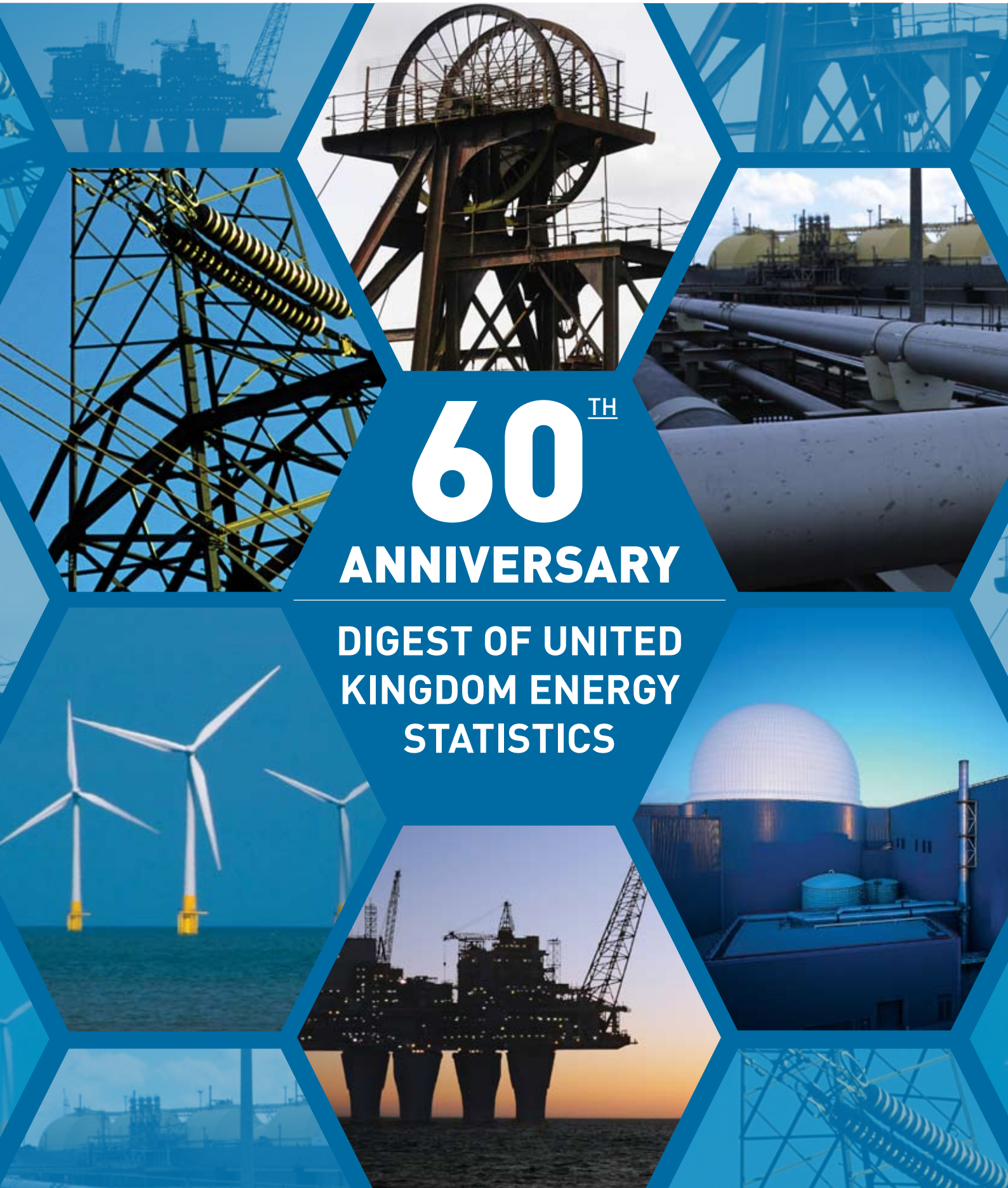
DEPARTMENT OF ENERGY & CLIMATE CHANGE



60TH ANNIVERSARY

DIGEST OF UNITED KINGDOM ENERGY STATISTICS

Contents

60th Anniversary: Digest of United Kingdom Energy Statistics

Foreword by Secretary of State

In the 60 years since the first Digest of UK Energy Statistics, the way we use energy has changed to reflect changes in the economy, of our life at home and how we want to travel.

We have seen changes too in the dominant fuel: when DUKES was first published in 1948, coal was the dominant fuel used in the UK, moving to oil in the 1970s, and then, after the two oil crises, the further development of nuclear power and the start of the production of British gas – to rise from less than two percent of generation in 1990 to two-fifths a decade later.

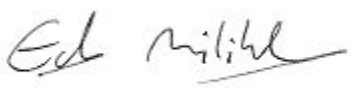
We have seen changes in the levels of energy needed: growing strongly in the 1950s and 1960s, followed, as the economy focused on services and awareness of energy efficiency increased, by lower levels of demand growth since the 1970s.

In the next 60 years, we don't know exactly what changes and new technologies will shape our energy systems. But we do know three things.

We know the future must be low carbon, to tackle the great challenge of climate change.

We know the future will mean a decreasing rather than increasing production of British oil and gas.

And we know that in planning the scenarios, making the decisions, and securing a just and rapid transition, it will be more not less important to be rigorously informed by the numbers – and DUKES, as the foremost source of statistics, is a fundamental part of that mission. Many thanks to the statisticians and their teams who continue to make DUKES such a valuable resource.



Ed Miliband
Secretary of State of Energy and Climate Change

Introduction
Trends over 60 years

History of the Digest of UK Energy Statistics
The first "Ministry of Fuel and Power Statistical Digest" was published in July 1944 as a White Paper with other White Papers in October 1946 and November 1948. However, the first Digest that was not a White Paper, dates from the "Ministry of Fuel and Power Statistical Digest 1948 and 1949" which was actually published in 1950. Thereafter the Digests took as their title year the last calendar year of data until the 1968 issue that was called "… 1968 and 1969" and after that the title year was the year of publication. Thus the Digest of UK Energy Statistics 2009 (DUKES or the Digest) will be the 60th on a consistent format.

Changes in Energy and Changes in Energy Statistics
The Digest has changed over the years to reflect the changes in energy. In the 1949 edition 74 of the 166 pages covered coal, by 2008 coal covered 22 out of 233 pages. At the same time others chapters have been introduced with Chapters of CHP and Renewables both first appearing in 1997.

Of course the dominance of coal as the key form of energy in the late 1940's, and for many years afterwards, directed the level of information that was published in the early years of the Digest. Early editions of the Digest covered material such as production and consumption as is the case now, but also covered material on employment, wages and ages of miners. There was information on welfare such as baths at mines (in 1948 only 372 of the 892 deep mines had baths) and a great deal of information on accidents and deaths – in 1948 468 people were killed at mines, a significant reduction from the 858 in 1938. The Digest also carried a great deal of information on how coal was produced and the processes used to mine and extract it – including that in 1948, UK mines employed 20,402 horses.

Changes to DUKES since 1948
The Digest has also changed in ways that may not be expected. For example the early years of the Digest contained adverts for companies such as mining specialists. Of course the Ministry noted that is was not endorsing any products, but now it would seem to potentially undermine the quality and independence of statistics to see adverts.

The way data has been presented has changed radically as well. For many years the Digest presented good factual information on all key fuels without a means of easily seeing how production fed through to final use or how the requirement for a fuel (say gas) was driven by the demand for another (say electricity). This was changed in 1999 when energy balances were introduced for all energy use and for each individual fuel.

With the inclusion of more chapters and the expansion of information, in 2002, the focus of each individual's year's publication was restricted to the latest few years, with the longer-term data being published on the website. Then as now a lot of users

are using DECC's statistics pages (www.decc.gov.uk/en/content/cms/statistics/statistics.aspx) to access the Digest, but many still feel an attachment to a publication that provides so much information on energy.

Changes in the Production of Energy Data

As well as changes in energy production and use which makes up the rest of this publication, it is also interesting to think of the changes that have occurred in the physical production of energy data. It is hard to imagine now, but the first computer (a mainframe) was first used for energy data in 1982 when it was used for some oil data. Until then all the work on producing the data in the Digest had been carried out on paper spreadsheets.

By the late 1980's personal PCs were being introduced and the process started to fully computerise the production of the Digest. The introduction of computers also made it easier to provide more accessible analysis in the forms of charts and energy flow diagrams. For many years any charts included in the Digest had to be hand drawn.

The data that are collected has changed through time as well to respond to changes in the energy system, for example privatisation and the introduction of competition which has resulted in more companies operating in the market and a more complex task to analyse these data whilst ensuring individual company data remains confidential. To provide an illustration of this, prior to competition in the domestic gas market to know the price of domestic gas all that was needed was the British Gas tariff leaflet which listed the 3 main prices. Now to produce an average price for household gas over 250 different prices have to be analysed.

Technology has also changed the data collection process which has moved from postal to fax to secure on-line delivery. Of course the production of the Digest is only possible with the co-operation of the many energy companies who provide the Department information and we would like to thank all for their help to date and continuing help in the future.

Overall changes in energy production and consumption

This section looks at a very aggregate level at changes in the production and use of energy in the UK over the past 60 years with a more detailed analysis of each fuel in the chapters that follow. Charts 1 to 3 below show how energy production, primary energy use and final consumption have all changed (primary energy use is the first use of an energy source; so the gas that is used to generate electricity is a primary fuel, the electricity is a secondary source; final consumption is the ultimate use of a fuel, so the use of the electricity is final consumption). Overall all 3 measures reflect a similar picture with the decline of coal given the rise of oil and petroleum products and gas. But each series does tell a different story.

Production

In the 1950's and 1960's virtually all the energy produced in the UK was coal. There was a small amount of primary electricity, via hydro schemes but all other fuels such as oil were imported or made from coal such as town gas and electricity. The

situation changed dramatically during the 1970's as the UK started to produce oil and gas. So by 1980 coal represented 39 per cent of production, crude oil 41 per cent, gas 16 per cent and primary electricity (nuclear and hydro) 4 per cent. Since then oil has continued to account for just over 40 per cent of production (and was 44 per cent in 2008), whilst gas has overtaken coal and its share has grown considerably to account for 39 per cent. Another significant change is that by 2008 the UK produced more primary electricity (at 7 per cent of the total) than coal as more renewable generation has come on stream.

In terms of quantity the period around 2000 saw UK energy production at its highest. In 2000 the UK was exporting significant amounts of both gas and crude oil which meant that total production had risen from around 220 Million tonnes of oil equivalent (Mtoe) in 1990 to nearly 290 Mtoe in 2000. Indeed in 2000 the sum of oil (138 Mtoe) and gas (108 Mtoe) were higher than total production in 1990. By 2008 UK production had fallen back to the levels seen in the late 1970s at just less than 180 Mtoe.

Chart 1: UK Indigenous production 1948 to 2008

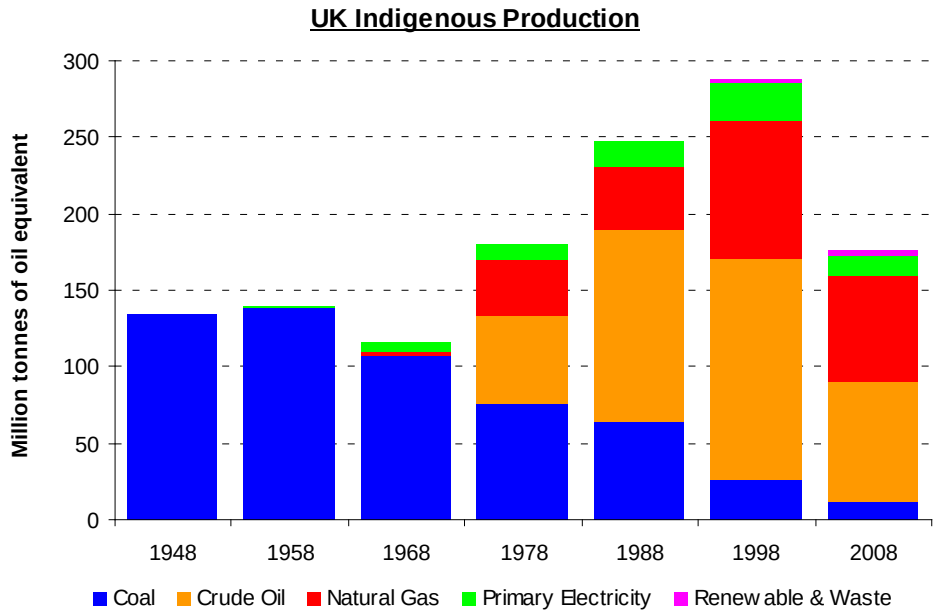


Table 1: UK Indigenous production 1950 to 2008

Million tonnes of oil equivalent

	1948	1958	1968	1978	1988	1998	2008
Coal	134.1	138.6	107.1	75.5	63.3	25.8	11.4
Crude Oil	0.2	0.2	0.2	58.2	125.5	145.3	78.6
Natural Gas			1.9	36.2	42.1	90.2	69.7
Renewable & Waste						2.5	4.0
Primary Electricity	0.4	1.3	7.0	10.3	17.0	24.0	13.0
Total	**134.7**	**140.1**	**116.2**	**180.2**	**247.8**	**287.2**	**176.9**

Primary consumption

Chart 2: UK Primary Energy Consumption 1948 to 2008

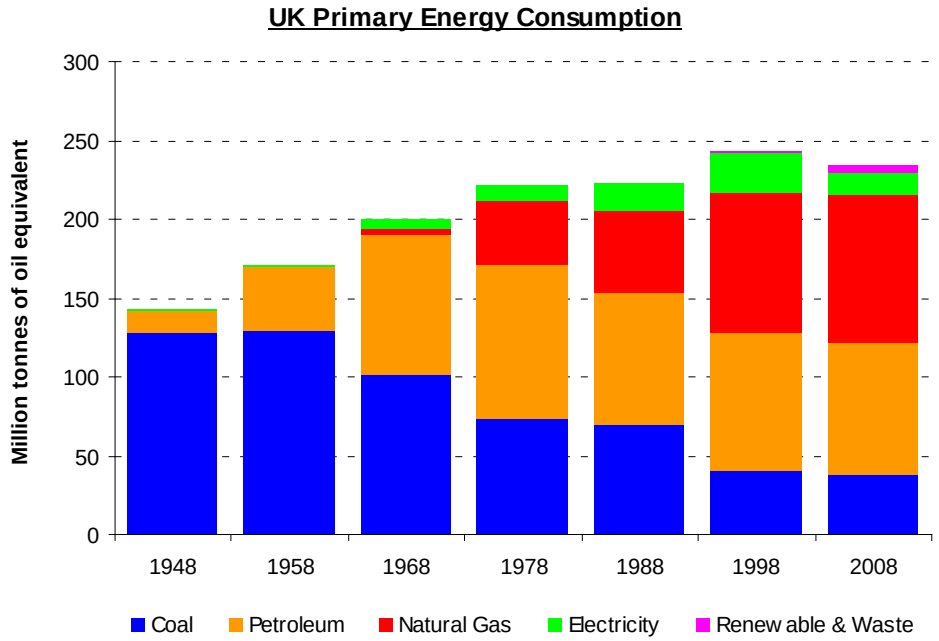


Chart 2 further illustrates the dominance of coal in the UK in the 1950's and 1960's as it was not only used directly but also used to produce town gas and electricity. However, the chart and associated data below in table 2 also show how use of petroleum products (such as petrol, fuel oil and diesel) also increased which in turn increased use of crude oil in refineries to make these fuels. Of course in the 1950's and 60's the crude oil was imported. Primary oil use almost tripled between 1948 and 1958 and then doubled again by 1968 to stand at 90 Mtoe. However, with the two oil crises in the 1970's and the discovery of UK gas use of petroleum products fell off and in 1988 was lower than in 1968. But gas use grew significantly from 3 Mtoe in 1968 to nearly 90 in 1998 when it had become the most significant primary fuel.

Table 2: UK Primary Energy Consumption 1948 to 2008

Million tonnes of oil equivalent

	1948	**1958**	**1968**	**1978**	**1988**	**1998**	**2008**
Coal	128.0	129.2	100.7	73.3	69.6	40.9	37.9
Oil	14.3	40.6	89.7	97.0	84.0	87.1	83.5
Natural Gas		0.0	3.0	41.0	51.5	88.3	93.7
Electricity	0.4	1.3	7.0	10.3	18.1	25.0	13.9
Renewable & Waste						2.1	5.3
Total	**142.7**	**171.1**	**200.4**	**221.6**	**223.2**	**243.4**	**234.2**

These data also show how primary electricity has changed. Initially a small amount of hydro electricity was generated but during the decades from the 1960's, primary electricity grew as nuclear generation grew. More recently nuclear generation has produced less power whilst maintenance work has been undertaken and the oldest

nuclear plants have closed. However, in the last few years there has been an increase in renewable generation specifically from wind.

One of the consequences of these changes is that it has resulted in an increase in the diversity of the UK primary energy mix. Detailed analysis of this is undertaken each year in the DECC statistics publication UK Energy Sector Indicators, www.decc.gov.uk/en/content/cms/statistics/publications/indicators/indicators.aspx, which shows that on a index of diversity the UK has moved from around 1.0 in 1970 to around 1.35 (and thus more diverse) in 2007.

Final Consumption

Final energy consumption is the energy that is used in homes, businesses and transport. In many ways it tells the same story as the analysis of production and primary use: the decline of coal and rise of oil and gas, but it also illustrates some other changes. Firstly there is the increasing use of electricity. Electricity consumption accounted for only 3 per cent of final consumption in 1948 (4 Mtoe) but by 2008 this had increased to 19 per cent (29 Mtoe). The second key point is that through trade and greater efficiency at refineries, increasing final use of petroleum products has been achieved against a fairly steady level of primary oil use.

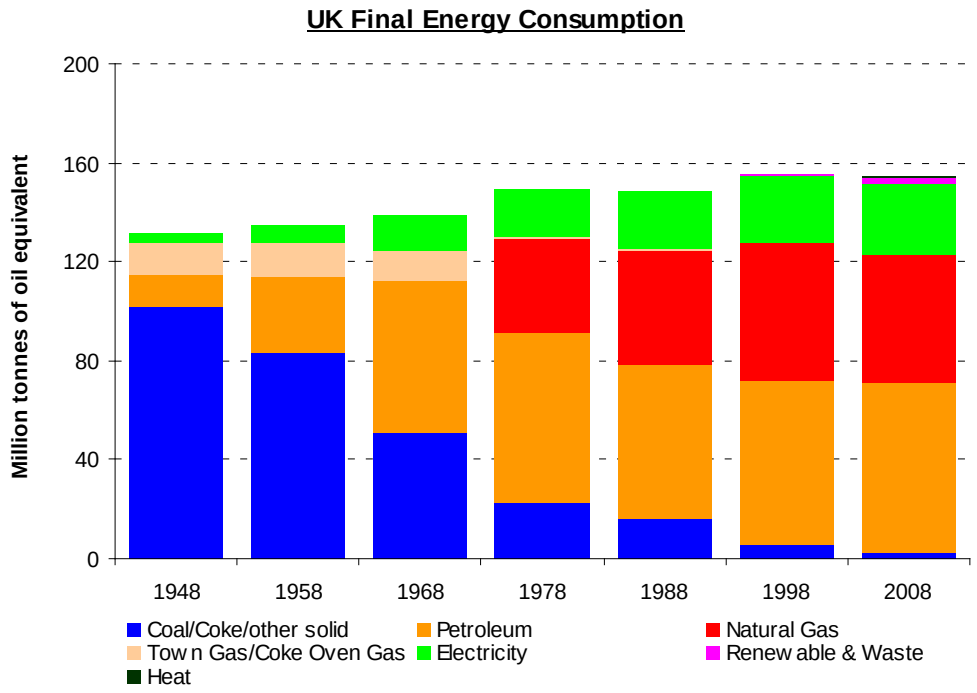
Table 3: UK Final Energy Consumption 1948 to 2008

Million tonnes of oil equivalent

	1948	**1958**	**1968**	**1978**	**1988**	**1998**	**2008**
Coal/Coke/other solid	101.5	83.3	50.7	22.8	16.3	5.3	2.6
Petroleum	13.2	30.5	61.2	68.2	62.0	66.1	68.1
Natural Gas			0.2	37.8	46.3	55.9	51.7
Town Gas/Coke Oven Gas	12.5	13.4	12.2	1.0	0.8	0.4	0.1
Electricity	4.2	7.4	14.7	19.3	22.8	27.1	29.4
Renewable & Waste					0.4	0.9	1.8
Other							1.1
Total	**131.5**	**134.7**	**138.9**	**149.1**	**148.6**	**155.6**	**154.8**

However, the recurrent story of energy use over the past 60 years is simply reflected in the fact that coal use has fallen: coal comprised almost 100 per cent of production, 90 per cent of primary consumption and 77 per cent of final energy use in 1948; to respective 2008 proportions of 6 per cent, 16 per cent and 1 per cent.

Chart 3: UK Final Energy Consumption 1948 to 2008



References

Digest of UK Energy Statistics 2009 and earlier editions back to 1948/49

Chapter 1 - Coal

The UK coal industry has seen a significant change since 1948, which has been reflected in the type and detail of statistics published in the Digest of UK Energy Statistics (DUKES).

Coal Statistics

It is important to note that whilst this publication concentrates on energy statistics over the last 60 years, information on coal production has been collected since 1853. From the records that are available, these were first published through a series of Geological Survey Memoirs on the Mineral Statistics of the United Kingdom until 1872. From 1873 all collieries were required by statute to complete annual returns, first to the Home Office, then (from 1920) to the Mines Department of the Board of Trade which was incorporated into the Ministry of Fuel and Power in 1942. Since then, coal information has been collected and published by a number of government departments but was first published as part of the statistical digest in 1948 by the Ministry of Fuel and Power.

Table 1.1: Employment and mines producing coal, 1948 to 2008

	Total number of deep mines producing coal at the end of the year	Number of National Coal Board producing coal at the end of the year	Number of opencast mines producing coal at the end of the year	Employment (Thousand)
1948	1,445	940	111	720
1953	1,337	875	92	713
1958	1,349	793	151	699
1963	943	580	33	528
1968[1]	..	330	44	331
1973	..	261	..	252
1978	..	223	..	240
1983	..	170	..	148
1988	..	86	..	69
1993	..	17	..	10
1998	21	..	..	11
2003[2]	20	..	35	6
2008[2]	13	..	33	6

[1] From 1965 to 1994 published figures in DUKES were mainly based on mines operated by the National Coal Board.

[2] Table 2.10 and 2.11 of DUKES 2004 and 2009 lists all coal mines in production.

Trends in coal production

As Table 1.1 shows, there has been a decline of 97 per cent in the total number of mines producing coal over the last 60 years. Ninety-three per cent of total mines (1,556) in 1948 were deep mined, of which 65 per cent (940) were operated by the National Coal Board (NCB)[1]. In comparison, there were a total of 46 mines in 2008, of which 13 were deep mines, a decline in deep mines of 99 per cent since 1948. Between 1963 and 1968, 43 per cent (250) fewer NCB mines were in operation. However, the largest percentage

[1] Established as a statutory corporation pursuant to the Coal Industry Nationalisation Act 1946, the NCB assumed ownership of the majority of the nation's coal and coal mines on 1 January 1947. It was subsequently renamed the British Coal Corporation (BCC) in 1987. Pursuant to the Coal Industry Act 1994 the mining activities of the Corporation were returned to the private sector that year. At the same time there was established the Coal Authority, a non-departmental public body, which inherited BCC's coal ownership and the sole powers to licence extraction. Having divested itself of subsidiary undertakings and non-core assets, BCC was finally dissolved in 2004.

change occurred between 1988 and 1993 where 80 per cent (69 mines) of NCB mines closed down. During the five year period between 1993 and 1998, which covered the transition from a nationalised coal industry to a privatised one, the number of deep mines in production increased by 24 per cent (4 deep mines) and then, as before, continued to decline.

The number of opencast mines was small in comparison to the number of deep mines in 1948. There were 111 operational opencast sites in the UK, this fell to 92 in 1953 (decrease of 17 per cent) but increased over the next five years to stand at 151 in 1958 (an increase of 64 per cent). Since then, the number of opencast mines in operation has declined by 78 per cent, to stand at 33 in 2008, the same as the levels reported in 1963.

Employment in the coal industry followed a similar pattern to mines, with figures standing at 720 thousand in 1948[2]. Between 1958 and 1963 employment in coal mines fell from 699 thousand to 528 thousand, a decrease of 24 per cent with a further fall of 37 per cent in the next five year period, to stand at 331 thousand in 1968. This fall continued over the next 40 years and in 2008, the number of people employed was 6 thousand.

Coal production

In 1948, coal production stood at 210 million tonnes, of which deep-mined production accounted for 95 per cent. Chart 1.1, shows a steady growth in production between 1948 and 1952, where it peaked at 228 million tonnes with 95 per cent being deep-mined production. Beyond this point, coal production began to fall.

Deep mined coal

Deep mined production fell by an average of 3 per cent between 1954 and 1970, from 217 million tonnes to 137 million tonnes and remained around this level in 1971. Miners' striking over pay in 1972 and 1974 resulted in deep mined production falling sharply during this period, by 20 and 17 per cent. Despite these sharp decreases, deep-mined production showed an average year-on-year fall of only 2 per cent between 1971 and 1980. During the next decade, deep-mined production increased by an average of 4 per cent. Although, the 1984 miners' strike had a substantial effect on the amount of coal produced in the UK, which saw deep-mined production falling by 66 million tonnes (65 per cent) between 1983 and 1984, the UK coal industry recovered and returned to the long term trend in 1985 producing more than double the levels of 1984 (an increase of 40 million tonnes). Between 1992 and 1993 deep-mined production, once again, declined sharply, showing a year-on-year decrease of 23 per cent. This however, coincided with the closure of 33 deep-mine sites, so with only the more productive mines operating, production per deep-mine increased by 1,652 thousand tonnes to 2,968 thousand tonnes (Chart 1.2). Thereafter, deep-mined production declined at a steady rate and stood at 8,096 thousand tonnes in 2008, a 5 per cent increase on 2007.

[2] Employment in the coal industry peaked at 1,191 thousand in 1920.

Chart 1.1: Coal production and imports, 1948 to 2008

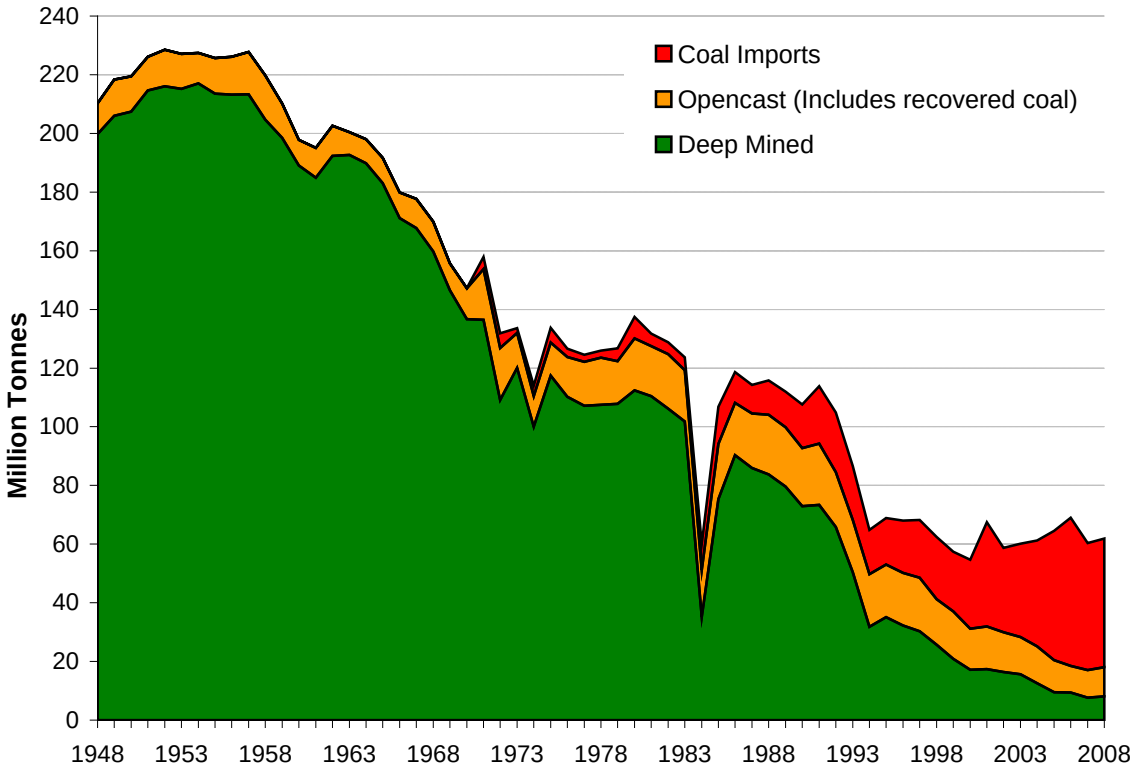
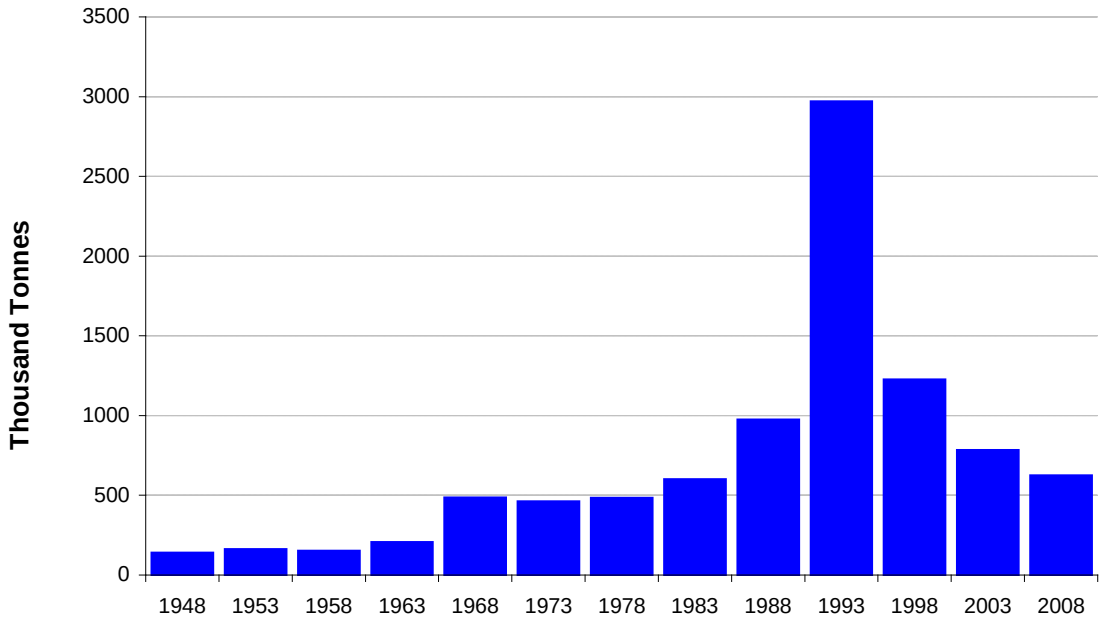


Chart 1.2: Production per deep-mine, 1948 to 2008

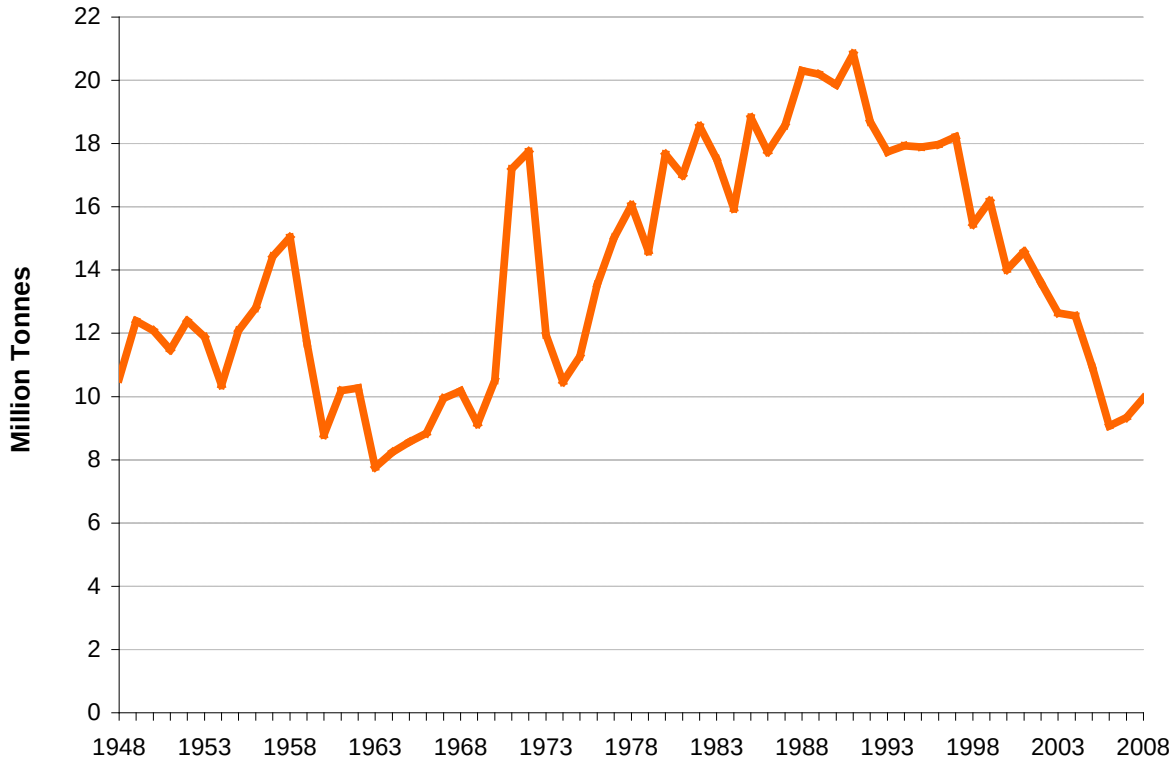


Opencast coal

Opencast production (including recovered coal) increased on average by 3 per cent between 1948 and 1953 (Chart 1.3). Following a decrease in 1954, production increased by 17 per cent in 1955, with a further increase of 13 per cent in 1957. Production then declined by a considerable amount from 15 million tonnes in 1958 to 9 million tonnes in 1960 and continued to stay at around this level throughout the 1960s. Opencast production showed signs of steady growth in the 1970s and 1980s, with an average year-on-year increase of 5 per cent. This growth continued into the 1990s, with production

peaking in 1991, to stand at 21 million tonnes. Thereafter, production declined by an average of 8 per cent between 1991 and 1993 and then remained stable at around 18 million tonnes until 1997. Since then, opencast production has been declining, but exceeded deep-mined in 2005 for the first time, accounting for 53 per cent of total production (21 million tonnes). In 2008, production by opencast sites stood at 10 million tonnes, a 7 per cent increase on 2007.

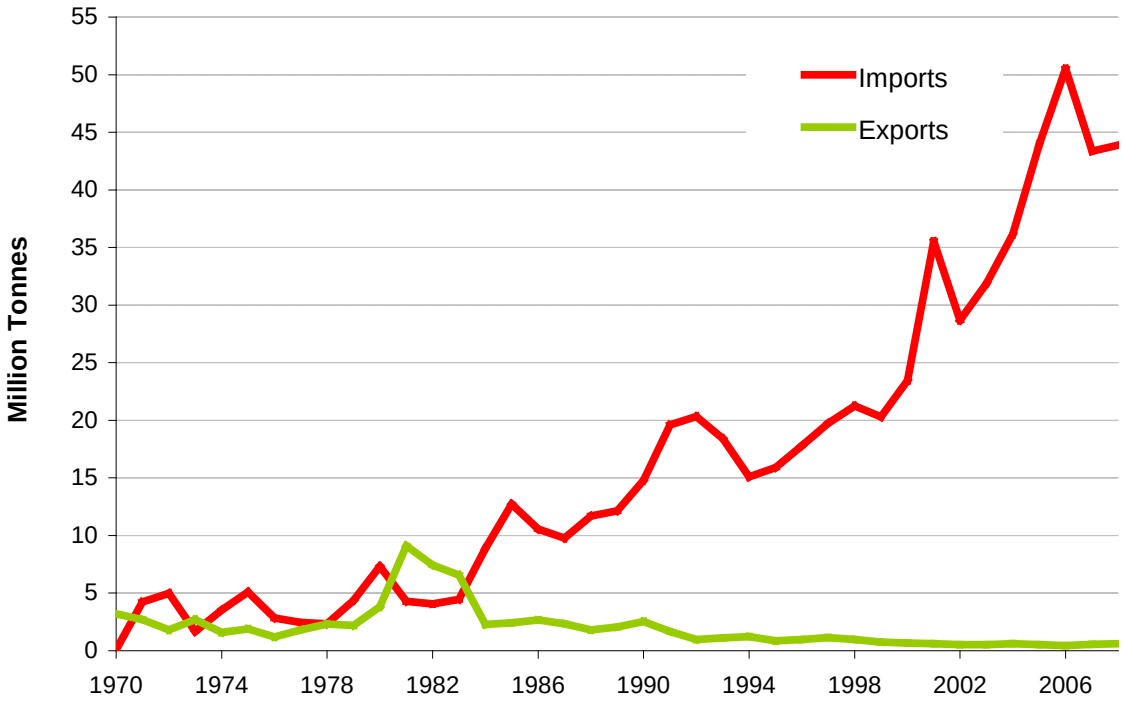
Chart 1.3: Opencast production 1948 to 2008



Trade in coal

Imports, initially of coal types in short supply in this country, started in 1970 and grew steadily to reach the 20 million tonnes a year mark by the late 1990s. The very rapid expansion of imports in 2001 meant that imports exceeded the level of UK production for the first time. In 2002 imports fell sharply and were slightly lower than UK production but picked up in 2003 and exceeded production again. This rapid growth continued and in 2006 reached a new record of 51 million tonnes (73 per cent of coal supplied). In 2007, imports fell back from this peak by 14 per cent to a little over 43 million tonnes but increased marginally in 2008.

Chart 1.4: Coal imports and exports, 1970 to 2008

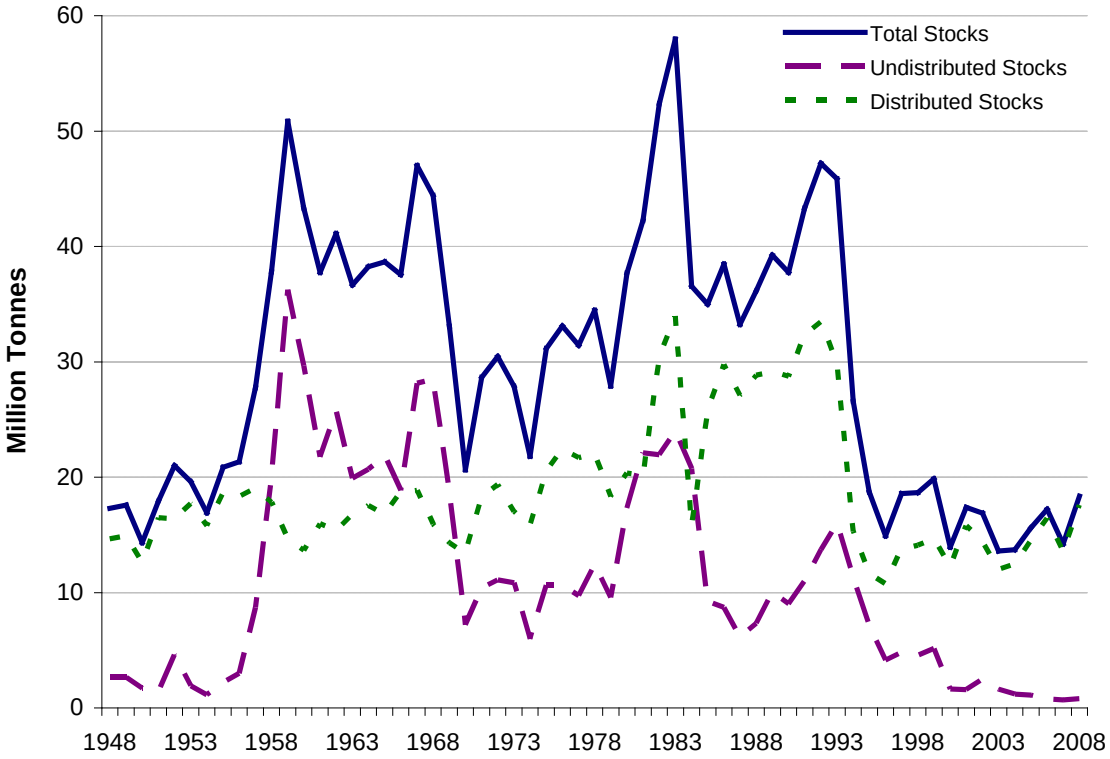


Generally, coal exports are comparatively smaller than coal imports (Chart 1.4). In 1948, 16 million tonnes of coal were exported from the UK. This level has gradually declined over the last 60 years and in 2008 stood at 1 million tonnes, just over 1 per cent of total coal imports.

Coal stocks

Stock levels in the late 1940s and early 1950s were relatively low and stood at 21 million tonnes in 1952 (Chart 1.5). During this period, distributed stocks were substantially higher (mainly due to electricity generators) unlike undistributed stocks (held at collieries), which contributed to 22 per cent of total stocks. However, undistributed stocks increased quite rapidly in 1959, by more than 7 times compared to the levels in 1952, to stand at 36 million tonnes. It was the second consecutive year, where they had exceeded distributed stocks. During the next decade, total stocks fluctuated between 51 million tonnes in 1959 to 44 million tonnes in 1968. Within two years of this, total stocks fell sharply, to 21 million tonnes and distributed stocks were, once again, higher than the stocks held at collieries. In 1983, total stocks, reached a record high of 58 million tonnes, of which 59 per cent was distributed. This level was short-lived and decreased by 37 per cent, as a result of the 1984 miners' strike. The early 1990s saw stocks rising again, reaching 47 million tonnes in 1992 but soon fell to the levels last seen in the late 1940s. These levels continued through to the new millennium with distributed stocks accounting for a far higher proportion of total stocks. In 2008 coal stocks stood at 18 million tonnes, of which 96 per cent were distributed.

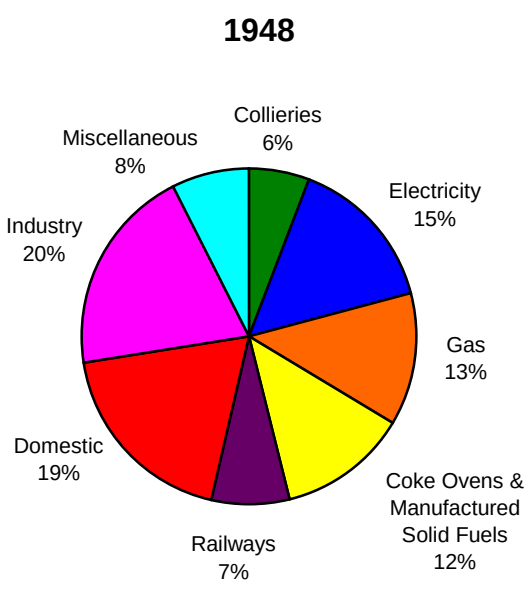
Chart 1.5: Coal stocks, 1948 to 2008



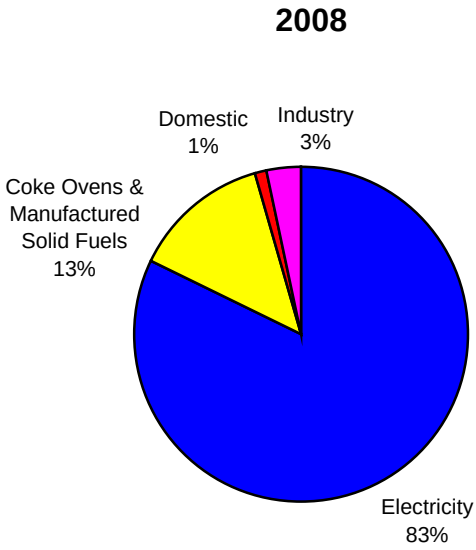
Inland Consumption of Coal

Total inland consumption of coal has fallen by 71 per cent from 197 million tonnes in 1948 to 58 million tonnes in 2008. The industrial sector consumed the largest amount of coal in 1948, with a share of 20 per cent (39 million tonnes) of total consumption (Chart 1.6). This was followed closely with 19 per cent (37 million tonnes) consumed by the domestic sector, 15 per cent (29 million tonnes) by electricity generators and 13 per cent (25 million tonnes) by the gas industry. Whilst there has been a decline in the percentage share of coal consumed in most sectors, consumption by coke ovens and the manufacturing of solid fuels has remained at around 12 per cent since 1948 but levels have changed from 24 million tonnes to 8 million tonnes in 2008. The electricity generation sector is the only sector whose share and level of total consumption has increased over the last 60 years and stood at 83 per cent (48 million tonnes) in 2008. This has largely been due to an increase in electricity generated in the UK. Coal use has remained significant due to the fluctuations in gas prices which made coal fired stations generate electricity at a lower cost than some gas fired stations. However, this change in coal use over the past 60 years has not been reflected in the domestic sector where, compared to 37 million tonnes in 1948, 2008 domestic consumption was only 1 million tonnes.

Chart 1.6: Coal consumption by industry, 1948 and 2008



Total Demand: 195 million tonnes



Total Demand: 58 million tonnes

Note: Less than 0.25% was consumed by collieries, railways and other sectors. No coal was consumed by the gas industry.

References:

Coal since 1853 reference spreadsheet available at
www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx
Digest of UK Energy Statistics 2009 and earlier editions back to 1948/49

Chapter 2 - Solid Fuels

The manufacture of solid fuels from coal has been recorded in official statistics since 1921. The largest element within this category is coke oven coke (sometimes referred to as "Hard coke") but manufactured solid fuels also include hard coke breeze, gas coke, gas coke breeze and manufactured smokeless fuels. Petroleum coke is excluded from this chapter as it is not produced from the carbonisation of coal.

Trends in solid fuel manufacturing

- Coke oven coke is defined as "the solid product obtained from carbonisation of coal, principally coking coal, at high temperature in the absence or near absence of air; it is low in moisture and volatile matter and used mainly in the iron and steel industry".
- Hard coke breeze is a related product and is coke that is too small to be used in blast furnaces, i.e. "coke screened below 19 mm (¾ inch) with no fines removed" but this screening size may have varied over time and between areas of the country to meet the requirements of particular markets. For the most recent years, the iron and steel industry has reclassified the majority of hard coke breeze production as coke oven coke production and no longer makes a distinction.
- Gas coke is no longer produced but was the solid fuel residue after gas had been distilled from coal in retorts at gasworks. It was thus a by-product of the Town Gas industry and mainly sold as a domestic fuel.
- Gas coke breeze (i.e. small sized gas coke) was also produced as part of the gasification process and used mainly by industry and power stations.

Other manufactured smokeless fuels

Other manufactured smokeless fuels encompass two categories. Firstly there are low temperature carbonisation cokes (sometimes called semi-cokes) and secondly there are patent fuels or hard coal briquettes which are manufactured from coal fines by shaping with the addition of a binding agent (typically pitch). Both are manufactured mainly for the domestic market for use in both open fires and in boilers. In the past products whose characteristics, including size, made them suitable for open fires were called 'premium smokeless fuels'. Brand names for these manufactured fuels (many of which are no longer in production) include "Coalite", "Homefire", "Phurnacite", "Ancit", "Rexco", "Cleanglow", "Phimax", "Warmco", "Taybrite" and "Wildfire".

The carbonisation or distillation of coal produces by-products that can also be used as fuels. These include coke oven gas, blast furnace gas, benzoles and tars. However, while these are not covered here, they are covered for the most recent eleven years in Chapter 2 of the Digest of United Kingdom Energy statistics, Table 2.9 (www.decc.gov.uk/en/content/cms/statistics/source/coal/coal.aspx)

Structure of the manufactured solid fuel industry

The main producers of coke over the period from 1948 are coal producers, the iron and steel industry, the gas industry and independent production companies. The first three of these have all been in both public and private ownership at some time in this period. During some of the earlier periods when production was in the hands of private companies the ability to report production without disclosing information given in confidence was limited.

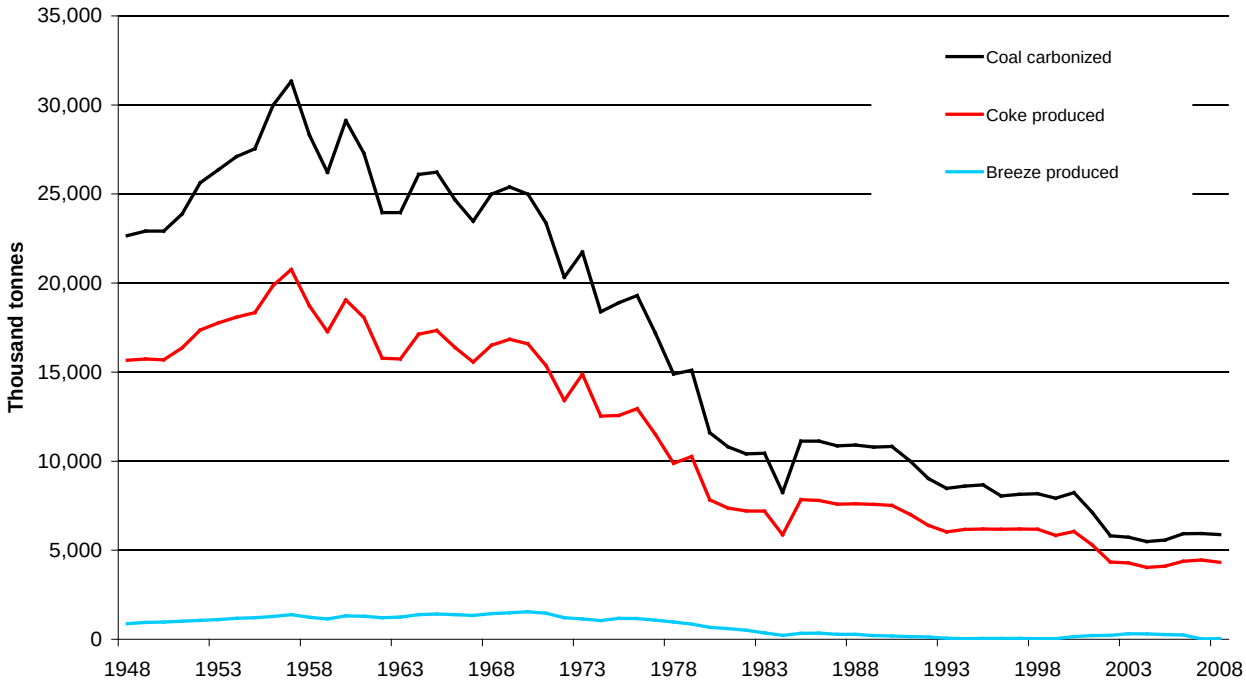
Coke oven coke production

Coke oven coke has always been produced in larger quantities than gas coke. Chart 2.1 shows the trend in coke oven coke production since 1948. Coke production was on a rising trend until the mid 1950s, peaking in 1957 at 20.8 million tonnes. The average rate of growth over the 9 years to 1957 was 3.2 per cent a year. After 1957 the rate of decline in coke production in the next 25 years was sharper than the previous growth rate falling at an average rate of 4.2 per cent a year between 1957 and 1982. The decline was then at a slower rate of 1.0 per cent a year between 1982 and 2000 after which the number of integrated steel works in Great Britain was reduced from four to three. Since 2002 coke production has been fairly flat at between 4.0 and 4.5 million tonnes per year.

At its peak in 1970 hard coke breeze production amounted to just over 1.5 million tonnes and was equivalent to almost 9 per cent of total production of solid fuels at coke ovens. For 2007 and 2008 production is sufficiently small for it not to be distinguished in the statistics.

A downward spike of production can be identified in 1984, this was a direct result of strikes at coal mines which curtailed the amount of coal delivered to coke ovens and hence coke production.

Chart 2.1: Coal carbonized and coke oven coke and coke breeze produced since 1948



Coke oven coke imports and exports

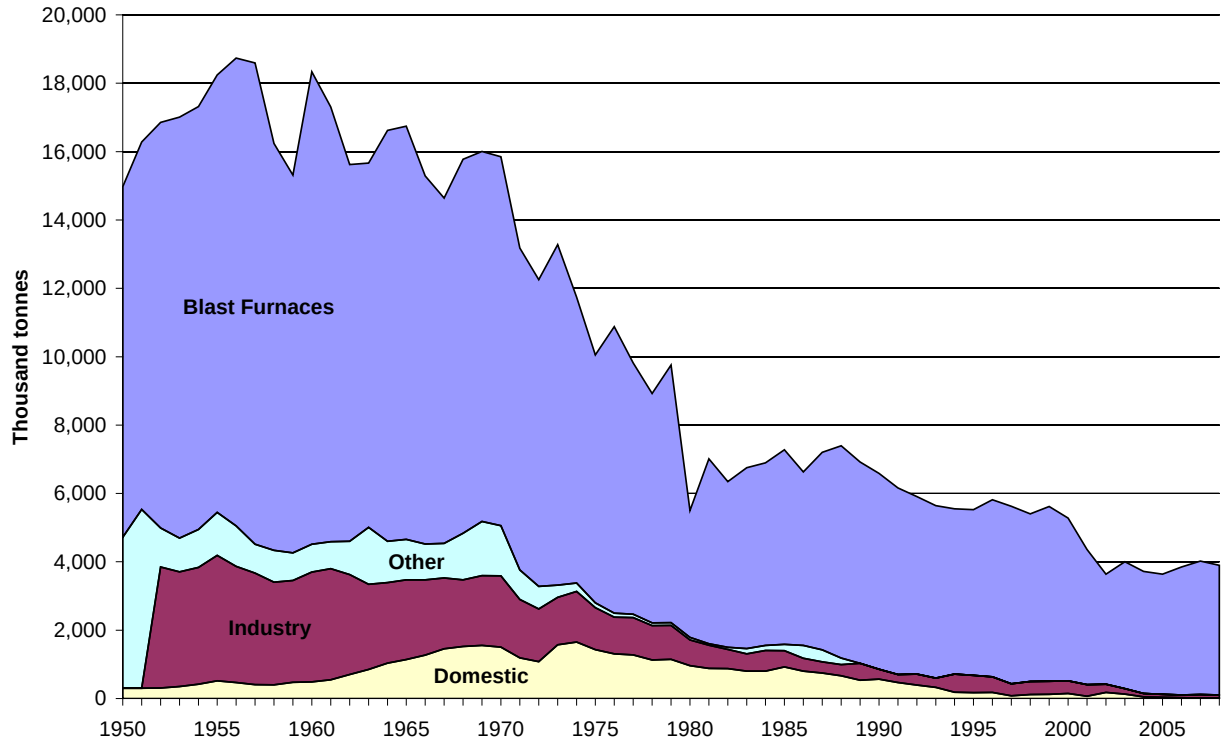
Prior to 1970 the UK was an exporter of coke with no imports, however since the 1970s the level of imports has increased with a particular spike in 1984 during the miners' strike, and in 2008 stood at about 1 million tonnes equivalent to around an eighth of the UK's coke supply. Since the late 1980s on average only about 3 per cent of UK coke production has been exported, and in the last 5 years exports have been in the range 65 to 111 thousand tonnes.

Coke oven coke and coke oven coke breeze consumption

Data on the consumption of coke oven coke is shown in Chart 2.2. In the 1950s blast furnaces accounted for around two thirds of coke consumption but this has gradually increased to close to 100 per cent as domestic and industrial uses declined. When domestic consumption was at its peak in 1974, it accounted for 10 per cent of total coke oven coke consumption.

Coke oven coke breeze consumption is mainly by the iron and steel industry where it is used as a boiler fuel. At its peak in 1970, 1.5 million tonnes were produced.

Chart 2.2: Coke oven coke consumption



Gas coke

Gas coke is a by-product of the production of town gas from coal in a retort at gasworks. In 1974, once natural gas had fully replaced town gas, the production of gas coke ceased. Gas coke breeze (like coke oven coke breeze) comprises smaller sizes of gas coke making it more suited for use in industrial boilers. However, not all of this would have been used for energy purposes since the building block industry that began in the 1930s was based on using gas coke breeze – hence the term “breeze block”. At its peak, 15.8 million tonnes of gas coke and gas coke breeze were produced in 1955. After this, gas coke and gas coke breeze production declined at an average rate of over 20 per cent a year.

At its peak in the mid 1950s, domestic sector consumption of gas coke accounted for around 30 per cent of the total, but domestic sector use increased in the 1960s (to a peak of 3.6 million tonnes in 1963) as smokeless zones were introduced under the Clean Air Act and consumption by other users declined.

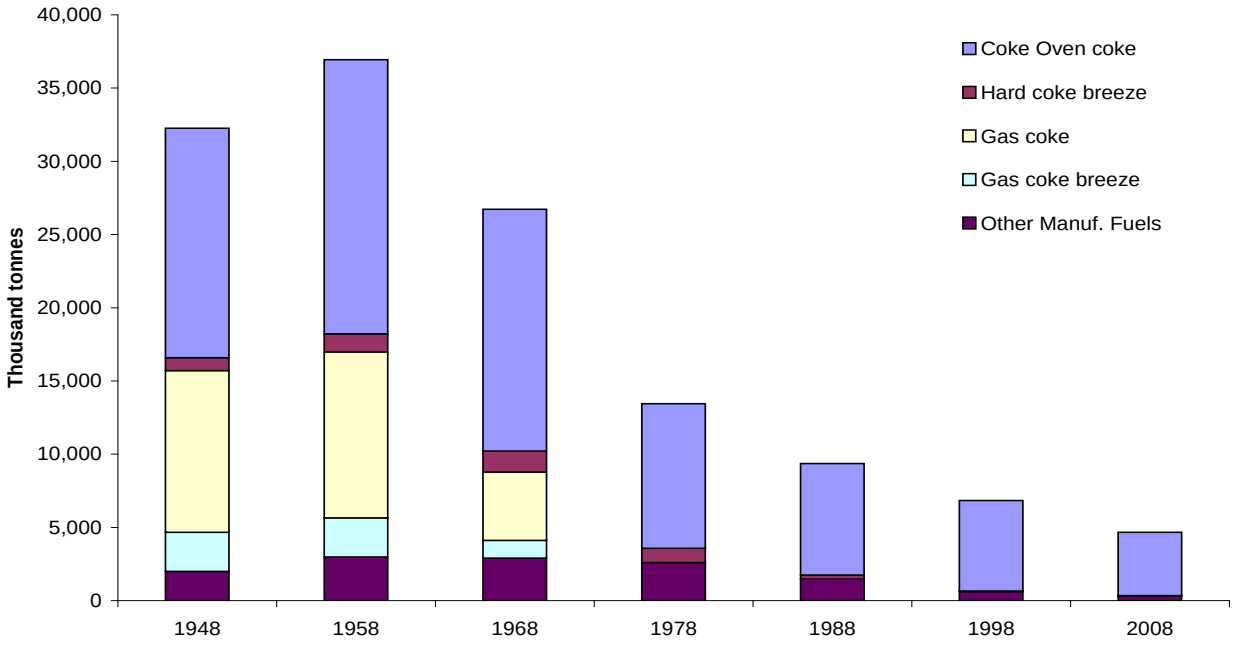
Other manufactured solid fuels

Coal briquettes and ovoids (which are manufactured from coal fines by adding a binding agent such as pitch) have been manufactured at least since 1905. Detailed data for the production of these other manufactured solid fuels are not available before 1963 because they would have disclosed data for individual private companies. These fuels were mainly (but not exclusively) for the domestic market, enabling solid fuels to continue to be burned in homes (either in open hearths or in boilers) once the Clean Air Act had introduced smokeless zones throughout the UK. Local authorities were empowered under the Clean Air Act of 1956 to declare 'smoke control areas' in which the emission of smoke from chimneys constituted an offence. They were also empowered to make grants towards the costs incurred by owners and occupiers of premises in these areas in making the necessary changes to their appliances. However, initially some of these fuels were also used by industry. Production and consumption closely follow each other since imports and exports and changes of stock levels of these fuels were relatively small. At its peak in 1972 3.7 million tonnes were produced while domestic demand peaked in 1971 at 3.1 million tonnes.

All manufactured solid fuels

At their peak in the mid 1950s production of all manufactured solid fuels together amounted over 37 million tonnes. This compares with just 4.7 million tonnes in 2008. Coke oven coke has been the largest component in all years shown in Chart 2.3, and even when gas coke production and manufactured smokeless fuels production were at high levels in 1958, coke oven coke was just over 50 per cent of the total. In the most recent year coke oven coke was 93 per cent of the total.

Chart 2.3: Total manufactured solid fuels production in selected years



A spreadsheet containing the historic series used in this article is available in MS Excel format at:
www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx

References:

Digest of UK Energy Statistics 2009 and earlier editions back to 1948/49
Britain Handbook (1966 Edition)

Chapter 3 - Petroleum

The role of petroleum in the UK's energy balance has evolved dramatically since the first publication of DUKES in 1948. The predominance of coal, in both indigenous energy production and in meeting UK energy demand, that existed since the Industrial Revolution was increasingly challenged by the petroleum alternative post-1948. Even before crude oil discoveries in the North Sea, petroleum had surpassed coal as the largest contributor to UK primary fuel and petroleum products had become the largest fuel delivered into final consumption.

This article attempts to highlight the most significant trends in petroleum's contribution to the UK's energy supply since 1948.

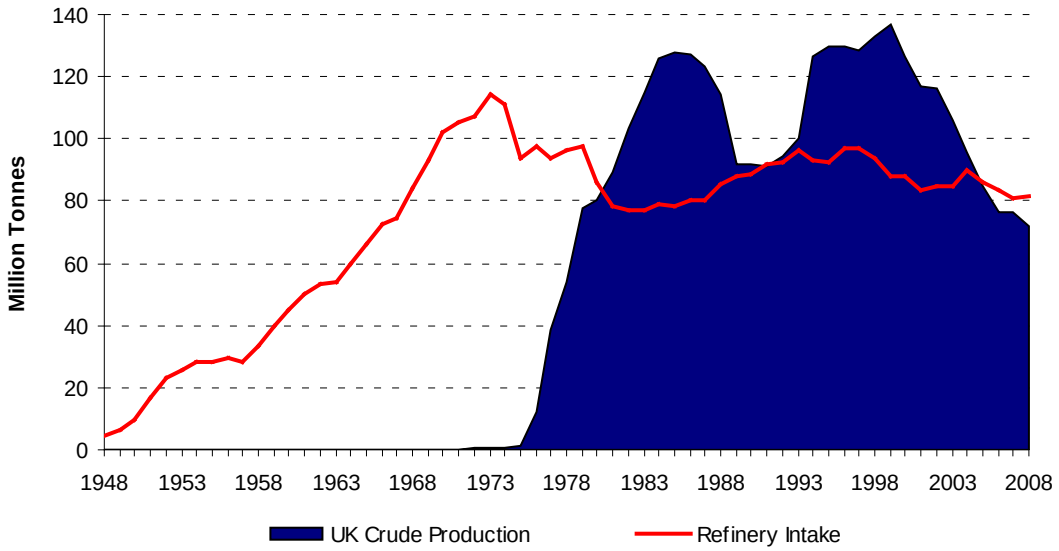
Crude Oil Production

Prior to the discovery of large quantities of crude oil in the North Sea, UK onshore production averaged less than 150 thousand tonnes a year from 1948 to 1970. Offshore North Sea production began in earnest from 1975, with production increasing from 1.6 million tonnes in 1976 to 80 million tonnes in 1980. Indigenous crude production exceeded UK refinery intake in 1981 and reached 128 million tonnes in 1985.

As illustrated in Chart 3.1, UK crude oil production decreased sharply following the Piper Alpha disaster of 1988. As offshore rigs were closed for safety upgrades and maintenance, production fell to 91 million tonnes by 1991, marginally below UK refinery intake. The level of production rose throughout the 1990s and peaked at 137 million tonnes in 1999, exceeding UK refinery intake by almost 50 million tonnes. Since 1999, production has been in continual decline at an average annual rate of 6.9 per cent to 2008, falling below UK refinery intake in 2005.

Many of the initial crude oil fields discovered in the 1970s, such as Brent and Forties, are in the later stages of their life. However, since the beginning of 2005, 27 new fields have been developed including the very large Buzzard field which commenced production in January 2007. Buzzard alone accounted for 14 per cent of UK output in 2008.

Chart 3.1: UK Crude Oil Production & Refinery Intake, 1948 to 2008



Refinery Intake

UK refinery intake peaked in 1973 at 114 million tonnes, a level 41 per cent higher than the intake in 2008. As illustrated in Chart 3.1, post-1945 UK refinery intake grew by an average annual rate of 15 per cent from 1948 to 1973. In October 1973, the world oil market was struck by a supply shock known as the "First Oil Crisis". Members of OPEC (Organisation of Petroleum Exporting Countries) agreed to simultaneously decrease crude oil production and increase the posted price of oil. UK refinery intake, after having fallen by 16 per cent in 1975, remained stable until the "Second Oil Crisis" of 1979, which resulted from the contraction of crude production in Iran and led to a 12 per cent reduction in 1980 intake.

UK refinery intake levels fell to 77 million tonnes in 1983, its lowest level for 16 years. Refinery intake increased at a low but consistent rate between 1985 and 1993, when throughput reached 96 million tonnes. After peaking at 97 million tonnes in 1997, UK refinery intake has fallen to 81 million tonnes in 2008, marginally below 2007 levels.

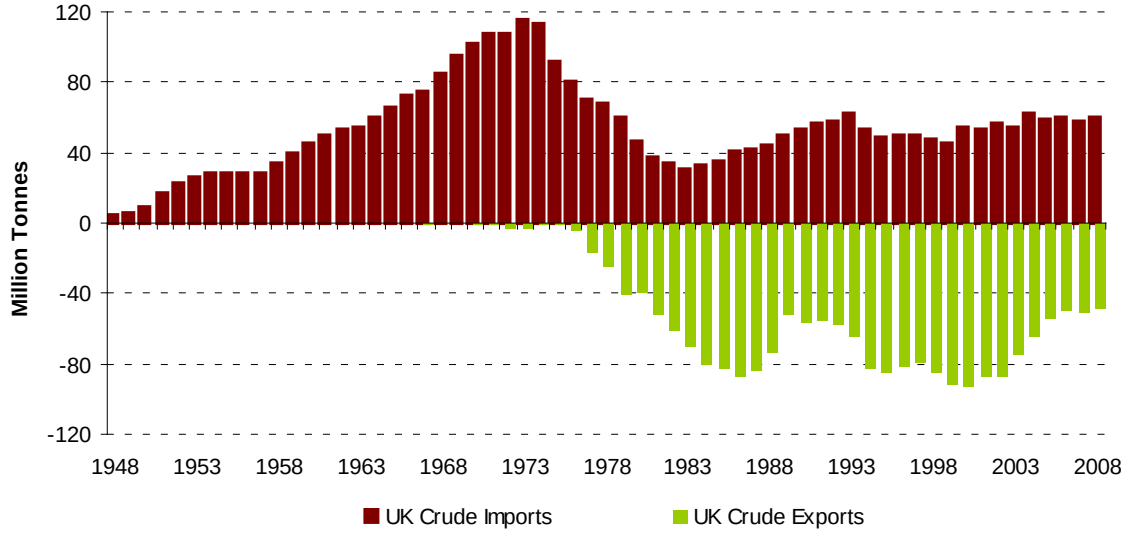
Crude Oil Imports and Exports

The evolution of UK foreign trade in crude oil between 1948 and 2008 is intrinsically linked to the relationship between indigenous crude oil production and refinery intake illustrated above. Until North Sea field discoveries in the 1970s, almost all of the UK's crude oil was imported. Total crude oil imports, illustrated in Chart 3.2, follow the same sharply upward trend as UK refinery intake until 1973, when imports peaked at 115 million tonnes. Crude oil imports decreased rapidly, mirroring the strong growth in indigenous production after 1975. UK crude imports declined to 30 million tonnes in 1983, a 12 per cent year-on-year average decrease from 1973.

Increasing indigenous production provided scope for the export of crude oil. Exports grew sharply from 1.5 million tonnes in 1975 to 87 million tonnes by 1986, representing an average annual rate of increase of 61 per cent. After becoming a net exporter of crude oil in 1981, the UK's trade surplus increased to its historic peak of 48 million tonnes in 1984.

Following the Piper Alpha disaster, UK net exports declined. Between 1989 and 1993, imports and exports were approximately equivalent, imports surpassing exports marginally in 1991 and 1992. During the 1990s, when UKCS production was at its highest, imports fell gradually and exports returned to pre-1988 levels. After peaking at 93 million tonnes in 2000, by 2008 crude exports have fallen 48 per cent to 48 million tonnes, 11.7 million tonnes lower than imports. The UK returned to being a net importer of crude oil in 2005.

Chart 3.2: Crude Oil Imports and Exports, 1948 to 2008



Until 1973, the principle sources of UK crude oil imports were Saudi Arabia, Iran and Kuwait. In 1973, the Middle East accounted for 72 per cent of all UK crude imports. African crude oil imports accounted for a third of UK imports in 1970, after having risen significantly in the 1960s. However, in the ten-year period following the nationalisation of Libyan oil resources in 1969, exports from Africa contracted by over 90 per cent.

The composition of UK crude oil imports has changed fundamentally since the early 1980s. The Middle East's share has fallen below one-third of total imports from 1983 and below ten per cent since 1999. Africa's share of imports has also remained below ten per cent since 1987. However, the share of Norwegian crude oil has grown from nil in 1970 to over 50 per cent of UK imports since 1991. In 2008, Norwegian crude imports equalled 31 million tonnes, equivalent to two thirds of total UK imports.

In the period 1980 to 2008, the composition of UK crude oil exports has remained relatively constant. The European Union was the main destination of UK exports, their share averaging 62 per cent over this period, with the vast majority of these being delivered to France, Germany and the Netherlands. Since 1980, the USA has received an average share of 25 per cent of UK crude exports. In 2008, exports to the USA were 9.7 million tonnes, 24 per cent of UK exports. Exports to EU countries amounted to 28.7 million tonnes, equivalent to 70 per cent of total exports.

Refinery Capacity

Crude oil distillation capacity in the UK has followed the same general trend over the past 60 years as refinery output. Rising sharply from 10 million tonnes per year in 1950, refinery capacity reached its historical peak of 149 million tonnes per year in 1974. Until 1970 there was little excess capacity above refinery throughput, however, following large expansion, distillation capacity rose to one-third higher than refinery throughput by 1974. Most UK refineries reduced their capacity in the late 1970s as refinery intake decreased. Between 1980 and 1984, four major refineries were shut down. Since 1985, UK refinery capacity has remained fairly constant at around 90 million tonnes per year, with excess capacity almost negligible during the 1990s before increasing gradually since 2001. In 2008, UK distillation capacity stood at 91 million tonnes per year.

Chart 3.3: UK Crude Oil Distillation Capacity by Region, 1950 to 2008

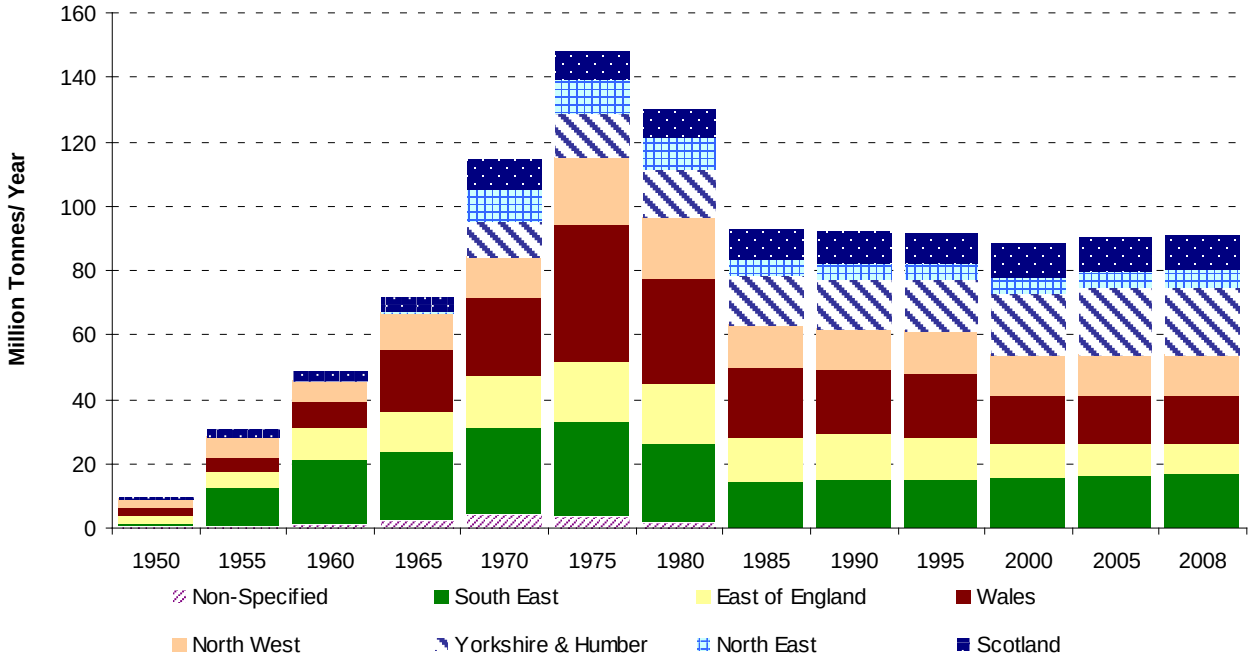


Chart 3.3 illustrates that the largest expansion of refinery facilities in the 1950s was seen in South East England. In 1960, when the South East accounted for 41 per cent of UK capacity, the country's two largest refineries were located at Fawley, Hampshire and the Isle of Grain, Kent. The 1960s were the decade of greatest expansion. Whilst the South East retained the greatest share, capacity in Wales increased to over five times its 1960 level by 1975, following the construction and expansion of refineries around Milford Haven, Pembrokeshire. By 1975, four of the UK's 19 refineries were located around Milford Haven, with a combined capacity of 35 million tonnes per year. Welsh refineries accounted for 29 per cent of UK distillation capacity in 1975.

Between 1975 and 1985, following refinery closures and downscales, capacity in Wales and South East England halved. Since 1985, the number of refineries with distillation capacity above 1.5 million tonnes per year has fallen from 12 to 9 following the closure of refineries at Shellhaven in Essex, and Milford Haven and Llandarcy in South Wales. Over the period, UK refinery capacity has shifted from the south and west to the north and east of the UK. In 2008, refineries on the North Sea coast accounted for 51 per cent of UK refinery capacity, compared to a share of 27 per cent in 1950.

Inland Deliveries of Petroleum Products

In 1948, inland deliveries of petroleum products, excluding refinery fuel use, totalled 13 million tonnes. Motor spirit and fuel oil accounted for 35 per cent and 22 per cent respectively of total deliveries, whilst gas/diesel oil's share was 18 per cent. In the ten years to 1957, deliveries had almost doubled to 23 million tonnes, before increasing at a much greater rate to their peak of 99 million tonnes in 1973.

This was a period of rapid expansion in the use of petroleum products in the UK transport sector. The combination of a strong increase in car ownership and the emergence of the road haulage industry, facilitated by the expansion of the domestic road network, led to a rapid increase in demand for petroleum fuels. Deliveries of motor spirit increased four-fold and gas/diesel oil nine-fold between 1948 and 1973. In 1973, motor spirit accounted for 17 per cent and gas/diesel oil for 21 per cent of petroleum product deliveries.

However, the sharpest increase over this period was in fuel oil where demand increased by an average annual rate of 12 per cent between 1948 and 1973. This was driven by increased demand for electricity generation and also for large-scale industrial use. Fuel oil represented an average 42 per cent share of product deliveries from 1958 to 1973.

Chart 3.4: UK Inland Deliveries of Petroleum Products, 1948 to 2008

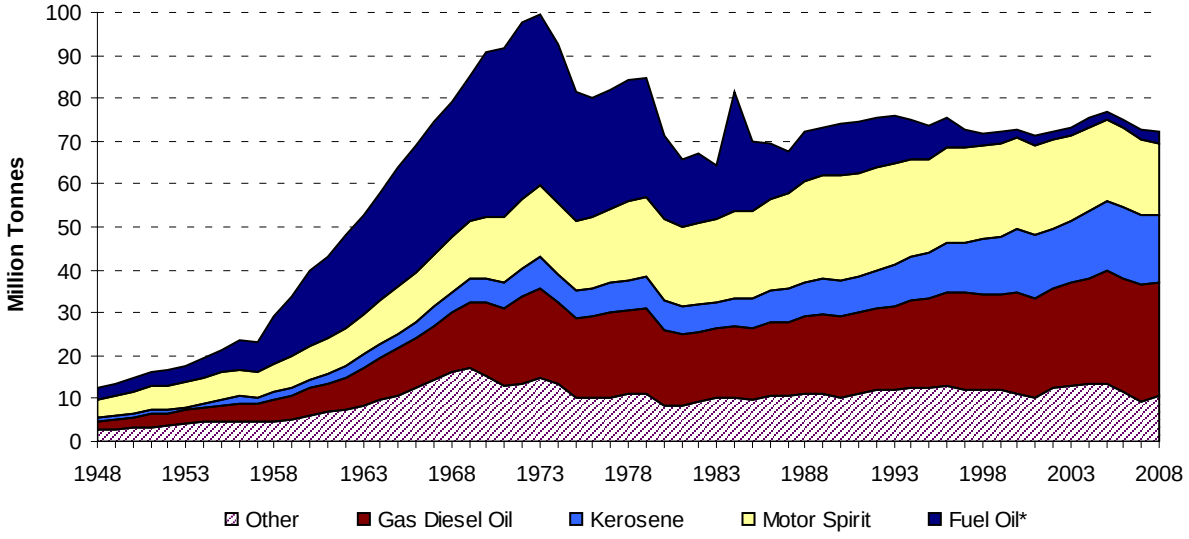


Chart 3.4 shows that 1973 also marks a turning point with regard to refinery intake. By 1983, inland deliveries of petroleum products had fallen to a post-1965 low of 64 million tonnes, representing a decline of 35 per cent from the 1973 peak. Over three-quarters of this fall were attributable to the rapid decline in fuel oil deliveries over this ten-year period, as it became increasingly uneconomic for use in large-scale energy generation. The long-term decline of fuel oil deliveries was interrupted only by the coal miners' strike of 1984, as fuel oil was used as a short-term substitute for coal-fired electricity generation. Since 1999, fuel oil deliveries (excluding refinery fuel use) have remained below 1948 levels, and in 2008 represented three per cent of deliveries. Deliveries of motor spirit increased slowly after 1973, and peaked at 24 million tonnes in 1990, around a third of total inland petroleum product deliveries. Gas/diesel oil deliveries had grown to 25 per cent of total deliveries and kerosene, which was beginning to increase, accounted for a 12 per cent share.

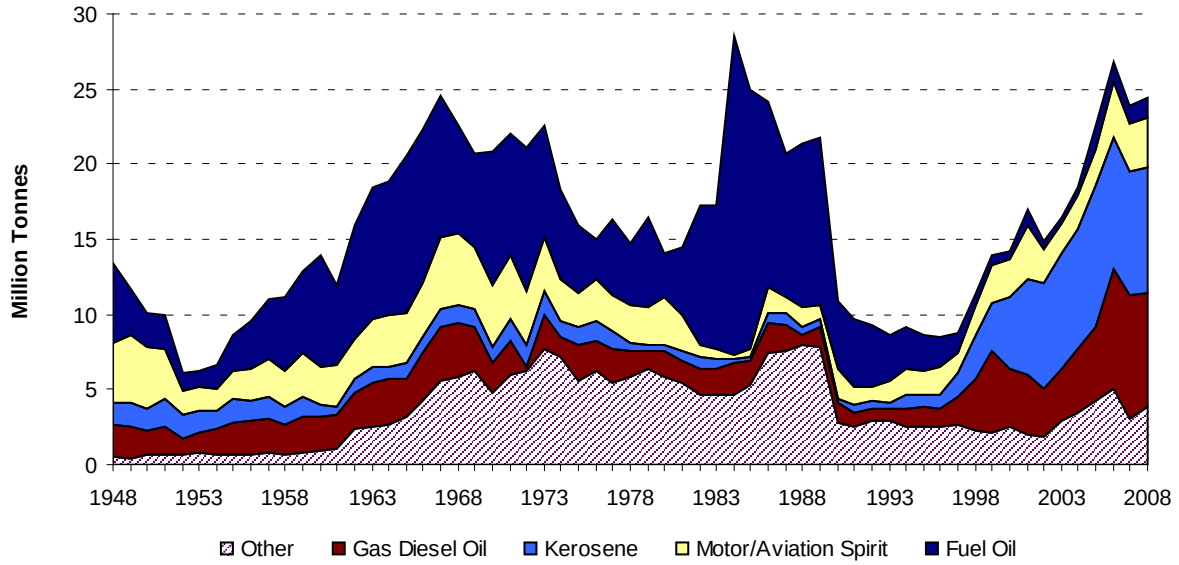
Whilst total inland deliveries have remained relatively stable since 1990, the composition has changed. A transition from motor spirit to diesel within automotive fuel use, and greater efficiency of car engines, has seen motor spirit deliveries fall by 31 per cent between 1990 and 2008, and total gas/diesel oil deliveries increased by 42 per cent over the same period. The growth of international air travel since 1990 has resulted in an 83 per cent increase in total UK kerosene deliveries by 2008. In 2008, 37 per cent of total petroleum product deliveries were gas/diesel oil, 23 per cent motor spirit and 22 per cent kerosene.

2008 saw an increase in the use of biofuels in transport, as prompted by the Renewable Transport Fuel Obligation. Biodiesel comprised 3.5 per cent of automotive diesel deliveries in 2008. This coupled with increased prices and decreased demand, a consequence of reduced economic growth, saw the first reduction in automotive diesel deliveries since 1981. With the inclusion of biodiesel, total DERV increased modestly in 2008.

Imports of Petroleum Products

Following the expansion of UK refineries in the early 1950s, imports of petroleum products fell by 55 per cent between 1948 and 1952 to 6 million tonnes. Imports then steadily increased between 1953 and 1967, with fuel oil accounting for an average of 40 per cent of imports over this period. Other imports over this period were predominantly split between motor spirit, naphtha and bitumen. After reaching 24 million tonnes in 1967, UK petroleum product imports declined to 14 million tonnes by 1980, due principally to a sharp decrease in fuel oil imports.

Chart 3.5: UK Imports of Petroleum Products, 1948 to 2008



The coal miners' strike of 1984 prompted an immediate need for very significant quantities of fuel oil. With indigenous refinery output unable to meet the renewed demand for a coal substitute fuel, imports played a crucial role in meeting short-term demand. The spike in fuel oil imports, illustrated in Chart 3.5, reached 21 million tonnes in 1984 and brought total petroleum product imports to 28 million tonnes, their highest level over this 60 year period.

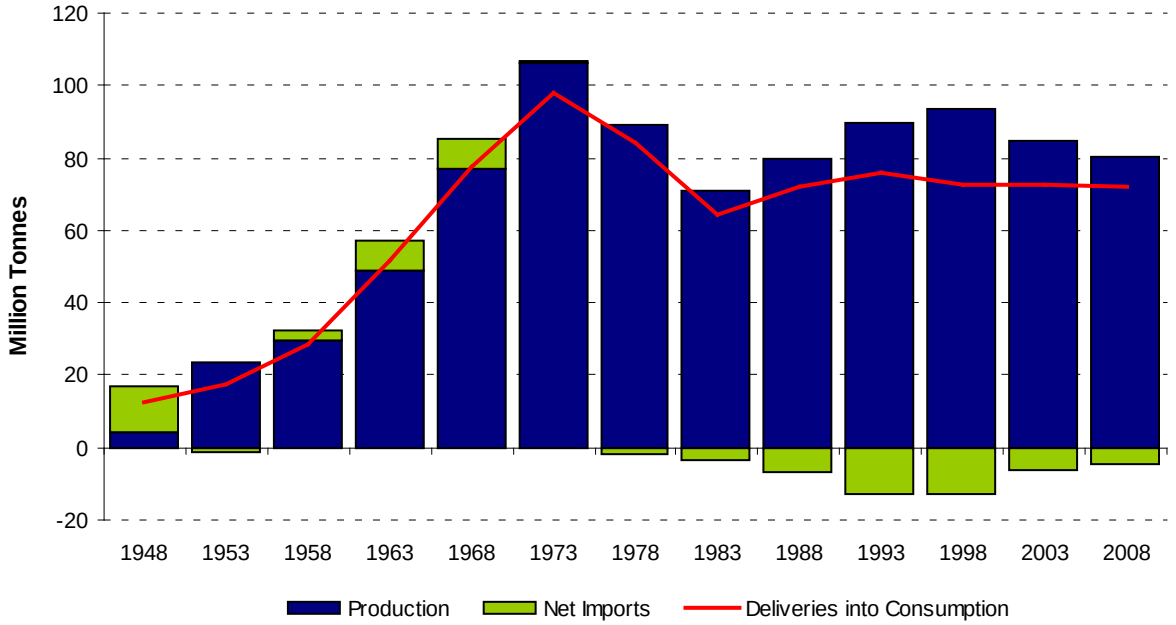
The subsequent decline in fuel oil imports, combined with small imports of transport fuels, resulted in total petroleum product imports falling as low as 8.4 million tonnes in 1996. Since 1996 however, imports to the UK have risen steadily, driven almost entirely by rising gas/diesel oil and kerosene imports, as indigenous refinery output has not expanded or been re-configured to match the evolving demand patterns for these fuels. In 2008, petroleum product imports totalled 23.9 million tonnes, with kerosene and gas/diesel oil accounting for 8.5 and 7.5 million tonnes respectively. Both fuels' imports are more than twice 1998 levels.

However, despite these increases in product imports, the UK has continued to be a net exporter of petroleum products since 1985, led particularly by fuel oil and motor spirit. In 2008, UK exports of these products amounted to 7.3 and 7.0 million tonnes respectively, equivalent to 25 and 24 per cent of total petroleum product exports.

UK Petroleum Product Balance

Chart 3.6 illustrates how indigenous refinery production and net imports of petroleum products have met total inland deliveries into consumption.

Chart 3.6: UK Petroleum Product Balance, 1948 to 2008



In 1948, with refinery output of only 4 million tonnes, net imports of petroleum products totalling 13 million tonnes constituted the largest contributor to UK inland deliveries. Whilst in 1953 the UK was a marginal net exporter of products, the trend until 1970 was of indigenous refinery output meeting an ever increasing proportion of inland product demand, with the UK remaining a small net importer of products.

Refinery product output peaked at 106 million tonnes in 1973. Following this peak in indigenous production, refinery output remained greater than total inland deliveries. This production surplus provided scope for the UK to become a net exporter of petroleum products from the mid-1970s onwards. Remaining a minor net exporter of products throughout the 1980s, net exports rose to 13.0 million tonnes in both 1993 and 1998, equivalent to around 14 per cent of UK refinery output in their respective years. Net exports have fallen since 2000, standing at 4.9 million tonnes in 2008, equivalent to 6.1 per cent of indigenous refinery production.

References:

Digest of UK Energy Statistics 2009 and earlier editions back to 1948/49
Long term trends Chapter 3 available on DECC Website at:
www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx

Energy Trends tables
"Crude Oil and petroleum: production, imports and exports, 1890 to 2005"
"Crude oil and petroleum products: imports by product, 1920 to 2006"
Available on DECC Website at:
www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx

JODI Annual Balances 1948 and 2008

One means of examining the evolution of UK oil production, trade and consumption of petroleum products is to examine 1948 and 2008 data in the form of a Joint Oil Data Initiative (JODI) balance. JODI is an internationally agreed format which countries submit on a monthly basis. These tables allow us to concisely illustrate the differences between petroleum's role in the UK economy in 2008 and at the time of the first publication of DUKES sixty years previous.

Country UNITED KINGDOM
Year 1948 *Unit* Thousand Metric Tons

		Crude Oil			Petroleum Products					
					LPG	Gasoline	Kerosene	Gas/Diesel Oil	Fuel Oil	Total Oil
Production		153	Refinery Output			618	121	888	1,757	4,426
Imports		4,641	Imports			3,941	1,487	2,116	5,202	13,242
Exports		0	Exports			-63	-10	-29	-112	-344
Stocks	Closing		Stocks	Closing						
	Change			Change						
Refinery Intake		4,538	Demand			4,538	1,439	2,185	3,141	13,165

Despite the clear gulf between the scale of the two balances, there are a few revealing anomalies. In 2008, UK demand for fuel oil was only marginally greater than that in 1948, and fuel oil imports in 2008 were less than one quarter of their 1948 levels. Equally, imports of gasoline were 16 per cent lower in 2008 than sixty years earlier.

Country UNITED KINGDOM
Year 2008 *Unit* Thousand Metric Tons

		Crude Oil			Petroleum Products					
					LPG	Gasoline	Kerosene	Gas/Diesel Oil	Fuel Oil	Total Oil
Production		65,497	Refinery Output		2,248	20,319	9,640	26,971	11,349	80,340
Imports		51,466	Imports		805	3,324	8,489	7,468	1,198	23,916
Exports		-41,504	Exports		-1,060	-7,018	-2,121	-7,277	-7,304	-28,811
Stocks	Closing	4,813	Stocks	Closing	156	999	1,343	2,288	638	6,872
	Change	-173		Change	-30	25	277	34	-55	292
Refinery Intake		75,844	Demand		3,294	16,708	15,836	26,579	3,289	75,856

Please note that DECC records of petroleum stock levels are unavailable as far back as 1948. LPG data is also unfortunately unavailable for this year.

Chapter 4 - Gas

History of Gas Supply and Use

Public supply of gas in Britain dates from 1807 when Pall Mall in London was the first street to be lit by gas. In 1812 the London and Westminster Gas Light and Coke Company received a Royal Charter to supply gas light in London. In the early years gas was used almost exclusively for lighting and was provided by a growing number of commercial and municipal undertakings which made gas from coal. Between the First and Second World Wars the industry faced increasing competition from electricity and by 1939 the gas industry had changed to being a supplier of gas for heating rather than just lighting.

The Gas Industry

Prior to 1949 the industry was a mixture of private and municipal undertakings. The Gas Act of 1948 vested the assets of 991 undertakings (269 of which belonged to local authorities) in 12 Area Gas Boards co-ordinated by the Gas Council (Great Britain). The advent of North Sea natural gas in the 1960s, with the requirement for a national transmission system, led to a strengthening of the Gas Council's role. The structure of the industry was changed again under the Gas Act of 1972 and on 1 January 1973 the British Gas Corporation came into being and the 12 separate Area Boards were dissolved.

The Gas Market

When British Gas was privatised in December 1986 it was given a statutory monopoly of supplies of natural gas to premises taking less than 732,000 kWh (25,000 therms) a year. Larger customers could buy their gas from any supplier but no additional suppliers entered the market until 1990. Further moves to promote self-sustaining competition in gas supply resulted in the threshold being reduced to 73,200 kWh (2,500 therms) in July 1992 leaving only the domestic sector and small industrial and commercial premises outside the competitive market place. In addition the separation of British Gas's supply and transportation activities took place in December 1993. Finally the 1995 Gas Act extended competition in stages to all gas supply and full competition was achieved in May 1998. From there being just the one company at the time of privatisation, in mid 2001 there were 34 companies supplying gas to consumers.

In Northern Ireland the gas supply industry was not nationalised and remained in the hands of municipal undertakings and statutory and non-statutory companies until they ceased to operate in 1988. Natural gas was not available in Northern Ireland until 1996 when the province was linked to the mainland's transmission system via a pipeline link from Scotland. At first it was used only for power generation although since 1997 supplies have been available to industrial and commercial consumers as well.

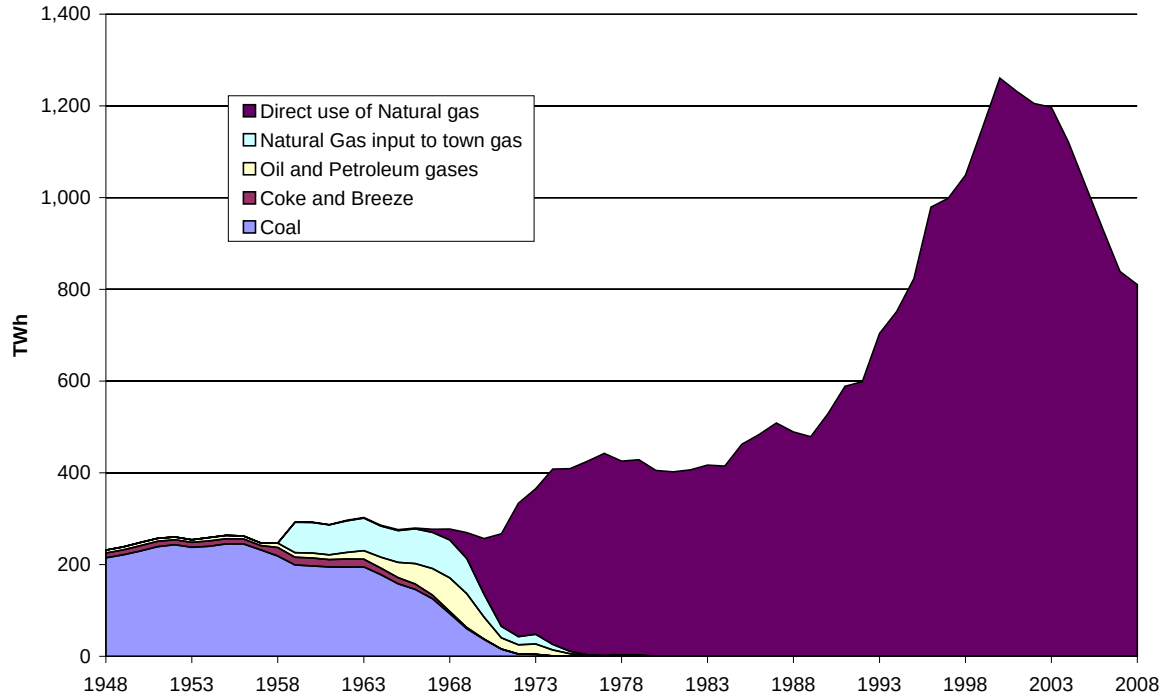
Gas Statistics

Full statistics for the industry can be traced back only as far as 1921. Before that date companies were required to report on their activities to the Board of Trade and limited information is available from 1882. But it was the advent of nationalisation and the start of regular publication of gas data in DUKES that marks the start of the statistical history of gas use in the UK. For consistency, all data presented below have been converted to GWh.

Gas production

Today we are used to gas being extracted from wells in the same way as oil and often its production is associated with oil. However, in its early years coal was the primary fuel from which gas was made, with town gas being produced by high temperature carbonisation i.e. the heating of coal in retorts and the injection of steam (Chart 4.1). In the 1950s and 60s oil was also used in gas making. Traditional town gas supplies were supplemented by quantities of gas from coke ovens, blast furnaces and refineries and also by methane imported as LNG from the Algerian Sahara.

Chart 4.1: Fuel input to gas making



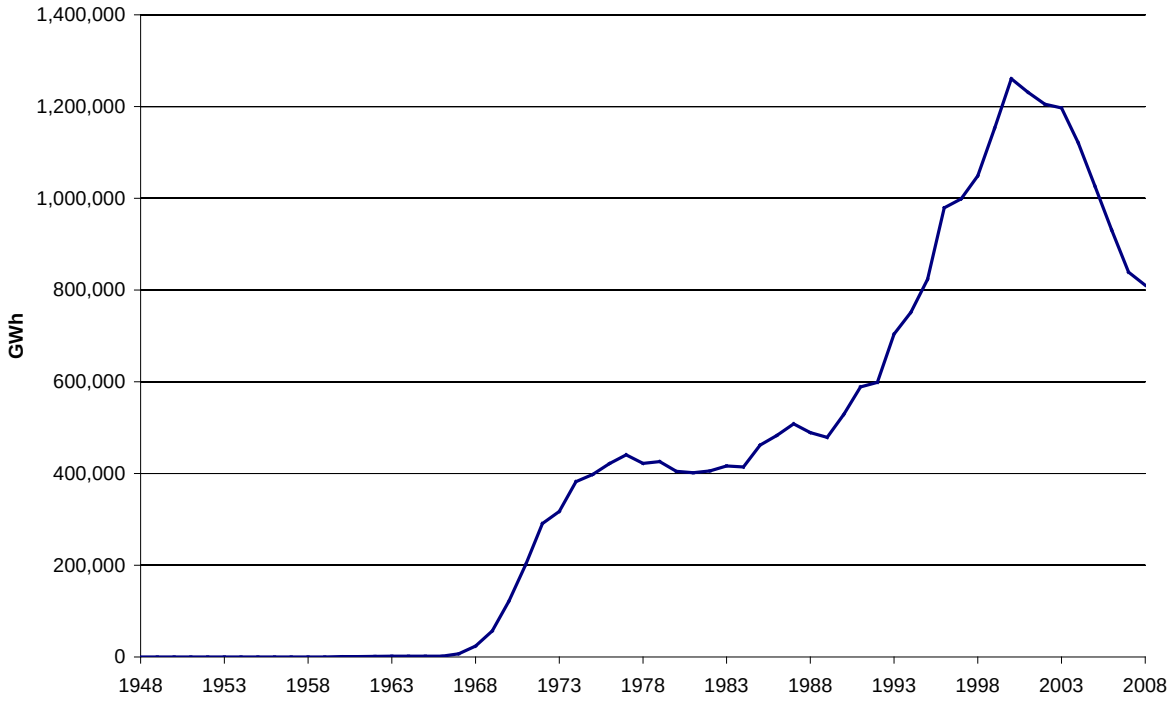
The production of substantial quantities of natural gas from beneath the Southern North Sea (which began in July 1967) transformed the industry and in the 1970s the quantity of gas produced and consumed was four times that of the 1960s. At first natural gas was converted into town gas and natural gas supplies to gas works peaked in 1971. Direct supplies of natural gas began in 1968 and by 1972 exceeded town gas supplies for the first time. Gas making from coal ceased in 1979 but town gas supplies remained in Northern Ireland until 1988.

When gas was made from other fossil fuels a large part of the energy content of these fuels was lost in the transformation process. Typically in the 1930s the energy

content of the gas produced was only a quarter of the energy content of the input fuels. As a result gas was a relatively expensive fuel. Today there are no transformation losses but some gas is lost during the distribution process and some is used by producers and distributors (about 6.4 per cent in 2008).

Gas production (Chart 4.2) in the form of methane started in the early 1960s but by 1966 just 1,876 GWh was being produced. However, in the next 5 years the industry expanded significantly with annual production increasing by an average of 138 per cent per year until 1971 when output had reached 201,721 GWh. The industry continued to expand but at a lower rate of 17 per cent per year until 1976 when output had reached 421,700 GWh. From 1976 to 1992 there was more a more gradual rise of around 2 per cent per year, but this was followed by far more significant growth of 10 per cent per year between 1992 and 2000, when output rose from 598,761 GWh to 1,260,656. Since 2000 production has been in decline with output falling by an average of 5 per cent per year. In 2008, production was at 809,649 GWh, around 36 per cent lower than the 2000 peak.

Chart 4.2: UK natural gas production



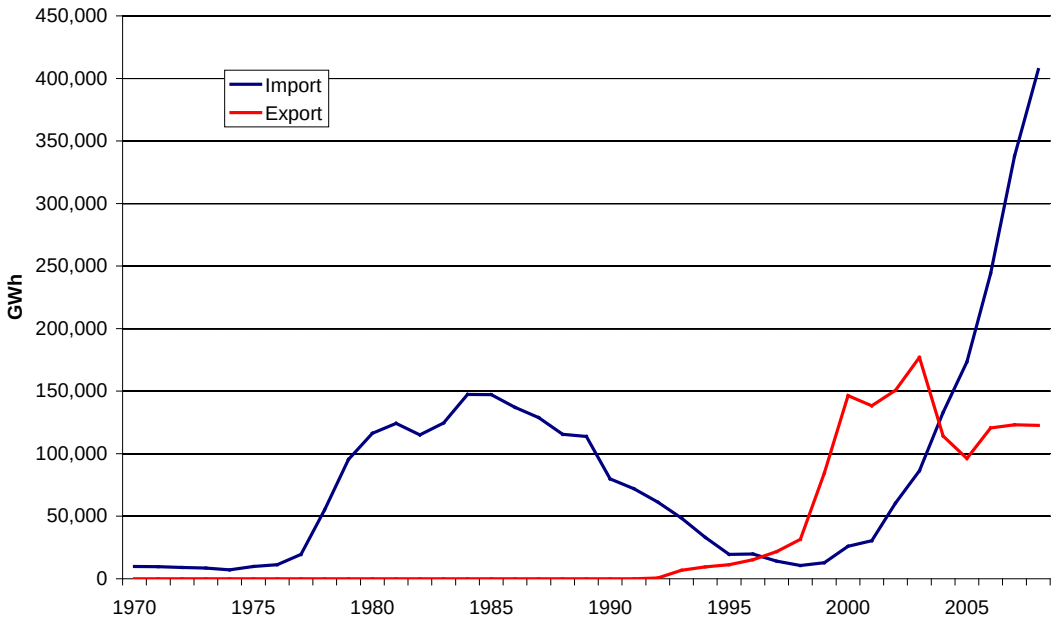
Gas Trade

As well as the Southern North Sea gas fields, the discovery of oil in the Northern North Sea provided additional sources of gas in the form of associated gas which was largely separated from the oil on the oil platforms and piped to Scotland and Northern England. Further gas was discovered on the continental shelf between Britain and Norway leading to the first piped imports of Norwegian natural gas in 1977. In the 1980s the UK consumed 25 per cent more gas than it produced (Chart 4.3) because of these imports, but in the late 1980s imports of gas declined as output from the UK/Norwegian transboundary Frigg field tailed off and UK production

increased, including from the Irish Sea. In the 1990s the UK become a net exporter of natural gas through the Bacton to Zeebrugge interconnector (which has tied the UK gas market more closely to that of continental Europe and continental price mechanisms), from the Markham and Windermere fields in the southern North Sea (which are connected by pipeline to mainland Europe) and also to the Republic of Ireland via pipelines from Scotland.

By 1997 the UK was a net exporter of gas with net exports of 7,600 GWh. Net exports reached a peak of 120,300 GWh in 2000 and total exports remained at levels between 150,000 and 200,000 GWh until 2003 (with net exports around 90,000 to 100, 000 GWh). But by 2004 UK production had declined and imports had increased bringing to an end the short period of net exporting. As gas production has fallen in the UK, by 2008, net imports had risen to 284,000 GWh and were accounting for around 26 per cent of total UK demand.

Chart 4.3: UK trade in natural gas, 1970 to 2008

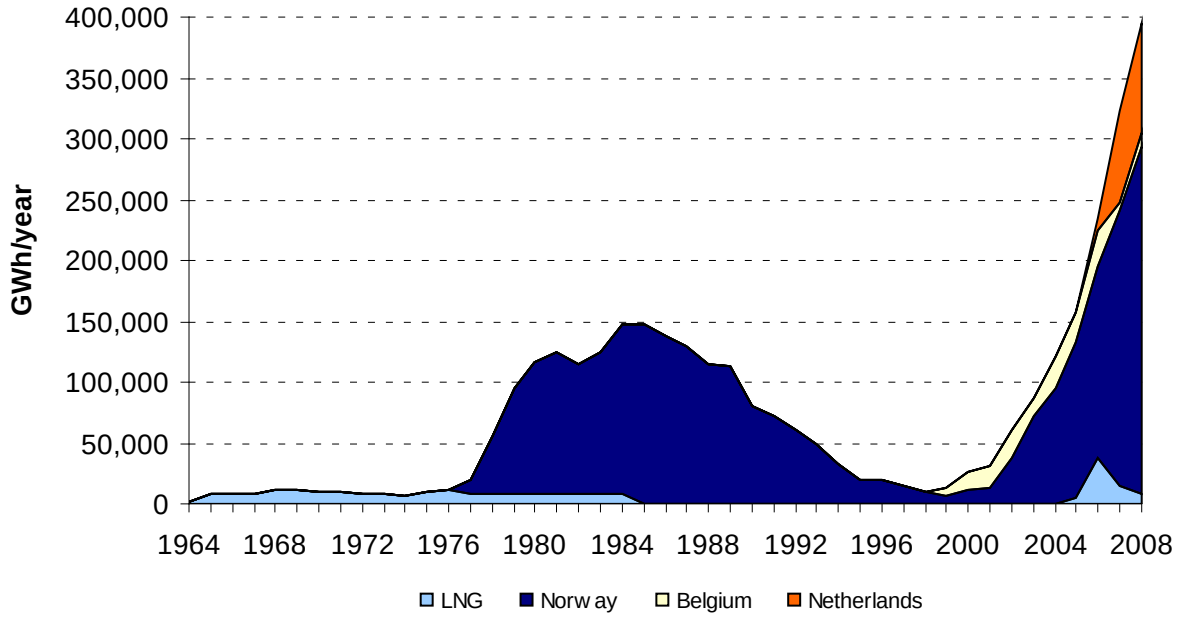


Imports

The UK first began importing gas from Algeria in liquefied form (LNG) in 1964 and continued to do so until the contract expired in 1984. In 1977 gas production commenced from the transboundary Frigg field. Approximately 40 per cent of Frigg gas was located in the UK sector of the North Sea with the remaining 60 per cent located in the Norwegian sector. Frigg production peaked around 1985 and then went into decline as reserves were depleted. Frigg ceased production in 2004. However, the Frigg pipeline infrastructure was also used for other Norwegian field developments (East Frigg, Lille Frigg and Froy). Additional supplies from Norway to the Frigg terminal commenced in 2001 with gas imports via the Vesterled pipeline (from Heimdal and later renamed the Frigg Norway pipeline).

Other gas import developments have included: 1998 - Bacton-Zeebrugge interconnector (initially mainly for export, but subsequent major increase in import capacity; 2005 – LNG imports recommence at the Isle of Grain terminal (with limited LNG imports at Gasport Teesside in 2007), sources by the end of 2008 – Algeria, Egypt, Qatar and Trinidad & Tobago; 2006 – additional imports from Norway via the Langeled pipeline and from the Netherlands via the BBL interconnector; 2007- additional imports of gas from Norway via the new Tampen Link pipeline which connects with the existing UK FLAGS pipeline. In addition, additional LNG capacity has been developed in late 2008 and the start of 2009.

Chart 4.4: UK natural Gas imports by source



Norway has traditionally been the major source of imports to the UK and in 2008 it accounted for 72 per cent, with the Netherlands accounting for 23 per cent, LNG imports 2 per cent and flows through the interconnector from Belgium 3 per cent. Imports from Belgium in chart 4.4 represent the source of the gas, not the physical origin, and are the physical flows through the pipeline as opposed to the nominated flows used by National Grid.

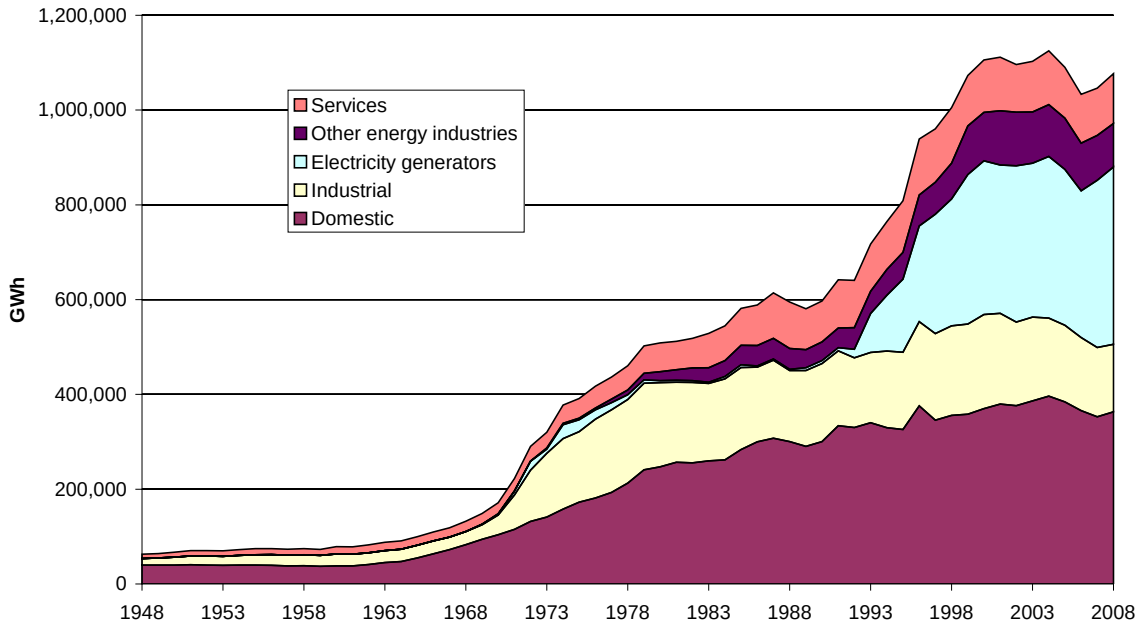
Gas consumption

The advent of natural gas in the 1970s led to a substantial increase in gas consumption. Between 1960 and 1970, gas consumption doubled and then trebled between 1970 and 1980. Total gas use was 509,000 GWh in 1980, compared to 79,000 GWh in 1960. During the 1980s, gas consumption grew more steadily, increasing by just 17 per cent over the decade, but then with the introduction of gas-fired power generation virtually doubled again between 1990 and 2000, leaving gas consumption at 1,106,000 GWh in 2000. Since then gas use has fluctuated more given year on year changes in generation mix, temperatures and increasing awareness of energy efficiency. The peak of gas use to date has occurred in 2004 at 1,125, 000 GWh but had fallen to 1,077,000 in 2008, a reduction of 4.3 per cent since 2004 (Chart 4.5). There were around 22 million gas customers in the UK in 2007

compared with 13 million in the 1960s with most of the increase being domestic sector customers

The way in which gas has been used has changed through time. From a predominant use for lighting in its early years, space heating and cooking use developed and predominated until use for industrial processes really began in the early 1970s. Alongside greater use in industry there have also been increases in services and energy industry use since 1980 and most recently, with the advent of combined cycle gas turbine power stations, a rapid growth in gas use for electricity generation since the early 1990s. To put the change in gas use for electricity generation in context throughout the 1990s gas consumption for generation grew by an average of 70 per cent per year compared to average growth of around 10 per cent per year in the domestic, industrial and services sectors since these sectors had already converted to gas in the late 1960s and 70s. Since 2000 gas consumption has generally been on a downward trend, excepting annual variation in consumption for generation. Both the services and domestic sectors have seen consumption fall by around 1 per cent per year on average, whilst the industrial sector has reduced gas use by around 4 per cent per year.

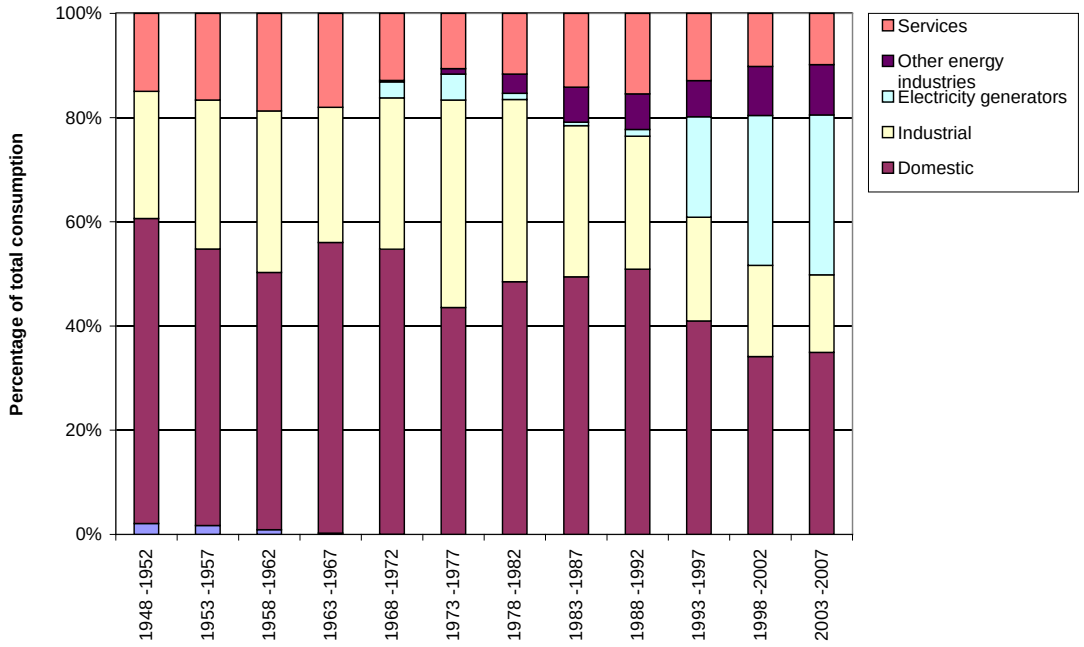
Chart 4.5: Gas consumption by sector



Whilst initially dominant, the domestic sector's share of gas consumption has generally been declining since the 1940s when it stood at over 60 per cent (Chart 4.6) as gas has made inroads into other markets. In the 1970s industry took an increasing share of the gas market as processes requiring bulk heat were converted to gas from coal and oil so by the mid 1970s industrial gas use was only just below that of domestic (in 1973, 44 per cent of gas use was for domestic, 42 per cent for industry). Moving into the 1980s the domestic sector's share of use grew again to around 50 per cent where it stayed until the early 1990s when use of gas for electricity generation started to grow. In 1992, 3 per cent of total gas use was for

electricity generation. By 1994 this had become 15 per cent and by 1999 almost 30 per cent. Electricity generation has consumed around 30 per cent of gas for each year in the current decade. With the improvements to energy efficiency a factor in reducing domestic consumption, by 2008, more gas was used for generation (35 per cent) than for any other purpose.

Chart 4.6: Proportion of gas consumption by sector



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A History of the British Gas Industry, Trevor I Williams (OUP, 1981)
Gas Undertakings 1920 and Gas Undertakings 1938

The data set on which this article is based is available on the DECC web site at www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx. The data have been converted into a common energy unit of GWh.

Chapter 5 - Electricity

History of the electricity Industry

In 1881, Godalming in Surrey was the first town to provide a true public electricity supply scheme combining public and private lighting in one commercial undertaking. Water power from the River Wey was used. The first steam station was at Holborn Viaduct in London in 1882, but like Godalming it could not compete on price with gas for lighting and it closed in 1884.

The Electricity Supply Act of 1919 established the Electricity Commissioners with the duty of promoting, regulating and supervising the supply of electricity. The Electricity (Supply) Act of 1926 set up a Central Electricity Board who devised a scheme for connecting areas with primary transmission lines of 132,000 volts. Standardisation of frequency at 50 Hz ac (some areas such as North East England used 40 Hz) took longer and the full grid was not completed until 1947. In 1945 240 volts ac became standard.

On 1st August 1948 the British electricity supply industry was nationalised. The British Electricity Authority (BEA) became responsible for the generation of electricity and its bulk transmission to 14 separate statutory Area Electricity Boards. It also had a general co-ordinating role for all of the industry except the north of Scotland. In 1957 the BEA was abolished and in England and Wales the Central Electricity Generating Board (CEGB) took responsibility for the generation of electricity. It also took responsibility for the transport of this power through the nation-wide transmission system (the “National Grid”) to a number of “bulk supply points”. In England and Wales 12 Area Electricity Boards received power at these supply points and delivered it to customers through their own distribution networks. The Electricity Act 1989 brought privatisation which introduced competition into the industry (from 1st April 1990). The Area Boards became public electricity supply companies (PES). The national grid and pumped storage stations were vested in the National Grid Company and the CEGB’s fossil fuelled power stations were divided between two new generating companies, National Power and PowerGen. The CEGB’s nuclear stations were transferred to a new public sector company, Nuclear Electric.

Since the 1989 Electricity Act many new companies, including a number of public electricity suppliers, have become involved in electricity generation, often through the construction of new combined cycle gas turbine (CCGT) power stations. There were a number of mergers and take-overs between electricity generation and electricity supply businesses including by foreign companies. Following an early wave of takeovers by US-based utility companies such as Enron and TXU, this foreign ownership has been mainly European. Since May 1999 the electricity market in Great Britain has been fully open to competition with all consumers able to choose their supply company.

In March 2001, the means of trading electricity changed with the introduction in England and Wales of the New Electricity Trading Arrangements (NETA). This replaced the Electricity Pool of England and Wales and was designed to be more efficient and provide greater choice for market participants, whilst maintaining the operation of a secure and reliable electricity system. In April 2005 this system was extended to Scotland under BETTA.

Scotland

In Scotland, the 1948 nationalisation saw two Area Boards created in South East and South West Scotland (under the BEA). The Highlands and Islands of Scotland had, since 1943, been served by a public corporation called the North of Scotland Hydro-Electric. In 1957 the South of Scotland Electricity Board (SSEB) took over the British Electricity Authority's functions in Scotland. In 1990 the SSEB's two nuclear stations were transferred to a new public sector company, Scottish Nuclear. Until the end of March 2005, the two main companies, Scottish Power and Scottish and Southern Energy, covered the full range of electricity provision. They operated generation, transmission, distribution and supply businesses. In addition, there were a number of small independent hydro stations and some independent generators operating fossil-fuelled stations, which sold their output to Scottish Power and Scottish and Southern Energy. At this time the Scottish transmission system was regarded as being linked to that in England and Wales by two interconnectors but under BETTA National Grid took on responsibility for operating the transmission system in Scotland as well as England and Wales. Thus a single Great Britain market has been created and the transmission network is regarded as a single system.

Northern Ireland

In 1951 the 73 electricity supply companies in Northern Ireland were combined into three publicly owned companies run by Belfast City Corporation, Londonderry Corporation and the Electricity Board of Northern Ireland. These bodies also owned and operated Northern Ireland's power stations. In 1973 these three bodies became one publicly owned company, Northern Ireland Electricity Supply (NIES). In 1992 the power stations were sold to private sector companies and the rest of NIES was privatised as Northern Ireland Electricity. In December 2001, the link between Northern Ireland's grid and that of Scotland was inaugurated. A link between the Northern Ireland grid and that of the Irish Republic was re-established in 1996, along which electricity is both imported and exported. However, on 1 November 2007 the two grids were fully integrated and a joint body SEMO (Single Electricity Market Operator) was set up by SONI (System Operator for Northern Ireland) and Eirgrid from the Republic to oversee the new single market.

Electricity Statistics

Changes to the structure of the industry have affected the availability of electricity statistics. Before 1951 the available data relate to Great Britain and public supply only. Limited statistics on electricity generation and use in Northern Ireland were collected from 1951 onwards as were statistics of generation by companies mainly for their own use (autogenerators). Detailed generation, fuel use, and electricity consumption statistics covering all of the UK are not available before 1987.

Power Generation Industry

In 1948 the newly nationalised power generation industry had a much different structure to today. Power stations were very much locally based, smaller in size and mainly coal-fired.

So although there were more power stations operating in Great Britain than in March 1949, in May 2008 the generating capacity was 5 times the 1949 size (Table 5.1). In March 1949 the largest station was at Barking, Greater London (522 MW) and the only other station greater than 500 MW was at Hams Hall, Birmingham. In contrast, over 40 per cent of the thermal stations in Great Britain in 2008 were greater than 500 MW in size. Nearly half the stations in 1949 were under 10 MW in size but accounted for only 2½ per cent of the generating capacity at the time. Forty five per cent of the capacity was in the 38

generating stations that were between 100 and 300 MW in size, as Charts 5.1 and 5.2 show.

Table 5.1: Power stations[(1)] by size in March 1949 and May 2008

	March 1949		May 2008	
	Number operational	Total installed capacity	Number operational (2)	Total installed capacity
Megawatts (MW)				
under 10 MW	143	331	11	56
10 to 24 MW	45	774	13	138
25 to 49 MW	27	1,002	14	311
50 to 99 MW	39	2,815	6	67
100 to 149 MW	21	2,539	6	535
150 to 299 MW	17	3,332	6	1,315
300 to 399 MW	3	1,012	4	1,455
400 to 499 MW	-	-	9	3,698
500 to 999 MW	2	1,038	22	15,685
1,000 to 1,499 MW	-	-	15	18,994
1,500 to 1,999 MW	-	-	9	12,970
2,000 to 2,499 MW	-	-	4	12,576
over 2,500 MW	-	-	1	3,945
Total	297	12,845	120	71,745

(1) Stations in the North of Scotland (mainly hydro) and stations in Northern Ireland are not included in this table because the information was not available for March 1949.
(2) Gas turbines on the site of a larger coal, oil or gas fired station are counted as one station but Didcot A and Didcot B are counted separately.

Of the generating capacity not shown in Table 5.1, it is estimated that there were 34 Hydro stations in the North of Scotland in 1949 with a combined capacity of around 260 MW.

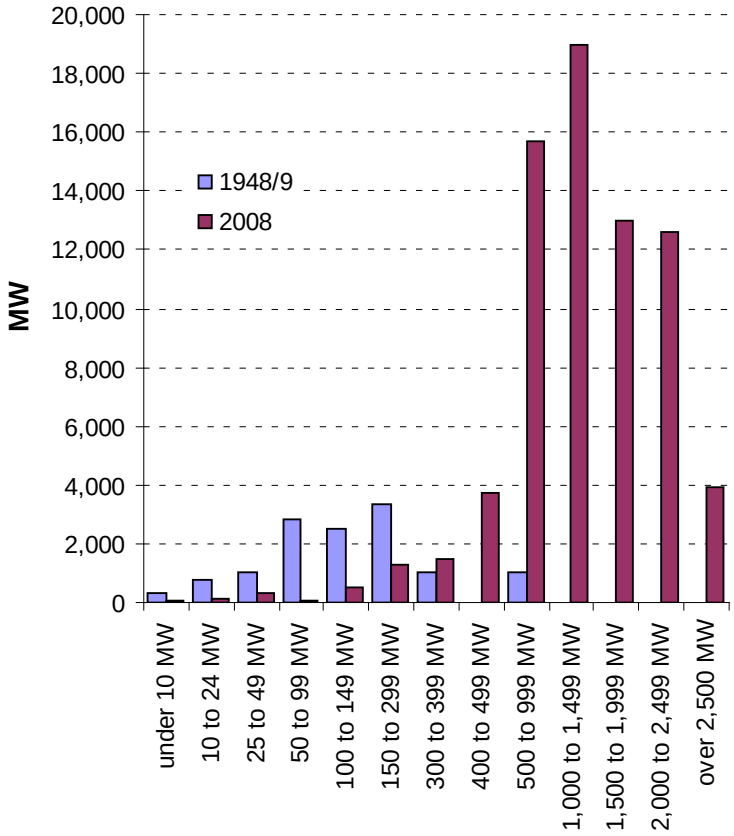
Table 5.11 of the Digest of United Kingdom Energy Statistics lists power stations (over 1 MW) in operation each year, and this is one of the most accessed tables from the Digest on the DECC web site. As a companion to this table, and as part of the 60th anniversary publication, a corresponding table for 1949 has been produced and is on the DECC website listing the 297 stations, their "Division" (which corresponds to today's DNO areas and their installed capacity.

Table 5.2: Power stations[(1)] by type in March 1949

Type of station	Number operational	Total installed capacity (MW)
Steam	197	12,596
Internal combustion	61	52
Hydro	21	171
Internal combustion and Hydro	12	7
Steam and internal combustion	6	19
Total	297	12,845

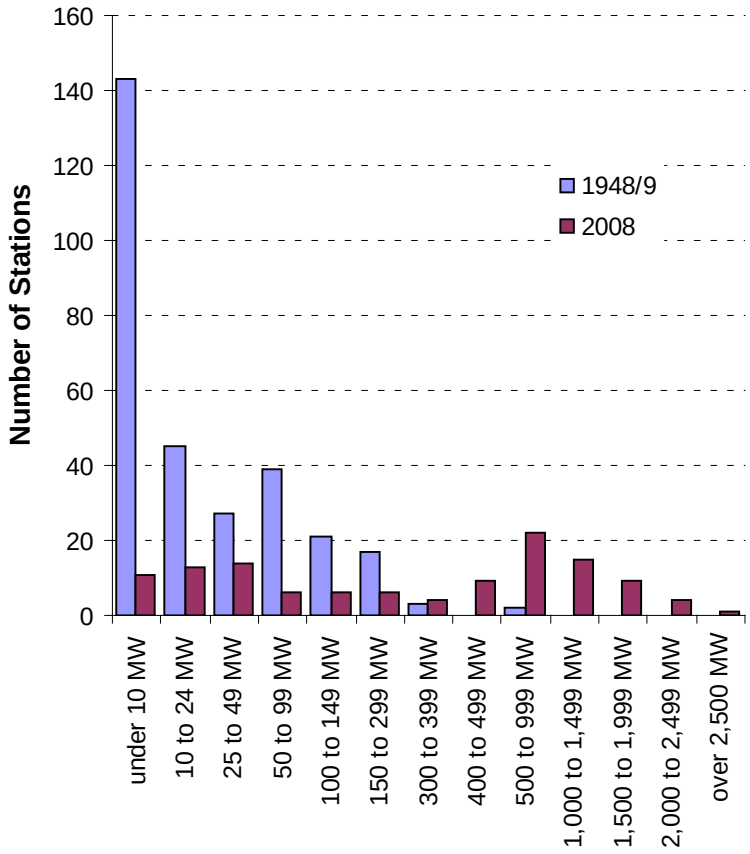
(1) Stations in the North of Scotland (mainly hydro) and stations in Northern Ireland are not included in this table because the information was not available for March 1949.

Chart 5.1: Power station capacity 1949 and 2008



In 1949 two thirds of the power stations in Great Britain were steam stations overwhelmingly fired by coal (and coke). A further fifth of stations were internal combustion engines (and hence oil fired) and just over 10 per cent were hydro or both hydro and internal combustion. Because the steam fired stations (on average over 60 MW each in size) were much larger than the internal combustion stations (typically less than 1 MW each in size), 98 per cent of generating capacity was accounted for by steam stations, just over 1 per cent by hydro and just under 1 per cent by internal combustion stations. At the end of 2007, 78 per cent of the capacity of UK major power producers was in conventional steam stations and CCGT stations, 15 per cent was nuclear, 2 per cent was internal combustion engines and gas turbines and the remaining 5 per cent hydro pumped storage, natural flow hydro and other renewables.

Chart 5.2: Number of power stations 1949 and 2008

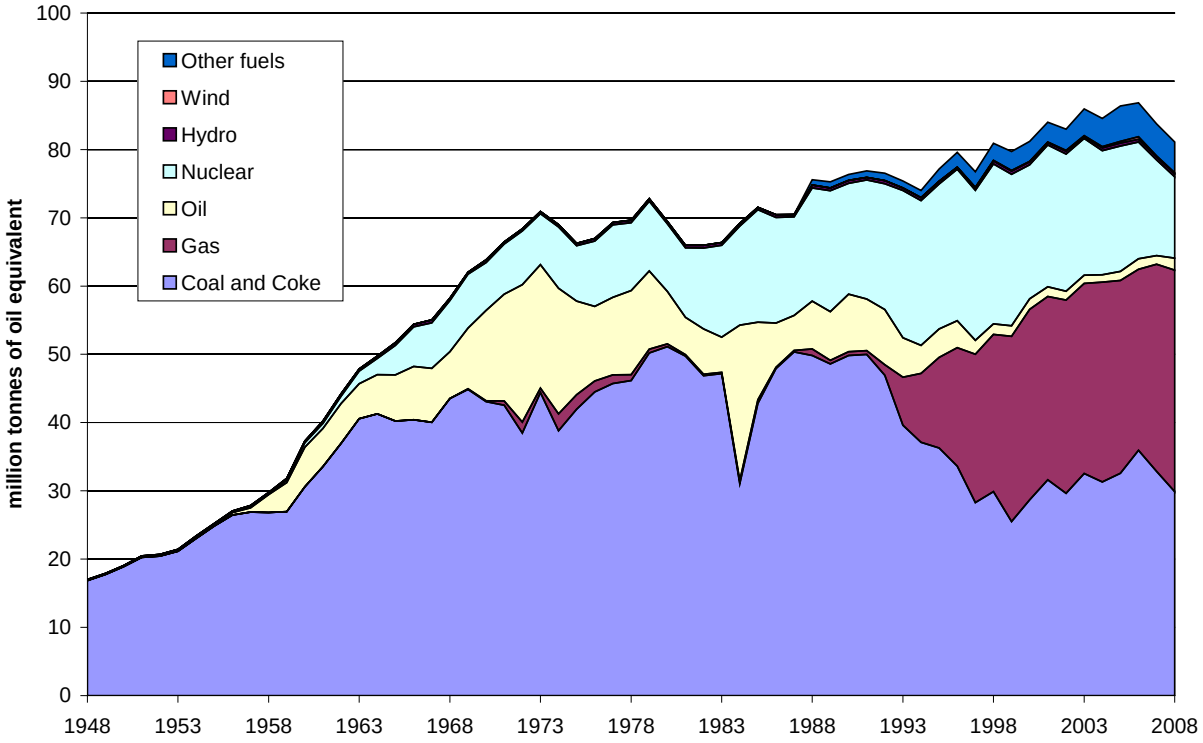


Fuels used to generate electricity

Although the first public supply of electricity used hydro power as a source, coal quickly became the fuel of choice for generation and maintained that lead until natural gas use briefly exceeded coal use in 1999. Subsequently use of coal and gas has tended to fluctuate under the influence of prices and availability of other sources such as nuclear but with coal use higher by between 1 and 9 Mtoe in each year since 2000 (Chart 5.3). Oil began to be used in quantity for generation in the 1950s and reached its peak in the early 1970's. The first nuclear power station began generating in the UK in 1956, but commercial scale nuclear generation dates from 1962. Although some gas was used for generation in the 1970s, between 1975 and 1990 a European Community Directive limited the use of natural gas in public supply power stations.

The use of gas as a major fuel for generation dates from the commissioning of the first CCGT station in 1992. Gas consumption increased more than 10 fold (1.5 to 17.4 Mtoe) between 1992 and 1996 and then increased by more than 50 per cent again to 27.1 Mtoe in 1999. Since then gas use has remained in the high 20s' Mtoe and exceeded 30 Mtoe in 2007 and 2008. With the inclusion of all generators in the statistics from 1987, other fuels such as coke oven gas and blast furnace gas (used for generation in the iron and steel industry) and more recently renewable sources of energy such as landfill gas and wind all show sizeable growth.

Chart 5.3: Fuels used to generate electricity 1948 to 2008



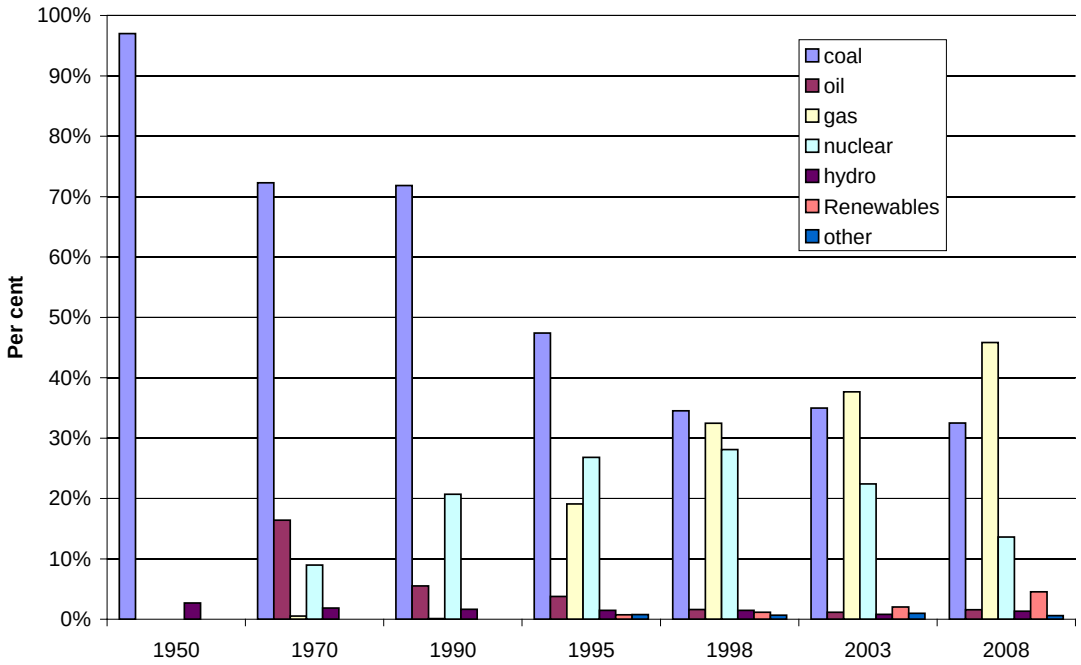
Generation by fuel type

Although following a similar pattern to fuel use, differences in efficiency means that generation by fuel has shown even more change than fuel consumption (Chart 5.4).

At the start of the publication of the Digest, coal was the dominant fuel for electricity generation and coal generation accounted for 97 per cent of all generation in 1950. Very little had really changed over the next 20 years with coal still dominant at 72 per cent but oil had overtaken hydro to become the next largest source of power accounting for 16 per cent of all generation. The early 1970's was the peak of oil use as prices shot up following the 1973 oil crisis (although a second peak can be seen around 1984 reflecting the impact of the miners strike). As a result it was nuclear power that started to challenge the position of coal with nuclear generation increasing from 9 per cent in 1970 to 21 per cent in 1990, whilst coal was still providing three quarters (72 per cent of power). Nuclear power continued to increase throughout the 1990's and by 1998 nuclear power was providing 28 per cent of all electricity.

However, it was the introduction of gas generation via CCGT plants and the abundance of UK gas that resulted in a substantial decline in coal generation. In 1990 there were essentially no gas fired generation plants. But by 1995 gas produced electricity supplied 19 per cent; by 1998 this had become 32 per cent and by 2003, 38 per cent. With nuclear still growing and offering a base load position it was coal generation that gave way to gas. By 1995 coal was providing 35 per cent of electricity a figure it was still proving in 2003, but by then coal was providing less electricity than gas. The use of gas and coal has continued to fluctuate largely dependent on prices, but with nuclear declining to 13 per cent in 2008, there was more scope for use of other fuels and in 2008 gas generation was up to 46 per cent. This most recent period has also seen the increase in renewable generation made up of hydro, waste and the largest growing area of wind. By 2008 renewable power was providing 5.5 per cent of total generation.

Chart 5.4: Electricity generation by fuel type



Note: Data used in this chart are on different definitions across the years as a mix of electricity supplied and generated has been used. Pumped storage generation has not been included.

One feature that is clear from chart 5.4 is the extent to which the UK generation mix has become more diverse particularly over the past 10 years.

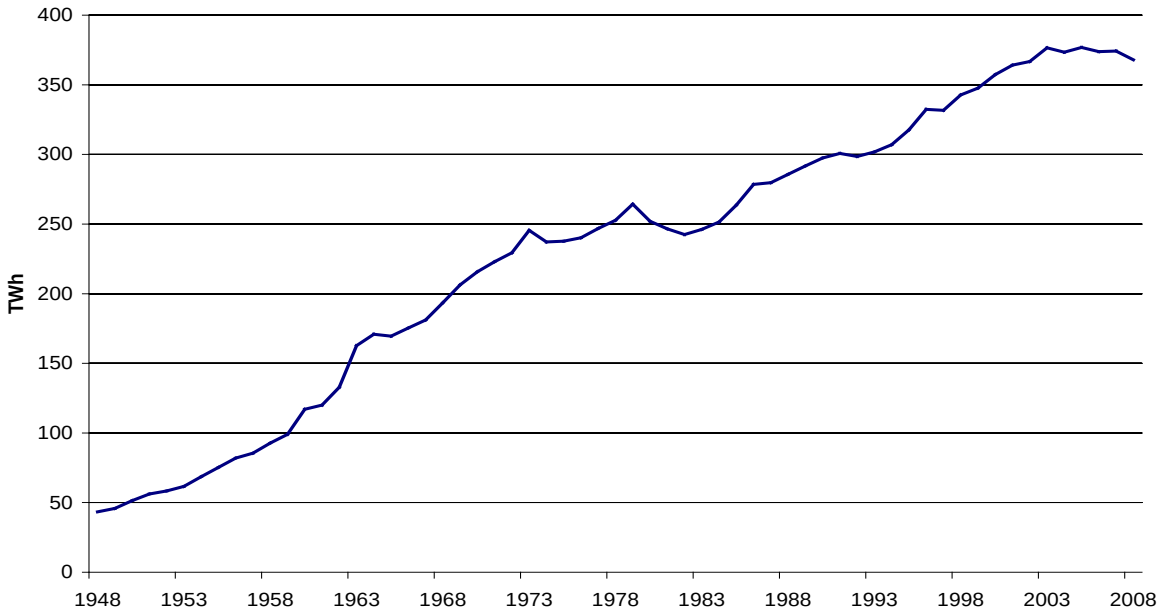
Interconnectors

The UK has two interconnectors with Europe. A connection to the grid systems of continental Europe was established in 1986 in the form of a cable between England and France of 2,000 MW capacity, replacing an earlier 160 MW link that operated in the 1960s. In addition there is also a link between the Irish Republic and Northern Ireland which was operational until 1975 and re-instated in 1996 (300 MW capacity, doubled to 600 MW in 2001). Overall Imports have made up a very small proportion of electricity consumed in the UK. Net imports reached a peak of around 5 per cent of total electricity supplied in the early 1990's but have generally declined since then. However between 2007 and 2008 net imports increased from 1 to 3 per cent.

Electricity supplied

One of the drivers behind changes in the generation mix has been the increase in demand for power. Over the period 1948 to 2008, electricity supplied has grown on average by around 4 per cent per year. In earlier periods growth was sharper (Chart 5.4) with supply growing by 8 per cent per year between 1948 to 1959 and 13 per cent a year for the five subsequent years before returning to trend growth of 4 per cent per year until 1973. The rest of 1970's and early 1980's saw little overall growth in electricity supply as demand was reduced during periods of slower economic growth, indeed after 1979 electricity supplied fell for 3 years before growing in 1983 and only exceeding 1979 levels in 1986. From 1987 the rate of growth has slowed to around 2 per cent per year and for the last three years electricity supply has shown a slight year on year decrease. This latest change reflects both greater focus on energy efficiency, (partly driven by higher prices) and the current economic climate.

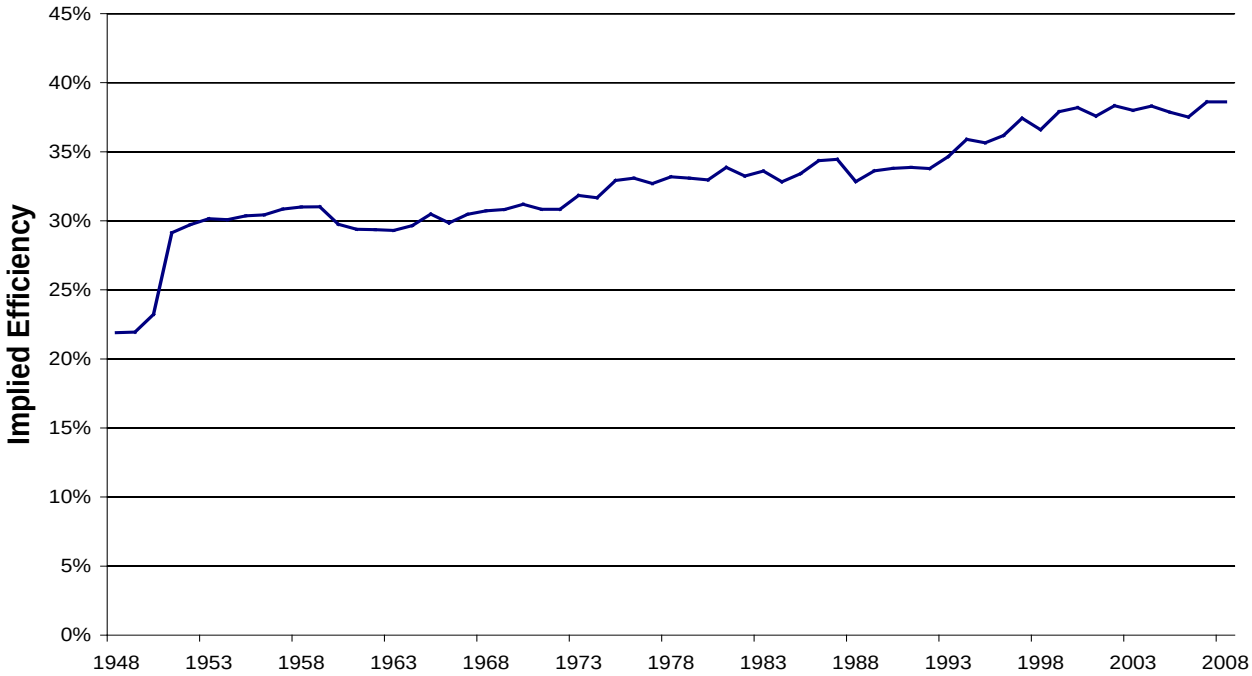
Chart 5.5: Electricity supplied (net) 1948 to 2008



Power station efficiency

In the 1940s electricity supplied represented only 21 per cent of the fuel used in power stations. By the 1960s this had increased to 30 per cent (chart 5.6). In the 1990s this had risen gradually, by a further 6 percentage points to 36 per cent since then the gradual increase has continued to 39 per cent in 2007, mainly as a result of the introduction of combined cycle gas turbine stations and the closure of the remaining small coal fired stations.

Chart 5.6: Conversion efficiency of power stations 1948 to 2008

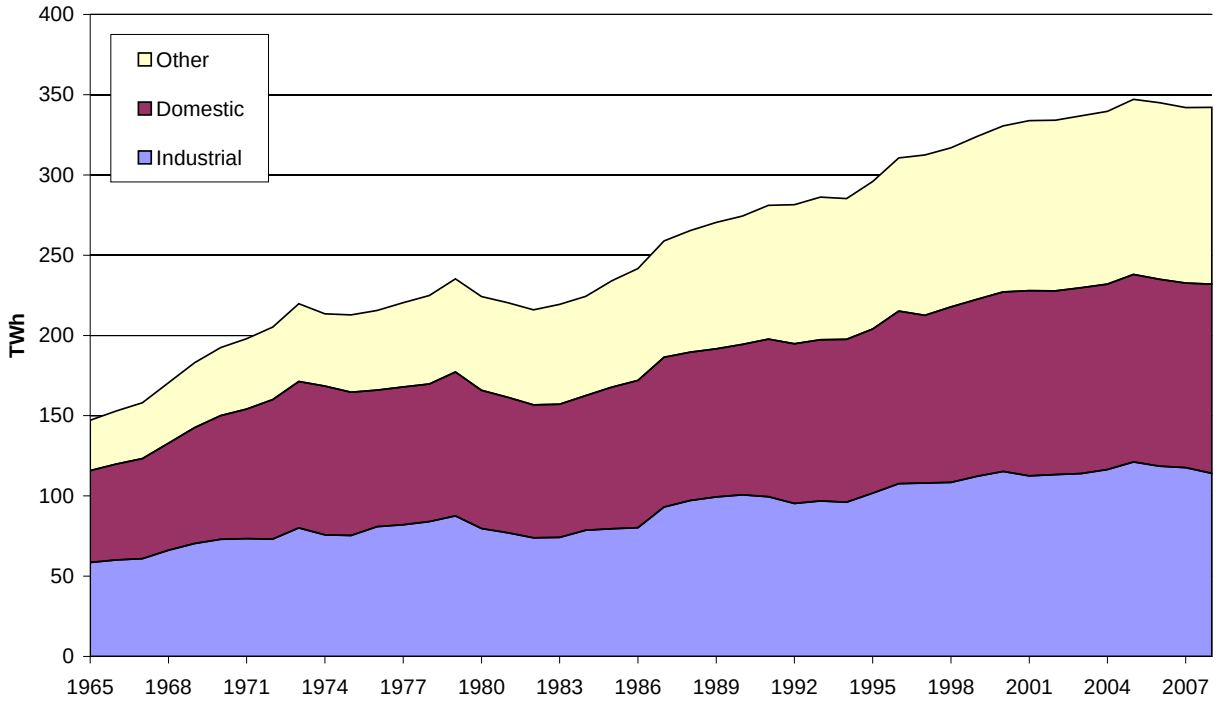


Electricity consumption

The proportion of electricity consumption attributable to each major sector has evolved over the last 60 years as chart 5.7 shows from 1965 onwards. In 1960s the industrial and domestic sectors each accounted for around 40 per cent of electricity consumption, with other users (which includes services) around 20 per cent. However it was demand from the domestic and services sectors that grew most both by around 55 per cent between 1965 and 1975 to 89 TWh and 48 TWh respectively , whilst industrial use grew by 29 per cent to 75 TWh. This meant that the domestic sector was now the largest at 42 per cent of total demand, (although its peak was the year before at 43 per cent) with industrial demand representing 35 per cent and services 23 per cent. Since 1975 the service sector has seen the largest growth in electricity demand, reflecting changes in the economy. Between 1975 and 2008 services use of electricity grew by 129 per cent compared to 32 per cent for domestic and 51 per cent for industry. As a result by 2008 demand for electricity is fairly evenly spread across all sectors with industrial demand of 114 TWh (33 per cent), Domestic 118 TWh (34 per cent) and services 110 TWh (32 per cent).

A further point to note is the time at which each of the three sectors saw demand pass 100 TWh. For the industrial sector this first occurred in 1990, but did not again until 1995, whilst domestic surpassed 100 TWh in 1993 and services in 1999.

Chart 5.7: Electricity consumption 1965 to 2008



How the consumption of electricity and other fuels has changed over the last 30 years is explored in more detail in the DECC data set “Energy Consumption in the United Kingdom” which is available on the DECC’s Statistics web site at: www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx

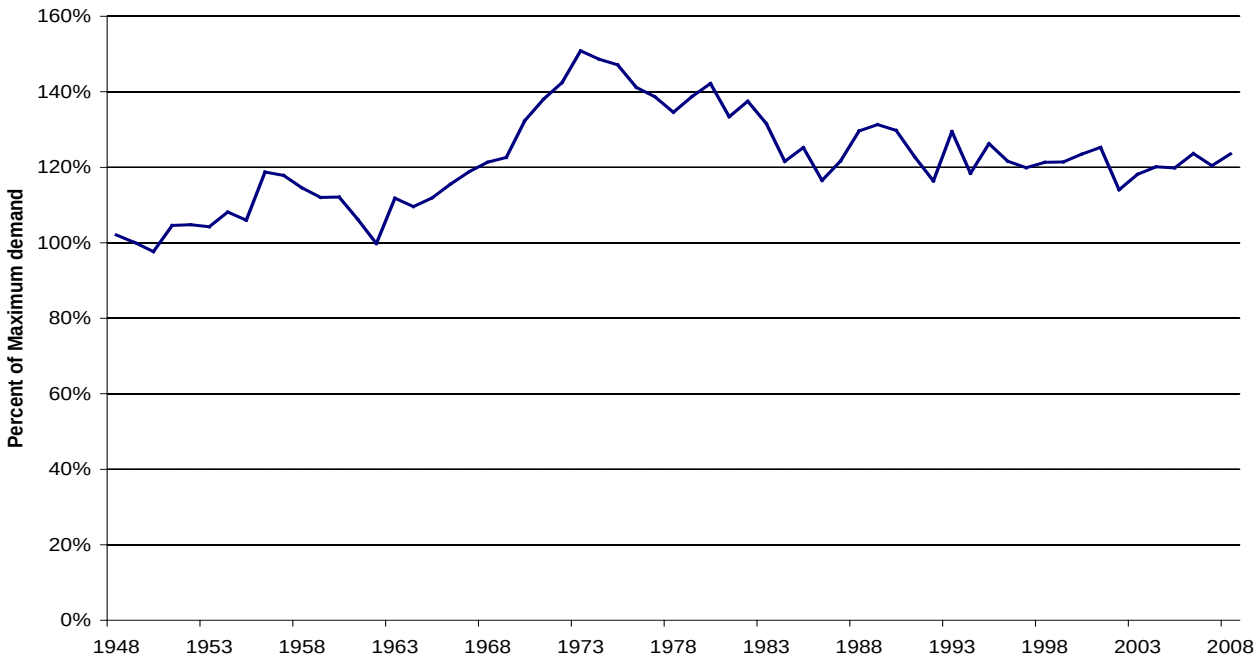
For example, on average, in households over the period 1996 to 2006, lighting and appliances accounted for 64 per cent of electricity consumption, space heating for 15 per cent, water heating for 15 per cent, and cooking for 6 per cent, according to figures compiled by the Building Research Establishment. A snapshot of consumption within the

services sector in 2006 showed that lighting accounted for 40 per cent of electricity consumption, space heating and hot water for 18 per cent, catering for 14 per cent, cooling and ventilation for 9 per cent, and computing for 6 per cent, and for all other uses (mainly for powering equipment) the remaining 13 per cent. Whilst of industrial elelctricity use, in 2006, 28 per cent of industrial electricity use was for motors, 14 per cent for high temperature processes (such as used in metal manufacture, glass manufacture and mechanical engineering) and 19 per cent for low temperature processes (such as those used in the food and paper industries). Of the remaining industrial electricity use, 9 per cent was for space heating, 9 per cent for compressed air, 7 per cent for drying and separation processes, 6 per cent for refrigeration, 3 per cent for lighting, and 6 per cent for all other uses.

Capacity margin

The highest demand for electricity in the UK usually occurs in the early evening of a particularly cold winter's day. A robust electricity system requires that there is sufficient generating capacity available to meet this demand. The last time that capacity was insufficient to meet demand was in 1962, but as Chart 5.8 shows, since then power station building has ensured that there has been a significant margin of capacity over demand. This plant margin exceeded 50 per cent in 1973, but in recent years has been between 15 and 25 per cent.

Chart 5.8: UK Plant margin 1948 to 2008



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Energy Consumption in the United Kingdom

Chapter 6 - Combined Heat and Power

Combined Heat and Power (CHP) first appeared as a separate chapter in the Digest of UK Energy Statistics (DUKES) in 1997 although for 4 years previously DUKES contained an Annex giving a snapshot of the latest available CHP statistics. This is not to imply that CHP is a new feature of the UK's energy economy. Far from it, because coal-fired steam turbines generating heat and electricity had been in use since the 1930s.

Surveys of private generation and Industrial CHP were undertaken in 1953, 1963, 1977, 1983 and 1988 and analysed for the early 1990s. Detailed results for the first three of these surveys have been difficult to track down with only the comparative data given in the two later surveys readily available. These surveys were mainly concerned with electricity generation and heat production was not recorded.

Table 6.1: CHP 1953 to 2008

	CHP Generation		CHP electrical generating capacity	Number of CHP schemes	CHP as percentage of UK electricity supplied
		GWh	MW		%
1953	*(1)*	6,010	..	..	8
1963	*(1)*	7,495	..	..	5
1977		10,450	2,793	<240	4
1983		7,500	2,254	<150	3
1988		8,700	1,793	120	3
1993		14,171	2,556	996	5
1998		17,573	3,440	1,335	5
2003		23,938	4,495	1,356	6
2007		27,851	5,450	1,435	7
2008		27,911	5,469	1,439	7

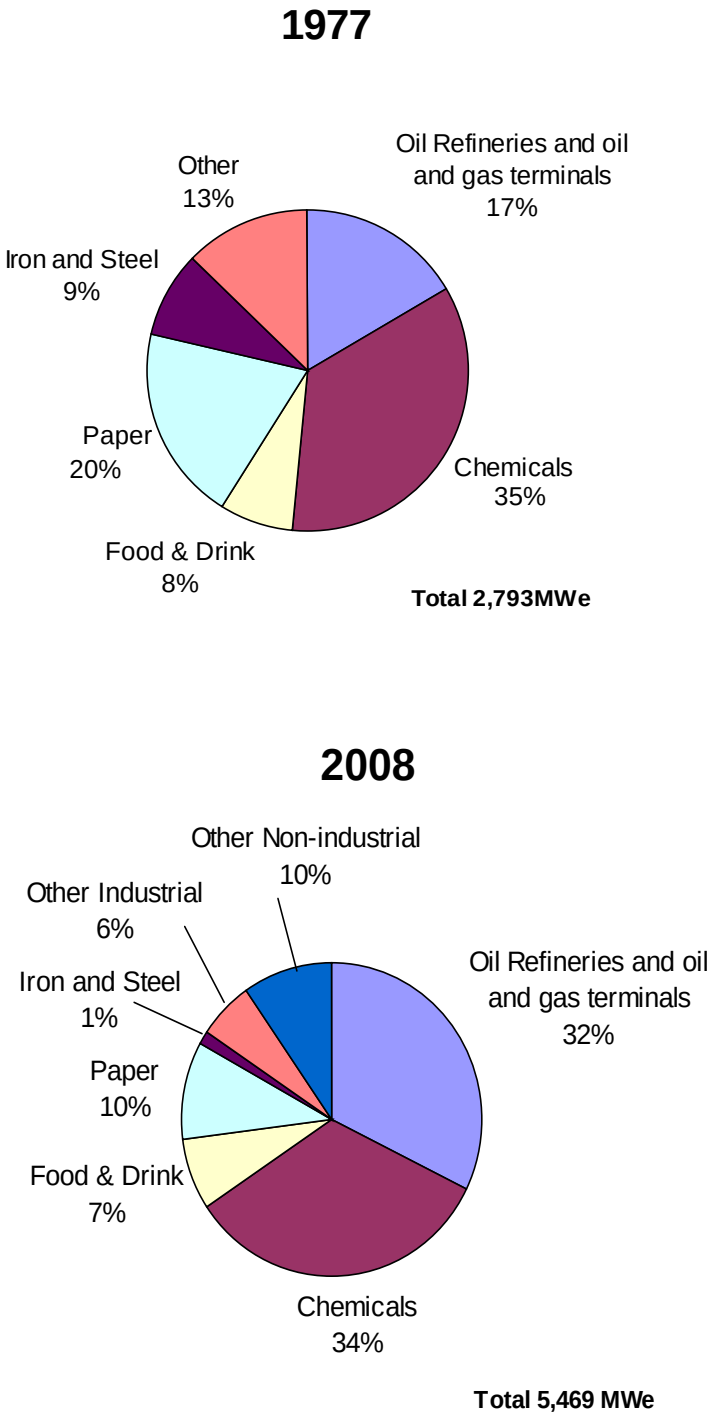
(1) Generation excluding electricity used on works

As Table 6.1 shows, generation from CHP schemes grew until the 1970s but then declined to a low point around 1983. The Energy Act of that year sought to assist CHP by promoting the industrial generation of electricity, but a greater effect appears to have been from the opening up of the electricity and gas markets to competition in the late 1980s. This made it easier for companies generating electricity (or commissioning on site generation by a third party) to sell surplus electricity to the grid or to other nearby customers. It also led to a fall in gas prices making gas-fired CHP in particular more economically attractive.

CHP had previously been the province of manufacturing industry and as the UK's manufacturing base declined so did the use of coal-fired CHP. CHP capacity therefore reached a low point in 1988 of 1.8 GW. Even at that stage there were signs of recovery, however, since the remaining CHP plants were being used more intensively than earlier in the 1980s when load factor dropped to 38 per cent. CHP has tended to be concentrated in five sectors of manufacturing industry where there has been a particular need for steam or

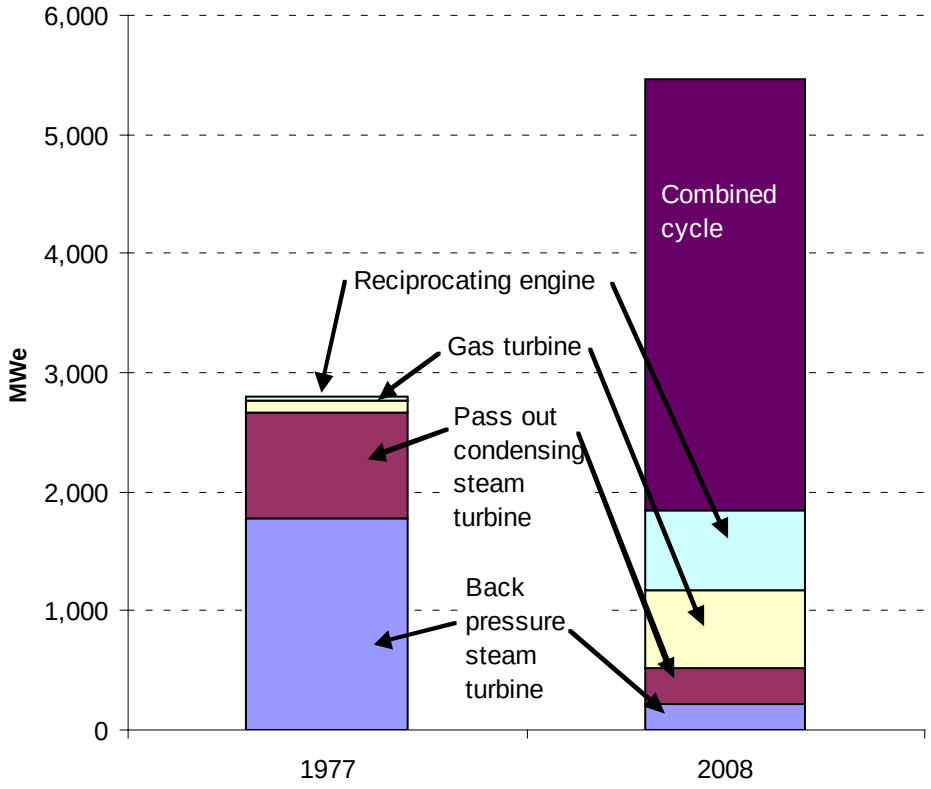
heat (oil refining, chemicals, food and drink, paper and iron and steel). Thirty years ago these five sectors together accounted for 87 per cent of total UK CHP generating capacity and today the same five sectors still account for almost the same proportion - 85 per cent). But within that 85 per cent, these five sectors each account for substantially different proportions. Other manufacturing sectors such as textiles and engineering which previously accounted for most of the remaining 15 per cent have now been joined by non-industrial uses such as in hospitals, hotels, and leisure facilities as Chart 6.1 shows.

Chart 6.1: CHP capacities in 1977 and 2008



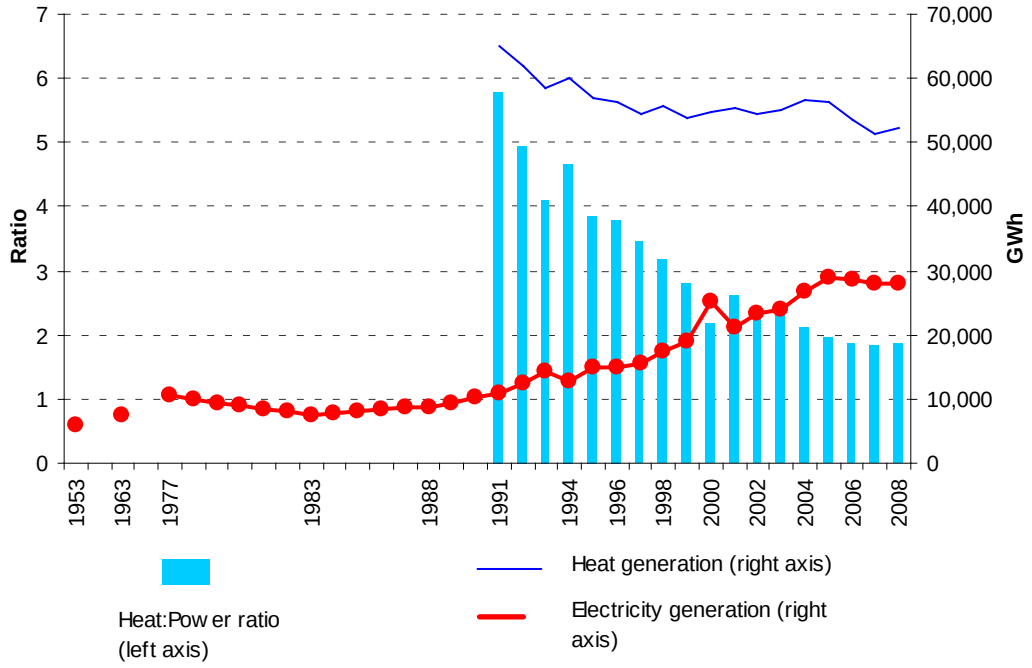
The main driver behind the revival of CHP during the 1990s was the availability of gas turbines, and internal combustion engines both fired by natural gas. Whereas the older systems had been geared to producing far more heat (usually as steam) than electricity (heat to power ratios of around 6:1), newer systems made CHP available to applications with a smaller heat load compared to the electricity load with some heat to power ratios for smaller capacity systems of 1:1. Chart 6.2 compares the type of installations in 1977 and 2008. Combine cycle installations now dominate with just over 3,600 MWe of capacity, although they accounted for only 1,000 MWe 10 years earlier in 1997. Open cycle gas turbines and reciprocating engines have also grown in popularity, each accounting for around 10 per cent of total CHP capacity in 2008.

Chart 6.2: Types of CHP installation in 1977 and 2008



Electricity generation from CHP in the UK has thus risen steadily from its low point in 1983 to nearly 29,000 GWh. While heat generation from CHP is not as high as the 65,000 GWh achieved in 1991, it has nonetheless levelled off at close to 55,000 GWh in each of the last ten years. Chart 6.3 (taken from the long term trends Annex of the latest Digest) summarises the trends since 1953.

Chart 6.3: CHP Electricity and heat generation 1953 to 2008



With systems that are more flexible in operation than in the past, in overall efficiency terms around 70 per cent of the fuel used in CHP schemes is either converted into electricity or usable heat. This compares very well with the 36 per cent efficiency of a modern conventional coal fired power station and the 49 per cent efficiency of Combined Cycle Gas Turbine (CCGT) stations. Load factors (i.e. the amount of time for which a CHP scheme operates) are currently around 60 per cent having shown a steady increase through the 1990s from their low point of 38 per cent in the 1980s.

References:

"Combined Heat and Power and electricity generation in British Industry 1983-1988", Energy Efficiency Series No. 5; Published by HMSO for the Department of Energy, 1986 – ISBN 0 11 412825 1

"Co-generation and electricity production in British industry 1988", Energy Efficiency Series No.12; Published by HMSO for the Department of Energy, 1990 – ISBN 0 11 412958 4

Digest of UK Energy Statistics 2009 (DUKES) Long term trends Chapter 6 available on DECC Web Site at:
www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx

Chapter 7 - Renewable Energy

Renewables and Waste first appeared as a separate chapter in the Digest of UK Energy Statistics (DUKES) in 1997, although for 6 years previously DUKES contained an Annex giving a snapshot of the latest available renewables statistics. However, renewables have featured in the UK's energy economy at least since the early 1920s when large scale generation from hydro–electric sources contributed between 10 and 15 GWh each year.

Renewable Energy Statistics

The first year for which consultants were commissioned by DTI (the Department with energy responsibilities at that time) to bring together all available data on the use of renewables for energy purposes was 1988. This has been followed up every year since with appropriate surveys, estimates and re-appraisals of past data as new sources of information became available. As the renewables industry has developed so various trade associations and administrative systems have come into being providing qualitative, if not quantitative information that can be used to build a statistical picture of the industry. While figures of generation from hydro sources have been available for the last 60 years, it was not until 1990 that the regular surveys covered all large scale hydro to which estimates were added for small hydro installations. In the 1960s and 1970s while generation from hydro sources was available, the capacity to generate from hydro was not separately recorded in DUKES, but it can be deduced that growth in capacity was quite modest over this period.

Table 7.1: Electricity from renewables 1948 to 2008

	Electricity Generation from renewables *(1)* GWh	Renewables used for electricity generation Thousand toe	Electrical generating capacity from renewables MW	Renewables as percentage of UK electricity generated *(2)* %
1948	1,345	116	343	2.9
1953	1,892	163	646	2.8
1958	2,699	232	1,006	2.7
1963	3,274	281	..	2.1
1968	3,552	305	1,248	1.7
1973	3,861	332	..	1.5
1978	4,025	346	..	1.5
1983	4,548	391	..	1.7
1988	5,468	627	1,542	1.9
1993	5,717	831	1,876	1.8
1998	8,648	1,453	2,563	2.4
2003	10,600	2,532	3,452	2.7
2008	21,597	4,282	6,803	5.5

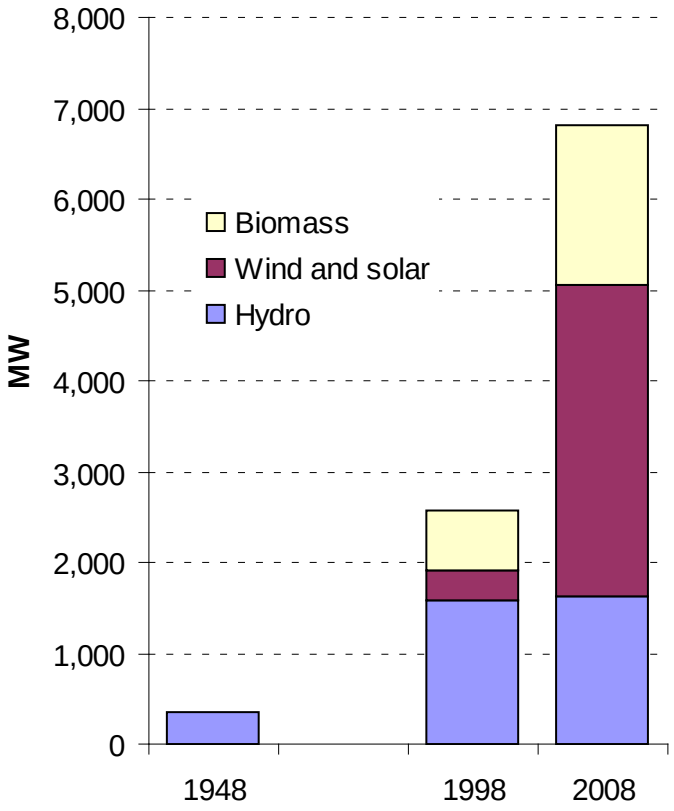
(1) hydro only before 1988.
(2) until 1988 this is the percentage of electricity generated by major power producers. It is estimated that the inclusion of other generators would reduce the figures by about 0.1 percentage points in the 1980s.

History of Renewable Energy Sources

The first of the UK's four pumped storage hydro schemes was commissioned in 1961 and while these are not renewable sources (because electricity generated from other sources is used to pump water back to an upper reservoir for re-use in off-peak periods) initially generation from pumped storage was included with natural flow hydro in the statistics. In Table 7.1 an adjustment has been made to the historical statistics to allow for this.

As Table 7.1 shows, generation from hydro schemes grew strongly in the 1950s, plateaued until the 1980s but took off again in the 1990s and 2000s assisted first by the Non-Fossil Fuel Obligation Orders and Scottish equivalents (Scottish Renewables Orders), and then by Renewables Obligation Certificates. Generating capacity for all renewable sources has more than trebled in the last 15 years. However, because the total amount of electricity generated in the UK has also been on a rising trend over the last 60 years, it is only in the last quarter of this period that the percentage of generation accounted for by renewables has moved out of the 1.5 to 2 per cent range to reach 5.5 per cent in 2008.

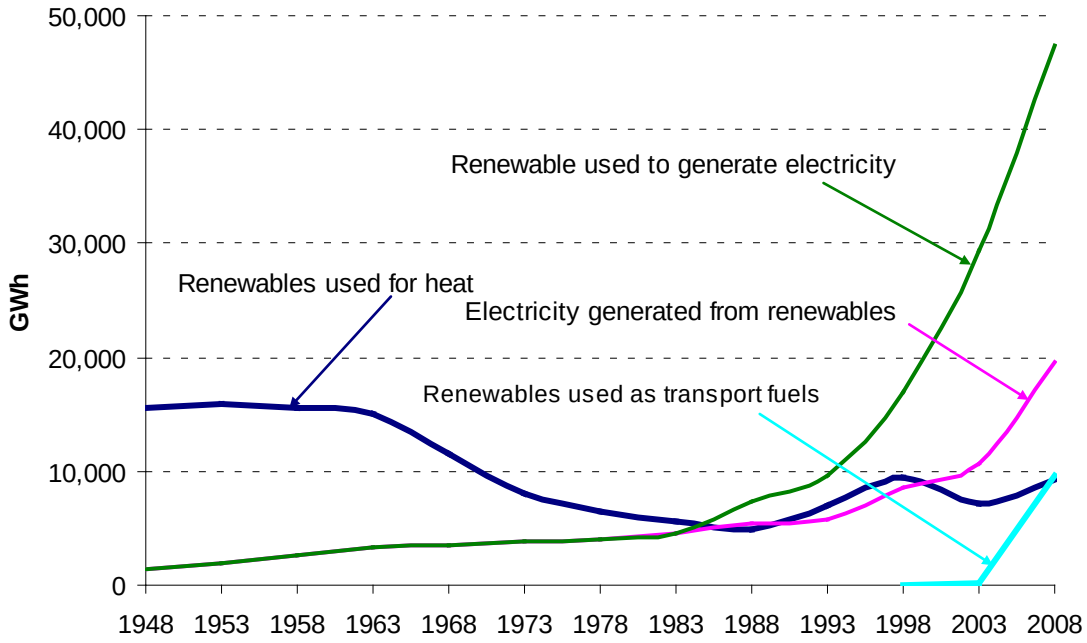
Chart 7.1: Renewables generating capacities in 1948, 1998 and 2008



The use of renewables for heat, because of its comparatively low level, has been more difficult to measure. Until the announcement of proposed renewables incentives for heat in 2009, energy policy concentrated on renewables for electricity. Indeed before 1988 the largest use of renewables for heat would have been the burning of wood along with coal and manufactured solid fuels in domestic boilers and on open fires. This energy source did not feature in UK energy statistics, but assumptions can be made to give indicative figures. In 1990, it was estimated that wood use by households was equivalent to 4 per cent of their coal and other solid fuel use. If the same proportion is applied to coal and solid fuel use in 1948 then in that year energy use equal to some 1.1 million tonnes of oil equivalent (toe) may have been from wood burning to produce heat. This amount would

then have declined in the 1960s and 1970s (Chart 7.2) along with the downturn in the use of solid fuels for domestic heating to reach a low point of 174 thousand toe in 1990/91. Recent increases in domestic (and commercial) wood use are attributed to the popularity of burning wood on open fires as a secondary form of winter heating. The burning of waste wood from industrial processes to produce heat before 1992 was not measured but it has been assumed that it was no higher than the 240 thousand toe recorded in that year. Table 7.2 sets out the possible levels of renewables used for heat over the last 60 years.

Chart 7.2: Use of renewables for electricity, heat and transport 1948 to 2008



Note that heat generated from renewables will be lower than the fuel inputs measured here because of conversion losses.

Table 7.2: Heat from renewables 1948 to 2008 (largely estimated)

	Wood combustion - domestic	Wood combustion - industrial	Other renewables used for heat	Total renewables used for heat	
	Thousand toe	Thousand toe	Thousand toe	Thousand toe	GWh
1948	1,097	240	..	1,337	15,554
1953	1,129	240	..	1,369	15,921
1958	1,103	240	..	1,343	15,621
1963	1,050	240	..	1,290	15,006
1968	759	240	..	999	11,614
1973	445	240	..	685	7,965
1978	314	240	..	554	6,438
1983	241	240	..	481	5,593
1988	176	240	..	416	4,839
1993	204	237	157	598	6,955
1998	204	437	165	806	9,374
2003	206	225	192	623	7,245
2008	359	81	330	797	9,264

Since 2003 a further use for renewables has begun to figure in the statistics with the blending of bioethanol and biodiesel into fuels used for transport. Data for the consumption of biodiesel and bioethanol for 2003 and 2008 have been converted to GWh and added to Chart 7.2, above, although the 5 year time scale does not show that consumption doubled in each year since 2005.

References:

Digest of UK Energy Statistics 2009 (DUKES) Long term trends Chapter 7 available on DECC Web Site at:
www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx

Digest of UK Energy Statistics 2009 and earlier editions back to 1948/49

Electricity since 1920 reference spreadsheet available at:
www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx

Chapter 8 - Prices

Energy Prices in the UK have changed a great deal over the last 60 years. Changes in the UK fuel mix, in technologies, and in UK and global demand for energy, as described in other chapters in this publication, have all played a part in price developments.

UK energy prices are influenced by a number of factors, both local and global. Prices of primary fuels (gas, coal, oil) will obviously affect the price of secondary fuels (electricity, road fuels), but can also themselves be affected by the price of the other primary fuels.

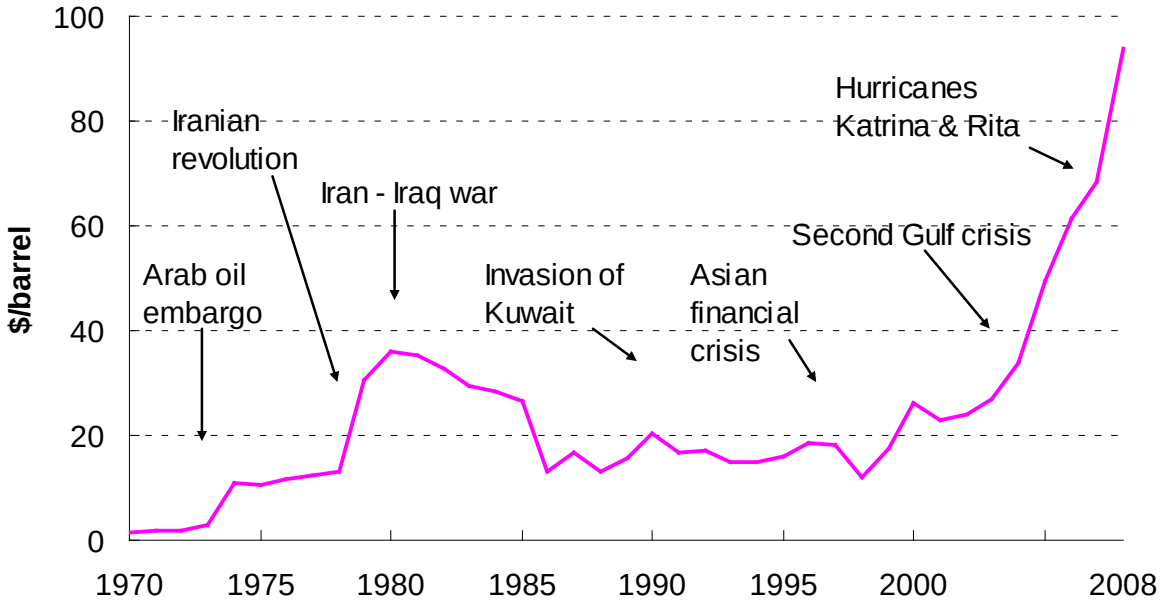
In early editions of DUKES there was no price information, with the publication only dealing with volumes. Domestic and industrial price series were introduced in 1968, and continued to be published in DUKES until 2001, when they moved to the newly created Quarterly Energy Prices. However, the evolution of prices over the last 60 years has shaped fuel use in the UK, and is an important part of the energy story.

The price of crude oil is the main driver in the cost of all energy. Petroleum products such as petrol are made from crude oil and as such changes in the price of oil will be reflected in the cost of these products. However, gas prices have also historically been linked to oil, and as initially oil and then gas have formed a major input to electricity generation the price of electricity has also been driven by oil prices. Therefore an analysis of prices over the past 60 years should start with a look at the developments in oil prices. Please note that the charts used in this chapter plot annual averages, and thus smooth out some of the peaks and troughs that would be found by looking at monthly or daily data.

Crude oil

Chart 8.1 shows how crude oil prices have evolved since 1970. Between 1948 and 1970 global oil prices were relatively stable, growing between 1948 and 1960 generally in line with inflation, followed by a ten year period when prices remained at a fairly constant level.

Chart 8.1: Oil prices in current prices

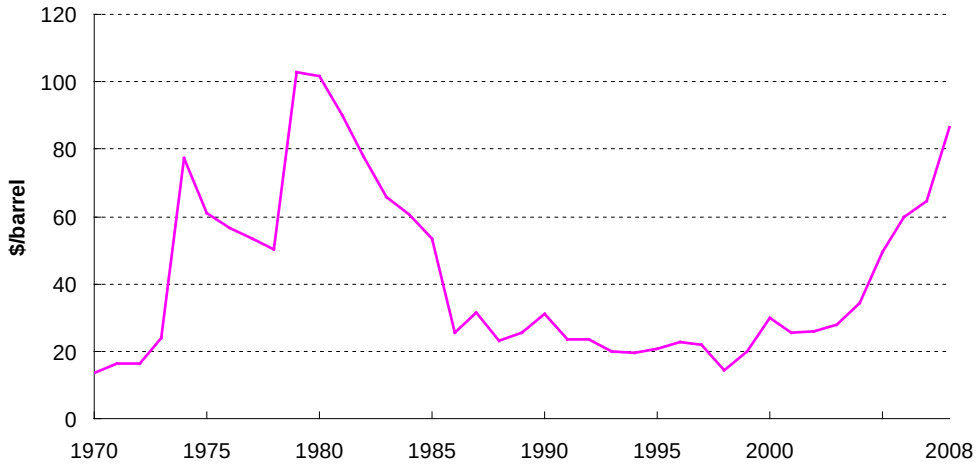


Source: OECD

This situation changed in the 1970's as OPEC came to the fore. OPEC, the organization of the petroleum exporting countries, was formed in 1960 with founder members Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. Other countries joined later in the decade. In 1973, the Arab-Israeli war led OPEC to embargo Arabian oil, causing prices to increase by 400 per cent in 6 months. Following the Iranian revolution of 1979 and the Iran-Iraq war of 1980, reduced oil production caused oil prices to hit record highs. Saudi Arabia caused a price crash in 1986 by increasing production in excess of its OPEC quotas. Production uncertainty surrounding the first Gulf War in 1990 caused price spikes, although subsequently oil prices declined steadily for several years. Further dips in prices were caused by a decline in Far East demand due to the Asian financial crisis of 1997, and the decline in US demand following the terrorist attacks of September 11 in 2001. The commencement of the Iraq War in 2003, damage to US refineries due to Hurricanes Katrina and Rita in 2005, conflict in Lebanon in 2006, increased demand from emerging economies and geopolitical tensions coupled with the weak dollar in 2008 have all led to price increases, resulting in crude oil prices reaching a high of over $140 per barrel in July 2008. Prices then dropped sharply into December 2008 as the world economy slowed.

In real terms, the price highs in July 2008 were 10 per cent higher than the peaks reached in the late 1970's. However, the average annual 2008 price was below the previous annual average peak. Chart 8.2 shows oil prices in real terms, that is with the effects of inflation removed from the series.

Chart 8.2: Oil prices in real terms (2005 $ prices)

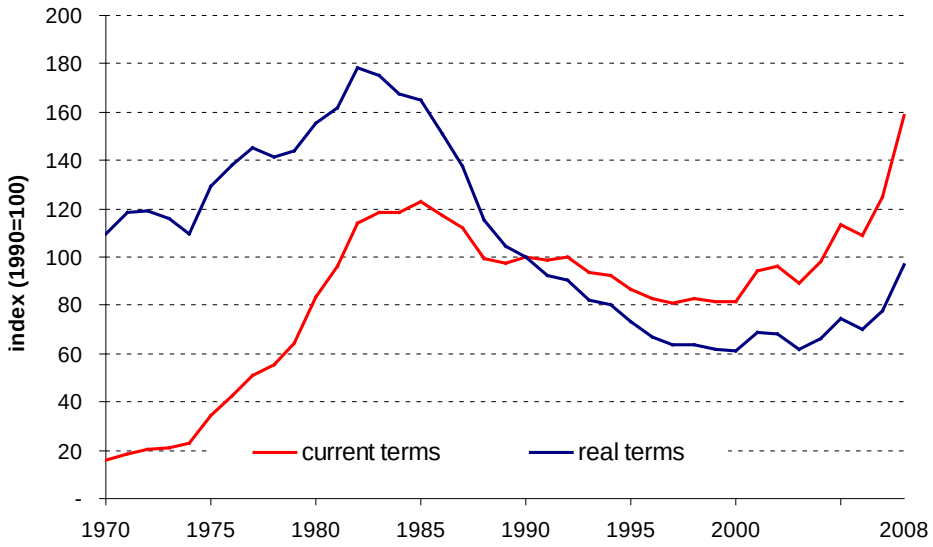


Source: DECC calculations on OECD data

Coal

In current terms, coal prices increased steeply throughout the 1970's and decreased through the late 1980's and 1990's. Since 2000 prices have increased above the highs in the early 1980's. In real terms, coal prices fell steadily from 1981 through to 2000, and have since increased, but not to the highs of the early 1980's. Coal prices are generally affected by oil prices, though less so than gas, as the cost of oil impacts on the cost of coal production and transport, as can be seen by the high coal prices both in the early 1980's and currently. Coal can be used as a substitute for certain uses of oil and gas, in particular for the generation of electricity. As a consequence, the relative price of coal and gas is a major factor in determining the changes to the mix of fuel used for electricity generation. In the past few years the price of coal has increased sharply as demand from both China and India has increased.

Chart 8.3: Coal prices to industry in real and current terms



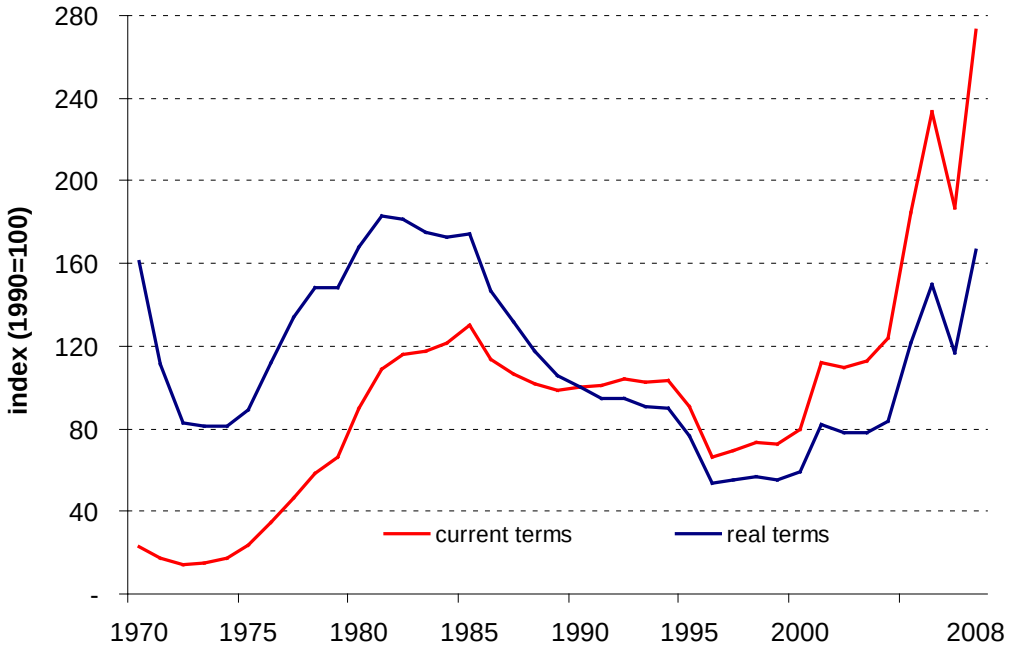
Gas

In the late 1960's, following the discovery of large fields of natural gas in the North Sea, the UK's entire gas supply infrastructure was converted to use natural gas. This resulted in a substantial increase in gas demand and consumption. Gas consumption increased steadily to 2000 with growth from all sectors, particularly from electricity generators in the 90's.

However, since 2000 UK production has fallen as UK reserves deplete, and in 2004 the UK became a net importer of gas for the first time since 1996. The UK gas market is currently in a transitional phase as it adjusts to increasing import dependence. Prices in both current and real terms have increased sharply in recent years and with the UK importing greater volumes of gas in winter, have created greater seasonal variability in UK prices.

The UK imports gas from Europe via pipelines, and from further afield via tankers of Liquid Natural Gas (LNG). Therefore gas prices in the UK are affected by both local and global price effects which also impact on the value of UK gas exports. Gas prices in Europe are commonly contractually linked to oil prices. Chart 8.4 shows gas prices in both current and real terms. The peaks in the real price series of the early 80's and in 2008 are very similar to the pattern seen in chart 8.2 for crude oil.

Chart 8.4: Gas prices to industry in real and current terms



Electricity

As a secondary fuel, the price of electricity is related to the price of the fuels used to generate it. Coal was initially the fuel of choice for power generation, and remained the primary generation fuel until natural gas overtook coal in 1999. Electricity generation from oil peaked in the early 1970's, before oil price increases reduced demand, although oil use increased during the miners' strike in 1984 as a direct replacement for coal. Nuclear generation increased from 1970 onwards, peaking in the late 1990's whilst more recently renewable sources have grown and are now used more than oil.

Chart 8.5: Electricity prices to industry in real and current terms

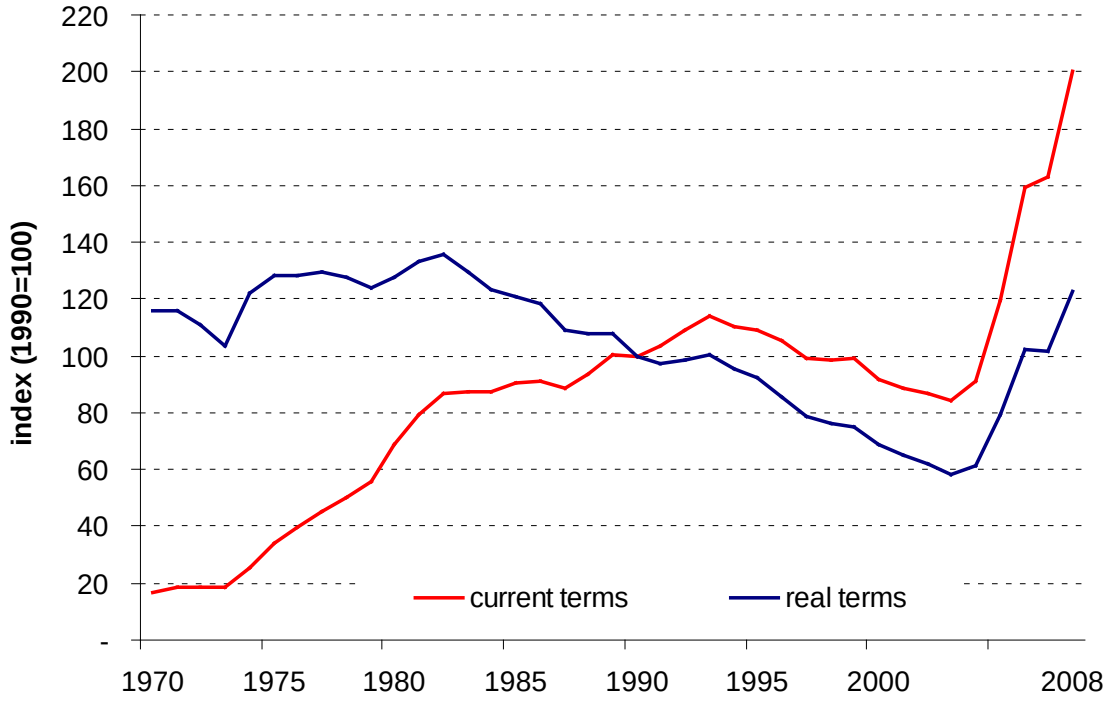
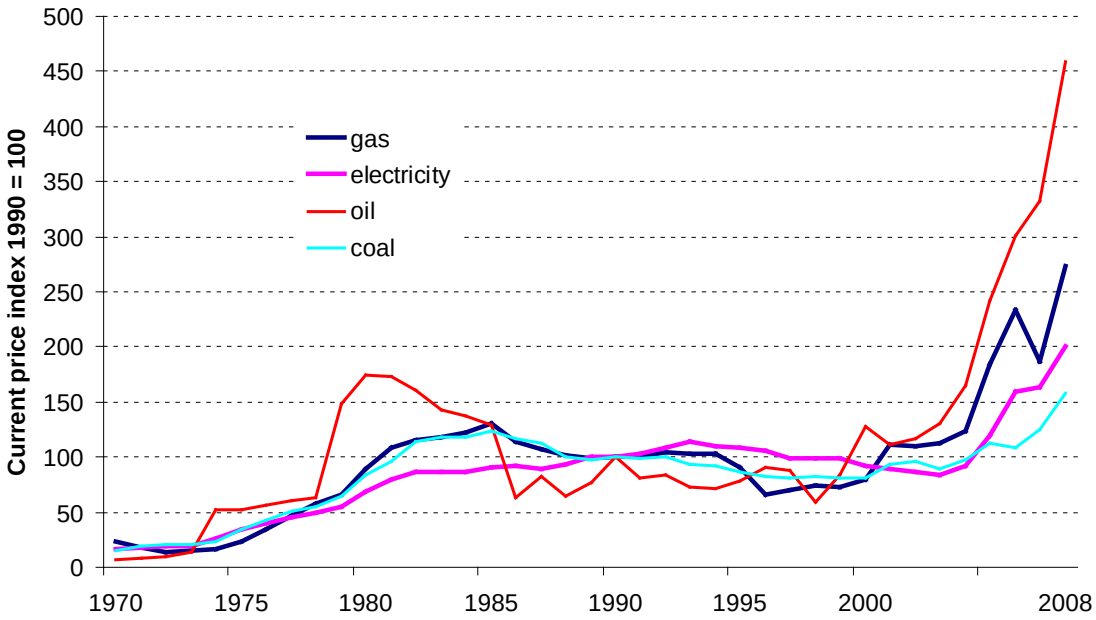


Chart 8.5 shows that in current terms, electricity prices rose from 1970 through to the mid-1990s, then declined until the early 2000's before increasing once more. In real terms, the recent increases, driven by high gas and coal prices, in turn driven by high oil prices, have not exceeded the highs reached during the mid-1980's.

Chart 8.6 below shows gas, coal and electricity prices and suggests the close links between these fuels and oil prices. Generally a rise in oil prices is followed by rises in the prices of the other fuels.

Chart 8.6: UK coal, gas and electricity prices compared to oil



Retail prices

For most fuels there is a difference in the prices paid by households and those paid by industrial consumers. Larger consumers can negotiate volume discounts and, generally, the larger the consumer, the lower the price they pay for each unit of energy. For example, in 2008 domestic gas users paid an average of 3.2 pence per kWh for gas, whilst industrial users paid 2.1 pence per kWh. The electricity generators paid an even lower price of 1.7 pence per kWh, reflecting the greater volumes they purchase.

Prices to industry are generally relatively volatile, and tend to follow the wholesale price of the fuel closely. Companies supplying energy to the domestic market tend to try to minimise tariff changes as far as possible, leading to more stable prices.

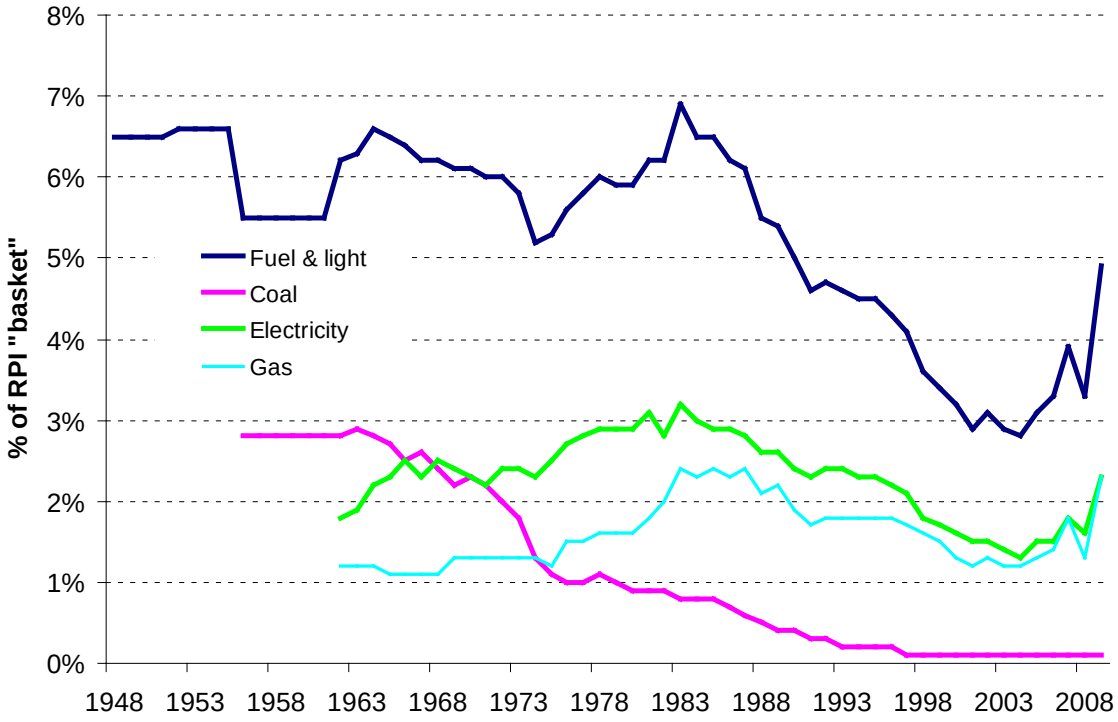
Until the mid 1990's retail supply of electricity and gas were monopoly activities, with all consumers taking their gas from British Gas and electricity from their regional electricity supplier. The first trial in competitive gas supply to domestic consumers started in April 1996, and all customers were able to choose their gas supplier by May 1998. Competition in domestic electricity supply began on 14 September 1998 and was extended to all consumers in Great Btitain by May 1999.

Competition had an immediate and noticeable effect on prices to domestic consumers. For gas, prices in the 3 years between 1997 (the year before competition) and 2000 fell by 13 per cent in real terms, before rising wholesale gas prices reversed the trend. For electricity, prices between 1998 and 2003 fell by 15 per cent in real terms, before rising wholesale electricity prices began to factor into the market.

A key measure of domestic prices for fuel and light is the retail prices index. This index is created by weighting together the price of gas, electricity etc. The weights of

relative fuels are changed each year to ensure that they remain representative over time. In 1948 the index included coal, gas and electricity as you would expect, but also candles and lamp oil. In the 50's candles and lamp oil were removed from the index to be replaced by paraffin. In 1987, butane entered the index, replacing paraffin. The weight for fuel and light in the RPI (Retail Price Index) has changed over the years reflecting both consumption patterns and prices in the previous years. Chart 8.7 below shows how the proportions have changed in the last 60 years. In 1960 approximately 3 per cent of household spending was on coal, this has now fallen to 0.1 per cent.

Chart 8.7: RPI weights for fuel and light



Source: Office for National Statistics

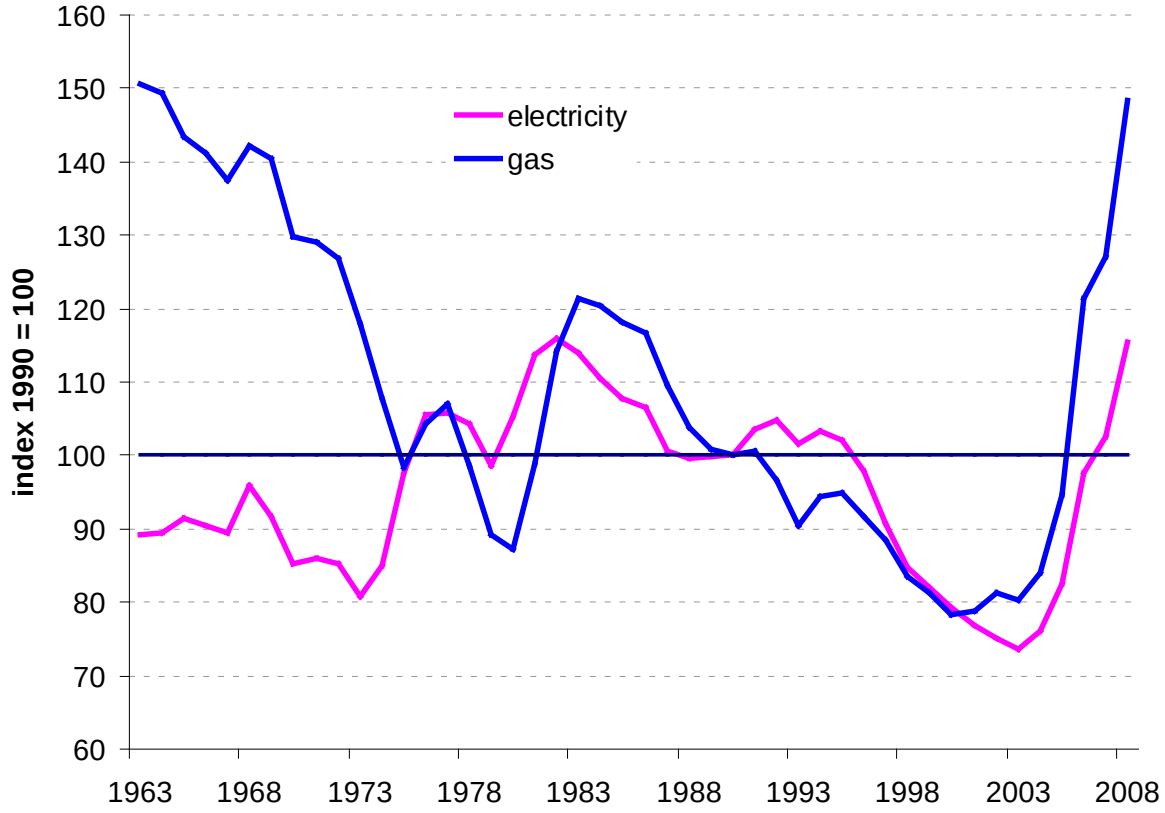
In general energy spend was broadly constant at around 6 per cent till the mid 80's. It then fell to 3 per cent in 2004, before its recent climb to just under 5 per cent in 2009.

Chart 8.8 shows retail prices for electricity and gas in real terms. Gas prices fell to the end of the 1970's as UK production increased. Prices then increased till the mid 80's following the rise in crude oil prices. Prices then fell, particularly in the late 90's as the UK became a net exporter of gas. In the last few years prices have increased reflecting crude oil prices and the UK's return to being a net importer. Electricity prices follow a broadly similar pattern, which is not surprising given the earlier discussion in this chapter about the close links between electricity prices and that of the other energy commodities.

Gas and electricity bills will follow closely the pattern of changes in price, as volume usage does not change much from one year to another, though generally warm weather will result in falls in demand and vice versa. In 1990, based on average

electricity consumption of 3,300 kWh and gas consumption of 18,000 kWh, an average household dual fuel bill was £530. In 2000, despite general inflation growth of 35 per cent, bills had only increased to £552. Following the sharp rises in energy prices in the last few years, bills are now at the £1,000 level, having grown well above the general level of inflation in the economy.

Chart 8.8: RPI electricity and gas prices in real terms



Source: DECC calculation on ONS retail price data

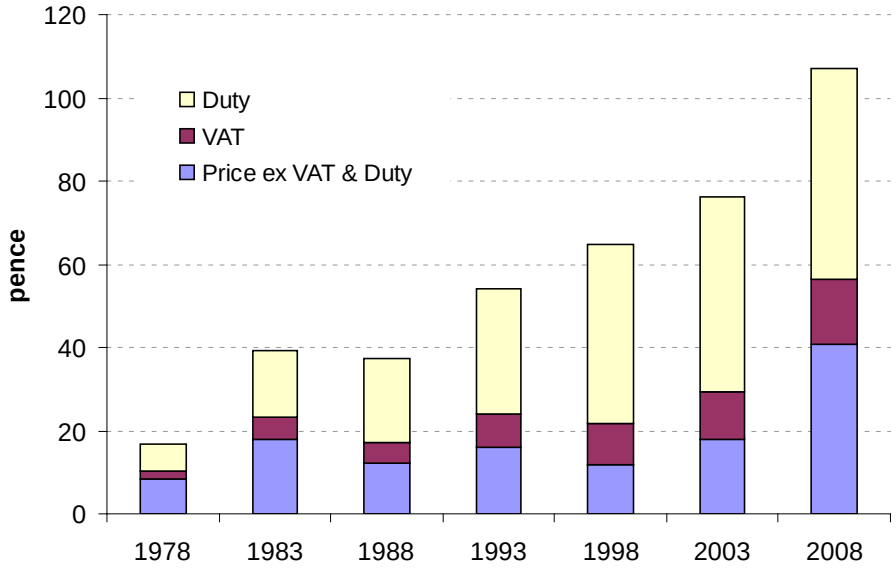
Domestic energy prices are subject to VAT. This was introduced in 1994 at a rate of 8%, and was subsequently lowered to 5% in 1997.

Road Fuels

The price of the energy commodity is not the only factor that influences the prices faced by end users. Road fuel prices in the UK are affected by the price of oil, but also by the tax and duty applied to the fuel. VAT rates on petrol reached 25 per cent in the mid-1970's, though are currently set at 15 per cent, following the decision to temporarily reduce rates at the end of 2008. Chart 8.9 shows the breakdown of the purchase price of petrol over the past 30 years. It can be seen that tax and duty together account for over 60 per cent of the 2008 pump price of petrol and diesel compared to 50 per cent in 1978 and over 80 per cent in 1998. The duty on petrol has increased since the start of the 90's following the use of the fuel price escalator. The escalator was introduced as a measure to stem the increase in pollution from road transport, and resulted in duty increasing at a rate of 3 per cent above inflation.

The escalator was formally abolished in 2000 and in subsequent years changes to duty rates have taken the cost of oil into account. In April 2009 the duty rate rose on unleaded petrol from 52.35p to 54.19p per litre.

Chart 8.9: Components of UK petrol price 1978 to 2008



References

Price indices are available for domestic gas and electricity prices from 1962 onwards from the Retail Price index (RPI) published by the Office for National Statistics (ONS).

Price indices from 1970 onwards are published in Tables 2.1.1 (domestic) and 3.3.1 (industrial) of Quarterly Energy Prices.

Road fuel prices are published annually in Table 4.1.2 of Quarterly Energy Prices.

Retail Price Index (RPI):
Office for National Statistics
www.statistics.gov.uk/hub/index.html

Domestic and industrial prices and price indices, and road fuel prices:
Quarterly Energy Prices
www.decc.gov.uk/en/content/cms/statistics/publications/prices/prices.aspx

Oil prices:
OECD Factbook 2009
http://lysander.sourceoecd.org/vl=9694782/cl=35/nw=1/rpsv/factbook2009/05/02/03/index.htm

Annex A

Timeline of selected events

Department responsible for energy	Year	Event
Ministry of Fuel and Power	1948	Electricity Supply Nationalised
		Gas industry nationalised
		Coal production high of 228m tonnes
	1953	94% of gas creation comes from coal
		World's first nuclear power station opens at Calder Hall, Cumbria
Ministry of Power	1958	
		OPEC created
	1963	
		First shipment of LNG arrives in Britain
		North Sea gas discovered in West Sole field
		North Sea gas production and natural gas conversion programme starts
	1968	
Ministry of Technology		
Department of Trade and Industry		
	1973	British Gas Corporation created; First oil crisis - October 1973
Department of Energy		
		North Sea oil production starts
		Natural gas conversion programme completed
	1978	
		Second oil crisis - October 1979
		Iran/Iraq war - crude oil prices hit high
	1983	
		Year long miners' strike starts - 5 March 1984
		British Gas privatised
	1988	Piper Alpha oil disaster - 8 July 1988
		Electricity industry privatised
		First UK commercial windfarm operational
Department of Trade and Industry	1993	
		Natural gas available in Northern Ireland for first time
		UK becomes net exporter of gas
	1998	GB gas market fully competitive
		GB electricity market fully competitive; UK oil production hits peak of 137m tonnes
		UK Gas production peaks at 115 billion cubic metres; First commercial offshore wind farm
	2003	Iraq war - crude oil price rises
		UK returns to be net importer of gas
		Hurricanes in the US damage oil refineries - crude price increases
BERR *		
Department of Energy and Climate Change	2008	Crude oil prices hit $140 per barrel

**BERR = Department for Business, Enterprise and Regulatory Reform*

Annex B
Glossary and Acronyms

Aviation spirit — A light hydrocarbon oil product used to power piston-engined aircraft power units.

Benzole — A colourless liquid, flammable, aromatic hydrocarbon by-product of the iron and steel making process. It is used as a solvent in the manufacture of styrenes and phenols but is also used as a motor fuel.

Biodiesel — Produced from vegetable oils or animal fats by mixing them with ethanol or methanol to break them down.

Bioethanol — Created from crops rich in starch or sugar by fermentation, distillation and finally dehydration.

Blast furnace gas — Mainly produced and consumed within the iron and steel industry. Obtained as a by-product of iron making in a blast furnace, it is recovered on leaving the furnace and used partly within the plant and partly in other steel industry processes or in power plants equipped to burn it. A similar gas is obtained when steel is made in basic oxygen steel converters; this gas is recovered and used in the same way.

Breeze — Breeze can generally be described as coke screened below 19 mm (¾ inch) with no fines removed but the screen size may vary in different areas and to meet the requirements of particular markets.

Butane — Hydrocarbon (C_4H_{10}), gaseous at normal temperature but generally stored and transported as a liquid. Used as a component in Motor Spirit to improve combustion, and for cooking and heating (see LPG).

Coke oven coke — The solid product obtained from carbonisation of coal, principally coking coal, at high temperature, it is low in moisture and volatile matter. Used mainly in iron and steel industry.

Coke oven gas — Gas produced as a by-product of solid fuel carbonisation and gasification at coke ovens, but not from low temperature carbonisation plants. Synthetic coke oven gas is mainly natural gas which is mixed with smaller amounts of blast furnace and basic oxygen steel furnace gas to produce a gas with almost the same quantities as coke oven gas.

Coking coal — Within this publication, coking coal is coal sold by producers for use in coke ovens and similar carbonising processes. The definition is not therefore determined by the calorific value or caking qualities of each batch of coal sold, although calorific values tend to be higher than for steam coal. Not all coals form cokes. For a coal to coke it must exhibit softening and agglomeration properties, ie the end product must be a coherent solid.

Combined cycle gas Turbine (CCGT) — Combined cycle gas turbine power stations combine gas turbines and steam turbines which are connected to one or more electrical generators in the same plant. The gas turbine (usually fuelled by natural gas or oil) produces mechanical power (to drive the generator) and heat in the form of hot exhaust gases. These gases are fed to a boiler, where steam is raised at pressure to drive a conventional steam turbine, which is also connected, to an electrical generator.

Combined Heat and Power (CHP)	CHP is the simultaneous generation of usable heat and power (usually electricity) in a single process. The term CHP is synonymous with cogeneration and total energy, which are terms often used in the United States or other Member States of the European Community. The basic elements of a CHP plant comprise one or more prime movers driving electrical generators, where the steam or hot water generated in the process is utilised via suitable heat recovery equipment for use either in industrial processes, or in community heating and space heating.
Conventional thermal power stations	These are stations which generate electricity by burning fossil fuels to produce heat to convert water into steam, which then powers steam turbines.
Crude oil	A mineral oil consisting of a mixture of hydrocarbons of natural origins, yellow to black in colour, of variable density and viscosity.
DERV	Diesel engined road vehicle fuel used in internal combustion engines that are compression-ignited.
Distillation	A process of separation of the various components of crude oil and refinery feedstocks using the different temperatures of evaporation and condensation of the different components of the mix received at the refineries.
Downstream	Used in oil and gas processes to cover the part of the industry after the production of the oil and gas. For example, it covers refining, supply and trading, marketing and exporting.
Energy use	Energy use of fuel mainly comprises use for lighting, heating or cooling, motive power and power for appliances.
Ethane	A light hydrocarbon gas (C_2H_6) in natural gas and refinery gas streams (see LPG).
Final energy consumption	Energy consumption by final user – ie which is not being used for transformation into other forms of energy.
Fossil fuels	Coal, natural gas and fuels derived from crude oil (for example petrol and diesel) are called fossil fuels because they have been formed over long periods of time from ancient organic matter.
Indigenous production	For oil this includes production from the UK Continental Shelf both onshore and offshore.
Landfill gas	The methane-rich biogas formed from the decomposition of organic material in landfill.
Liquefied natural Gas (LNG)	Natural gas that has been converted to liquid form for ease of storage or transport.
Liquefied petroleum Gas (LPG)	Gas usually propane or butane, derived from oil and put under pressure so that it is in liquid form. Often used to power portable cooking stoves or heaters and to fuel some types of vehicle, eg some specially adapted road vehicles, forklift trucks.
Lead Replacement Petrol (LRP)	An alternative to Leaded Petrol containing a different additive to lead (in the UK usually potassium based) to perform the lubrication functions of lead additives in reducing engine wear.

Major power producers	Companies whose prime purpose is the generation of electricity.
Megawatt (MW)	1,000 kilowatts. MWe is used to emphasise when electricity is being measured. MWt is used when heat ("thermal") is being measured.
Motor spirit	Blended light petroleum product used as a fuel in spark-ignition internal combustion engines (other than aircraft engines).
Natural gas	Natural gas is a mixture of naturally occurring gases found either in isolation, or associated with crude oil, in underground reservoirs. The main component is methane; ethane, propane, butane, hydrogen sulphide and carbon dioxide may also be present, but these are mostly removed at or near the well head in gas processing plants.
Natural gas liquids (NGLs)	A mixture of liquids derived from natural gas and crude oil during the production process, including propane, butane, ethane and gasoline components (pentanes plus).
Non-energy use	Includes fuel used for chemical feedstock, solvents, lubricants, and road making material.
Patent fuel	A composition fuel manufactured from coal fines by shaping with the addition of a binding agent (typically pitch). The term manufactured solid fuel is also used.
Petrochemical feedstock	All petroleum products intended for use in the manufacture of petroleum chemicals. This includes middle distillate feedstock of which there are several grades depending on viscosity. The boiling point ranges between 200°C and 400°C.
Petroleum cokes	Carbonaceous material derived from hydrocarbon oils, uses for which include metallurgical electrode manufacture and in the manufacture of cement.
Plant capacity	The maximum power available from a power station at a point in time.
Plant loads, demands and efficiency	Measures of how intensively and efficiently power stations are being used.
Primary fuels	Fuels obtained directly from natural sources, eg coal, oil and natural gas.
Primary electricity	Electricity obtained other than from fossil fuel sources, eg nuclear, hydro and other non-thermal renewables. Imports of electricity are also included.
Propane	Hydrocarbon containing three carbon atoms (C_3H_8), gaseous at normal temperature, but generally stored and transported under pressure as a liquid.
Refinery fuel	Petroleum products produced by the refining process that are used as fuel at refineries.
Renewable energy sources	Renewable energy includes solar power, wind, wave and tide, and hydroelectricity. Solid renewable energy sources consist of wood, straw, short rotation coppice, other biomass and the biodegradable fraction of wastes. Gaseous renewables consist of landfill gas and sewage gas. Non-biodegradable wastes are not counted as a renewables source but appear in the Renewable sources of energy chapter of this Digest for completeness.

Reserves	With oil and gas these relate to the quantities identified as being present in underground cavities. The actual amounts that can be recovered depend on the level of technology available and existing economic situations. These continually change; hence the level of the UK's reserves can change quite independently of whether or not new reserves have been identified.
Secondary fuels	Fuels derived from natural primary sources of energy. For example electricity generated from burning coal, gas or oil is a secondary fuel, as are coke and coke oven gas.
Steam coal	Within this publication, steam coal is coal classified as such by UK coal producers and by importers of coal. It tends to be coal having lower calorific values; the type of coal that is typically used for steam raising.
Thermal Sources of Electricity	These include coal, oil, natural gas, nuclear, landfill gas, sewage gas, municipal solid waste, farm waste, tyres, poultry litter, short rotation coppice, straw, coke oven gas, blast furnace gas, and waste products from chemical processes.
Tonne of oil equivalent (toe)	A common unit of measurement which enables different fuels to be compared and aggregated.
Thermal efficiency	The thermal efficiency of a power station is the efficiency with which heat energy contained in fuel is converted into electrical energy. It is calculated for fossil fuel burning stations by expressing electricity generated as a percentage of the total energy content of the fuel consumed (based on average gross calorific values). For nuclear stations it is calculated using the quantity of heat released as a result of fission of the nuclear fuel inside the reactor.
UKCS	United Kingdom Continental Shelf
Ultra low sulphur Diesel (ULSD)	A grade of diesel fuel which has a much lower sulphur content (less than 0.005 per cent or 50 parts per million) and of a slightly higher volatility than ordinary diesel fuels. As a result it produces fewer emissions when burned. As such it enjoys a lower rate of excise duty in the UK than ordinary diesel (by 3 pence per litre) to promote its use. Virtually 100 per cent of sales of DERV fuel in the UK are ULSD.
Ultra low sulphur Petrol (ULSP)	A grade of motor spirit with a similar level of sulphur to ULSD (less than 0.005 per cent or 50 parts per million). In the March 2000 Budget it was announced that a lower rate of excise duty than ordinary petrol for this fuel would be introduced during 2000, which was increased to 3 pence per litre in the March 2001 Budget. It has quickly replaced ordinary premium grade unleaded petrol in the UK market place.
Upstream	A term to cover the activities related to the exploration, production and delivery to a terminal or other facility of oil or gas for export or onward shipment within the UK.
Watt (W)	The conventional unit to measure a rate of flow of energy. One watt amounts to 1 joule per second.

Annex C
Contact List

This publication has been produced by the Statistics team within the Department of Energy and Climate Change. A special thanks goes to Mike Janes, Adam Palin and James Ley who contributed to the publication whilst in the statistics team. The following people may be contacted for further information about the material published.

Topic	Contact	Telephone	E-mail
Head of Statistics	Duncan Millard	0300 068 5051	Duncan.Millard@decc.gsi.gov.uk
Total energy statistics	Iain MacLeay	5048	Iain.MacLeay@decc.gsi.gov.uk
Coal and solid fuels	Mita Kerai	5044	Mita.Kerai@decc.gsi.gov.uk
Oil and upstream gas resources	Clive Evans Warren Evans	5040 5059	Clive.Evans@decc.gsi.gov.uk Warren.Evans@decc.gsi.gov.uk
Petroleum (downstream)	Alison Colquhoun Warren Evans	5038 5059	Alison.Colquhoun@decc.gsi.gov.uk Warren.Evans@decc.gsi.gov.uk
Gas supply (downstream)	James Hemingway	5042	James.Hemingway@decc.gsi.gov.uk
Electricity	Alison Judd Chris Michaels	5043 5050	Alison.Judd@decc.gsi.gov.uk Chris.Michaels@decc.gsi.gov.uk
Combined heat and power	Alison Judd	5043	Alison.Judd@decc.gsi.gov.uk
Renewable sources of energy	Julian Prime	5054	Julian.Prime@decc.gsi.gov.uk
Energy prices	Jo Marvin	5049	Jo.Marvin@decc.gsi.gov.uk
General enquiries (energy helpdesk)	Clive Sarjantson	5056	Clive.Sarjantson@decc.gsi.gov.uk

All the above can be contacted by fax on 0300 068 5003

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