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.

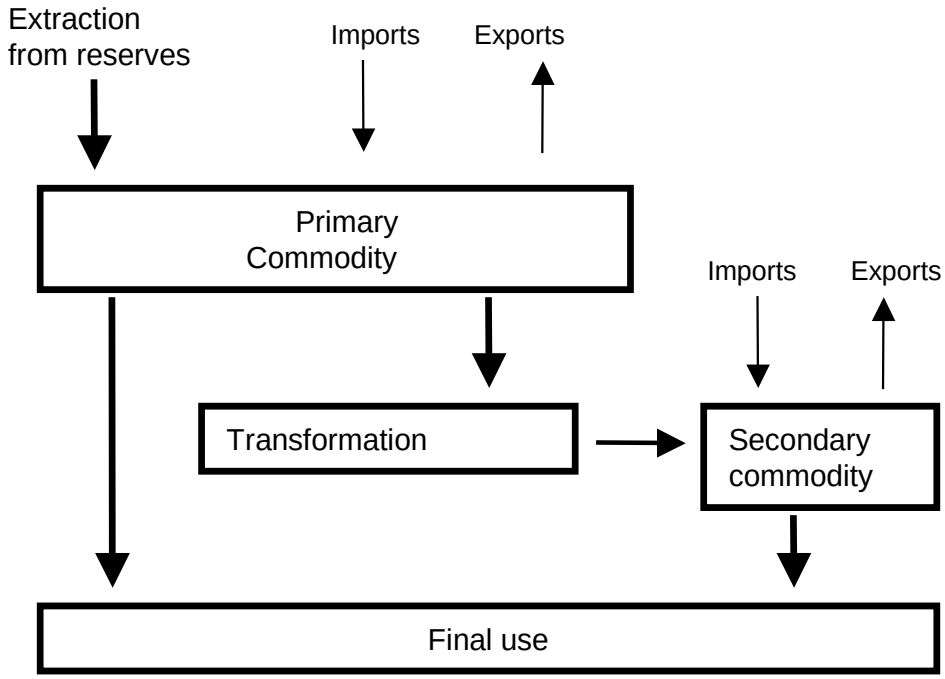
A.5 A simplified model of the commodity flow underlying the balance structure is given in Chart A.1. It illustrates how primary commodities may be used directly and/or be transformed into secondary commodities. The secondary fuels then enter final consumption or may also be transformed into another energy 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 2017 shows that 1,435

thousand tonnes of oil equivalent of coal feeds into the production of 1,351 thousand tonnes of oil equivalent of coke, representing a loss of 84 thousand tonnes of oil equivalent in the manufacture of coke in 2017. In 2017, energy losses during the production of electricity and other secondary fuels amounted to 35.8 million tonnes of oil equivalent, (18 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 2017, energy industry use amounted to 12.0 million tonnes of oil equivalent of energy (6.0 per cent of primary demand), down 0.1 per cent on 2016, reflecting the reduced energy needed as coal production fell. 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, 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 40.0 per cent (in 2017) 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 *Major 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

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

LENGTH

1 mile	= 1.6093 kilometres
1 kilometre (km)	= 0.62137 miles

TEMPERATURE

1 scale degree Celsius (C)	= 1.8 scale degrees Fahrenheit (F)

For conversion of temperatures: $^oC = 5/9 (^oF - 32)$; $^oF = 9/5\ ^oC + 32$

Average conversion factors for petroleum 2017

	Litres per tonne
Crude oil:	
Indigenous	1,199
Imported	1,181
Average of refining throughput	1,192
Ethane	2,730
Propane	1,939
Butane	1,736
Naphtha	1,483
Aviation gasoline	1,405
Motor spirit:	
All grades	1,362
Super[1]	1,359
Premium[1]	1,370
Middle distillate feedstock	..
Kerosene:	
Aviation turbine fuel	1,251
Burning oil	1,246

	Litres per tonne
DERV fuel:	
0.005% or less sulphur	1,193
Gas /Marine diesel oil	1,171
Fuel oil (1% or less sulphur)	
All grades:	1,012
Light:	..
Medium	..
Heavy:	..
Lubricating oils:	
White	1,154
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 2017. The litres to tonnes conversions are made at a standard temperature of 15°C.

[1] Based on 2016 deliveries due to incomplete 2017 delivery data

.. 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	1.517
Liquid fuels			
Gas oil	3190	0.254	2.724
Fuel oil	3217	0.267	
Burning oil	3150	0.245	2.524
Naptha	3131	0.236	
Petrol	3135	0.239	2.292
Diesel	3164	0.244	2.650
Aviation spirit	3128	0.238	2.225
Aviation turbine fuel	3150	0.245	2.514
Solid fuels			
Industrial coal	2428	0.322	
Domestic coal	2631	0.315	
Coking coal	3044	0.344	

All emission factors are based on a Gross Calorific Value basis

The information above is based on the 2018 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 2017 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.

A.1 Estimated average calorific values of fuels 2017

	GJ per tonne net	GJ per tonne gross
Coal:		
All consumers (weighted average) *(1)*	25.9	27.3
Power stations *(2)*	25.3	26.7
Coke ovens *(1)*	30.2	31.8
Low temperature carbonisation plants and manufactured fuel plants	26.9	28.4
Collieries	27.4	28.9
Agriculture	28.1	29.5
Iron and steel	28.9	30.4
Other industries (weighted average)	25.4	26.7
Non-ferrous metals	23.7	25.0
Food, beverages and tobacco	27.9	29.3
Chemicals	25.2	26.5
Textiles, clothing, leather etc.	28.0	29.4
Pulp, paper, printing etc.	23.0	24.2
Mineral products	26.2	27.6
Engineering (mechanical and electrical engineering and vehicles)	27.9	29.4
Other industries	30.9	32.5
Domestic		
House coal	27.2	28.7
Anthracite and dry steam coal	32.4	34.1
Other consumers	25.1	26.4
Imported coal (weighted average)	26.2	27.6
Exports (weighted average)	30.6	32.2
Coke (including low temperature carbonisation cokes)	29.8	29.8
Coke breeze	29.8	29.8
Other manufactured solid fuels	31.1	32.7

	GJ per tonne net	GJ per tonne gross	Moisture content
Renewable sources:			
Domestic wood *(3)*	14.7	16.3	20%
Industrial wood *(4)*	19.0	20.3	0%
Straw	13.1	15.4	15%
Poultry litter (5)	7.9	9.9	20%
Meat and bone	16.2	18.3	11%
General industrial waste	15.2	16.0	5%
Hospital waste	13.3	14.0	5%
Municipal solid waste *(6)*	6.5	9.3	30%
Refuse derived waste *(6)*	13.0	18.5	30%
Short rotation coppice *(7)*	12.6	14.2	30%
Tyres	30.4	32.0	5%
Wood pellets	16.9	18.3	10%
Biodiesel	37.2	38.7	4%
Bioethanol	26.8	29.7	10%
Petroleum:			
Crude oil (weighted average)	43.4	45.7	
Petroleum products (weighted average)	43.9	46.2	
Ethane	46.6	50.7	
Butane and propane (LPG)	45.9	49.3	
Light distillate feedstock for gasworks	45.4	47.8	
Aviation spirit and wide cut gasoline	45.0	47.4	
Aviation turbine fuel	43.9	46.2	
Motor spirit	44.7	47.1	
Burning oil	43.9	46.2	
Gas/diesel oil	42.6	45.3	
DERV	42.9	45.7	
Fuel oil	40.7	43.3	
Power station oil	40.7	43.3	
Non-fuel products (notional value)	40.8	43.0	

	MJ per cubic metre net	MJ per cubic metre gross
Natural gas produced *(8)*	35.8	39.8
Natural gas consumed *(9)*	35.6	39.5
Coke oven gas	16.2	18.0
Blast furnace gas	3.0	3.0
Landfill gas *(10)*	19-23	21-25
Sewage gas *(10)*	19-23	21-25
Anaerobic Digestion - farm/food food *(7)*	19-24	21-26

(1) Applicable to UK consumption - based on calorific value for home produced coal plus imports and, for "All consumers" net of exports.

(2) Home produced plus imports

(3) On an "as received" basis; seasoned logs at 20% moisture content. On a "dry" basis 20.3 GJ per tonne.

(4) Data reported on an oven dry basis of 20.3 GJ per tonne.

(5) The calorific value of poultry litter typically ranges on a net basis from 5 GJ/tonne to 10 GJ/tonne depending upon the moisture content of the fuel. For poultry manure, much lower calorific values should be used.

(6) Average figure based on survey returns.

(7) On an "as received" basis; at 30% moisture content. On a "dry" basis 18.6 GJ per tonne.

(8) The gross calorific value of natural gas can also be expressed as 11.126 kWh per cubic metre. This value represents the average calorific value seen for gas when extracted. At this point it contains not just methane, but also some other hydrocarbon gases (ethane, butane, propane). These gases are removed before the gas enters the National Transmission System for sale to final consumers.

(9) UK produced and imported gas. This weighted average of calorific values will approximate the average for the year of gas entering the National Transmission System. It can also be expressed as 11.007 kWh per cubic metre.

(10) Calorific value varies depending on the methane content of the gas.

Note: The above estimated average calorific values apply only to the year 2017. For calorific values of fuels in earlier years see Tables A.2 and A.3 and previous issues of this Digest. See the notes in Chapter 1, paragraph 1.55 regarding net calorific values. 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 calorific values for coal other than imported coal are based on estimates provided by the main coal producers, but with some exceptions as noted on Table A.2. The calorific values for petroleum products have been calculated using the method described in Chapter 1, paragraph 1.31. Data reported in this Digest in 'thousand tonnes of oil equivalent' have been prepared on the basis of 1 tonne of oil equivalent having an energy content of 41.868 gigajoules (GJ), (1 GJ = 9.478 therms) - see notes in Chapter 1, paragraph 1.28.

A.2 Estimated average gross calorific values of fuels 1980, 1990, 2000, 2010 and 2015 to 2017

GJ per tonne (gross)

	1980	1990	2000	2010	2015	2016	2017
Coal							
All consumers *(1)(2)*	25.6	25.5	26.2	25.8	26.0	26.0	25.9
All consumers - home produced plus imports minus exports *(1)*	..	..	27.0	27.1	27.0	27.2	27.3
Power stations *(2)*	23.8	24.8	25.6	24.9	25.1	25.2	25.4
Power stations - home produced plus imports *(1)*	..	..	26.0	25.8	26.2	26.2	26.7
Coke ovens *(2)*	30.5	30.2	31.2	30.5	31.8	31.8	31.8
Coke ovens - home produced plus imports *(1)*	..	..	30.4	30.5	31.8	31.8	31.8
Low temperature carbonisation plants and manufactured fuel plants	19.1	29.2	30.3	30.2	28.5	28.4	28.4
Collieries	27.0	28.6	29.6	29.3	29.0	29.0	28.9
Agriculture	30.1	28.9	29.2	28.0	29.5	29.5	29.5
Iron and steel industry *(3)*	29.1	28.9	30.7	30.4	30.4	30.4	30.4
Other industries *(1)*	27.1	27.8	26.7	27.7	26.8	26.7	26.7
Non-ferrous metals	..	23.1	25.1	25.4	25.1	25.1	25.0
Food, beverages and tobacco	28.6	28.1	29.5	28.6	29.4	29.4	29.3
Chemicals	25.8	27.3	28.7	26.7	26.5	26.5	26.5
Textiles, clothing, leather and footwear	27.5	27.7	30.4	29.5	29.5	29.5	29.4
Pulp, paper, printing, etc.	26.5	27.9	28.7	24.1	24.2	24.2	24.2
Mineral products *(4)*	..	28.2	27.0	27.6	27.9	27.9	27.6
Engineering *(5)*	27.7	28.3	29.3	29.5	29.5	29.5	29.4
Other industry *(6)*	28.4	28.5	30.2	32.6	32.6	32.8	32.5
Unclassified	..	27.1	..	..	..	..	..
Domestic							
House coal	30.1	30.2	30.9	29.8	30.1	28.9r	28.7
Anthracite and dry steam coal	33.3	33.6	33.5	34.7	34.3	34.4	34.1
Other consumers	27.5	27.5	29.2	25.5	26.4	26.4	26.4
Transport - Rail	..	..	..	30.3	30.2	30.2	30.1
Imported coal *(1)*	..	28.3	28.0	27.9	27.4	27.5	27.6
of which Steam coal	..	..	26.6	26.5	26.5	27.0r	27.0
Coking coal	..	..	30.4	32.1	31.8	31.8	31.8
Anthracite	..	..	31.2	31.0	31.5	31.6	31.5
Exports *(1)*	..	29.0	32.0	32.3	32.2	32.2	32.2
of which Steam coal	..	..	31.0	31.2	31.2	31.2	31.0
Anthracite	..	..	32.6	33.2	32.5	32.5	32.5
Coke *(7)*	28.1	28.1	29.8	29.8	29.8	29.8	29.8
Coke breeze	24.4	24.8	24.8	29.8	29.8	29.8	29.8
Other manufactured solid fuels *(1)*	27.6	27.6	30.8	32.6	32.7	32.7	32.7
Petroleum							
Crude oil *(1)*	45.2	45.6	45.7	45.7	45.7	45.7	45.7
Liquified petroleum gas	49.6	49.3	49.1	49.2	49.3	49.3	49.3
Ethane	52.3	50.6	50.7	50.7	50.7	50.7	50.7
LDF for gasworks/Naphtha	47.8	47.9	47.6	47.8	47.8	47.9	47.8
Aviation spirit and wide-cut gasoline (AVGAS and AVTAG)	47.2	47.3	47.3	47.4	47.4	47.4	47.4
Aviation turbine fuel (AVTUR)	46.4	46.2	46.2	46.2	46.2	46.2	46.2
Motor spirit	47.0	47.0	47.0	47.1	47.2	47.1	47.1
Burning oil	46.5	46.2	46.2	46.2	46.2	46.2	46.2
Vaporising oil	45.9	45.9	..	..	..	..	..
Gas/diesel oil (8)	45.5	45.4	45.6	45.3	45.3	45.3	45.3
DERV (8)	..	..	..	45.6	45.7	45.7	45.7
Fuel oil	42.8	43.2	43.1	43.3	43.4	43.3	43.3
Power station oil	42.8	43.2	43.1	43.3	43.4	43.3	43.3
Non-fuel products (notional value)	42.2	43.2	43.8	43.1	42.8	42.8	43.0
Petroleum coke (Power stations)	..	..	..	30.9	28.6	28.6	28.6
Petroleum coke (Other)	..	39.5	35.8	35.8	35.8	35.8	35.8
Natural Gas *(9)*	..	38.4	39.4	40.0	40.2	40.1r	39.8
Renewable sources							
Domestic wood	..	..	10.0	13.9	16.3	16.3	16.3
Industrial wood	..	..	11.9	13.7	20.3	20.3	20.3
Straw	..	..	15.0	15.8	15.8	15.7	15.4
Poultry litter	..	..	8.8	9.1	9.1	9.5	9.9
Meat and bone	..	..	17.3	20.0	20.0	19.0	18.3
General industrial waste	..	..	16.0	16.0	16.0	16.0	16.0
Hospital waste	..	..	14.0	14.0	14.0	14.0	14.0
Municipal solid waste	..	..	9.5	9.5	9.6	9.8	9.3
Refuse derived waste	..	..	18.6	18.5	18.5	18.5	18.5
Short rotation coppice	..	..	10.6	11.1	14.2	14.2	14.2
Tyres	..	..	32.0	32.0	32.0	32.0	32.0
Wood pellets	..	..	..	17.2	18.3	18.3	18.3
Biodiesel	..	..	..	38.7	38.7	38.7	38.7
Bioethanol	..	..	..	29.7	29.7	29.7	29.7

(1) Weighted averages.

(2) Home produced coal only.

(3) From 2001 onwards almost entirely sourced from imports.

(4) Based on information provided by the British Cement Industry Association; almost all coal used by this sector in the latest 4 years was imported.

(5) Mechanical engineering and metal products, electrical and instrument engineering and vehicle manufacture.

(6) Includes construction.

(7) Since 1995 the source of these figures has been the ISSB.

(8) DERV included within gas/diesel oil until 2005.

(9) Natural Gas figures are shown in MJ per cubic metre.

A.3 Estimated average net calorific values of fuels 1980, 1990, 2000, 2010 and 2015 to 2017

GJ per tonne (net)

	1980	1990	2000	2010	2015	2016	2017
Coal							
All consumers *(1)(2)*	24.3	24.2	24.9	24.5	24.7	24.7	24.6
All consumers - home produced plus imports minus exports *(1)*	..	..	25.6	25.7	25.7	25.8	25.9
Power stations *(2)*	22.6	23.6	24.3	23.6	23.9	23.9	24.1
Power stations - home produced plus imports *(1)*	..	..	24.7	24.5	24.9	24.9	25.3
Coke ovens *(2)*	29.0	28.7	29.6	29.0	30.2	30.2	30.2
Coke ovens - home produced plus imports *(1)*	..	..	28.9	29.0	30.2	30.2	30.2
Low temperature carbonisation plants and manufactured fuel plants	18.1	27.7	28.8	28.7	27.0	26.9	26.9
Collieries	25.7	27.2	28.1	27.9	27.5	27.5	27.4
Agriculture	28.6	27.5	27.8	26.6	28.1	28.1	28.1
Iron and steel industry *(3)*	27.6	27.5	29.2	28.9	28.9	28.9	28.9
Other industries *(1)*	25.7	26.4	25.4	26.3	25.4	25.4	25.4
Non-ferrous metals	..	21.9	23.8	24.1	23.8	23.8	23.7
Food, beverages and tobacco	27.2	26.7	28.0	27.2	28.0	28.0	27.9
Chemicals	24.5	25.9	27.2	25.4	25.2	25.2	25.2
Textiles, clothing, leather and footwear	26.1	26.3	28.9	28.0	28.1	28.1	28.0
Pulp, paper, printing, etc.	25.2	26.5	27.3	22.9	23.0	23.0	23.0
Mineral products *(4)*	..	26.8	25.7	26.3	26.5	26.5	26.2
Engineering *(5)*	26.3	26.9	27.8	28.0	28.0	28.0	27.9
Other industry *(6)*	27.0	27.1	28.7	31.0	31.0	31.1	30.9
Unclassified	..	25.7	..	..	..	..	..
Domestic							
House coal	28.6	28.7	29.4	28.3	28.6	27.5r	27.2
Anthracite and dry steam coal	31.6	31.9	31.9	32.9	32.6	32.6	32.4
Other consumers	26.1	26.1	27.7	24.3	25.1	25.1	25.1
Transport - Rail	..	..	..	28.8	28.7	28.7	28.6
Imported coal *(1)*	..	26.9	26.6	26.5	26.0	26.1	26.2
of which Steam coal	..	..	25.3	25.2	25.2	25.7r	25.7
Coking coal	..	..	28.9	29.0	30.2	30.2	30.2
Anthracite	..	..	29.6	29.5	30.0	30.0	29.9
Exports *(1)*	..	27.6	30.4	30.7	30.6	30.6	30.6
of which Steam coal	..	..	29.4	29.6	29.6	29.6	29.4
Anthracite	..	..	30.9	31.6	30.9	30.9	30.9
Coke *(7)*	28.1	28.1	29.8	29.8	29.8	29.8	29.8
Coke breeze	24.4	24.8	24.8	29.8	29.8	29.8	29.8
Other manufactured solid fuels *(1)*	26.2	26.2	29.3	31.0	31.1	31.1	31.1
Petroleum							
Crude oil *(1)*	42.9	43.3	43.4	43.4	43.4	43.4	43.4
Liquified petroleum gas	46.2	46.0	46.0	46.0	46.0	45.9	45.9
Ethane	48.1	46.6	46.6	46.6	46.6	46.6	46.6
LDF for gasworks/Naphtha	45.4	45.5	45.3	45.4	45.4	45.5	45.4
Aviation spirit and wide-cut gasoline (AVGAS and AVTAG)	44.8	44.9	44.9	45.0	45.0	45.0	45.0
Aviation turbine fuel (AVTUR)	44.1	43.9	43.9	43.9	43.9	43.9	43.9
Motor spirit	44.7	44.7	44.7	44.7	44.8	44.8	44.7
Burning oil	44.2	43.9	43.9	43.9	43.9	43.9	43.9
Vaporising oil	43.6	43.6	..	..	..	..	..
Gas/diesel oil (8)	42.8	42.7	42.9	42.6	42.6	42.6	42.6
DERV (8)	..	..	..	42.9	42.9	42.9	42.9
Fuel oil	40.2	40.6	40.5	40.7	40.8	40.7	40.7
Power station oil	40.2	40.6	40.5	40.7	40.8	40.7	40.7
Non-fuel products (notional value)	40.1	41.0	41.6	40.9	40.6	40.7	40.8
Petroleum coke (Power stations)	..	..	..	29.3	27.2	27.2	27.2
Petroleum coke (Other)	..	37.5	34.0	34.0	34.0	34.0	34.0
Natural Gas *(9)*	..	34.6	35.5	36.0	36.1	36.1r	35.8
Renewable sources							
Domestic wood	..	..	..	12.3	14.7	14.7	14.7
Industrial wood	..	..	..	12.1	19.0	19.0	19.0
Straw	..	..	..	13.4	13.4	13.4	13.1
Poultry litter	..	..	..	7.6	7.6	7.6	7.9
Meat and bone	..	..	..	16.8	16.8	16.8	16.2
General industrial waste	..	..	..	15.2	15.2	15.2	15.2
Hospital waste	..	..	..	13.3	13.3	13.3	13.3
Municipal solid waste	..	..	..	6.7	6.7	6.8	6.5
Refuse derived waste	..	..	..	13.0	13.0	13.0	13.0
Short rotation coppice	..	..	..	9.3	12.6	12.6	12.6
Tyres	..	..	..	30.4	30.4	30.4	30.4
Wood pellets	..	..	..	16.8	16.9	16.9	16.9
Biodiesel	..	..	..	37.2	37.2	37.2	37.2
Bioethanol	..	..	..	26.8	26.8	26.8	26.8

For footnotes see table A.2

The net calorific value of natural gas is the gross calorific value x 0.9.