oil. • The European energy sector is the **highest user of renewable energy sources worldwide**. This gives the European energy sector advantages, as political requirements to lower world CO2 emissions are strengthened.	• **Renewable energy**: The transformation to a low carbon economy presents many new possibilities for developing and selling renewable energies, as well as for constructing new infrastructures. • Electricity use in the **transport sector**: Developments in electricity-driven vehicles such as plug-in cars have been progressing at a fast pace in recent years. • Energy-**efficient technologies**: As energy prices rise, customers will begin to ask for more energy-efficient technologies. • **New services** such as intelligent energy solutions will emerge and help customers to control energy use following fluctuations in prices.
Weaknesses	**Threats**
• Extremely **capital intensive**: The high need for long-term investments with long 'pay-back times' may discourage investors. • **Lack of competition** may potentially demotivate leading energy companies to make the required investments in infrastructure and innovations. • The continued high dependence on **fossil fuels** makes some parts of the energy sector vulnerable to changes in prices and supply in the worldwide oil market. • **Conservativeness**: Some experts within the sector think that the energy sector is too conservative. This is partly due to too few investments in R&D of renewable technologies, and in inattentiveness to gender issues and upcoming shortages of skilled labour.	• **Political interference**: The importance of the sector means that the risk of political interference in the market is always present. This risk concerns both internal political regulations, as well as international geopolitical conflicts. • **Rising prices of fossil fuels**: If prices of fossil fuels suddenly rise dramatically, the European energy sector will face serious problems in delivering energy at affordable prices. • **Doing business as usual**: If the required investments in renewable energy sources and infrastructure are not made, the sector will not be able to meet rising demands and the political requirements concerning reductions of CO2 emissions. • A **lack of skilled labour** seems to be on the increase.

Important drivers of change and their consequences

This final section highlights the most important drivers of change and their sectoral consequences for energy production. Some drivers of change such as liberalisation have already led to major changes in the energy sector, while others such as the global climate debate are only just emerging.

The most important drivers of change in the European energy sector are outlined below.

Liberalisation and creation of an internal market

There is widespread agreement that the ongoing liberalisation and the creation of an internal European energy market have been the most important drivers of change in the energy sector in recent years. The processes of liberalisation have, among others, led to a high level of company concentration in the sector. Having to compete in the internal market, energy companies have changed from being monopolised national agencies to becoming huge international enterprises. Liberalisation has also resulted in major rationalisation processes of energy companies, thereby, causing significant job losses throughout the EU. The creation of a liberalised internal European energy market is far from complete. The lack of cross-border transition capacity is still significant, and some EU Member States are still far from liberalising price settings and the consumer's choice of supplier. Furthermore, the increasing company concentration is endangering free competition and a well-functioning European energy market.

Ongoing climate debate and requirements to lower CO_2 emissions

The global debate on climate change and environmental issues has put pressure on the energy sector. As it is responsible for a significant part of the EU's CO_2 emissions, the EU goal of cutting down green house gas emissions by up to 30% by 2020[6] is already changing the energy sector, as it now focuses increasingly on extending the share of renewable energy sources as a proportion of total energy production. The conversion to renewable sources will most likely stop employment decline in the sector, since renewable energy sources are much more labour intensive than nuclear and fossil fuels. The introduction of the CO_2 allocation and trading system also has the potential to create massive changes in the sector if prices of CO_2 quotas continue to rise.

Steady rise in energy demand

Europe's demand for energy is continuously rising and is projected to rise by at least 2% a year in the next 15–20 years. This means that energy production also has to be increased, which thus poses a double challenge for the energy sector since it has to simultaneously cut down CO_2 emissions. The rise in demand for energy will most probably lead to increasing prices of electricity and gas, and could potentially weaken the position of consumers.

Investments in restructuring and extending Europe's energy infrastructure

The European energy infrastructure is outdated and needs to be renewed. Furthermore, rising energy demand and requirements to use more renewable energy sources mean that energy infrastructure will have to be extended and adapted to these new conditions. The large-scale investments needed to update the energy infrastructure will most probably bring in new financial players, such as equity and pensions funds, into the energy sector.

Together with the forthcoming development and implementation of renewable energy technologies, the extension of the energy infrastructure could create a serious gap of skills and personnel in the sector.

[6] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0002:FIN:EN:HTML

Innovation and R&D

Although some experts criticise the energy sector for putting too little effort into innovation and R&D, new technologies in, for example renewable energy sources and energy efficiency, are changing the European energy sector. Another example of innovation is the development of electrically-driven vehicles, which is currently progressing at a very promising speed. Experts expect that plug-in cars will be able to make up significant market shares in the next 20 years – a development, which would create many changes in the energy sector, since it has to extend and adapt energy infrastructure to the transport sector.

Breakthroughs in hydrogen and fuel cell technologies could also change the energy sector dramatically by making small-scale generation facilities more advantageous to large-scale power plants.

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Annex

List of experts interviewed

Name	Title and organisation/company
David Buchan	Senior Research Fellow, Oxford Institute for Energy Studies (OIES) Energy editor at *Financial Times*, 2000–2002
Lars Sjunneson	President of the European Hydrogen Association (EHA) Professor at Lund University, Sweden R&D Director, E.ON Sweden
Per Soerensen	Vice-President, European Mine, Chemical and Energy Workers' Federation (EMCEF)
Torkil Bentzen	Chair, Energy Technology Development Programme of the Danish Ministry of Transport and Energy Former Executive Vice-President, DONG Energy Former Chief Executive Officer (CEO) of Sjællandske Kraftværker and Energi E2
Christine Jenkins	Energy Policy and Security of Supply Unit, European Commission Directorate General for Energy and Transport
Lars Aagaard	Deputy CEO, Danish Energy Agency (DEA) – Member of Eurelectric
Norbert Scheider	Senior Vice-President and Head of EU Liaisons Office, E.ON AG
Pauline Lauson	Regulatory Affairs Manager, E.ON UK
Kjær Lundø Jakobsen	Vice-President, Business Development, Vestas Blades A/S
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