EUSUSTEL

European Sustainable Electricity; Comprehensive Analysis of Future European Demand and Generation of European Electricity and its Security of Supply

WP1: Country-wise analysis for EU-25

The case of the

United Kingdom

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DRAFT REPORT

Contents

Geographical description

The **United Kingdom** consists of four entities: England, Scotland, Wales and Northern Ireland, and is a Member State of the European Union. Its surface area is 244 820 km^2 of which 1.3% is occupied by water. England mainly consists of lowlands with the highest peaks mostly found in the northwest with heights no more than 1000m. Wales and Scotland are more mountainous regions where the majority of water reserves of the country exist. Wind resources are substantial in many coastal areas of the UK, particularly in Scotland, Wales and Northern Ireland (Wikipedia 2005). The offshore resource is particularly large.

Demographics

The population of the country is 60 270 700 people (estimation in July 2004) with population density of 246.5 inhabitants per square kilometre. The average size of households for the year 2005 is about 2.27 inhabitants per household (EU-15 Energy and Transport Outlook to 2030).

The population is expected to grow by 2030 to around 63.5 million, with an average growth rate of 0.2% annually.

The high population density is limiting the exploitation of the good onshore wind farm sites. Consequently, given the excellent offshore wind potential, the development of offshore wind farms is quite promising (Wikipedia 2005).

Economy status

The United Kingdom, the fourth largest economy in the world and the second in Europe, is a financial centre and trading power. London is the largest financial centre in the world.

The Gross Domestic Product of the country for the year 2003 was 1666 billion US$ and the GDP per Capita (2003) 28 237 US$. The GDP growth for 2004 was 3%.

The GDP growth of the UK, starting from 1990 and projecting to 2030, is accelerating both in absolute and in per capita terms. Absolute GDP exhibits an average annual growth rate of 2.43%. However, GDP/per capita is not increasing as rapidly as absolute GDP, particularly in the projected decades of 2020-2030. Figure 1. plots the relevant data sets:

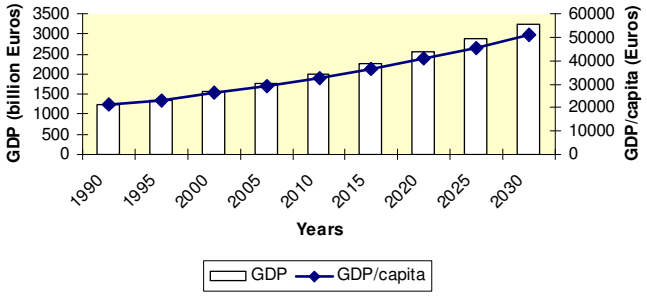

Figure 1. GDP and GDP/capita from 1990 to 2030

(European Commission 2003)

Table 1. Percentage of Labour force and GDP by sector for year 2003

	Labour force by occupation (%)	GDP by sector (%)
Services	74	72.6
Industry	25	26.5
Agriculture	1	0.9

The reported labour force for the year 2003 is 29.6 million people, around 49% of the total population, and the unemployment rate in year 2003 is 5% (Wikipedia 2005).

Energy

Domestic Production

The UK produces half of the oil in Europe. The quality of this oil is very good, as it contains low levels of contaminants such as sulphur, and it is sold at high prices. The total energy production in 2000 was 2.5 times more than that in 1973 mainly due to oil and gas production increase. However, from 1999 to 2003 the crude oil production declined by almost 24% (DTI 2005).

The country is also the biggest producer and a large exporter of natural gas in the European Union. The production increased by 5.87% from 1999 to 2001, and since then declined by around 9%. The decline is expected to continue as the reserves are depleting (DTI 2005). Gas production grew strongly from 1991 to 1999, driven by power sector market liberalization (and associated expansion of CCGT capacity) and the decline of the coal industry.

Coal production decreased by one quarter in the period from 1980 to 2000. In 2015 it is estimated that coal production will be only 10% of the 1990 levels, and the general decline will continue, albeit more gradually, through 2030.

The profile of the primary energy production in figure 2 contains historical data (from 1990) and projected data retrieved from the PRIMES (European Commission) model for up to 2030. For all the sources of energy apart from renewables there is a clear decline expected after 2005.

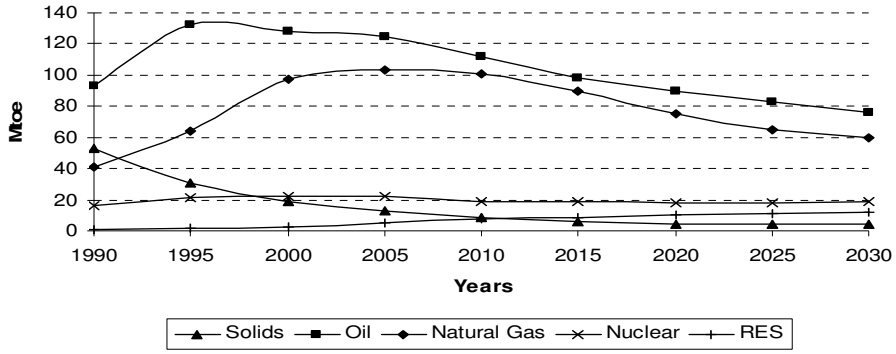

Figure 2. Primary Energy Production profile 1990-2030 for all sources

(European Commission 2003)

Imports/exports

In the early 1970s the UK imported almost half of its primary energy sources. From 1981 it became a net exporter of energy due to oil and gas production increase. Until 2003 the trend remained the same apart from a period of four years (1989-1992) caused by an accident at the Piper Alpha oil production platform in in 1988 (DTI 2004).

In particular, in 2003 coal imports exceeded the domestic production. Exports of natural gas in 2004 fell by 35.5% compared with 2003 and imports increased by 54.2%. Consequently, the UK became a net importer of gas in 2004, for the first time since 1996 (DTI 2005).

Reserves

The recorded reserves of oil were approximately constant from the mid mid-1980s to the mid-1990s, despite large increases production . Since the mid-1990s, reserves have decline quite strongly, due to continued strong production but few new discoveries and low oil prices, which reduced exploration activity.

Reserve estimates are revised annually. At the end of 2003 remaining proven, probable and possible oil reserves stood at 1,267 million tones, with annual production of around 106 million tonnes in 2003. Remaining gas reserves were estimated to be 1,206 billion cubic metres at the end of 2003, wit production of about 102 billion cubic metres.

Final Energy Use by sector and fuel

The residential and transport sectors demand by far the most energy in comparison with the other sectors. From 1987 the transport sector overtook the residential in energy demand and in 2003 the former accounted for 34% while the latter for 31%. Industrial energy demand accounted for 23% of the final energy demand (DTI 2003;DTI 2004). The energy demand by sector has remained relatively stable and it is projected to remain in almost the same percentages in the future (European Commission 2003).

Another parameter of interest regarding energy demand is the type of fuel in highest demand. Oil is the most highly demanded source followed by natural gas and electricity (DTI 2004;European Commission 2003). Since 1990 oil and gas have undergone a slight increase in demand, but electricity demand growth has been more rapid and it is estimated that in 2030 the demand will be more than double (103%) the 1990 levels (European Commission 2003). The increase of natural gas demand is mainly due to its use in power generation. From 1990 where only 1.1% of the power generated was coming from gas come estimates suggest that by 2020 this percentage could reach 74% (International Energy Agency 2002).

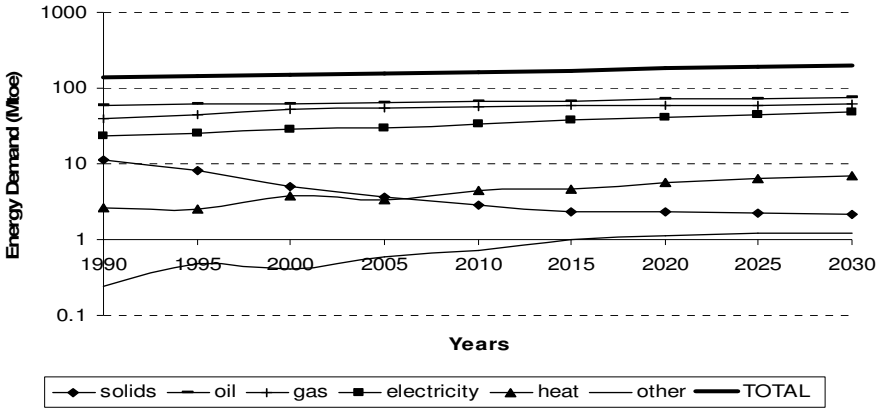

Figure 3. Energy Demand profile for all fuels (1990-2030)

Source: (European Commission 2003)

The energy demand by fuel as indicated by Figure 3., is increasing through the years between 1990 and 2030, with heat (from CHP and District Heating) and electricity showing a more rapid increase and solid fuels always decreasing.

Electricity

General

Total electricity generation in the UK in 2004 was 375 TWh, 2% higher than in 2003. (DTI 2005). Total installed generation capacity was 70 GW in 2002, and system peak demand for 2001/02 was 61.5 GW, equivalent to 87.5% of the total installed capacity. System load factor for the same year was 54% (DTI 2004).

The transmission and distribution system consists of various interconnectors. The Scottish network is connected to the National Grid's transmission system in England

and Wales via a 1 200 MW interconnector. Northern Ireland is connected with the Electricity Supply Board in the Republic of Ireland. In the international scene, UK and France are interconnected with a 2 GW High Voltage Direct Current. There are also proposed links with the Republic of Ireland, Norway and The Netherlands (International Energy Agency 2002).

Electricity production in the UK is derived from a mix of fossil fuels, nuclear and renewable sources. The introduction of competition in the electricity sector in 1990/91 boosted the use of natural gas for electricity generation. During the decade 1990-2000 the electrical energy generation increased by almost 20% and the participation of gas rose from 1.1% to 40% for the same period. Simultaneously, the participation of coal in the electricity generation mix fell by almost one-third. But during 1999-2001 the use of coal increased by 24% (in Mtoe) due to increase of wholesale prices of gas and to a 10.5% decrease in nuclear power output in 1999-2000. Oil has been displaced by the general increase in gas use; its participation in electricity generation has declined from 10.8% to 1.5% (International Energy Agency 2002).

The 'dash for gas' did not seriously affect the other sources. Nuclear output remained at 85 TWh or 23%, hydro at 5.2 TWh or 1.4%, combustible renewables at 4.4 TWh or 1.2% and solar, wind, and other renewables at 1.1 TWh or 0.3%.

The electricity production is following a constantly increasing profile through the whole range of years between 1990 and 2030 with an average growth rate of 1.65%. Electricity generation from thermal processes follows the same trend. On the contrary, nuclear is declining. Hydro and wind represent a continuously increasing power output with a remarkable growth projected from 2005 to 2010, driven by national and EU policy. Figure 4 indicates these trends:

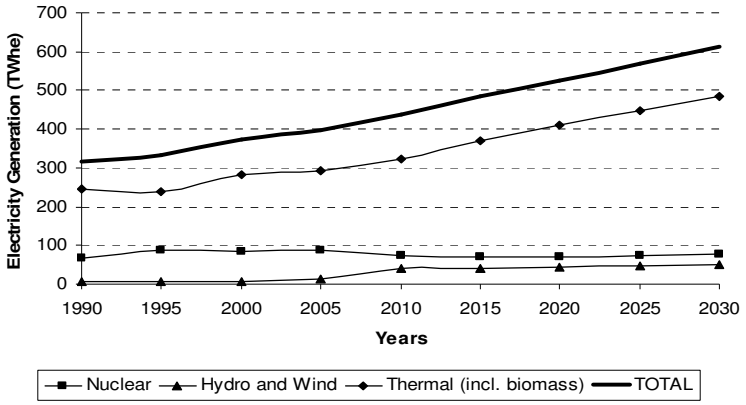

Figure 4. Electricity generation profile for all sources (1990-2030)

(European Commission 2003)

Combined Heat and Power (CHP) units have increased their share of the generation mix in the last decade (more than double between 1991 and 2002) and have contributed to reducing national CO_2 emissions. However, the rapid growth experienced has stalled in recent years, primarily due to high natural gas prices. The load factor fluctuates affected by the gas prices and in 2002 was 58%. The electricity

generated from these systems was just over 6% of total electricity in 2002 (DTI 2004).

For electricity and steam generation the installed capacity follows almost the same pattern as the energy generation one, as the thermal option possesses the biggest part (78.60%) followed by nuclear (15.76%).

It has been shown that electricity demand represents almost 20% of the total energy demand in UK and according to governmental sources its growth rate between 1998 and 2000 was 1.9% per annum. Furthermore, a loss of 36 GW is expected to occur (due to closure of nuclear and coal power plant) by 2020 which will have to be replaced by some 25 to 50 GW of new capacity (International Energy Agency 2002).

Renewables

There has been significant growth in the UK renewables sector. In 1990 renewables (biofuels, wave, photovoltaics, wind and small scale re-furbished hydro) accounted for 0.03% of the primary energy production but in 2003 this number has risen to 2%, which represents 3% of total electricity production. During the decade between 1990 and 2000 the combustible renewables accounted for 82% of renewable energy sources while wind energy only for 2.5% (IEA, 2002). However, the technical potential for developing wind energy is large. Offshore wind has the technical potential to cover 100% of the country's electricity demands (ignoring intermittency issues), due to the windy coastlines (one of the windiest in Europe). The aim of current policy is to reach 10% of electricity sold (not necessarily generated) in UK, by 2010, from renewable sources.

Environmental issues

The United Kingdom has agreed to reduce its Greenhouse Gas emissions, according to Kyoto Protocol commitments, by 12.5% over the period of 2008-12 relative to the levels of 1990. The government has also set a tougher national target of a 20% reduction by that period, and a long term goal of a 60% emission reduction compared to 1997 levels by 2050 . According to the DTI (2004) for the year 2003, CO_2 accounted for 85% of the total climate forcing gas emissions in the country, with methane (CH_4) and nitrous oxide (N_2O) being at the levels of 7% and 6% respectively. HFCs (1.5%), PFCs and SF_6 (both 0.3%) are the three remaining gases emitted.

During the last fifteen years the UK has reduced its Greenhouse Gas (GHG) emissions mainly through fuel switching (to natural gas) in the power sector, energy efficiency and pollution control measures, but also policies for methane emissions reduction. On the contrary, transportation and residential sector emissions are increasing and are expected to keep doing so. By 2020, some projections suggest that CO_2 emissions will be 4% to 7% over the expected levels of 2010 (International Energy Agency 2002).

An important factor is the relevant relation between carbon emissions, GDP and electrcity generation. Figure 5 estimates growth in these, and indicates signifcant decoupling of emissions growth from electricity production and GDP growth.

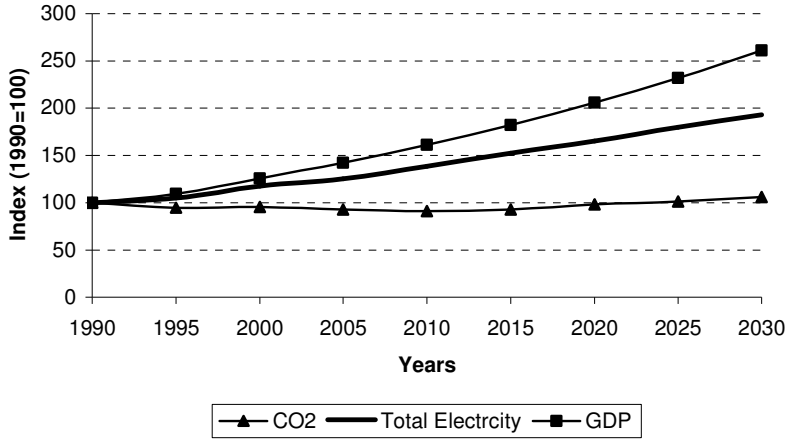

Figure 5. CO_2 emissions relevant to electrcity generation and GDP growth
(European Commission 2003)

Policy issues

General

Energy and environmental policy in the UK mainly focuses on the reduction of carbon emissions (60% by 2050 with substantial achievements by 2020) whilst simultaneously considering the reliability of energy supply in a liberalised and competitive market and social concerns. It suggests that energy efficiency (along with a diversified energy portfolio) is going to play a major role as the cheapest and safest way to achieve these aims (DTI 2003).

Energy and Electricity

In 1990/91 the Electricity Pool market arrangement was formed, as the start of electricity market reform. Market imperfections and inefficiencies became apparent over time, illustrated by prices of electricity remaining higher than could be justified by expected marginal costs. On 27 March 2001 the New Electricity Trading Arrangements (NETA) were introduced, intended to ameliorate the market environment that had been created by the Electricity Pool. It put in place arrangements for electricity trading like most other commodities, through bilateral contracts and spot markets. The NETA included England and Wales, but from April 1st of 2005 it was replaced by the British Electricity Trading and Tranmsission Arrangements (BETTA) which now includes Scotland. Under NETA (and now BETTA) the utilities are obliged to seperate their supply and distribution sectors (DTI 2003). With NETA the market improved in many points, such as: (International Energy Agency 2002):

- Almost half the electricity is generated by new entrants
- Wholesale electricity prices reduced by 20-25%
- Bilateral contracts increased by 5 times (93% of electricity is traded using bilateral contracts)
- Generators are more transparent in the way they move in the market
- Energy security and diversity is now at higher levels

Measures have been taken in order to support the achievement of a target of 10% of renewable electricity by 2010. The Renewables Obligation (RO) was one of them, set up in April 2002, concerning the electrcity markets of England and Wales, and requires that suppliers obtain an increasing proportion of electricity from renewables. It will stay in force until at least 2026. In addition to the RO, renewables support programmes, support for the domestic renewables industry and strategic frameworks for offshore wind have been introduced. The emissions trading system, from 2005, is going to strengthen incentives for renewables through providing an additional financial incentive to reduce carbon intensity of electricity consumption (DTI 2003).

For low-carbon generation it is expected an advanced role for both renewables and CHP technologies (DTI 2003).
The nuclear option is carbon-free technology but currently not economically or politically favourable, facing concerns over the options for long-term waste disposal and concerns regarding the safety of legacy waste. However, the current Government is leaving the option open for future needs, and expert opinion is divided over the possibility of new build as operating reactors approach the end of their lives.

The coal industry in the UK has been left to find its own place in the market. However, due to low world coal prices , the Coal Operating Aid Scheme was introduced on April 2000 for helping the existing viable production units. No help for the short-term market issues was included. In July 2002 coal subsidies ended. But since gas prices tend to increase due to reduced production and higher oil prices, coal use in power generation has grown a little and might move upwards in the future given that R&D may produce new low carbon emissions technologies (International Energy Agency 2002).

The oil and gas industry is 100% privatised and the petrol retail market is highly competitive. Taxes on petroleum products are high (one of the highest in IEA countries) with the tax Component accounting for 78.9% of the total price at the end of 2001 (International Energy Agency 2002).
The downstream gas industry has been a successful example of liberalisation since the retail market was open to competition from 1998. Transco, which is the private gas transmission company, is subject to economic and safety regulation, by Ofgem and the Health and Safety Executive respectively. These two regulators deal with different aspects of regulation for Transco and sometimes their decisions conflict. This fact causes distortions in market functions and should be eliminated in the future (International Energy Agency 2002).

Environment

In addition to the Renewables Obligation, four other major market-based measures have been introduced, motivated largely by claimte change. They are: (a) the Climate Change Levy, (b) the Climate Change Agreements and (c) Emissions Trading Scheme and (d) the Energy Efficiency Committment.

The Climate Change Levy was set into action on 1st April 2001. It is a tax for energy use in industry, commerce, agriculture and the public sector applied to gas, electricity, liquified petroleum gas (LPG) and coal. Electricity produced by renewables and 'good quality' CHP units is excluded. The levy will be revenue neutral for the manufacturing and service sectors of the economy with most income from the measure returned to companies on the basis of the employment taxes which they pay. Some income from the measure is directed to helping improve the energy efficiency of businesses.

The Climate Change Agreements are a voluntary measure addressed to energy-intensive sectors of industry. They reward participants by reducing the Climate Change Levy by up to 80%. In return they have to meet stringent targets of energy consumption or emissions reduction. The companies that decided to enter the Climate Change Agreements can use the Emissions Trading Scheme (ETS) to help them reduce their emissions. The ETS is a voluntary measure, started in April 2002, working side by side with the Climate Change Levy. It aimed to facilitate companies in the UK to gain experience with carbon emissions trading. The ETS has set an overall target, and has included a number of participating organisations, each of them taking over its own sub-target to fulfill, following their own tactics. By February 2002, 46 companies had completed the first stage of the Emissions Trading Scheme with success (International Energy Agency 2002). The ETS has since been subsumed by the EU Emissions Trading Scheme.

The Energy Efficiency Commitments (EEC) require energy suppliers to deliver energy savings through energy efficiency measure in UK households, and had delivered more than three quarters of the 62 TWh energy efficiency target by its second year (DEFRA 2004). A proposal to extend the EEC for a further six years (2005-2011) includes incentives for energy services and innovative products such as micro-CHP.

Future policy

Current energy policy debates including two key issues: how to *deliver* on the various targets for energy efficiency improvement and renewable energy, and on the future for nuclear power. The broad aspirations described in the Energy White Paper (DTI 2003) were widely supported. However, the paper lacked detail, for example on the targets within different sectors and on the policy instruments to be used. As described above, a wide range of policy instruments are in place, but there is a lack of a broader coordination between them, and concerns that specific instruments lack the power to achieve the national goals. The policy programme is currently under review, and consultations are under way concerning how to improve the effectiveness of key instruments, such as the Renewables Obligation.

The Energy White Paper deliberately avoided a specific commitment for or against nuclear power, choosing instead to 'keep the option open'. It is widely anticipated that the Labour Government reelected in May 2005 will shortly bring forward a debate on the future of nuclear power. The UK nuclear industry has made clear that it does not wish to own a new generation of power plant, but rather to operate it. This leaves questions about the possible role for public ownership, and of foreign private sector investment. What is clear is that the current generation of nuclear plant will be shutting down over the coming two decades, requiring major replacement investments in some form of low carbon power sources.

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