Department for Business, Energy & Industrial Strategy

DIGEST OF UNITED KINGDOM ENERGY STATISTICS 2020

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The United Kingdom Statistics Authority has designated these statistics as National Statistics, in accordance with the Statistics and Registration Service Act 2007 and signifying compliance with the UK Statistics Authority: Code of Practice for Statistics.

The continued designation of these statistics as National Statistics was confirmed in September 2018 following a compliance check by the Office for Statistics Regulation. The statistics last underwent a full assessment against the Code of Practice in June 2014.

Designation can be broadly interpreted to mean that the statistics:

- meet identified user needs
- are well explained and readily accessible
- are produced according to sound methods, and
- are managed impartially and objectively in the public interest

Once statistics have been designated as National Statistics it is a statutory requirement that the Code of Practice shall continue to be observed.

Any enquiries regarding this publication should be sent to us at: energy.stats@beis.gov.uk

Contents

Monthly and quarterly data are also available for Energy, Solid fuels and derived gases, Petroleum, Gas, Electricity and Renewables at:
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy/about/statistics

Information on Energy Prices is also available at:
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy/about/statistics

A list of tables

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Introduction

I This issue of the Digest of United Kingdom Energy Statistics (DUKES) continues a series which commenced with the Ministry of Fuel and Power Statistical Digest for the years 1948 and 1949, published in 1950. The Ministry of Fuel and Power Statistical Digest was previously published as a Command Paper, the first being that for the years 1938 to 1943, published in July 1944 (Cmd. 6538).

II The current issue updates the figures given in the Department for Business, Energy and Industrial Strategy's (BEIS) *Digest of United Kingdom Energy Statistics 2019*, published in July 2019.

III This publication consists of seven chapters and four annexes. The first chapter deals with overall energy. The other chapters cover the specific fuels, renewable sources of energy and combined heat and power. The annexes cover conversion factors and calorific values, a glossary of terms, further sources of information and major events in the energy industries.

IV Some additional information appears elsewhere on the internet. The tables on the internet are provided in Microsoft Excel format. Most internet versions of the tables include data for earlier years, which are not referenced in this publication. For example, commodity and energy balances (see VII and VIII, below) for 1998 to 2016 are included in the tables on the internet, and tables that reference five years in this publication show twenty-two years in their internet form. In addition, the following appear on the internet:

Long term trends tables
Major events from 1990 to 2020 - Annex D
(only Major events for 2018 to 2020 appear in this publication)
Energy and the environment – Annex E
UK oil and gas resources - Annex F
Foreign trade – Annex G
Flow charts – Annex H
Energy balance: net calorific values – Annex I
Heat reconciliation – Annex J

V Annual information on prices is included in the publication *Energy Prices*. The data are also available on the Department for Business, Energy and Industrial Strategy (BEIS) section of the GOV.UK website. Further information on these publications can be found in Annex C.

VI Where necessary, data have been converted or adjusted to provide consistent series. However, in some cases changes in methods of data collection have affected the continuity of the series. The presence of remaining discontinuities is indicated in the chapter text or in footnotes to the tables.

VII Chapters 2, 3, 4, 5 and 6 contain production and consumption of individual fuels and are presented using *commodity balances*. A commodity balance illustrates the flows of an individual fuel through from production to final consumption, showing its use in transformation (including heat generation) and energy industry own use. Further details of commodity balances and their use are given in Annex A, paragraphs A.7 to A.42.

VIII The individual commodity balances are combined in an *energy balance,* presented in Chapter 1, *Energy*. The energy balance differs from a commodity balance in that it shows the interactions between different fuels in addition to illustrating their consumption. The energy balance thus gives a fuller picture of the production, transformation and use of energy showing all the flows. Expenditure on energy is also presented in energy balance format in Chapter 1. Further details of the energy balance and its use are given in Annex A, paragraphs A.43 to A.58.

IX Chapter 1 also covers general energy statistics and includes tables showing energy consumption by final users and an analysis of energy consumption by main industrial groups. Fuel production and consumption statistics are derived mainly from the records of fuel producers and suppliers.

X Chapters 6 and 7 summarise the results of surveys conducted by Ricardo Energy & Environment on behalf of BEIS which complement work undertaken by BEIS. These chapters estimate the contribution made by renewable energy sources to energy and combined heat and power (CHP) production and consumption in the United Kingdom.

XI Some of the data shown in this Digest may contain previously unpublished revisions and estimates of trade from HM Revenue and Customs and the Office for National Statistics. These data are included in Annex G.

Definitions

XII The text at the beginning of each chapter explains the main features of the tables. Technical notes and definitions, given at the end of this text, provide detailed explanations of the figures in the tables and how they are derived. Further information on methodologies are also provided on the BEIS section of the GOV.UK website for each fuel

XIII Most chapters contain some information on ‘oil’ or ‘petroleum’; these terms are used in a general sense and vary according to usage in the field examined. In their widest sense they are used to include all mineral oil and related hydrocarbons (except methane) and any derived products.

XIV An explanation of the terms used to describe electricity generating companies is given in Chapter 5, paragraphs 5.85 to 5.93.

XV Data in this issue have been prepared on the basis of the Standard Industrial Classification (SIC 2007) as far as is practicable. For further details of classification of consumers see Chapter 1, paragraphs 1.57 to 1.61.

XVI Where appropriate, further explanations and qualifications are given in footnotes to the tables.

Proposed change to use net calorific values when producing energy statistics

XVII A consultation was launched in the 2005 edition of the Digest seeking views of users as to whether Net Calorific Values (NCVs) should be used in place of Gross Calorific Values (GCVs). As a result of this consultation, it was recognised that there are good arguments both for and against moving from GCV to NCV. However, it was concluded that there would be no demonstrable advantage to changing the method of presenting UK Energy statistics, and so GCVs continue to be used in this edition and will be used in future editions of the Digest. The fuel specific NCVs will continue to be published, and are shown in Annex A. The total energy balances on a net calorifc basis are now produced as part of the additional content of the Digest, Annex I.

Geographical coverage

XVIII The geographical coverage of the statistics is the United Kingdom. However, within UK trade statistics, shipments to the Channel Islands and the Isle of Man from the United Kingdom are not classed as exports. Supplies of solid fuel and petroleum to these islands, from the UK, are therefore included as part of United Kingdom inland consumption or deliveries.

Periods

XIX Data in this Digest are for calendar years or periods of 52 weeks, depending on the reporting procedures within the fuel industry concerned. Actual periods covered are given in the notes to the individual fuel chapters

Revisions

XX The tables contain revisions to some of the previously published figures, and where practicable the revised data have been indicated by an ‘r’. The ‘r’ marker is used whenever the figure has been revised from that published in the 2019 Digest, even though some figures may have already been amended on the published version of the tables. A table showing the size of revisions to key aggregates is available (Chapter 1, table 1J). Statistics on energy in this Digest are classified as National Statistics. This means that they are produced to high professional standards as set out in the UK Statistics Authority’s Code of Practice for Official Statistics. The Code of Practice requires that all the public bodies that produce official statistics “Publish a revisions policy for those outputs that are subject to scheduled revisions, and provide a statement explaining the nature and extent of revisions at the same time that they are released”. The following statement outlines the policy on revisions for energy statistics.

Revisions to data published in the *Digest of UK Energy Statistics*.

It is intended that any revisions should be made to previous years' data only at the time of the publication of the Digest (i.e. in July 2020 when this Digest is published, revisions can be made to 2018 and earlier years). In exceptional circumstances previous years' data can be amended between Digest publication dates, but this will only take place when quarterly *Energy Trends* is published. The reasons for substantial revisions will be explained in the 'Highlights' sheet of the table concerned. Valid reasons for revisions of Digest data include:

- revised and validated data received from a data supplier;
- the figure in the Digest was wrong because of a typographical or similar error.

In addition, when provisional annual data for a new calendar year (e.g. 2020) are published in *Energy Trends* in March of the following year (e.g. March 2021), percentage growth rates are liable to be distorted if the prior year (i.e. 2019) data are constrained to the Digest total, when revisions are known to be required. In these circumstances the prior year (i.e. 2019) data will be amended for all affected tables in *Energy Trends* and all affected Digest tables will be clearly annotated to show that the data has been updated in *Energy Trends*.

Revisions to 2020 data published in *Energy Trends* prior to publication in the 2021 edition of the *Digest of UK Energy Statistics.*

- All validated amendments from data suppliers will be updated when received and published in the next statistical release.
- All errors will be amended as soon as identified and published in the next statistical release.
- Data in energy and commodity balances format will be revised on a quarterly basis, to coincide with the publication of *Energy Trends*.

Further details on the UK Statistics Authority's Code of Practice for Official Statistics can be found at: www.statisticsauthority.gov.uk/code-of-practice/. BEIS's statements of compliance with the Code are available at:
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy/about/statistics#corporate-procedures-and-standards. The UK Statistics Authority undertake regular assessments of BEIS's energy statistics, and their reports can be accessed at:
www.statisticsauthority.gov.uk/publications-list/?keyword=&type=assessment-report.
The authority's recommendations have been incorporated into this publication and other BEIS energy statistical publications and outputs.

Energy data on the internet

XXI Energy data are held on the BEIS section of the GOV.UK website, under "statistics". The Digest is available at: www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes. Information on further BEIS energy publications is given in Annex C.

XXII The Department for Business, Energy and Industrial Strategy was created on 14 July 2016. This Department took over energy policy from the former Department of Energy and Climate Change. Within this publication references to BEIS's predecessor Department refer to DECC.

XXIII Short term statistics are published:

- monthly, by BEIS;
- quarterly, by BEIS in *Energy Trends,* and *Energy Prices;*
- quarterly, by BEIS in a Statistical Press Release which provides a summary of information published in *Energy Trends* and *Energy Prices*.

Table numbering

XXIV Page 10 contains a list showing the tables in the order in which they appear in this issue, and their corresponding numbers in previous issues.

Symbols used

XXV The following symbols are used in this Digest:

.. not available
- nil or not separately available
r revised since the previous edition

Rounding convention

XXVI Individual entries in the tables are rounded independently and this can result in totals, which are different from the sum of their constituent items.

Acknowledgements

XXVII Acknowledgement is made to the main coal producing companies, the electricity companies, the oil companies, the gas pipeline operators, the gas suppliers, National Grid, the Institute of Petroleum, the Coal Authority, the United Kingdom International Steel Statistics Bureau, Ricardo Energy & Environment, the Department for Environment, Food and Rural Affairs, the Department for Transport, OFGEM, Building

Research Establishment, HM Revenue and Customs, the Office for National Statistics, and other contributors to the enquiries used in producing this publication.

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XXIX For enquiries concerning particular data series or chapters contact those named on page 9 or at the end of the relevant chapter.

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Tables as they appear in this issue and their corresponding numbers in the previous three issues

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	1.1	1.2	1.3	-		1.9	5.4	5.4
	1.2	1.3	-	-		5.4	5.5	5.5
	1.3	-	-	-		5.5	5.6	5.6
	-	-	-	1.4		5.6	5.7	5.7
	-	-	1.4	1.5		5.7	5.8	5.8
	-	1.4	1.5	1.6		5.8	5.9	5.9
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					HEAT AND	7.2	7.2	7.2
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	4.4	4.4	4.4	4.4				
	4.5	4.5	4.5	4.5				
	4.6	4.6	4.6	4.6				

Chapter 1
Energy

Key points

- **In 2019, UK energy production was down 0.2 per cent on a year earlier**. The fall was due to reduced output from gas and nuclear. Overall fossil fuel production decreased, with coal output reaching a record low.
- Imports and exports in 2019 were both down; **overall net imports decreased and accounted for 35.2 per cent of UK consumption of energy products**.
- **Primary energy consumption was down by 1.5 per cent on 2018 but on a temperature adjusted basis primary energy consumption was down 1.2 per cent** continuing the downward trend of the last ten years. UK temperatures were broadly similar, whilst there was a small decrease in heating degree days compared to 2018. (Tables 1.1.7 and 1.1.8).
- **Final energy consumption fell by 0.9 per cent** as demand for heating decreased particularly in the first quarter of 2019 compared with 2018. On a temperature adjusted basis final energy consumption was also down by 0.9 per cent on 2018 levels.
- **Fossil fuels remain the dominant source of energy supply, but now account for 78.3 per cent,** a record low level. Supply from renewables increased, with their contribution accounting for 12.3 per cent of final consumption on the EU agreed basis (see Chapter 6).
- In 2019, there was a continuation of the switch in the main sources of electricity generation away from coal and gas to renewables. Generation from coal fell by 59 per cent, whilst gas rose by 0.3 per cent and renewables rose by 10 per cent**. Renewables' share of generation was at a record high level of 37.1 per cent in 2019,** up from 33.1 per cent in 2018, due to increased wind, solar and plant biomass capacity (see chapters 5 and 6).
- Provisional BEIS estimates suggest that **overall emissions fell by 14.2 million tonnes of carbon dioxide ($MtCO_2$) (3.9 per cent) to 351.5 $MtCO_2$** between 2018 and 2019, mainly due to the changes in the fuel mix used for electricity generation, away from coal towards renewables.

Introduction

1.1 This chapter presents figures on overall energy production and consumption. Figures showing the flow of energy from production, transformation and energy industry use through to final consumption are presented in the format of an energy balance based on the individual commodity balances in Chapters 2 to 6.

1.2 The chapter begins with aggregate energy balances covering the last three years (Tables 1.1 to 1.3) starting with the latest year, 2019, compiled using Gross Calorific Values (see paragraph 1.29). Energy value balances then follow this for the same years (Tables 1.4 to 1.6) and Table 1.7 shows sales of electricity and gas by sector in value terms. The explanation of the principles behind the energy balance and commodity balance presentations, and how this links with the figures presented in other chapters, is set out in Annex A. Information on long term trends (Tables 1.1.1 to 1.1.9) are available on BEIS's energy statistics website at:
www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

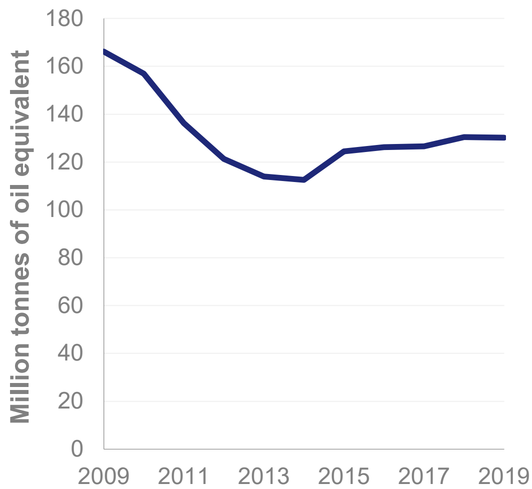
Aggregate energy balance (Tables 1.1, 1.2 and 1.3)

1.3 These tables show the flows of energy in the United Kingdom from production to final consumption through conversion into secondary fuels such as coke, petroleum products, secondary electricity and heat sold. The figures are presented on an energy supplied basis, in tonnes of oil equivalent (toe), a unit of energy where 1 toe = 41.868 GJ, see also paragraph 1.28 for other energy units. The basic principles of energy balances and guidance on what is included in each row is detailed in Annex A of this publication.

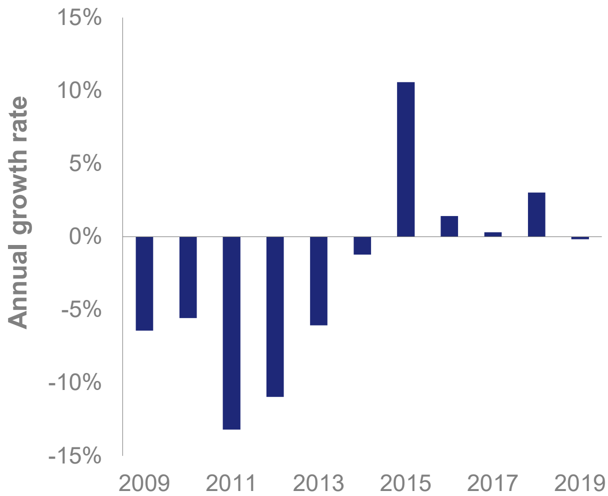
Energy production and supply

1.4 **Indigenous production in 2019 was 0.2 per cent lower than in 2018** (Chart 1.1). This fall, the first since 2014, follows four consecutive annual rises, and production is now 56 per cent below the peak recorded in 1999 with output falling in each of the years between 2000 and 2014 due to declines in output from the UK Continental Shelf (UKCS). **The fall in 2019 was due to the continued decline in coal production and reduced output from gas and nuclear.** Primary oil production rose by 1.9 per cent to the highest level since 2011, due to new production from the Clair Ridge field which opened at the end of 2018. The combined output of wind, hydro and solar photovoltaics rose by 11 per cent, mainly due to increases in wind and solar capacity, whilst bioenergy production rose by 1.6 per cent. Gas production fell by 2.9 per cent due to the closure of the Theddlethorpe gas terminal in 2018 as well as reduced output from several of the larger terminals; **overall fossil fuel production decreased by 0.3 per cent.**

Chart 1.1: UK energy production level



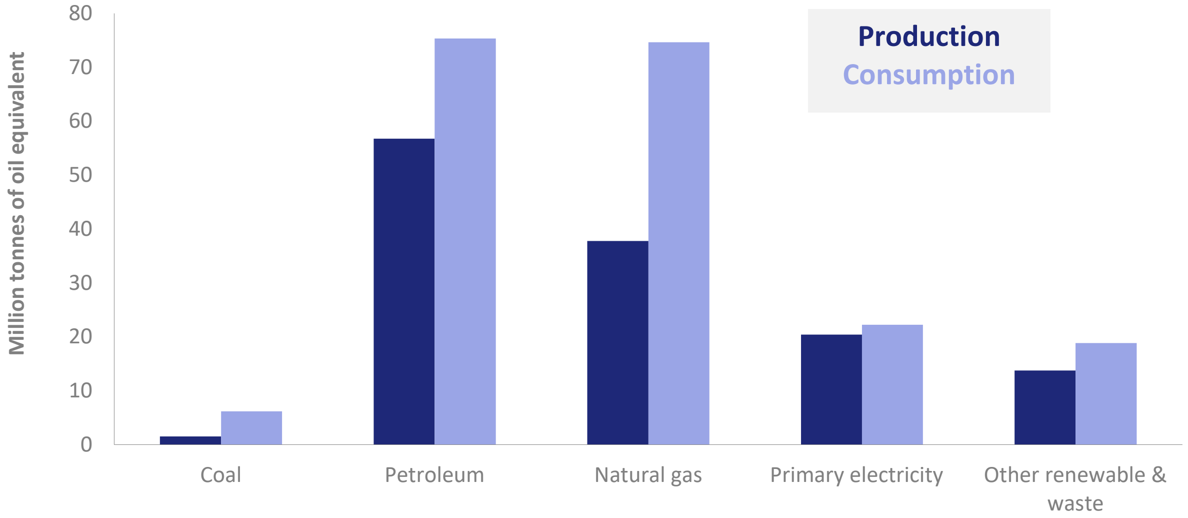
Annual growth rate



1.5 The reduction in coal output, down 14 per cent to a record low level, is due to reduced demand from electricity generators coupled with mine closures. Nuclear output was down 5.7, to the lowest level since 2008, due a series of prolonged outages throughout the year at Dungeness B and Hunterson B which reduced the UK's operational nuclear capacity, resulting in primary electricity (nuclear plus wind, solar and hydro) output being down 0.5 per cent. More details on these changes are given in the later fuel specific chapters.

1.6 **In 2019, the primary supply of fuels was 197.3 million tonnes of oil equivalent (mtoe), a 1.7 per cent decrease compared to 2018**. Chart 1.2 illustrates the figures for the production and consumption by fuels in 2019. In 2019, aggregate consumption was not met by indigenous production; this continues the trend since 2004 when the UK became a net importer of fuel. The differences between production and consumption are met mainly by trade but stock changes and the use of fuel in international shipping (marine bunkers) are also factors.

Chart 1.2: Production and consumption by fuels 2019



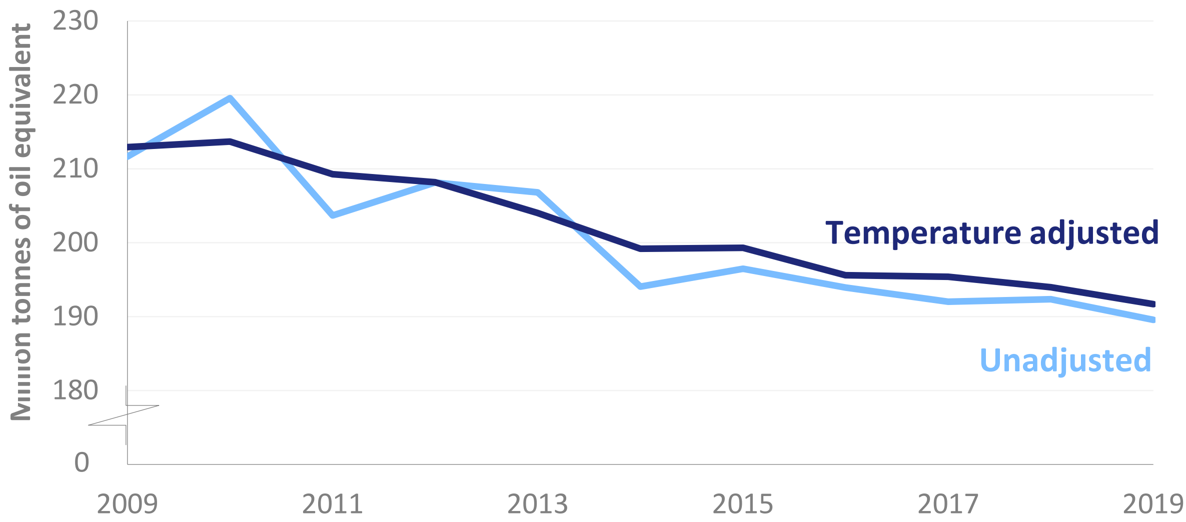
1.7 As explained in subsequent chapters, the UK has traded fuels such as oil and gas regardless of whether it has been a net exporter or importer. Imports in 2019 at 150.7 mtoe fell by 2.4 per cent from 2018 and were down 16 per cent from their peak in 2013. Imports of primary oil, petroleum products and gas all fell, with imports of petroleum products down by 5.8 per cent with imports of road fuels and heating oils both down. Exports at 80.5 million toe were down 1.2 per cent, with crude oil exports remaining stable following a 16 per cent increase in 2018 due to strong production and favourable price spreads resulting in increased demand for Brent crude from Asia. The UK remained a net importer of all main fuel types in 2019. In 2019 the UK net import gap fell back to 70.2 million toe from the 2013 peak of 104 million toe. **Net imports accounted for 35.2 per cent of consumption of energy products in the UK in 2019, down from their share of 47.9 per cent in 2013** (see table 1B and chart 1.7).

Energy demand and final consumption

1.8 **Total primary energy demand was lower in 2019 than in 2018 at 197.6 mtoe**. The fall in demand compared to a year earlier was mainly due to reduced losses in transformation, as renewables displaced coal and gas in generation. Average temperatures overall in 2019 were broadly similar to 2018, whilst the average number of heating degree days was down from 5.5 to 5.4.

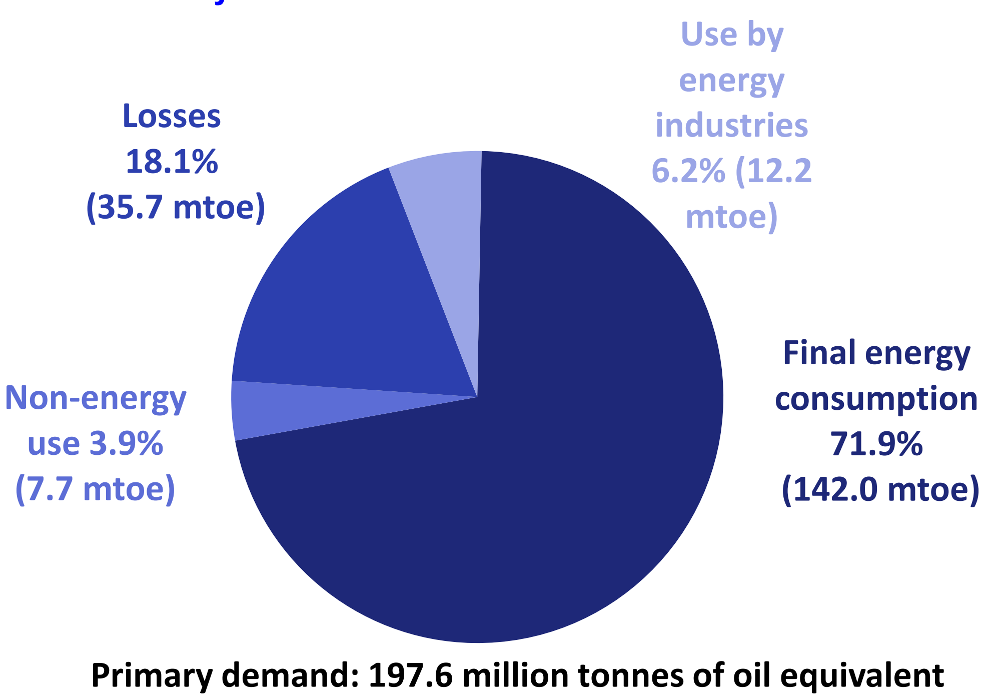
1.9 Primary energy consumption (primary supply less non-energy use) was down by 1.5 per cent in 2019**. On a temperature corrected basis, primary energy consumption was estimated to have fallen by 1.2 per cent.** A table showing temperature corrected demand is shown in Table 1.1.4 in the annex on long term trends, while Chart 1.3, shows the continued fall in primary energy consumption.

Chart 1.3: Primary energy consumption 2009 - 2019



1.10 In 2019, gas accounted for 40.6 per cent of UK generation up from 39.5 per cent in 2018. Coal's share declined further, accounting for only 2.1 per cent in 2019. Nuclear accounted for 17.3 per cent of generation, down from 2018, with thermal renewables accounting for a record 11.5 per cent share. **Generation from wind, hydro and solar photovoltaics rose by 11 per cent, to a record high level, due to increased wind and solar capacity and accounted for a record 25.6 per cent of generation. Overall renewables' share of generation was at a record high of 37.1 per cent in 2019.** More details on electricity are available in Chapter 5, with further information on renewable generation available in Chapter 6.

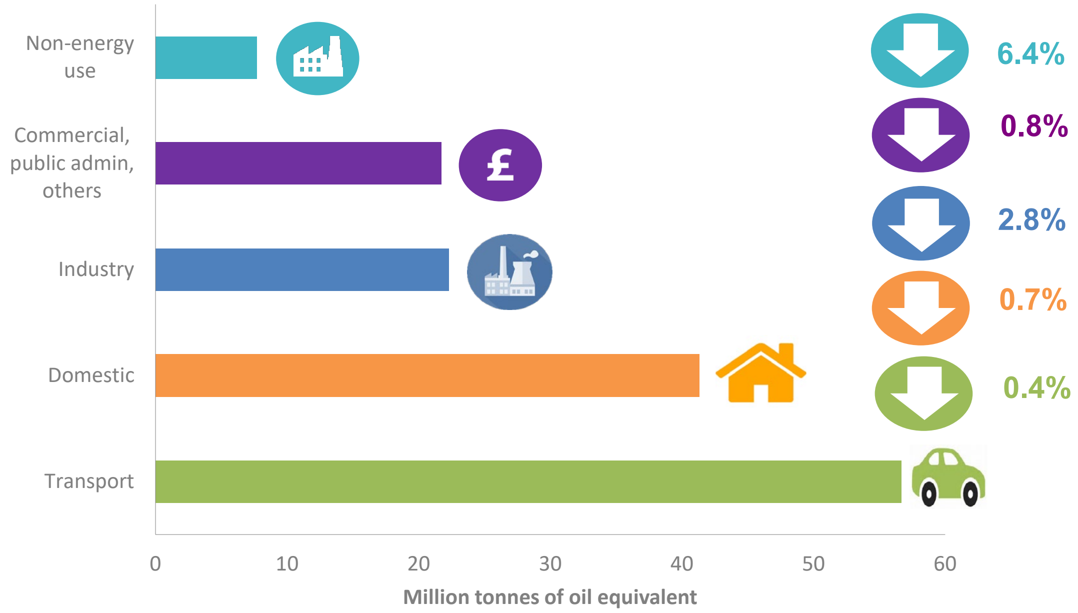
Chart 1.4: Primary demand 2019



1.11 The continued switch from coal to renewables for generation has resulted in a **sharp decrease in carbon dioxide emissions between 2018 and 2019**. Provisional BEIS estimates suggest that overall emissions fell by 14.2 million tonnes of carbon dioxide ($MtCO_2$) (3.9 per cent) to 351.5 $MtCO_2$ between 2018 and 2019. More details of carbon dioxide emissions are available in a Statistical Release, published in March 2020, which is available on the BEIS section of the GOV.UK website at: www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2019

1.12 Total **final consumption**, which includes non-energy use of fuels, was 149.7 million tonnes of oil equivalent in 2019. Chart 1.5 shows consumption by category, with transport and domestic use accounting for nearly two thirds of final consumption.

Chart 1.5: Final consumption 2019



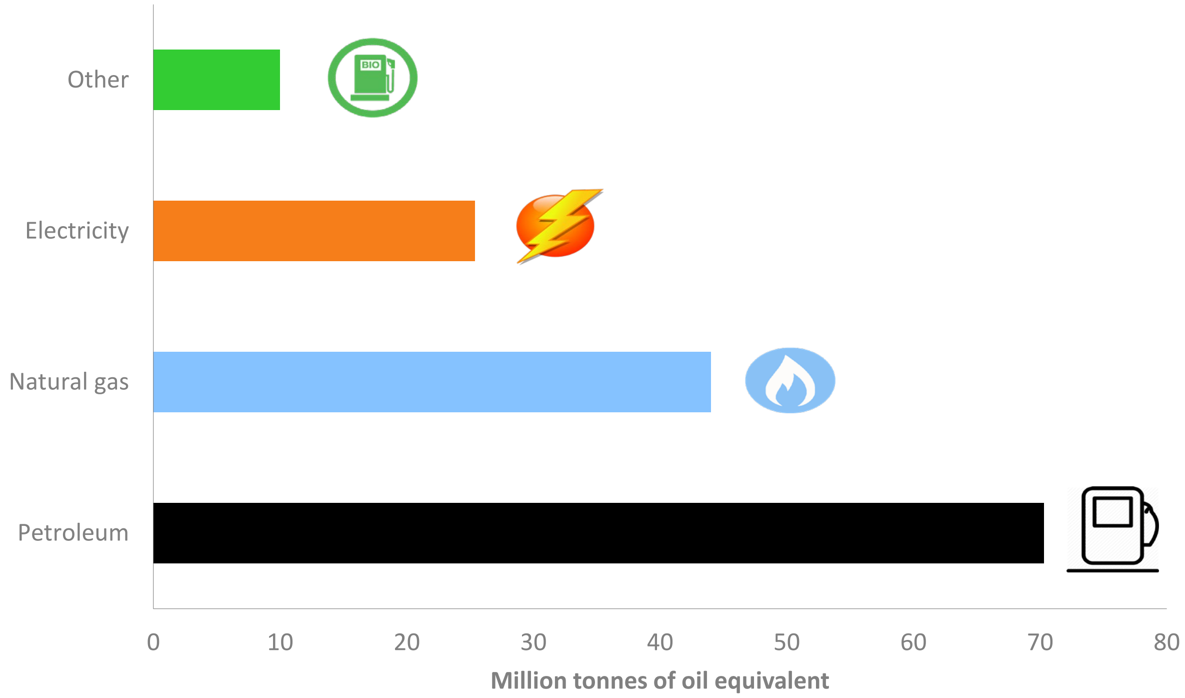
1.13 Final consumption (including non-energy use) decreased by 1.9 million tonnes of oil equivalent, **down 1.2 per cent, on the consumption in 2018.** Domestic sector consumption fell by 0.7 per cent (0.3 million tonnes). The fall in domestic use was mainly due to the warmer weather in the first quarter of 2019 compared to 2018 when the UK was in the midst of the 'Beast from the East' weather storm. On a temperature adjusted basis domestic consumption is estimated to have increased by 0.1 per cent in 2019, but is down by 5.0 per cent over the last 10 years.

1.14 **Consumption in the transport sector fell by 0.4 per cent, despite slightly increased demand in air transport consumption.** Consumption in the service sector fell by 0.8 per cent on decreased heating demand, whilst consumption in the industrial sector fell by 2.8 per cent. There was a fall in non-energy use of 6.4 per cent.

1.15 **Final energy consumption (where non-energy use is excluded) was down by 0.9 per cent on the year**. On a temperature corrected basis final energy consumption was estimated to also be down 0.9 per cent in 2019 compared to 2018.

1.16 The main fuels used by final consumers in 2019 were petroleum products (47.0 per cent), natural gas (29.4 per cent) and electricity (17.0 per cent). Biofuels accounted for 4.6 per cent of final consumption. The amount of heat that was bought for final consumption accounted for 0.8 per cent of the total final consumption.

Chart 1.6: Final consumption by fuel 2019



1.17 Of the petroleum products consumed by final users 10 per cent was for non-energy purposes; for natural gas 0.9 per cent was consumed for non-energy purposes. Non-energy use of fuels includes use as chemical feedstocks and other uses such as lubricants. Non-energy use of fuels for 2019 is shown in Table 1A. Further details of non-energy use are given in Chapters 2, 3 and 4.

Table 1A: Non-energy use of fuels 2019

Thousand tonnes of oil equivalent

	Petroleum	Natural gas	Manufactured fuel
Petrochemical feedstocks	4,536	401	50
Other	2,708	-	-
Total	**7,244**	**401**	**50**

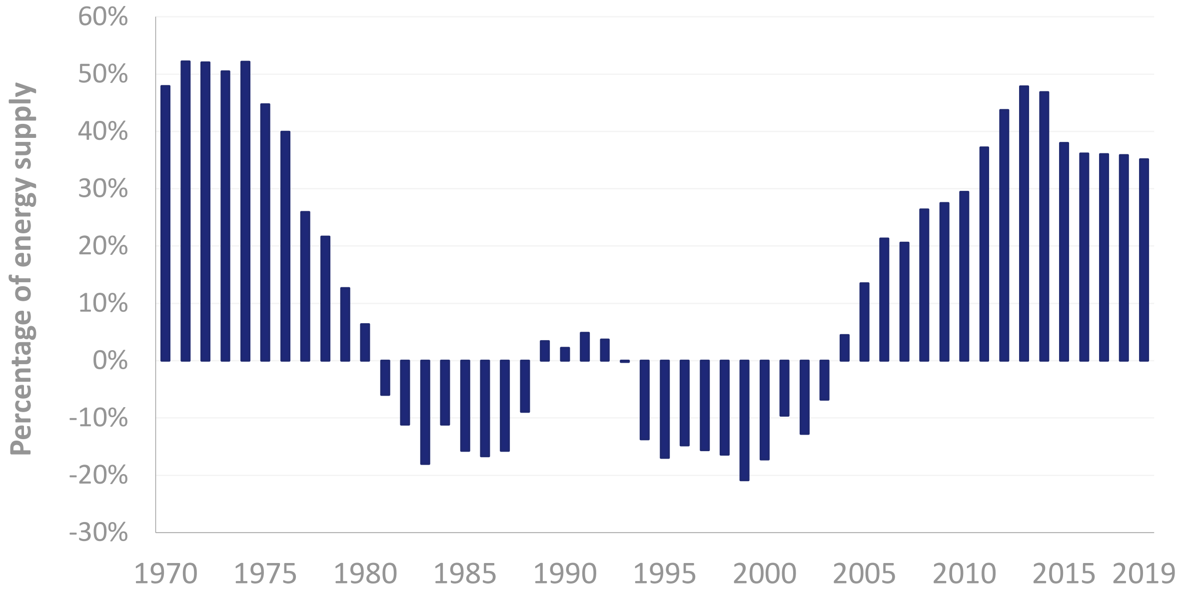
1.18 The data in the energy balances (Table 1.1) can be viewed in a number of ways, with a number of other statistics derived to produce different descriptions of the UK energy market. There is significant focus on import dependency and also at fossil fuel dependency. Import dependency (Table 1B) is calculated by dividing net imports by primary supply, including an addition for the energy supplied to marine bunkers. Chart 1.7 shows this on a longer time frame.

Table 1B: Net import dependency 2018 to 2019

Thousand tonnes of oil equivalent

	2017	2018	2019
Net imports	73,220	72,907	70,227
Primary energy supply + bunkers	203,263	203,197	199,751
Net import dependency	36.0%	35.9%	35.2%

Chart 1.7: Net import dependency 1970 - 2019



1.19 The energy used in the UK can also be classified by whether its source was from fossil fuels, low-carbon sources or other (Table 1C). The main fossil fuel sources in the UK are coal, gas and oil. The low carbon sources include nuclear and renewables such as wind; hydro; solar photovoltaics (pv) and biofuels. **In 2019, the share of primary energy consumption from fossil fuels decreased further to a record low of 78.3 per cent, whilst that from low-carbon sources increased from 18.9 per cent to a record 19.8 per cent share.**

1.20 The largest component of the low carbon series is now biomass, which overtook nuclear for the first time, with its share of energy supplied rising to 7.3 per cent in 2019, whilst nuclear fell back to 7.0 per cent. There was also rises in the shares from renewables (wind, solar and hydro). The 'other' category, shown for completeness, includes net imports of electricity, as imports and exports could come from either of the previous categories, and non-biodegradable wastes. Headline data, taken from Table 6.7, show that renewables had a "normalised" 12.3 per cent share of final energy consumption in 2019 (the normalisation process takes out weather effects from this statistic). There are other ways to measure renewables contribution to energy, and these are discussed in more detail in Chapter 6.

Table 1C: Fossil fuel and low carbon dependencies 2017 to 2019

			Per cent
	2017	2018	2019
Fossil fuel	80.3%	79.4%	78.3%
Low carbon	18.3%	18.9%	19.8%
Other	1.4%	1.7%	1.9%

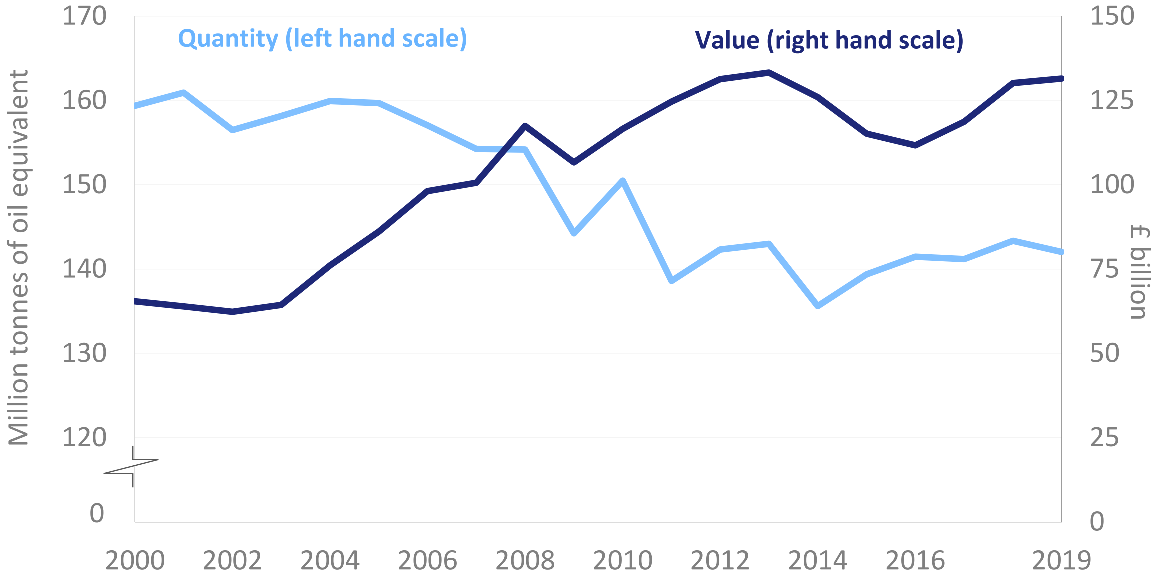
Value balance of traded energy (Tables 1.4, 1.5 and 1.6)

1.21 Tables 1.4 to 1.6 present the value of traded energy in a similar format to the energy balances. The balance shows how the value of inland energy supply is made up from the value of indigenous production, trade, tax and margins (profit and distribution costs). The lower half of the tables show how this value is generated from the final expenditure on energy (from the industrial and domestic sectors) through transformation processes and other energy sector users. The balances only contain values of energy which are traded, i.e. where a transparent market price is applicable. Further technical notes are given in paragraphs 1.39 to 1.45.

1.22 **Total expenditure by final consumers** in 2019 is estimated to be £131,500 million, (£131,175 million shown as actual final consumption and £325 million of coal consumed by the iron and steel sector in producing coke for their own consumption), which was **broadly similar to the 2018 level.**

1.23 **Total expenditure by final consumers in 2019 is down by 1.3 per cent (down 11 per cent in real terms when adjusted for inflation) from the peak in 2013.** The most significant changes from then being the reduced prices in crude and petroleum products. In 2019, crude oil prices averaged just below $64 per barrel which was 41 per cent lower compared to the average price of just under $109 per barrel in 2013. Chart 1.8 shows energy consumption and expenditure by final users.

Chart 1.8: Energy consumption and estimated expenditure on energy by final users 2000 - 2019



1.24 Of the total final expenditure on energy in 2019 (£132 billion), the biggest share of 50 per cent (£66 billion) fell to the transport sector. Industry purchase was 10 per cent (£13 billion), the domestic sector purchase was 27 per cent (£36 billion) and the remaining 13 per cent (£17 billion) were in the service sector.

Sales of electricity and gas by sector (Table 1.7)

1.25 Table 1.7 shows broad estimates for the total value of electricity and gas to final consumption. Net selling values provide some indication of typical prices paid in broad sectors and can be of use to supplement more detailed and accurate information contained in the rest of this chapter. More detailed information on energy prices is available in *Energy Prices*, available on BEIS's energy statistics website at: www.gov.uk/government/collections/quarterly-energy-prices

The energy industries

1.26 **The energy industries in the UK play a central role in the economy by producing, transforming and supplying energy in its various forms to all sectors.** They are also major contributors to the UK's Balance of Payments through the exports of crude oil and oil products. The box below summarises the energy industries' contribution to the economy in 2019, based on the latest available data from the Office for National Statistics (ONS):

- 2.5 per cent of GVA (Gross Value Added);
- 9.1 per cent of total investment;
- 29.5 per cent of industrial investment;
- 177,000 people directly employed (6.0 per cent of industrial employment);
- Many others indirectly employed (e.g. an estimated 121,000 in support of UK Continental Shelf production).

1.27 The share of GVA at 2.5 per cent compares to a peak level of 10.4 per cent in 1982. **The share fell to below 4 per cent in all years since 1997, with energy's share of the UK economy falling to a low of 2.2 per cent in 2017 before rising marginally in 2018 and 2019**. In 2019 investment in the energy industries rose marginally with increased spending for oil and gas extraction and gas, but reduced spending for electricity although it remained as the major contributor. Employment has remained broadly unchanged in the last ten years, but it fell by 2.7 per cent in 2019 compared to 2018 with falls in the electricity and gas sectors.

Technical notes and definitions

I Units and measurement of energy

Units of measurement

1.28 The original units of measurement appropriate to each fuel are used in the individual fuel chapters. A common unit of measurement, the tonne of oil equivalent (toe), which enables different fuels to be compared and aggregated, is used in Chapter 1. In common with the International Energy Agency and with the Statistical Office of the European Communities, the tonne of oil equivalent is defined as follows:

1 tonne of oil equivalent = 10^7 kilocalories
= 396.83 therms
= 41.868 Gigajoules (GJ)
= 11,630 Kilowatt hours (kWh)

This unit should be regarded as a measure of energy content rather than a physical quantity. One tonne of oil is not equal to one tonne of oil equivalent.

Calorific values when producing energy statistics

1.29 In this publication Gross Calorific Values (GCVs) are used to convert fuel from their original units to tonnes of oil equivalent (toe). An alternative is to use Net Calorific Values (NCVs) as detailed in paragraph XVII of the introduction. The fuel specific GCVs and NCVs are shown at Annex A. However, as some EU targets are calculated on data converted using net calorific values, aggregate energy balances for the most recent years have been calculated using NCVs; these are used in Table 6.7, and are available in Annex I at:
www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes.

Thermal content - energy supplied basis of measurement

1.30 Tables 1.1 to 1.3 and 1.1.1 to 1.1.5 (available on the BEIS section of GOV.UK at:
www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes) are compiled on an energy-supplied basis. Detailed data for individual fuels are converted from original units to tonnes of oil equivalent using gross calorific values and conversion factors appropriate to each category of fuel. The results are then aggregated according to the categories used in the tables. Gross calorific values represent the total energy content of the fuel, including the energy needed to evaporate the water present in the fuel (see also paragraph 1.55).

1.31 Estimated gross and net calorific values for 2019 are given in Table A.1 in Annex A. Calorific values are reviewed each year in collaboration with the fuel industries, and figures for earlier years can be found in Tables A.2 and A.3. To construct energy balances on an energy supplied basis calorific values are required for production, trade, and stocks, as follows:

Coal The weighted average gross calorific value of all indigenous coal consumed is used to derive the thermal content of coal production and undistributed stocks. Thermal contents of imports and exports allow for the quality of coal. Thermal contents of changes in coal stocks at secondary fuel producers are the average calorific values of indigenous coal consumed.

Petroleum The gross calorific values, included in Annex A and used in the construction of these energy balances from 1990 onwards, have been calculated using a formula derived by the US Bureau of Standards. This formula estimates the gross calorific value of products according to their density as follows:

$GJ = 51.83 - 8.78 \times d^2$, where *d* is the density of the product in terms of kilograms per litre.

For crude petroleum and refinery losses, the weighted average calorific value for all petroleum products from UK refineries is used. A notional figure of 42.9 GJ per tonne is used for non-energy petroleum products (industrial and white spirits, lubricants, bitumen, petroleum coke, waxes and miscellaneous products).

Gases Although the original unit for gases is the cubic metre, figures for gases are generally presented in the fuel sections of this Digest in gigawatt hours (GWh), having been converted from cubic metres using gross calorific values provided by the industries concerned. Conversion factors between units of energy are given on the inside back page and in Annex A.

Electricity and heat Unlike other fuels, the original unit used to measure electricity and heat is a measure of energy. The figures for electricity and heat can therefore be converted directly to toe using the conversion factors on the inside back page and in Annex A.

Primary electricity Hydro electricity and net imports of electricity are presented in terms of the energy content of the electricity produced (the energy supplied basis). This is consistent with international practice. Primary inputs for nuclear electricity assume the thermal efficiencies at nuclear stations given in Chapter 5, Table 5.10 (36.4 per cent in 2019).

Non-energy uses of fuel

1.32 Energy use of fuel mainly comprises use for lighting, heating, motive power and power for appliances. Non-energy use includes use as chemical feedstocks, solvents, lubricants and road making material. It should be noted that the amounts of non-energy use of natural gas included in the Digest are approximate. Further discussion of non-energy uses of lubricating oils and petroleum coke appears in Chapter 3.

Autogeneration of electricity

1.33 Autogeneration is defined as the generation of electricity by companies whose main business is not electricity generation, the electricity being produced mainly for that company's own use. Estimated amounts of fuel used for thermal generation of electricity by such companies, the output of electricity and the thermal losses incurred in generation are included within the Transformation section in the energy balances shown in Tables 1.1 to 1.3. Electricity used in the power generation process by autogenerators is shown within the Energy Industry Use section. Electricity consumed by industry and commerce from its own generation is included as part of final consumption. This treatment is in line with the practice in international energy statistics.

1.34 Figures on total amount of fuel used and electricity generated by autogenerators, and the amount of electricity for own consumption is shown in Tables 5.1 to 5.6. Table 5.4 summarises the figures by broad industrial groups. Much of the power generated is from combined heat and power (CHP) plants and data from Chapter 7 are included within Table 5.4. Differences will occur where CHP plants are classified to major power producers, and this mainly affects the chemicals sector. The method of allocating fuel used in CHP plants between electricity production and heat production is described in Chapter 7. This method can give rise to high implied conversion efficiencies in some sectors, most notably in the iron and steel sector.

Final consumption, deliveries, stock changes

1.35 Figures for final consumption relate to deliveries, if fuels can be stored by users and data on actual consumption are not available. Final consumption of petroleum and solid fuels is on a deliveries basis throughout, except for the use of solid fuels by the iron and steel industry. Figures for domestic use of coal are based on deliveries to merchants. Figures for stock changes in Tables 1.1 to 1.3 cover stocks held by primary and secondary fuel producers, major distributors of petroleum products, and stocks of coke and breeze held by the iron and steel industry; for coal they also include an estimate of volumes in transit. Figures for stock changes in natural gas represent the net amount put into storage by gas companies operating pipelines.

1.36 Figures for final consumption of electricity include sales by the public distribution system and consumption of electricity produced by generators other than the major electricity producing companies. Thus, electricity consumption includes that produced by industry and figures for deliveries of other fuels to industry exclude amounts used to generate electricity (except for years prior to 1987, shown in tables giving long term trends).

Heat sold

1.37 Heat sold has been separately identified in the energy balances since 1999. It is defined as heat that is produced and sold under the provision of a contract. The introduction of heat sold into the energy and commodity balances did not affect the individual fuel totals, since the energy used to generate the heat has been deducted from the final consumption section of the energy balances and transferred to the transformation section. Details of the methodology used and tables that show the detailed analysis of the heat generation row of the main energy balances, by sector generating the heat, are available at: www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes. To make the heat sold information more transparent, data on the quantity of fuel by consuming sector used to produce heat that is subsequently sold are also available in Annex J.

II Energy balances (Tables 1.1, 1.2 and 1.3)

1.38 Tables 1.1, 1.2 and 1.3 show the energy flows as the primary fuels are processed (or used) and as the consequent secondary fuels are used. The net inputs to transformation are shown in the transformation rows and hence outputs from transformation processes into which primary fuels are input (such as electricity generation, heat generation or petroleum refining) appear as positive figures under the secondary product's heading in the tables. Similarly, the net inputs are shown as negative figures under the primary fuel headings.

III Value balances (Tables 1.4, 1.5 and 1.6)

Valuation of energy purchases

1.39 In common with the rest of the chapter, these tables covering energy expenditure follow a balance format. While a user may derive data on a similar basis as that previously published, the balance tables allow for more varied use and interpretation of traded energy value data. That said, the tables continue to only show values for energy that has to be purchased and therefore do not include estimated values of a sector's internal consumption, such as coal used in the process of coal extraction.

The value balance

1.40 The tables balances around **market value of inland consumption**, with the lower half of the tables showing the total value of consumption by end users, sub-divided into energy sector users and final users both for energy and non-energy use. The top half of the tables show the supply components that go to make up the final market value of inland consumption, namely upstream cost of production, imports, taxes and the margins and costs of delivering and packaging the fuel for the final consumer. The total final consumers' value of energy consumption is represented by the lines 'total non-energy sector use' and iron and steel sectors' purchases of coal for use in solid fuel manufacture. All figures are estimates and have been rounded to the nearest £5 million.

1.41 In keeping with the energy balances, the value balances, since 2000, have included data on heat generation and heat sold. Additionally, an estimate of the amount of Climate Change Levy (CCL) and the Carbon Price Support (CPS) paid is included in Tables 1.4, 1.5 and 1.6. The CCL was introduced in April 2001 and is payable by non-domestic final consumers of gas, electricity, coal, coke and LPG, with the Carbon Price Support (CPS), a tax on fossil fuel used to generate electricity, was introduced in April 2013.

1.42 The value balance demonstrates how the value chain works in the production and consumption of energy. For example, in 2019, £21,085 million of crude oil was indigenously produced, of which £18,290 million was exported; and £19,480 million of crude oil was imported. Allowing for stock changes, this provides a total value of UK inland crude oil supply of £22,245 million. This fuel was then completely consumed within the petroleum industry in the process of producing £31,105 million of petroleum products. Again, some external trade and stock changes took place before arriving at a basic value of petroleum products of £34,940 million. In supplying the fuel to final consumers, distribution costs were incurred, and some profit was made amounting to £2,325 million, whilst duty and tax meant a further £33,700 million was added to the basic price to arrive at the final market value of £71,045 million. This was the value of petroleum products purchased, of which industry purchased

£1,200 million, domestic consumers for heating purposes purchased £1,245 million, with the vast majority £62,335 million, purchased by the transport sector.

Fuel definitions in value balances

1.43 **Crude oil** includes Natural Gas Liquids (NGLs) and refinery feedstocks. **Natural gas** does not include colliery methane. **Electricity** only includes electricity delivered via the public distribution system and therefore does not include value of electricity produced and consumed by autogenerators; however, the fuels used by autogenerators are included under Transformation. **Manufactured solid fuels** include coke, breeze and other solid manufactured fuels, mainly products from patent fuel and carbonisation plants. **Other fuels** include all other fuels not separately listed, where they can be clearly considered as traded and some reasonable valuation can be made. Fuels mainly contributing to this year's values are wood, coke oven and colliery methane gases sold on to other industrial users and some use of waste products such as poultry litter.

Energy end use

1.44 Values represent the cost to the final user including transportation of the fuel. They are derived, except where actual values are available, from the traded element of the volumes presented in aggregate energy balance and end user prices collected from information supplied by users or energy suppliers. The **energy sector** consists of those industries engaged in the production and sale of energy products, but values are not given for consumption of self-generated fuels e.g. coke oven gas used by coke producers. Many of the processes in the **iron and steel** industry are considered to be part of the energy sector in the energy balances, but for the purposes of this economic balance their genuine purchases are treated as those of final consumers, except for purchases of coal directly used in coke manufacture, which is shown separately as part of the manufacture of solid fuels. Coal used directly in or to heat blast furnaces is shown as iron and steel final use. **Transformation** includes those fuels used directly in producing other fuels e.g. crude oil in petroleum products. **Electricity generators** keep and use stocks of coal, and the stocks used in consumption each year are shown separately. The value and margins for these being assumed to be the same as other coal purchased in the year. **Road transport** includes all motor spirit and DERV (diesel-engined road vehicle) use. **Commercial and other users** include public administration and miscellaneous uses not classified to the industrial sector.

Supply

1.45 The supply side money chain is derived using various methods. **Indigenous production** represents the estimated basic value of in-year sales by the upstream producers. This value is gross of any taxes or cost they must meet. The valuation problems in attributing network losses in gas and electricity between upstream and downstream within this value chain means any costs borne are included in the production value. **Imports and exports** are valued in accordance with data published by HM Revenue and Customs, contained in Annex G. However, crude oil is treated differently, where the value is formed from price data taken from a census survey of refiners and volume data taken from Table 3.1. These values are considered to reflect the complete money chain more accurately than Tables G.1 to G.7. **Stock changes** are those for undistributed stocks except for coal where coke oven and generators' stocks are included. A stock increase takes money out of the money chain and is therefore represented as a negative. **Distribution costs** are arrived at by removing an estimate of producers' value along with any taxes from the end user values shown. For most fuels, the estimate of producer value is derived from the consumption used for end use and the producer price taken from survey of producers. No sector breakdown is given for gas and electricity margins because it is not possible to accurately measure delivery costs for each sector. **Taxes** include VAT where not refundable and duties paid on downstream sales. Excluded are the gas and fossil fuel levies, petroleum revenue tax and production royalties and licence fees. The proceeds from the fossil fuel levy are redistributed across the electricity industry, whilst the rest are treated as part of the production costs.

Sales of electricity and gas by sector (Table 1.7)

1.46 This table provides data on the total value of gas and electricity sold to final consumers. The data are collected from the energy supply companies. The data are useful in indicating relative total expenditure between sectors, but the quality of data provided in terms of industrial classification has been worsening in recent years. Net selling values provide an indication of typical prices paid in broad sectors.

IV Measurement of energy consumption

Primary fuel input basis

1.47 Energy consumption is usually measured in one of three different ways. The first, known as the primary fuel input basis, assesses the total input of primary fuels and their equivalents. This measure includes energy used or lost in the conversion of primary fuels to secondary fuels (for example in power stations and oil refineries), energy lost in the distribution of fuels (for example in transmission lines) and energy conversion losses by final users. Primary demands as in Table 1.1, 1.2 and 1.3 are on this basis.

Final consumption - energy supplied basis

1.48 The second method, known as the energy supplied basis, measures the energy content of the fuels, both primary and secondary, supplied to final users. Thus, it is net of fuel industry own use and conversion, transmission and distribution losses, but it includes conversion losses by final users. Table 1D presents shares of final consumption on this basis. The final consumption figures are presented on this basis throughout Chapter 1.

1.49 Although this is the usual and most direct way to measure final energy consumption, it is also possible to present final consumption on a primary fuel input basis. This can be done by allocating the conversion losses, distribution losses and energy industry use to final users. This approach can be used to compare the total primary fuel use which each sector of the economy accounts for. Table 1E presents shares of final consumption on this basis.

Final consumption - useful energy basis

1.50 Thirdly, final consumption may be expressed in the form of useful energy available after deduction of the losses incurred when final users convert energy supplied into space or process heat, motive power or light. Such losses depend on the type and quality of fuel and the equipment used and on the purpose, conditions, duration and intensity of use. Statistics on useful energy are not sufficiently reliable to be given in this Digest; there is a lack of data on utilisation efficiencies and on the purposes for which fuels are used.

Shares of each fuel in energy supply and demand

1.51 The relative importance of the energy consumption of each sector of the economy depends on the method used to measure consumption. Shares of final consumption on an energy supplied basis (that is in terms of the primary and secondary fuels directly consumed) in 2019 are presented in Table 1D. For comparison, Table 1E presents shares of final consumption on a primary fuel input basis.

Table 1D: Primary and secondary fuels consumed by final users in 2019 – energy supplied basis

	Percentage of each fuel						Percentage of each sector					
	Industry	Transport	Domestic	Others	Total		Solid fuels	Petroleum	Gas	Electricity	Bioenergy	Total
Solid fuels	71	1	27	1	100	Industry	6	11	40	36	7	100
Petroleum	4	86	4	6	100	Transport	0	96	-	1	3	100
Gas	20	-	61	19	100	Domestic	1	6	65	22	6	100
Electricity	31	2	35	32	100	Others	0	18	38	38	6	100
Bioenergy	21	25	35	19	100							
All fuels	**15**	**40**	**29**	**15**	**100**	**All users**	**1**	**45**	**31**	**18**	**5**	**100**

Table 1E: Total primary fuel consumption by final users in 2019 - primary input basis

	Percentage of each fuel						Percentage of each sector					
	Industry	Transport	Domestic	Others	Total		Coal	Petroleum	Gas	Primary electricity	Bioenergy	Total
Coal	48	1	32	19	100	Industry	9	7	51	19	14	100
Petroleum	4	86	4	6	100	Transport	0	95	1	1	3	100
Gas	25	1	51	23	100	Domestic	4	5	66	14	11	100
Primary electricity	31	2	35	32	100	Others	4	12	50	20	14	100
Bioenergy	28	11	35	27	100							
All fuels	**19**	**32**	**30**	**18**	**100**	**All users**	**4**	**36**	**39**	**12**	**10**	**100**

1.52 In 2019, every 1 toe of secondary electricity consumed by final users required, on average, 0.1 toe of coal, 1.1 toe of natural gas, 0.6 toe of primary electricity (nuclear) and 0.6 toe of oil and bioenergy combined. The extent of this primary consumption is hidden in Table 1D, which presents final consumption only in terms of the fuels directly consumed. When all such primary consumption is allocated to final users, as in Table 1E, the relative importance of fuels and sectors changes; the transport sector, which uses very little electricity, declines in importance, whilst the true cost of final consumption in terms of coal use can now be seen.

1.53 Another view comes from shares of users' expenditure on each fuel (Table 1F based on Table 1.4). In this case the importance of fuels which require most handling by the user (solids and liquid fuels) is slightly understated, and the importance of uses taxed at higher rates (transport) is overstated in the "All users" line.

Table 1F: Value of fuels purchased by final users in 2019

	Percentage of each sector						
	Solid fuels	Petroleum	Gas	Secondary electricity	Heat	Biofuels	Total
Industry	6	9	15	65	4	1	100
Transport	-	94	-	1	-	5	100
Domestic	1	3	40	52	1	3	100
Others	-	13	14	72	1	-	100
All users	**1**	**51**	**14**	**30**	**1**	**3**	**100**

Systems of measurement - international statistics

1.54 The systems of energy measurement used in various international statistics differ slightly from the methods of the Digest. The key difference is the conversion factors used in BEIS's headline data that change the units for fuels for a volume or weight measure to an energy basis, as discussed in the paragraph below. However, in line with the International Recommendations for Energy Statistics (IRES) the UK does make data available on both bases. Other differences are that both the International Energy Agency (IEA) as well as the United Nations' IRES have International Aviation Bunkers as well as International Marine Bunkers shown together and not included in the country's energy supply. The UK in its energy balances continues to show fuel used for international marine bunkers in this manner but has maintained its practice of showing fuel for international aviation as part of final consumption - this practice is also followed by Eurostat.

Net calorific values

1.55 Calorific values (thermal contents) used internationally are net rather than gross. The difference between the net and gross thermal content is the amount of energy necessary to evaporate the water present in the fuel or formed during the combustion process. The differences between gross and net values are generally taken to be 5 per cent for liquid and solid fuels (except for coke and coke breeze where there is no difference), 10 per cent for gases (except for blast furnace gas, 1 per cent), 15 per cent for straw, and 20 per cent for poultry litter. The calorific value of wood is highly dependent on its moisture content. In Annex A, the gross calorific value is given as 16.3 GJ at 20 per cent moisture content for domestic wood and 20.3 GJ for dry (industrial) wood. Both gross and net calorific values are shown in Annex A. Energy balances on a net calorific basis are published in Annex I available at:
www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes

V Definitions of fuels

1.56 The following paragraphs explain what is covered under the terms "primary" and "secondary" fuels.

Primary fuels

Coal - Production comprises all grades of coal, including slurry.
Primary oils - This includes crude oil, natural gas liquids (NGLs) and feedstock.
Natural gas liquids - Natural gas liquids (NGLs) consist of condensates (C5 or heavier) and petroleum gases other than methane C1, that is ethane C2, propane C3 and butane C4, obtained from the onshore processing of associated and non-associated gas. These are treated as primary fuels when looking at primary supply but in the consumption data presented in this chapter these fuels are treated as secondary fuels, being transferred from the primary oils column in Tables 1.1, 1.2 and 1.3.
Natural gas - Production relates to associated or non-associated methane C1 from land and the United Kingdom sector of the Continental Shelf. It includes that used for drilling production and pumping operations, but excludes gas flared or re-injected. It also includes colliery methane piped to the surface and consumed by collieries or others.
Nuclear electricity - Electricity generated by nuclear power stations belonging to the major power producers.
Natural flow hydro-electricity - Electricity generated by natural flow hydroelectric power stations, whether they belong to major power producers or other generators. Pumped storage stations are not included (see under secondary electricity below).
Renewable energy sources - In this chapter figures are presented for renewables and waste in total. Further details, including a detailed breakdown of the commodities and technologies covered are in Chapter 6.

Secondary fuels

Manufactured fuel - This heading includes manufactured solid fuels such as coke and breeze, other manufactured solid fuels, liquids such as benzole and tars and gases such as coke oven gas and blast furnace gas. Further details are given in Chapter 2, Tables 2.5 and 2.6.
Coke and breeze – Coke, oven coke and hard coke breeze. Further details are given in Chapter 2, Table 2.5.
Other manufactured solid fuels – Manufactured solid fuels produced at low temperature carbonisation plants and other manufactured fuel and briquetting plants. Further details are given in Chapter 2, Table 2.5.
Coke oven gas - Gas produced at coke ovens, excluding low temperature carbonisation plants. Gas bled or burnt to waste is included in production and losses. Further details are given in Chapter 2, Table 2.6.
Blast furnace gas - Blast furnace gas is mainly produced and consumed within the iron and steel industry. Further details are given in Chapter 2, Table 2.6.
Petroleum products - Petroleum products produced mainly at refineries, together with inland deliveries of natural gas liquids.

Secondary electricity - Secondary electricity is that generated by the combustion of another fuel, usually coal, natural gas, biofuels or oil. The figure for outputs from transformation in the electricity column of Tables 1.1, 1.2 and 1.3 is the total of primary and secondary electricity, and the subsequent analysis of consumption is based on this total.
Heat sold – Heat sold is heat that is produced and sold under the provision of a contract.

VI Classification of consumers

1.57 The Digest has been prepared, as far as is practicable, on the basis of the *Standard Industrial Classification (SIC) 2007,* details of which are available at: www.ons.gov.uk/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007). Table 1G shows the categories of consumers together with their codes in SIC 2007. SIC(2007) replaced SIC(2003) on 1 January 2008, with energy statistics being compiled on the new basis from 2010. SIC(2003) was introduced at the start of 2003; the previous classification SIC(1992) was used from 1995. Between 1986 and 1994 data in the Digest were prepared on the basis of SIC(1980). The changes in classification between SIC(1992), SIC(2003) and SIC(2007) are mainly in the very detailed classifications at the four or five digit level. As such the classifications used for energy statistics are unaffected by these changes.

1.58 The coverage varies between tables (e.g. in some instances the 'other' category is split into major constituents, whereas elsewhere it may include transport). This is because the coverage is dictated by what data suppliers can provide. The table also shows the disaggregation available within industry. This disaggregation forms the basis of virtually all the tables that show a disaggregated industrial breakdown.

1.59 There is also an 'unclassified' category in the industry sector (see Table 1G). In cases where the data supplier has been unable to allocate an amount between categories, but the Department for Business, Energy and Industrial Strategy has additional information, from other data sources, with which to allocate between categories, then this has been done. Where such additional information is not available the data are included in the 'unclassified' category, enabling the reader to decide whether to accept a residual, pro-rate, or otherwise adjust the figures. The 'miscellaneous' category also contains some unallocated figures for the services sector.

Table 1G: SIC 2007 classifications

Fuel producers	05-07, 09, 19, 24.46, 35
Final consumers:	
Industrial	
Unclassified	See paragraph 1.59
Iron and steel	24, (*excluding* 24.4, 24.53, 24.54)
Non-ferrous metals	24.4, (*excluding* 24.46), 24.53, 24.54
Mineral products	08, 23
Chemicals	20-21
Mechanical engineering and metal products	25, 28
Electrical and instrument engineering	26-27
Vehicles	29-30
Food, beverages & tobacco	10-12
Textiles, clothing, leather, & footwear	13-15
Paper, printing & publishing	17-18
Other industries	16, 22, 31-33, 36-39
Construction	41-43
Transport	49-51 (part*)
Other final users	
Domestic	Not covered by SIC 2007
Public administration	84-88
Commercial	45-47, 49-51 (part*), 52-53, 55-56, 58-66, 68-75, 77-82
Agriculture	01-03
Miscellaneous	90-99

* Note – transport sector includes only energy used for motion/traction purposes. Other energy used by transport companies is classified to the commercial sector.

1.60 In Tables 7.8 and 7.9 of Chapter 7 the following abbreviated grouping of industries (Table 1H), based on SIC 2007, is used in order to prevent disclosure of information about individual companies.

Table 1H: Abbreviated grouping of Industry

Iron and steel and non-ferrous metal	24
Chemicals	20-21
Oil refineries	19.2
Paper, printing and publishing	17-18
Food, beverages and tobacco	10-12
Metal products, machinery and equipment	25, 26, 27, 28, 29, 30
Mineral products, extraction, mining and agglomeration of solid fuels	05, 06, 08, 23
Sewage Treatment	(parts of 36 and 37)
Electricity supply	35.1
Other industrial branches	07, 13, 14, 15,16, 19.1, 24.46, 22, 31, 32, 33, 35.2, 36 & 37 (remainder) 41, 42, 43
Transport, commerce, and administration	1, 2, 3, 45 to 99 (except 93)
Other	35.3, 93

1.61 In Table 5.4 the list above is further condensed and includes only manufacturing industry and construction as follows in Table 1I.

Table 1I: Abbreviated grouping of Industry for Table 5.4

Iron and steel and non-ferrous metals	24
Chemicals	20-21
Paper, printing and publishing	17-18
Food, beverages and tobacco	10-12
Metal products, machinery and equipment	25-30
Other (including construction)	08, 13-16, 19, 22-23, 31-33, 36-39, 41-43

VII Monthly and quarterly data

1.62 Monthly and quarterly data on energy production and consumption (including on a seasonally adjusted and temperature corrected basis) split by fuel type are provided on the BEIS section of the GOV.UK website at: www.gov.uk/government/statistics/total-energy-section-1-energy-trends. Quarterly figures are also published in BEIS's quarterly statistical bulletins *Energy Trends* and *Energy Prices*. See Annex C for more information about these bulletins.

VIII Statistical differences

1.63 Tables 1.1 to 1.3 each contain a statistical difference term covering the difference between recorded supply and recorded demand. These statistical differences arise for a number of reasons. The data within each table are taken from varied sources, as described above and in later chapters; for example, producers, intermediate consumers (such as electricity generators), final consumers and HM Revenue and Customs. Also, some of the figures are estimated either because data in the required detail are not readily available within the industry or because the methods of collecting the data do not cover the smallest members of the industry. Typically, the supply of fuels is easier to measure than demand, and thus greater reliance can be made of these numbers.

IX Revisions

1.64 Table 1J shows a summary of the revisions made to the major energy aggregates between this year's edition of DUKES and the immediately preceding version. This year, the revisions window for DUKES has been opened back to 2016. Changes this year include more accurate data of the coal production split between steam coal, coking coal and anthracite, and some reclassifications of existing renewables capacity and generation data.

Table 1J: Revisions since DUKES 2019

Thousand tonnes of oil equivalent

	2016	2017	2018	Percentage revisions to 2018 data
Production	289	238	452	0.3%
Primary supply	427	478	618	0.3%
Primary demand	292	302	519	0.3%
Transformation	25	138	1	0.0%
Energy industry use	0	95	82	0.7%
Final consumption	135	95	308	0.2%
Industry	66	152	217	1.0%
Transport	0	1	-71	-0.1%
Other	69	-86	481	0.8%
Non energy use	0	28	-320	-3.7%

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Chapter 2
Solid fuels and derived gases

Key points

- **In 2019, coal comprised 2.8 per cent of UK primary energy demand. This is down from 4.0 per cent the previous year** and 18 per cent in 2013. (Table 1.1)

- **Coal demand in the UK is at a record low because of falling demand for electricity generation. Demand fell by 33 per cent** from 11.9 million tonnes in 2018 to 8.0 million tonnes in 2019 (Table 2.4), with a 56 per cent decrease in the use of coal for electricity generation to a record low. In May 2019 electricity was generated from coal on only 5 days with the longest coal free spell (18 days and 6 hours) since the 1880's. **Just over a third - 36 per cent - of demand for coal was for electricity generation**. Overall demand has fallen by 87 per cent since 2013 as coal generation decreased following government initiatives that resulted in gas being favoured for generation. (Table 2.1)

- **Coal production fell by 16 per cent compared to last year**, down to an all-time low of 2.2 million tonnes, less than a fifth of the production recorded in 2013 (Table 2.4). This decrease was mainly due to lower demand for coal-fired electricity and coal mines closing and other collieries producing less coal as they near closure.

- **In 2019, 6.5 million tonnes of coal was imported, down by 36 per cent compared to 2018. Net imports accounted for 73 per cent of the UK's supply. Russia was the UK's largest supplier of coal imports** with a share of 37 per cent. The other main suppliers were the USA with a 27 per cent share and Colombia with a 17 per cent share. (Table 2B)

- **Total stock levels marginally fell** in 2019 to 5.3 million tonnes, compared to 2018. (Table 2.4)

Introduction

2.1 This chapter presents statistics on supply and demand for coal (tables 2.1 - 2.4) and manufactured solid fuels, including coke oven coke, coke breeze, patent fuel, coke oven gas, blast furnace gas, benzole and tar (tables 2.5 and 2.6). A full list of tables is available at the end of the chapter.

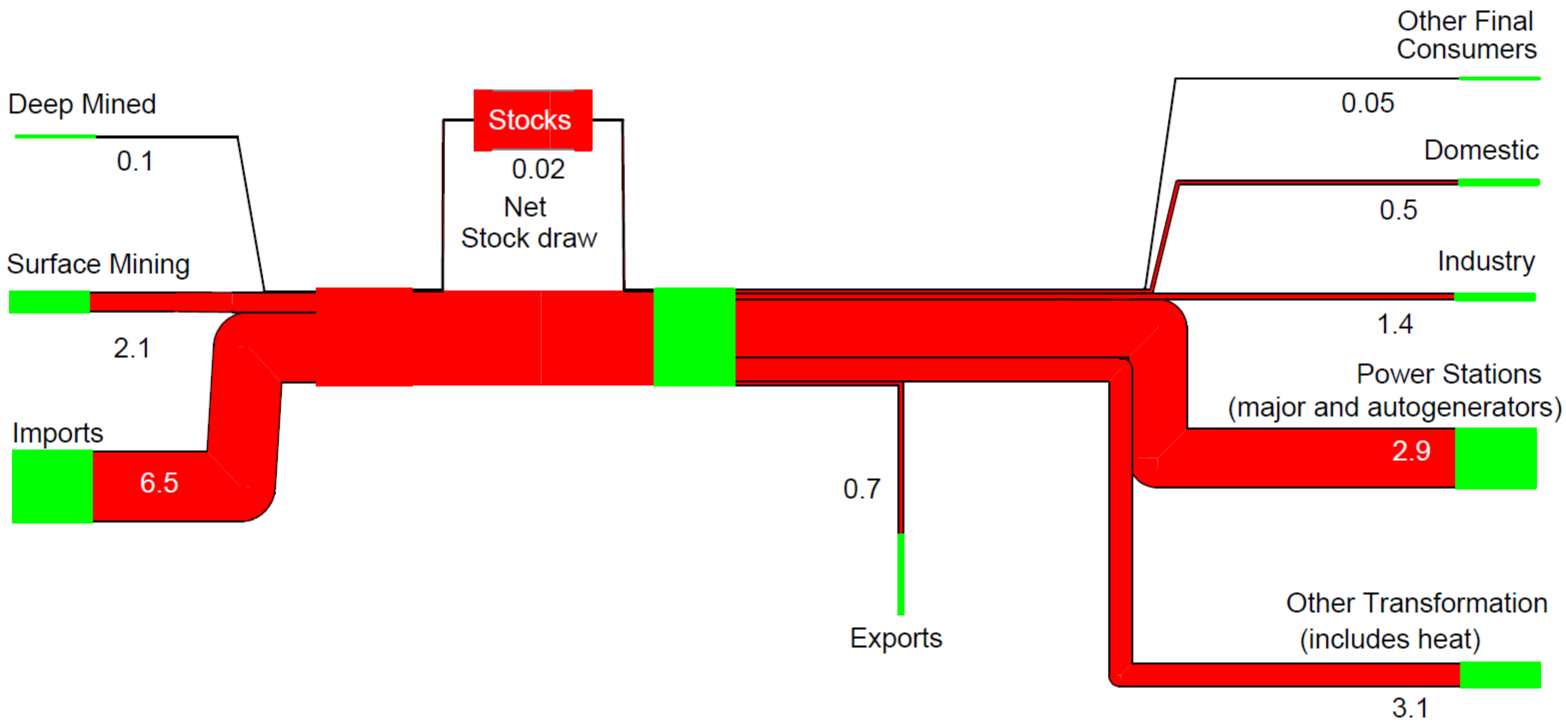
2.2 **In 2019, coal comprised 2.8 per cent of UK primary energy demand. This is down from 4.0 per cent the previous year** and 16 per cent since 2000. Most coal is used for electricity generation, coke manufacture, or in blast furnaces in the steel industry.

2.3 Below, an energy flow chart for 2019 shows the flows of coal from production and imports through to consumption. It is a way of simplifying the figures that can be found in the commodity balance for coal in Table 2.4. The chart illustrates the flow of coal from the point of supply (on the left) to its eventual final use (on the right).

Revisions

2.4 Splits of coal production by coal type for 2016-2018 have been revised in line with new data received from UK coal producers.

Coal flow chart 2019 (million tonnes of coal)

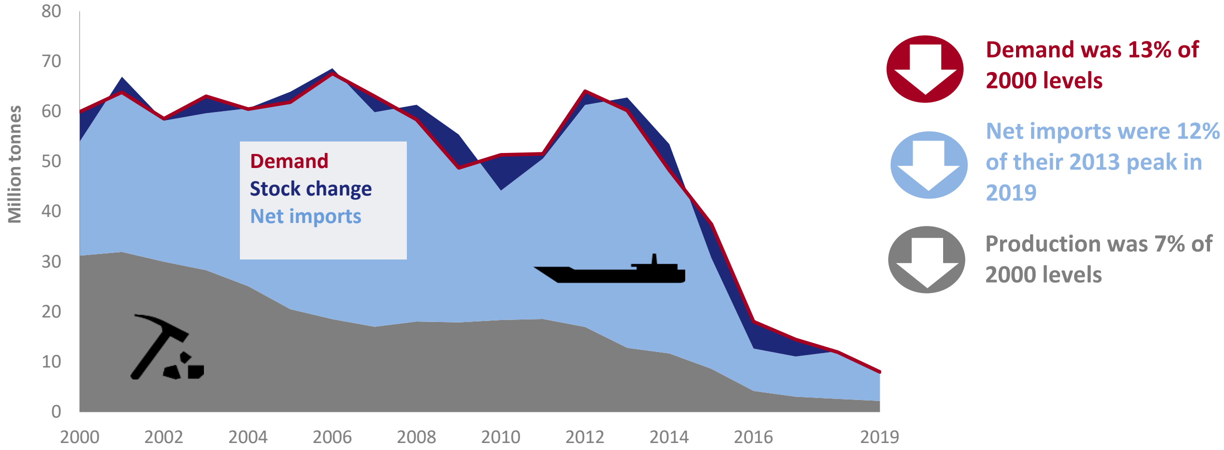


Notes: This flow chart is based on the data that appear in Tables 2.1 and 2.4.

Coal supply and demand (Table 2.1)

2.5 **With reduced demand for coal, supply has contracted substantially with an abrupt fall in 2014 and following years. In 2019, coal production fell 16 per cent compared to 2018 to an all-time low of 2.2 million tonnes.** Net imports fell 39 per cent to 5.8 million tonnes and accounted for 73 per cent of the UK's supply, but were 12% of the peak of 50.0 million tonnes in 2013, (Chart 2.1).

Chart 2.1: UK coal supply and demand 2000 - 2019



2.6 **Deep mined** production in the UK was only 4.6 per cent of production, despite quadrupling to 99 thousand tonnes due to Aberpergwm colliery increasing production. In 2015 deep mined production provided nearly a third of total coal production. This was the year that the last large deep mines in operation closed - Hatfield, Thoresby and Kellingley. **Surface mined** production decreased 19 per cent, to a new record low of 2.1 million tonnes due to lower demand for coal-fired electricity and coal mines closing and other collieries producing less coal as they near closure. Surface mined coal was 13 million tonnes in 2000.

2.7 **Steam coal**, mainly used by power stations, accounted for 45 per cent of total coal production in 2019, with 32 per cent **coking coal** and 23 per cent **anthracite** (Table 2.1). In 2015 steam coal accounted for 89 per cent of production, with 10 per cent anthracite and 1 per cent coking coal. No coal slurry has been produced since the last UK sites closed in 2013.

2.8 Table 2A shows how production of coal is divided between England, Wales and Scotland. In 2019, 54 per cent of coal output was in Wales, 26 per cent in England and 20 per cent in Scotland. Wales became the main producer of coal when the last remaining large deep mines, which were in England, closed in 2015. Only smaller deep mines remain in England and Wales. There is no longer any deep mining of coal in Scotland (Map 2A).

Table 2A: Output from UK coal mines and employment in UK coal mines [1, 2]

		Million tonnes			Number		
		Output			Employment		
		2017	2018	2019	2017	2018	2019
Deep mined	England	0.02	0.01	0.00	48	37	8
	Wales	0.00	0.01	0.10	4	90	134
	Total	0.02	0.02	0.10	52	127	142
Surface mining	England	1.0	0.9	0.6	115	110	144
	Scotland	0.8	0.6	0.4	159	73	87
	Wales	1.2	1.0	1.1	294	280	326
	Total	3.0	2.6	2.1	568	463	557
Total	England	1.0	0.9	0.6	163	147	152
	Scotland	0.8	0.6	0.4	159	73	87
	Wales	1.2	1.1	1.2	298	370	460
	Total	3.0	2.6	2.2	620	590	699

Source: The Coal Authority

1. *Output is the tonnage declared by operators to the Coal Authority, including estimated tonnages. It excludes estimates of slurry recovered from dumps, ponds, rivers, etc.*
2. *Employment includes contractors and is as declared by licensees to the Coal Authority at 31 December each year.*

2.9 Table 2A also shows how numbers employed in the production of coal have changed over the last three years. **During 2019 total employment, including contractors, was 18 per cent higher than in 2018.** As of 31 December 2019, 66 per cent of the 699 people employed in UK coal mining worked in Wales, while 22 per cent were employed in England and 12 per cent in Scotland. Deep mined employment in Wales increased from 90 in 2018 to 134 in 2019 as a result of Aberpergwm coming out of care and maintenance and producing again from September 2018. Surface mining employment rose in Wales from 280 in 2018 to 326 in 2019, mainly due to Nant Helen coming out of care and maintenance in January 2019. England’s surface mining employment also showed a rise from 110 in 2018 to 144 in 2019, mainly due to Shotton taking on more staff as the main site went into restoration and the extension produced more coal.

2.10 **In 2019 UK imports at 6.5 million tonnes fell by 36 per cent compared to 2018 and has fallen by 72 per cent since 2000 as demand for coal has fallen.** Net imports comprise 73 per cent of the UK’s demand, compared to 38 per cent in 2000. The proportion of net imports increased over the last 19 years as coal mine closures saw domestic production fall faster than imports.

2.11 The majority of UK coal imports came from four countries, as shown by the map below. In 2019, 37 per cent of the UK’s total coal imports came from Russia (2.4 million tonnes), 27 per cent (1.8 million tonnes) came from the USA and 17 per cent (1.1 million tonnes) came from Colombia and 6 per cent (0.4 million tonnes) came from Australia.

Chart 2.2: UK Coal Imports in 2019 (thousand tonnes)

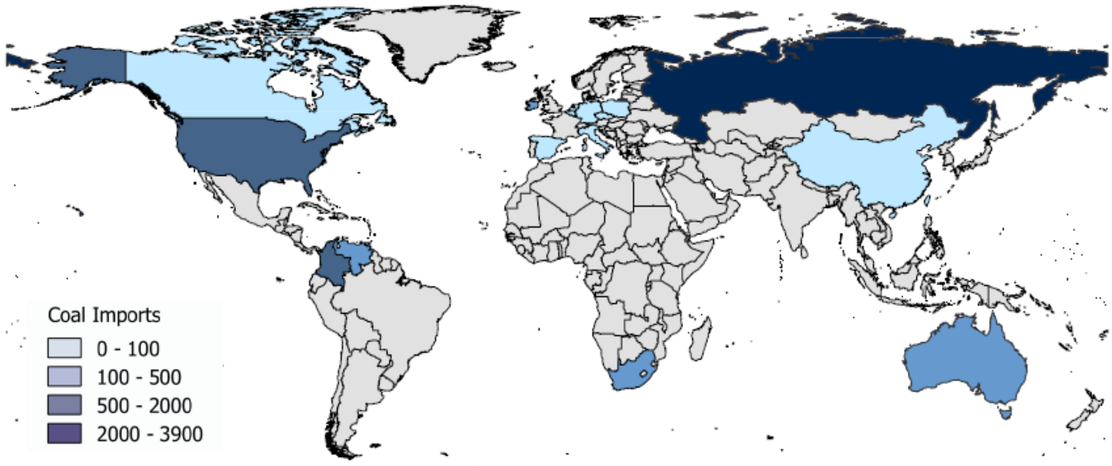


Table 2B: Imports of coal in 2019[1]

Thousand tonnes

	Steam coal	Coking coal	Anthracite	Total
Russia	1,707	710	4	2,421
United States of America	799	970	-	1,769
Australia	-	423	-	423
Colombia	1,078	-	-	1,078
European Union[2]	307	33	80	420
Republic of South Africa	158	-	-	158
Other countries	201	41	19	260
Total all countries	4,249	2,177	102	6,529

Source: HM Revenue and Customs, ISSB

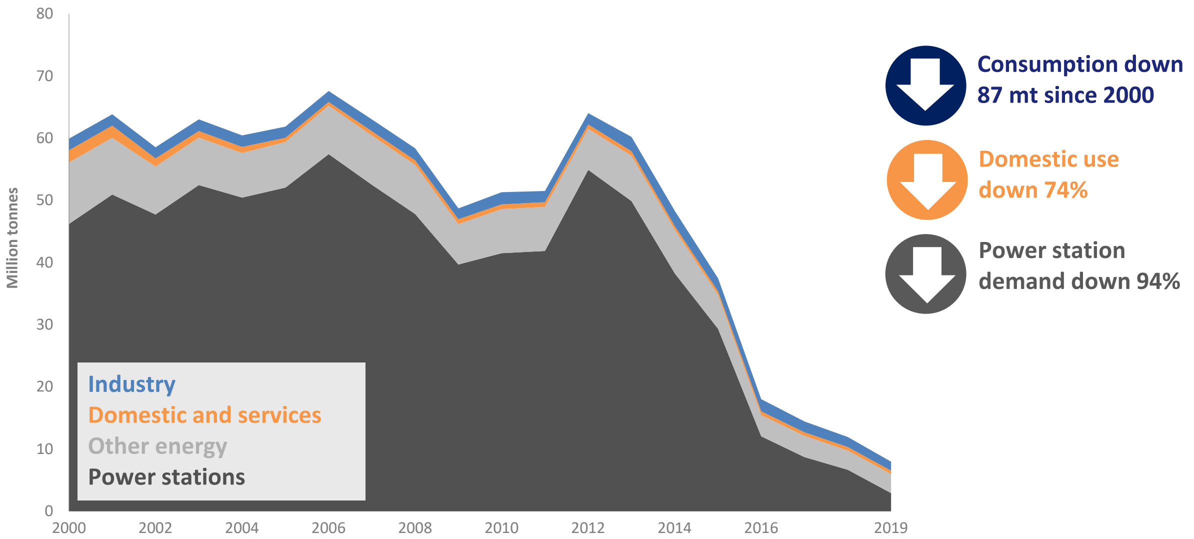
1. *Country of origin basis.*
2. *Includes non-EU coal routed through the Netherlands.*

2.12 Steam coal accounted for 65 per cent of the total imports. Of the rest, 33 per cent was coking coal, with anthracite accounting for the remainder. In 2019, Russia accounted for 40 per cent of total steam coal imports. A further 25 per cent came from Colombia. The UK imported 45 per cent of coking coal from the USA with a further 33 per cent from Russia and 19 per cent from Australia. The small volume of imported anthracite was mainly from the European Union (78 per cent).

2.13 In 2018, the latest year for which EU data is available, the UK remained as the seventh largest importing country in the EU and accounted for 6 per cent of total EU imports (164 million tonnes). From 1999 to 2015 the UK had been in the top two largest importers with Germany but fell to the sixth largest in 2016 due to lower demand. In 2018, Germany was the top importing country in the EU accounting for 27 per cent, followed by Poland with a 12 per cent share and Spain with a 10 per cent share of the total.

Coal Consumption

Chart 2.3: Coal consumption, 2000 - 2019



2.14 **The transformation sector represented 75 per cent (6 million tonnes) of overall demand for coal in 2019.** Electricity generation accounted for 36 per cent of demand for all types of coal and 86 per cent of demand for steam coal. Most coking coal was used in coke ovens (61 per cent) and the rest in blast furnaces (39 per cent) in the UK iron and steel industry. Coking coal used in blast furnaces decreased from 1.2 million tonnes in 2018 to 1.1 million tonnes in 2019. An energy balance flow chart for manufactured fuel, similar to that at the start of this chapter, is included in annex H.

2.15 **Electricity generation use of coal by major power producers fell by 56 per cent from 7 million tonnes in 2018 to 3 million tonnes (a new record low) in 2019.** Coal use by autogenerators was broadly stable at 16 thousand tonnes in 2019. Electricity generation favoured gas, nuclear and renewables over coal. Additionally, generation capacity which had fallen in recent years continued to fall with the following power stations closing in the last year - Fiddlers Ferry unit 1 (March 2019), Cottam Power Station (September 2019) and Aberthaw B (December 2019). There were only 5 major power stations remaining at the end of 2019. In May 2019 electricity was generated from coal on only 5 days breaking the record for the longest coal free spell (18 days and 6 hours) since the 1880's. This was broken again in May 2020.

2.16 **Coal consumption by final consumers fell 8.7 per cent compared to 2019, to 2.0 million tonnes. This comprised 25 per cent of total demand (DUKES Table 2.4).** Final consumption mainly covers steam raising for industrial processes, space or hot water heating, or heat for processing. Steam coal accounted for 79 per cent of this final consumption (up marginally from 2018).

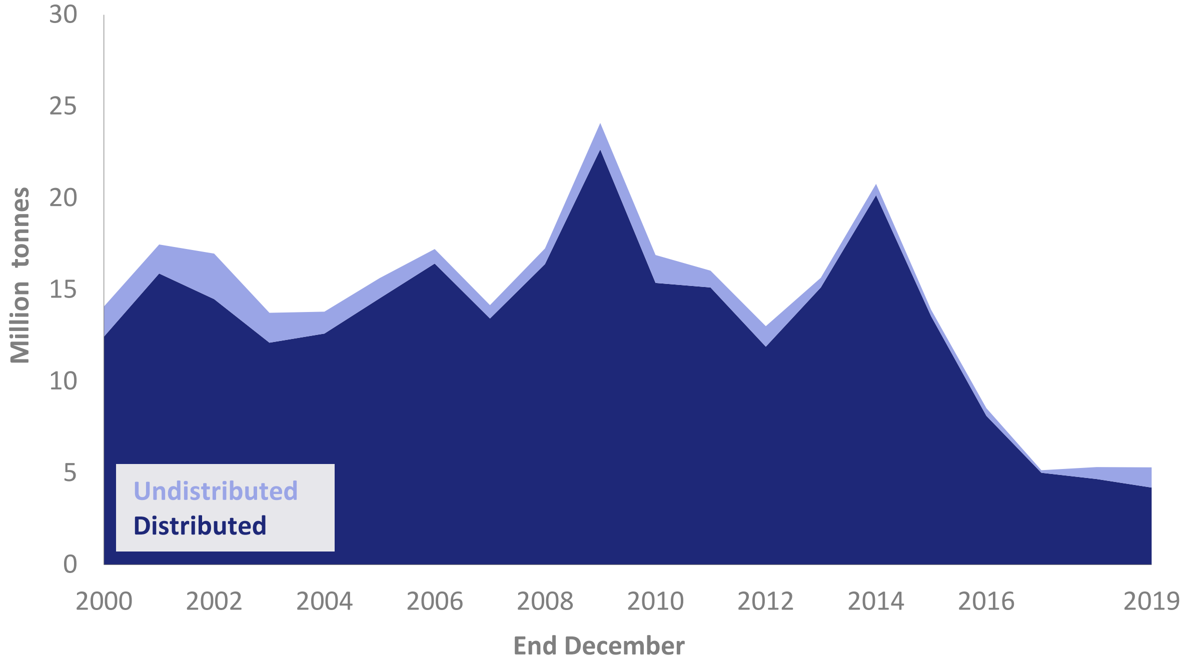
2.17 The industrial sector is the largest final consumer (accounting for 73 per cent of total final consumption in 2019). Eighty-four per cent of the coal used in the industrial sector was steam coal and manufacturers of mineral products (e.g. cement, glass and brick) were the largest users. The domestic sector accounted for 25 per cent of the final consumption of coal, with 63 per cent of this demand being for steam coal and the remainder for anthracite. Domestic consumption fell by 5.0 per cent in 2019 compared with 2018.

2.18 **In 2018, the UK was the seventh largest consumer of coal among the EU countries for the second year running. It had been the third largest in 2016.** The UK accounted for 5 per cent of total coal consumption in the EU. The top consumer was Poland accounting for 32 per cent of total EU consumption, while Germany was second accounting for 22 per cent.

Coal Stocks

2.19 In line with much of what we see with coal, the main changes to coal stocks came post 2014 when stocks began to decline year on year. Coal stocks fell to 5.3 million tonnes in 2019, which was 0.3 per cent lower than in 2018 (Chart 2.4). Stocks at major power stations fell 5.1 per cent from 3.9 million tonnes to 3.7 million tonnes, a record low in the published time series. Stocks held by coke ovens fell 1.8 per cent to 0.4 million tonnes.

Chart 2.4: Coal stocks in the UK 2000 – 2019



Coal Resources

2.20 **As of June 2020, the Coal Authority estimates that overall there are 3,906 million tonnes of coal resources, including prospects** (Table 2C), down marginally from 3,910 million tonnes assessed in June 2019. Of the economically recoverable and minable coal resource in current operations (including those in the planning or pre-planning process) 1,033 million tonnes is in underground mines and 46 million tonnes in surface mines. Overall England had a 77 per cent share of UK current mines and licenced resources, followed by Scotland with 14 per cent and Wales 9 per cent.

2.21 In prospects, there were 2,050 million tonnes suitable for underground mining and 777 million tonnes suitable for surface mining. Table 2C gives details of the resource assessment by England, Scotland and Wales as at 12 June 2020.

Table 2C: Identified GB coal resource assessment at 12 June 2020

UNDERGROUND MINING

Million tonnes

	England	Scotland	Wales	Total
Operational mines	0	0	23	23
Planning granted	5	0	0	5
In planning process	340	0	0	340
Pre-planning	480	107	78	665
Prospects	2,000	0	50	2,050
Closed mines still in licence	0	0	0	0
Total	**2,825**	**107**	**151**	**3,083**

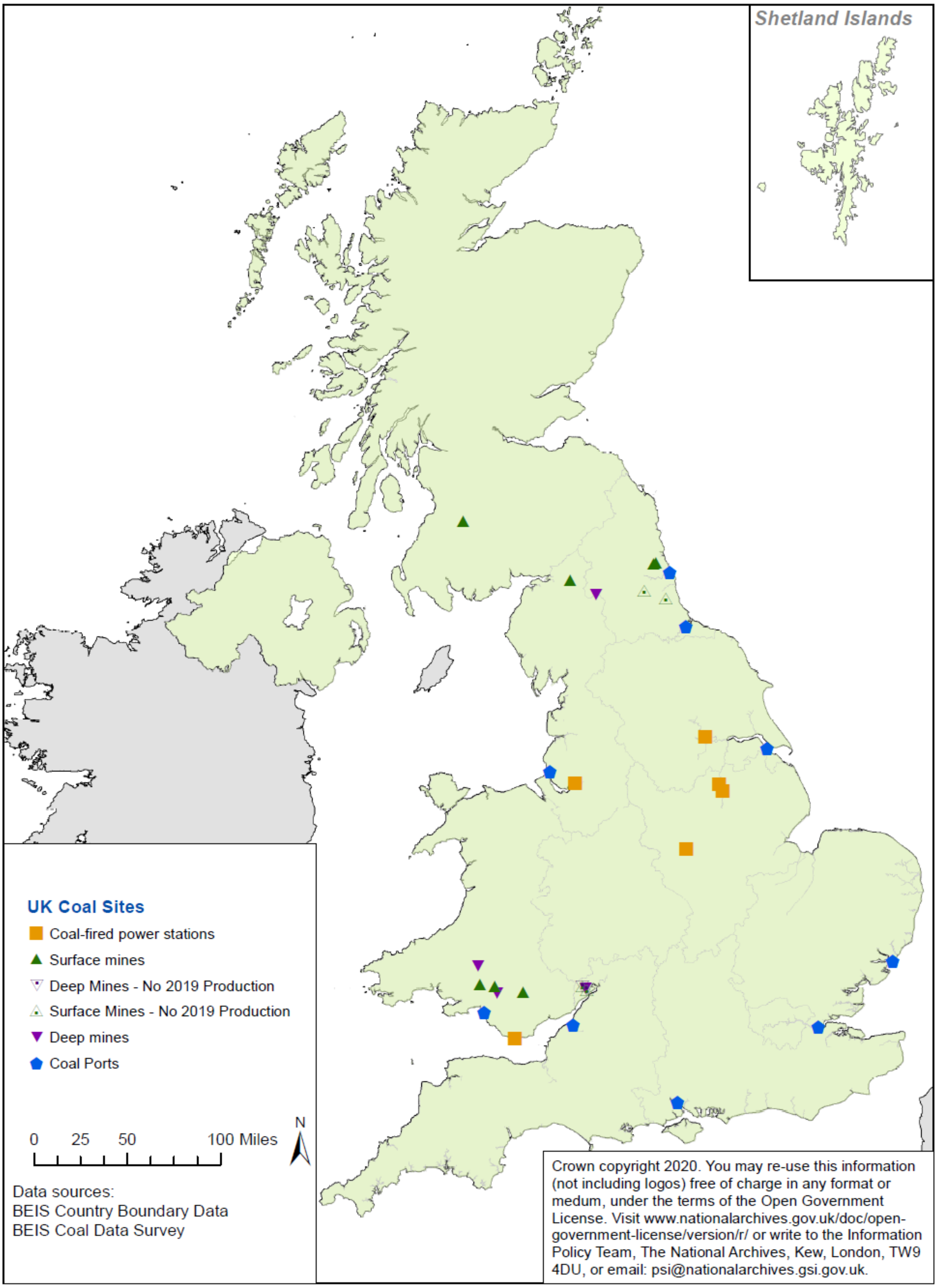
SURFACE MINING

Million tonnes

	England	Scotland	Wales	Total
Operational mines	0	0	2	2
Planning granted	0	0	0	0
In planning process	4	0	0	4
Pre-planning	0	40	0	40
Prospects	516	115	147	777
Total	**520**	**155**	**149**	**823**

Source: Coal Authority

Map 2A: UK coal production sites and ports as the end of December 2019[1]



[1] *Includes non-coastal ports: Immingham (River Humber), Avonmouth (River Avon) and Tilbury (River Thames)*

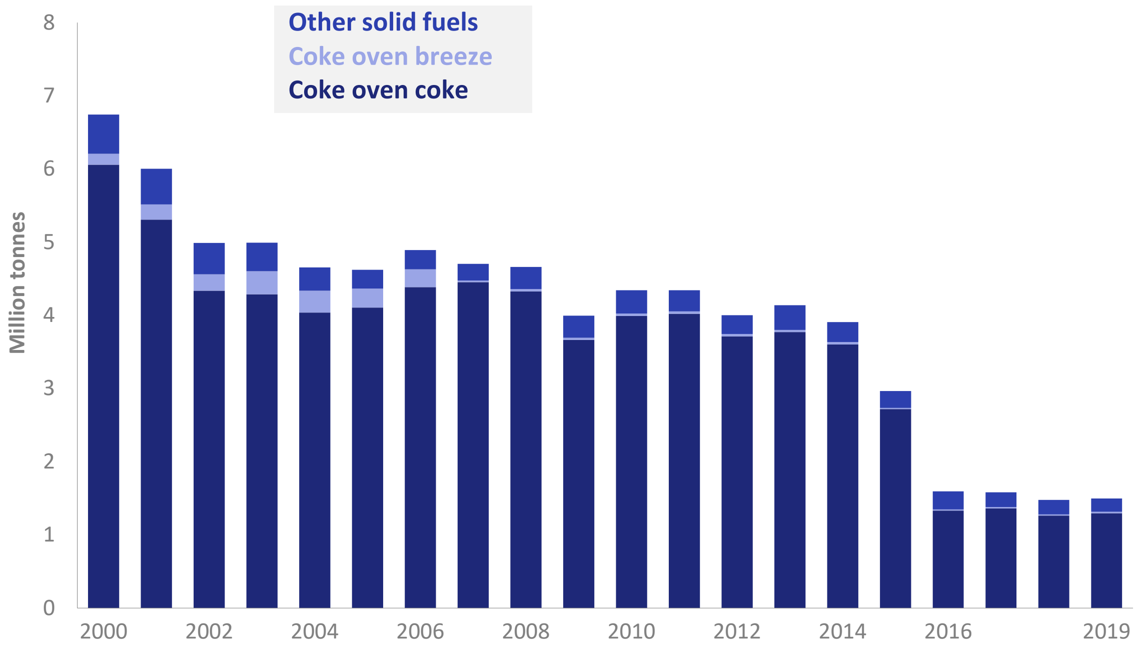
Manufactured Solid Fuels (Tables 2.5 and 2.6)

Production, Trade and Consumption

2.22 Manufactured Solid Fuels cover coke oven coke, coke oven breeze and patent fuels. Coke is a high-carbon, low impurity fuel produced by heating coal in an airless kiln. It is principally used in blast furnaces to smelt iron ore but is also burnt in stoves and forges as a low smoke fuel. Coke breeze consists of small pieces of coke (less than 19mm) separated by screening. Iron and steelworks use coke breeze in the sintering process whereby fine pieces of iron ore are agglomerated to a useable size for the main blast furnace. Patent fuels are mainly solid smokeless fuels for the domestic market for use in both open fires and in boilers.

2.23 In 2019, home produced coke oven coke rose to 1.3 million tonnes, which was 2.6 per cent higher than in 2018 (Chart 2.5). Monckton Coke and Chemicals, the only dedicated coke plant in the UK closed in December 2014. However, coke is still being produced and used at steelworks, mainly Port Talbot and Scunthorpe. In 2019, 67 per cent of the UK's supply of coke oven coke was domestically produced, with the remainder being imported.

Chart 2.5: Total manufactured solid fuels production in the UK 2000 - 2019

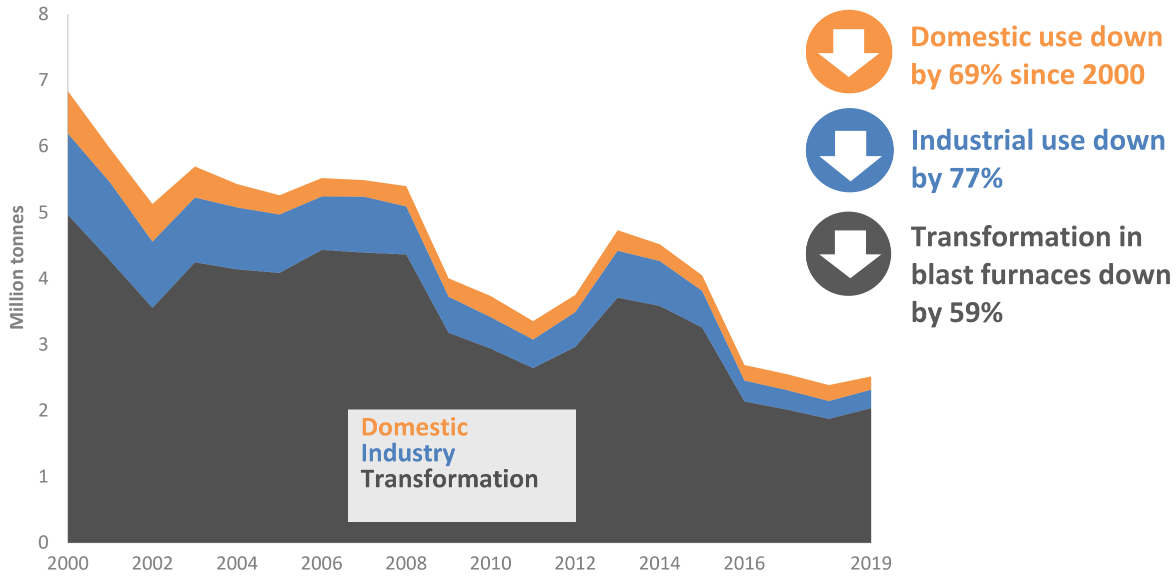


2.24 The main purpose of coke oven coke is for use in blast furnaces in the UK iron and steel industry. In 2019, blast furnace use had risen to 1.7 million tonnes, up 9.6 per cent from 2018. However, blast furnace use has fallen by 40 per cent since 2015. This is due to reduced steel production in the UK. Notably, SSI steelworks at Redcar ceased production in mid-September 2015 (with the subsequent closure in October).

2.25 Most of the supply of **coke breeze** is from re-screened coke oven coke, with direct production accounting for only 3.0 per cent of total supply in 2019. In that year, 55 per cent of coke breeze was used in blast furnaces (0.3 million tonnes) for transformation and 45 per cent used for final consumption.

2.26 Other manufactured solid fuels (patent fuels) are manufactured smokeless fuels, produced mainly for the domestic market. A small amount of these fuels (only 9 per cent of total supply in 2019) was imported.

Chart 2.6: Total manufactured solid fuels consumption in the UK 2000 - 2019



2.27 Overall, consumption of manufactured solid fuels (MSF) fell by 63 per cent from 2000 to 2019. Transformation of coke and coke breeze in blast furnaces remained the principal use, with an 81 per cent share of MSF demand in 2019. Final consumption of coke and coke breeze by industrial users saw the largest drop, by 77 per cent from 2000 to 2019. Final consumption of manufactured solid fuels by domestic users fell by 69 per cent over the same time period.

MSF by-products - Blast furnace & coke oven gas, benzole and tars (Table 2.6)

2.28 The carbonisation and gasification of solid fuels in coke ovens produces coke oven gas as a by-product. In 2019, production of coke oven gas was 3.6 TWh, 2.6 per cent higher than in 2018. Some of this (36 per cent) was used to fuel the coke ovens themselves. Another 26 per cent was used for electricity generation, 26 per cent for iron, and steel and other industrial processes (including heat production), 8 per cent in blast furnaces and 4 per cent was lost.

2.29 Blast furnace gas is a by-product of iron smelting in a blast furnace. A similar product is obtained when steel is made in basic oxygen steel (BOS) converters and "BOS" gas is included in this category. Most of these gases are used in other parts of integrated steel works. Production increased by 3.0 per cent in 2019 compared with 2018. The generation of electricity in 2019 used 53 per cent of total blast furnace gas and BOS gas, while 35 per cent was used in coke ovens and blast furnaces themselves, 9 per cent was lost or burned as waste and a further 3 per cent was used in the iron and steel industry.

2.30 Demand for benzole and tars increased by 4.3 per cent to 581 GWh in 2019, all of which was met by domestic production. From 2009, based on information from the EU-ETS, all consumption of these products has been allocated to non-energy use – see also paragraph 2.53 (d) and (e).

List of DUKES coal tables

Table	Description	Period
2.1-2.3	Commodity balances for coal – supply, demand & final consumption	1998-2019
2.4	Supply and consumption of coal	1996-2019
2.5	Supply and consumption of coke oven coke, coke breeze and other manufactured solid fuels	1996-2019
2.6	Supply and consumption of coke oven gas, blast furnace gas, benzole and tars	1996-2019
2.7	Deep mines and surface mines in production, December 2019.	2019

2.1.1	Coal production and stocks	1970-2019
2.1.2	Inland consumption of solid fuels	1970-2019

Technical notes and definitions

2.31 These notes and definitions are in addition to the technical notes and definitions covering all fuels and energy as a whole in Chapter 1. Additional guidance on the compilation of the solid fuels and derived gases statistics can be found in the document 'Data Sources and Methodologies', available on the BEIS section of the GOV.UK website at: www.gov.uk/government/collections/coal-statistics. For notes on the commodity balances and definitions of the terms used in the row headings see Annex A.

Coal production

2.32 **Deep mined**: The statistics cover saleable output from deep mines including coal obtained from working on both revenue and capital accounts. All licensed collieries (and British Coal collieries prior to 1995) are included, even where coal is only a subsidiary product.

2.33 **Surface** mines: The figures cover saleable output and include the output of sites worked by operators under agency agreements and licences, as well as the output of sites licensed for the production of coal as a subsidiary to the production of other minerals. The term 'surface mining' has now replaced opencast production as defined in DUKES pre-2011. Opencast production is a particular type of surface mining technique.

2.34 **Other sources/ slurry**: Estimates of slurry etc recovered and disposed of from dumps, ponds, rivers, etc.

Steam coal, coking coal and anthracite

2.35 **Steam coal** is coal classified as such by UK coal producers and by importers of coal. It tends to have calorific values at the lower end of the range.

2.36 **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.

2.37 **Anthracite** is coal classified as such by UK coal producers and importers of coal. Typically it has a high heat content making it particularly suitable for certain industrial processes and for use as a domestic fuel. Some UK anthracite producers have found a market for their lower calorific value output at power stations.

Allocation of imported coal

2.38 Although data are available on consumption of home-produced coal, and also on consumption of imported coal by secondary fuel producers, there is only very limited direct information on consumption of imported coal by final users. Guidance on how BEIS allocate imports to final users is outlined in paragraph 3.2.5 of the 'Data Sources and Methodologies' document. This guidance can be found on the BEIS section of the GOV.UK website at: www.gov.uk/government/collections/coal-statistics.

Coal consumption

2.39 Figures for actual consumption of coal are available for all fuels and power producers and for final use by the iron and steel industry. The remaining final users' consumption figures are based on information on disposals to consumers by producers and on imports.

2.40 Annex A of this Digest outlines the principles of energy and commodity balances and defines the activities that fall within these parts of the balances. However, the following additional notes relevant to solid fuels are given below:

Transformation: Blast furnaces: Coking coal injected into blast furnaces is shown separately within the balance tables.

Transformation: Low temperature carbonisation plants and patent fuel plants: Coal used at these plants for the manufacture of domestic coke such as Coalite and of briquetted fuels such as Phurnacite and Homefire.

Consumption: Industry: The statistics comprise sales of coal by the six main coal producers and a few small producers to the iron and steel industry (excluding those used at coke ovens and blast furnaces) and to other industrial sectors, estimated proportions of anthracite and steam coal imports, and submission made to the EU Emissions Trading Scheme. The figures exclude coal used for industries' own generation of electricity, which appear separately under transformation.

Consumption: Domestic: Some coal is supplied free of charge to retired miners and other retired eligible employees through the National Concessionary Fuel Scheme (NCFS). The concessionary fuel provided in 2019 is estimated at 22.9 thousand tonnes. This estimate is included in the domestic steam coal and domestic anthracite figures.

Stocks of coal

2.41 Undistributed stocks are those held at collieries and surface mine sites. It is not possible to distinguish these two locations in the stock figures. Distributed stocks are those held at power stations and stocking grounds of the major power producing companies (as defined in Chapter 5), coke ovens, low temperature carbonisation plants and patent fuel plants.

Coke oven coke (hard coke), hard coke breeze and other manufactured fuels

2.42 The statistics cover coke produced at coke ovens owned by Corus plc, Coal Products Ltd and other producers. Low temperature carbonisation plants are not included (see paragraph 2.38). Breeze (as defined in paragraph 2.43) is excluded from the figures for coke oven coke.

2.43 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. Coke that has been transported from one location to another is usually re-screened before use to remove smaller sizes, giving rise to further breeze.

2.44 The coke screened out by producers as breeze and fines appears as transfers in the coke breeze column of the balances. Transfers out of coke oven coke have not always been equal to transfers into coke oven breeze. This was due to differences arising from the timing, location of measurement and the practice adopted by the iron and steel works. Since 2000, however, the Iron and Steel Statistics Bureau have been able to reconcile these data. Since 2007, most of the supply of coke breeze was reclassified to coke oven coke following better information received by the Iron and Steel Statistics Bureau.

2.45 Figures are derived from returns made to HM Revenue and Customs and are broken down in greater detail in Annex G on the BEIS section of the GOV.UK website at:
www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes.

2.46 In Table 2.5, the export figures used for hard coke, coke breeze and other manufactured solid fuels for the years before 1998 (as reported on the BEIS web site) are quantities of fuel exported as reported to BEIS or its predecessor Departments by the companies concerned, rather than quantities recorded by HM Revenue and Customs in their Trade Statistics. A long-term trend commentary and tables on exports are on the BEIS section of the GOV.UK website at:
www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes.

2.47 In 1998, an assessment using industry data showed that on average over the previous five years 91 per cent of imports had been coke and 9 per cent breeze and it is these proportions that have been used for 1998 and subsequent years in Table 2.5.

2.48 The calorific value for coke breeze has been set the same as for coke oven coke. This is following information from the iron and steel industry on the similarities between the two types of manufactured fuels.

2.49 Imports and exports of manufactured smokeless fuels can contain small quantities of non-smokeless fuels.

2.50 Other manufactured solid fuels are mainly solid smokeless fuels for the domestic market for use in both open fires and in boilers. A smaller quantity is exported (although exports are largely offset by similar quantities of imports in most years). Manufacture takes place in patented fuel plants and low-temperature carbonisation plants. The brand names used for these fuels include Homefire, Phurnacite, Ancit and Coalite.

2.51 Consumption of coke and other manufactured solid fuels: These are disposals from coke ovens to merchants. The figures also include estimated proportions of coke imports.

Blast furnace gas, coke oven gas, benzole and tars

2.52 The following definitions are used in the tables that include these fuels:

(a) Blast furnace gas: includes Basic Oxygen Steel furnace (BOS) gas. Blast furnace gas is the gas produced during iron ore smelting when hot air passes over coke within the blast ovens. It contains carbon monoxide, carbon dioxide, hydrogen and nitrogen. In a BOS furnace the aim is not to introduce nitrogen or hydrogen into the steel making process, so pure oxygen gas and suitable fluxes are used to remove the carbon and phosphorous from the molten pig iron and steel scrap. A similar fuel gas is thus produced.

(b) Coke oven gas: is a gas produced during the carbonisation of coal to form coke at coke ovens. In 2009, some coke oven gas was produced using a combination of gases other than natural gas and blast furnace gas. This total has been added to the production of coke oven gas rather than transfers because it is specifically defined as the mixture of natural gas, blast furnace gas and BOS gas. See the paragraph below on synthetic coke oven gas for a complete definition of this.

(c) Synthetic coke oven gas: is mainly natural gas that is mixed with smaller amounts of blast furnace and BOS gas to produce a gas with almost the same qualities as coke oven gas. The transfers row of Table 2.6 shows the quantities of blast furnace gas used for this purpose and the total input of gases to the synthetic coke oven gas process. There is a corresponding outward transfer from natural gas in Chapter 4, Table 4.1.

(d) Benzole: a colourless, liquid, flammable, aromatic hydrocarbon by-product of the iron and steel making process. It is used in the UK as a solvent in the manufacture of styrenes and phenols. All consumption of benzole has been allocated to non-energy use from 2009 onwards.

(e) Tars: viscous materials usually derived from the destructive distillation of coal, which are by-products of the coke and iron making processes. All consumption of tars has been allocated to non-energy use from 2009 onwards.

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Chapter 3
Petroleum

Key points

- **Crude oil (including NGL) production** in 2019 grew for the second consecutive year reaching the highest level since 2010 following new projects that came online towards the end of 2017. Production in 2019 stands at 38 per cent of the UK's peak in 1999 and is not sufficient to meet demand, meaning imports remain important (Chart 3.1, DUKES Table 3.1).

- **Imports of crude oil from the US continue to rise and in 2019 reached new record highs**, contributing 26 per cent of UK imports. While Norway remains the single largest source of crude to the UK, its share has fallen in recent years from more than 60 per cent to just under 40 per cent in 2019 (DUKES Table 3.9).

- **Exports of crude oil and NGLs reached a 10 year high in 2019.** The UK became a net importer in 2005, reaching a net trade peak in 2012. Annual net trade has since been in decline, although net imports halved to current levels in 2018 with the development of new projects that near exclusively export abroad (DUKES Table 3.1).

- **Over 40 per cent of the UK's total energy production in 2019 was from crude oils** with UK refineries producing 61 million tonnes of oil products. Oil products made up nearly half of UK final consumption of energy in 2019. (DUKES Table 1.1, Chart 3.2)

- The gap between UK refinery production and domestic demand means that the UK exported 21 million tonnes of petroleum products. **Almost half of all UK exports is petrol**, much of which is to the Netherlands and the US (DUKES Table 3.10).

- **Russia, the Netherlands, Belgium and the US were large sources of road diesel in 2019**; these four countries accounted for almost three quarters of total road diesel imports. **The top three suppliers of jet fuel were Saudi Arabia, India, and Kuwait** in 2019, comprising more than half of UK jet fuel imports (DUKES Table 3.9).

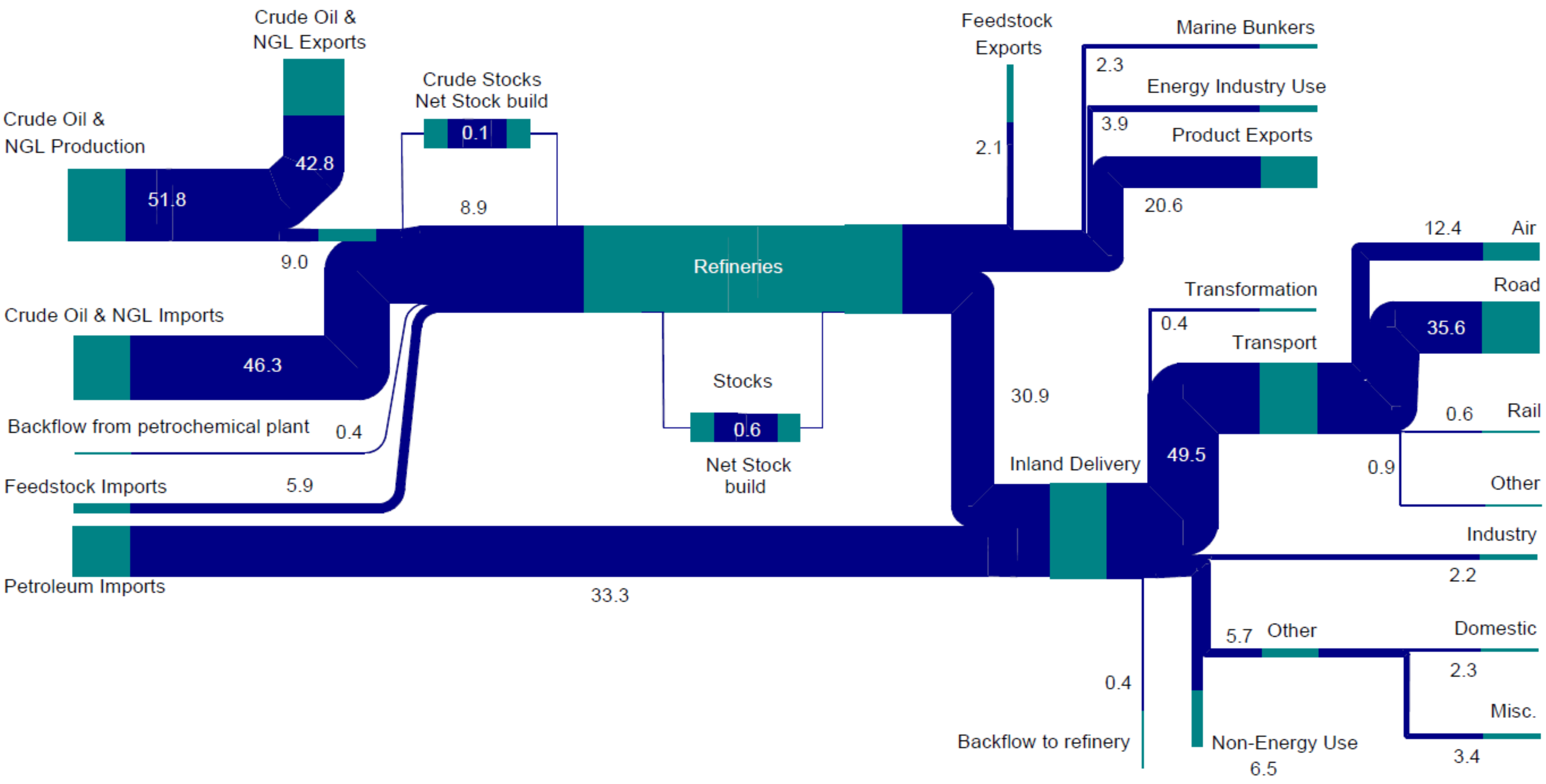
- **Total demand fell by 1.9 per cent.** Transport contributes to more than 70 per cent of total demand, and transport fuels fell by 1.1 per cent in 2019. A further 9.4 per cent of demand is from the petrochemical industry and this also fell in 2019, by 6.6 per cent (DUKES Table 3.2, Chart 3.3).

Introduction

3.1 As a key fuel in the UK's energy mix, oil met nearly half of consumer demand in 2019. The majority of this is used for transport including road fuels and for air travel, and oil met 96 per cent of energy used in the transport sector in 2019. Production of crude from the UK Continental Shelf (UKCS) increased by 1.9 per cent to reach 52 million tonnes and comprised 44 per cent of total energy production in the UK. (Table 1.1)

3.2 The flow chart on the following page shows the movement of primary oils and petroleum products, illustrating how crude oils are supplied, transformed in refineries, and then consumed in the various sectors of the UK's economy. The widths of the bands are proportional to the size of the flow they represent.

Petroleum Flow Chart 2019 (million tonnes)

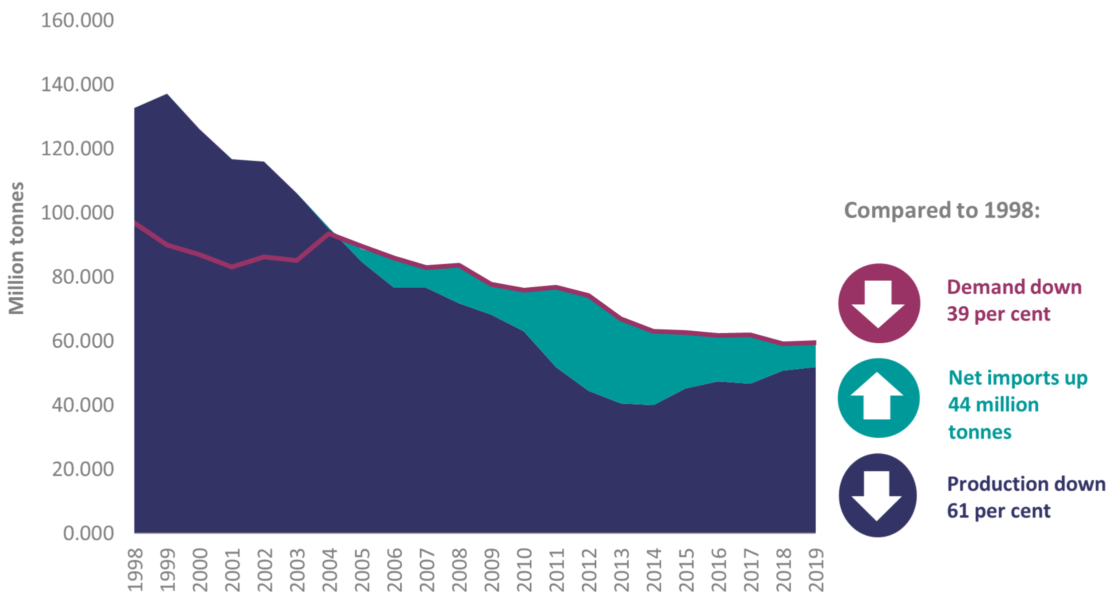


Note:
This flow chart is based on the data that appear in Tables 3.1 and 3.2.
The numbers on either side of the flow chart will not match due to losses in transformation.
Biofuels are not included.

Supply and demand for primary oil (Table 3.1)

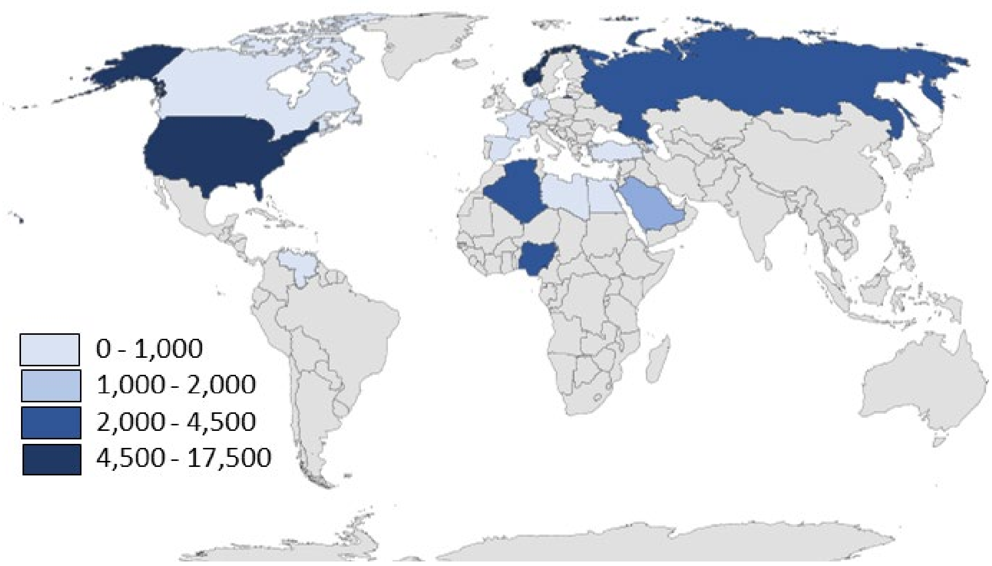
3.3 Chart 3.1 summarises trends in production, trade and demand of crude oils since 1998. There has been a steep decline in primary oil production from the UKCS. **From its peak of 137 million tonnes in 1999 UKCS production of primary oils has dropped by nearly two-thirds to 52 million tonnes**, with the UK becoming a net importer in 2005. Crude oil (including NGL) production in 2019, at 52 million tonnes, grew for the second consecutive year (by 1.9 per cent) following new projects that came online since the end of 2017. This is the highest level of indigenous production since 2010 but is not sufficient to meet demand, at 59 million tonnes, meaning imports remain important.

Chart 3.1: Primary oil supply and demand, 1998-2019



3.4 The sources of crude oil imports from other countries are shown in Map 3A. The main source of the UK's imports has historically been Norway given its proximity to the UK and similarity in its crude types. UK imports from Norway remained stable in 2019 compared to 2018, with Norway providing 39 per cent of total UK imports. However, this current stability follows recent sharp decreases in supply from Norway; in 2016 Norway provided 62 per cent of UK imports, which dropped to 39 per cent by 2018 (Table 3.9).

Map 3A: Source of UK crude oil imports 2019 (thousand tonnes, Table 3.9)



3.5 **Imports from the US continue to rise and in 2019** a 50 per cent (3.8 million tonne) increase was seen compared to 2018 as US exports reached new record highs since the lifting of the crude export ban at the end of 2015. The US share of UK imports reached 26 per cent in 2019 from 17 per cent in 2018. This was mainly at the expense of imports from Nigeria (down 2.9 million tonnes) and Algeria (down 1.5 million tonnes)

3.6 **Imports from OPEC countries accounted for just 20 per cent of the UK's crude imports in 2019 at 9.0 million tonnes,** this being a 36 per cent reduction compared to 2018. Most imports from OPEC countries come from Algeria and Nigeria, with both showing substantial reductions by one-half and three-quarters, respectively, in 2019.

3.7 The UK is a significant exporter of crude oils as well as an importer. **Crude oil exports remained stable at 41 million tonnes in 2019,** following the 18 per cent increase in 2018 due to strong production and favourable price spreads resulting in strong demand for Brent crude from Asia.

3.8 The UK **remains a net importer of primary oil products at 7.3 million tonnes in 2019,** a 0.6 million tonne decrease compared to 2018.This is relatively stable when looking back at 2018 where we saw a sharp decline in net imports of primary oils as they almost halved to 7.9 million tonnes compared with 2017**,** the result of several factors including a decrease in refinery demand and a record low in use of indigenous crude during 2018. In 2019 refinery use of indigenous crude recovered on the record low seen in 2018 by 1.1 million tonnes in 2019 (Energy Trends, Table 3.10).

3.9 Crude oil has historically been principally exported to the Netherlands, Germany, and China, which together comprised 79 per cent of total crude exports in 2019, up from 69 per cent in 2018. This increase in share on 2018 is notably due to exports increasing by more than two-thirds to Germany (up 2.9 million tonnes) and by nearly half to China (up 3.3 million tonnes). China was the second largest recipient of UK crude exports after the Netherlands in 2019, which decreased by 12 per cent.

UK refineries

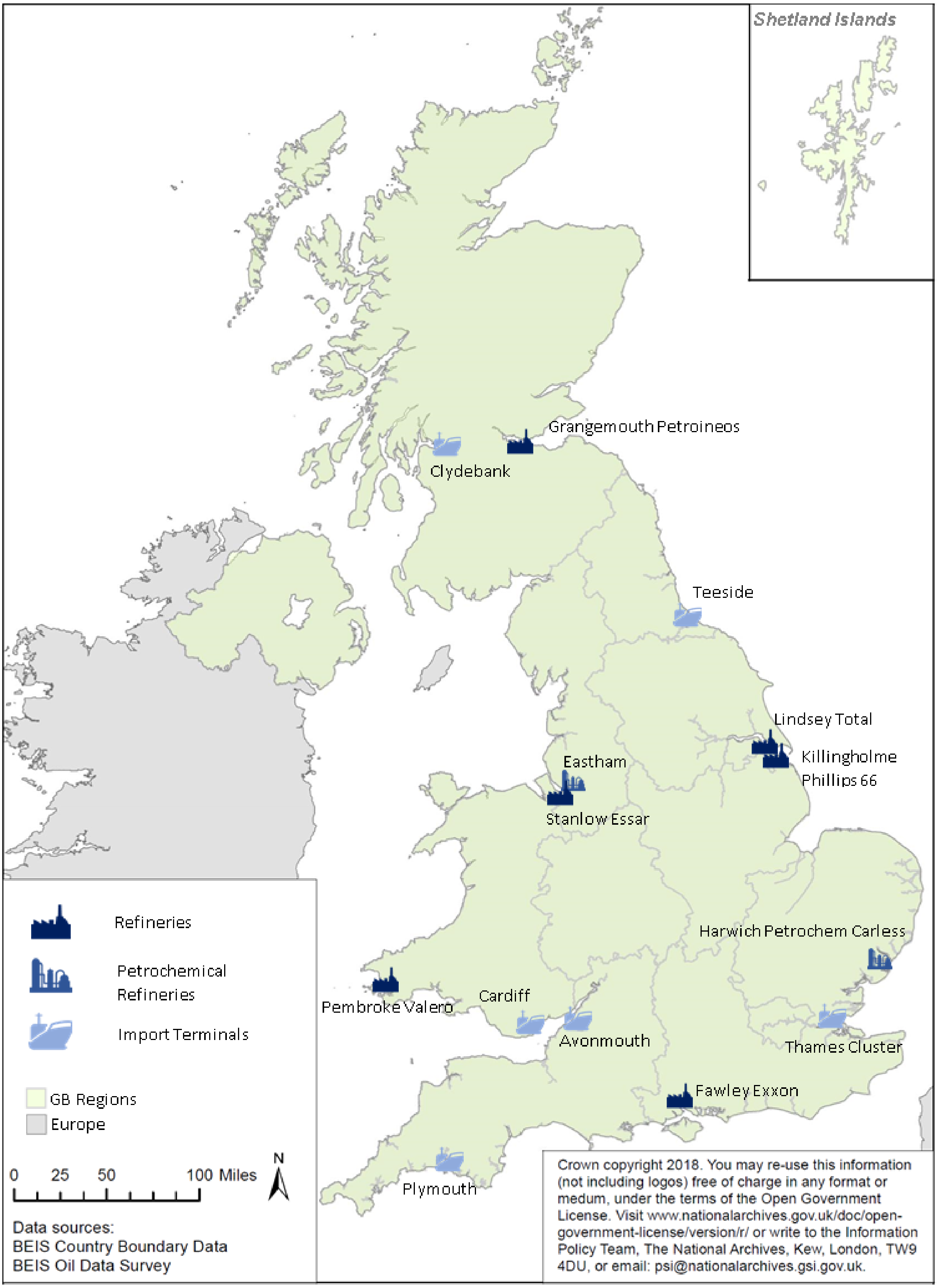
3.10 In 2019 UK refineries received 59 million tonnes of primary oils for processing, an increase of 0.5 million tonnes on 2018. Data for refinery capacity as at the end of 2019 are presented in Table 3A, with the location of these refineries illustrated in Map 3B. The location of the UK's petrochemical refineries and major import terminals are also marked on the map.

Table 3A: UK refinery processing capacity as at end 2019

Refinery	Atmospheric Distillation	Reforming	Cracking and Conversion
Fawley Exxon	13.3	4.4	5.0
Stanlow Essar	9.8	1.5	4.0
Pembroke Valero	10.9	2.1	6.3
Grangemouth PetroIneos	10.2	1.9	3.5
Killingholme Phillips 66	11.9	2.6	10.7
Lindsey Total	5.0	0.7	3.8
Petrochemical refineries			
Harwich Petrochem Carless	< 1.0	-	-
Eastham Refinery	1.2	-	-
Total	**62.3**	**13.2**	**33.3**

Million tonnes per annum

Map 3B: Distribution of GB refineries and import terminal clusters as at end 2019



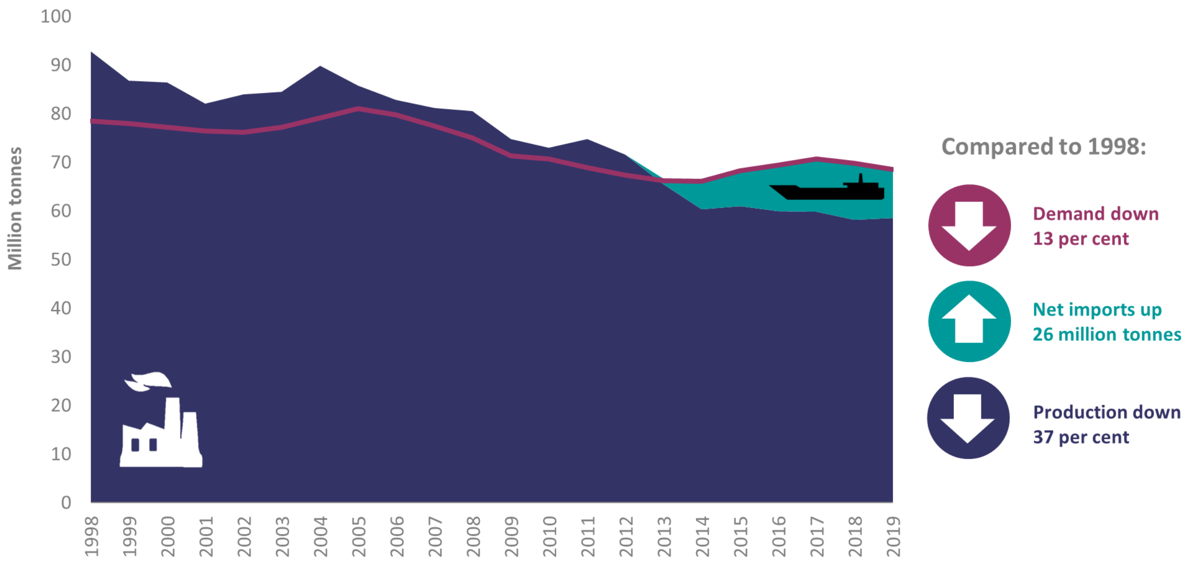
3.11 **Refinery capacity has decreased because of rationalisation in this sector and closures in recent years** including Murco at Milford Haven in 2014, as well as the Petroplus Teeside refinery in 2009, and the Petroplus Coryton refinery in 2012.

Supply and demand for petroleum products (Table 3.2-3.4)

3.12 Chart 3.2 shows refinery production of petroleum products since 1998. **Despite recent rationalisation in the sector the UK's refineries produced 61 million tonnes of product in 2019**. Relatively stable production in recent years has been at least partially due to higher margins for refinery operators following a fall in crude prices in 2016. In 2019, production of petroleum products increased by 0.3 million tonnes.

3.13 The UK's refinery capacity remains substantial at 33 million tonnes, and one of the highest in Europe. However, over recent years the rationalisation in the sector has meant that in 2019 UK refinery production remains down by one-third since 2008.

Chart 3.2: Production and trade in petroleum products, 1998- 2019



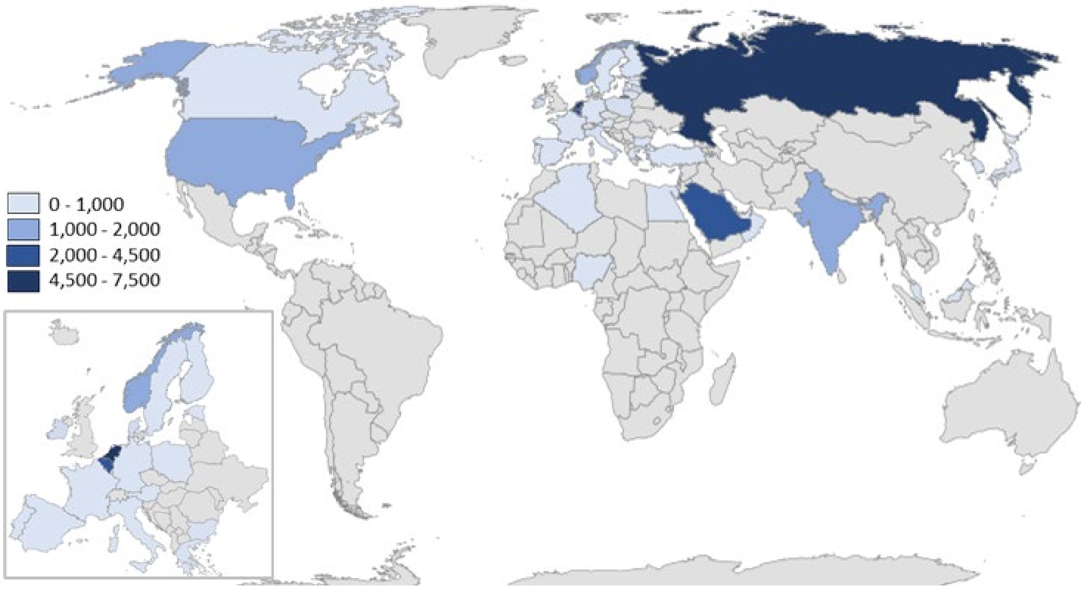
3.14 In 2019 the UK remained a net importer of petroleum products by 13 million tonnes. As with crude oil, imports are critically important to meet UK domestic demand; the UK has been a net importer since 2013. In common with many other countries, domestic supply and demand are not matched on a product-by-product basis.

3.15 The UK's refineries were developed to produce petrol and fuel oil for electricity generation. However, as demand for diesel and jet fuel have increased UK refineries have not been able to keep pace and now produce a surplus of petrol. To balance demand the UK trades widely and is one of the largest importers of jet fuel and road diesel in the OECD and one of the largest exporters of petrol.

3.16 Map 3C shows the principal product trading partners with the UK. Eight countries account for over three-quarters of the total volume of imports[1]. Historically the bulk of products have come via the Netherlands, which acts as a major trading hub (the fuel might have been refined elsewhere in Europe or beyond). Russia, the Netherlands, Belgium and the US were large sources of road diesel in 2019; these four countries accounted for almost three quarters of total road diesel imports in 2019.

[1] Netherlands, Russia, Saudi Arabia, Belgium, the US, India, Norway and Kuwait (DUKES Table 3.9)

Map 3C: Map of imports of petroleum products 2019 (thousand tonnes, Table 3.9)



3.17 **The diversity of supply is increasing as demand for key transport fuels increases.** There is a clear split between imports from European countries (which are mainly diesel) and imports from the Middle East (where the bulk of jet fuel is sourced from generally more modern refinery operations than seen in Europe). The top three suppliers of jet fuel were Saudi Arabia, India, and Kuwait in 2019, comprising more than half of UK jet fuel imports (Table 3.9).

3.18 For further detail on the diversity of supply of crude and key transport fuels see Energy Trends special article, Diversity of supply for oil and oil products, at:
www.gov.uk/government/publications/energy-trends-september-2019-special-feature-article-diversity-of-supply-for-oil-and-oil-products-in-oecd-countries-in-2018

3.19 The misalignment between UK refinery production and domestic demand means that the UK exported 21 million tonnes of petroleum products. Almost half of all UK exports is petrol, (much of which continues to go to the Netherlands and the US). Although the US has historically imported the largest share from the UK, this shifted in 2019 and exports to the Netherlands took a 38 per cent share of UK petrol exports compared to 31 per cent for the US. In 2019 gas oil accounted for 13 per cent and fuel oil accounted for 11 per cent of total exports. Exports by country are shown in the experimental table Exports of Crude Oil & Petroleum Products by Country of Destination (Table 3.10).

Consumption of petroleum products (Tables 3.2. to 3.4)

3.20 More than 70 per cent of the demand for oil is consumed for transport purposes - for planes and road vehicles, including goods vehicles. Oil is critical to transport requirements and will likely remain so in the near term. Cars are more amenable to being adapted to electrification and alternative fuels, although technology to reduce the emissions from planes and large goods vehicles is a priority for government ambitions for Net Zero by 2050 and Project FlyZero.

3.21 Final consumption of petroleum products decreased for the second year running by 1.9 per cent in 2019, this also being the second decrease since 2013 following a period of growth (as illustrated in Chart 3.2). Chart 3.3 shows that consumption in 2019 was primarily for road and aviation fuel, and total transport demand decreased by 1.1 per cent, which was a contributor to the fall in overall consumption.

3.22 Outside of transport, 'non-energy' use of oil is the single most significant sector. Here oil is not burnt but instead used as a feedstock to produce plastics and vinyls within the petrochemical industry. Non-energy use of oil has been growing in recent years and is currently around 9 per cent of total demand for oil. Non-energy use was down 6.6 per cent on 2018.

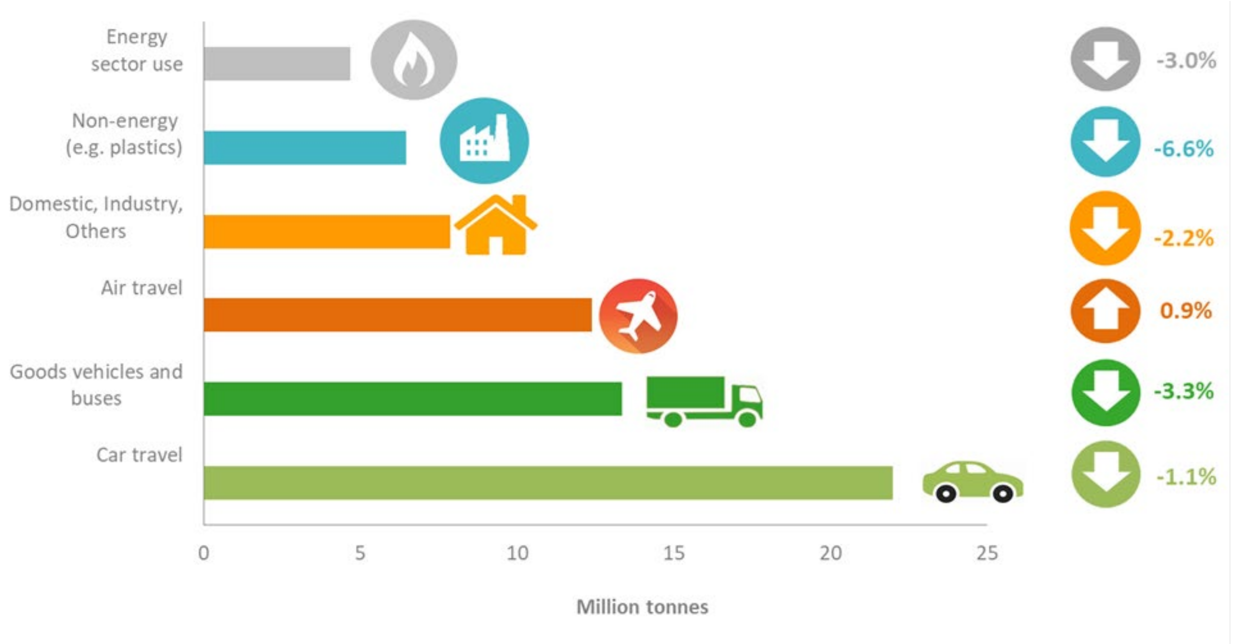
3.23 Oil products are also used by refineries to fuel the refining process, and very small amounts are

3.24 used for electricity generation. Use of oil products in the energy industry, which includes electricity generation and petroleum refineries, was 1.0 per cent lower in 2019.

3.25 Larger volumes are used by industry and to heat homes and businesses that are 'off-grid' and not connected to the gas transmission network. Use in these other sectors was down by 2.2 per cent in 2019 (Chart 3.3). This edition of the Digest continues to use the new method introduced in 2018 to estimate demand in these sectors, re-allocating previously 'unclassified' volumes to the domestic, public administration and commercial sectors.

For further detail see Energy Trends special article, Changes to method of estimating sector demand for oil products, at:
www.gov.uk/government/publications/energy-trends-june-2019-special-feature-article-change-to-method-of-estimating-sector-demand-for-oil-products

Chart 3.3: Oil consumption in the UK 2019



3.26 Historically consumption of petrol was greater than diesel until the end of 2004, which marked a period of crossover. Demand for petrol had until very recently decreased each year since 2000, whereas demand for diesel has increased in 17 of the last 19 years. Diesel has accounted for around two-thirds of road fuel consumption since 2014, but in a recent reversal of the trend of growth diesel consumption (excluding biodiesel) has fallen for the second year in a row since 2009. This is partly a result of slowing growth in the diesel vehicle fleet following sharp drops in new registrations after changes to diesel vehicle taxation announced in 2018, as well as increased efficiencies.

3.27 Table 3B shows that the volume of diesel being consumed by cars and taxis almost quadrupled between 1995 and 2019 as diesel registrations have doubled since 2001. This displacement of petrol registrations and demand reversed in 2018 meaning demand for diesel (excluding biodiesel) fell by 3.4 per cent in 2019. The first annual increase in petrol was seen with a growth of 1.1 per cent in 2019 compared to 2018.

For further information see Energy Trends special article, Road fuel consumption and the UK motor vehicle fleet, at:
www.gov.uk/government/publications/energy-trends-june-2019-special-feature-article-road-fuel-consumption-and-the-uk-motor-vehicle-fleet

Table 3B: Estimated consumption of road transport fuels by vehicle class

	1995	2000	2005	2010	2019[a]
Petrol:					*Million tonnes*
Cars and taxis	19.9	20.2	18.1	14.1	11.3
Light goods vehicles	1.6	1.0	0.5	0.3	0.2
Motorcycles etc.	0.2	0.2	0.2	0.2	0.2
Total	**21.7**	**21.4**	**18.9**	**14.6**	**11.7**
Diesel:					
Cars and taxis	2.8	4.1	6.6	8.6	10.7
Light goods vehicles	2.5	3.5	4.6	4.8	5.8
Heavy goods vehicles	6.2	6.1	6.7	5.9	6.3
Buses and coaches	1.7	1.5	1.5	1.4	1.0
Total	**13.2**	**15.3**	**19.4**	**20.7**	**23.8**

[a] *Data for 2019 have been estimated using 2018 percentage splits*

Stocks of oil (Table 3.7)

3.28 Under international commitments to both the European Union and the International Energy Agency, the UK is obliged to hold oil stocks to offset the impact of significant disruptions to the global oil market. Such disruptions are relatively rare, but since the Arab-Israeli war of 1974 there have been three globally co-ordinated releases of oil in response to the Gulf War (1990–1991), Hurricane Rita (2005), and the civil war in Libya (2011).

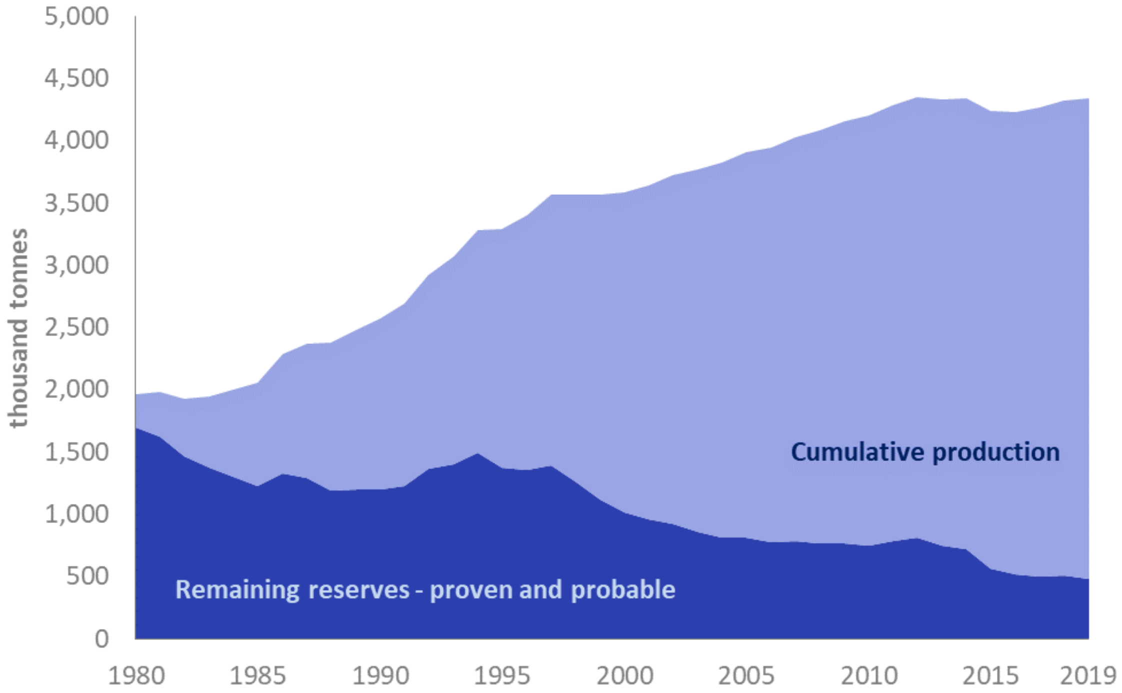
3.29 **At the end of 2019, the UK held 15.2 million tonnes of stocks (Energy Trends Table 3.6).** Of this total, 12.8 million tonnes were held for emergency purposes (DUKES Table 3.7), broadly equivalent to around just over 61 days of typical consumption. These stocks are held both in the UK and overseas under contractual arrangements that allow stocks to be repatriated to the UK if necessary. For the last quarter of 2019, just under 4.7 million tonnes were held in other EU countries, most notably in the Netherlands. The UK also holds further stocks in the UK (not shown here) under contractual arrangement for other countries, but to a far smaller degree.

Oil resources

3.30 The Oil and Gas Authority estimates that there are 481 million tonnes of proven and probable (2P) oil reserves at the end of 2019, of which 390 million tonnes are proven reserves[2]. The volume produced plus 2P reserves have more than doubled since 1980, reflecting new discoveries, new technology allowing exploitation of resources that were previously regarded as uncommercial, and the inclusion of already-known fields as they entered production or moved from 'prospective' to 'probable' status. Replenishment of sanctioned oil and gas reserves through exploration and maturation of contingent resources has recently flattened. The apparent decline in reserves in 2015 was due to re-classification of some reserves that had not yet been sanctioned - these will be included in future as and when sanctioned.

[2] The Oil and Gas Authority will update with detailed estimates in November 2020: www.ogauthority.co.uk/data-centre/data-downloads-and-publications/reserves-and-resources/

Chart 3.4: Oil reserves, 1980 - 2019



Further Information

3.31 In addition to the information in this chapter, there is considerable data on BEIS's website. Information on long-term trends (Tables 3.1.1 and 3.1.2) and the annex on the oil and gas resources in the UK (Annex F) provide a more complete picture of the UK oil and gas production sector. These tables are at www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

List of DUKES oil tables

Table	Description	Period
3.1	Primary oil commodity balances	1998-2019
3.1au	Primary oil commodity balances – alternative units (barrels and litres)	1998-2019
3.2-3.4	Petroleum products commodity balances	1998-2019
3.2-3.4au	Petroleum products commodity balances – alternative units (barrels and litres)	1998-2019
3.5	Supply and disposal of petroleum	2012-2019
3.6	Additional information on inland deliveries of selected products	2012-2019
3.7	Stocks of crude oil and petroleum products at end of year	2012-2019
3.8	Additional information on inland deliveries for non-energy uses	2012-2019
3.9	Imports of crude oil and petroleum products by country of origin	2012-2019
3.10	Exports of crude oil and petroleum products by country of destination (experimental)	2016-2019
3.1.1	Crude oil and petroleum products: production, imports and exports	1970-2019
3.1.2	Inland deliveries of petroleum	1970-2019
F.1	Crude oil and natural gas liquids production	1998-2019
F.3	Natural gas liquids net production	1999-2019
F.4	Disposals of crude oil	1998-2019

Technical notes and definitions

3.32 These notes and definitions are in addition to the technical notes and definitions covering all fuels and energy in Chapter 1.

Sources of data

3.33 Most of the data included in the text and tables of this chapter are derived from BEIS's Downstream Oil Reporting System (DORS), which replaced the UK Petroleum Industry Association (UKPIA) reporting system in 2005. Data relating to the inland operations of the UK oil industry (i.e. information on the supply, refining and distribution of oil in the UK) are collected from companies. The data format and coverage have been designed to meet most of the needs of both Government and the industry itself. Each member of UKPIA and several other contributing companies provides returns on its refining activities and deliveries of various products to the internal UK market. This information is supplemented whenever necessary to allow for complete coverage within the statistics, with separate exercises carried out on special topics (for example, supermarket shares) or with the use of additional data (such as trade data from HM Revenue and Customs (HMRC) to cover import activity by non-reporting companies). In addition to these data sources, BEIS make use of the Emissions data from the EU's Emissions Trading Scheme provided on major energy users to ensure the consistency of data on fuel used within refineries (refinery gases and petroleum coke) and sectoral usage of Gas oil and Fuel oil.

3.34 In 2014 BEIS introduced a new reporting form to major oil importers. The new form indicated the need for more detailed surveys of large importers within the UK and from January 2015 all major importers were obliged to complete the more detailed DORS form used by refiners. The DORS survey now offers substantially greater insight (particularly with respect to trade and blending activities).

Statistical differences

3.35 The upper half of the balance tables represents the supply side and calculates overall availability of the various products in the UK by combining production at refineries with trade (imports and exports), stock changes, product transfers and deliveries to international marine bunkers (fuel used by ships travelling to a foreign destination).

3.36 The lower half of the table reports the demand side and covers the uses made of the different products, including the use made within the refining process, and details of the amounts reported by oil companies within the UK as delivered for final consumption.

3.37 In Tables 3.1 to 3.5, there are headings titled "statistical differences". These are differences between the separately observed figures for production and delivery of crude oil and products during the path of their movement from the point of production to the point of consumption.

3.38 The statistical differences headings listed in the primary oil commodity balances (Table 3.1) are differences between the separately observed and reported figures for production from onshore or offshore fields and supply to the UK market that cannot be accounted for by any specific factors. Primarily they result from inaccuracies in the meters at various points along offshore pipelines. These meters vary slightly in their accuracy within accepted tolerances, giving rise to both losses and gains when the volumes of oil flowing are measured. Errors may also occur when non-standard conditions are used to meter the oil flow.

3.39 The statistical difference for primary oils in the table includes own use in onshore terminals and gas separation plants, losses, platform and other field stock changes. Another factor is the time lag that can exist between production and loading onto tankers being reported at an offshore field and the arrival of these tankers at onshore refineries and oil terminals. This gap is usually minimal and works such that any effect of this at the start of a month is balanced by a similar counterpart effect at the end of a month. However, there can be instances where the length of this interval is considerable and, if it happens at the end of a year, there can be significant effects on the statistical differences seen for the years involved.

3.40 Another technical factor that can contribute to the statistical differences relates to the recording of quantities at the producing field (which is the input for the production data) and at oil terminals and refineries, since they are in effect measuring different types of oil. Terminals and refineries can measure a standardised, stabilised crude oil, that is, with its water content and content of Natural Gas Liquids

(NGLs) at a standard level and with the amounts being measured at standard conditions. However, at the producing field they are dealing with a “live” crude oil that can have a varying level of water and NGLs within it. While offshore companies report live crude at field, the disposals from oil terminals and offshore loading fields are reported as stabilised crude oil. This effectively assumes that terminal disposals are stabilised crude production figures. These changes were introduced in the 2002 edition of this Digest.

3.41 Part of the overall statistical difference may also be due to problems with the correct reporting of individual NGLs at the production site and at terminals and refineries. It is known that there is some mixing of condensate and other NGLs in with what might otherwise be stabilised crude oil before it enters the pipeline. This mixing occurs as it removes the need for separate pipeline systems for transporting the NGLs and it also allows the viscosity of the oil passing down the pipeline to be varied as necessary. While the quantity figures recorded by terminals are in terms of stabilised crude oil, with the NGL component removed, there may be situations where what is being reported does not comply with this requirement.

3.42 With the downstream sector, the statistical differences can similarly be used to assess the validity and consistency of the data. From the tables, these differences are generally a very small proportion of the totals involved.

3.43 Refinery data are collated from details of individual shipments received and made by each refinery and terminal operating company. Each year there are thousands of such shipments, which may be reported separately by two or three different companies involved in the movement. While intensive work is carried out to check these returns, it is possible that some double counting of receipts may occur.

3.44 Temperature, pressure, and natural leakage also contribute to the statistical differences. In addition, small discrepancies can occur between the estimated calorific values used at the field and the more accurate values measured at the onshore terminal where data are shown on an energy basis. The statistical differences can also be affected by rounding, clerical errors or unrecorded losses, such as leakage. Other contributory factors are inaccuracies in the reporting of the amounts being disposed of to the various activities listed, including differences between the quantities reported as going to refineries and the actual amounts passing through refineries.

3.45 Similarly, the data under the statistical difference headings in Tables 3.2 to 3.4 are the differences between the deliveries of petroleum products to the inland UK market reported by the supplying companies and estimates for such deliveries. These estimates are calculated by taking the output of products reported by refineries and then adjusting it by the relevant factors (such as imports and exports of the products, changes in the levels of stocks etc.).

3.46 It may be thought that such differences should not exist as the data underlying both the observed deliveries into the UK market and the individual components of the estimates (i.e. production, imports, exports, stocks) come from the same source (the oil companies). While it is true that each oil company provides data on its own activities in each area, there are separate areas of operation within the companies that report their own part of the overall data. Table 3C illustrates this.

Table 3C: Sources of data within oil companies

Area covered	Source
Refinery production	Refinery
Imports and exports	Refinery, logistics departments, oil traders
Stocks	Refinery, crude and product terminals, major storage and distribution sites
Final deliveries	Sales, marketing and accounts departments, trade associations

3.47 Each individual reporting source will have direct knowledge of its own data. For example, refineries will know what they produce and how much leaves the refinery gate as part of routine monitoring of the refinery operations. Similarly, other data such as sales to final consumers or imports and exports will be closely monitored. Companies will ensure that each component set of data reported is as accurate as possible but their reporting systems may not be integrated, meaning that internal consistency checks across all reported data cannot be made. Each part of a company may also work to different timings as well, which may further add to the degree of differences seen.

3.48 The main area where there is known to be a problem is with the “Transfers” heading in the commodity balances. The data reported under this heading have two components. Firstly, there is an allowance for reclassification of products within the refining process. For example, butane can be added to motor spirit to improve the octane rating, aviation turbine fuel could be reclassified as domestic kerosene if its quality deteriorates, and much of the fuel oil imported into the UK is further refined into other petroleum products. Issues can arise with product flows between different reporting companies, for example when company A delivers fuel oil to company B who report a receipt of a feedstock. Secondly, and in addition to these inter-product transfers, the data also include an allowance to cover the receipt of backflows of products from petrochemical plants that are often very closely integrated with refineries. A deduction for these backflows thus needs to be included under the "Transfers" heading so that calculated estimates reflect net output and are thus more comparable with the basis of the observed deliveries data.

3.49 There is scope for error in the recording of these two components of transfers. With inter-product transfers, the data are recorded within the refinery during the refining and blending processes where the usual units used to record the changes are volumes rather than masses. Different factors apply for each product when converting from a volume to mass basis, as shown by the conversion factors given in Annex A of this Digest. Thus, a balanced transfer in volume terms may not be equivalent when converted to a mass basis. This is thought to be the main source of error within the individual product balances.

Revisions to published data

3.50 Substantial revisions were made in 2019 to sector estimates of demand following an extensive programme of improvement that is ongoing. This work has been delayed by the UK-wide lockdown during the COvid-19 pandemic. For further information see Energy Trends special article, Change to method of estimating sector demand for oil products, at:
www.gov.uk/government/publications/energy-trends-june-2019-special-feature-article-change-to-method-of-estimating-sector-demand-for-oil-products

3.51 Minor revisions have been made following updates received from data suppliers.

Indigenous production

3.52 The term indigenous is used throughout this chapter and includes oil from the UK Continental Shelf, both offshore and onshore. Production of feedstocks at petrochemical plants that are delivered to refineries as backflows have not been included in production figures in the text or charts in this chapter.

Deliveries

3.53 These are deliveries into consumption, as opposed to being estimates of actual consumption or use. They are split between inland deliveries and deliveries to marine bunkers. Inland deliveries will not necessarily be consumed in the UK (e.g. aviation fuels).

Imports and exports

3.54 They can differ in some cases from the import and export figures provided by HMRC that are given in Annex G on BEIS’s energy statistics website. Such differences arise from timing differences between actual and declared movements but also result from the Customs figures including re-exports. These are products that may have originally entered the UK as imports from another country and been stored in the UK prior to being exported back out of the UK, as opposed to having been produced in the UK.

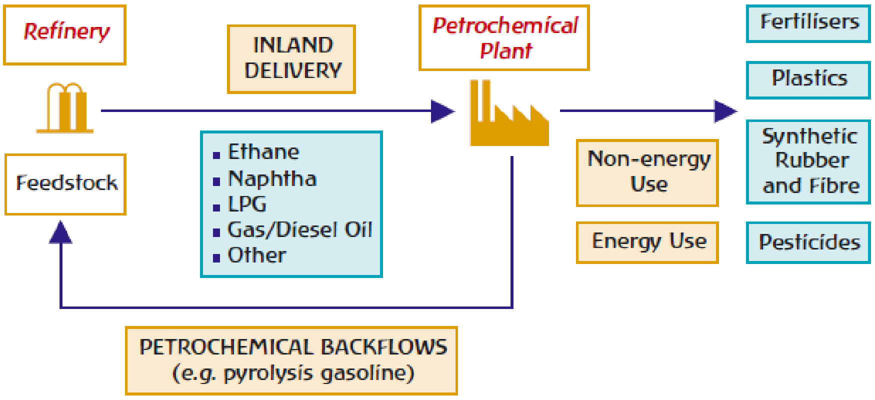
Marine bunkers

3.55 This covers deliveries to be used by ocean going and coastal vessels under international bunker contracts. Other deliveries to fishing, coastal and inland vessels are excluded. As part of BEIS’s audit programme, UK refinery contacts reviewed the provision of fuel to marine bunkers in 2009. Whilst several companies have reviewed their methodology there are still issues with determining the final destination of fuel when these are supplied to third parties that are not part of BEIS’s monitoring programme. This issue impacts on both the volumes delivered directly to marine vessels, and whether those vessels are engaged in domestic or international navigation. Whilst BEIS will continue to work closely with reporting companies to improve the estimation of marine fuel use. We have aligned energy demand for shipping in line with the estimates of marine fuel use in the UK's National Atmospheric Emissions Inventory (NAEI). The NAEI figures use BEIS's estimate of marine fuels and derive the split between international and domestic use based on an activity-based study of the UK's marine fuel use.

Backflows from the petrochemical sector

3.56 BEIS and Industry have also worked to better understand product flows between refiners and petrochemical plants. Whilst most petroleum products are used for energy purposes, substantial volumes are delivered to the petrochemical industry as a feedstock for the manufacturing of plastics, synthetic fibres and other products. These products are used, but they are not combusted. The refining and petrochemical industries are often closely related as shown in Figure 3.1 below. Refineries deliver product to a petrochemical plant for the production of a range of products, but these plants also return some petroleum products back to refineries for further processing.

Figure 3.1: Deliveries to the Petrochemical Sector (Source: IEA)



3.57 Since the 2015 edition of this Digest BEIS has separately identified deliveries of backflows from petrochemical plants under both the upstream side of the balance (in Table 3.1 they are included as part of the 'feedstocks' column) and the downstream part of the balance (in Table 3.2 to 3.4 the volumes are shown on the 'other' row in the transformation section).

Crude and process oils

3.58 These are all feedstocks, other than distillation benzene, for refining at refinery plants. Gasoline feedstock is any process oil whether clean or dirty which is used as a refinery feedstock for the manufacture of gasoline or naphtha. Other refinery feedstock is any process oil used for the manufacture of any other petroleum products.

Refineries

3.59 Refineries distil crude and process oils to obtain petroleum products. This excludes petrochemical plants, plants only engaged in re-distilling products to obtain better grades, crude oil stabilisation plants and gas separation plants.

Products used as fuel (energy use)

3.60 The following paragraphs define the product headings used in the text and tables of this chapter. The products are used for energy, either directly as a fuel or as an input into electricity generation.

Refinery fuel - Petroleum products used as fuel at refineries.

Ethane - A naturally gaseous straight-chain hydrocarbon (C2H6) in natural gas and refinery gas streams. Primarily used, or intended to be used, as a chemical feedstock.

Propane - Hydrocarbon containing three carbon atoms (C3H8), gaseous at normal temperature but generally stored and transported under pressure as a liquid. Used mainly for industrial purposes, but also as transport, Liquid Petroleum Gas (LPG), and some domestic heating and cooking.

Butane - Hydrocarbon containing four carbon atoms (C_4H_{10}), otherwise as for propane. Additionally, used as a constituent of motor spirit to increase vapour pressure and as a chemical feedstock.

Naphtha (Light distillate feedstock) - Petroleum distillate boiling predominantly below 200°C.

Aviation spirit - All light hydrocarbon oils intended for use in aviation piston-engine power units, including bench testing of aircraft engines.

Motor spirit - Blended light petroleum components used as fuel for spark-ignition internal-combustion engines other than aircraft engines:

(i) Premium unleaded grade - all finished motor spirit, with an octane number (research method) not less than 95.

(ii) Lead Replacement petrol / Super premium unleaded grade - finished motor spirit, with an octane number (research method) not less than 97.

Aviation turbine fuel (ATF) - All other turbine fuel intended for use in aviation gas-turbine power units and including bench testing of aircraft engines.

Burning oil (kerosene or "paraffin") - Refined petroleum fuel, intermediate in volatility between motor spirit and gas oil, used primarily for heating. White spirit and kerosene used for lubricant blends are excluded.

Gas/diesel oil - Petroleum fuel having a distillation range immediately between kerosene and light-lubricating oil:

(i) **DERV (Diesel Engine Road Vehicle) fuel** - automotive diesel fuel for use in high speed, compression ignition engines in vehicles subject to Vehicle Excise Duty.

(ii) **Gas oil** - used as a burner fuel in heating installations, for industrial gas turbines and as for DERV (but in vehicles not subject to Vehicle Excise Duty e.g. agricultural vehicles, fishing vessels, construction equipment used off road and usually coloured with a red marker dye). Gas oil used for oil and gas extraction is included from 2005 onwards.

(iii) **Marine diesel oil** - heavier type of gas oil suitable for heavy industrial and marine compression-ignition engines.

Fuel oil - Heavy petroleum residue blends used in atomising burners and for heavy-duty marine engines (marine bunkers, etc.) with heavier grades requiring pre-heating before combustion. Excludes fuel oil for grease making or lubricating oil and fuel oil sold as such for road making.

Products not used as fuel (non-energy use)

3.61 The following paragraphs define the product headings used in the text and tables of this chapter, which are used for non-energy purposes.

Feedstock for petroleum chemical plants - 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. (A deduction has been made from these figures equal to the quantity of feedstock used in making the conventional petroleum products that are produced during the processing of the feedstock. The output and deliveries of these conventional petroleum products are included elsewhere as appropriate.)

White spirit and specific boiling point (SBP) spirits - These are refined distillate intermediates with a distillation in the naphtha / kerosene range. **White spirit** has a boiling range of about 150°C to 200°C and is used as a paint or commercial solvent. **SBP spirit** is also known as **Industrial spirit** and has a wider boiling range that varies up to 200°C dependent upon its eventual use. It has a variety of uses that vary from use in seed extraction, rubber solvents and perfume.

Lubricating oils (and grease) - Refined heavy distillates obtained from the vacuum distillation of petroleum residues. Includes liquid and solid hydrocarbons sold by the lubricating oil trade, either alone or blended with fixed oils, metallic soaps and other organic and/or inorganic bodies. A certain percentage of inland deliveries are re-used as a fuel, but all inland deliveries of lubricating oils have been classified as non-energy use only. Some deliveries are used for energy purposes, but it is difficult to estimate energy use figures with any degree of accuracy, hence no such estimates appear in the commodity balance tables. DUKES Table 3.8 (prior to 2010, table 3D, within the main text) provides limited information on the use of lubricants and grease. The information which was published under the heading of "Motors" has been amended to now include "Gear Oils and Transmission" to give a full picture of the lubricants used by vehicles.

Bitumen - The residue left after the production of lubricating oil distillates and vacuum gas oil for upgrading plant feedstock. Used mainly for road making and building construction purposes. Includes other petroleum products such as creosote and tar mixed with bitumen for these purposes and fuel oil sold specifically for road making.

Petroleum wax - Includes paraffin wax, which is a white crystalline hydrocarbon material of low oil content normally obtained during the refining of lubricating oil distillate, paraffin scale, slack wax, microcrystalline wax and wax emulsions. Used for candle manufacture, polishes, food containers, wrappings etc.

Petroleum cokes - Carbonaceous material derived from hydrocarbon oils, uses for which include metallurgical electrode manufacture. Quantities of imports of this product are used as a fuel as it has a higher energy content than coal, though a lower energy content than fuel oils.

Miscellaneous products - Includes aromatic extracts, defoament solvents and other minor miscellaneous products.

Main classes of consumer

3.62 The following are definitions of the main groupings of users of petroleum products used in the text and tables of this chapter.

Electricity generators - Petroleum products delivered for use by major power producers and other companies for electricity generation including those deliveries to the other industries listed below which are used for autogeneration of electricity (Tables 3.2 to 3.4). This includes petroleum products used to generate electricity at oil refineries and is recorded in the Transformation section, as opposed to other uses of refinery fuels that are recorded in the Energy Industry Use section. From the 2009 chapter of the Digest, data in Chapter 3 (Table 3.2 to 3.4) has been aligned with Chapter 5 (Table 5.4). The data on oil used for electricity generation collected from major power producers and autogenerators is judged to be at least as accurate as the data from refiners on deliveries, and has the advantage of consistency.

Agriculture - Deliveries of fuel oil and gas oil/diesel for use in agricultural power units, dryers and heaters. Burning oil for farm use.

Iron and steel - Deliveries of petroleum products to steel works and iron foundries. This is now based on information from the Iron and Steel Statistics Bureau.

Other industries - The industries covered correspond to the industrial groups shown in Table 1G of Chapter 1, excluding Iron and Steel.

National navigation - Fuel oil and gas/diesel oil delivered, other than under international bunker contracts, for fishing vessels, UK oil and gas exploration and production, coastal and inland shipping and for use in ports and harbours.

Railways - Deliveries of fuel oil, gas/diesel oil and burning oil to railways now based on estimates produced by Ricardo Energy and Environment as part of their work to compile the UK National Atmospheric Emissions Inventory (NAEI).

Air transport - Total inland deliveries of aviation turbine fuel and aviation spirit. The figures cover deliveries of aviation fuels in the UK to international and other airlines, British and foreign Governments (including armed services) and for private flying. In order to compile the NAEI, Ricardo Energy and Environment need to estimate how aviation fuel usage splits between domestic and international consumption. Information from Ricardo Energy and Environment suggests that virtually all aviation spirit is used domestically while just 5 per cent of aviation turbine fuel use is for domestic consumption. A further 5 per cent is estimated to be consumed by the military.

Road transport - Deliveries of motor spirit and DERV fuel for use in road vehicles of all kinds.

Domestic - Fuel oil and gas oil delivered for central heating of private houses and other dwellings and deliveries of kerosene (burning oil) and liquefied petroleum gases for domestic purposes (see Tables 3.2 to 3.4).

Public services - Deliveries to national and local Government premises (including educational, medical and welfare establishments and British and foreign armed forces) of fuel oil and gas oil for central heating and of kerosene (burning oil).

Miscellaneous - Deliveries of fuel oil and gas oil for central heating in premises other than those classified as domestic or public.

Biofuels in transport

3.63 The quantity of biofuels blended into motor spirit and DERV are shown in Table 3.6 of this chapter. Total consumption of biofuels and road fuels are shown in Table 3D, this is based on the volume of fuel for which excise duty has been paid to HM Revenue and Customs (HMRC). As a percentage of road fuels biofuels increased significantly from 2007 until 2010 however this percentage has remained relatively flat since at 5 per cent, up 1 per cent on 2018. Whilst petrol has remained flat in recent years there has been an increase in consumption of bio diesel, up 40 per cent on 2018. Further details on biofuel consumption can be found in Chapter 6. Biofuels are also included in the overall energy balances in Chapter 1.

Table 3D: Consumption of Biodiesel and Bioethanol in the UK 2008 to 2019

Year	Biodiesel	All diesel including biodiesel	Biodiesel as % diesel	Bioethanol	All petrol including bioethanol	Bioethanol as % petrol	Biofuels as % total
2008	886	25,686	3.4%	206	22,709	0.9%	2.3%
2009	1,044	25,089	4.2%	320	22,029	1.5%	2.9%
2010	1,049	25,773	4.1%	631	20,650	3.1%	3.6%
2011	925	25,926	3.6%	652	19,548	3.3%	3.5%
2012	634	26,348	2.4%	775	18,792	4.1%	3.1%
2013	766	26,969	2.8%	820	18,020	4.6%	3.5%
2014	954	27,985	3.4%	814	17,672	4.6%	3.9%
2015	669	28,884	2.3%	795	17,319	4.6%	3.2%
2016	708	30,106	2.4%	759	17,101	4.4%	3.1%
2017	697	r 30,410	2.3%	753	r 16,783	4.5%	3.1%
2018	r 1,139	r 30,513	3.7%	761	r 16,601	4.6%	4.0%
2019	1,598	30,032	5.3%	752	16,852	4.5%	5.0%

Source: HM Revenue and Customs *Million litres*

Monthly and quarterly data

3.64 Monthly or quarterly aggregate data for certain series presented in this chapter are available. This information can be obtained free of charge by following the links given in the Energy Statistics section of the BEIS website on GOV.UK at:
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy/about/statistics

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Chapter 4
Natural Gas

Key points

- Natural gas imports reached a peak in 2010, since when import levels have declined and remained broadly level in recent years. However, **in 2019 pipeline imports were down sharply owing to a three-fold increase in imports of Liquefied Natural Gas (LNG)**. This was the result of increased diversification of supply from other countries and global oversupply driving down prices. (Table 4.5, Chart 4.3).

- **Like 2018, UK exports remain below 100 TWh of gas – only the third time since 1999.** Using physical rather than commercial flows of gas, net imports were down 0.9 per cent in 2019 compared to 2018 (Table 4.5) as exports increased slightly to 87 TWh while imports were largely unchanged.

- **UK natural gas production in 2019 decreased by 2.9 per cent compared with 2018** to 439 TWh. The longer-term trend has been a pattern of decline and continued into 2019 following the closure of the Theddlethorpe gas terminal in August 2018 and the Rough storage facility, from which the last of the cushion gas has now been extracted. In 2019 production remained two-thirds below the peak levels seen in 2000 (Table 4.1, Chart 4.1).

- **Total gas demand (natural gas plus colliery methane) was 0.7 per cent lower than 2018 at 878 TWh** as demand for gas fell across most sectors, including gas for electricity generation and the domestic sector. (Table 4.1, Chart 4.5).

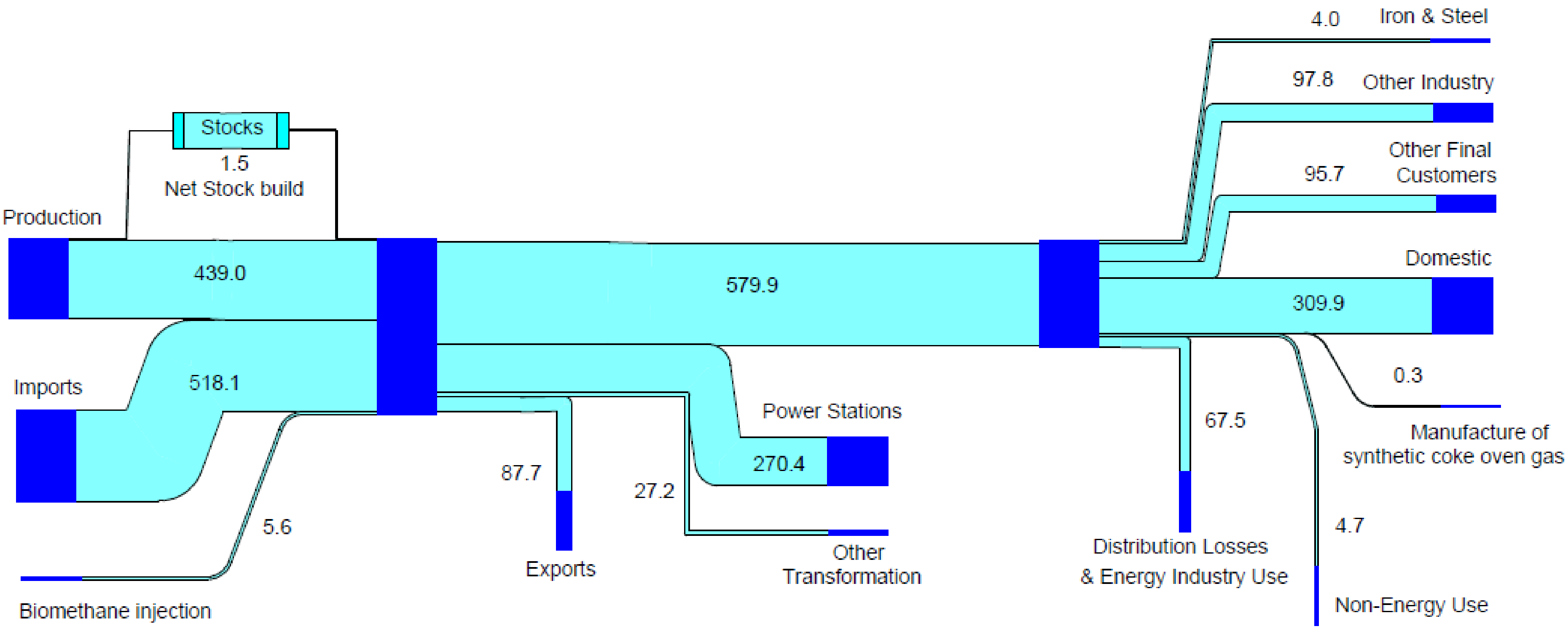
- **Final consumption decreased by 0.9 per cent in 2019 to 512 TWh,** driven by milder temperatures reducing demand in contrast to the severe weather brought over by the 'Beast from the East' in 2018. There were decreases in the domestic (-0.9 per cent), public administration (-2.0 per cent) and industrial (-1.2 per cent) sectors. (Table 4.1, Chart 4.4).

Introduction

4.1 Gas is one of the key pillars of the UK's energy mix, accounting for 29 per cent of the UK's energy production and second only to oil. Gas production from the UK's Continental Shelf (UKCS) would have been sufficient to meet nearly 50 per cent of UK demand in 2019. Gas is particularly important for electricity generation where it meets around 40 per cent of the fuel required in power stations. It is also critical for space heating, domestically and in offices, hotels and restaurants. In 2019 gas met nearly two thirds of total domestic energy demand.

4.2 An energy flow chart for 2019, showing the flows of natural gas from production and imports through to consumption, is included below as a summary of the figures in the commodity balance tables. It illustrates the flow of gas from the point at which it becomes available from indigenous production or imports (on the left) to the final use of gas (on the right), as well as volumes transformed into other forms of energy or exported.

Natural gas flow chart 2019 (TWh)



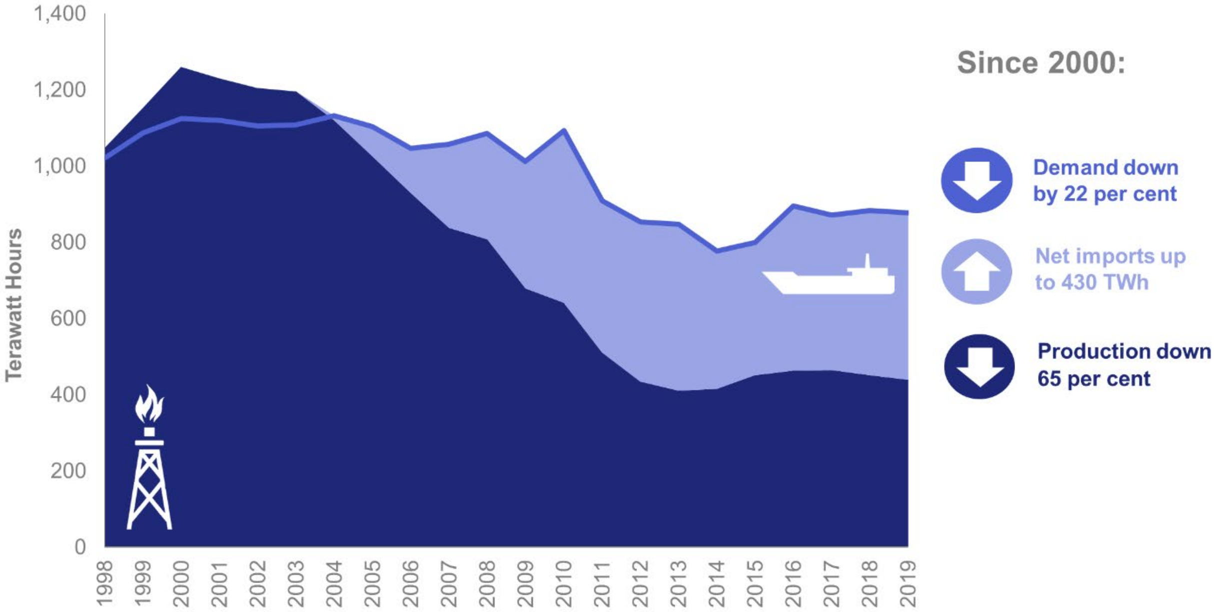
Note:
This flow chart is based on data that appear in Table 4.1, excluding colliery methane.

Supply of gas

4.3 Mirroring the long-term trend in declining gas production since the turn of the century, gas production fell in 2019 and is 65 per cent below the peak recorded in 2000 (Chart 4.1). Despite this decline, the UK remains one of the two major gas-producing nations within the EU, alongside the Netherlands, and domestic production matches over half of UK demand.

4.4 At 439 TWh, production decreased by 2.9 per cent compared with 2018. One cause of this was the closure of the Theddlethorpe gas terminal in August 2018 as well as the running down of cushion gas extraction from the Rough Facility – a former long-term storage site that has now closed.

Chart 4.1: Changes in UK gas production and demand, 1998 – 2019



4.5 As well as a decline in production, demand has decreased since the mid-2000s as Chart 4.1 illustrates. This has been driven mainly by reduced industrial consumption (Chart 4.5). Despite this, there has been a growth in net imports with pipelines from Norway, the Netherlands and Belgium. In addition, UK imports via shipments of Liquefied Natural Gas (LNG) to terminals at Milford Haven (South Hook and Dragon) and the Isle of Grain. Much of this infrastructure has been relatively recent, with the completion of the pipeline between the UK and the Netherlands in 2006 and the completion of two new LNG terminals in 2009.

4.6 On a physical flow basis[1], net imports were down by 0.9 per cent in 2019 as exports rose slightly to 87 TWh and imports remained stable on the year before. However, the composition of imports has changed significantly where LNG imports comprised 39 per cent of all imports in 2019 compared to 15 per cent in 2018. Pipeline imports fell by 28 per cent percent with declines from Norway (21 per cent), the Netherlands (42 per cent) and Belgium (89 per cent). Imports from Belgium have generally been reduced since October 2018 due to the termination of the Bacton-Zeebrugge Interconnector long term capacity contract.

4.7 Conversely, imports of LNG have tripled, accounting for the second highest record share of the UK's total imports at 39 per cent. Decreased global demand and increased availability from the diversification of the LNG market was a significant factor for this increase, as well as substantial increases in imports from Qatar - the UK's biggest LNG supplier. In addition, there was a global

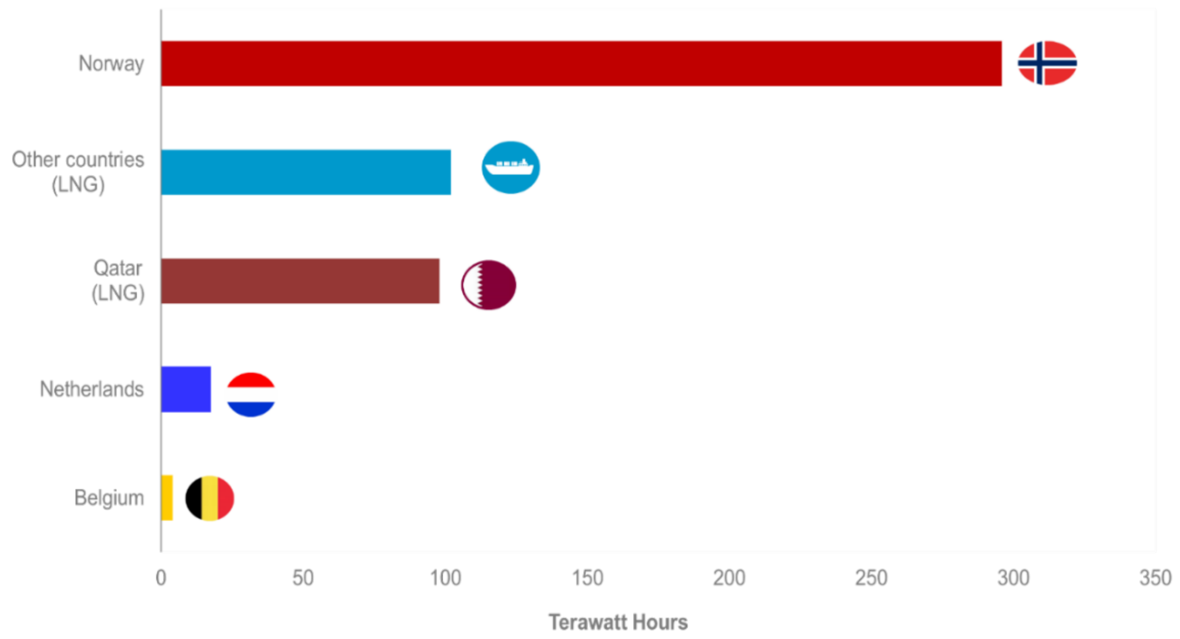
[1] Physical flows of gas are volumes that have moved between countries and are shown in DUKES Table 4.5. Nominated, or commercial, flows include volumes to and from Belgium where trades have taken place between companies, but then 'sold back' before the gas has been physically transferred. These are shown in DUKES Tables 4.1 and 4.2.

oversupply in LNG as new projects came onstream most notably in the US and Russia, pushing wholesale LNG gas prices downwards.

For further details on latest trends in LNG supply, see the Energy Trends special feature that was published in March 2020:
www.gov.uk/government/publications/energy-trends-march-2020-special-feature-article-trends-in-trade-of-liquefied-natural-gas-in-the-uk-and-europe

4.8 Chart 4.2 shows UK imports by source. Despite the 21 per cent decrease in 2019, pipeline imports from Norway remain the principal source of UK gas imports, meeting 57 per cent of the UK import volumes over the year. For LNG, Qatar remains the primary supplier at nearly half of all volumes although the mix of LNG sources has become increasingly diversified in recent years. After importing to the UK LNG market for the first time in 2017, export volumes from Russia and the USA have increased to 34 TWh and 33 TWh in 2019, respectively, forming 33 per cent of LNG imports combined. For further details and to see the imports and exports of other countries see Table 4.5.

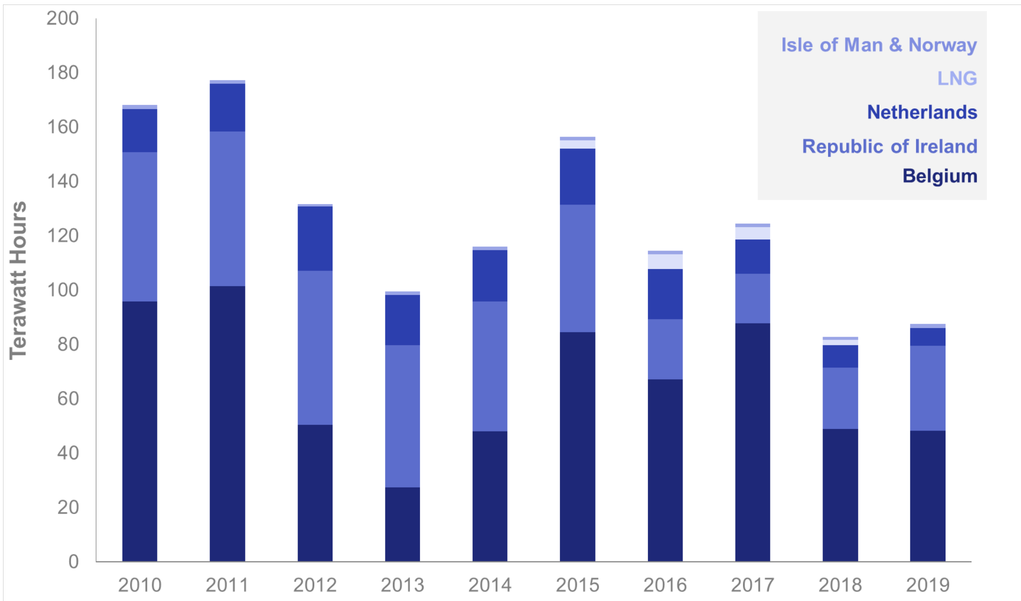
Chart 4.2: Gas imports by country 2019 (physical flows basis, Table 4.5)



4.9 The UK is a major exporter of gas within Europe, despite demand outstripping supply from the UK's Continental Shelf. Chart 4.3 shows that export volumes have been considerable but vary in response to the prevailing market conditions at the time.

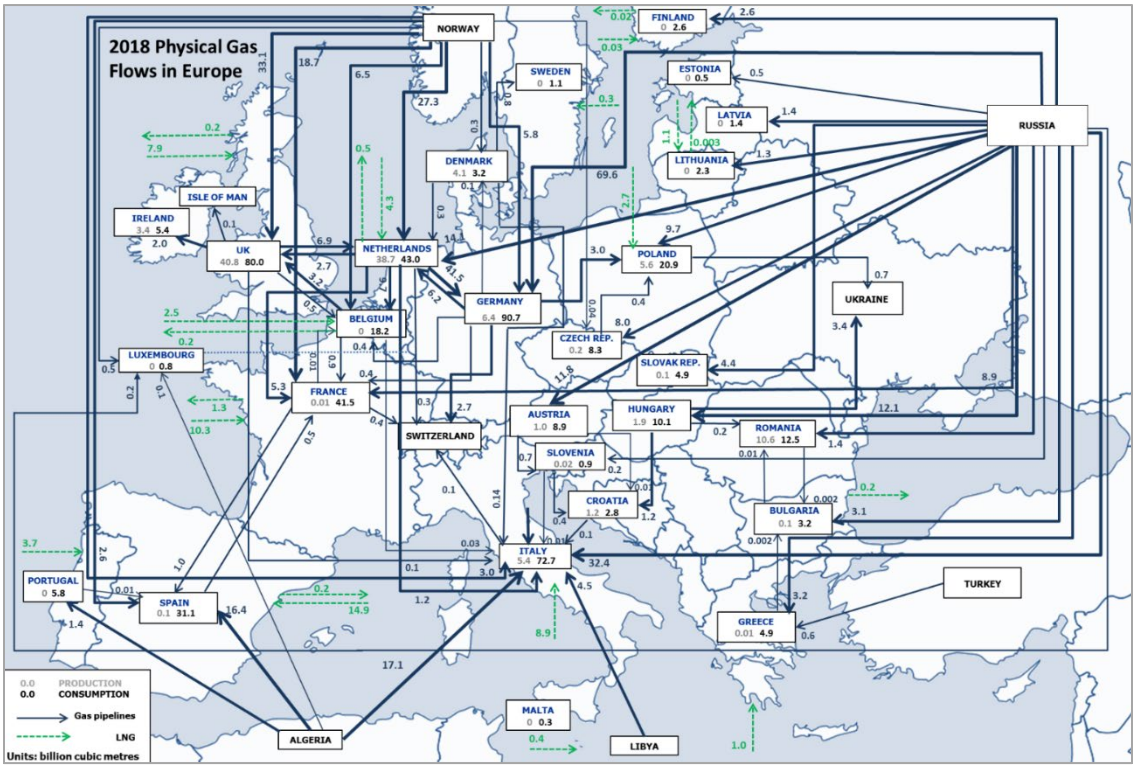
4.10 UK physical exports were 5.6 per cent higher than the record lows seen in 2018 at 83 TWh. The increase was largely driven by a 38 per cent increase in exports to Ireland. Due to the ending of the long-term capacity contract for the UK-Belgium interconnector, exports to Belgium remain low compared to previous years. Despite the year-on-year increase, exports remain below 100 TWh and 2019 is only the third annual total since 1999 that the UK exported less than 100 TWh of gas.

Chart 4.3: Export volumes by year and country, 2009 – 2019 (physical flows basis, Table 4.5)



4.11 The European transit system for gas is complex, with multiple connectors giving a high degree of interconnectivity. Map 4A is illustrative of this and shows how gas flows into the EU (from Russia, Norway and by ship principally) and onto the UK (principally from Norway and by ship). The UK National Gas Transmission System is similarly complex map and is illustrated in Map 4B.

Map 4A: The European gas transit system

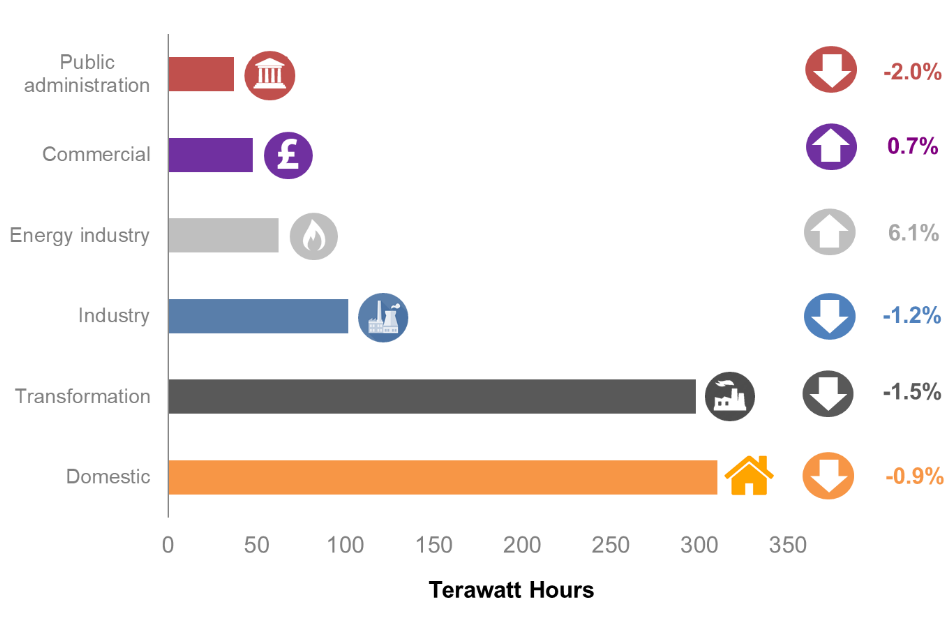


4.12 For further details on supply of gas to the UK and Europe see the Energy Trends special feature that was published in December 2019: www.gov.uk/government/publications/energy-trends-december-2019-special-feature-article-diversity-and-security-of-gas-supply-in-the-eu-2018

Demand for gas

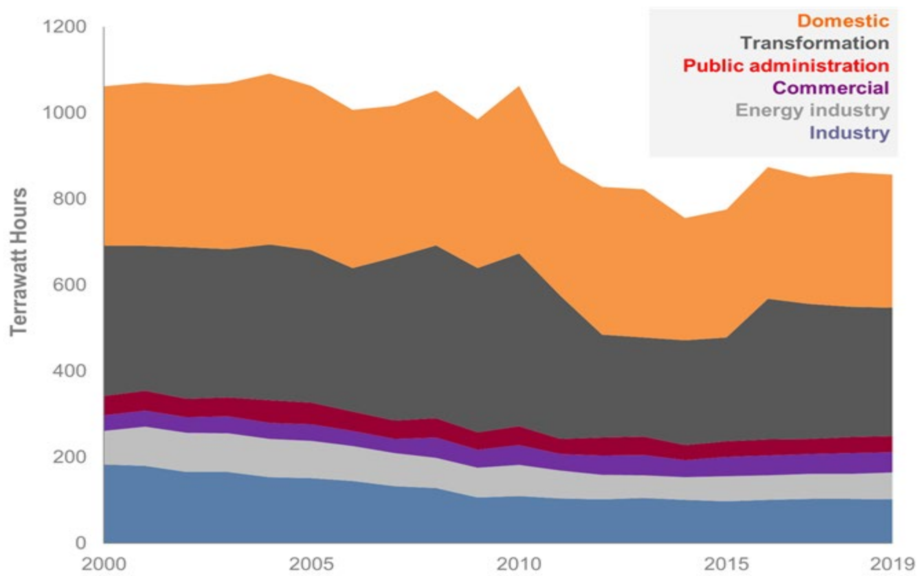
4.13 **Gas demand can be broadly broken down into two main sectors of very substantial size; domestic consumption and gas for electricity generation**, with demand for industry, commercial, public administration and other sectors making up the rest (see Chart 4.4).

Chart 4.4: Gas demand in 2019[2]



4.14 **Whilst gas is a critical part of the UK's energy demand, the long-term trend is downwards, down by a fifth (22 per cent) in 2019 since 2000 (Chart 4.5, DUKES Table 4.1).** Most notably, industry demand has shrunk by 45 per cent since 2000. Demand for generation and domestic demand has also shrunk by 17 and 16 per cent, respectively, despite a rising population and growing number of homes. Increased efficiencies, including greater levels of home insulation, are in part responsible for this. Despite the overall downwards trend, there are notable peaks that correspond with weather variations, which generate a greater demand for space heating in homes and offices.

Chart 4.5: Changes in gas demand over time, 2000 - 2019 (DUKES Table 4.1) [2]



[2] Note: Transformation includes colliery methane

4.15 **Gas demand in 2019 decreased by 0.7 per cent compared to 2018 to 878 TWh.** In contrast to the cold weather brought over by the 'Beast from the East' in the first quarter of 2018, 2019 saw milder temperatures. Comparatively low levels of demand in Q1 2019 contributed to an annual 0.9 per cent reduction in domestic consumption for gas. Similarly, industrial usage fell by 1.2 per cent, with slight decreases in most sectors, contributing to an overall decrease in final consumption of 0.9 per cent.

4.16 Gas demand for transformation, including electricity and heat generation, fell by 1.5 per cent. This includes gas used for electricity generation which decreased by 1.6 per cent because of the continued increase in output from renewable sources. The only broad sector that saw an increase was in the energy industry (by 6.1 per cent) and this was due to increased demand for Oil and Gas extraction.

4.17 More detailed analysis of gas consumption in the domestic sector is available in the National Energy Efficiency Data-Framework (NEED): www.gov.uk/government/collections/national-energy-efficiency-data-need-framework. For definitions of the various sectors used for sales and consumption analyses see Chapter 1, and Annex A.

Sub-national gas data

4.18 In December 2019, BEIS published sub-national energy statistics data on its website: www.gov.uk/government/collections/sub-national-gas-consumption-data, including consumption data at both regional (NUTS1) and local (LAU1) level. Data for earlier years are presented on the website.

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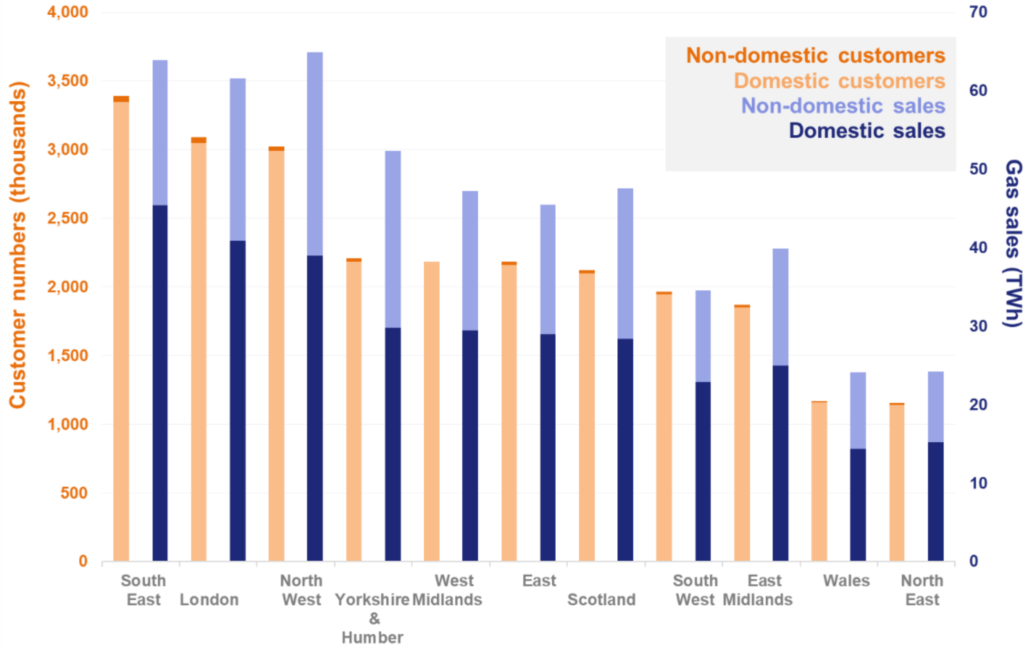
Chart 4.6: Domestic and non-domestic gas customer numbers and sales by region, 2018/19



Domestic customers (with an annual consumption of 73,200 kWh or lower) will include some small industrial and commercial consumers. Data excludes approximately 74,000 customers (0.3 per cent) for whom regional allocation was not possible.

4.19 The total number of customers in 2018/19 remained similar to 2017/18.With the exception of the West Midlands where the number of meters stayed the same, all areas saw a small rise in the total number of customers. Within this, the South East and London have the largest numbers of consumers, whilst there are fewest in the North East. Total sales were up in all regions last year, with largest increases in the North West, Wales and the East of England. A more detailed summary of this data can be found at: www.gov.uk/government/statistics/sub-national-electricity-and-gas-consumption-summary-report-2018

4.20 In March 2020, BEIS published percentage of domestic gas customers by region and supplier type data for Quarter 4 2019 on its website:
www.gov.uk/government/statistical-data-sets/quarterly-domestic-energy-price-stastics

Table 4A: Domestic gas market penetration (in terms of percentage of customers supplied[1]) by region, Quarter 4 2019

	All Payment Types	
Region/Country[2]	**Home supplier (%)**	**Other large supplier (%)**
South Wales	22	78
North East	23	77
East Midlands	22	78
North Scotland	29	71
South East	23	77
Southern	29	71
Yorkshire	25	75
Eastern	29	71
South Scotland	27	73
South West	29	71
West Midlands	31	69
North West	27	73
Merseyside & N Wales	34	66
London	35	65
Great Britain	**28**	**72**

[1] Table is not adjusted to account for survey coverage. The Domestic Fuels Inquiry survey coverage is estimated at around 88%. All those not surveyed are with non-home suppliers.

[2] The regions used in this table are the distribution areas of the former public electricity suppliers.

4.21 **At the end of December 2019, BEIS estimated that 72 per cent of domestic gas customers in Great Britain are not with their 'home' supplier, British Gas.** The data in Table 4A are based on the BEIS domestic prices survey, which does not include many small suppliers and therefore underestimates the proportion of customers not with their home supplier. By the end of December 2019, of the companies surveyed, around 28 per cent of customers were supplied by British Gas. For all types of domestic customers, it is in the markets in South Wales and the East Midlands that new suppliers have taken more of a market share.

4.22 Competition in the domestic market has continued to increase in 2019 as the concentration of sales by the largest three and largest six suppliers for each relevant sector have continued to dilute compared to past years. **Competition remained broadly unchanged between 2008 and 2013, but from 2014 onwards the competition has gradually increased[3].** In 2018 (the latest year for which the analysis is available), the top nine suppliers accounted for around 75 per cent of sales, like 2017 but down from 80 per cent of sales in 2014.

[3] For further information see Energy Trends special article, Competition in gas supply, at: www.gov.uk/government/statistics/energy-trends-september-2019-special-feature-article-competition-in-gas-supply

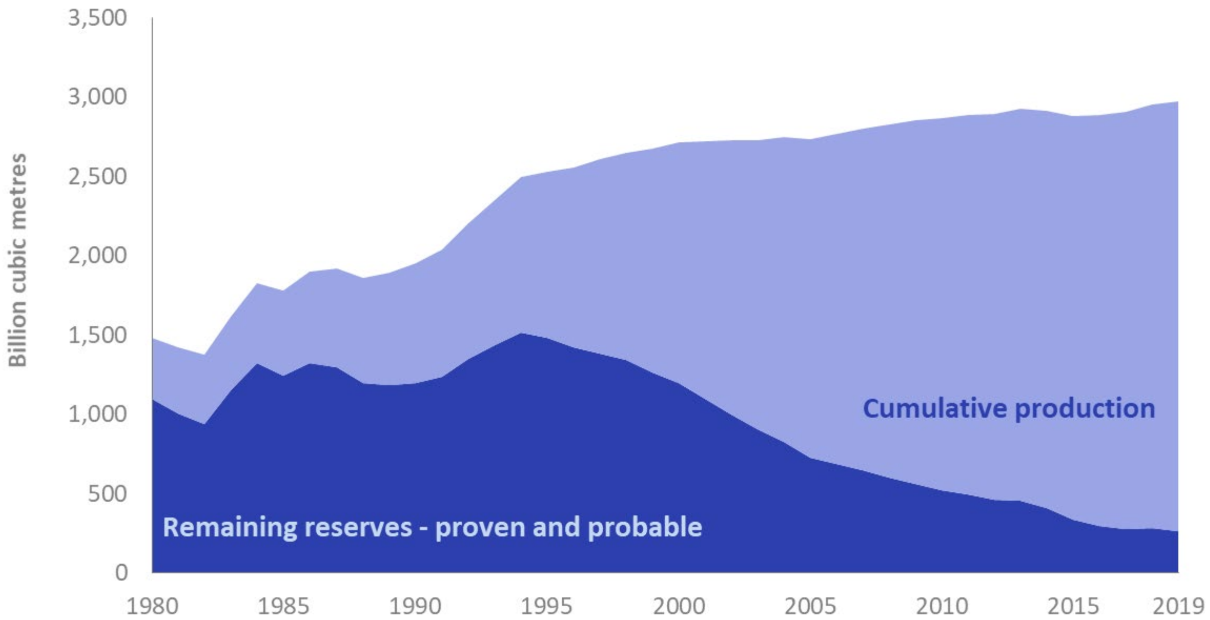
Map 4B: The North Sea Oil and Gas Transmission System

Source: Oil and Gas Authority and BEIS

Gas resources

4.23 The Oil and Gas Authority estimates that there are 260 billion cubic metres of proven and probable (2P) gas reserves, of which 174 billion cubic metres are proven reserves[4]. There has been a steady decline in 2P reserves since 1994 (as shown in Chart 4.7), initially associated with a higher rate of production. At the end of 2019 cumulative production plus 2P reserves was 2,971 billion cubic metres. The apparent decline in reserves in 2015 was due to re-classification of some reserves that had not yet been sanctioned - these will be included in future as and when sanctioned.

Chart 4.7: Gas reserves, 1980 - 2019



List of DUKES gas tables

Table	Description	Period
4.1	Natural gas commodity balances	1998-2019
4.2	Supply and consumption of natural gas and colliery methane	1996-2019
4.3	UK continental shelf and onshore natural gas production and supply	2008-2019
4.4	Gas storage sites and import/export facilities in the United Kingdom	November 2019
4.5	Natural gas imports and exports	2000-2019
4.6	Liquefied natural gas imports by terminal	2006-2019
4.1.1	Natural gas and colliery methane production and consumption	1970-2019
F.2	Gas production	1998-2019

[4] The Oil and Gas Authority will update with detailed estimates in November 2020: www.ogauthority.co.uk/data-centre/data-downloads-and-publications/reserves-and-resources/

Technical notes and definitions

These notes and definitions are in addition to the technical notes and definitions covering all fuels and energy in Chapter 1, paragraphs 1.29 to 1.63. For notes on the commodity balances and definitions of the terms used in the row headings see Annex A, paragraphs A.7 to A.42. While the data in the pdf copy of this Digest cover only the most recent five years, these notes also cover data for earlier years that are available on the BEIS energy statistics website.

Definitions used for production and consumption

4.24 **Natural gas** production in Tables 4.1 and 4.2 relates to the output of indigenous methane at land terminals and gas separation plants (includes producers' and processors' own use). For further explanation, see Annex F on BEIS's energy statistics website under 'Production of gas' - www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes. Output of the Norwegian share of the Frigg and Murchison fields is included under imports. A small quantity of onshore produced methane (other than colliery methane) is also included.

4.25 **Colliery methane** production is colliery methane piped to the surface and consumed at collieries or transmitted by pipeline to consumers. As the output of deep-mined coal declines so does the production of colliery methane, unless a use can be found for gas that was previously vented. The supply of methane from coal measures that are no longer being worked or from drilling into coal measures is licensed under the same legislation as used for offshore gas production.

4.26 **Transfers** of natural gas include natural gas use within the iron and steel industry for mixing with blast furnace gas to form a synthetic coke oven gas. For further details see paragraph 2.52 in Chapter 2.

4.27 **Non-energy use** is gas used as feedstock for petrochemical plants in the chemical industry as raw material to produce ammonia (an essential intermediate chemical in the production of nitrogen fertilisers) and methanol. The contribution of liquefied petroleum gases (propane and butane) and other petroleum gases is shown in Tables 3.2 to 3.4 of Chapter 3. Firm data for natural gas are not available but estimates for 2011 to 2015 are shown in Table 4.2 and estimates for 2013 to 2019 in Table 4.1. The estimates for the years up to 2011 have been obtained from AEA's work for the National Atmospheric Emissions Inventory; 2012-13 data are BEIS extrapolations.

Sectors used for sales/consumption

4.28 For definitions of the various sectors used for sales and consumption analyses see Chapter 1 paragraphs 1.55 to 1.60 and Annex A, paragraphs A.31 to A.42.

Data collection

4.29 Production figures are generally obtained from returns made under OGA's Petroleum Production Reporting System (PPRS). BEIS also obtain data on the transmission of natural gas from National Grid (who operate the National Transmission System) and from other pipeline operators. Data on consumption are based on returns from gas suppliers and UK Continental Shelf (UKCS) producers who supply gas directly to customers (see paragraph 4.31).

4.30 The production data are for the UK (including natural gas from the UKCS - offshore and onshore). The restoration of a public gas supply to parts of Northern Ireland in 1997 means that all tables in this chapter, except Tables 4A and 4B, cover the UK.

4.31 BEIS carry out an annual survey of gas suppliers to obtain details of gas sales to the various categories of consumer. The larger gas suppliers (defined as those with more than about a 0.5 per cent share of the UK market up to 1997 and those known to supply more than 1,750 GWh per year for 1998 onwards) provide a detailed breakdown of sales for final consumption to BEIS on an annual basis. This provides the main data source for the UK's gas demand. Prior to 2013, companies supplying less than 1,750 GWh provided gas sales as a single sum which was then apportioned across sectors using the same proportional split as seen in the data from the large suppliers. From 2013 onwards, data from smaller suppliers were provided broken down by broad sector (e.g. domestic, other industry etc.) to allow more accurate apportioning of these data.

4.32 Data on sectoral gas use are primarily derived from surveys of large and small gas suppliers. Beyond this, data for electricity generation by major power producers are adjusted, such that the data agree with a separate data set collected via the Major Power Producers' (MPP) survey. Data for autogenerators are similarly adjusted to match CHP data (see Chapter 7) provided to BEIS, with the appropriate amount of gas used for autogeneration being subtracted from each sector and added to the autogeneration figure. The same methodology is applied for heat sold, which makes up the heat generation figure. For 2000 and subsequent years, gas consumption for the iron and steel sector is based on data provided by the Iron and Steel Statistics Bureau (ISSB) rather than gas suppliers, since gas suppliers were over-estimating their sales to this sector. The difference between the ISSB and 'gas suppliers' figures has been re-allocated to other sectors.

Methodology updates

4.33 Biomethane has been injected into the National Grid from certified Renewable Heat Incentive (RHI) installations since 2014. These volumes have been small, but increasing, with biomethane accounting for 0.5 per cent of supply in 2019. This gas is included in the transfers row in Tables 4.1, 4.2 and 4.3 in this chapter and is separately identified in the monthly Energy Trends tables. Since 2017, data for biomethane gas injection has been expanded from RHI only to also include data from the environmental consultancy NNFCC. More information on Biomethane injection can be found at https://ee.ricardo.com/downloads/energy/restats-%E2%80%93-the-definitive-source-of-uk-renewable-en

4.34 In 2016 BEIS updated the methodology to calculate gas exports to the Republic of Ireland to remove virtual reverse flows, which ensures that only physical flows are reported in line with international reporting standards. Republic of Ireland and Northern Ireland gas flows are now taken from published data by Gas Networks Ireland. In previous years Republic of Ireland flows have been calculated but we now take these flows from Gas Networks Ireland (GN). These flows, along with reported flows from Manx Utilities to Isle of Man and data from the Bacton Terminal is compared to GM10 data reported to BEIS by National Grid to identify exported flows.

4.35 BEIS updated our gas data collection methodology and analysis in 2014 (see Energy Trends June 2014 special feature for details: www.gov.uk/government/statistics/energy-trends-june-2014. This change in methodology resulted in shifts in sectoral gas use going back to 2008. Notably, gas use was moved out of the industrial sector with a subsequent increase in the services sector.

Period covered

4.36 Figures generally relate to years ended 31 December. However, before 2004, data for natural gas for electricity generation relate to periods of 52 weeks.

Monthly and quarterly data

4.37 Monthly data on natural gas production and supply are available in Energy Trends Table 4.2, and a quarterly commodity balance is published in Energy Trends Table 4.1:
www.gov.uk/government/collections/gas-statistics

Statistical and metering differences

4.38 DUKES Table 4.3 shows production, transmission, and consumption figures for off and onshore natural gas. This departs from the standard balance methodology to maintain the link with historical and monthly data. This section of the technical notes illustrates how total gas consumption shown in Table 4.3 and Table 4.1 are mapped. Production includes waste and own use for drilling, production, and pumping operations, but excludes gas flared. Gas available in the UK excludes waste, own use for drilling etc., stock change, and net trade. Gas transmitted is after stock change, own use, and losses at inland terminals. The amount consumed in the UK differs from the total gas transmitted because of losses in transmission, differences in temperature and pressure between the points at which the gas is measured and delays in reading meters. The figures include an adjustment to the quantities billed to allow for the estimated consumption remaining unread at year end.

4.39 In Table 4.3 there are several headings that refer to statistical or metering differences. These arise because measurement of gas flows, in volume and energy terms, takes place at several points along the supply chain. The main sub-headings in the table represent the instances in the supply chain where accurate reports are made of the gas flows at that key point in the supply process. It is possible to derive alternative estimates of the flow of gas at any point by taking the estimate for the previous point in the supply chain and then applying the known losses and gains in the subsequent part of the supply chain. The differences seen when the actual reported flow of gas at any point and the derived estimate are compared and separately identified in the table wherever possible, under the headings statistical or metering differences.

4.40 Losses and metering differences attributable to the information provided on the upstream gas industry are zero from 2001 onwards because these data are no longer reported in the revised PPRS System. This simplified system for reporting the production of crude oil, NGLs and natural gas in the UK was implemented from 1 January 2001; it reduced the burden on the respondents and improved the quality of data reported on gas production.

4.41 The differences in the natural gas commodity balances arise from several factors:

- Limitations in the accuracy of meters used through the supply chain. While standards are in place, a degree of error is allowed which, with large flows, can become significant.
- Differences in the methods used to calculate the flow of gas in energy terms. For example, at the production end, rougher estimates of the calorific value of the gas produced are used which may be revised only periodically, rather than the more accurate and more frequent analyses carried out further down the supply chain. At the supply end, although the calorific value of gas shows day-to-day variations, for the purposes of recording the gas supplied to customers a single calorific value is used. Until 1997 this was the lowest of the range of calorific values for the actual gas being supplied within each LDZ, resulting in a "loss" of gas in energy terms. In 1997 there was a change to a "capped flow-weighted average" algorithm for calculating calorific values resulting in a reduction in the losses shown in the penultimate row of Table 4.3. This change in algorithm, along with improved meter validation and auditing procedures, also reduced the level of the "metering differences" row within the downstream part of Table 4.3.
- Differences in temperature and pressure at points at which gas is measured. Until February 1997 British Gas used "uncorrected therms" on their billing system for tariff customers when converting from volume to an energy measure. This made their supply figure too small by a factor of 2.2 per cent, equivalent to about 1 per cent of the wholesale market.
- Differences in the timing of reading meters. While National Transmission System meters are read daily, customers' meters are read less frequently and profiling is used to estimate consumption. Profiling will tend to underestimate consumption in a strongly rising market.
- Other losses from the system, for example theft through meter tampering by consumers.

4.42 The headings in Table 4.3 show where, in the various stages of the supply process, it has been possible to identify these metering differences as having an effect. Usually they are aggregated with other net losses as the two factors cannot be separated. Whilst the factors listed above can give rise to either losses or gains, losses are more common. However, the negative downstream gas metering difference within the transmission system in 2003 was an anomaly that was investigated by National Grid during 2004. They concluded that this unaccounted element of National Transmission System shrinkage was due to an exceptional run of monthly negative figures between February and June 2003 within what is usually a variable but mainly positive series. However, after a comprehensive investigation of this exceptional period no causal factors were identified. It is probable that the meter error or errors that caused this issue were corrected during the validation of metering.

4.43 Care should be exercised when interpreting the industrial subsector data. Companies switch contracts between gas suppliers, meaning it has not been possible to ensure consistent classification in industry sectors and across years. There are substantial estimates prior to 2013.

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Chapter 5
Electricity

Key points

- **In 2019, electricity consumption accounted for 17 per cent of the UK's final consumption.** This proportion has been relatively stable in recent years. (Table 1.1)

- **UK generation was 325 TWh in 2019, a decrease of 2.4 per cent compared to 2018** and the lowest value in more than twenty years. As well as lower demand, this was linked to higher net imports of electricity, up 11 per cent compared to 2018. (Table 5.1)

- **Total electricity demand was 346 TWh in 2019, 2.0 per cent lower than in 2018.** There were year on year decreases in electricity consumption for all sectors with consumption down 2.4 per cent for the industrial sector, down 1.2 per cent for the domestic sector and down 1.7 per cent for other final users (including commercial and transport use). (Table 5.1)

- **Fuel used for electricity generation totalled 59.9 Million tonnes of oil equivalent (Mtoe) in 2019. This was a decrease of 2.6 per cent compared to 2018** and the lowest value in more than twenty years. This partly reflects the lower electricity generation in 2019 as well as the shift in the generation mix to renewable alternatives. (Table 5.3)

- **The share of generation from fossil fuels fell to 43.1 per cent in 2019, with a record low share for coal of just 2.1 per cent of generation.** Gas's share of generation was slightly higher in 2019 at 40.6 per cent. The total generation from fossil fuels was 140 TWh, just over half the 276 TWh that was generated from fossil fuels in 2009. (Table 5.6)

- **Renewables' share of generation reached another record high in 2019 at 37.1 per cent. This is the first time they have accounted for more than one third of total generation.** This was driven by increased capacity, up 6.7 per cent in 2019 (de-rated to account for intermittency). Renewable generation in 2019 totalled 121 TWh, just 19 TWh lower than the total generation from fossil fuels. (Table 5.6)

- **Low carbon generation reached a record high share of 54.4 per cent in 2019, which was 1.8 pp higher than 2018.** The increase in low carbon share was not as large as the increase in renewable generation share because the nuclear share of generation fell, down to 17.3 per cent in 2019 as a result of outages and maintenance. (Table 5.6)

Introduction

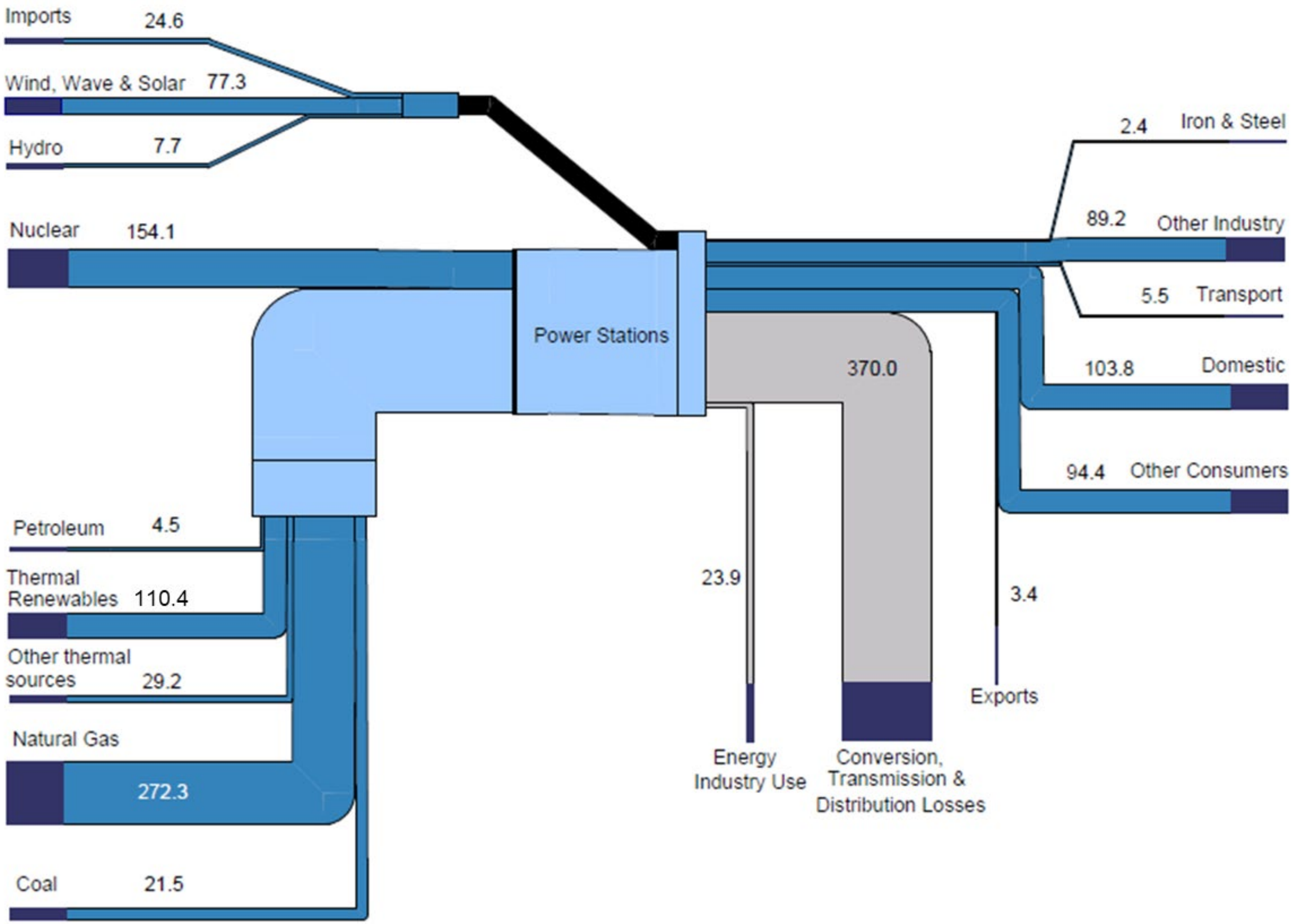
5.1 This chapter presents statistics on electricity from generation through to sales, and includes generating capacity, fuel used for generation, load factors and efficiencies. It also includes a map showing the electricity network in the United Kingdom and the location of the main power stations as at the end of May 2020. A **full list** of tables is available at the end of the chapter.

5.2 **In 2019, electricity consumption accounted for 17 per cent of the UK's final energy consumption[1].** This proportion has been relatively stable in recent years.

5.3 Below is an energy flow chart for 2019, showing the flows of electricity from fuel inputs through to consumption. It illustrates the flow of primary fuels used to produce electricity through to the final use of the electricity produced or imported as well as the energy lost in conversion, transmission and distribution. The widths of the bands are proportional to the size of the flows they represent.

[1] *See section 1.16 for details.*

Electricity flow chart 2019 (TWh)



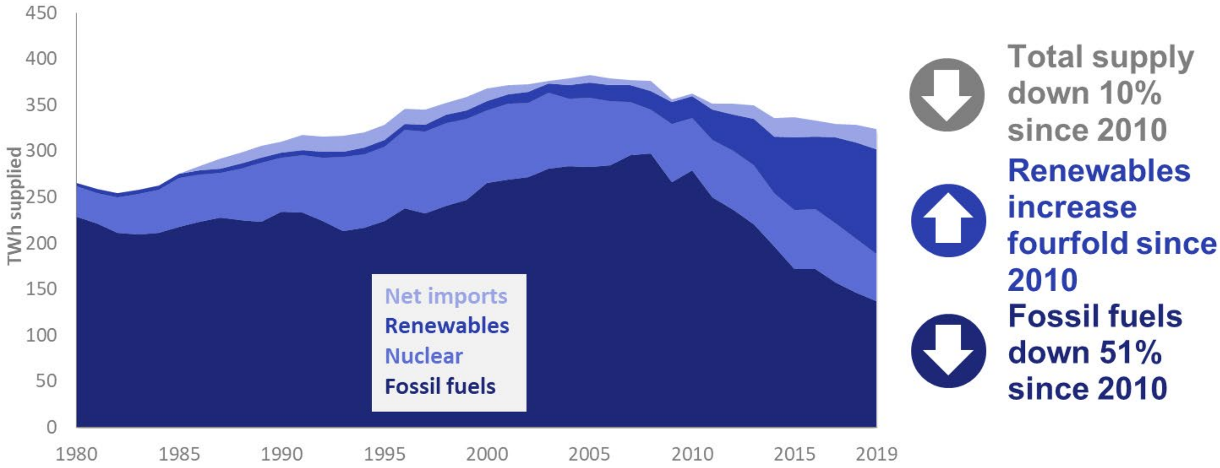
This flow chart is based on the data in Tables 5.1 (for imports, exports, use, losses and consumption) and 5.6 (fuel used).
1. Hydro includes generation from pumped storage while electricity used in pumping is included under Energy Industry Use.
2. Conversion, Transmission and Distribution Losses are calculated as fuel used (Table 5.6) minus generation (Table 5.6) plus losses (Table 5.1).

Electricity supply (Table 5.1)

5.4 Total UK electricity supply in 2019 was 346 TWh, down slightly from 352 TWh in 2018. UK generation (including pumped storage) accounted for 93.9 per cent of total supply, which was slightly lower than the proportion in 2018 (down 0.7 percentage points (pp)). UK generation was 325 TWh in 2019, a decrease of 2.4 per cent compared to 2018 and the lowest value in more than twenty years. Net imports (imports minus exports) were 21.2 TWh in 2019, accounting for 6.1 per cent of total supply.

5.5 Electricity supply is driven by demand, as it is generated or imported as needed[2]. In recent years, demand for electricity has decreased as energy efficiency measures have improved and increased in number. The total electricity demand comprises energy industry use, losses in transmission or distribution and final consumption by end users. Total electricity demand was 346 TWh in 2019, a decrease of 2.0 per cent compared to 2018. Final consumption is a substantial proportion of total demand and in 2019 accounted for 85.4 per cent. A summary of UK supply is provided in Chart 5.1.

Chart 5.1: Electricity supply, 1980 - 2019



5.6 The UK is a net importer of electricity and total net imports continued to increase in 2019, up 11 per cent compared to 2018. In 2019 imports increased to 24.6 TWh (+15 per cent) and exports increased to 3.4 TWh (up 52 per cent). This included the first year of operation for the GB-Belgium interconnector which began operating on 31st January 2019. Table 5A below summarises interconnector capacity, net imports and utilisation while chart 2 shows the interconnectors' trade flows.

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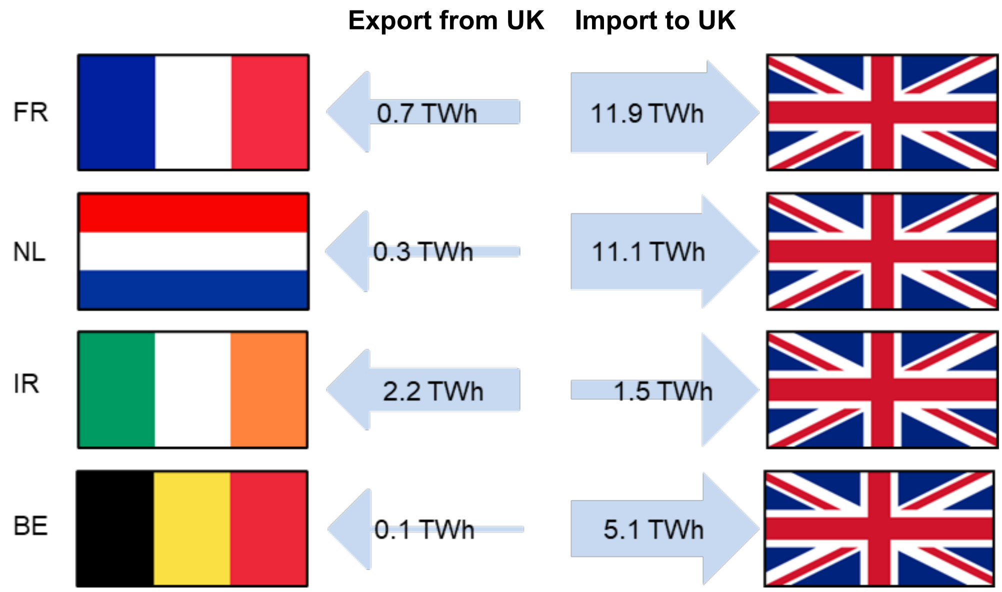
[2] *In the statistics there is a small difference between electricity supply and electricity demand due to different data collection methods. This is called the statistical difference. Further explanations of the statistical difference can be found in paragraphs 5.112 and in paragraph A.19 of DUKES Annex A.*

Table 5A: Net Imports via interconnectors 2017 to 2019

	France – GB[a]	Ireland – N. Ireland[b]	Nether-lands – GB[a]	Ireland – Wales[a]	Belgium - GB	Total
Capacity (MW)	2,000	540	1,000	500	1,000	5,040
Net Imports (GWh)						
2017	7,181	-110	6,858	831	0	14,760
2018	12,890	-471	6,185	504	0	19,108
2019	11,147	-825	5,695	180	4,973	21,170
Utilisation (%)[c]						
2017	67%	14%	83%	46%	0%	49%
2018	78%	26%	75%	47%	0%	53%
2019	72%	30%	73%	52%	59%	63%

a. Figures taken from the demand data available on the National Grid website at https://demandforecast.nationalgrid.com/efs_demand_forecast/faces/DataExplorer
b. Figures supplied by EirGrid
c. Utilisation is total imports and exports across the interconnector in the year divided by the total possible imports and exports.

Chart 5.2: Electricity imports and exports in 2019



5.7 For the French interconnector, net imports decreased 14 per cent in 2019 compared to 2018 to a total of 11.9 TWh. This was due to a 11 per cent decrease in imports and an 84 per cent increase in exports. The French interconnector had a utilisation of 72 per cent in 2019, which was 6 pp lower than in 2018.

5.8 For the interconnector with the Netherlands, the UK had net imports of 5.7 TWh in 2019, 7.9 per cent lower than in 2018. This was driven by a 5.4 per cent reduction in imports but a 71 per cent increase in exports, with utilisation down to 73 per cent.

5.9 For the Ireland-Wales interconnector, the UK remained a net importer in 2019, but net imports reduced by 64 per cent to 0.2 TWh. Imports decreased by 3.1 per cent compared to 2018 but exports increased 37 per cent. The interconnector's utilisation was slightly higher than in 2018 at 52 per cent.

5.10 The new interconnector with Belgium had net imports of 5.0 TWh, with a 59 per cent utilisation rate.

5.11 In contrast to the other interconnectors, the UK is a net exporter on the Ireland-Northern Ireland interconnector with net exports of 0.8 TWh. Imports decreased by 20 per cent while exports increased by 33 per cent, with the interconnector utilisation up 4 pp to 30 per cent.

Electricity demand and consumption (Table 5.1)

5.12 Total electricity demand in 2019 was lower than in 2018, down 2.0 per cent to 346 TWh. Most of this demand (295 TWh, 85.4 per cent) was from final consumption. The remaining demand was split between energy industry use (24 TWh, 6.9 per cent of demand) and losses (26 TWh, 7.6 per cent of demand).

5.13 Energy industry use decreased in 2019 to 24 TWh. Most of this demand was for electricity generation, which accounted for 62 per cent of energy industry use in 2019, a slightly higher share (up 2.0 pp) than in 2018. The lower demand for electricity generation included a substantial reduction in electricity demand for pumped storage, down 30 per cent compared to 2018. Pumped storage uses cheaper electricity to pump water to a higher reservoir. It can then be released later to generate electricity. Generation at pumped storage plants was substantially lower in 2019, reducing the amount of electricity used for pumping. There were also decreases in electricity demand for coke manufacture and for use in other fuel industries, in line with the changes in the fuel mix described in 5.32.

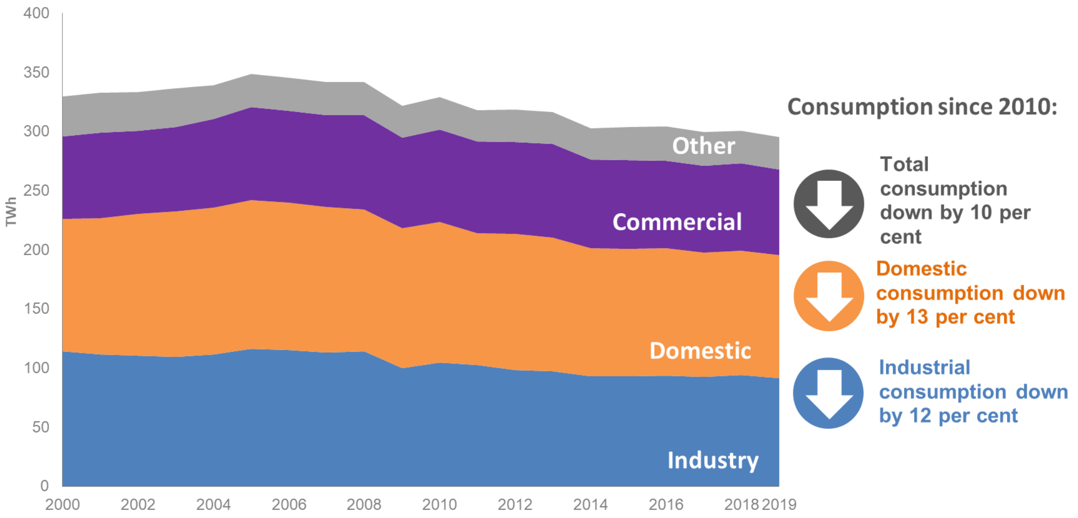
5.14 Losses decreased by 0.9 per cent in 2019 compared to 2018, to 26 TWh, in line with the lower generation. This was a 7.6 per cent share of the demand, similar (up 0.1 pp) to the share in 2018. Losses comprise three components[3]:

- Transmission losses (7.6 TWh) from the high voltage transmission system, which represented 29 per cent of the losses figure in 2019.
- Distribution losses (17.8 TWh), which occur between the gateways to the public supply system's network and the customers' meters accounted for 67 per cent of losses.
- Theft or meter fraud (just under 1.0 TWh) was 3.6 per cent of losses.

5.15 Final consumption by end users totalled 295 TWh in 2019, down 1.7 per cent compared to 2018. The breakdown across sector is shown in chart 5.3.

[3] *See paragraph 5.99 for further information on the calculation of losses.*

Chart 5.3: Final consumption of electricity by major sector, 2000-2019



5.16 There were year on year decreases in electricity consumption for all sectors in 2019 compared to 2018. Consumption was down 2.4 per cent for the industrial sector, down 1.2 per cent for the domestic sector and down 1.7 per cent for other final users (including the commercial sector and transport use).

5.17 Temperatures influence the actual level of electricity consumption, especially in the winter months as customers adjust heating levels in their homes and businesses. The average temperature in 2019 was similar to 2018 (down 0.1 degree) but this does not reflect the seasonal variations. In particular, 2019 had a much milder winter than 2018 which saw the 'Beast from the East' cold weather system. This milder weather reduced the demand for electricity in Quarter 1 of 2019, while the temperatures were relatively similar for the rest of the year and had more similar consumption patterns.

5.18 Domestic consumption decreased in 2019 compared to 2018, down 1.2 per cent for the full year to 104 TWh. Since the peak of domestic consumption in 2005 at 126 TWh, it has tended to decline each year. This has been linked to continuing energy efficiency improvements reducing demand. In 2019 there was a larger drop, as the milder winter led to a 6.6 per cent reduction in domestic consumption in the first quarter of 2019[4] while the remaining quarters were more similar in terms of temperature and electricity consumption patterns.

5.19 Industrial consumption was 92 TWh in 2019, a decrease of 2.4 per cent on 2018. This trend reflected lower productivity in the manufacturing sector, as measured by the Office for National Statistics Index of Production[5]. Since 2010, industrial consumption has declined 12 per cent, with year on year increases occurring in 2017 and 2018.

5.20 Commercial consumption totalled 72 TWh in 2019. This was a decrease of 2.1 per cent from 2018. As with the domestic consumption, this decrease is largely linked to changes in temperature, in particular the much milder temperatures in Quarter 1 of 2019.

5.21 Transport consumption increased to 5.5 TWh in 2019, up by 9.5 per cent compared to 2018. Rail accounted for 93.3 per cent of electricity consumption in the transport sector, with the remainder from road. Road consumption increased to 0.4 TWh in 2019, up by 52 per cent, which reflects the increased use of electric vehicles[6]. Despite the rise in electricity consumption for transport, oil remains the dominant fuel in this sector, with less than 1 per cent of UK energy demand for transport being met by electricity.

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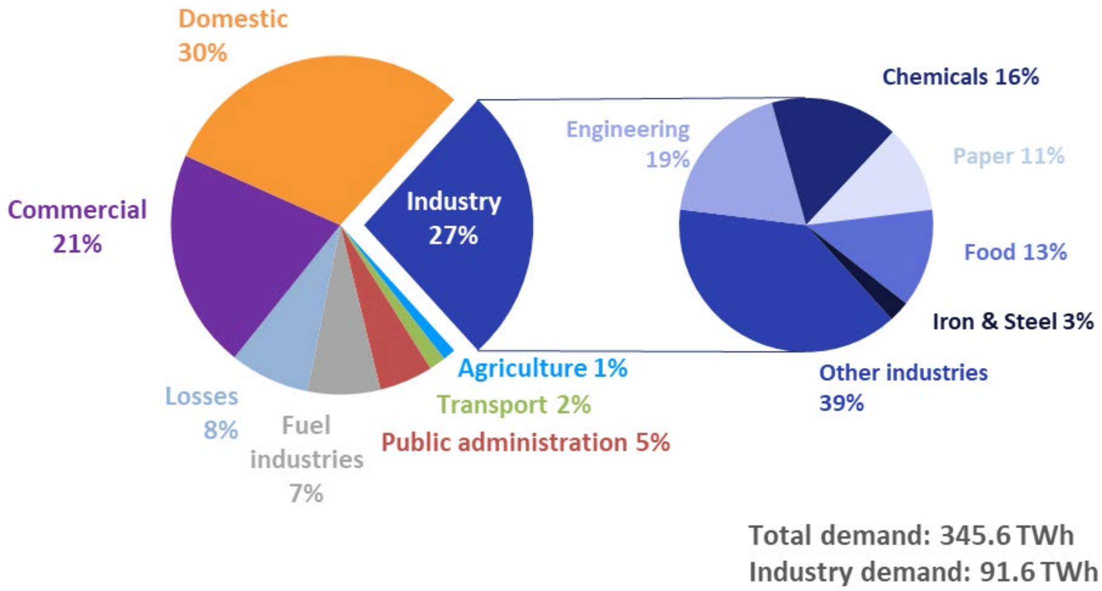
[4] *Quarterly data on electricity consumption is presented in Table 5.2 of Energy Trends:* *www.gov.uk/government/statistics/electricity-section-5-energy-trends*

[5] *Office for National Statistics (ONS) publishes the Index of Production available here:* *www.ons.gov.uk/economy/economicoutputandproductivity/output/bulletins/indexofproduction/previousReleases*

[6] *Department for Transport publish statistics on number of vehicles by propulsion type here:* *www.gov.uk/government/collections/vehicles-statistics*

Chart 5.4: Electricity demand by sector 2019



5.21 When total electricity demand is split by sector, domestic demand has the largest share at 30.0%, followed by industrial demand at 26.5%. Chart 5.4 shows the full breakdown of the proportions of total electricity demand accounted for by each sector, including a breakdown of the demand for different industries. Key figures are:

- Domestic demand: 30.0 per cent of total demand (up 0.3 pp since 2018).
- Industrial demand: 26.5 per cent of total demand (down 0.1 pp on 2018).
- Commercial demand: 21.0 per cent of total demand (unchanged from 2018).
- Energy industries demand (for generating electricity): 6.9 per cent of total demand (down 0.4 pp on 2018).

Electricity distributed via the public distribution system and for other generators (Table 5.2)

5.22 The majority of electricity in the UK is supplied by the public distribution system (PDS), which includes the interconnected high voltage transmission network and the lower voltage distribution network. In recent years, the proportion of electricity supplied from the PDS has reduced. In 2019, 316 TWh of UK electricity was supplied by the PDS, down 2.2 per cent on 2018. Most of the electricity supplied from the PDS comes from Major Power Producers[7] (MPPs), who supplied 267 TWh in 2019. The remainder comes from transfers from other generators[8] selling surplus electricity into the PDS as well as from net imports. The volume of electricity transferred to the PDS by other generators increased substantially in 2019, up 8 per cent to 25 TWh.

5.23 The proportion of electricity supplied by MPPs decreased in 2019, offset by increased generation from other generators as well as higher net imports. The volume of supply from MPPs was down by 4.1 per cent compared to 2018, to 267 TWh. However, electricity supplied from other generators increased by 8.0 per cent to 55.6 TWh, of which 46 per cent was transferred to the PDS.

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[7] *Further information on the definitions of MPPs and other generators can be found in paragraph 5.89.*

[8] *Other generators are businesses that generate their own electricity and may export surplus to the grid, and microgeneration by the domestic and commercial sectors. This includes autogenerators.*

Additionally, net imports increased by 10.8 per cent compared to 2018, to 21 TWh[9], ensuring that supply met demand.

5.24 Electricity supplied by other generators has increased year on year since 2012 and this has reduced the proportion of electricity supplied from the PDS. The proportion of electricity supplied by the PDS was 91.2 per cent in 2019, down 0.4 pp compared to 2018 and down 2.6 pp over the last 5 years. The increased supply from other generators has been driven by higher autogeneration and local generation, partly as result of small-scale renewable schemes such as Feed-in Tariffs (FiTs).

5.25 Other generators and autogenerators produce electricity as part of their manufacturing or other commercial activities, principally for their own use. Overall final electricity consumption by other generators was 7.4 per cent in 2019, up 0.2 pp compared to 2018 and up 2.3 pp over the last 5 years. Within this, there are different trends for the individual sectors outlined below.

5.26 While total energy industry use decreased in 2019 compared to the previous year[10], the energy industry use by other generators increased by 9.2 per cent to 8.4 TWh in 2019. This increased the proportion of energy industry use by other generators to 35.1 per cent (up 5.2 pp on 2018). Other generators' consumption was particularly high for petroleum refineries, where 73.4 per cent of consumption came from other generation.

5.27 Other generators and autogenerators produce electricity as part of their manufacturing or other commercial activities, principally for their own use[11]. In 2019, 10.9 per cent of industrial demand for electricity was met by other generation, a similar proportion to 2018 (up 0.2 pp). In the commercial sector, 9.3 per cent of demand was met by other generation in 2019, which was up 0.7 pp compared to 2018.

5.28 Domestic electricity generation and consumption by households with microgeneration units (such as solar photovoltaic panels) increased sharply since the launch of Feed In Tariffs in April 2010 in Great Britain; the scheme closed to new entrants at the end of March 2019.[12]. In 2019, the domestic sector consumed 1.7 TWh of self-generated electricity, an increase of 5.4 per cent on 2018. Despite the increase, self-generated electricity still accounts for only 1.6 per cent of domestic consumption.

Combined Heat and Power (CHP) plants

5.29 Combined Heat and Power (CHP) is the simultaneous generation of useable heat and power in a single process and is frequently referred to as cogeneration. A large proportion of CHP schemes in the UK are covered by the CHPQA programme and are covered in detail in Chapter 7, along with background information.

5.30 In 2019, CHP comprised 11.7 per cent of MPP's thermal electricity generation, and 62.2 per cent of thermal autogeneration. Table 5B summarises the quantity of CHP capacity and generation covered in Chapter 7 using statistics sourced from the CHPQA programme compared to other CHP plants not covered by the scheme.

9 For more information on net imports, imports and exports see paragraph 5.6.

10 For more information on Energy Industry use see paragraph 5.13.

11 See Table 5.4 for details of the fuels used by other generators to generate electricity and the quantities of electricity generated and consumed.

12 See Chapter 6 on renewables paragraph 6.70 for further information on FiTs uptake.

Table 5B: Combined Heat and Power (CHP) electricity generation and capacity in 2019, compared to UK generation and capacity

		Generation (GWh)	Capacity (MW)
Major Power Producers (Thermal)	CHPQA (ch 7)	7,436	1,990
	CHP (not included in ch 7)	16,517	2,349
	Other thermal generation	180,359	62,220
	Total MPP thermal generation	204,312	66,559
Autogenerators (Thermal)	CHPQA (ch 7)	16,025	4,060
	CHP (not included in ch7)	6,050	495
	Other thermal generation	13,416	6,808
	Total thermal autogeneration	35,491	11,363
Transfers		83,202	n/a
Total		323,005	77,922

Electricity fuel use, generation and supply (Tables 5.3 & 5.6)

5.31 Fuel used for electricity generation totalled 59.9 Million tonnes of oil equivalent (Mtoe) in 2019. This was a decrease of 2.6 per cent compared to 2018[13] and the lowest value in more than twenty years. This partly reflects the lower electricity generation in 2019 (down 2.4 per cent) but was largely due to the shift in the generation mix to renewable alternatives, as detailed in Chart 5.5 overleaf. For wind, hydro and solar, the fuel used is assumed the same as the electricity generated, unlike thermal generation where conversion losses are incurred[14].

5.32 For MPPs, fuel use decreased to 48.8 Mtoe in 2019, a decrease of 4.3 per cent on 2018 (table 5.3). This is in line with a 4.1 per cent reduction in MPP generation in 2019 compared to 2018, as detailed in Table 5.2. Fuel use by other generators increased by 5.2 per cent to 11.1 Mtoe in 2019. This was driven by a substantial increase in thermal renewable fuel used, up 7.5 per cent to 4.8 Mtoe.

5.33 The amount of fossil fuel used in electricity generation decreased by 9.1 per cent in 2019 compared to 2018 to a total of 25.7 Mtoe. Coal use decreased by 56 per cent in 2019 to reach a new record low level of 1.9 Mtoe. There was also a small decrease in the amount of gas used, down 0.4 per cent to 23.4 Mtoe, the lowest value for gas since 2015. The main driver for the shift in generation between coal and gas was an increase in the carbon price floor in April 2015, from £9 per tonne of CO_2 to £18 per tonne of CO_2. Since coal generation produces more than double the amount of carbon dioxide per GWh of electricity supplied than gas, this made generation from coal more expensive than gas. The shift away from coal generation also led to two more of the UK's coal generation plants closing in 2019, leaving only five coal-fired power stations in operation[15].

5.34 Bioenergy and other fuels were the only categories (apart from non-thermal renewables) where an increase in fuel use was seen between 2018 and 2019. In 2019, 9.5 Mtoe of bioenergy fuel was used, up 7.0 per cent since 2018. This is in line with increased capacity for bioenergy generation, as detailed in Paragraph 5.55. The use of other fuels also increased in 2019, up 10.0 per cent to 2.5 Mtoe in 2019. This includes the non-renewable component of waste.

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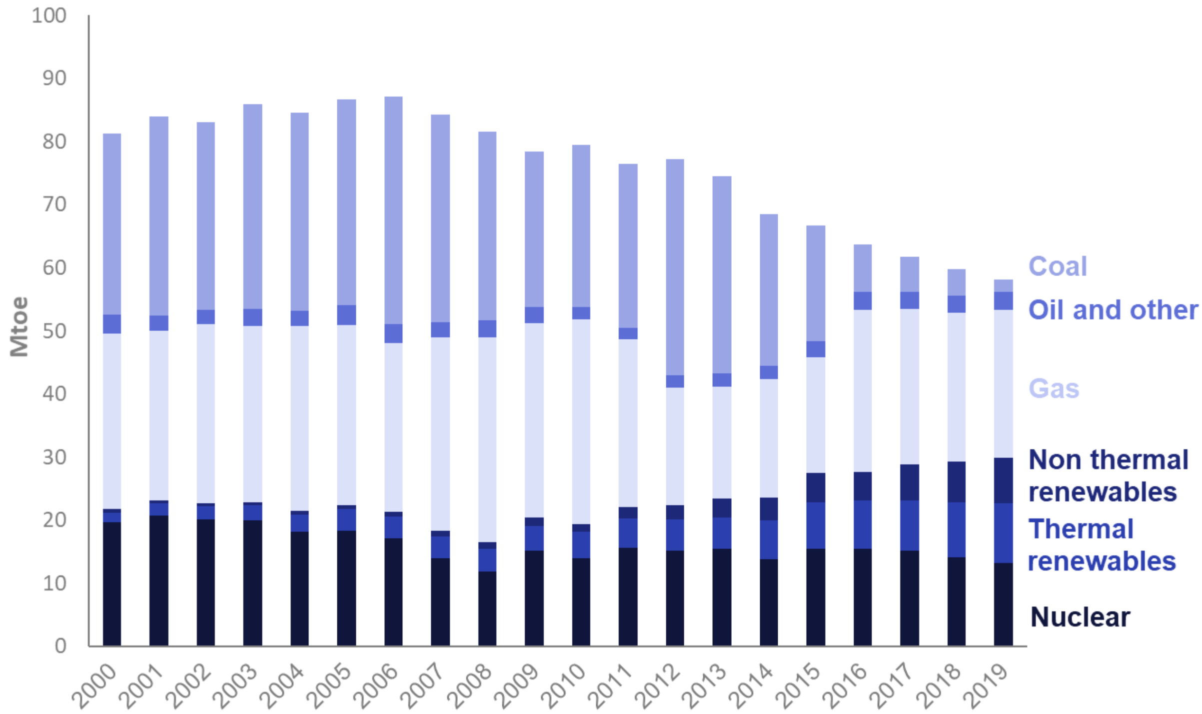
[13] A historical series of fuel used in generation on a consistent, energy supplied, fuel input basis is available at Table 5.1.1.

[14] As an example, this means that if one unit of electricity produced from coal is switched to wind, the fuel used will show a fall from around three units (as coal's thermal efficiency is around one-third) to one unit.

[15] See table 5C for details of power plant closures in 2019.

Chart 5.5: Fuel used in generation by all generators, 2000 - 2019



5.35 The overall trends in generation are similar to those seen in fuel use, with a big decrease in fossil fuel generation and substantial growth in renewable generation. Total electricity generated was 325 TWh in 2019, a decrease of 2.4 per cent compared to 2018. This included 1.8 TWh of pumped storage generation. MPPs accounted for 83 per cent of this generation in 2019, which was 1.7 pp lower than in 2018.

5.36 Fossil fuel generation totalled 140 TWh in 2019. This was down 6.3 per cent compared to 2018 and the lowest value in more than twenty years. Over the decade, fossil fuel generation almost halved from 276 TWh in 2009. Most of the decrease was in coal generation, which was 6.9 TWh in 2009 and saw a 59 per cent decrease compared to 2018. For comparison, coal generation was 103 TWh in 2009. Gas generation was similar in 2018 and 2019, up by 0.3 per cent.

5.37 The decline in fossil fuel generation was made possible by the substantial growth in renewable generation and this trend continued in 2019. Renewable generation[16] increased by 9.5 per cent in 2019 compared to the previous year to reach 121 TWh. This was just 19 TWh lower than the total generation from fossil fuels. There were increases in each category of renewables as detailed below.

5.38 Generation from wind and solar[17] sources increased by 11 per cent in 2019 compared to 2018 to 77 TWh. This was driven by increases in capacity for these sources, with wind capacity up 10.7 per cent) and solar capacity up 2.1 per cent[18]. The increased generation was despite average weather conditions being less favourable in 2019 compared to 2018, with average wind speeds down 0.3 knots and average daily sun hours down by 0.3. Average wind speeds were the lowest they had been since 2012[19], reflecting the importance of the increased capacity for wind generation.

5.39 Hydro natural flow generation increased by 9.0 per cent in 2019 compared to 2018, to 5.9 TWh. Capacity for hydro generation was unchanged over this time, but average rainfall was up 7.3 per cent, increasing the level of generation.

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[16] *Renewables include wind, natural flow hydro, solar, wave, tidal and bioenergy (including co-firing).*

[17] *Including generation from wave and tidal*

[18] *See 5.50 for more details on capacity.*

[19] *See Energy Trends tables 7.2 and 7.3 for details on weather conditions.*

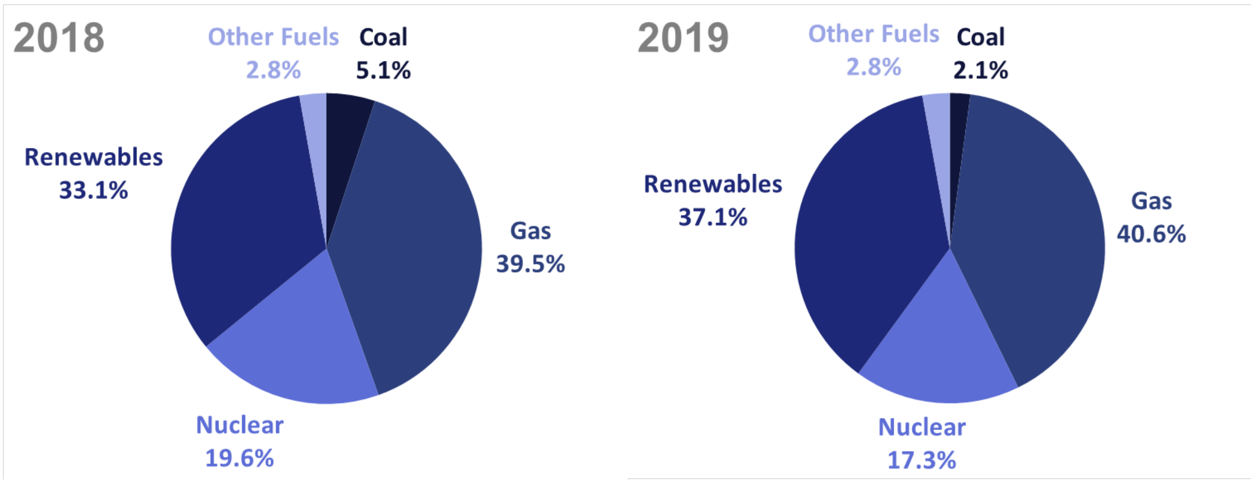
5.40 Thermal renewable generation[20], which covers bioenergy including biodegradable wastes, increased to 37 TWh in 2019, up 6.8 per cent on the previous year. This was partly attributable higher capacity for bioenergy generation, up by 4.7 per cent.

5.41 Nuclear generation fell 13.6 per cent to 56 TWh in 2019, which is the lowest level of nuclear generation since 2008. This was the result of a series of prolonged outages throughout the year which reduced the UK's operational nuclear capacity.

5.42 Not all electricity produced by generators is available for use by consumers, as power plants require a portion for their own works. In 2019, a total of 14.8 TWh was used on works, a 3.8 per cent decrease compared to 2018. The two largest decreases in use on works were for nuclear generators (down 14 per cent in line with the lower nuclear generation from nuclear) and a reduction of 30 per cent in the use of energy for pumped storage generation.

5.43 Subtracting the electricity used on works from the total generated gives the gross electricity supplied. In 2019 this totalled 310 TWh, down 2.3 per cent on 2018. When the electricity used in pumped storage generation is accounted for, the net electricity supplied in 2019 was 308 TWh.

Chart 5.6: Shares of electricity generation, by fuel[21]



5.44 The changes in generation in 2019 also led to changes in the shares of generation, as shown in Chart 5.6. These include a substantial decrease in the share of generation from fossil fuels and the renewable share of generation increasing to more than a third of the total.

5.45 The share of generation from fossil fuels fell to 43.1 per cent in 2019, down from 44.9 per cent in 2018, a difference of -1.8 pp. Most notably, coal's share of generation fell to 2.1 per cent in 2019, down 2.9 pp on the previous year to a record low share for coal. Gas's share of generation was slightly higher in 2019, up 1.1 pp to 40.6 per cent.

5.46 Renewables' share of generation reached another record high in 2019 at 37.1 per cent. This is the first time they have accounted for more than one third of total generation. The 2019 share was 4.0 pp higher than in 2018 and 30.4 pp higher than in 2009. This rise in renewables share was due to an increase in the share from wind and solar to 23.8 per cent (+2.9 pp on 2018) and an increased share for thermal renewables of 11.5 per cent (+1.0 pp on 2018) – both of these were record high levels. The share of generation from hydro natural flow has been relatively stable across the time series and was 1.8 per cent in 2019 (up 0.2 pp on 2018).

20 For consistency with the Renewables Chapter (Chapter 6), non-biodegradable wastes (previously included in thermal renewables / bio-energy) have been moved to the 'other fuels' category for 2007 onwards for autogeneration and for 2013 onwards for MPPs. Prior to this, they have remained in thermal renewables.

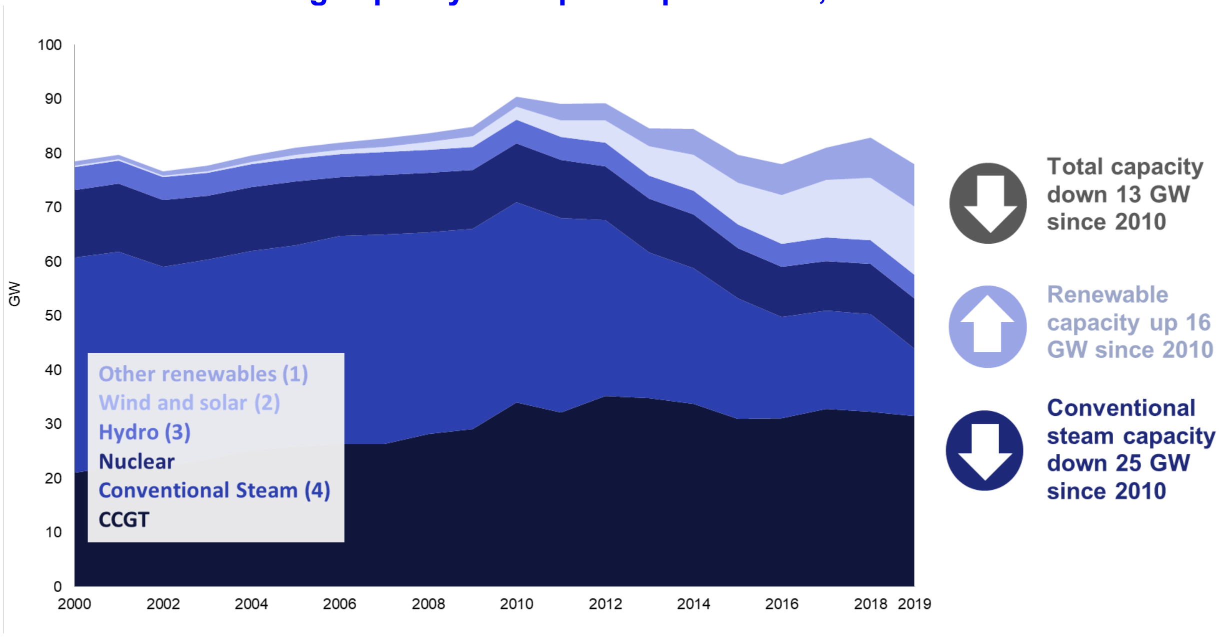
21 Further information on this and the alternative input basis of comparing fuel use can be found in paragraph 5.96.

5.47 Low carbon generation consists of renewable and nuclear generation and the rise in renewables share of generation also drove an increase in the share of generation from low carbon sources. Low carbon generation reached a record high share of 54.4 per cent in 2019, which was 1.8 pp higher than 2018. The increase in low carbon share was not as large as the increase in the share for renewable generation because the nuclear share of generation declined to 17.3 per cent in 2019, down 2.3 pp on 2018. This was the lowest share of generation from nuclear since 2010, primarily as a result of outages and maintenance.

Plant capacity (Tables 5.7, 5.8 and 5.9)

5.48 Electricity generation capacity is the maximum power available to the UK at any one time. Capacity is provided by MPPs[22] and other generators including non-MPP renewables. In this section, wind, small scale hydro and solar PV capacity is **de-rated** to account for intermittency, to enable direct comparison with conventional fuels which are less dependent on the weather (Table 5.7).

Chart 5.7: Generating capacity of all power producers, 2000-2019



1. *'Other renewables' includes bioenergy.*
2. *Wind included from 2007*
3. *'Hydro' includes natural flow and pumped storage.*
4. *'Conventional steam' includes a small proportion of non-CCGT plants, gas turbines and plants that can be fuelled by a combination of gas, coal and oil.*

5.49 Total capacity for all generators decreased to 77,920 MW in 2019. This was a decrease of 6.0 per cent on the 82,909 MW capacity in 2018. While there were increases in renewable capacity, this was more than offset by decreases in capacity for fossil fuel generation.

5.50 Total renewable capacity increased by 6.7 per cent in 2019 to reach 22,005 MW, though this has been de-rated to account for intermittency. This drove large increases in generation from renewable sources as detailed in paragraph 5.36. Renewable capacity accounted for more than a quarter of all generating capacity in 2019, 28.2 per cent, which was an increase of 3.4 pp compared to 2018. Capacity was stable or increased for all types of renewable generation, as detailed below.

5.51 Wind capacity (de-rated) increased to 10,361 MW, an increase of 11 per cent on 2018. This increased wind's share of capacity to 13.3 per cent in 2019 (up 2.0 pp).

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[22] *From 2006 onwards, MPP capacities are measured in Transmission Entry Capacity (TEC) terms, rather than Declared Net Capacity (DNC). The effect of this change has been to increase the capacity of MPPs by about 2,000 MW in total. A full definition of TEC and DNC is given in paragraph 5.100. Renewables installed capacity figures are given in table 6.4.*

5.52 Solar capacity (de-rated) increased in 2019 to 2,269 MW, up by 2.1 per cent compared to 2018. Overall, solar accounted for 2.9 per cent of generation capacity in 2019.

5.53 Capacity for hydro generation was unchanged in 2019, with natural flow hydro capacity at 1,619 MW (de-rated for small scale generation) and capacity for pumped storage generation at 2,744 MW. The capacity for pumped storage has not changed since 2007. Hydro capacity was 5.6 per cent of generation capacity in 2019.

5.54 Generation capacity of renewables other than hydro, wind and solar increased to 7,756 MW in 2019, up 4.4 per cent compared to 2018. This represented 10.0 per cent of total generation capacity in 2019, an increase of 1.0 pp. The majority of this was bioenergy capacity, with 22 MW of wave and tidal stream capacity.

5.55 Fossil fuel conventional steam capacity decreased by 34.8 per cent in 2019, to 10,216 MW. This represented 13.1 per cent of all generators' capacity in 2019, a decrease of 5.8 pp compared to 2018. Two large coal fired power stations closed in 2019, Aberthaw B (1,500 MW) and Cottam (2,000 MW). This decreased MPP conventional steam capacity, while there was a slight increase in capacity for other generators.

5.56 Combined Cycle Gas Turbine stations (CCGT) had a total capacity of 31,469 MW in 2019, a decrease of 2.5 per cent compared to 2018. This was linked to the closure of Deeside (500 MW) and Barry (235 MW of CCGT capacity). Despite the decrease, CCGT continued to account for 40.4 per cent of generation capacity in 2019. This was the largest share of generation capacity and was higher than the share in 2018 (up 1.5 pp).

Table 5C: Major Power Producers thermal capacity opened, closed, converted, increased or reduced (as at end of May 2020), since end-2010

Site	Fuel	Status	Previous Capacity (MW)	New Capacity (MW)	Year of closure/opening, capacity change or conversion
Langage	CCGT	Opened	0	905	2010
Severn Power	CCGT	Opened	0	850	2010
Staythorpe C	CCGT	Opened	0	1,752	2010
Barkip	Waste	Opened	0	3	2011
Blackburn	CCGT	Opened	0	60	2011
Fife	CCGT	Closed	123	0	2011
Grain CHP	CCGT	Opened	0	1,517	2011
Riverside	Waste	Opened	0	80	2011
Teesside	CCGT/OCGT[1]	Partially Closed	1,875	45	2011
Tilbury B	Coal	Converted	1,063	0	2011
Tilbury B	Biomass	Converted	0	750	2011
Derwent	CCGT	Mothballed	228	0	2012
Grain A	Oil	Closed	1,300	0	2012
Kingsnorth A	Coal/Oil	Closed	1,940	0	2012
Oldbury	Nuclear[2]	Closed*	434	0	2012
Pembroke B	CCGT	Opened	0	2,199	2012
Shotton	CCGT	Closed	210	0	2012
Wylfa (Reactor 2)	Nuclear[3]	Partially Closed	980	490	2012
Cockenzie	Coal	Closed	1,152	0	2013
Didcot A	Coal/Gas	Closed	1,958	0	2013
Drax	Coal[4]	Partially Converted	3,960	3,300	2013
Drax	Biomass[4]	Partially Converted	0	660	2013
Fawley	Oil	Closed	1,036	0	2013
Ironbridge	Coal[5]	Converted	1,000	0	2013
Ironbridge	Biomass[5]	Converted	0	370	2013
Keadby	CCGT	Mothballed	749	0	2013
Kings Lynn	CCGT	Mothballed	340	0	2013
Roosecote	CCGT	Closed*	229	0	2013
Teesside	OCGT[1]	Closed	45	0	2013
Tilbury B	Biomass	Closed*	750	0	2013
West Burton	CCGT	Opened	0	1,332	2013
Barking	CCGT	Closed	1,000	0	2014
Drax	Coal[4]	Partially Converted	3,300	2,640	2014
Drax	Biomass[4]	Partially Converted	660	1,320	2014
Ferrybridge C	Coal	Partially Closed	1,960	980	2014
Glanford Brigg	CCGT/OCGT[6]	Partially Closed	150	99	2014
Littlebrook D	Oil	Closed	1,370	0	2014
Markinch CHP	Biomass	Opened	0	60	2014
Runcorn	Waste	Opened	0	86	2014
Blackburn Meadows	Biomass	Opened	0	33	2015

Site	Fuel	Status	Previous Capacity (MW)	New Capacity (MW)	Year of closure/opening, capacity change or conversion
Drax	Coal[4]	Partially Converted	2,640	1,980	2015
Drax	Biomass[4]	Partially Converted	1,320	1,980	2015
Ferrybridge Multi-Fuel	Waste	Opened	0	79	2015
Ironbridge	Biomass[5]	Closed	370	0	2015
Lynemouth	Coal	Mothballed	420	0	2015
Wylfa (Reactor 1)	Nuclear[3]	Closed	490	0	2015
Carrington	CCGT	Opened	0	910	2016
Ferrybridge C	Coal	Closed	980	0	2016
Killingholme A and B	CCGT/OCGT[7]	Partially Closed	900	600	2016
Longannet	Coal	Closed	2,260	0	2016
Rugeley	Coal	Closed	448	0	2016
Wilton 11	Waste	Opened	0	55	2016
Uskmouth	Coal	Mothballed	220	0	2017
Ballylumford B	OCGT	Closed	540	0	2018
Deeside	CCGT	Closed	498	0	2018
Drax	Coal[4]	Converted	1,980	1,320	2018
Drax	Biomass[4]	Converted	1,980	2,640	2018
Eggborough	Coal	Closed	1,960	0	2018
Lynemouth	Biomass	Converted	0	420	2018
Peterborough	CCGT/OCGT[8]	Partially Closed	360	245	2018
Barry	CCGT/OCGT[9]	Closed	375	0	2019
Aberthaw B	Coal	Closed	1,559	0	2019
Five Oaks	Oil	Closed	9	0	2019
Cottam	Coal	Closed	2,000	0	2019
Knapton	CCGT[10]	Closed	42	0	2019
Ferrybridge Multi-Fuel 2	Waste	Opened	0	77	2019
Aberthaw GT	Oil	Closed	51	0	2020
Fiddler's Ferry	Coal	Closed	1,510	0	2020

* site was mothballed before closure

1. Reduced capacity from 1,875 MW (CCGT 1,830 MW / OCGT 45 MW) to 45 MW (OCGT) in 2011 before closing in 2013.
2. Reactor 2 with capacity of 217 MW closed on 30 June 2011, reactor 1 with capacity of 217 MW closed on 29 February 2012.
3. Reactor 2 closed on 30 April 2012, reactor 1 closed on 31 December 2015 (both with a capacity of 490 MW).

4. Partly converted to biomass. Two 660 MW units were converted to biomass, one in 2013 and 2014, before a third unit (also 660 MW) was converted to high-range co-firing (85% to <100% biomass) in 2015. A fourth unit (660 MW) was then converted in August 2018. Overall capacity remains at 3,960 MW (coal 1,320 MW, biomass 2,640 MW).

5. Converted from coal to dedicated biomass in 2013 (at 740 MW), before reducing to 370 MW in April 2014 after a fire at one of the biomass units.
6. Operated as a CCGT at 360 MW until 2018, but now operating as an OCGT (245 MW) with the steam side being decommissioned.
7. Operated as a CCGT until March 2018, before running as an OCGT for one year. The site was then closed in March 2019.
8. Operated as a CCGT at 360 MW until 2018, but has since operated as an OCGT at 245 MW, with the steam side being decommissioned.
9. Operated as a CCGT until March 2018, before running as an OCGT for one year. The site was then closed in March 2019.
10. Gas turbine on site sold. Currently no generating capacity

5.57 Since 2010, MPPs proportion of capacity has reduced from 92 per cent to 85 per cent in 2019. This declining trend is a result of MPP plant closures and a steady increase in small-scale renewable capacity from other generators.

5.58 The overall decrease in generation capacity was driven by a decrease in MPP capacity, down by 7.9 per cent in 2019 to a total of 66,559 MW. By contrast there was a 6.5 per cent increase in capacity for other generators, up to 11,361 MW in 2019. The overall capacity changes were driven by increased renewables capacity (up 7.4 per cent for MPPs and 5.3 per cent for other generators) offset by a decrease in MPP capacity for fossil fuel conventional steam generation, which was down 44 per cent compared to 2018.

5.59 MPP generating capacity in the UK decreased overall, with decreases for England and Wales (down 9.4 per cent) and for Northern Ireland (down 11.1 per cent) but an increase for Scotland (up 3.4 per cent. The changes in capacity have affected the breakdown of capacity between the countries of the UK, with the share for England and Wales down 1.4 pp and the share for Scotland up 1.5 pp. These changes are summarised in Table 5D below.

5.60 The countries' capacity changes were driven by the closure of fossil fuel plants and increases in renewable capacity. Coal fired conventional steam capacity in 2019 was down 45 per cent in England and Wales and down 34 per cent in Northern Ireland compared to 2018. Over the same time period, renewables capacity increased by 6.3 per cent in England and Wales, 5.7 per cent in Scotland and 9.8 per cent in Northern Ireland (Table 5.8).

Table 5D: MPP Capacity Summary, 2016 to 2019

	2016	2017	2018	2019	% Change 2019 vs 2018
Capacity (MW)[1]					
England and Wales	57,787	60,099	61,050	55,341	-9.4%
Scotland	7,880	8,372	8,779	9,074	3.4%
Northern Ireland	2,298	2,369	2,412	2,144	-11.1%
Total	**67,965**	**70,840**	**72,241**	**66,559**	-7.9%
Share (%)[2]					
England & Wales	85.0%	84.8%	84.5%	83.1%	-1.4%
Scotland	11.6%	11.8%	12.2%	13.6%	1.5%
Northern Ireland	3.4%	3.3%	3.3%	3.2%	-0.1%

[1] Capacity data for MPP by grid country is taken from Table 5.8

[2] Share is calculated as the country's capacity divided by the total capacity

5.61 The capacity of other generators (non MPPs) increased by 6.5 per cent in 2019, to 11,361 MW. This was driven by increases in capacity for generation in the chemicals, paper, printing and publishing and other industrial sectors. Decreases were seen for the generation capacity for oil and gas terminals, oil refineries (down 5.6 per cent) and for the iron and steel sector (down 0.9 per cent). Table 5.9 gives a full breakdown of the generating capacity for generators other than MPPs according to the industrial classification of the generator[23].

[23] *For CHP, schemes are classified according to the sector that receives most of the heat (as opposed to the sector in which the CHP operator was considered to operate.*

Plant loads, demand and efficiency for MPPs (Table 5.10)

5.62 Looking at the maximum load (demand) on the electricity grid compares winter periods rather than calendar years[24]. The maximum load (demand) in the UK during the winter of 2019/20 was 48,230 MW, which occurred on 20th November 2019, in the half-hour ending 17:30. This was 3.8 per cent higher than the maximum seen in the previous winter, which occurred on 23rd January 2019. In Great Britain the maximum demand at this time was 46,802 MW, which was 4.1 per cent lower than the maximum the previous winter. For Northern Ireland, the simultaneous maximum load at this time was 1,428 MW, which was 11.3 per cent lower than the previous year.

5.63 For the 2019/20 winter, the maximum demand was 72.5 per cent of the UK MPP capacity[25], which was 1.4 pp lower than in 2018/19. For Great Britain the maximum demand met was 72.7 per cent of MPP capacity, an increase of 2.8 pp compared to 2018. The increased percentage of capacity is driven by a decrease in MPP capacity in Great Britain, as the maximum load was lower than in 2018/19. In Northern Ireland, the maximum demand met was 66.6 per cent of MPP capacity, a decrease of 0.2 pp compared to 2018/19. These percentages do not include the capacities available via the interconnectors with neighbouring grid systems nor demand for electricity via these interconnectors.

5.64 As Northern Ireland operates from a separate electricity grid to Great Britain, its own maximum load occurred at a different time, on 2nd December 2019 in the half-hour ending at 17:30. The load was 1,560 MW[26], which was 7.6 per cent lower than the previous winter.

5.65 Plant load factors[27] measure how intensively each type of plant has been used, with a higher value demonstrating a higher intensity of use. For all plants in 2019, the load factor was 35.4 per cent, a decrease of 3.3 pp compared to 2018. While nuclear plants continued to have the highest plant load factor at 62.9 per cent in 2019, this was 9.9 pp lower than in 2018 because of the reduction in supply because of plant outages. The reduced supply of electricity from coal in 2019 resulted in a coal-fired power station load factor of 7.8 per cent, which was 6.4 pp lower than in 2018. This is a new low for coal-fired stations. Load factors for natural flow hydro and wind (as well as other renewables) can be found in table 6.5[28], with a summary of the trends on an unchanged configuration basis[29] provided below.

5.66 In 2019, the overall wind load factor was 32.0 per cent, an increase of 0.6 pp on 2018. When split by type of wind generation, the load factor for onshore wind was 26.6 per cent (up 0.2 pp) while the load factor for offshore wind was 40.4 per cent, up 0.3 pp compared to 2019. These increases came despite lower average wind speeds. The solar photovoltaic load factor was stable in 2019 at 11.2 per cent (down 0.1 pp) in line with slightly lower average sun hours. There was an increase in the hydro load factor in 2019, up by 3.0 pp compared to 2018 to 36.2 per cent. This was linked to an increase in rainfall in 2019.

5.67 Thermal efficiency measures the efficiency with which the heat energy in fuel is converted into electrical energy. The efficiencies presented here are calculated using gross calorific values to obtain the energy content of the fuel inputs[30]. The largest change in efficiency was for nuclear generation, which has generally remained between 38 and 40 per cent over the last decade, but was 36.5 per cent

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[24] Maximum demand figures cover the winter period ending the following March. With the advent of the British Electricity Trading and Transmission Arrangements (BETTA) (see paragraph 5.78), England, Wales and Scotland are covered by a single network and a single maximum load is shown for Great Britain for 2006 to 2016.

[25] The MPP capacity is 66.559 MW, as measured at the end of December 2019. It is taken from Table 5.7.

[26] Data supplied by EirGrid.

[27] The plant load factors for All plants and Conventional Thermal and other stations contain revisions back to 2010, ensuring that both the capacity and supply values are for MPPs only.

[28] The load factors presented in table 5.10 use transmission entry capacity (as presented in table 5.7). For hydro and wind, this has been de-rated for intermittency, so is not suitable for calculating load factors. The installed capacity measure used in Chapter 6 has not been de-rated and are used in Table 6.5.

[29] For renewables load factors, including the unchanged configuration and standard (average beginning and end of year) measures, see table 6.5.

[30] For more information on gross and net calorific values, see paragraph 5.103.

in 2019, a decrease of 3.3 pp. This may be linked to lower efficiency from more frequent outages. Gas efficiency for CCGT generators remained consistent in 2019 at 48.8 per cent (-0.2pp on 2018) while coal generators saw a decrease in efficiency of 2.2pp to 31.9 per cent.

Power stations in the United Kingdom (Tables 5.11 and 5.12)

5.68 **The total installed capacity of major UK power stations was 80,374 MW**[31] at the end of May 2020. Table 5.11 is a database of UK capacity with details of these Major Power Producers (MPPs) as well as the four interconnectors allowing trade with Europe, and an aggregate of other generating stations showing renewable sources and smaller (<1 MW) Combined Heat and Power (CHP) plants. Table 7.10 shows CHP schemes of 1 MW and over for which the information is publicly available. Total power output of these stations is given (electricity plus heat), not just that which is classed as good quality CHP under the CHP Quality Assurance programme (CHPQA, see Chapter 7), since CHPQA information for individual sites is not publicly available.

5.69 Table 5.12 shows capacity of the transmission and distribution networks for Great Britain, Northern Ireland and the UK as a whole. The UK transmission network connected capacity reduced each year from 2012 to 2015 due to closures and conversions of coal, oil and gas plants but has remained relatively consistent since then. Across the UK in 2019, transmission capacity was 70,809 MW, a decrease of 2.4 per cent on 2018.

5.70 Since 2011 the distribution network capacity increased annually, mainly as a result of increased embedded renewable generation being installed. In 2019 the UK distribution network capacity totalled 32,875 MW, which was an increase of 3.6 per cent compared to 2018. In 5 years, the distribution network capacity has increased substantially, up by 54 per cent.

5.71 The biggest changes in transmission capacity were for coal (down 31 per cent) and OCGT (down 18 per cent), alongside a substantial increase for offshore wind capacity, up 21 per cent. This is in line with the plant closures for coal and OGCT presented in Table 5C. For the distribution network, there were large increases in offshore wind capacity (up 22 per cent), OCGT capacity (up 18 per cent) and other fuels capacity (up 17 per cent), with a 14 per cent decrease in oil generation capacity.

5.72 In 2019 the total installed capacity (for both transmission and distribution networks) for the UK was 104 GW, slightly lower than in 2018 (down 0.6 per cent). Of the total UK capacity, 96.3 per cent of the UK's capacity was connected in Great Britain and 3.7 per cent in Northern Ireland. For Great Britain, it is estimated that 69 GW was connected to the transmission network, equivalent to 66.2 per cent of the Great Britain total capacity. From the Northern Ireland total capacity (3.8 GW), 56.7 per cent was estimated as connected to the transmission network.

Carbon dioxide emissions from power stations

5.73 **It is estimated that carbon dioxide emissions from power stations accounted for 16.3 per cent of the UK's total carbon dioxide emissions in 2019**. The overall emissions per GWh of electricity generated decreased in 2019 as the mix of fuels used changed, moving away from coal-fired generation and generating more from gas and renewable sources.

5.74 Emissions vary by type of fuel used to generate the electricity and emissions estimates per unit of electricity generation for 2017 to 2019 are shown in Table 5E below.

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[31] The total installed capacity for stations listed in table 5.11 differs from the total in table 5.7, as the latter is on a Transmission Entry Capacity basis and taken as at the end of 2019. See paragraph 5.101 for more information on the measures of capacity.

Table 5E: Estimated carbon dioxide emissions per GWh of electricity supplied 2017 to 2019 [1,2]

Fuel	Emissions (tonnes of carbon dioxide per GWh electricity supplied)		
	2017	2018	2019[3]
Coal	918	921	985
Gas	380	377	371
All fossil fuels	488	480	446
All fuels (including nuclear and renewables)	239	222	198

1 The carbon intensity figures presented in Table 5E are different to those produced for the Greenhouse Gas Inventory (GHGI). The differences arise because of methodology differences, including geographical coverage and treatment of auto generators but are principally due to the GHGI presenting figures based on a 5-year rolling average whereas those in Table 5E are presented as single year figures.

2. The numerator includes emissions from power stations, with an estimate added for auto-generation. The denominator (electricity supplied by all generators) used in these calculations can be found in table 5.6, with the figure for All fuels in 2019 being 309,927 GWh.

3. The 2019 emissions figures are provisional.

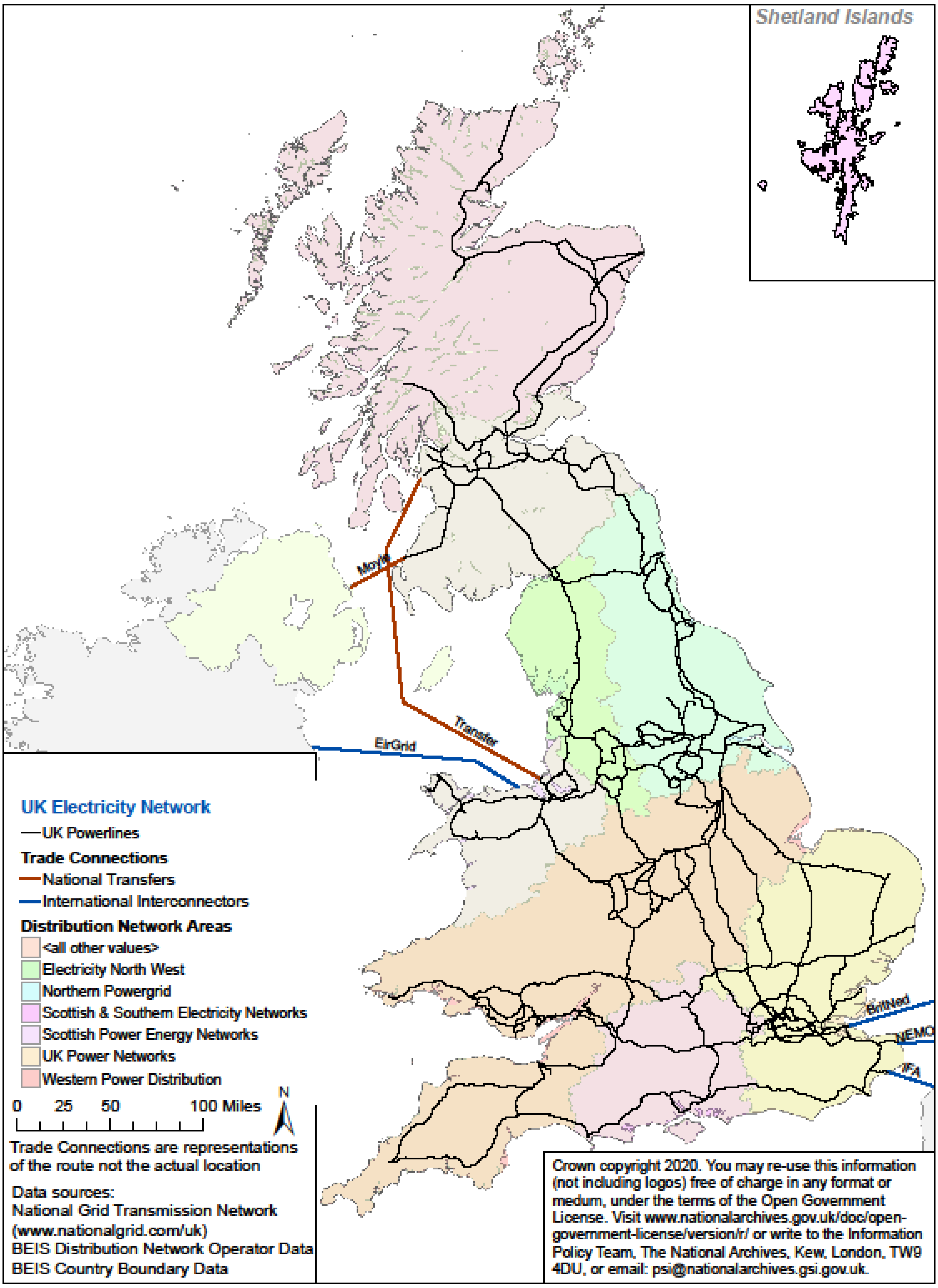
Sub-national electricity data

5.75 The collection of data relating to regional and local consumption of electricity began in 2004. For details of the availability of local level electricity (and gas) data see Chapter 4, paragraph 4.17 and the sub-national electricity statistics pages on the BEIS section of the GOV.UK website at: www.gov.uk/government/collections/sub-national-electricity-consumption-data. Data repeated here in previous editions of this publication as Table 5E are available via that link. The regional data will not sum exactly to the figures given in table 5.4 as the regional data are not based exactly on a calendar year and are obtained via different data sources.

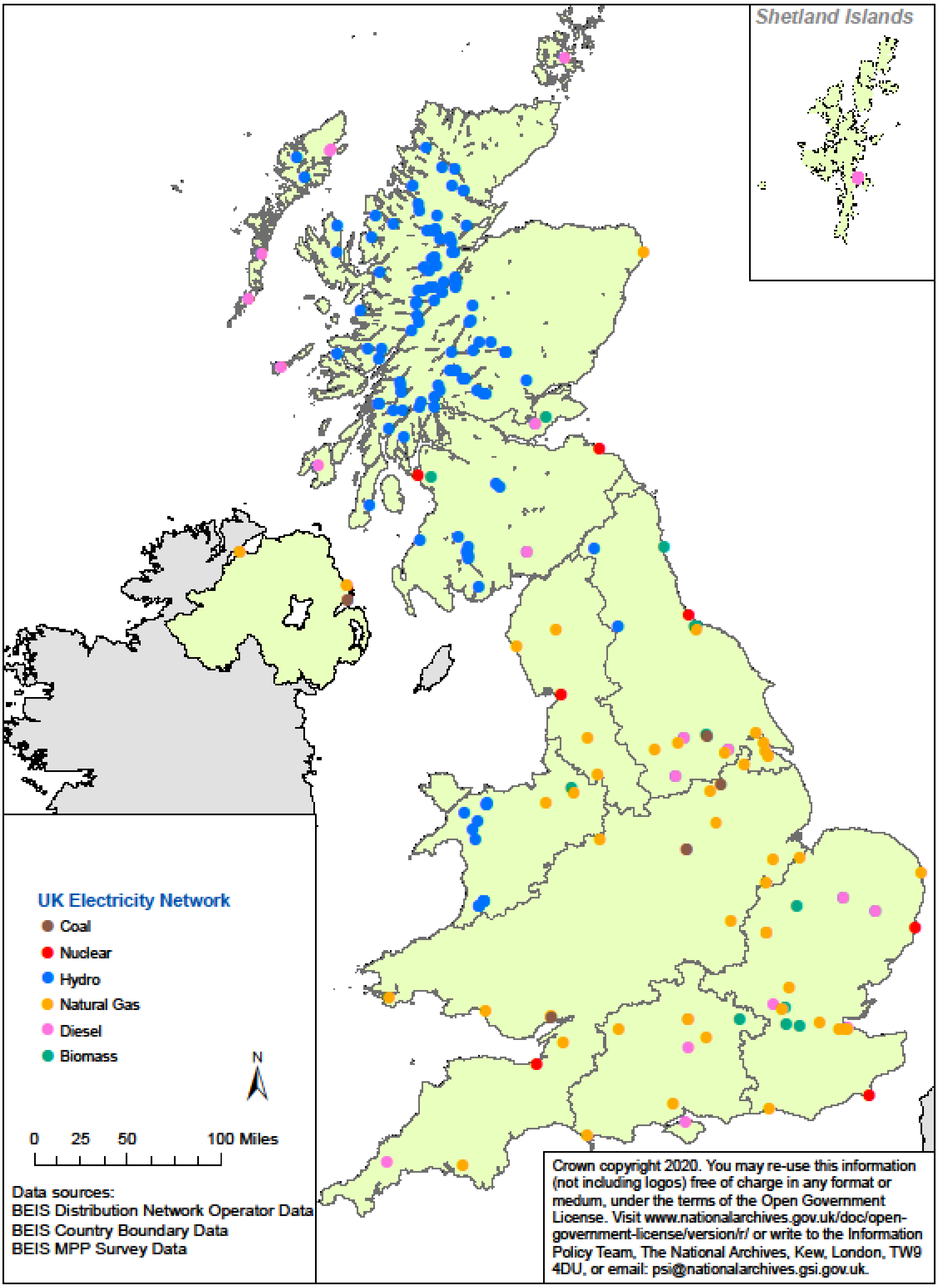
Electricity price and market penetration

5.76 Electricity price and market penetration data are published by BEIS in the Quarterly Energy Prices publication, available at: www.gov.uk/government/statistical-data-sets/quarterly-domestic-energy-price-statistics. Data on Domestic electricity market penetration, repeated here in previous editions of this publication as Table 5F, are available in table 2.4.1 of Quarterly Energy Prices.

UK Distribution Network Operating Areas and GB Power Lines Map
Major Power Producers in the UK (operational May 2020)



Major Power Producers in the UK (operational May 2019)



List of DUKES electricity tables

Table	Description	Period
5.1	Commodity balances for UK electricity	1998-2019
5.2	Commodity balances for electricity (separates out the *public* distribution system for electricity from the electricity generated and consumed by *autogenerators*)	1998-2019
5.3	Fuels used to generate electricity in the UK (by MPP/other and fuel)	1996-2019
5.4	Fuels consumed for electricity generation (autogeneration) by main industrial groups	1996-2019
5.5	Electricity supply, consumption and sales (links between DUKES tables and long-term trends data)	1996-2019
5.6	Electricity fuel use, generation and supply (by MPP/other and fuel type)	1996-2019
5.7	Plant capacity (MPPs, other and all, by type)	1996-2019
5.8	Major Power Producers Plant capacity (by region & type)	1999-2019
5.9	Capacity of other generators (by sector)	1996-2019
5.10	Plant loads, demand and efficiency	1996-2019
5.11	List of major power producers (power stations) in operation	May 2020
5.12	Plant installed capacity, by connection (GB, NI, by plant type)	2011-2019
	Long term trends commentary and tables on fuel use, generation, supply and consumption back to 1970 can be found on BEIS section of the GOV.UK website, at: www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes	1970-2019

Structure of the UK electricity industry

5.77 Up to March 2005 the electricity industries of Scotland, Northern Ireland and England and Wales operated independently although interconnectors joined all three grid systems together. From April 2005, under the British Electricity Trading and Transmission Arrangements (BETTA) introduced in the Energy Act 2004, the electricity systems of England and Wales and Scotland have been integrated. The paragraphs below describe the position up to March 2005 but indicate the further changes that have been made under BETTA.

5.78 From the period immediately after privatisation of the industry in 1990, when there were seven generating companies in England and Wales and 12 Regional Electricity Companies distributing and supplying electricity to customers in their designated area, there were many structural and business changes and residual flotations. Competition developed in mainland Britain as follows:

(a) From 1 April 1990, customers with peak loads of more than 1 MW (about 45 per cent of the non-domestic market) were able to choose their supplier;

(b) From 1 April 1994, customers with peak loads of more than 100 kW were able to choose their supplier;

(c) Between September 1998 and May 1999, the remaining part of the electricity market (i.e. below 100 kW peak load) was opened up to competition.

5.79 Since the late 1990s, there have been commercial moves toward vertical re-integration between generating, electricity distribution and/or electricity supply businesses. Those mergers that have taken place were approved by the relevant competition authority. Initially the National Grid Company was owned by the 12 privatised regional electricity companies but was floated on the Stock Exchange in 1995. National Grid (and its predecessors since 1990) has owned and operated the high voltage transmission system in England and Wales linking generators to distributors and some large customers. The transmission system is linked to continental Europe via an interconnector to France under the English Channel, and since 1 April 2011, to the Netherlands under the North Sea (see Table 5.10). Up to March 2005, the Scottish transmission system was regarded as being linked to that in England and Wales by two interconnectors but under BETTA National Grid also took on responsibility for operating the system in Scotland, to form a single Great Britain transmission network.

5.80 In Scotland, 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.

5.81 The electricity supply industry in Northern Ireland has been in private ownership since 1993 with Northern Ireland Electricity plc (NIE) (part of the Viridian Group) responsible for power procurement, transmission, distribution and supply in the Province. Generation is provided by three private sector companies who own the four major power stations. 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. In July 2012, an interconnector between the Irish Republic and Wales began operations.

5.82 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. These arrangements were based on bi-lateral trading between generators, suppliers, traders and customers. They were designed to be more efficient and provide greater choice for market participants, whilst maintaining the operation of a secure and reliable electricity system. The system included forwards and futures markets, a balancing mechanism to enable National Grid, as system operator, to balance the system, and a settlement process. In April 2005 this system was extended to Scotland under BETTA.

Technical notes and definitions

5.83 These notes and definitions are in addition to the technical notes and definitions covering all fuels and energy as a whole in Chapter 1. For notes on the commodity balances and definitions of the terms used in the row headings see Annex A, paragraphs A.7 to A.42. While the data written version of this Digest cover only the most recent years, these notes also cover data for earlier years that are available on the BEIS energy statistics website.

Electricity generation from renewable sources

5.84 Figures on electricity generation from renewable energy sources are included in the tables in this section. Further detailed information on renewable energy sources is included in Chapter 6.

Combined heat and power

5.85 Electricity generated from combined heat and power (CHP) schemes, CHP generating capacities and fuel used for electricity generation are included in the tables in this chapter. However, more detailed analyses of CHP schemes are set out in Chapter 7.

Generating companies

5.86 Following the restructuring of the electricity supply industry in 1990, the term "Major generating companies" was introduced into the electricity tables to describe the activities of the former nationalised industries and distinguish them from those of autogenerators and new independent companies set up to generate electricity. The activities of the autogenerators and the independent companies were classified under the heading "Other generating companies". In the 1994 Digest, a new terminology was adopted to encompass the new independent producers, who were then beginning to make a significant contribution to electricity supply. Under this terminology, all companies whose prime purpose is the generation of electricity are included under the heading "Major power producers" (or MPPs). The term "Other generators" ("Autogenerators" in the balance tables) is restricted to companies who produce electricity as part of their manufacturing or other commercial activities, but whose main business is not electricity generation. "Other generators" also covers generation by energy services companies at power stations on an industrial or commercial site where the main purpose is the supply of electricity to that site, even if the energy service company is a subsidiary of a MPP. Additionally (and particularly since 2010), this category includes generation from the domestic sector.

5.87 The definition of MPPs was amended in 2008 to include major wind farm companies, but this change only applies to data for 2007 onwards. Many generators of electricity from renewable sources (apart from large scale hydro, large scale wind, large scale solar and some biofuels) are also included as "Other generators" because of their comparatively small size, even though their main activity is electricity generation.

5.88 Major wind farm operators have been included under MPPs, for 2007 onwards, in the monthly, quarterly, and annual tables of electricity statistics produced by BEIS. Until then, all generation using wind turbines was excluded from the MPP classification. This was because originally such generation was by small independent companies and collecting data on a monthly basis was prohibitively costly and unnecessarily burdensome on such companies. Similarly, major solar site operators were included as MPPs for the first time in 2015.

5.89 Generation from wind has now become more concentrated in the hands of larger companies and BEIS has extended its system of monthly data collection to cover the largest wind power companies and, from 2015, solar. The intention is that, in future, any company whose wind generation capacity increases to above 50 MW will be asked to provide monthly data for generation from wind and thus be included in the list of MPPs. The inclusion of major wind farm and solar site operators under MPPs affects the majority of the electricity tables in DUKES, with figures for MPPs and the public distribution system increased, and other generators reduced.

5.90 **Major power producers at the end of 2019 were[32]:**

AES Ballylumford Ltd†*, AES Kilroot Power Ltd, Anesco Ltd, Baglan Generating Ltd†, Banks Renewables Limited, BayWa R.E Ltd, Black Hill Wind Ltd, British Energy Generation Ltd (Eng & Wales), British Solar Renewables Ltd, Calon Energy Ltd†, Carrington Power Ltd, Centrica Barry Ltd, Centrica Brigg Ltd, Coolkeeragh ESB Ltd, Corby Power Ltd, Coryton Energy Company Ltd, Cubico Sustainable Investments Ltd, Drax Power Ltd†, E.ON UK plc, Ecotricity Ltd, EDF Energy (Cottam Power) Ltd†*, EDF Energy Renewables Ltd, Eneco Wind UK Ltd*, EP Langage Ltd†*, EP SHB Ltd, EPR Ely Ltd, EPR Eye Ltd, EPR Glanford Ltd, EPR Scotland Ltd, EPR Thetford Ltd, Falck Renewables Wind Ltd, Fellside Heat and Power Ltd*, Ferrybridge Mulitfuel Energy Ltd, First Hydro Company, Fred Olsen Renewables Ltd, FS Shotwick Ltd*, GLID Wind Farms Topco†, Greencoat Solar I LLP*, Greencoat UK Wind Plc†*, Indian Queens Power Ltd*, John Laing Environmental Assets Group, Kentish Flats Ltd, Lightsource Renewable Energy Ltd†*, Londonwaste Ltd†, Lynemouth Power Ltd, Magnox Electric Ltd, Marchwood Power Ltd, Octopus Investments Ltd, Orsted Burbo (UK) Ltd†, Peel Energy Ltd*, Pennant Walters Ltd*, Peterborough Power Ltd†, REG Windpower Ltd, Renewable Energy Solutions Services Ltd†*, Renewable Energy Systems (Aviva)†, Renewable Energy Systems (OI)*, Renewable Energy Systems (Penmanshiel)*, Renewable Energy Systems (TRIG)*, Renewable Energy Systems Limited (Glenmont)†*, Riverside Resource Recovery Ltd*, Rocksavage Power Company Ltd, RWE Npower (Kielder), RWE Npower Ltd, RWE Npower Renewables Ltd, RWE Npower Renewables Ltd (Offshore)*, RWE Renewables*, Saltend Cogeneration Company Ltd*, Scira Offshore Energy Ltd, Scotia Wind (Craigengelt) Ltd*, Scottish & Southern Energy plc†*, Scottish & Southern Energy Plc (Fiddlers Ferry)†*, Scottish & Southern Energy Plc (Medway and Keadby), Scottish & Southern Energy plc (Networks), Scottish Power Renewables UK Ltd, Seabank Power Ltd*, SembCorp Utilities (UK) Ltd, SembCorp Utilities (UK) Ltd (Wilton 10), Severn Power Ltd, SIMEC Uskmouth Power Ltd, Slough Heat and Power Ltd, South East London Combined Heat and Power Ltd, Spalding Energy Company Ltd, Statkraft Energy Ltd, Statkraft Wind UK Ltd, SUEZ Recycling and

32 ** company reports wind generation and † company reports solar generation*

Recovery (UK) Ltd (Wilton 11)*, Temporis Capital Ltd, Third Energy UK Gas Ltd, Toucan Energy Services Ltd, Uniper UK Ltd†, Ventient Energy Services Ltd, Viridor Waste Management Ltd*, VPI Immingham LLP, Wadlow Energy Ltd, Willmount Ltd,Wise Energy Ltd and WPO UK Services Ltd†.

5.91 **Major wind farm companies were added to the list of MPPs in 2007. At the end of 2019 these comprised:**

Banks Renewables Limited, BayWa R.E Ltd, Black Hill Wind Ltd, Ecotricity Ltd, EDF Energy Renewables Ltd, Eneco Wind UK Ltd, Falck Renewables Wind Ltd, Fred Olsen Renewables Ltd, GLID Wind Farms Topco, Greencoat Solar I LLP, Greencoat UK Wind Plc, John Laing Environmental Assets Group, Kentish Flats Ltd, Orsted Burbo (UK) Ltd, Peel Energy Ltd, Pennant Walters Ltd, REG Windpower Ltd, Renewable Energy Systems (Aviva), Renewable Energy Systems (OI), Renewable Energy Systems (Penmanshiel), Renewable Energy Systems (TRIG), Renewable Energy Systems Limited (Glenmont), RWE Npower Renewables Ltd, RWE Npower Renewables Ltd (Offshore), RWE Renewables, Scira Offshore Energy Ltd, Scotia Wind (Craigengelt) Ltd, Scottish & Southern Energy plc, Scottish Power Renewables UK Ltd, Statkraft Wind UK Ltd, Temporis Capital Ltd, Ventient Energy Services Ltd, Wadlow Energy Ltd, Willmount Ltd, WPO UK Services Ltd.

5.92 **Major solar farm companies were added to the list of MPPs in 2016. At the end of 2019 these comprised:**

Anesco Ltd, British Solar Renewables Ltd, Cubico Sustainable Investments Ltd, Ecotricity Ltd, Eneco Wind UK Ltd, FS Shotwick Ltd, Greencoat Solar I LLP, Kentish Flats Ltd, Lightsource Renewable Energy Ltd, Octopus Investments Ltd, REG Windpower Ltd, Renewable Energy Solutions Services Ltd, Renewable Energy Systems (TRIG), Scotia Wind (Craigengelt) Ltd, Scottish & Southern Energy plc, Toucan Energy Services Ltd, Wise Energy Ltd.

Types of station

5.93 The various types of station identified in the tables of this chapter are as follows:

Conventional steam stations are stations that generate electricity by burning fuel to convert water into steam, which then powers steam turbines.

Nuclear stations are also steam stations but the heat needed to produce the steam comes from nuclear fission.

Gas turbines use pressurised combustion gases from fuel burned in one or more combustion chambers to turn a series of bladed fan wheels and rotate the shaft on which they are mounted. This then drives the generator. The fuel burnt is usually natural gas or gas oil.

Combined cycle gas turbine (CCGT) stations combine in the same plant gas turbines and steam turbines connected to one or more electrical generators. This enables electricity to be produced at higher efficiencies than is otherwise possible when either gas or steam turbines are used in isolation. The gas turbine (usually fuelled by natural gas or oil) produces mechanical power (to drive the generator) and waste heat. The hot exhaust gases (waste heat) are fed to a boiler, where steam is raised at pressure to drive a conventional steam turbine that is also connected to an electrical generator.

Natural flow hydro-electric stations use natural water flows to turn turbines.

Pumped storage hydro-electric stations use electricity to pump water into a high level reservoir. This water is then released to generate electricity at peak times. Where the reservoir is open, the stations also generates some natural flow electricity; this is included with natural flow generation. As electricity is used in the pumping process, pumped storage stations are net consumers of electricity.

Solar generators use photovoltaic cells and modules to directly convert solar energy into electricity, using both direct and diffuse radiation.

Wind farms use wind flows to turn turbines.

Other stations include stations burning fuels such as landfill gas, sewage sludge, biomass and waste.

Electricity supplied – input and output basis

5.94 The energy supplied basis defines the primary input (in million tonnes of oil equivalent, Mtoe) needed to produce 1 TWh of hydro, wind, or imported electricity as:

$$\text{Electricity generated (TWh)} \times 0.085985$$

The primary input (in Mtoe) needed to produce 1 TWh of nuclear electricity is similarly

$$\frac{\text{Electricity generated (TWh)} \times 0.085985}{\text{Thermal efficiency of nuclear stations}}$$

5.95 Figures on fuel use for electricity generation can be compared in two ways. Table 5.3 illustrates one way by using the volumes of **fuel input** to power stations (after conversion of inputs to an oil equivalent basis), but this takes no account of how efficiently that fuel is converted into electricity. The fuel input basis is the most appropriate to use for analysis of the quantities of particular fuels used in electricity generation (e.g. to determine the additional amount of gas or other fuels required as coal use declines under tighter emissions restrictions). A second way uses the amount of electricity generated and supplied by each fuel. This **output** basis is appropriate for comparing how much, and what percentage, of electricity generation comes from a particular fuel. It is the most appropriate method to use to examine the dominance of any fuel and for diversity issues. Percentage shares based on fuel outputs reduce the contribution of coal and nuclear, and increase the contribution of gas (by one percentage point in 2018) compared with the fuel input basis. This is because of the higher conversion efficiency of gas. Fuel input is set to match electricity output for non-thermal renewables.

Public distribution system

5.96 This comprises the grid systems in England and Wales, Scotland and Northern Ireland. In April 2005 the Scotland and England and Wales systems were combined into a single grid.

Sectors used for sales/consumption

5.97 The various sectors used for sales and consumption analyses were standardised across all chapters from the 2016 Digest onwards. For definitions of the sectors see Chapter 1 paragraphs 1.57 to 1.61 and Annex A paragraphs A.31 to A.42.

Losses

5.98 The losses component of electricity demand are calculated as follows:

Transmission losses: electricity lost as a percentage of electricity entering the GB transmission system (as reported by National Grid); this is applied to the electricity available figure in DUKES 5.5 (328,737 GWh in 2019).

Distribution losses: electricity lost in distribution as a percentage of electricity entering the distribution system (as reported by the distribution network operators); this is applied to electricity available less transmission losses.

Theft: a fixed percentage of 0.3 per cent is assumed to be stolen from the distribution network. This is applied to electricity available less transmission losses.

Transmission Entry Capacity, Declared Net Capacity and Installed Capacity

5.99 Transmission Entry Capacity (TEC) is a Connection and Use of System Code term that defines a generator's maximum allowed export capacity onto the transmission system. In the generating capacity statistics of the 2007 Digest, it replaced Declared Net Capacity (DNC) as the basis of measurement of the capacity of Major Power Producers from 2006. DNC is the maximum power available for export from a power station on a continuous basis minus any power generated or imported by the station from the network to run its own plant. It represents the nominal maximum capability of a generating set to supply electricity to consumers. The maximum rated output of a generator (usually under specific conditions designated by the manufacturer) is referred to as its Installed Capacity. For the nuclear industry, the World Association of Nuclear Operators (WANO) recommends that capacity of its reactors is measured in terms of Reference Unit Power (RUP) and it is the RUP figure that is given as the installed capacity of nuclear stations.

5.100 DNC is used to measure the maximum power available from generating stations that use renewable resources. For wind and wave and small-scale hydro a factor is applied to declared net capability to take account of the intermittent nature of the energy source. These factors are 0.43 for wind, 0.365 for small scale hydro and 0.17 for solar photovoltaics. Further information on this can be found at: www.legislation.gov.uk/uksi/1990/264/made?view=plain.

Load factors

5.101 The following definitions are used in Table 5.10:

Maximum load – This is twice the largest number of units supplied in any consecutive thirty minutes commencing or terminating at the hour.

Simultaneous maximum load met – The maximum load on the transmission network at any one time, net of demand met by generation connected to the distribution network. From 2005 (following the introduction of BETTA – see paragraph 5.77) it is measured by the sum of the maximum load met in Great Britain and the load met at the same time in Northern Ireland. Prior to 2005 it was measured by the sum of the maximum load met in England and Wales and the loads met at the same time by companies in other parts of the United Kingdom.

Plant load factor – The average hourly quantity of electricity supplied during the year, expressed as a percentage of the average output capability at the beginning and the end of year.

System load factor – The average hourly quantity of electricity available during the year expressed as a percentage of the maximum demand nearest the end of the year or early the following year.

Thermal efficiency

5.102 Thermal efficiency 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. The efficiency of CHP systems is illustrated in Chapter 7, Table 7D. Efficiencies based on gross calorific value of the fuel (sometimes referred to as higher heating values or HHV) are lower than the efficiencies based on net calorific value (or lower heating value LHV). The difference between HHV and LHV is due to the energy associated with the latent heat of the evaporation of water products from the steam cycle which cannot be recovered and put to economic use.

Period covered

5.103 Until 2004, figures for the MPPs relate to periods of 52 weeks as listed below (although some data provided by electricity supply companies related to calendar months and were adjusted to the statistical calendar). In 2004, a change was made to a calendar year basis. This change was made in the middle of the year and the data are largely based on information collected monthly. The January to May 2004 data are therefore based on the 21 weeks ended 29 May 2004 and the calendar months June to December 2004, making a total of 361 days. In terms of days, 2004 is therefore 1.1 per cent shorter than 2005:

Year	**52 weeks ended**
2003	28 December 2003
2004	21 weeks ended 29 May 2004 and 7 months ended 31 December 2004
2005 – 2019:	12 months ended 31 December

5.104 Figures for industrial, commercial and transport undertakings relate to calendar years ending on 31 December, except for the iron and steel industry where figures relate to the following 52 or 53 week periods:

Year	**53 weeks ended**
2003	3 January 2004
	52 weeks ended
2004	1 January 2005
2005	31 December 2005
2006	30 December 2006
2007	29 December 2007
2008	27 December 2008
	53 weeks ended
2009	2 January 2010
	52 weeks ended
2010	1 January 2011
2011	31 December 2011
2012	29 December 2012
2013	28 December 2013
2014	27 December 2014
	53 weeks ended
2015	2 January 2016
	52 weeks ended
2016	1 January 2017
2017	31 December 2017
2018	30 December 2018
2019	29 December 2019

Monthly and quarterly data

5.105 Monthly and quarterly data on fuel use, electricity generation and supply and electricity availability and consumption are available on the BEIS section of the GOV.UK website at: www.gov.uk/government/collections/electricity-statistics. Monthly data on fuel used in electricity generation by MPPs are given in Monthly Table 5.3 and monthly data on generation by type of plant and type of fuel are given in Monthly Table 5.4. Monthly data on availability and consumption of electricity by the main sectors of the economy are given in Monthly Table 5.5. A quarterly commodity balance for electricity is published in BEIS's quarterly statistical bulletin *Energy Trends* (Quarterly Table 5.2) along with a quarterly table of fuel use for generation, electricity generated, and electricity supplied by all generators (Quarterly Table 5.1) and a quarterly table of electricity imports and exports (Quarterly Table 5.6). These quarterly tables are also available from BEIS's energy statistics web site. See Annex C for more information about *Energy Trends*.

Data collection

5.106 For MPPs, as defined in paragraphs 5.88 to 5.94, the data for the tables in this Digest are obtained from the results of monthly surveys sent to each company, covering generating capacity, fuel use, generation and sales of electricity (where a generator also supplies electricity).

5.107 Similarly, an annual inquiry is sent to licensed suppliers of electricity to establish electricity sales by these companies. Electricity consumption for the iron and steel sector is based on data provided by the Iron and Steel Statistics Bureau (ISSB) rather than electricity suppliers since electricity suppliers tend to over-estimate their sales to this sector by including some companies that use steel rather than manufacture it. The difference between the ISSB and electricity suppliers' figures has been re-allocated to other sectors. A further means of checking electricity consumption data is now being employed on data for 2006 and subsequent years. A monthly inquiry is sent to electricity distributors, as well as the National Grid, to establish electricity distribution and transmission losses. Copies of the survey questionnaires are available in *electricity statistics: data sources and methodologies*, at: www.gov.uk/government/collections/electricity-statistics.

5.108 A sample of companies that generate electricity mainly for their own use (known as autogenerators or autoproducers – see paragraph 5.87, above) is covered by a quarterly inquiry commissioned by BEIS but carried out by the Office for National Statistics (ONS). Where autogenerators operate a combined heat and power (CHP) plant, this survey is supplemented (on an annual basis) by information from the CHP Quality Assessment scheme (for autogenerators who have registered under the scheme – see Chapter 7 on CHP). There are two areas of autogeneration that are covered by direct data collection by BEIS, mainly because the return contains additional energy information needed by the Department. These are the Iron and Steel industry, and generation on behalf of London Underground.

5.109 In addition to the above sources, some administrative data is used for renewable generation and capacity in the hands of non-major power producers - this includes data from the Renewables Obligation and Feed in Tariff schemes.

Statistical differences

5.110 Statistical differences are included in Tables 5.1 and 5.2. These arise because data collected on production and supply do not match exactly with data collected on sales or consumption. One of the reasons for this is that some of the data are based on different calendars as described in paragraphs 5.105 and 5.106, above. Sales data based on calendar years will always have included more electricity consumption than the slightly shorter statistical year of exactly 52 weeks.

5.111 Care should be exercised in interpreting the figures for individual industries in the commodity balance tables. Where companies have moved between suppliers, it has not been possible to ensure consistent classification between and within industry sectors and across years. The breakdown of final consumption includes some estimated data. In 2019, for about five per cent of consumption of electricity supplied by the public distribution system, the sector figures are partially estimated.

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Chapter 6
Renewable sources of energy

Key points

- **Renewables' share of electricity generation reached a record high in 2019 at 37.1 per cent, up from 33.1 per cent in 2018**. Since 2004, the renewables share of electricity generation has increased tenfold.
- **Renewable electricity generation also reached a record high in 2019 at 121 TWh, an increase of 9.5 per cent from 2018 (Table 6.4).** This was driven by increased capacity, especially in offshore and onshore wind.
- **Both offshore and onshore wind generation reached record highs with both achieving 32 TWh in 2019;** offshore generation increased by 20 per cent and onshore by 6.5 per cent compared with 2018 (Table 6.4).
- **Onshore wind was the leading technology in terms of capacity at 29.9 per cent**, followed by solar PV at 28.3 per cent and onshore wind at 21.1 per cent (Table 6.4).
- **Renewable heat increased by 2.4 per cent,** primarily due to the increases in generation from wood fuel.

Progress against the Renewable Energy Directive (RED)

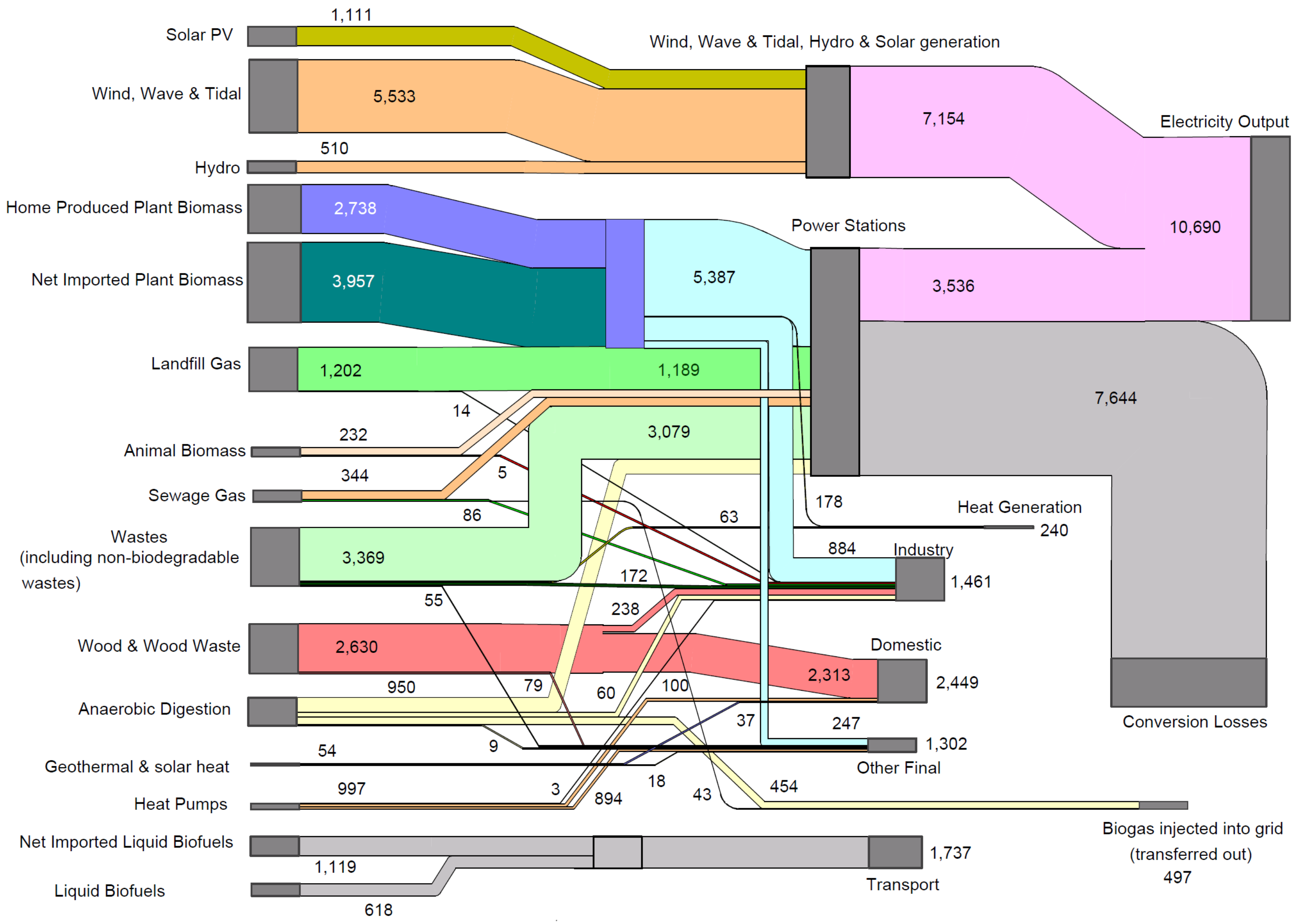
- **In 2019, 12.3 per cent of total energy consumption came from renewable sources (Table 6.7);** up from 11.2 per cent in 2018 (revised). On a RED basis, renewable electricity represented 35 per cent of total electricity generation; renewable heat 7.9 per cent of overall heat; and renewables in transport, 8.8 per cent.

Introduction

6.1 This chapter presents statistics on supply, demand, and consumption for renewable sources of energy (Tables 6.1 – 6.6) for 2019 together with an update of the UK's progress against its renewable energy target (Table 6.7). The UK has a varied mix of renewable technologies including biomass which is a key fuel source in both electricity generation and heat. Wind, solar photovoltaics, hydro and shoreline wave and tidal also contribute to electricity generation and active solar, heat pumps and deep geothermal are used in heat generation. Data sources used to compile these statistics, along with methodology notes can be found via this link: www.gov.uk/government/publications/renewable-energy-statistics-data-sources-and-methodologies).

6.2 The renewable energy flow chart below summarises the flows of renewables from fuel inputs through to consumption for 2019 and includes energy lost in conversion. The data are sourced from the commodity balance Table 6.1 and Table 6.4 for electricity outputs.

Renewables flow chart 2019 (thousand tonnes of oil equivalent)



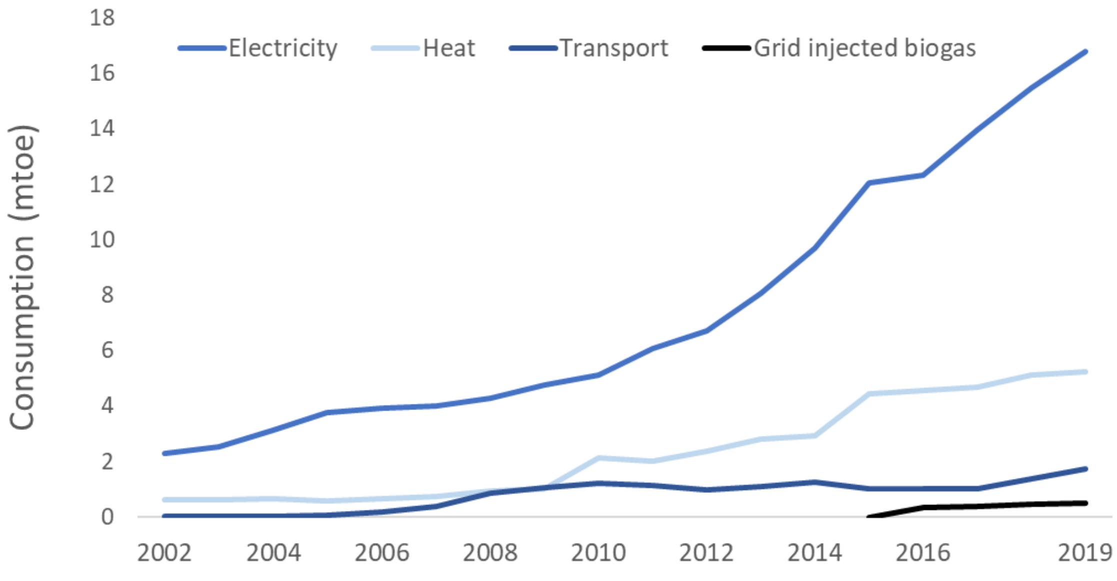
Note: This flow chart is based on data that appear in Tables 6.1 and 6.4

Renewable fuel demand (Tables 6.1 and 6.6)

6.3 The commodity balances for renewables (Tables 6.1 to 6.3) show the complete picture for renewables showing production, imports and exports, and transfers out (specifically biogas injected into the gas grid) to show supply. The demand side then shows how the fuel supplied is consumed across the different sectors; transformation (electricity and fuel input for heat sold), along with other consuming sectors; industry, transport, domestic, and other final consumers. Table 6.1 shows the renewables balances for 2019, and tables 6.2 and 6.3 show the balances for 2018 and 2017 respectively. Table 6.1 shows that 82 per cent) of renewable fuel sources were produced domestically in 2019. This reflects the local nature of utilising natural resources such as wind, solar and hydro. However, certain bio energy fuels are transportable, and a significant proportion is imported, with the bulk of this (72 per cent) being plant biomass, mostly wood pellets used in electricity generation.

6.4 Table 6.6 shows a time series of renewable fuel use. It most closely matches the demand row in the balances though biogas injected into the grid is included to ensure a complete picture of renewable generation. In this table, non-biodegradable waste is shown as a 'below the line' item though all waste is included in Table 6.1. This year, for the first time, biogas injected into the gas grid is separated out; in previous years it had been included under heat, though once in the gas grid, some would subsequently be supplied to electricity generators. Chart 6.1 below is derived from Table 6.6 and shows how renewable fuels (i.e. on an input basis[1]) is split between electricity generation, heat transport, and (new for this year) biogas injected into the grid. Total demand in 2019 increased by 8.4 per cent, to 24.3mtoe, largely due to increases in wind generation (particularly offshore), and bioenergy, mostly plant biomass, used in electricity generation. High growth rates were notable in liquid biofuels used in transport and also sewage gas injected into the grid (though from a low base).

Chart 6.1: Demand for renewable energy by end use, 2002 -2019

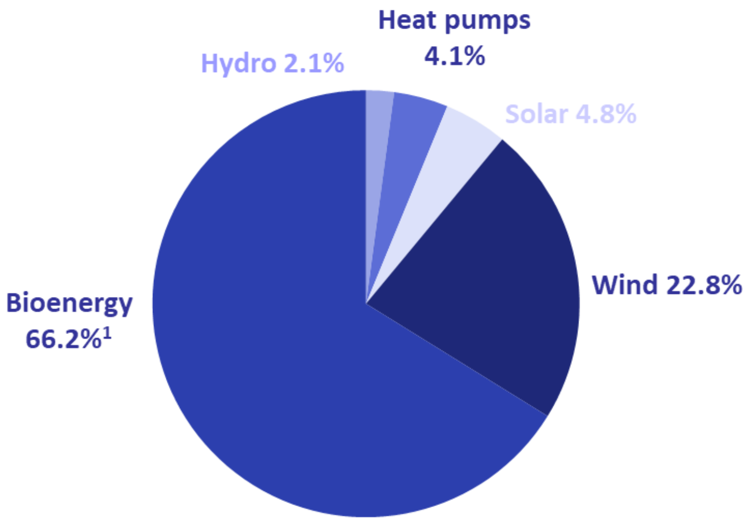


6.5 While renewable energy demand has been continually climbing since 2002, the proportion of renewable fuels used for electricity generation has remained broadly stable in recent years, fluctuating between 67 and 70 per cent since 2012 with the proportion in 2019 at 69 per cent.

[1] For combustible fuels used to generate electricity, this refers to the energy value of the fuel source rather than the actual electricity generated. For heat generation and primary electricity sources (solar photovoltaics, wind, hydro, and wave and tidal), the output energy is deemed to be equal to the fuel inputs.

6.6 In 2019, two-thirds of renewable fuel was accounted for by bioenergy (including transport biofuels and biogas injected into the grid) with wind accounting for 23 per cent. Chart 6.2 shows a comparison for the key renewable sources.

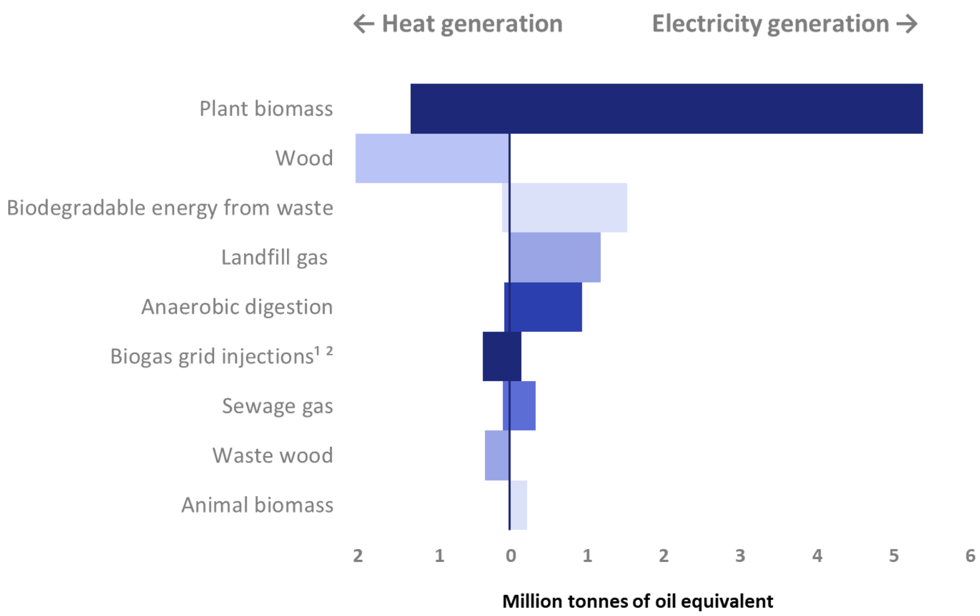
Chart 6.2: Renewable fuel use 2019



Total renewable fuels 24.3 mtoe

[1] Includes liquid biofuels and biogas injected into the gas grid

6.7 Whilst several renewable technologies are specific to either electricity generation or heat production, combustible fuels are used for both purposes. In 2019, two-thirds of biomass was used in electricity generation. Chart 6.3 shows a further breakdown of biomass by source and how its use is split between heating and electricity generation.



[1]Biogas from anaerobic digestion and sewage gas sites which are connected to the national gas grid.
[2]The electricity and heat split is estiamted based on the proportion of natural gas used for electricity generation.

6.8 Where biofuels are used for generation, a comparison is made in the electricity generation section (paragraph 6.14) between the fuel input split and actual output generation.

Overall Renewable Electricity (Table 6.4)

6.9 Total **renewable capacity** increased between 2018 and 2019 by 6.5 per cent (2.9 GW). Most of the increase is due to increased wind (2.3 GW)

6.10 In 2019, **electricity generated from renewables increased by 9.5 per cent** on 2018, from 110 TWh to 121 TWh.

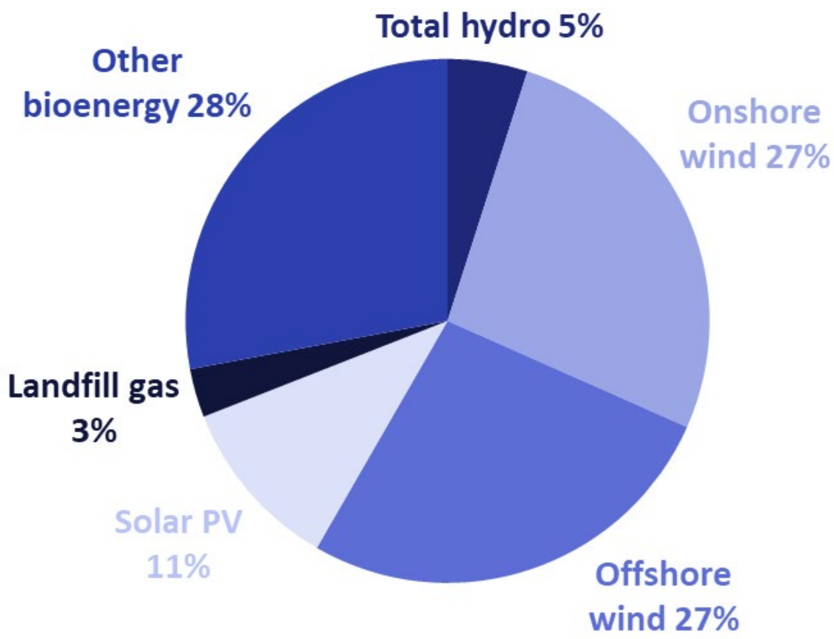
6.11 In 2019, onshore wind had the highest share of **capacity** at 29.9 per cent and, although offshore's share was less at 21.1 per cent, generation from the two sources was similar with each representing 26.7 per cent of total generation.

6.12 **Renewable sources represented 37.1 per cent of the electricity generated in the UK in 2019** compared to 33.1 per cent in 2018, an increase of 4.0 percentage points (measured using the "international basis", i.e. electricity generated from all renewables except non-biodegradable wastes as a percentage of all electricity generated in the UK). See Chapter 5 for details on total electricity generation.

6.13 Wind generation represented 71 per cent of the total increase in **generation**; onshore wind increased by 2.0 TWh (6.5 per cent) and offshore by 5.5 TWh (20 per cent) reflecting the greater increase in offshore wind capacity. Plant biomass generation increased by 2.1 TWh (9.2 per cent) and Hydro by 0.5 TWh (9.0 per cent). Chart 6.6 shows how generation from the different technologies have grown since 2000.

6.14 Whilst bioenergy dominates on a fuel input basis (Chart 6.2), primary generation (hydroelectricity, wind power and solar) together provide a larger contribution when the **output** of electricity is being measured as chart 6.4 shows;

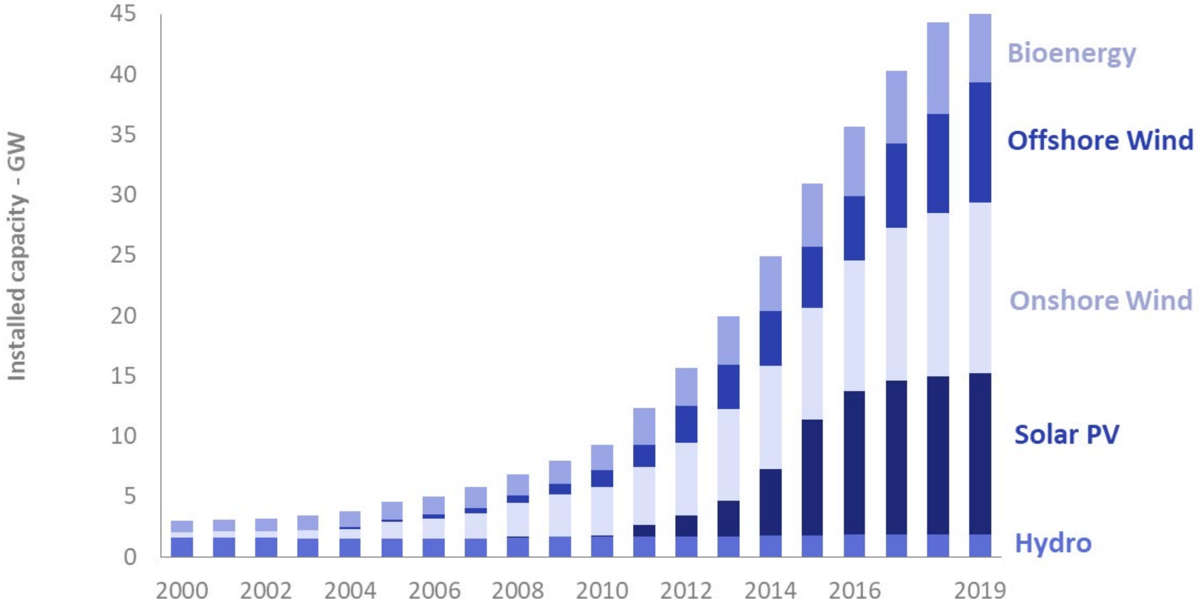
Chart 6.4: Electricity generation by fuel source 2019



This is because on an energy supplied basis the inputs are deemed to be equal to the electricity produced for hydro, wind, wave and solar, i.e. are deemed to be 100 per cent efficient. However, for landfill gas, sewage sludge, municipal solid waste and other bioenergy sources a substantial proportion of the energy content of the input is lost in the process of conversion to electricity (7.5 mtoe in 2019), as the renewables flow chart illustrates.

Charts 6.5 and 6.6 show the long-term trends in capacity and generation.

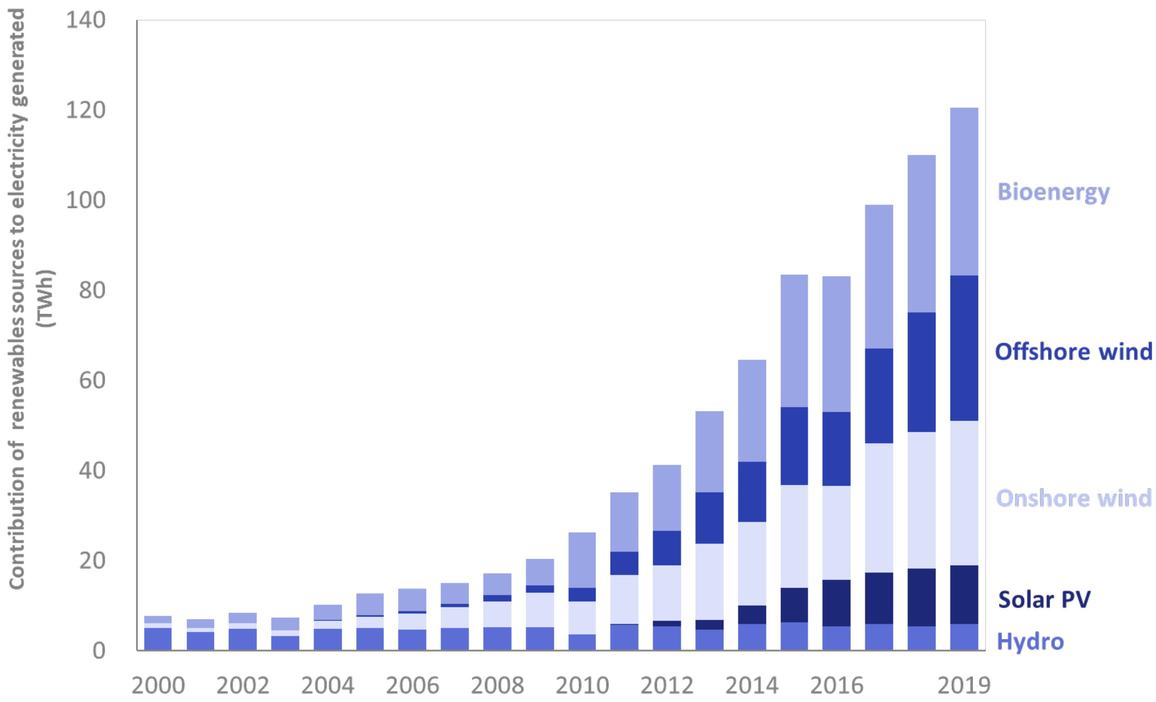
Chart 6.5: Electrical generating capacity by main renewable sources 2000 - 2019



(1) All waste combustion is included because both biodegradable and non-biodegradable wastes are burned together in the same plant.

(2) Hydro includes both large scale and small scale, and shoreline wave (22 MW in 2019).

Chart 6.6: Electricity generation by main renewable sources 2000 - 2019



Note: Hydro bar includes shoreline wave/tidal (0.014 TWh in 2019)

Load factors (Table 6.5)

6.15 **Load factors** are the ratio of how much electricity was generated as a proportion of the total generating capacity. Within renewables, load factors[2] can be heavily influenced by weather conditions; wind speeds affect the load factors for onshore and offshore wind, hours of sunshine impact the load factor for solar PV and, to a lesser extent, rainfall impacts the load factor for hydro. The load factor calculation assumes that capacity is added evenly throughout the year, which may not always be the case; for example, a large generator could add a high capacity installation towards the end of the year and only generate for a very short period. To remove this effect, Table 6.5 shows load factors on an "unchanged configuration basis". This calculation includes only those generators who producing for the whole year r providing a more reflective picture of the underlying trend. Table 6A shows the share of total generation and capacity by source alongside the relevant load factors for 2019.

Table 6A Share of generation and capacity by leading technologies in 2019

	Share of total capacity	Share of total generation	Load factor[1]
Onshore wind	29.9%	26.7%	26.2%
Solar photovoltaics	28.3%	10.7%	11.2%
Offshore wind	21.1%	26.7%	39.6%
Bioenergy	16.6%	31.0%	62.8%
Hydro	4.0%	4.9%	35.5%
Total	100%	100%	31.2%

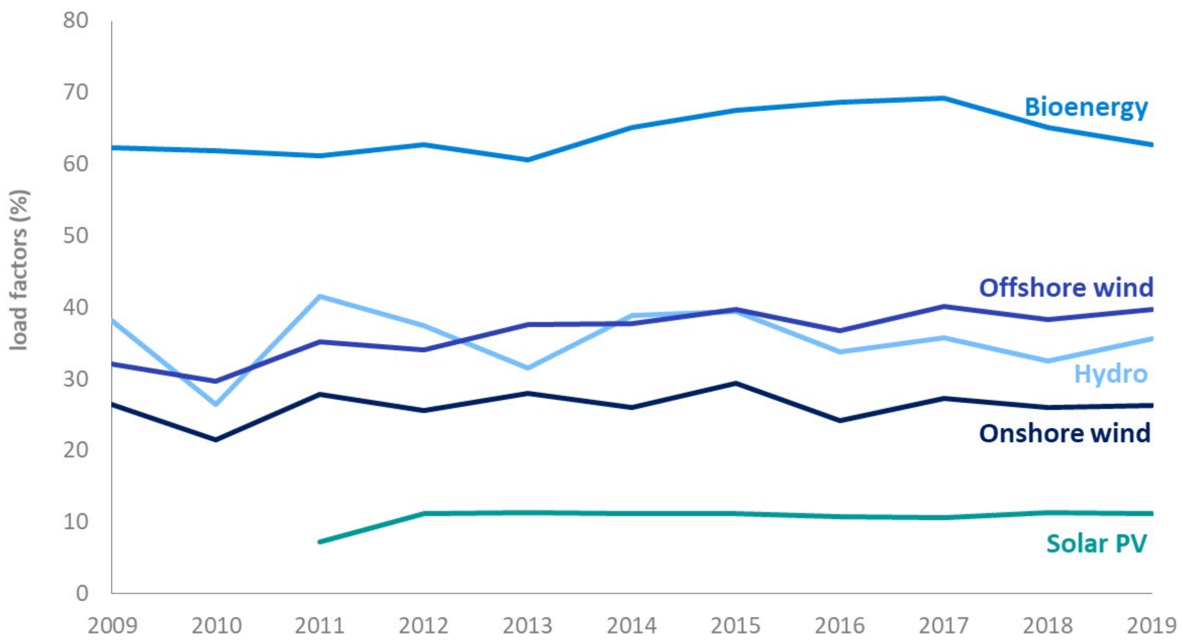
[1] Unchanged configuration basis.

6.16 Table 6A shows that the technologies with highest capacity do not necessarily have the highest share of generation because generation is dependent on the load factor (a high load factor giving a relatively higher share of generation). For example, solar photovoltaics represent a high proportion of renewable capacity, (the second highest in 2019 at 28 per cent, behind onshore wind's share at 30 per cent) but a comparatively low share of generation (11 per cent in 2019). Conversely, bioenergy (including landfill gas and waste) showed the fourth lowest share of capacity (17 per cent) but the highest share of generation (31 per cent) due to the high load factor.

6.17 Chart 6.7 shows how load factors for the key renewable technologies have fluctuated since 2008. Although bioenergy has been grouped into one category, it is mostly influenced by plant biomass which represents around two-thirds of all generation from bioenergy. Bio energy load factors steadily increased between 2011 and 2017, largely driven by the conversion of three processing units from coal to biomass at the Drax power station, which tend to operate at high load factors, and have a large share of bio energy capacity. There were further conversions of large power stations to plant biomass in 2018 which have resulted in a dip in load factors as there is now more spare capacity. On an unchanged configuration basis, the load factor for plant biomass in 2019 was very similar to 2018. The load factors for the weather dependent technologies have also fluctuated from year to year though there is no evidence of an underlying trend.

[2] For further details of how load factors are calculated, refer to the methodology note: www.gov.uk/government/uploads/system/uploads/attachment_data/file/729822/Renewables_methodology_note.pdf

Chart 6.7: Load factors[3] for renewable electricity generation 2009 - 2019



Electricity Generation, Capacity, and Load Factors by technology (tables 6.4 and 6.5)

6.18 This section discusses trends in generation, capacity (Table 6.4), and load factors (Table 6.5), for the key technologies.

Wind

6.19 **Total wind generation increased by 13 per cent to a record 64 TWh in 2019**. Wind speeds in 2019 (see Energy Trends Table 7.2) were down on 2018 (by 0.31 knots on average) but this was more than offset by additional capacity coming online.

6.20 **Onshore wind generation increased by 6.5 per cent to a record 32 TWh in 2019**. The increase in generation is a result of 0.6 GW of newly installed capacity. The largest new sites are Dorenell (177 MW) and Kype Muir (88 MW) in Scotland and Clocaenog Forest (97 MW) in Wales. However, the lower wind speeds did impact on load factors for onshore wind; both the standard measure and the unchanged configuration basis load factors increased by 0.2 percentage points to 26.6 and 26.2 respectively.

6.21 **Offshore wind generation increased by 20 per cent to 32 TWh,** the largest increase of any technology and again was the result of new capacity that came online in 2019 and late 2018. New offshore wind capacity included the completion of the Beatrice expansion, Hornsea One (1218 MW) becoming operational in stages and the first stage of East Anglia One coming online (179 MW). These three schemes are all supported by Contracts for Difference (CfD), see paragraphs 6.65 to 6.67.

6.22 Load factors for offshore wind were higher than those for onshore wind, partly because wind speeds are much stronger off the coasts, but also because (unlike wind over land), breezes can be

[3] On an unchanged configuration basis

strong in the afternoon, matching times of high electricity demand. Despite lower wind speeds for the year load factors for both offshore and onshore generation rose in 2019, load factors increased for offshore generation from 40.1 per cent to 40.4 per cent and onshore generation from 26.4 to 26.6. This can be explained due to the additional capacity that came online late in 2018, meaning it contributed comparatively more to 2019 generation. On an unchanged configuration basis, the load factor for offshore wind rose from 38.3 to 39.6 per cent in 2019.

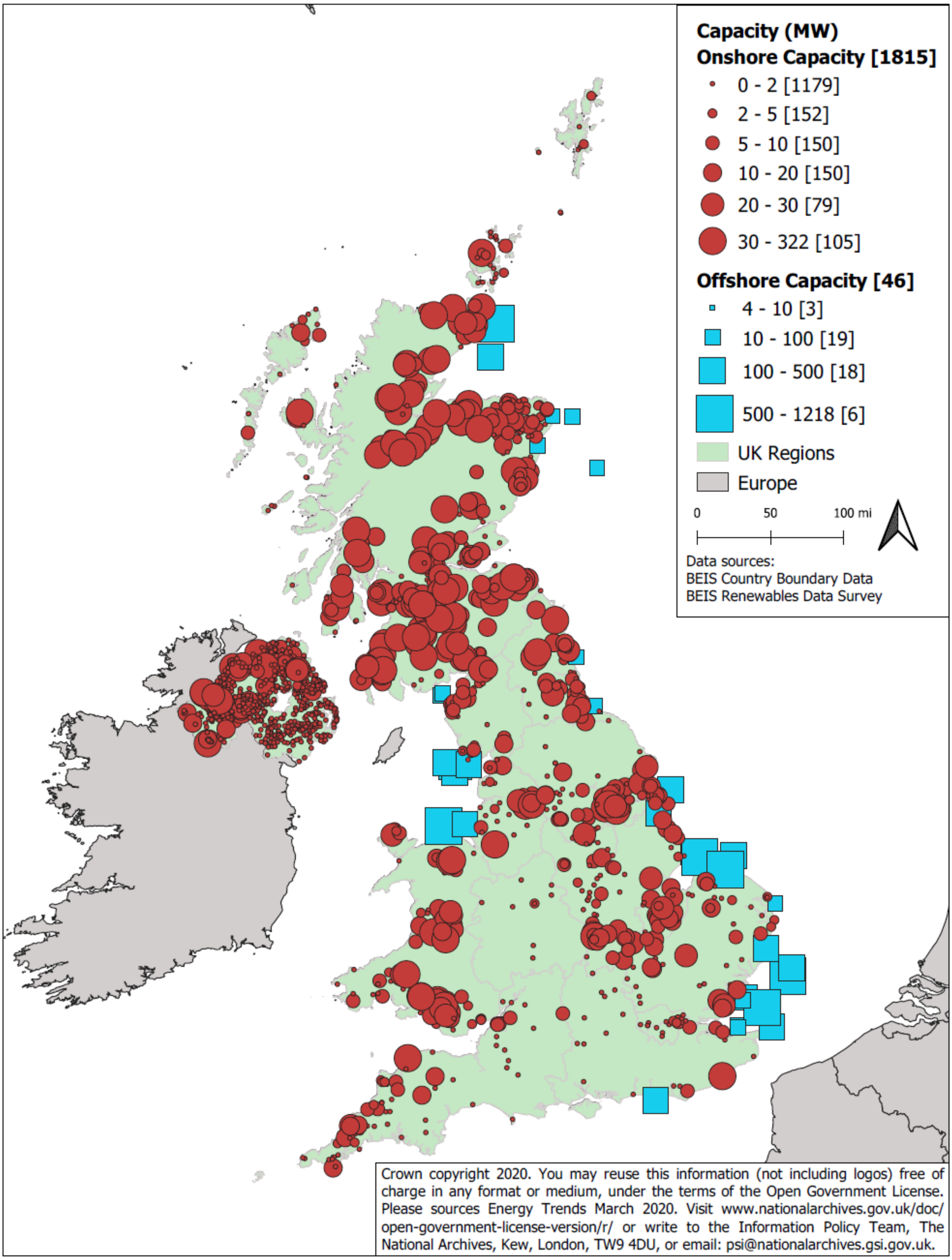
Table 6B: Number of operational wind farms split by Feed in Tariff[4] (FiTs) and non FiTs accredited sites, as at end of December 2019

	FiTs confirmed	Other sites	Total
Onshore Wind	7,602	2,192	9,794
Offshore Wind	-	44	44
Total	**7,602**	**2,236**	**9,838**

The map on the following page shows the location of wind farms operational at the end of 2019 along with an indication of capacity.

[4] See 6.68 – 6.72 for more details on FiTs

UK Onshore and Offshore Wind Capacity



Solar Photovoltaics

6.23 **Solar photovoltaic generation grew by 1.4 per cent to a record 12.9 TWh in 2019.** Generation was boosted by an increase in average sunlight hours decreased by 0.3 hours per day with just 0.3 GW of capacity being added during the year, the lowest annual increase since 2011. This compares with 4.1 GW additional capacity in 2015, the highest year on year increase in absolute terms since the series began. Solar photovoltaic capacity has the second highest share of total capacity at 28 per cent of renewable electricity generating capacity.

6.24 The load factor for solar photovoltaics decreased slightly by 0.1 percentage points from 11.3 per cent to 11.2 per cent on both the actual load factor measure and on an unchanged configuration basis. This reflects a fall in average sun light hours from 4.7 in 2018 to 4.4 in 2019.

Hydro generation

6.25 **Generation from hydro increased by 9.0 per cent in 2019 to 5.9 TWh**. Average rainfall was higher in 2019 though remains 1.3 per cent below the long-term average. There was no new capacity for small scale generation and no new capacity for large scale. The load factor for hydro rose to 36.2 per cent from 33.2 per cent. The relationship between average rainfall and the load factor is not always straightforward because generation is also affected by the timing of rainfall and local groundwater conditions.

Wave and Tidal

6.26 Although very small when compared with other renewable technologies, **generation from wave and tidal in 2019 increased to 14 GWh.**

Bio energy and Waste

6.27 **Generation from bio energy and wastes** increased by 6.8 per cent to 37 TWh, whilst capacity increased by only 3.4 per cent to 7.8 GW.

6.28 **Generation from plant biomass showed the highest growth for bioenergy, by 2.1 TWh (9.2 per cent) to 25 TWh in 2019.** Capacity increased by only 1.8 per cent to 4.5 MW however a lot of new capacity came online in 2018 and this was the first full year that these sites were operating. The new capacity in 2018 included Lynemouth Power station, a former coal power station which closed in 2015 and reopened in 2018 as a wood burning plant and another unit at Drax was converted to plant biomass. The load factor on for plant biomass on an unchanged configuration basis was 72.2 per cent, a similar level to 2018 (72.8 per cent).

6.29 **Anaerobic digestion generation increased by 4.0 per cent to 2.9 TWh.** Capacity increased by just 0.6 per cent remaining at 0.5 GW, the result of 44 new sites coming online. Load factors continue to vary because full plant output is not fully achieved for between three and six months following commissioning. This time lag resulted in lower load factors last year but an increase of 1.1 percentage points to 62.6 per cent.

6.30 **Energy from waste generation increased by 9.1 per cent to 3.8 TWh.** Capacity increased by 16 per cent to 1.3 GW. However, the load factor load factor decreased by 0.4 percentage points to 35.4. On an unchanged configuration basis, the load factor fell from 36.0 to 35.3 per cent.

6.31 **Generation from landfill gas fell for the eighth year in a row**. The fall of 7.4 per cent (to 3.6 TWh) was a less than the rate of decline seen in 2017 and 2018. Many factors can affect landfill gas yields including age of refuse leading landfill operators to respond by reducing gas yields by operating at lower turndown, and then removing the plant when it is no longer economic to run. More recently, microgeneration schemes are operating at such sites.

6.32 **Animal biomass generation was up slightly compared to 2018,** by 4.2 per cent to 0.7 TWh whilst capacity remained unchanged. **Sewage gas generation increased by 5.7 per cent to over 1.0 TWh** with capacity remaining at the same level.

6.33 For primary renewable electricity generation (for example wind and solar photovoltaics), the fuel input is deemed to be equal to the output generation and are thus considered to be 100 per cent efficient. However, for bio energy, there are conversion losses through the combustion process due to inefficiencies. Generally, the growth in input fuel will track the growth in output generation, unless there is a shift in conversion efficiencies. Table 6C shows the comparative growth rates between 2018 and 2019 for bioenergy fuel inputs and generation outputs.

Table 6C: Growth in fuel inputs versus generation for bioenergy

Growth between 2018 and 2019	Fuel use (Table 6.6)	Generation (Table 6.4)
Bioenergy:		
Landfill gas	-7.4%	-7.4%
Sewage sludge digestion	5.7%	5.7%
Biodegradable energy from waste *(8)*	11.9%	9.1%
Co-firing with fossil fuels	55.9%	55.9%
Animal Biomass *(3)*	5.7%	4.2%
Anaerobic digestion	4.0%	4.0%
Plant Biomass *(4)*	10.0%	9.2%
Total bioenergy	6.9%	6.8%

6.34 For most biofuels, growth in fuel use is similar to generation growth with the exception of biodegradable energy from waste and animal biomass.

Different measures of electricity generation (Tables 6.4 and 6.7)

6.35 Generation from **sources claiming Renewable Obligation Certificates (RO)** in 2019, at 79.3 TWh, was 1.9 per cent greater than in 2018. RO supported generation has increased by over 73 TWh since its introduction in 2002, an increase of a factor of thirteen[5]. As a proportion of total electricity sales, RO supported generation increased (by 1.0 percentage points) to 28.5 per cent. This is a smaller increase than the increase for renewables share of total generation because there was more generation supported by other schemes, particularly Contracts for Difference (CfD) (see paragraphs 6.65 – 6.67).

6.36 The Renewable Energy Directive measure also increased by 3.3 percentage points to 34.9 per cent. The international basis share which is calculated using unsmoothed annual generation whereas the Renewable Energy Directive measure smooths the effects of volatile wind speeds or rainfall on trends. Chart 6.8 shows the relative growth rates for the three different measures; the effect of the normalisation process can be most clearly seen in the trends between 2015 and 2016 where low wind speeds during 2016 resulted in a relatively flat growth rate for overall generation (the international basis) but the Directive measure showed an increase.

Table 6D: Percentages of electricity derived from renewable sources

	2004	2010	2017	2018	2019
International Basis[1]	3.6%	6.9%	29.2%	33.1%	37.1%
Renewable Obligation[2]	3.1%	7.2%	26.1%	27.5%	28.5%
2009 Renewable Energy Directive[3]	3.5%	7.5%	28.0%	31.6%	34.8%

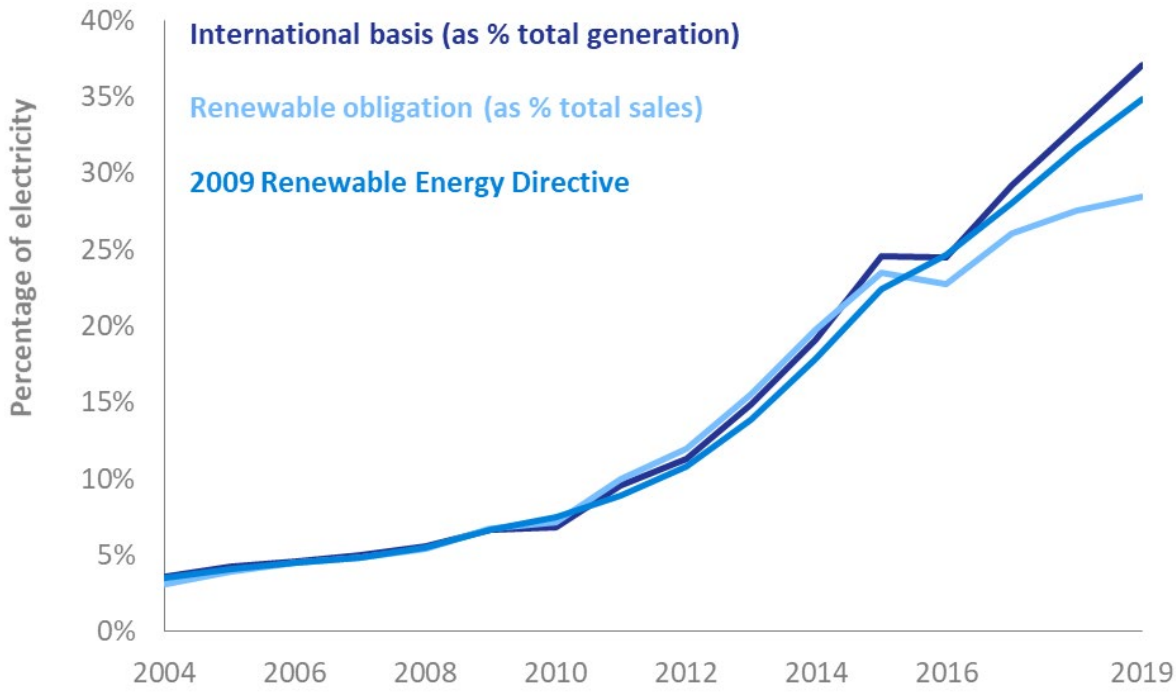
[1] All renewable electricity as a percentage of total UK electricity generation

[2] Measured as a percentage of UK electricity sales

[3] 2009 Renewable Energy Directive measured as a percentage of gross electricity consumption

[5] A small amount is due to existing hydro stations being refurbished and thus becoming within the scope of the RO definition, as opposed to new capacity being installed.

Chart 6.8: Growth in electricity generation from renewable sources 2004 - 2019



Renewable heat (Table 6.6)

6.37 This year, Table 6.6 has been reconfigured so that biogas produced by anaerobic digestion and sewage gas which is injected into the gas grid is treated separately. Previously it was included under heat though this was misleading as it will be used for the same end uses as all gas in the National Grid (i.e. some will be used for electricity generation). It will also aid comparisons with the renewable energy balances (Table 6.1) because here it is treated as a 'transfer out', hence not included in total renewable demand. Remaining consumption on site is still classified as heat.

6.38 **Renewable heat generation increased by 2.4 per cent in 2019 to 5.2 mtoe.** Of this increase, 59 per cent was accounted for by wood (72 ktoe) with the remainder accounted for by increases in plant biomass and heat pumps.

6.39 The largest increases in percentage terms were sewage gas and anaerobic digestion each increasing by 5.5 per cent.

6.40 Biogas injected into the gas grid increased by 58 ktoe (13 per cent) to 497 ktoe in 2019. Almost two thirds of the increase was from anaerobic digestion sites which increased by 9.1 per cent to 454 ktoe. Sewage gas increased by less in absolute terms (by 20 ktoe) but showed a higher percentage growth (89 per cent). Biogas from these sites were included for the first time in 2018 so the high growth rate was from a very low base in that year (just 23 ktoe).

6.41 **Around 19 per cent of renewable heat (including biogas injected into the gas grid) was supported by the Renewable Heat Incentive[6] (RHI) or Renewable Heat Premium Payment (RHPP) in 2019, compared to 17 per cent in 2018**. Non-domestic heat generation supported by RHI increased by 15 per cent to 1,005 ktoe. Of this increase, biomethane accounted for the largest share at 55 per cent, followed by CHP at 24 per cent. Domestic heat generation supported by RHI rose by 12 per cent with air source heat pumps accounting for 68 per cent of this increase, followed by ground source heat pumps at 16 per cent. Further information on the RHI and RHPP schemes can be found in paragraphs 6.80 to 6.82.

[6] www.gov.uk/government/collections/renewable-heat-incentive-statistics

6.42 **Heat generation accounts for 22 per cent of all renewable use**. This is a slight fall of the overall share of 23 per cent in 2018. This measure now excludes biogas injected into the grid in the numerator; for comparison purposes with last year's DUKES, had this been included, the share would have been 24 per cent in 2019 (the share for 2018 as reported in DUKES 2019 was 25 per cent). Whilst total renewable fuel used for heat increased, it did so at a lower rate than renewable fuels used for transport and for electricity generation (27 per cent and 8.5 per cent respectively).

6.43 **Domestic wood combustion retained the largest share of renewable heat at 44 per cent**, the same percentage as 2018. The share of all other renewable fuels used for heat generation varied by less than 0.2 of a percentage point compared to 2018.

Liquid biofuels for transport (Tables 6.1 and 6.6)

6.44 Biofuels are made from recently living biological material[7] and can be waste products, residues, or sourced from crops. The main biofuels added to petrol are bioethanol, and biomethanol, and those added to diesel are FAME (fatty acid methyl ester), HVO (hydrotreated vegetable oil), or pure plant oil.

6.45 **In 2019, 1,598 million litres of biodiesel[8] were consumed, 40 per cent higher than in 2018.** It is estimated that 573 million litres of biodiesel were produced in the UK in 2019, 7.1 per cent higher than in 2018. Of this, about 314 million litres have been used for non-transport applications, exported or held in stocks. Therefore, an estimated 1,339 million litres of biodiesel were imported in 2019. The total annual capacity for biodiesel production in the UK in 2019 is estimated to be around 689 million litres.

6.46 **Consumption of bioethanol decreased in 2019, by 1.2 per cent to 752 million litres**. The UK capacity for bioethanol remained stable at 905 million litres, but actual production was estimated to be 262 million litres. Of UK production, less than 1 million litres was known to be used for non-transport applications, or exported, so an estimated 490 million litres were imported.

6.47 During 2019, biodiesel accounted for 5.3 per cent of diesel, and bioethanol 4.5 per cent of motor spirit. The combined contribution of liquid biofuels for transport was 5.0 per cent, up from 4.0 per cent from 2018.

6.48 Volume data have been converted from litres to tonnes of oil equivalent as shown in both the commodity balances (Tables 6.1 to 6.3) and in Table 6.6. In addition, these data are also included in the aggregate energy balances (Tables 1.1 to 1.3). The tables show the contribution that liquid biofuels are making towards total renewable sourced energy. Renewable biofuels used for transport increased by 27 per cent (to 1,738 ktoe) between 2018 and 2019 due to the increase in biodiesel whilst bioethanol consumption fell slightly. In 2019, liquid biofuels for transport comprised 7.2 per cent of total renewable sources (Table 6.6), 1.1 percentage points greater than in 2019.

6.49 When measuring the contribution of transport biofuels for the Renewable Energy Directive, only those meeting sustainability criteria are counted. The data referred to above do not contain sustainability information, including which fuels carry a higher reward (mostly sourced from waste), and the table which does, is not yet a complete data set for 2019. This is due to the RTFO allowing suppliers to make claims for RTFCs up to August after the obligation period (in order to allow suppliers to optimise their supply chain verification processes), as well as, allowing sufficient time for the Department for Transport to make necessary compliance checks before applications are processed. Table 6.7 records progress against the directive and includes an estimate of the proportion of biofuels being compliant and also the proportion meeting the double credited criteria (mostly those from waste sources). Further information on the RTFO is given in paragraphs 6.76 to 6.79.

[7] Department for Transport Renewable Transport Fuel Obligation statistics, notes and definitions; www.gov.uk/government/uploads/system/uploads/attachment_data/file/519910/notes-and-definitions.pdf
[8] The most usual way for biodiesel to be sold is for it to be blended with ultra-low sulphur diesel fuel.

Renewable sources data used to indicate progress under the 2009 EU Renewable Energy Directive (RED) (Table 6.7)

6.50 The 2009 Renewable Energy Directive (RED) has a target for the UK to obtain 15 per cent of its energy from renewable sources by 2020. The target uses a slightly different definition of renewable and total energy than is used in the rest of the Digest, including the use of 'normalised' wind and hydro generated electricity. Further details on the RED methodology can be found in the methodology document:
www.gov.uk/government/publications/renewable-energy-statistics-data-sources-and-methodologies

6.51 Table 6.7 brings together the relevant renewable energy and final energy consumption data to show progress towards the target of 15 per cent of UK energy consumption to be sourced from renewables by 2020, and shows the proportions of electricity, heat and transport energy coming from renewable sources.. **During 2019, 12.3 per cent of final energy consumption was from renewable sources, an increase of 1.1 percentage points on 2018**. This is an update of the provisional figure published in the June 2020 edition of Energy Trends which indicated that the UK had achieved 13.2 per cent. This was higher than the updated estimate due to additional quality assurance revealing an error in the data in additional to new data received relating to liquid biofuels used in transport. The UK has exceeded its four interim targets (the fourth was 10.2 averaged over 2017 and 2018, and the UK achieved 10.6 per cent). The final target is 15.0 per cent and will be reported in early 2022.

6.52 Overall renewable sources, excluding non-biodegradable wastes, provided 12.9 per cent of the UK's total primary energy demand in 2019 (excluding energy products used for non-energy purposes). This is a different measure to that reported in the RED which is based on final energy consumption. The primary energy demand basis typically produces higher percentages because thermal renewables are measured including the energy that is lost in transformation. The thermal renewables used in the UK are less efficient in transformation than fossil fuels, so as non-thermal renewables such as wind (which by convention are 100 per cent efficient in transformation) grow as a proportion of UK renewables use, then the gross final energy consumption percentage will overtake the primary energy demand percentage. Both these percentage measures are directly influenced by overall energy use: for instance, whilst the renewable energy component (the numerator in the RED calculation) increased by 8.7 per cent whilst the final consumption denominator decreased by 1.1 per cent. Table 6E shows both measures.

Table 6E: Percentages of energy derived from renewable sources since 2015

	2015	2016	2017	2018	2019
Eligible renewable energy sources as a percentage of capped gross final energy consumption (i.e. the basis for the Renewable Energy Directive)	8.4%	9.1%	9.9%	11.2%	12.3%
Renewable energy as a percentage of primary energy demand	9.0%	9.5%	10.5%	11.7%	12.9%

Member state comparison of progress against the Directive

6.53 The UK exceeded its fourth interim target; averaged over 2017 and 2018, at 10.6 per cent against its target of 10.2 per cent. The Fifth Progress Report was published in early 2020[9] and the sixth, which will include performance against the final 15 per cent target, is due to be published by Eurostat early in 2022.

6.54 Eurostat publishes data on how countries are progressing towards their RED targets, with the most recent year available being 2018[10] where progress was 18.0 per cent (including the UK) for all member states, 0.5 percentage points greater compared to 2017, and requiring a 2.0 percentage point increase to reach the 20 per cent target in 2020. The UK ceased to be an EU member state in January 2020 and Eurostat now publish progress excluding the UK. On this basis, the EU27 member states have achieved 18.9 per cent. Eurostat also publishes data for some non-member states including Iceland, Norway, Montenegro, North Macedonia, Albania, and Serbia, though these countries' progress is not included in overall progress to the 20 per cent target. In 2018, Norway showed the highest proportion of renewables at 72.8 per cent, though of the member states, Sweden was the highest at 54.6 per cent. From 2017 to 2018, the UK increased its share by 1.3 percentage points, the sixth highest increase of all reporting countries.

6.55 In 2018, three additional member states achieved their targets Greece, Cyprus, and Latvia, bringing the total to twelve; Bulgaria, The Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Finland, and Sweden had all previously achieved their targets. Two member states (Hungary and Romania) had previously achieved their targets but in 2018, progress had reverted to below target.

Revisions to published data and new reporting

6.56 Renewables data have been revised back to 2016, with the most recent years seeing the largest revisions: mostly the result of more up to date information. There were also some reclassifications of existing capacity and generation. Where revisions have been made, the values in the excel versions of the tables have been suffixed with an "r" to indicate the value has been changed since last published.

6.57 Unlike other fuel sources, the renewables energy balances have zero statistical differences as the data are mostly taken from a single source where there is less likelihood of differences due to timing, measurement, or differences between supply and demand.

6.58 Due to changes made in the data collection process, data on stock changes for biofuels became available in 2018 and is now part of the routine data collection.

[9] https://ec.europa.eu/energy/en/topics/renewable-energy/progress-reports
[10] http://ec.europa.eu/eurostat/web/energy/data/shares

Technical Notes

European and UK Renewable Energy Policy Context

EU Renewable Energy Directive

6.59 In March 2007, the European Council agreed to a common strategy for energy security and tackling climate change. An element of this was establishing a target of 20 per cent of EU's energy to come from renewable sources. In 2009, a new Renewable Energy Directive (Directive 2009/29/EC) ('RED') was implemented on this basis and resulted in agreement of country "shares" of this target. For the UK, its share is that 15 per cent of final energy consumption - calculated on a net calorific value basis, and with a cap on fuel used for air transport - should be accounted for by energy from renewable sources by 2020. The RED included interim targets and required each Member State to produce a National Renewable Energy Action Plan (which contains a progress trajectory and identifies measures which will enable countries to meet their targets). The Directive also requires each Member State to submit a report to the Commission on progress in the promotion and use of energy sources every two years. The UK's action plan and progress reports (covering performance during 2009 and 2010, 2011 and 12, 2013 and 14, 2015 and 16 and 2017 and 18) are available at:

www.gov.uk/government/uploads/system/uploads/attachment_data/file/47871/25-nat-ren-energy-action-plan.pdf,

www.gov.uk/government/publications/first-progress-report-on-the-promotion-and-use-of-energy-from-renewable-sources-for-the-uk,

www.gov.uk/government/publications/second-progress-report-on-the-promotion-and-use-of-energy-from-renewable-sources-for-the-united-kingdom,

www.gov.uk/government/publications/third-progress-report-on-the-promotion-and-use-of-energy-from-renewable-sources-for-the-united-kingdom,

https://ec.europa.eu/energy/en/topics/renewable-energy/progress-reports

UK Renewables Policy

6.60 The UK's low carbon policies have seen renewable electricity capacity increase by more than three times since 2010. In 2016, renewables provided nearly one quarter of the UK's electricity generation, and we are on track to comfortably exceed our ambition of delivering 30% of the UK's electricity from renewables in 2020-21.

Renewables Obligation (RO)

6.61 The Renewables Obligation (RO) came into effect in April 2002[11]. It places an obligation on UK electricity suppliers to present a certain number of Renewables Obligation Certificates (ROCs) to Ofgem, the administrator of the scheme, in respect of each megawatt hour of electricity supplied each year. The Obligation is intended to incentivise renewable generating capacity and so contribute to our renewable energy and climate change targets. Ofgem issues ROCs free of charge to qualifying renewable generators. Generators sell those ROCs to suppliers or traders, with or without the electricity generated, as tradable commodities. This allows them to receive a premium in addition to the wholesale price of their electricity. Suppliers present ROCs to Ofgem to demonstrate their compliance with the obligation or make a payment into a buy-out fund.

[11] The Renewables Obligation covering England and Wales and the analogous Renewables (Scotland) Obligation came into effect in April 2002. Northern Ireland introduced a similar Renewables Obligation in April 2005. Strictly speaking until 2005, the RO covers only Great Britain, but in these UK based statistics Northern Ireland renewable sources have been treated as if they were also part of the RO.

6.62 When the Obligation was first introduced, 1 ROC was awarded for each MWh of renewable electricity generated. In 2009, 'banding' was introduced, meaning different technologies now receive different numbers of ROCs depending on their costs and potential for large scale deployment. A list of technologies eligible for the RO, and the level of ROCs received, is available on Ofgem's website at: www.ofgem.gov.uk/publications-and-updates/renewables-obligation-guidance-generators

In 2018, measures were introduced to control the cost of biomass conversions and co-firing under the RO. Details are available at
www.gov.uk/government/consultations/controlling-the-costs-of-biomass-conversion-and-co-firing-under-the-renewables-obligation

6.63 The RO scheme closed to new capacity on 31 March 2017 although grace periods extended the closure date to March 2019 in certain specified situations. Stations that accredited in the early years of the scheme will continue to receive support until 2027. Later stations will be supported for 20 years or until the final closure of the scheme on 31 March 2037, whichever is the earliest.

6.64 Table 6.4 contains a row showing the total electricity eligible for the RO. Prior to 2002 the main instruments for pursuing the development of renewables capacity were the Non Fossil Fuel Obligation (NFFO) Orders.

Contracts for Difference (CfDs)

6.65 The Contracts for Difference (CfD) scheme is our main mechanism for supporting new renewable electricity generation projects in Great Britain. The CfD scheme tackles the risks and uncertainties of the underlying economics of different forms of electricity generation by offering long term contracts for low carbon energy. Support is provided in the form of a private law contract between a generator and the Low Carbon Contracts Company (a government-owned company).

6.66 Generators must sell their electricity to the market as usual, but in addition generators receive a top-up payment (when market prices are below the strike price) to a fixed and secure price (known as a "strike price") for each unit of electricity they generate. This certainty allows investors to be confident about the returns of their capital in advance of investing billions into new infrastructure schemes. It also encourages banks to lend at cheaper rates because the projects are less risky. When market prices are higher than the strike price, generators must pay back the difference. This provides protection to consumers when electricity prices are high.

6.67 CfDs are awarded to the cheapest projects via a competitive auction mechanism. To date, three auctions have awarded support to over 11GW of new renewable electricity capacity projects across technologies. The third allocation round saw offshore wind strike prices fall by around 30% from the second auction held in 2017. This is the first time that renewables are expected to come online below market prices and without additional subsidy on bills, meaning a better deal for consumers. The government plans to open the fourth allocation round in 2021. Further details are available at:
www.gov.uk/government/publications/contracts-for-difference/contract-for-difference

Feed-in Tariffs (FIT)

6.68 The Feed-in Tariffs (FIT) scheme is a policy mechanism designed to support investment in small-scale renewable and low-carbon electricity generation projects up to 5MW capacity. FITs is now closed to new entrants but continues to support existing generation. It offers long term support to projects and provides tariffs based on the costs of generation for each technology. The technologies supported are: solar PV, onshore wind power, hydropower, anaerobic digestion (AD), and micro (<2kW) combined heat and power (micro-CHP). Under the scheme, generators receive three sources of income/savings:

- A Generation tariff - a payment for every kWh generated, dependent on the technology and capacity of the installation, and date installed;

- An Export tariff - an additional payment for every kWh exported to the local electricity network; and
- Bill savings - additional benefit from usage of electricity “onsite” as opposed to paying the retail price for importing that energy from the grid.

A prerequisite for receiving support through FITs was registering with the Microgeneration Certification Scheme (MCS).

6.69 The scheme has been hugely successful in attracting investment. A review of the scheme took place in 2015 and new measures were introduced in early 2016 to ensure the scheme’s costs were effectively controlled; providing value for money for the consumers that fund it through their electricity bills. The scheme closed to new applications on 31 March 2019 subject to a grace period and a number of time-limited extensions. Existing generating stations under the scheme will continue to receive support for up to 25 years.

Feed-in Tariffs Supported Capacity

6.70 Much small-scale (up to 5 MW capacity) renewable electricity in Great Britain is supported by and has increased as a result of, the FIT scheme. During the first nine months (April and December 2010) of the FIT scheme, a total of 106 MW of renewable capacity was installed and subsequently confirmed on it. During 2011, a further 954 MW of FIT supported renewable capacity was installed. For 2012, 855 MW of capacity was added and in 2013, 613 MW. In 2014, 980 MW of capacity was added, while in 2015, a further 1,709 MW of FIT capacity was installed, with 83 per cent of this new capacity coming from solar photovoltaics (PV). A further 677 MW capacity was installed in 2016, of which 69 per cent of this new capacity came from PV. In 2017, 181 MW of new capacity was installed, with Solar PV accounting for 87 per cent of this. In 2018 155 MW of new capacity was installed in FITs, of which 85 per cent was Solar PV.

6.71 FITs closed to new entrants at the end of March 2019 but 96 MW was installed on FITs in the first three months of 2019, ahead of the deadline. Solar PV accounted for 94 per cent of this new capacity. Total FITs capacity stood at 6,340 MW at the end of March 2019, although this number is still subject to further revision. Not all small-scale generators are accredited on FITs, the number of sub-50 kW installations that are registered with the MCS but not accredited on FITs grew by 32,000 in 2019, accounting for around 102 MW. The number of installations registered on the MCS continues to grow.

6.72 Table 6F shows the number of sites generating renewable electricity at the end of 2019. There were 1,037,035 sites, although this figure is dominated by small-scale solar PV installations confirmed on FIT.

Table 6F: Number of sites generating renewable electricity, as at end of December 2019 (excluding co-firing)[12]

	FIT confirmed	Other sites	Total
Onshore Wind	7,602	2,215	9,817
Offshore Wind	-	44	44
Marine energy	-	20	20
Solar PV	857,770	166,054	1,023,824
Hydro	1,175	345	1,520
Landfill gas	-	456	456
Sewage sludge digestion	-	194	194
Energy from waste	-	62	62
Animal biomass (non-AD)	-	6	6
Anaerobic digestion	421	236	657
Plant biomass	-	435	435
Total	**866,968**	**170,067**	**1,037,035**

Smart Export Guarantee (SEG)

6.73 Following on from the closure of the FIT scheme to new installations, supplier- led smart export guarantee (SEG) was introduced across Great Britain on 1 January 2020. Under the SEG, licensed electricity suppliers (with 150,000 domestic customers or more) are required to offer small-scale low-carbon generators a price per kWh for electricity exported to the grid.

6.74 Remuneration is available to solar PV, wind, anaerobic digestion, hydro all up to 5MW in capacity, and micro-combined heat and power installations, up to 50kW. Mandated suppliers are required to provide at least one SEG compliant tariff. They are free to determine the price and length of contract, with the proviso that remuneration must be greater than zero at all times. The SEG has been successful in bringing forward a range of competitive offerings to the market with small-scale generators having several tariffs to choose from.

6.75 The SEG ensures that that homes and businesses supplying their own low-carbon electricity are able to receive payment for the excess electricity that they export to the grid from their energy suppliers. The export must be metered (with a meter capable of reporting exports on a half hourly basis) and registered for settlement – typically smart meters will provide this functionality. It complements the move to a smart energy system, where consumers can make some of their own electricity, and increasingly control when they use power (for example to charge electric cars) to minimise costs.

Further information on the SEG is available at:
www.gov.uk/government/consultations/the-future-for-small-scale-low-carbon-generation &
www.ofgem.gov.uk/environmental-programmes/smart-export-guarantee-seg/about-smart-export-guarantee-seg

Renewable Transport Fuel Obligation (RTFO)

6.76 The Renewable Transport Fuel Obligation, introduced in April 2008, placed a legal requirement on road transport fuel suppliers (who supply more than 450,000 litres of fossil petrol, diesel or renewable fuel per annum to the UK market) to ensure that 4.75 per cent (by volume) of their overall fuel sales were from a renewable source by 2013/14 and in subsequent years. Under the RTFO all obligated companies are required to submit data to the RTFO administrator on volumes of fossil and renewable

[12] The number of sites (as with overall capacity) is subject to revision, due to lags in data sources. This particularly affects solar PV, where more sites may have come online since compiling this edition of DUKES.

fuels they supply. Renewable Transport Fuel certificates are issued in proportion to the quantity of biofuels registered.

6.77 The RTFO (amendment) Order, made in 2011, introduced mandatory carbon and sustainability criteria for all renewable fuels and double rewards for some fuel types, including those made from waste and residue materials. From April 2013 the end uses covered by the RTFO were amended to include non-road mobile machinery, agriculture and forestry tractors and recreational craft when not at sea.

6.78 The Renewable Transport Fuels and Greenhouse Gas Emissions Regulations, made in 2018, have introduced an increase in the obligation rising incrementally through 9.75% in 2020 to 12.4% in 2032. The Regulations also aim to increase the supply of the fuels of the greatest future strategic importance to the UK, through the introduction of an obligation to provide a proportion of 'development' fuels and by setting a maximum limit for supply of fuels made from crops.

6.79 Further information on the RTFO policy can be found at:
www.gov.uk/government/collections/renewable-transport-fuels-obligation-rtfo-orders#guidance
The verified RTFO biofuels statistics, including information on origin and sustainability from 2008 onwards can be found at: www.gov.uk/government/collections/biofuels-statistics.

Renewable Heat Incentive and Premium Payment

6.80 The Renewable Heat Incentive (RHI) scheme is a government financial incentive scheme introduced to encourage a switch to renewable heating systems in place of fossil fuels. The tariff based scheme is split into two parts:

- The non-domestic RHI scheme which has been open to commercial, industrial, public sector, not for profit and community generators of renewable heat since November 2011.
- The domestic RHI scheme which opened on 9 April 2014 and is available to homeowners, private and social landlords and people who build their own homes.

Further information on this scheme, including details of the technologies, can be found at:
www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi.

6.81 The Renewable Heat Premium Payment (RHPP) voucher scheme, launched in August 2011, made one-off payments to householders to help them buy renewable heating technologies. This scheme closed on 31 March 2014 prior to the introduction of the domestic RHI scheme. Further information on the RHPP can be found at www.gov.uk/renewable-heat-premium-payment-scheme with further data available at www.gov.uk/government/collections/renewable-heat-incentive-renewable-heat-premium-payment-statistics.

6.82 Table 6G below shows the breakdown of technologies accredited to the domestic scheme, over the period 9 April 2014 (launch date) to 31 December 2019, with average installed capacity and heat paid out for under the scheme. In total there were 75,847 accreditations, with 4,400Gwh of heat generated and paid for. Further data and information relating to the RHI can be found at: www.gov.uk/government/collections/renewable-heat-incentive-statistics

Table 6G: Domestic Renewable Heat Incentive accreditations, estimated total capacity installed and heat paid for to December 2019

Technology	Number of accreditations	Estimated[1] capacity of accredited applications (MW)	Heat paid out under the scheme (GWh)
Air source heat pump	43,518	433	1,447
Ground source heat pump	10,689	140	717
Biomass systems	12,658	328	2,173
Solar thermal	8,982	27	62
Total	**75,847**	**927**	**4,400**

[1] Estimated capacity of accredited applications is calculated by multiplying the number of accredited applications by the average capacity of accredited applications.

Table 6H: Non-domestic Renewable Heat Incentive accreditations (full applications), total capacity installed and heat paid for to December 2019

Technology	Number of accreditations	Total capacity of accredited full applications (MW)	Heat paid out under the scheme (GWh)
Small biomass boiler (<200 kW)	12,968	1,519	10,566
Medium biomass boiler (200-1000 kW)	3,773	2,072	13,010
Large biomass boiler (>1000 kW)	129	649	3,748
Solar thermal (<200 kW)	316	6	8
Small water or ground source heat pumps (< 100 kW)	951	27	147
Large water or ground source heat pumps (>100 kW)	287	126	371
Air Source Heat Pumps	544	15	53
CHP	77	275	1,207
Deep Geothermal	0	0	0
Biogas	748	306	2,445
Biomethane1	94	N/A	9,838
Total	**19,887**	**4,995**	**41,393**

[1] Biomethane plants do not directly generate heat and therefore do not have an associated capacity. Biomethane is injected into the gas grid. An estimate of heat generated from biomethane is calculated by multiplying a calorific value by the amount of biomethane injected into the gas grid.
[2] Heat represented in this table is based on meter readings received by Ofgem and does not record any activity for which there has been no reading. There can be a considerable time lapse between the generation of heat and the submission of meter readings to Ofgem

Sources of Renewable Energy

6.83 Since the 2018 edition of The Digest, the background on sources of renewable energy have been moved to the methodology note which can be accessed via the following link: www.gov.uk/government/collections/renewables-statistics#methodology

This now incorporates background information along with the data sources and methodology employed to produce renewable energy statistics.

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Chapter 7
Combined heat and power

Key Points

- The Good Quality CHP capacity decreased by 13 MWe between 2018 and 2019 from 6,063 MWe to 6,050 MWe. (Table 7A)
- The amount of good quality electricity produced in 2019 was 23.5 TWh (Table 7.4), which is 2.2 per cent higher than in 2018. The good quality electricity generated by CHP in 2019 corresponds to 7.1 per cent of all electricity supplied in the UK.
- Sixty-nine percent of the fuel used in CHP schemes in 2019 was natural gas. This is essentially unchanged from 2018. In 2019, the share of total fuel that was renewable was 18.8 per cent, a 1.0 percentage point increase between 2018 and 2019.
- The Oil and Gas sector has the largest Good Quality CHP capacity (36 per cent), followed by the Chemicals sector (19 per cent), Other sector (13 per cent) and then the Transport Commerce and Administration sector (9.4 per cent).
- Both the absolute and relative CO_2 savings delivered by CHP fell have fallen each year between 2017-2019 for all fuels however savings delivered by CHP relative to the fossil fuel basket are more steady over time.

Introduction

7.1 This chapter sets out the contribution made by Combined Heat and Power (CHP) to the United Kingdom's energy requirements. The data presented in this chapter have been derived from information submitted to the CHP Quality Assurance programme (CHPQA) or by following the CHPQA methodology in respect of data obtained from other sources. The CHPQA programme was introduced by the Government to provide the methods and procedures to assess and certify the quality of the full range of CHP schemes. It is a rigorous system for the Government to ensure that the incentives on offer are targeted fairly and benefit schemes in relation to their environmental performance.

7.2 CHP is the simultaneous generation of usable heat and power (usually electricity) in a single process. The term CHP is synonymous with cogeneration, which is commonly used in other Member States of the European Community and the United States. CHP uses a variety of fuels and technologies across a wide range of sizes and applications. The basic elements of a CHP plant comprise one or more prime movers (a reciprocating engine, gas turbine, Rankine cycle turbine using steam or organic fluids and, more recently, steam screw expanders) driving electrical generators, with the heat generated in the process captured and put to further productive use, such as for industrial processes, hot water and space heating or cooling (via absorption chillers). In cases where the outputs of the CHP scheme are power, heat and cooling, this is referred to as tri-generation.

7.3 CHP is typically sized to make use of the available heat[1], and connected to the lower voltage distribution system (i.e. embedded). This means that, unlike conventional power stations, CHP can provide efficiency gains by avoiding significant transmission and distribution losses, which currently represent about 7.6 per cent of electricity demand in the UK. These gains are reflected in the calculation of CO_2 savings delivered by CHP (see paragraphs 7.29-7.30). CHP can also provide important network services such as black start[2], improvements to power quality, and some have the ability to operate in island mode if the grid goes down. There are six principal types of CHP system:

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[1] *But not always, see paragraph 7.6. In such cases there is an impact upon the electrical capacity and electrical output classified as CHP.*

[2] *Black start is the capability to operate in island mode if the grid goes down.*

steam turbine, gas turbine, combined cycle systems, reciprocating engines, Organic Rankine Cycle (ORC) and steam expander systems. Each of these is defined in paragraph 7.37 later in this chapter.

UK energy markets, and their effect on CHP

7.4 Two major factors affecting the economics of CHP are the relative cost of fuel (principally natural gas) and the value that can be realised for electricity both for own use and export. This is known as the spark spread (i.e. the difference between the price of electricity and the price of the gas required to generate that electricity). The larger the spark spread the more favourable are the economics of CHP operation. At the start of 2013 the spark spread started to increase and did so each quarter until the middle of 2016. Between 2016 and 2018 the spark gap fluctuated in magnitude up and down. However, since 2018 the spark gap has increased steadily and at an accelerated rate during 2019. By Q4 2019 it stood at 5.6, the highest level since Q2 of 2000[3].

7.5 The effect of the introduction of a specific solid biomass CHP Renewable Heat Incentive (RHI) tariff for installations commissioned after May 2014 has encouraged the commissioning of a growing number of units based on Organic Rankine Cycle (ORC) and steam screw expander technologies. Statistics tables 7.3 to 7.7 now include a specific entry for schemes based on ORC technology, reflecting this development. These technologies are described in paragraph 7.37.

Use of CHPQA in producing CHP statistics

7.6 The CHPQA programme is the major source for CHP statistics. CHPQA schemes accounted for 91 per cent of the capacity reported in this chapter for 2019. The following factors need to be considered when using the statistics produced:

- Through CHPQA, scheme operators have been given guidance on how to determine the boundary of a CHP scheme (what is regarded as part of the CHP installation and what is not). A scheme can include multiple CHP prime movers[4], along with supplementary boilers and generating plant, subject to appropriate metering being installed to support the CHP scheme boundaries proposed, and subject to appropriate metering and threshold criteria. (See CHPQA Guidance Note 11 available at www.gov.uk/chpqa-guidance-notes). This point is relevant when considering the figures in Table 7D, where the power efficiencies, heat efficiencies and heat to power ratios stated in that table for 2019 are those of the scheme, which may not be just the prime mover.

- The output of a scheme is based on gross power output. This means that power consumed by parasitic plant such as pumps and fans is included in the power output of the scheme.

- The main purpose of a number of CHP schemes is the generation of electricity including export to other businesses and to the grid. There may not be demand for all of the available heat from such schemes. In such cases, the schemes' total electrical capacity and electrical output have been scaled back using the methodologies outlined in CHPQA (see www.gov.uk/chpqa-guidance-notes). Only the power output from highly-efficient or "Good Quality" schemes is counted in this chapter. Consistent with this, the fuel reported in this chapter is only that which is considered to have generated the Good Quality power output and the heat. This means that where a scheme's power output has been scaled back the fuel reported in this chapter is less than the total fuel input to the scheme. Chapter 5 includes all CHP capacity, fuel inputs and power outputs, for both highly-efficient, or "Good Quality", and less efficient schemes, under the categories "Other generators".

- There are two load factors presented in Table 7A. Load Factor (CHPQA) is based on the Good Quality Power Output and Good Quality Power Capacity reported in this Chapter. Load Factor (Actual) is based on the Total Power Capacity and the Total Power Output. The Load Factor (CHPQA) is lower than the Load Factor (Actual) for schemes that have been scaled back on the power outputs. The load factor gives an indication of the degree to which the power generating capacity is utilized. Between 2007 and 2013 Load Factor (CHPQA) steadily declined, but has undergone a steady increase every year since then. In 2016 there was an appreciable upturn in Load Factor (Actual), which was due to a number of large CHP generators in the Chemicals and

[3] Based on fuels purchased by manufacturing industry, QEP 3.1.2 www.gov.uk/government/statistical-data-sets/prices-of-fuels-purchased-by-manufacturing-industry

4 The CHP prime mover is the heart of a CHP system and is a mechanical machine which drives the electricity generator or develops mechanical power for direct use

Oil Refineries sectors increasing their production of electricity. Load Factor (Actual) in 2019 was again high (59 per cent), which is the second highest since 2008 (with the exception of 2016).

Table 7A: A summary of the recent development of CHP[(1)]

	Unit	2015	2016	2017	2018	2019
Number of schemes		2130	2224	2406	2497	2547
Net No. of schemes added during year (2)		59	94	182	91	50
Electrical capacity (CHP_{QPC})	MWe	5708	5625	5919	6063	6050
Net capacity added during year		-179	-83	294	144	-13
Capacity added in percentage terms	Per cent	-3.0	-1.5	5.2	2.4	-0.2
Heat capacity	MWth	20091	19785	20586	20934	20690
Heat to power ratio *(3)*		2.06	1.99	1.95	1.87	1.78
Fuel input *(4)*	GWh	82576	85132	91257	93480	92591
Electricity generation (CHP_{QPO})	GWh	19534	20406	21771	22945	23461
Heat generation (CHP_{QHO})	GWh	40234	40671	42500	42836	41697
Overall efficiency *(5)*	Per cent	72.4	71.7	70.4	70.4	70.4
Load factor (CHPQA) *(6)*	Per cent	39.1	41.4	42.0	43.2	44.3
Load factor (Actual) *(7)*	Per cent	51.0	60.0	56.3	57.1	59.1

(1) Data in this table for 2018 have been revised since last year's Digest as more up to date information on the performance and status of some CHP schemes has become available.
(2) Net number of schemes added = New schemes – Decommissioned existing schemes.
(3) Heat to power ratios are calculated from the qualifying heat output (QHO) and the qualifying power output (QPO).
(4) Fuel input is the fuel deemed to have generated the qualifying power output (QPO) and qualifying heat output (QHO).
(5) Overall efficiencies are calculated using qualifying power output (QPO), qualifying heat output (QHO) and fuel input. Fuel input is expressed in Gross Calorific Value (GCV) terms. When fuel input is expressed in Net Calorific Value (NCV) terms, efficiencies will be higher.
(6) The load factor (CHPQA) is based on the qualifying power output (QPO) and qualifying power capacity (QPC) and does not correspond exactly to the number of hours run by the prime movers in a year.
(7) The load factor (Actual) is based on the total power generated and total power capacity.

Efficiency of CHP schemes

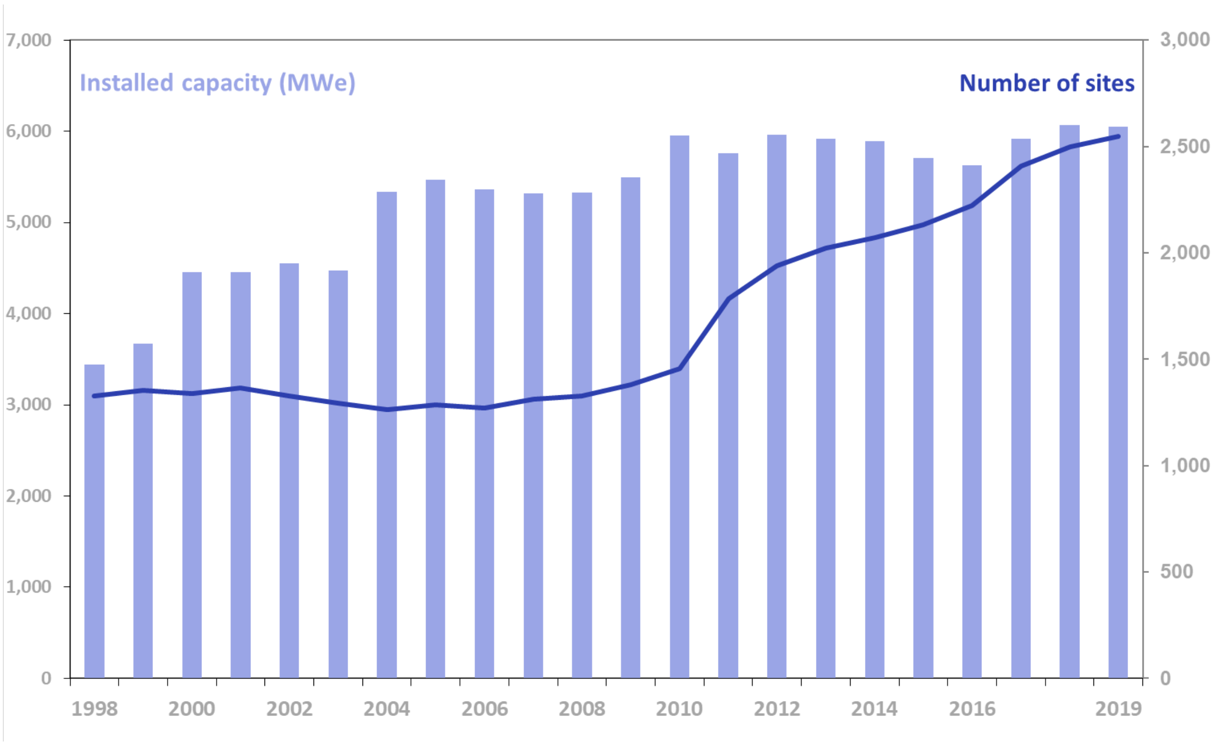
7.7 Good Quality CHP denotes schemes that have been certified as being highly efficient through the UK's CHP Quality Assurance (CHPQA) programme. The criteria used are in line with the requirements for high efficiency CHP set down in the Energy Efficiency Directive (2012/27/EU). A Good Quality CHP scheme, with installed capacity ≥1 MWe, must achieve 10 per cent primary energy savings compared with the EU reference values for separate generation of heat and power i.e. via a boiler and power station. Good Quality CHP schemes with installed capacity <1 MWe must achieve primary energy savings greater than zero per cent.

Changes in CHP capacity

7.8 Chart 7.1 shows the change in installed CHP capacity since 2001, when the CHPQA programme began. Installed capacity at the end of 2019 stood at 6,050 MWe, a decrease of 13 MWe (0.2 per cent) compared to 2018. There was a net increase of 50 (2.0 per cent) in the number of schemes between 2018 and 2019. Overall, between 2018 and 2019, there were 63 new schemes included in the database and a removal of 13 schemes. There have been revisions to the capacity figures for 2018 shown in the previous edition of the Digest, as more up to date information on the performance and operational status of some schemes has become available.

7.9 Included in the statistics are a number of CHP schemes fuelled by biogas generated by anaerobic digesters which do not submit to CHPQA. These particular schemes are included on the basis that food waste makes up part of the composition of the feedstock and that, therefore, pasteurisation of the feedstock, or digestate, is required. As stated in paragraph 7.1, where data from sources other than CHPQA are used, the CHPQA methodology is nevertheless used to determine the qualifying capacities, fuel inputs, power and heat outputs, which are reported in this chapter. Under CHPQA, heat is only counted if it is deemed "useful heat". Useful heat from CHP is heat that is demonstrably utilised to displace heat that would otherwise be supplied from other sources. In the absence of CHP heat, heat to carry out the necessary pasteurisation of the feedstock or digestate, where the feedstock includes food waste, would have to come from another source. As such, at least some of the heat output from these particular CHP schemes is deemed useful heat, and so these schemes are included in the statistics. It is possible to include these schemes as robust information has become available about the composition of the feedstock to the digesters. These schemes are included in the statistics for years of operation 2017, 2018 and 2019 and have not been added retrospectively for earlier years.

Chart 7.1: Operating CHP capacity 1998 - 2019



7.10 Table 7A gives a summary of the overall CHP market. In 2019, CHP schemes generated 23,461 GWh of Good Quality electricity, 2.2 per cent higher than in 2018. This generated electricity represents 7.1 per cent of the total electricity generated in the UK. The quantity of Good Quality electricity generated in industry rose by 1.1 per cent between 2018 and 2019. Good Quality electricity output rose in all industrial sectors between 2018 and 2019 with the exception of Chemicals and Mineral Products. In Chemicals, it fell by a significant 16 per cent and in Mineral Products it fell by 7.8 per cent. The fall in Chemicals was due to a fall in the heat generated rather than a fall in the total electricity generated; for a given level of electricity generated, the proportion of this which is deemed Good Quality decreases as the heat recovered decreases. A very large proportion of this effect in Chemicals was due to a fall in heat recovered at one large CHP scheme. The fall in Mineral Products was due to a fall in all electricity generated, not just Good Quality. The Transport, Commerce and Administration (TCA) sector continued the rise in Good Quality electricity outputs seen over a number of years, with an increase of 5.7 per cent between 2018 and 2019. There was another increase in Good Quality electricity output from the Other sector (5.9 per cent).

7.11 Table 7A shows that CHP schemes supplied a total of 41,697 GWh of heat in 2019. This was a decrease of 2.7 per cent (1,140 GWh) compared to 2018. All of this fall took place within industry, where there were falls in heat output in the Chemicals, Oil and Gas, Food and Drink and Mineral Product sectors. The most significant fall was within the Chemicals sector, where the heat output decreased by 12 per cent (1,183 GWh) between 2018 and 2019. As explained above, there was a significant fall in heat output at one CHP scheme in Chemicals. There were increases in heat output in the non-industrial sectors, with increases of 4.6 per cent (155 GWh) in Other and 1.4 per cent (53 GWh) in Transport, Commerce and Administration (TCA).

7.12 In terms of electrical capacity by size of scheme, schemes larger than 10 MWe represent 70 per cent of the total electrical capacity of CHP schemes, as shown in Table 7B. Schemes less than 1 MWe constitute the majority of scheme numbers (79 per cent), but just 6.7 per cent of the total capacity. However, over time the proportion of total capacity accounted for by schemes over 10 MWe has decreased steadily, and was 78 per cent in 2014.

Table 7B: CHP schemes by capacity size ranges in 2019

Electrical capacity size range	Number of schemes	Share of total (per cent)	Total electricity capacity (MWe)	Share of total (per cent)
Less then100 kWe	700	27.5	45	0.7
100 kWe - 1 MWe	1,320	51.8	358	5.9
1 MWe - 2 MWe	207	8.1	306	5.1
2 MWe - 10 MWe	252	9.9	1,126	19
> 10 MWe +	68	2.7	4,216	70
Total	**2,547**	**100**	**6,050**	**100**

7.13 Table 7.5 shows that 50 per cent of total electrical capacity operates in combined cycle gas turbine (CCGT) mode and 28 per cent is from reciprocating engines. Simple cycle gas turbines accounted for 12 per cent of installed capacity in 2019. Over time there has been a steady decrease in the proportion of total installed capacity taken up by CCGT and a steady increase in the proportion of this taken up by reciprocating engines. For example, in 2006 these proportions were 75 per cent (CCGT) and 11 per cent (reciprocating engines). Over the last few years there has been an absolute fall in the capacity of CCGT schemes, with the large majority of this capacity being lost from the Chemicals and Paper sectors. Over the same period, there has been an absolute increase in the installed capacity of reciprocating engines, with a large proportion of these additions taking place within the TCA and Other sectors. While the capacity of back-pressure steam turbines has been decreasing over the years, in recent years there has been an increase in the capacity of pass-out condensing steam turbine scheme as new biomass and waste fuelled CHP schemes have been developed .The relatively inefficient and inflexible nature of back pressure steam turbines means that this technology is falling out of favour.

7.14 Excluded from the statistics tables presented in this chapter are a number of very small CHP schemes (micro-CHP) installed since 2010 in response to the Feed-in Tariff (FiT) scheme. The overwhelming majority of these schemes are domestic. At the end of 2019 there were 531 such schemes registered with Ofgem for FiTs with a total installed capacity of 582 kWe. There are no data on electricity generation or fuel consumption for these schemes and, consequently, they have been left out of the statistics tables. However, if included, there would have a negligible impact upon the capacity and generation figures presented in the statistics tables.

7.15 Table 7.7 provides data on heat capacity for each type of CHP installation. Starting in the 2013 edition of the Digest, there has been a change implemented in how the heat capacity has been derived. Prior to this, for a number of schemes, the data held on heat capacity were either not complete or were not a true reflection of the capacity of the scheme to generate heat in CHP operating mode. To allow for this, a standard methodology was developed and applied for the first time in the 2013 edition of the Digest for the determination of the heat capacity. This is applied to new schemes and schemes undergoing a change in plant. Details of this methodology may be found in the CHP methodology note which is available from the following link:
www.gov.uk/government/publications/combined-heat-and-power-statistics-data-sources-and-methodologies

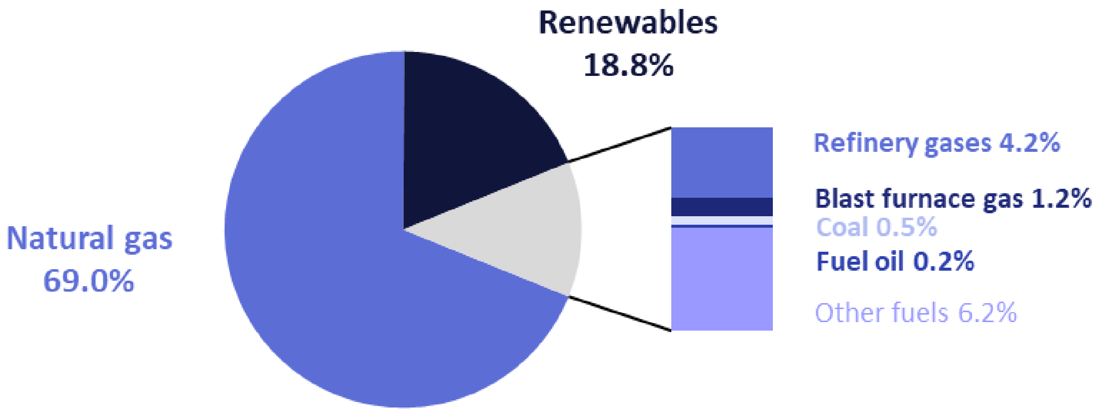
Fuel used by types of CHP installation

7.16 Table 7.2 shows the fuel used to generate electricity and heat in CHP schemes (see paragraphs 7.38 to 7.40 below for an explanation of the convention for dividing fuel between electricity and heat production). Table 7.3 gives the overall fuel used by types of CHP installation (which are explained in paragraph 7.37). Total fuel use is summarised in Chart 7.2. In 2019, 69 per cent of the total fuel use was natural gas and this is same as in 2018. CHP schemes accounted for 7.9 per cent of UK gas demand in 2019 (see Table 4.3). Coal and fuel oil only account of 0.7 percent of overall CHP fuel use.

7.17 The proportion of total fuel consumption that was renewable was 19 per cent in 2019. This is a 1 percentage point increase compared to 2018. Solid biomass fuels accounted for the largest share of renewable fuel (58 per cent), followed by gaseous renewable fuels (41 per cent) and liquid renewable fuels (1.7 per cent).

7.18 Fuels which are liquids, solids or gases that are by-products or waste products from industrial processes, or are renewable fuels, accounted for 29 per cent of all fuel used in CHP in 2019. This is 0.4 percentage points higher than in 2018. Over this period,there was a decrease in the consumption of waste heat as a energy input to CHP in the Chemicals sector.

Chart 7.2: Types of fuel used by CHP schemes in 2019



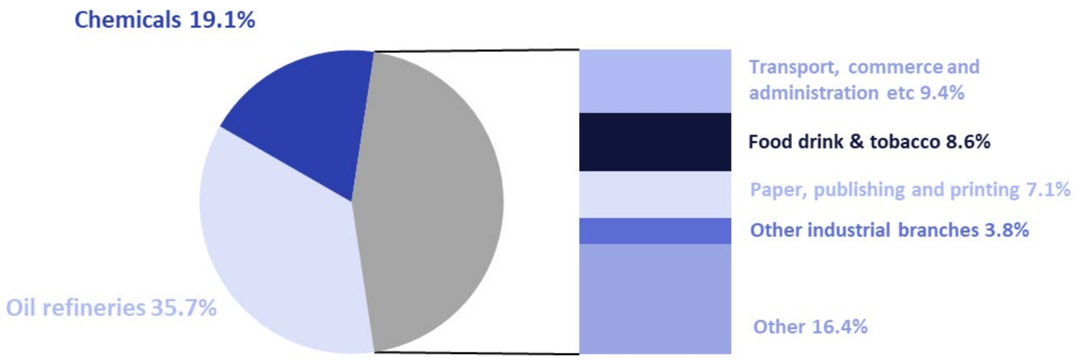
CHP capacity, output and fuel use by sector

7.19 In this chapter of the Digest, CHP is analysed by the sector using the heat or, where the heat is used by more than one sector, by the sector using the majority of the heat. This method of assigning a CHP scheme to a sector was rigorously applied for the first time in the 2008 edition of the digest and resulted in the movement of CHP schemes between sectors. One consequence of this was the removal of all schemes once allocated to the "electricity supply" sector and their distribution to other sectors. Full details of this reassignment are provided in paragraph 6.33 and Table 6J of the 2008 edition of the digest.

7.20 Table 7.8 gives data on all operational schemes by economic sector. A definition of the sectors used in this table can be found in Chapter 1, paragraph 1.59 and Table 1F:

- 426 schemes (77 per cent of electrical capacity) are in the industrial sector and 2,121 schemes (23 per cent of capacity) are in the agricultural, commercial, public administration, residential and transport sectors. The share of capacity in the industrial sector was lower in 2019 than in 2018 and this continues a long standing trend.
- The share of total installed Good Quality capacity taken up by each sector is shown in Chart 7.3. The Oil and gas terminals sector, which has been the largest sector since 2009, continues to have the largest share of total installed capacity, accounting for 36 per cent of all capacity. The Chemicals sector, which until 2008 had the largest share of capacity, had the second largest share in 2019 (19 per cent), followed by the "Other" sector (13 per cent) and Transport, commerce and administration (TCA) at 9.4 per cent. Between 2018 and 2019 the installed Good Quality capacity fell in Oil Refineries (2.1 per cent) and also slightly in Chemicals. In all of the other industrial sectors the capacity was either unchanged or increased slightly. The Good Quality capacity increased by 3.3 per cent and 2.4 per cent in the Other and TCA sectors, respectively.

Chart 7.3: CHP electrical capacity by sector in 2019



(1) Other sectors include agriculture, community heating, leisure, landfill and incineration
(2) Other industry includes textiles, clothing and footware, sewage treatment, metal machinery & equipment Iron steel & non ferrous metals and extraction/agglom. of solid fuels

7.21 Table 7C gives a summary of the 1,747 schemes installed in the commercial sector, public sector and residential buildings. These schemes form a major part of the "Transport, commerce and administration" and "Other" sectors in Tables 7.8 and 7.9. The vast majority of these schemes are based on spark ignition reciprocating engines fuelled with natural gas, though the larger schemes use compression ignition reciprocating engines or gas turbines. The largest proportion of the capacity remains in the health sector (33 per cent). About half of all schemes installed in buildings are in leisure and hotel settings, reflecting the suitability of CHP for meeting the demand profiles for heating and hot water in these types of building. The high heat to power ratio in the health sector is a reflection of the acute need for security of heat supply at hospitals, provided by back-up boilers, rather than the heat to power capacity ratios inherent in the prime mover used for power generation (see Definitions of schemes under Technical notes and definitions).

Table 7C: Number and capacity of CHP schemes installed in buildings by sector in 2019

	Number of schemes	Electrical capacity (MWe)	Heat capacity (MWth)
Leisure	582	76	125
Hotels	289	42	66
Health	257	221	1271
Residential Group Heating	133	110	476
Universities	101	107	532
Offices	43	17	22
Education	59	23	66
Government Estate	38	15	48
Retail	241	49	71
Other *(1)*	4	3	19
Total	**1,747**	**663**	**2,696**

(1) All schemes under Other are at airports

7.22 According to the Energy Performance in Buildings Directive, District Heating and Cooling (DHC) is the distribution of thermal energy in the form of steam, hot water or chilled products from a centralised place of production through a network to multiple buildings or sites for space or process heating or cooling. For statistical purposes, EUROSTAT further stipulates that, as well as more than one building or site having to be supplied, there must also be more than one customer for the heating or cooling supplied. Comprehensive data on Community Heating (CH) and District Heating (DH) schemes in the United Kingdom became available for the first time in 2017 when data submissions, made to the Office of Public Safety and Standards, as required under Article 3 of The Heat Network (Metering and Billing) Regulations 2014, were processed. Using these data and updated information from CHPQA, and adopting the EUROSTAT definition of DH, in 2018 there were an estimated 244 DH schemes using CHP in the UK, with a heat capacity of 5,351 MWth and supplying 7,760 GWh of heat to their associated DH networks[5].

CHP performance by main prime mover

7.23 Table 7D gives a summary of the performance of schemes in 2019 by main prime mover type. In 2019 the prime mover type with the highest average operating hours was reciprocating engines followed by gas turbines.

7.24 In 2019, the average operating hours were 3,878 hours. The average operating hours in 2018 (revised) was 3,784 hours, indicating an increase in the utilisation of good quality capacity over the period. This continues an upward trend in the utilisation of good quality capacity which started in 2014.

7.25 In 2019, the average electrical efficiency was 25 per cent and the heat efficiency 45 per cent, giving an overall average of 70 per cent. This overall efficiency is essentially unchanged since 2018. Overall efficiency is simply the sum of the individual electrical and heat efficiencies.

Table 7D: A summary of scheme performance in 2019

	Average operating hours per annum (Full load equivalent)	Average electrical efficiency (% GCV)	Average heat efficiency (% GCV)	Average overall efficiency (% GCV)	Average heat to power ratio
Main prime mover in CHP plant					
Back pressure steam turbine	1,665	6.8	89	96	13.1
Pass out condensing steam turbine	3,594	16	35	50	2.2
Gas turbine	4,045	25	39	63	1.6
Combined cycle	3,876	27	49	76	1.8
Reciprocating engine	4,113	31	37	68	1.2
Organic Rankine Cycle	2,944	8.2	56	65	6.9
All schemes	**3,878**	**25**	**45**	**70**	**1.8**

CHP schemes which export and schemes with mechanical power output

7.26 Table 7E shows the electrical exports from CHP schemes between 2017 and 2018. Power export figures are based upon export meter data. The total power exported given below is therefore the value registered on the power export meter, with one adjustment made for some schemes. Where the value registered on a scheme's power export meter is greater than the Total Power Output (TPO) for the scheme, the total power exported is capped at the TPO of the scheme. This adjustment is necessary in some situations where schemes import power from another place and onward supply this power, with the onward supplied power passing through the power export meter. Mathematically, this is shown as:

TPO Exported = Value registered on power export meter

If Value registered on power export meter > TPO, then TPO Exported is set to equal TPO.

The QPO exported is the TPO exported that is deemed good quality. This is calculated by assuming that any power consumed by the scheme is good quality power (QPO). This means that only if the scheme's consumption of power is less than the QPO will QPO become available for export. Mathematically, the QPO exported is:

QPO Exported = QPO for the scheme – Electricity consumed by the scheme, where

Electricity consumed by the scheme = Total Power Output – TPO Exported

[5] When comparing these statistics with other sources, care is required to ensure that the same definition of District Heating (DH) is being used.

If QPO for the scheme < Electricity consumed by the scheme, then QPO Exported is set to zero.

Table 7E also sets out the recipients of exported power.

Table 7E: Electrical exports from CHP (TPO)

GWh	2017	2018	2019
To part of same qualifying group *(1)*	1,145	7,657(r)	7,626
To a firm NOT part of same qualifying group	9,720	10,752(r)	10,605
To an electricity supplier	15,740	9,605(r)	11,054
Total	**26,605**	**28,014(r)**	**29,285**

(1) A qualifying group is a group of two or more corporate consumers that are connected or related to each other, for example, as a subsidiary, or via a parent or holding company, or in terms of share capital.

Table 7F: Electrical exports from CHP (QPO)

GWh	2017	2018	2019
	2017	2018	2019
To part of same qualifying group *(1)*	274	1,377	902
To a firm NOT part of same qualifying group	4,408	4,656(r)	4,236
To an electricity supplier	3,787	3,424(r)	4,759

Since 2015, there has been a strong correlation between the TPO exported and the Load Factor (Actual) shown in Table 7A. This is because the very large schemes, which drive the Load Factor (Actual), also tend to be the exporters of electricity. Over this period there has also been a strong correlation between QPO exported and Load Factor (CHPQA) for broadly the same reasons.

7.27 In 2019, 69 large schemes exported heat, with some exporting to more than one customer. In 2018 there were also 69 schemes exporting heat. As Table 7G shows, these schemes supplied 9,582 GWh of heat in 2019, which is a 2.8 per cent lower than in 2018. This fall in exported heat is consistent with the fall in heat generated mentioned above, since large reductions in generated heat have occurred at schemes that are heat exporters.

Table 7G: Heat exports from CHP

GWh	2017	2018	2019
To part of same qualifying group *(1)*	973	1,050	1,103
To a firm NOT part of same qualifying group	8,764	8,733(r)	8,391
To an electricity supplier	66	80	87
Total	**9,802**	**9,863(r)**	**9,582**

(1) A qualifying group is a group of two or more corporate consumers that are connected or related to each other, for example, as a subsidiary, or via a parent or holding company, or in terms of share capital.

7.28 There are an estimated 10 schemes with mechanical power output. For those schemes, mechanical power accounts for 9 per cent of their total power capacity (Table 7H). These schemes are predominantly on petro-chemicals or steel sites, using by-product fuels in boilers to drive steam turbines. The steam turbine is used to provide mechanical rather than electrical power, driving compressors, blowers or fans, rather than an alternator. The statistics on schemes with mechanical power are unchanged from those for 2018, published in the previous edition of the Digest.

Table 7H: CHP schemes with mechanical power output in 2019

	Unit	
Number of schemes		10
Total Power Capacity of these schemes (CHP_{TPC})	MWe	2,173
Mechanical power capacity of these schemes	MWe	203

Emissions savings

7.29 The calculation of carbon emissions savings from CHP is complex because CHP displaces a variety of fuels, technologies and sizes of plant. The methodology and assumptions used for calculating carbon emission savings are outlined in Energy Trends June 2003[6] (www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx). The figures compare CHP with the UK fossil fuel basket carbon intensity and the UK total basket carbon intensity, which includes nuclear and renewable generation. The carbon emission savings from CHP in 2019 as compared to the fossil fuel basket were 10.47 $MtCO_2$, which equates to 1.73 Mt CO_2 per 1,000 MWe installed capacity. Against the total basket, CHP saved 4.33 Mt CO_2 which equates to 0.72 Mt CO_2 per 1,000 MWe installed capacity.

7.30 Corresponding figures for 2017 and 2018 are shown in Table 7I. The 2017 and 2018 CO_2 savings are revised based on revisions to the relevant data for these years in Tables 7.1, 7.4, 7.6 and 7.9 and revisions to the CO_2 intensity of grid electricity. Absolute savings ($MtCO_2$) are sensitive to both the levels of CHP heat and power output, the fuels used in CHP generation and, especially, the CO_2 factor attributed to grid electricity that CHP electricity displaces. Between 2017 and 2019 there was a slight increase in CHP heat and power outputs (1.4% per cent) and an increase in the share of all fuel that was renewable. However, in spite of this, when measured against the total basket of grid electricity (i.e. including nuclear and renewables), both the absolute and relative CO_2 savings delivered by CHP fell each year between 2017-2019. This happened against a background of an 8.1 per cent fall in the carbon intensity of the total basket of electricity between 2017 and 2019. The CO_2 savings delivered by CHP relative to the fossil fuel basket are more steady over time, since reductions in the carbon intensity of this basket have been far less significant.

Table 7I: Carbon dioxide savings due to CHP, absolute and per 1,000 MWe of installed good quality CHP capacity

	2017		2018		2019	
	$MtCO_2$	$MtCO_2$/1000 MWe	$MtCO_2$	$MtCO_2$/1000 MWe	$MtCO_2$	$MtCO_2$/1000 MWe
Carbon savings against all fossil fuels	10.27	1.73	10.42	1.76	10.47	1.73
Carbon savings against all fuels (including nuclear and renewables)	4.69	0.79	4.42	0.75	4.33	0.72

Note: (1) The CO_2 savings in Table 7I assume that CHP generated electricity avoids the transmission and distribution losses associated with its conventionally generated equivalent. These losses are assumed to be 1.5% in the case of transmission losses and 6.0% in the case of distribution losses.

(2) The CO_2 savings quoted above for 2019 are based on preliminary CO_2 intensities, for that year, for the fossil fuel basket and the total fuel basket of conventional electricity generation. As such, they are subject to revision at a later date. The CO_2 savings quoted above for 2017 and 2018 have also been revised in response to changes in the CO_2 intensity factors for electricity for these years since reporting in DUKES 2019.The figures have also been revised to reflect revisions to CHP electricity and heat output and fuel consumption.

Government policy towards CHP

7.31 There are a range of support measures to incentivise the growth of Good Quality CHP in the UK. These include:

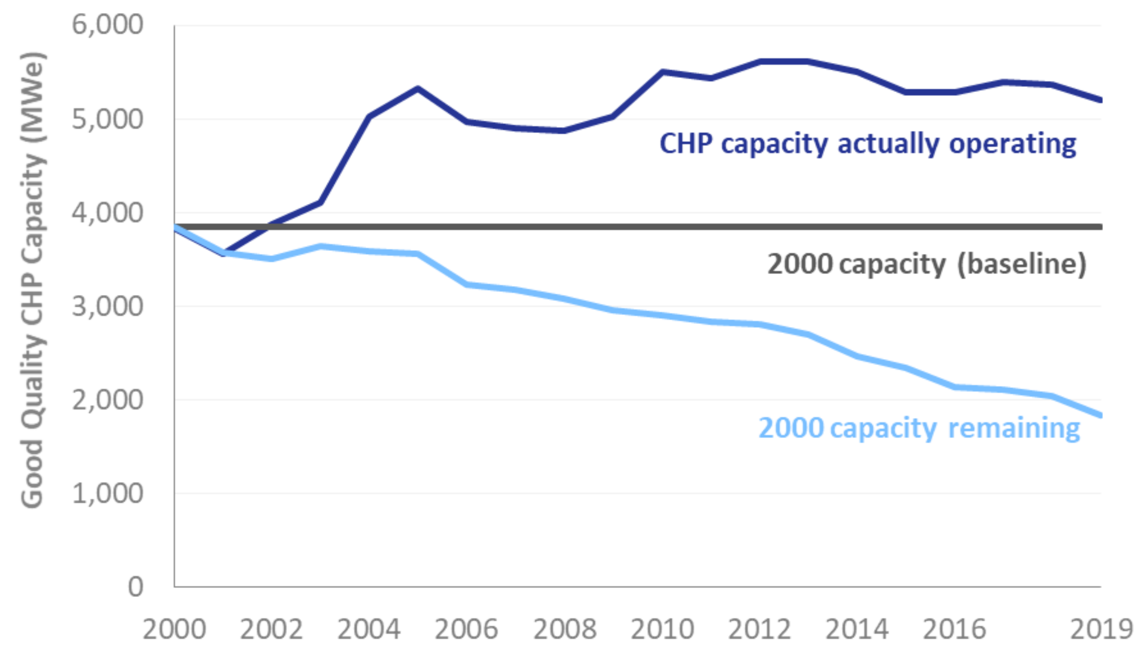
- Exemption from the Climate Change Levy (CCL) of all fuel inputs to, and electricity outputs from, Good Quality CHP. This exemption has been in place since the introduction of the CCL in 2001.
- From April 2013, exemption from Carbon Price Support (CPS) on fuel to CHP consumed for the generation of heat
- From April 2015, exemption from Carbon Price Support (CPS) on fuel to CHP consumed for the generation of Good Quality CHP electricity which is consumed on site

6 http://webarchive.nationalarchives.gov.uk/20060213234600/http:/www.dti.gov.uk/energy/inform/energy_trends/index.shtml

- Business Rates exemption for CHP power generation plant and machinery.
- Reduction of VAT (from 20 to 5 per cent) on domestic micro-CHP installations.
- Extension of the eligibility for Renewable Obligation Certificates (ROCs) to energy from waste plants that utilise CHP.
- Specific Renewable Heat Incentive (RHI) for biomass fuelled Good Quality CHP certified under CHPQA.
- Contract for Difference (CFD) for biomass fuelled CHP
- The zero-rating of heat under the Carbon Reduction Commitment Energy Efficiency Scheme (CRC), this means that allowances do not have to be purchased by a site covered by CRC for heat that it imports. This incentivises the use of CHP heat outputs.

7.32 Table 7.1 shows the installed Good Quality CHP capacity in each year. However, this table hides the underlying market activity that replaces older capacity as it is taken out of service over time. Chart 7.4 gives an idea of the scale of this activity since 2000 for CHP schemes certified under CHPQA. The baseline shows how much of the Good Quality CHPQA capacity that was in place in 2000 remained in place in subsequent years, while the upper line shows the actual Good Quality CHPQA capacity in place in each year. For any year since 2000, the gap between these two lines represents the new Good Quality CHPQA capacity installed between 2000 and that year. By 2018 there had been just over 3.4 GWe of new Good Quality CHPQA capacity installed since 2000.

Chart 7.4: Underlying market activity – operating Good Quality CHP versus retained Good Quality CHP, 2000 - 2019



International context

7.33 Phase III of EU ETS runs from 2013 until 2020. Under this phase there is no allocation made in respect of CO_2 emissions associated with the generation of electricity, including electricity generated by CHP. However, there is an allocation made in respect of EU ETS CO_2 emissions associated with measurable CHP heat consumption. The allocation is based upon harmonised benchmarks for heat production. In 2013 an EU ETS installation consuming CHP generated heat (not deemed at risk of carbon leakage) will have received a preliminary free allocation which is 80% of the allocation determined using this benchmark, declining linearly to 30% by 2020. Where the installation consuming the heat is deemed at significant risk of carbon leakage, then it will receive a preliminary free allocation which is 100% of the allocation determined using the benchmark for the duration of Phase III of EU ETS[7]. If the consumer of the heat is not an EU ETS installation, then the allocation is given to the heat producer. The benchmark for heat adopted by the European Commission is based on the use of natural gas with a conversion efficiency of 90% (N.C.V.). This means that the benchmark allocation made for each MWh of heat generated by a CHP scheme which is subsequently is 0.224 $tCO2$[8].

7 *In determining the final free allocation received by the installation, the preliminary free allocation is multiplied by a factor known as the cross-sectoral correction factor. The cross-sectoral correction factor is applied to ensure that the total amount of free allocation does not exceed a certain cap. For EU ETS Phase III, the cross-sectoral correction factor is a factor that is less than 1 and declines linearly from 0.94 to 0.82 between 2013 and 2020. This means that the final free allocation is always less than the preliminary free allocation.*

8 *Where the CHP supplies heat to an EU ETS Phase III sub-installation or installation and the sub-installation or installation produces a product that is product benchmarked, then an allocation is not made in respect of the heat supplied but in respect of the product produced.*

Technical notes and definitions

7.34 These notes and definitions are in addition to the technical notes and definitions covering all fuels and energy as a whole in Chapter 1, paragraphs 1.26 to 1.58.

Data for 2019

7.35 The data are summarised from the results of a long-term project undertaken by Ricardo Energy & Environment on behalf of the Department of Business, Energy and Industrial Strategy (BEIS). Data are included for CHP schemes installed in all sectors of the UK economy.

7.36 Data for 2019 were based on data supplied to the CHPQA programme, information from the Iron and Steel Statistics Bureau (ISSB), information from Ofgem in respect of “Renewables Obligation Certificates” (ROCs), information from the CHP Sales database maintained by the CHPA and from a survey of anaerobic digestion (AD) sites. Ninety-one per cent of the total capacity is from schemes that have been certified under the CHPQA programme. Sewage Treatment Works and other AD schemes that do not provide returns to CHPQA have been included based on ROCs and FITs information from Ofgem returns. The data from these sources accounts for approximately 6.1 per cent of total electrical capacity. The balance of the capacity is for schemes covered by ISSB sources (<1 per cent), CHPA Sales Database (<1 per cent) and for schemes not covered by the above sources which were interpolated from historical data (1 per cent).

Definitions of schemes

7.37 There are four principal types of CHP system:

- **Steam turbine,** where steam at high pressure is generated in a boiler. In **back pressure steam turbine systems**, the steam is wholly or partly used in a turbine before being exhausted from the turbine at the required pressure for the site. In **pass-out condensing steam turbine systems**, a proportion of the steam used by the turbine is extracted at an intermediate pressure from the turbine with the remainder being fully condensed before it is exhausted at the exit. (Condensing steam turbines without pass out and which do not utilise steam are not included in these statistics as they are not CHP). The boilers used in such schemes can burn a wide variety of fuels including coal, gas, oil, and waste-derived fuels. With the exception of waste-fired schemes, a steam turbine plant has often been in service for several decades. Steam turbine schemes capable of supplying useful steam have electrical efficiencies of between 10 and 20 per cent, depending on size, and thus between 70 per cent and 30 per cent of the fuel input is available as useful heat. Steam turbines used in CHP applications typically range in size from a few MWe to over 100 MWe.

- **Gas turbine systems**, often aero-engine derivatives, where fuel (gas or gas-oil) is combusted in the gas turbine and the exhaust gases are normally used in a waste heat boiler to produce usable steam, though the exhaust gases may be used directly in some process applications. Gas turbines range from 30 kWe upwards, achieving electrical efficiency of 23 to 30 per cent (depending on size) and with the potential to recover up to 50 per cent of the fuel input as useful heat. They have been common in CHP since the mid-1980s. The waste heat boiler can include supplementary or auxiliary firing using a wide range of fuels, and thus the heat to power ratio of the scheme can vary.

- **Combined cycle systems**, where the plant comprises more than one prime mover. These are usually gas turbines where the exhaust gases are utilised in a steam generator, the steam from which is passed wholly or in part into one or more steam turbines. In rare cases reciprocating engines may be linked with steam turbines. Combined cycle is suited to larger installations of 7 MWe and over. They achieve higher electrical efficiency and a lower heat to power ratio than steam turbines or gas turbines. Recently installed combined cycle gas turbine (CCGT) schemes have achieved an electrical efficiency approaching 50 per cent, with 20 per cent heat recovery, and a heat to power ratio of less than 1:1.

- **Reciprocating engine systems** range from less than 100 kWe up to around 5 MWe, and are found in applications where production of hot water (rather than steam) is the main requirement, for example, on smaller industrial sites as well as in buildings. They are based on auto engine or marine engine derivatives converted to run on gas. Both compression ignition and spark ignition firing is used. Reciprocating engines operate at around 28 to 33 per cent electrical efficiency with around 50 per cent to 33 per cent of the fuel input available as useful heat. Reciprocating engines produce two grades of waste heat: high grade heat from the engine exhaust and low grade heat from the engine cooling circuits.

- **Organic Rankine Cycle systems** operate on the same principle as steam turbines but, instead of using water steam as the working fluid, use organic substances with a lower boiling point and higher vapour pressure than water. This allows heat of a lower temperature to be converted into power via evaporation of the organic working fluid and expansion through a turbine. Low and medium temperature heat sources in the temperature range 80 to 350°C are exploited by ORC systems. The accessibility of low grade heat means that geothermal, industrial waste heat, biomass and solar heat sources can be exploited by ORC systems for the generation of power.

- **Steam screw expander systems** are based upon rotary screw expanders, rather than the turbine blades used in conventional steam turbine systems (see above). This allows power to be generated from wet steam, rather than the superheated dry steam that must be utilised in conventional steam turbines if turbine blade damage is to be avoided. Such systems can, for example, be installed in the place of pressure reduction valves in steam distribution systems, allowing the recovery of energy in the form of mechanical power and the onward supply of steam at the conditions desired downstream.

Determining fuel consumption for heat and electricity

7.38 In order to provide a comprehensive picture of electricity generation in the United Kingdom and the fuels used to generate that electricity, the energy input to CHP schemes has to be allocated between heat and electricity production. This allocation is notional and is not determinate.

7.39 The convention used to allocate the fuels to heat and electricity relates the split of fuels to the relative efficiency of heat and electricity supply. The efficiency of utility plant varies widely: electricity generation from as little as 25 per cent to more than 50 per cent and boilers from 50 per cent to more than 90 per cent. Thus it is around twice as hard to generate a unit of electricity as it is to generate a unit of heat. Accordingly, a simple convention can be implemented whereby twice as many units of fuel are allocated to each unit of electricity generated, as to each unit of heat supplied. This approach is consistent with the Defra Guidelines for Company Reporting on greenhouse gas emissions and for Negotiated Agreements on energy efficiency agreed between Government and industry as part of the Climate Change Levy (CCL) package. It recognises that, in developing a CHP scheme, both the heat customer(s) and the electricity generator share in the savings.

7.40 The assumption in this convention that it is twice as hard to generate a unit of electricity as heat, is appropriate for the majority of CHP schemes. However, for some types of scheme (for example in the iron and steel sector) this allocation is less appropriate and can result in very high apparent heat efficiencies. These, however, are only notional efficiencies.

The effects on the statistics of using CHPQA

7.41 Paragraph 7.6 described how schemes were scaled back so that only CHP_{QPC} and CHP_{QPO} are included in the CHP statistics presented in this Chapter. This is illustrated in Table 7J where it is seen that 446 schemes were scaled back for year of operation 2019. For information, in 2018, 431 schemes (revised) were scaled back.

7.42 In 2018, the power output from these schemes was scaled back from a total of 35,339 GWh to 12,772 GWh. The total fuel input to these schemes was 114,945 GWh of which 60,595 GWh was regarded as being for power only. For 2018, the total power output was scaled back from 34,872 GWh to 13,279 GWh.

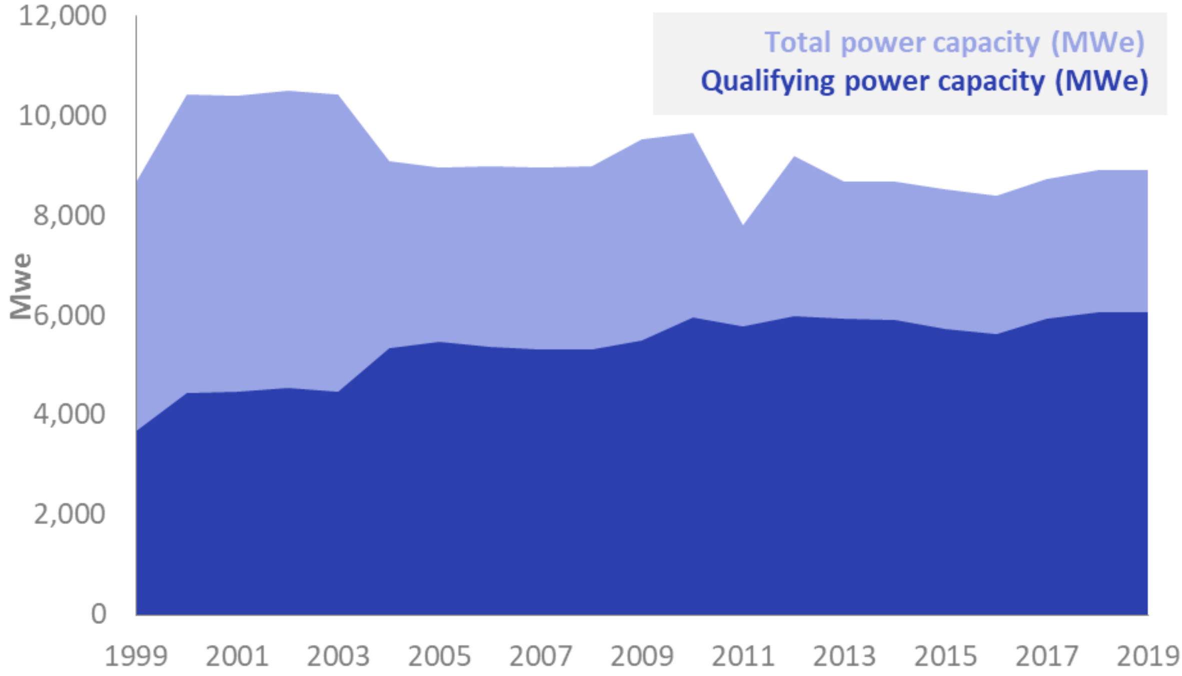
Table 7J: CHP capacity, output and fuel use which has been scaled back in 2019

	Units	
Number of schemes requiring scaling back		446
Total Power Capacity of these schemes (CHP_{TPC})	MWe	6,717
Qualifying Power Capacity of these schemes (CHP_{QPC})	MWe	3,877
Total power output of these schemes (CHP_{TPO})	GWh	35,339
Qualifying Power Output of these schemes (CHP_{QPO})	GWh	12,772
Electricity regarded as "Power only" not from CHP (CHP_{TPO} - CHP_{QPO})	GWh	22,567
Total Fuel Input of these schemes (CHP_{TFI})	GWh	114,945
Fuel input regarded as being for "Power only" use i.e. not for CHP	GWh	60,595

**This figure includes generation from major power producers*

7.43 The evolution of Total Power Capacity (TPC) and Qualifying Power Capacity (QPC) over time is shown in Chart 7.5.

Chart 7.5: Installed CHP capacity by year 1998 - 2019



Typical Power and Heat Efficiencies and Heat to Power Ratios of Prime Movers

7.44 The figures quoted above in Table 6D are for CHP schemes. These schemes may contain supplementary boilers, supplementary firing and auxiliary firing. The figures are, therefore, not reflective of the power and heat efficiencies and the heat to power ratios of the prime mover when it is considered in isolation.

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Digest of United Kingdom Energy Statistics 2020

Annexes

Annex A: Energy and commodity balances, conversion factors and calorific values

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Department for Business, Energy and Industrial Strategy

Annex A
Energy and commodity balances, conversion factors and calorific values

Balance principles

A.1 This Annex outlines the principles behind the balance presentation of energy statistics. It covers these in general terms. Fuel specific details are given in the appropriate chapters of this publication.

A.2 Balances are divided into two types, each of which performs a different function.

a) *commodity balance* – a balance for each energy commodity that uses the units usually associated with that commodity. By using a single column of figures, it shows the flow of the commodity from its sources of supply through to its final use. Commodity balances are presented in the individual fuel chapters of this publication.

b) energy balance - presents the commodity balances in a common unit and places them alongside one another in a manner that shows the dependence of the supply of one commodity on another. This is useful as some commodities are manufactured from others. The layout of the energy balance also differs slightly from the commodity balance. The energy balance format is used in Chapter 1.

A.3 Energy commodities can be either primary or secondary. Primary energy commodities are drawn (extracted or captured) from natural reserves or flows, whereas secondary commodities are produced from primary energy commodities. Crude oil and coal are examples of primary commodities, whilst petrol and coke are secondary commodities manufactured from them. For balance purposes, electricity may be considered to be both primary electricity (for example, hydro, wind) or secondary (produced from steam turbines using steam from the combustion of fuels).

A.4 Both commodity and energy balances show the flow of the commodity from its production, extraction or import through to its final use.

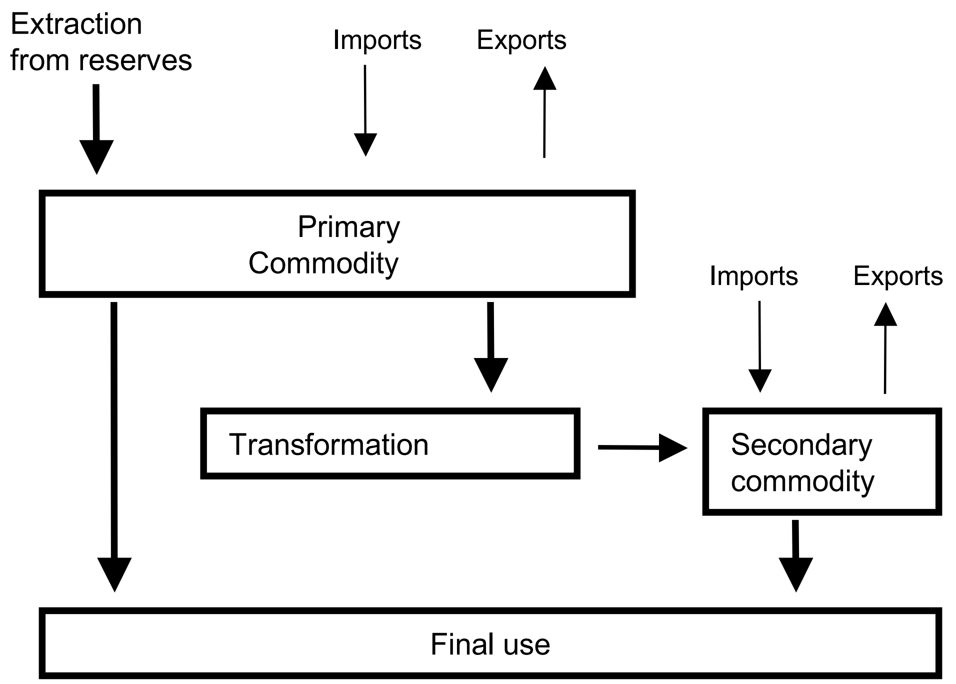
A.5 A simplified model of the commodity flow underlying the balance structure is given in Chart A.1. It illustrates how primary commodities may be used directly and/or be transformed into secondary commodities. The secondary fuels then enter final consumption or may also be transformed into another energy commodity (for example, electricity produced from fuel oil). To keep the diagram simple these “second generation” flows have not been shown.

A.6 The arrows at the top of the chart represent flows to and from the “pools” of primary and secondary commodities, from imports and exports and, in the case of the primary pool, extraction from reserves (eg the production of coal, gas and crude oil).

Commodity balances (Tables 2.1 to 2.3, 3.1 to 3.4, 4.1, 5.1, 5.2 and 6.1 to 6.3)

A.7 A commodity balance comprises a supply section and a demand section. The supply section gives available sources of supply (ie exports are subtracted). The demand section is divided into a transformation section, a section showing uses in the energy industries (other than for transformation) and a section covering uses by final consumers for energy or non-energy purposes. Final consumption for energy purposes is divided into use by sector of economic activity. The section breakdowns are described below.

Chart A.1: Energy flows



Supply

Production

A.8 Production, within the commodity balance, covers indigenous production (extraction or capture of primary commodities) and generation or manufacture of secondary commodities. Production is always gross, that is, it includes the quantities used during the extraction or manufacturing process.

Other sources

A.9 Production from other sources covers sources of supply that do not represent "new" supply. These may be recycled products, recovered fuels (slurry or waste coal), or electricity from pumped storage plants. The production of these quantities will have been reported in an earlier accounting period or have already been reported in the current period of account. Exceptionally, the *Other sources* row in the commodity balances for ethane, propane and butane is used to receive transfers of these hydrocarbons from gas stabilisation plants at North Sea terminals. In this manner, the supplies of primary ethane, propane and butane from the North Sea are combined with the production of these gases in refineries, so that the disposals may be presented together in the balances.

Imports and exports

A.10 The figures for imports and exports relate to energy commodities moving into or out of the United Kingdom as part of transactions involving United Kingdom companies. Exported commodities are produced in the United Kingdom and imported commodities are for use within the United Kingdom (although some may be re-exported before or after transformation). The figures thus exclude commodities either exported from or imported into HM Revenue and Customs bonded areas or warehouses. These areas, although part of the United Kingdom, are regarded as being outside of the normal United Kingdom's customs boundary, and so goods entering into or leaving them are not counted as part of the statistics on trade used in the balances.

A.11 Similarly, commodities that only pass through the United Kingdom on their way to a final destination in another country are also excluded. However, for gas these transit flows are included because it is difficult to identify this quantity separately, without detailed knowledge of the contract information covering the trade. This means that for gas, there is some over statement of the level of imports and exports, but the net flows are correct.

A.12 The convention in these balances is that exports are shown with a negative sign.

Marine bunkers

A.13 These are deliveries of fuels (usually fuel oil or gas oil) to ships of any flag (including the United Kingdom) for consumption during their voyage to other countries. Marine bunkers are treated rather like exports and shown with a negative sign.

Stock changes

A.14 Additions to (- sign) and withdrawals from stocks (+ sign) held by producers and transformation industries correspond to withdrawals from and additions to supply, respectively.

Transfers

A.15 There are several reasons why quantities may be transferred from one commodity balance to another:

- a commodity may no longer meet the original specification and be reclassified;
- the name of the commodity may change through a change in use;
- to show quantities returned to supply from consumers. These may be by-products of the use of commodities as raw materials rather than fuels.

A.16 A quantity transferred from a balance is shown with a negative sign to represent a withdrawal from supply and with a positive sign in the receiving commodity balance representing an addition to its supply. The transfers' row in Tables 1.1 to 1.3 should ideally sum to zero with transfers from primary oils to petroleum products amounting to a net figure of zero. Similarly the manufactured gases and natural gas transfers should sum to zero. However, differences in calorific values between the transferred fuels can result in non-zero values.

Total supply

A.17 The total supply available for national use is obtained by summing the flows above this entry in the balance.

Total demand

A.18 The various figures for the disposals and/or consumption of the commodities are summed to provide a measure of the demand for them. The main categories or sectors of demand are described in paragraphs A.31 to A.42.

Statistical difference

A.19 Any excess of supply over demand is shown as a statistical difference. A negative figure indicates that demand exceeds supply. Statistical differences arise when figures are gathered from a variety of independent sources and reflect differences in timing, in definition of coverage of the activity, or in commodity definition. Differences also arise for methodological reasons in the measurement of the flow of the commodity e.g. if there are differences between the volumes recorded by the gas producing companies and the gas transporting companies. A non-zero statistical difference is normal and, provided that it is not too large, is preferable to a statistical difference of zero as this suggests that a data provider has adjusted a figure to balance the account.

Transformation

A.20 The transformation section of the balance covers those processes and activities that transform the original primary (and sometimes secondary) commodity into a form which is better suited for specific uses than the original form. Most of the transformation activities correspond to particular energy industries whose main business is to manufacture the product associated with them. Certain activities involving transformation take place to make products that are only partly used for energy needs (coke oven coke) or are by-products of other manufacturing processes (coke oven and blast furnace gases). However, as these products and by-products are then used, at least in part, for their energy content they are included in the balance system.

A.21 The figures given under the activity headings of this section represent the quantities used for transformation. The production of the secondary commodities will be shown in the Production row of the corresponding commodity balances. The transformation section of the energy balance shows, for each fuel, the net inputs for transformation uses. For example, Table 1.1 for 2019 shows that 1,375 thousand tonnes of oil equivalent of coal feeds into the production of 1,292 thousand tonnes of oil equivalent of coke, representing a loss of 83 thousand tonnes of oil equivalent in the manufacture of coke in 2019. In 2019, energy losses during the production of electricity and other secondary fuels amounted to 32.9 million tonnes of oil equivalent, (17 per cent of primary supply) shown in the transformation row in Table 1.1.

Electricity generation

A.22 The quantities of fuels burned for the generation of electricity are shown in their commodity balances under this heading. The activity is divided into two parts, covering the major power producers (for whom the main business is the generation of electricity for sale) and autogenerators (whose main business is not electricity generation but who produce electricity for their own needs and may also sell surplus quantities). The amounts of fuels shown in the balance represent the quantities consumed for the gross generation of electricity. Where a generator uses combined heat and power plant, the figures include only the part of the fuel use corresponding to the electricity generated.

A.23 In relation to autogenerators' data, the figures for quantities of fuel used for electricity generation appear under the appropriate fuel headings in the *Transformation* section heading for *Autogenerators,* whilst the electricity generated appears in the *Electricity* column under *Production*. A breakdown of the information according to the branch of industry in which the generation occurs is not shown in the balance but is given in Chapter 5, Table 5.4. The figures for energy commodities consumed by the industry branches shown under final consumption include all use of electricity, but exclude the fuels combusted by the industry branches to generate the electricity.

Heat generation

A.24 The quantities of fuel burned to generate heat that is sold under the provision of a contract to a third party are shown in their commodity balances under this heading. It includes heat that is generated and sold by combined heat and power plants and by community heating schemes (also called district heating).

Petroleum refineries

A.25 Crude oil, natural gas liquids and other oils needed by refineries for the manufacture of finished petroleum products are shown under this heading.

Coke manufacture and blast furnaces

A.26 Quantities of coal for coke ovens and all fuels used within blast furnaces are shown under this heading. The consumption of fuels for heating coke ovens and the blast air for blast furnaces are shown under *Energy industry use*.

Patent fuel manufacture

A.27 The coals and other solid fuels used for the manufacture of solid patent fuels are reported under this heading.

Other

A.28 Any minor transformation activities not specified elsewhere are captured under this heading.

Energy industry use

A.29 Consumption by both extraction and transformation industries to support the transformation process (but not for transformation itself) are included here according to the energy industry concerned. Typical examples are the consumption of electricity in power plants (e.g. for lighting, compressors and cooling systems) and the use of extracted gases on oil and gas platforms for compressors, pumps and other uses. The headings in this section are identical to those used in the transformation section with the exception of *Pumped storage*. In this case, the electricity used to pump the water to the reservoir is reported. This section also includes consumption by those parts of the iron and steel industry which behave like an energy industry i.e. they are involved in the transformation processes (see paragraph A.20 of Annex A). In 2019, energy industry use amounted to 12.2 million tonnes of oil equivalent of energy (6.2 per cent of primary demand), up marginally on 2018. This series broadly follows the trend in UK energy production, so has generally been falling since 2000.

Losses

A.30 This heading covers the intrinsic losses that occur during the transmission and distribution of electricity and gas (including manufactured gases). Other metering and accounting differences for gas and electricity are within the statistical difference, as are undeclared losses in other commodities.

Final consumption

A.31 *Final consumption* covers both final energy consumption (by different consuming sectors) and the use of energy commodities for non-energy purposes, that is *Non energy use*. Final consumption occurs when the commodities used are not for transformation into secondary commodities. The energy concerned disappears from the account after use. Any fuel used for electricity generation by final consumers is identified and reported separately within the transformation section. When an enterprise generates electricity, the figure for final consumption of the industrial sector to which the enterprise belongs includes its use of the electricity it generates itself (as well as supplies of electricity it purchases from others) but does not include the fuel used to generate that electricity.

A.32 The classification of consumers according to their main business follows, as far as practicable, the *Standard Industrial Classification (SIC2007).* The qualifications to, and constraints on, the classification are described in the technical notes to Chapter 1. Table 1G in Chapter 1 shows the breakdown of final consumers used, and how this corresponds to the SIC2007.

Industry

A.33 Two sectors of industry (iron and steel and chemicals) require special mention because the activities they undertake fall across the transformation, final consumption and non-energy classifications used for the balances. Also, the data permitting an accurate allocation of fuel use within each of these major divisions are not readily available.

Iron and steel

A.34 The iron and steel industry is a heavy energy user for transformation and final consumption activities. Figures shown under final consumption for this industry branch reflect the amounts that remain after quantities used for transformation and energy sector own use have been subtracted from the industry's total energy requirements. Use of fuels for transformation by the industry may be identified within the transformation section of the commodity balances.

A.35 The amounts of coal used for coke manufacture by the iron and steel industry are in the transformation section of the coal balance. Included in this figure is the amount of coal used for coke manufacture by the companies outside of the iron and steel industry, i.e. solid fuel manufacturers. The corresponding production of coke and coke oven gas may be found in the commodity balances for these products. The use of coke in blast furnaces is shown in the commodity balance for coke, and the gases produced from blast furnaces and the associated basic oxygen steel furnaces are shown in the production row of the commodity balance for blast furnace gas.

A.36 Fuels used for electricity generation by the industry are included in the figures for electricity generation by autogenerators and are not distinguishable as being used by the iron and steel sector in the balances. Electricity generation and fuel used for this by broad industry group are given in Table 5.4.

A.37 Fuels used to support coke manufacture and blast furnace gas production are included in the quantities shown under *Energy industry use.* These gases and other fuels do not enter coke ovens or blast furnaces, but are used to heat the ovens and the blast air supplied to furnaces.

Chemicals

A.38 The petro-chemical industry uses hydrocarbon fuels (mostly oil products and gases) as feedstock for the manufacture of its products. Distinguishing the energy use of delivered fuels from their non-energy use is complicated by the absence of detailed information. The procedures adopted to estimate the use are described in paragraphs A.41 and A.42 under *Non energy use*.

Transport

A.39 Figures under this heading are almost entirely quantities used strictly for transport purposes. However, the figures recorded against road transport may include some fuel that is actually consumed in some "off-road" activities. Similarly, figures for railway fuels may include some amounts of burning oil not used directly for transport purposes. Transport sector use of electricity includes electricity used by rail companies (both over and underground) for traction purposes, and electricity used by electric road vehicles. The electricity used for non-traction purposes in industries classified to SIC2007 Groups 49 to 51 is included within the commercial sector. Fuels supplied to cargo and passenger ships undertaking international voyages are reported as *Marine bunkers* (see paragraph A.13). Supplies to fishing vessels are included under "agriculture".

Other sectors

A.40 The classification of all consumers groups under this heading, except *domestic and transport*, follows *SIC2007* and is described in Table 1G in Chapter 1. The consistency of the classification across different commodities cannot be guaranteed because the figures reported are dependent on what the data suppliers can provide.

Non energy use

A.41 The non energy use of fuels may be divided into two types. They may be used directly for their physical properties e.g. lubricants or bitumen used for road surfaces, or by the petro-chemical industry as raw materials for the manufacture of goods such as plastics. In their use by the petro-chemical industry, relatively little combustion of the fuels takes place and the carbon and/or hydrogen they contain are largely transferred into the finished product. However, in some cases heat from the manufacturing process or from combustion of by-products may be used. Data for this energy use are rarely available. Depending on the feedstock, non energy consumption is either estimated or taken to be the deliveries to the chemicals sector.

A.42 Both types of non energy use are shown under the *Non energy use* heading at the foot of the balances.

The energy balance (Tables 1.1 to 1.3)

Principles

A.43 The energy balance conveniently presents:

- an overall view of the United Kingdom's energy supplies;
- the relative importance of each energy commodity;
- dependence on imports;
- the contribution of our own fossil and renewable resources;
- the interdependence of commodities on one another.

A.44 The energy balance is constructed directly from the commodity balances by expressing the data in a common unit, placing them beside one another and adding appropriate totals. Heat sold is also included as a fuel. However, some rearrangements of the commodity balance format is required to show transformation of primary into secondary commodities in an easily understood manner.

A.45 Energy units are widely used as the common unit, and the current practice for the United Kingdom and the international organisations which prepare balances is to use the tonne of oil equivalent or a larger multiple of this unit, commonly thousands. One tonne of oil equivalent is defined as 10^7 kilocalories (41.868 gigajoules). The tonne of oil equivalent is another unit of energy like the gigajoule, kilocalorie or kilowatt hour, rather than a physical quantity. It has been chosen as it is easier to visualise than the other units. Due to the natural variations in heating value of primary fuels such as crude oil, it is rare that one tonne of oil has an energy content equivalent to one tonne of oil equivalent, however it is generally within a few per cent of the heating value of a tonne of oil equivalent. The energy figures are calculated from the natural units of the commodity balances by multiplying by the factors representing the calorific (heating) value of the fuel. The gross calorific values of fuels are used for this purpose. When the natural unit of the commodity is already an energy unit (electricity in kilowatt hours, for example) the factors are just constants, converting one energy unit to another.

A.46 Most of the underlying definitions and ideas of commodity balances can be taken directly over into the energy balance. However, production of secondary commodities and, in particular, electricity are treated differently and need some explanation. The components of the energy balance are described below, drawing out the differences of treatment compared with the commodity balances.

Primary supply

A.47 Within the energy balance, the production row covers only extraction of primary fuels and the generation of primary energy (hydro, nuclear, wind, solar photovoltaics). Note the change of row heading from *Production* in the commodity balances to *Indigenous production* in the energy balance. Production of secondary fuels and secondary electricity are shown in the transformation section and not in the indigenous production row at the top of the balance.

A.48 For fossil fuels, indigenous production represents the marketable quantity extracted from the reserves. Indigenous production of *Primary electricity* comprises hydro-electricity, wind, solar photovoltaics and nuclear energy. The energy value for hydro-electricity is taken to be the energy content of the electricity produced from the hydro power plant and not the energy available in the water driving the turbines. A similar approach is adopted for electricity from wind generators and photovoltaics. The electricity is regarded as the primary energy form because there are currently no other uses of the energy resource "upstream" of the generation. The energy value attached to nuclear electricity is discussed in paragraph A.52.

A.49 The other elements of the supply part of the balance are identical to those in the commodity balances. In particular, the sign convention is identical, so that figures for exports and international marine bunkers carry negative signs. A stock build carries a negative sign to denote it as a withdrawal from supply whilst a stock draw carries a positive sign to show it as an addition to supply.

A.50 The *Primary supply* is the sum of the figures above it in the table, taking account of the signs, and expresses the national requirement for primary energy commodities from all sources and foreign supplies of secondary commodities. It is an indicator of the use of indigenous resources and external energy supplies. Both the amount and mixture of fuels in final consumption of energy commodities in the United Kingdom will differ from the primary supply. The "mix" of commodities in final consumption will be much more dependent on the manufacture of secondary commodities, in particular electricity.

Transformation

A.51 Within an energy balance the presentation of the inputs to and outputs from transformation activities requires special mention, as it is carried out using a compact format. The transformation section also plays a key role in moving primary electricity from its own column in the balance into the electricity column, so that it can be combined with electricity from fossil fuelled power stations and the total disposals shown.

A.52 Indigenous production of primary electricity comprises nuclear electricity, hydro electricity, electricity from wind generation and from solar photovoltaics. Nuclear electricity is obtained by passing steam from nuclear reactors through conventional steam turbine sets. The heat in the steam is considered to be the primary energy available and its value is calculated from the electricity generated using the average thermal efficiency of nuclear stations, currently 36.4 per cent (in 2019) in the United Kingdom. The electrical energy from hydro and wind is transferred from the *Primary electricity* column to the *Electricity* column using the *transfers* row because this electricity is in the form of primary energy and no transformation takes place. However, because the form of the nuclear energy is the steam from the nuclear reactors, the energy it contains is shown entering electricity generation and the corresponding electricity produced is included with all electricity generation in the figure, in the same row, under the *Electricity* column.

A.53 Quantities of fuels entering transformation activities (fuels into electricity generation and heat generation, crude oil into petroleum product manufacture (refineries), or coal into coke ovens) are shown with a negative sign to represent the input and the resulting production is shown as a positive number.

A.54 For electricity generated by major power producers, the inputs are shown in the m*ajor power producers'* row of the *coal, manufactured fuel, primary oils, petroleum products, gas, bioenergy and waste* and *primary electricity* columns. The total energy input to electricity generation is the sum of the values in these first seven columns. The *Electricity* column shows total electricity generated from these inputs and the transformation loss is the sum of these two figures, given in the *Total* column.

A.55 Within the transformation section, the negative figures in the *Total* column represent the losses in the various transformation activities. This is a convenient consequence of the sign convention chosen for the inputs and outputs from transformation. Any positive figures represent a transformation gain and, as such, are an indication of incorrect data.

A.56 In the energy balance, the columns containing the input commodities for electricity generation, heat generation and oil refining are separate from the columns for the outputs. However, for the transformation activities involving solid fuels this is only partly the case. Coal used for the manufacture of coke is shown in the coke manufacture row of the transformation section in the coal column, but the related coke and coke oven gas production are shown combined in the *Manufactured fuels* column. Similarly, the input of coke to blast furnaces and the resulting production of blast furnace gas are not identifiable and have been combined in the *Manufactured fuels* column in the *Blast furnace* row. As a result, only the net loss from blast furnace transformation activity appears in the column.

A.57 The share of each commodity or commodity group in primary supply can be calculated from the table. This table also shows the demand for primary as well as foreign supplies. Shares of primary supplies may be taken from the *Primary supply* row of the balance. Shares of fuels in final consumption may be calculated from the final consumption row.

Energy industry use and final consumption

A.58 The figures for final consumption and energy industry use follow, in general, the principles and definitions described under commodity balances in paragraphs A.29 to A.42.

Standard conversion factors

1 tonne of oil equivalent (toe)	= 10^7 kilocalories				
	= 396.83 therms				
	= 41.868 GJ				
	= 11,630 kWh				
100,000 British thermal units (Btu)	= 1 therm				

This Digest follows UK statistical practice and uses the term "billion" to refer to one thousand million or 10^9

The following prefixes are used for multiples of joules, watts and watt hours:

kilo (k)	= 1,000	or 10^3
mega (M)	= 1,000,000	or 10^6
giga (G)	= 1,000,000,000	or 10^9
tera (T)	= 1,000,000,000,000	or 10^{12}
peta (P)	= 1,000,000,000,000,000	or 10^{15}

WEIGHT

1 kilogramme (kg)	= 2.2046 pounds (lb)
1 pound (lb)	= 0.4536 kg
1 tonne (t)	= 1,000kg
	= 0.9842 long ton
	= 1.102 short ton (sh tn)
1 Statute or long ton	= 2,240 lb
	= 1.016 t
	= 1.120 sh tn

LENGTH

1 mile	= 1.6093 kilometres
1 kilometre (km)	= 0.62137 miles

VOLUME

1 cubic metre (cu m)	= 35.31 cu ft
1 cubic foot (cu ft)	= 0.02832 cu m
1 litre	= 0.22 Imperial gallons (UK gal)
1 UK gallon	= 8 UK pints
	= 1.201 US gallons (US gal)
	= 4.54609 litres
1 barrel	= 159.0 litres
	= 34.97 UK gal
	= 42 US gal

TEMPERATURE

1 scale degree Celsius (C)	= 1.8 scale degrees Fahrenheit (F)

For conversion of temperatures: °C = 5/9 (°F –32); °F = 9/5 °C +32

Average conversion factors for petroleum 2019

	Litres per tonne
Crude oil:	
Indigenous	1,199
Imported	1,181
Average of refining throughput	1,192
Ethane	2,730
Propane	1,942
Butane	1,738
Naphtha	1,483
Aviation gasoline	1,370
Motor spirit:	
All grades	1,348
Super	1,370
Premium	1,348
Middle distillate feedstock	..
Kerosene:	
Aviation turbine fuel	1,250
Burning oil	1,246
DERV fuel:	
0.005% or less sulphur	1,186
Gas /Marine diesel oil	1,171
Fuel oil (1% or less sulphur)	
All grades:	1,017
Light:	..
Medium	..
Heavy:	..
Lubricating oils:	
White	1,157
Greases	..
Bitumen	980
Petroleum coke	..
Petroleum waxes	1,184
Industrial spirit	1,247
White spirit	1,251

Note: The above conversion factors, which for refined products have been compiled by BEIS using data from UK Petroleum Industry Association companies, apply to the year 2019. The litres to tonnes conversions are made at a standard temperature of 15ºC.
.. Denotes commercially sensitive because too few companies are producing this to be able to report it.

Fuel conversion factors for converting fossil fuels to carbon dioxide

	kg CO_2 per tonne	kg CO_2 per kWh	kg CO_2 per litre
Gases			
Natural Gas		0.184	
LPG		0.214	1.553
Liquid fuels			
Gas oil	3190	0.254	2.724
Fuel oil	3209	0.267	
Burning oil	3150	0.245	2.528
Naphtha	3131	0.236	
Petrol	3135	0.240	2.302
Diesel	3164	0.249	2.652
Aviation spirit	3128	0.238	2.226
Aviation turbine fuel	3150	0.245	2.518
Solid fuels			
Industrial coal	2355	0.317	
Domestic coal	2632	0.315	
Coking coal	3201	0.362	

All emission factors are based on a Gross Calorific Value basis

The information above is based on the 2020 Greenhouse gas conversion factors for company reporting, available at: www.gov.uk/government/collections/government-conversion-factors-for-company-reporting. The information on this website also provide emission factors on a Net Calorific Basis.

The figures are derived by Ricardo E&E based on data contained in the 2019 edition of this Digest, available at: www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes together with information from the National Atmospheric Emissions Inventory. More information on the Inventory is available at: http://naei.beis.gov.uk/reports/. For liquid fuels, the “kg CO_2 per tonne” figure remains fairly constant on a year to year basis, so it is possible to derive “kg CO_2 per kWh” and “kg CO_2 per litre” figures for other years using the average conversion factors for petroleum data contained annually in Annex A of the Digest.

Annex B
Glossary and Acronyms

Anthracite	Within this publication, anthracite is coal classified as such by UK coal producers and importers of coal. Typically it has a high heat content making it particularly suitable for certain industrial processes and for use as a domestic fuel.
Associated gas	Natural gas found in association with crude oil in a reservoir, either dissolved in the oil or as a cap above the oil.
Autogeneration	Generation of electricity by companies whose main business is not electricity generation, the electricity being produced mainly for that company's own use.
Aviation spirit	A light hydrocarbon oil product used to power piston-engined aircraft power units.
Aviation turbine fuel	The main aviation fuel used for powering aviation gas-turbine power units (jet aircraft engine).
Backflows	These are finished or semi-finished products, which are returned from final consumers to refineries for processing, blending or sale. They are usually by-products of petrochemical manufacturing.
BEIS	Department for Business, Energy and Industrial Strategy
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 constituent of motor fuel.
BETTA	British Electricity Trading and Transmission Arrangements (BETTA) refer to changes to electricity generation, distribution and supply licences. On 1 April 2005, the England and Wales trading arrangements were extended to Scotland by the British Electricity Trading and Transmission Arrangements creating a single GB market for trading of wholesale electricity, with common arrangements for access to and use of GB transmission system. From 1 April 2005, NGC has become the System Operator for the whole of GB. BETTA replaced NETA on 4 April 2005.
BG	British Gas
Biodiesel	(FAME - biodiesel produced to BS EN 14214). Produced from vegetable oils or animal fats by mixing them with ethanol or methanol to break them down.
Bioenergy	Bioenergy is renewable energy made from material of recent biological origin derived from plant or animal matter.
Bioethanol	Created from crops rich in starch or sugar by fermentation, distillation and finally dehydration.
Biogas	Energy produced from the anaerobic digestion of sewage and industrial waste.

Biomass	Renewable organic materials, such as wood, agricultural crops or wastes, and municipal wastes. Biomass can be burned directly or processed into biofuels such as ethanol and methane
Bitumen	The residue left after the production of lubricating oil distillates and vacuum gas oil for upgrading plant feedstock. Used mainly for road making and construction purposes.
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.
BNFL	British Nuclear Fuels plc.
BOS	Basic Oxygen Steel furnace gas
BRE	Building Research Establishment
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.
Burning oil	A refined petroleum product, with a volatility in between that of motor spirit and gas diesel oil primarily used for heating and lighting.
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).
Calorific values (CVs)	The energy content of a fuel can be measured as the heat released on complete combustion. The SI (Système International) derived unit of energy and heat is the Joule. This is the energy in a given quantity of the fuel and is often measured in GJ per tonne. The energy content can be expressed as an upper (or gross) value and a lower (or net) value. The difference between the two values is due to the release of energy from the condensation of water in the products of combustion. Gross calorific values are used throughout this publication.
Carbon Emission Reduction Target (CERT)	The Carbon Emissions Reduction Target (CERT) follows on from the Energy Efficiency Commitment (EEC). CERT requires gas and electricity suppliers to achieve targets for a reduction in carbon emissions generated by the domestic sector.
CCA	Climate Change Agreement. Climate Change Agreements allow energy intensive business users to receive a 65 per cent discount from the Climate Change Levy (CCL), in return for meeting energy efficiency or carbon saving targets. The CCL is a tax on the use of energy in industry, commerce and the public sector. The aim of the levy is to encourage users to improve energy efficiency and reduce emissions of greenhouse gases.
CCL	Climate Change Levy. The Climate Change Levy is a tax on the use of energy in industry, commerce and the public sector, with offsetting cuts in employers' National Insurance Contributions and additional support for energy efficiency schemes and renewable sources of energy. The aim of the levy is to encourage users to improve energy efficiency and reduce emissions of greenhouse gases.

CO_2 Carbon dioxide. Carbon dioxide contributes about 60 per cent of the potential global warming effect of man-made emissions of greenhouse gases. Although this gas is naturally emitted by living organisms, these emissions are offset by the uptake of carbon dioxide by plants during photosynthesis; they therefore tend to have no net effect on atmospheric concentrations. The burning of fossil fuels, however, releases carbon dioxide fixed by plants many millions of years ago, and thus increases its concentration in the atmosphere.

Co-firing The burning of biomass products in fossil fuel power stations

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 in 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 qualities 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, i.e. the end product must be a coherent solid.

Colliery methane Methane released from coal seams in existing and abandoned deep mines and from coal beds which is piped to the surface and consumed at the colliery or transmitted by pipeline to consumers.

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.

CHPQA Combined Heat and Power Quality Assurance Scheme

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.

Cracking/conversion	A refining process using combinations of temperature, pressure and in some cases a catalyst to produce petroleum products by changing the composition of a fraction of petroleum, either by splitting existing longer carbon chains or combining shorter carbon chain components of crude oil or other refinery feedstocks. Cracking allows refiners to selectively increase the yield of specific fractions from any given input petroleum mix depending on their requirements in terms of output products.
CRC	Carbon Reduction Commitment. The CRC Energy Efficiency scheme is a mandatory scheme aimed at improving energy efficiency and cutting emissions in large public and private sector organisations.
Crude oil	A mineral oil consisting of a mixture of hydrocarbons of natural origins, yellow to black in colour, of variable density and viscosity.
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DERV	Diesel engined road vehicle fuel used in internal combustion engines that are compression-ignited.
DFT	Department for Transport
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.
DNC	Declared net capacity and capability are used to measure the maximum power available from generating stations at a point in time.
DNO	Distribution Network Operator
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.
DUKES	Digest of United Kingdom Energy Statistics.
EHCS	English House Condition Survey
Embedded Generation	Embedded generation is electricity generation by plant which has been connected to the distribution networks of the public electricity distributors rather than directly to the National Grid Company's transmission systems. Typically they are either smaller stations located on industrial sites, or combined heat and power plant, or renewable energy plant such as wind farms, or refuse burning generators. The category also includes some domestic generators such as those with electric solar panels.
Energy use	Energy use of fuel mainly comprises use for lighting, heating or cooling, motive power and power for appliances. See also non-energy use.
ESA	European System of Accounts. An integrated system of economic accounts which is the European version of the System of National Accounts (SNA).

Ethane	A light hydrocarbon gas (C_2H_6) in natural gas and refinery gas streams (see LPG).
EU-ETS	European Union Emissions Trading Scheme. This began on 1st January 2005 and involves the trading of emissions allowances as means of reducing emissions by a fixed amount.
EUROSTAT	Statistical Office of the European Commission.
Exports	For some parts of the energy industry, statistics on trade in energy related products can be derived from two separate sources. Firstly, figures can be reported by companies as part of systems for collecting data on specific parts of the energy industry (e.g. as part of the system for recording the production and disposals of oil from the UK continental shelf). Secondly, figures are also available from the general systems that exist for monitoring trade in all types of products operated by HM Revenue and Customs.
Feed-In Tariffs	The Feed-in Tariffs (FITs) scheme was introduced to encourage deployment of small-scale (less than 5MW) low-carbon electricity generation. People with a qualifying technology received a guaranteed payment from an electricity supplier of their choice for the electricity they generated and used, as well as a guaranteed payment for unused surplus electricity they export back to the grid. The scheme closed at the end of March 2019.
Feedstock	In the refining industry, a product or a combination of products derived from crude oil, destined for further processing other than blending. It is distinguished from use as a chemical feedstock etc.
Final energy consumption	Energy consumption by final user – i.e. 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.
Fuel oils	The heavy oils from the refining process; used as fuel in furnaces and boilers of power stations, industry, in domestic and industrial heating, ships, locomotives, metallurgic operation, and industrial power plants etc.
Fuel oil - Light	Fuel oil made up of heavier straight-run or cracked distillates and used in commercial or industrial burner installations not equipped with pre-heating facilities.
Fuel oil - Medium	Other fuel oils, sometimes referred to as bunker fuels, which generally require pre-heating before being burned, but in certain climatic conditions do not require pre-heating.
Fuel oil - Heavy	Other heavier grade fuel oils which in all situations require some form of pre-heating before being burned.
Fuel poverty	A household is said to be in fuel poverty if they have required fuel costs that are above average (the national median level), and were they to spend that amount they would be left with a residual income below the official poverty line

Gas diesel oil The medium oil from the refinery process; used as a fuel in diesel engines (i.e. internal combustion engines that are compression-ignited), burned in central heating systems and used as a feedstock for the chemical industry.

GDP Gross Domestic Product.

GDP deflator An index of the ratio of GDP at current prices to GDP at constant prices. It provides a measure of general price inflation within the whole economy.

Gigajoule (GJ) A unit of energy equal to 10^9 joules.

Gigawatt (GW) A unit of electrical power, equal to 10^9 watts.

Green Deal A scheme by which energy-saving improvements can be made to a home or business without having to pay all the costs up front; energy-saving improvements include:

- insulation - e.g. loft or cavity wall insulation
- heating
- draught-proofing
- double glazing
- renewable energy technologies - e.g. solar panels or wind turbines

Heat pumps Heat pumps use a heat exchanger (much like that installed in fridges and freezers – although running in reverse) to take heat from the ground or air and convert it into heating in the home (either radiators, underfloor heating or warm air heating systems and hot water). Ground source heat pumps use pipes which are buried in the ground to extract heat. Air source heat pumps absorb heat from the outside air. Heat pumps need electricity to run, but the heat they extract from the ground or air is constantly being renewed naturally.

Heat sold Heat (or steam) that is produced and sold under the provision of a contract. Heat sold is derived from heat generated by Combined Heat and Power (CHP) plants and from community heating schemes without CHP plants.

HMRC HM Revenue and Customs.

Imports Before the 1997 edition of the Digest, the term "arrivals" was used to distinguish figures derived from the former source from those import figures derived from the systems operated by HM Revenue and Customs. To make it clearer for users, a single term is now being used for both these sources of figures (the term imports) as this more clearly states what the figures relate to, which is goods entering the UK.

Indigenous production The extraction or capture of primary fuels: for oil this includes production from the UK Continental Shelf, both onshore and offshore.

Industrial spirit Refined petroleum fractions with boiling ranges up to 200ºC dependent on the use to which they are put – e.g. seed extraction, rubber solvents, perfume etc.

International Energy Agency (IEA) The IEA is an autonomous body located in Paris which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

ISSB	International Steel Statistics Bureau
Joules	A joule is a generic unit of energy in the conventional SI system. It is equal to the energy dissipated by an electrical current of 1 ampere driven by 1 volt for 1 second; it is also equal to twice the energy of motion in a mass of 1 kilogram moving at 1 metre per second.
Kilowatt (kW)	1,000 watts
Landfill gas	The methane-rich biogas formed from the decomposition of organic material in landfill.
LDF	Light distillate feedstock
LDZ	Local distribution zone
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.
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, e.g. some specially adapted road vehicles, forklift trucks.
Lubricating oils	Refined heavy distillates obtained from the vacuum distillation of petroleum residues. Includes liquid and solid hydrocarbons sold by the lubricating oil trade, either alone or blended with fixed oils, metallic soaps and other organic and/or inorganic bodies.
Magnox	A type of gas-cooled nuclear fission reactor developed in the UK, so called because of the magnesium alloy used to clad the uranium fuel.
Major Power Producers (MPPs)	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.
Micro CHP	Micro CHP is a new technology that is expected to make a significant contribution to domestic energy efficiency in the future.
Motor spirit	Blended light petroleum product used as a fuel in spark-ignition internal combustion engines (other than aircraft engines).
NAEI	National Atmospheric Emissions Inventory
Naphtha	(Light distillate feedstock) – Petroleum distillate boiling predominantly below 200ºC.
National Allocation Plan (NAP)	Under the EU Emissions Trading Scheme (EU-ETS) Directive each EU country must have a National Allocation Plan which lays down the overall contribution of the EU-ETS participants (the "cap") for the country and the allowances that each sector and each individual installation covered under the Directive is allocated, effectively stating how much that sector can emit over the trading period of the scheme.

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 components are methane, ethane, propane and 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 - compressed — Natural gas that has been compressed to reduce the volume it occupies to make it easier to transport other than in pipelines. Whilst other petroleum gases can be compressed such that they move into liquid form, the volatility of natural gas is such that liquefaction cannot be achieved without very high pressures and low temperatures being used. As such, the compressed form is usually used as a “half-way house”.

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).

NDA — Nuclear Decommissioning Authority

NETA — New Electricity Trading Arrangements - In England and Wales these arrangements replaced “the pool” from 27 March 2001. The arrangements are based on bi-lateral trading between generators, suppliers, traders and customers and are designed to be more efficient, and provide more market choice.

NFFO — Non-Fossil Fuel Obligation. The 1989 Electricity Act empowers the Secretary of State to make orders requiring the Regional Electricity Companies in England and Wales to secure specified amounts of electricity from renewable sources.

NFPA — Non-Fossil Purchasing Agency

NIE — Northern Ireland Electricity

NI NFFO — Northern Ireland Non-Fossil Fuel Obligation

Non-energy use — Includes fuel used for chemical feedstock, solvents, lubricants, and road making material.

NO_X — Nitrogen oxides. A number of nitrogen compounds including nitrogen dioxide are formed in combustion processes when nitrogen in the air or the fuel combines with oxygen. These compounds can add to the natural acidity of rainfall.

NUTS — Nonmenclature of Units for Territorial Statistics

OFGEM — The regulatory office for gas and electricity markets

OFT — Office of Fair Trading

ONS — Office for National Statistics

Orimulsion — An emulsion of bitumen in water that was used as a fuel in some power stations until 1997.

OTS — Overseas Trade Statistics of the United Kingdom

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.

Photovoltaics The direct conversion of solar radiation into electricity by the interaction of light with the electrons in a semiconductor device or cell.

PILOT Phase 2 (PILOT) is the successor body to the Oil & Gas Industry Task Force (OGITF) and was established on 1 January 2000, to secure the long-term future of the oil and gas industry in the UK. A forum that brings together Government and industry to address the challenges facing the oil and gas industry. One outcome of PILOT's work is the published Code of Practice on Supply Chain Relationships.

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.

PPRS Petroleum production reporting system. Licensees operating in the UK Continental Shelf are required to make monthly returns on their production of hydrocarbons (oil and gas) to BEIS. This information is recorded in the PPRS, which is used to report flows, stocks and uses of hydrocarbon from the well-head through to final disposal from a pipeline or terminal (see DUKES annex F on the BEIS energy statistics website for further information).

Primary electricity Electricity obtained other than from fossil fuel sources, e.g. nuclear, hydro and other non-thermal renewables. Imports of electricity are also included.

Primary fuels Fuels obtained directly from natural sources, e.g. coal, oil and natural gas.

Process oils Partially processed feedstocks which require further processing before being classified as a finished product suitable for sale. They can also be used as a reaction medium in the production process.

Propane Hydrocarbon containing three carbon atoms (C_3H_8), gaseous at normal temperature, but generally stored and transported under pressure as a liquid.

RD Renewables Directive – this proposes that EU Member States adopt national targets that are consistent with the overall EU target of 20 per cent of energy from renewables by 2020.

Refinery fuel Petroleum products produced by the refining process that are used as fuel at refineries.

Reforming Processes by which the molecular structure of different fractions of petroleum can be modified. It usually involves some form of catalyst, most often platinum, and allows the conversion of lower grades of petroleum product into higher grades, improving their octane rating. It is a generic term for processes such as cracking, cyclization, dehydrogenation and isomerisation. These processes generally led to the production of hydrogen as a by-product, which can be used in the refineries in some desulphurization procedures.

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.

RESTATS The Renewable Energy Statistics database for the UK.

Ricardo-AEA Formerly known as AEA Energy & Environment.

RO Renewables Obligation – this is an obligation on all electricity suppliers to supply a specific proportion of electricity from eligible renewable sources.

ROCs Renewables Obligation Certificates

Seasonal Performance Factor The Seasonal Performance Factor (SPF) of a heat pump is the total useful heat delivered during a year divided by the annual electricity consumption of the pump. The SPF gives an indication of the efficiency of the pump, with values greater than 1 implying that more useful heat is produced than the electricity used to power the pump.

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.

SI (Système International) Refers to the agreed conventions for the measurement of physical quantities**.**

SIC The United Kingdom Standard Industrial Classification of Economic Activities (SIC) is used to classify business establishments and other standard units by the type of economic activity in which they are engaged. It provides a framework for the collection, tabulation, presentation and analysis of data and its use promotes uniformity. In addition, it can be used for administrative purposes and by non-government bodies as a convenient way of classifying industrial activities into a common structure.

The system is identical to the EUROSTAT System NACE at the four digit class level and the United Nations system ISIC at the two digit Divisional level.

SO_2	Sulphur Dioxide. Sulphur dioxide is a gas produced by the combustion of sulphur-containing fuels such as coal and oil.
SRO	Scottish Renewable Orders
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.
Synthetic coke oven gas	Mainly a natural gas, which is mixed with smaller amounts of blast furnace, and BOS (basic oxygen steel furnace) gas to produce a gas with almost the same quantities as coke oven gas.
Tars	Viscous materials usually derived from the destructive distillation of coal which are by-products of the coke and iron making processes.
Temperature correction	The temperature corrected series of total inland fuel consumption indicates what annual consumption might have been if the average temperature during the year had been the same as the average for the years 1981 to 2010.
Terawatt (TW)	1,000 gigawatts
Therm	A common unit of measurement similar to a tonne of oil equivalent 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.
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
TWh	Terawatt hour
UKCS	United Kingdom Continental Shelf
UKPIA	UK Petroleum Industry Association. The trade association for the UK petroleum industry.
UKSA	UK Statistics Authority
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, and initially enjoyed a lower rate of hydrocarbon oil duty in the UK than ordinary diesel to promote its use, although duty rates on standard diesel and ULSD have since been equalised. 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). ULSP initially enjoyed a lower rate of hydrocarbon oil duty in the UK than ordinary petrol to promote its use, although duty rates on standard petrol and ULSP have since been equalised. 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.
VAT	Value added tax
Watt (W)	The conventional unit to measure a rate of flow of energy. One watt amounts to 1 joule per second.
White spirit	A highly refined distillate with a boiling range of about 150ºC to 200ºC used as a paint solvent and for dry cleaning purposes etc.

Annex C
Further sources of United Kingdom energy publications

Some of the publications listed below give shorter term statistics, some provide further information about energy production and consumption in the United Kingdom and in other countries, and others provide more detail on a country or fuel industry basis. The list also covers recent publications on energy issues and policy, including statistical information, produced or commissioned by BEIS. The list is not exhaustive and the titles of publications and publishers may alter. All titles can be found on the GOV.UK website.

Department for Business, Energy and Industrial Strategy publications on energy statistics

Energy Statistics
Monthly, quarterly and annual statistics on production and consumption of overall energy and individual fuels in the United Kingdom together with energy prices is available in MS Excel format at: www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy/about/statistics

Energy Trends
A quarterly publication covering all major aspects of energy. It provides a comprehensive picture of energy production and use and contains analysis of data and articles covering energy issues. Available at: www.gov.uk/government/collections/energy-trends.

Energy Prices
A quarterly publication containing tables, charts and commentary covering energy prices to domestic and industrial consumers for all the major fuels as well as presenting comparisons of fuel prices in the European Union and G7 countries. Available at: www.gov.uk/government/collections/quarterly-energy-prices.

Energy Flow Chart
An annual publication illustrating the flow of primary fuels from home production and imports to their eventual final uses. They are shown in their original state and after being converted into different kinds of energy by the secondary fuel producers. Available at: www.gov.uk/government/collections/energy-flow-charts.

UK Energy in Brief
An annual publication summarising the latest statistics on energy production, consumption and prices in the United Kingdom. The figures are taken from “Digest of UK Energy Statistics”. Available at: www.gov.uk/government/collections/uk-energy-in-brief

Energy Consumption in the United Kingdom
Energy consumption in the United Kingdom brings together statistics from a variety of sources to produce a comprehensive review of energy consumption and changes in intensity and output since the 1970s, with a particular focus on trends since 2000. Available at: www.gov.uk/government/collections/energy-consumption-in-the-uk

Sub-National Energy Consumption statistics

Sub-National data are produced by BEIS to emphasise the importance of local and regional decision making for energy policy in delivering a number of national energy policy objectives. Data is available at:
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy/about/statistics

Fuel Poverty statistics

An annual report detailing the latest statistics on fuel poverty in England. Available at:
www.gov.uk/government/collections/fuel-poverty-statistics

Household Energy Efficiency statistics

BEIS publishes a range of information relating to the Energy Company Obligation (ECO) and Green Deal (GD). The headline release presents monthly updates of ECO measures and quarterly updates of in-depth ECO statistics, carbon savings and the Green Deal schemes. The detailed report presents annual updates on in-depth Green Deal statistics and insulation levels. Data is available at:
www.gov.uk/government/collections/household-energy-efficiency-national-statistics

National Energy Efficiency Data-framework (NEED)

BEIS has constructed a National Energy Efficiency Data-framework (NEED) to enable detailed statistical analysis of energy efficiency. The data framework matches the gas and electricity consumption data collected for BEIS sub-national energy consumption statistics and records of energy efficiency measures in the Homes Energy Efficiency Database (HEED) run by the Energy Saving Trust (EST), as well as typographic data about dwellings and households. Data is available at:
www.gov.uk/government/collections/national-energy-efficiency-data-need-framework

Smart Meters statistics

Data produced by BEIS on the roll-out of smart meters in Great Britain, covering both operating and installed meters.
www.gov.uk/government/collections/smart-meters-statistics

UK Greenhouse Gas Emissions statistics

Emissions data are produced by BEIS to show progress against the UK's goals, both international and domestic, for reducing greenhouse gas emissions. Data is available at:
www.gov.uk/government/collections/uk-greenhouse-gas-emissions-statistics

UK Energy and CO2 emissions projections

The Updated Energy Projections (UEP) are published annually by BEIS. They provide updated projections and analysis of energy use and carbon dioxide emissions in the UK. The UEP exercise incorporates all firm environmental policy measures and is based on updated assumptions consistent with the most recent UK Budget announcements. The latest report is available at:
www.gov.uk/government/collections/energy-and-emissions-projections

Department for Business, Energy and Industrial Strategy policy publications on energy and climate change

The Clean Growth Strategy
On 12 October 2017 The Clean Growth Strategy was published. The strategy sets out proposals for decarbonising all sectors of the UK economy through the 2020s. It explains how the whole country can benefit from low carbon opportunities, while meeting national and international commitments to tackle climate change. The strategy is available at:
www.gov.uk/government/publications/clean-growth-strategy

Energy Act 2016
The Energy Act 2016 was given Royal Assent on 12 May 2016. The Act is available at:
www.legislation.gov.uk/ukpga/2016/20/contents/enacted

Annual Energy Statement
The Annual Energy Statement fulfilled the commitment in the Coalition Programme for the Government to present an annual statement of energy policy to Parliament. The first statement was delivered to Parliament on 27 June 2010, with subsequent statements delivered on 23 November 2011, 29 November 2012 and 31 October 2013. The last Statement, delivered on 6 November 2014, is available at: www.gov.uk/government/publications/annual-energy-statement-2014

Energy Act 2013
The Energy Act 2013 was given Royal Assent on 18 December 2013. The Act is available at:
www.legislation.gov.uk/ukpga/2013/32/contents

Energy Act 2011
The Energy Act 2011 was given Royal Assent on 18 October 2011. The Act is available at:
www.legislation.gov.uk/ukpga/2011/16/contents

Electricity Market Reform (EMR) White Paper
On 12 July 2011 'Planning our electric future: a White Paper for secure, affordable and low-carbon electricity' was published. The White Paper sets out key measures to attract investment, reduce the impact on consumer bills, and create a secure mix of electricity sources including gas, new nuclear, renewables, and carbon capture and storage. The White Paper is available at:
www.gov.uk/government/publications/planning-our-electric-future-a-white-paper-for-secure-affordable-and-low-carbon-energy

Energy Act 2010
The Energy Act 2010 was given Royal Assent on 8 April 2010. The Act is available at:
www.legislation.gov.uk/ukpga/2010/27/contents

UK Low Carbon Transition Plan
The UK Low Carbon Transition Plan was published on 15 July 2009. The Plan is available at:
www.gov.uk/government/publications/the-uk-low-carbon-transition-plan-national-strategy-for-climate-and-energy

Energy Act 2008
The Energy Act 2008 was granted Royal Assent on 26 November 2008. The Act is available at:
www.legislation.gov.uk/ukpga/2008/32/contents

Climate Change Act 2008
The Climate Change Act 2008 was granted Royal Assent on 26 November 2008. The Act is available at: www.legislation.gov.uk/ukpga/2008/27/contents

Other publications including energy information

General

Eurostat Regional Yearbook (annual); *Statistical Office of the European Commission – Eurostat*
Eurostat Yearbook (annual); *Statistical Office of the European Commission - Eurostat*
Eurostatistics (monthly); *Statistical Office of the European Commission – Eurostat*
Overseas Trade Statistics (OTS) of the United Kingdom; *H.M. Revenue and Customs*
- OTS trade with EU countries (monthly)
- OTS trade with non-EU countries (monthly)

UK Index of Production (monthly); *Office for National Statistics*
United Kingdom Minerals Yearbook; *British Geological Survey*

Energy

BP Statistical Review of World Energy (annual); *BP*
Energy Balance Sheets; *Statistical Office of the European Commission – Eurostat*
Energy Statistics; *Statistical Office of the European Commission – Eurostat*
Energy Balances (annual); *United Nations Statistical Office*
Energy Statistics Yearbook (annual); *United Nations Statistical Office*
Energy Statistics Pocketbook (annual); *United Nations Statistical Office*
World Energy Statistics and Balances (annual); *International Energy Agency*

Coal

Annual Reports and Accounts of The Coal Authority and the private coal companies; (*apply to the Headquarters of the company concerned)*
Coal Information (annual); *International Energy Agency*

Oil and Gas

Annual Reports and Accounts of National Grid, Centrica and the independent oil and gas supply companies; (contact *the Headquarters of the company concerned directly)*
National Grid – Gas Ten Year Statement - (annual); *National Grid*
Oil and Gas Information (annual); *International Energy Agency*
Petroleum Review (monthly); *Energy Institute*

Electricity

Annual Reports and Accounts of the Electricity Supply Companies, Distributed Companies and Generators; (*apply to the Headquarters of the company concerned)*
Annual Report and Accounts of The Office of Gas and Electricity Markets; *OFGEM*
Electricity Information (annual); *International Energy Agency*
National Grid – Electricity Ten Year Statement - (annual); *National Grid*

Renewables

Renewables Information (annual); *International Energy Agency*

Prices

Energy Prices and Taxes (quarterly); *International Energy Agency*

Useful energy related websites

The BEIS section of the GOV.UK website can be found at:
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy

Other Government web sites

Department for Environment, Food and Rural Affairs	www.gov.uk/government/organisations/department-for-environment-food-rural-affairs
Department for Transport	www.gov.uk/government/organisations/department-for-transport
HM Government Online (GOV.UK)	www.gov.uk
HM Revenue & Customs	www.gov.uk/government/organisations/hm-revenue-customs
Ministry of Housing, Communities & Local Government	www.gov.uk/government/organisations/ministry-of-housing-communities-and-local-government
Northern Ireland Executive	www.northernireland.gov.uk
Ofgem (The Office of Gas and Electricity Markets)	www.ofgem.gov.uk
Scottish Government	www.gov.scot
Scottish Parliament	www.parliament.scot/index.aspx
UK Parliament	www.parliament.uk
UK Statistical System	www.statisticsauthority.gov.uk
Welsh Government	https://gov.wales

Other useful energy related web sites

BP	www.bp.com
British Geological Survey	www.bgs.ac.uk
BRE (Building Research Establishment)	www.bregroup.com
Coal Authority	www.gov.uk/government/organisations/the-coal-authority
Energy Institute	www.energyinst.org/home
Energy Networks Association	www.energynetworks.org
Energy UK	www.energy-uk.org.uk
Europa (European Union Online)	http://europa.eu
Eurostat (European statistics)	https://ec.europa.eu/eurostat
Interconnector	www.interconnector.com
International Energy Agency (IEA)	www.iea.org
International Steel Statistics Bureau (ISSB)	www.issb.co.uk
National Grid	www.nationalgrid.com
Oil & Gas UK	https://oilandgasuk.co.uk
Renewable UK	www.renewableuk.com
Ricardo Energy & Environment	https://ee.ricardo.com
The Stationery Office (TSO)	www.tsoshop.co.uk
UK-AIR: Air Information Resource	https://uk-air.defra.gov.uk
UK Petroleum Industry Association (UKPIA)	https://www.ukpia.com
United Nations Statistics Division	https://unstats.un.org/home
US Department of Energy	www.energy.gov
US Energy Information Administration	www.eia.gov

Annex D

Major events in the Energy Industry

2020

Electricity
In July 2020 construction work commenced on what is set to be the world's longest electricity interconnector, linking the UK's power system with Denmark. Due for completion in 2023, the 765-kilometre 'Viking Link' cable will stretch from Lincolnshire to South Jutland in Denmark.

In July 2020 approval was granted for the Vanguard offshore wind farm in Norfolk. The 1.8GW facility consisting of up to 180 turbines will generate enough electricity to power 1.95 million homes.

In May 2020 approval was granted for Britain's largest ever solar farm at Cleve Hill, near Whitstable in Kent. The 350MW facility, comprising of 800.000 solar panels, will begin operation in 2022 and will provide power to around 91,000 homes.

Energy Prices
In February 2020 the energy price cap was reduced by £17 to £1,162 per year, from 1 April for the six-month "summer" price cap period.

2019

Climate Change
The Government laid draft legislation in Parliament in early June 2019 to end the UK's contribution to climate change, by changing the UK's legally binding long-term emissions reduction target to net zero greenhouse gas emissions by 2050. The new target is based on advice from the government's independent advisors, the Committee on Climate Change (CCC).

The legislation was signed into law in late June 2019, following approval by the House of Commons and the House of Lords.

Energy Policy
A joint government-industry Offshore Wind Sector Deal was announced in March 2019, which will lead to clean, green offshore wind providing more than 30% of British electricity by 2030.

The deal will see industry invest £250 million, include a new Offshore Wind Growth Partnership to develop the UK supply chain with global exports set to increase fivefold to £2.6 billion by 2030, as well as challenging the sector to more than double the number of women entering the industry to at least 33% by 2030, with the ambition of reaching 40% - up from 16% in 2019.

Electricity
New solar homes and businesses creating and exporting electricity to the grid will be guaranteed a payment from suppliers under new laws introduced by the government in June 2019. The Smart Export Guarantee (SEG) will ensure small-scale electricity generators installing solar, wind or other forms of renewable generation with a capacity up to 5MW will be paid for each unit of electricity they sell to the grid - tracked by their smart meter.

2019 continued

Energy Prices
In August 2019 the energy price cap was reduced by £75 to £1,179 per year, from 1 October for the six-month "winter" price cap period.

In February 2019 the energy price cap was increased by £117 to £1,254 per year, from 1 April for the six-month "summer" price cap period.

2018

Energy Prices
In November 2018 Ofgem announced the final level of the price cap, following the statutory consultation published in September, at £1,137 per year for a typical dual fuel customer paying by direct debit. Price protection for 11 million customers on poor value default tariffs came into force on 1 January 2019. The price cap level will be updated in April and October every year to reflect the latest estimated costs of supplying electricity and gas, including wholesale energy costs.

In February 2018 the Domestic Gas and Electricity (Tariff Cap) Bill was introduced to Parliament, which will put in place a requirement on the independent regulator, Ofgem, to cap energy tariffs until 2020. It will mean an absolute cap can be set on poor value tariffs, protecting the 11 million households in England, Wales and Scotland who are currently on a standard variable or other default energy tariff and who are not protected by existing price caps

An extension to Ofgem's safeguard tariff cap was introduced in February 2018 which will see a further one million more vulnerable consumers protected from unfair energy price rises.

Nuclear
In June 2018 the Government announced a deal with the nuclear sector to ensure that nuclear energy continues to power the UK for years to come through major innovation, cutting-edge technology and ensuring a diverse and highly skilled workforce. Key elements include:

- a £200 million Nuclear Sector Deal to secure the UK's diverse energy mix and drive down the costs of nuclear energy meaning cheaper energy bills for customers;
- a £32 million boost from government and industry to kick-start a new advanced manufacturing programme including R&D investment to develop potential world-leading nuclear technologies like advanced modular reactors;
- a commitment to increasing gender diversity with a target of 40% women working in the civil nuclear sector by 2030.

BEIS news stories including press releases, speeches and statements are available here.

For major events in earlier years see the full version of this annex on the BEIS section of the GOV.UK website at:
www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

Digest of United Kingdom Energy Statistics

Enquiries about statistics in this publication should be made to the contact named at the end of the relevant chapter. Brief extracts from this publication may be reproduced provided that the source is fully acknowledged. General enquiries about the publication, and proposals for reproduction of larger extracts, should be addressed to BEIS, at the address given in paragraph XXVIII of the Introduction.

The Department for Business, Energy and Industrial Strategy (BEIS) reserves the right to revise or discontinue the text or any table contained in this Digest without prior notice

Standard conversion factors

This Digest uses the tonne of oil equivalent (toe) as the common unit of energy for comparing and aggregating fuels. The following table gives factors for converting between this unit and alternative units of energy found in this and other publications. (See Chapter 1, Technical notes and definitions and Annex A).

	to: Thousand toe	Terajoules (TJ)	Gigawatt hours (GWh)	Million therms
from:	multiply by			
Thousand toe	1	41.868	11.630	0.39683
Terajoules (TJ)	0.023885	1	0.27778	0.0094778
Gigawatt hours (GWh)	0.085985	3.6000	1	0.034121
Million therms	2.5200	105.51	29.307	1

A selection of estimated average gross calorific values

The following selection of estimated average gross calorific values apply to 2019. (For further information and more detailed calorific values see Annex A).

Solid fuels	**GJ per tonne**
Coal	
All consumers (weighted average)	26.9
Power stations (including imports; weighted average)	26.5
Iron and steel	30.4
Other industries (weighted average)	26.7
Imported coal (weighted average)	28.4
Exported coal (weighted average)	28.0
Coke	29.8
Coke breeze	29.8
Other manufactured solid fuel	29.6
Gases	
Natural gas (produced)	39.8
Landfill gas	21-25
Sewage gas	21-25

Renewable sources	**GJ per tonne**
Domestic wood	16.3
Industrial wood	20.3
Municipal solid waste	9.9
Petroleum	
Crude oil (weighted average)	45.7
Petroleum products (weighted average)	46.1
Motor spirit	47.0
Gas/diesel oil	45.3
DERV	45.6
Fuel oil	43.4