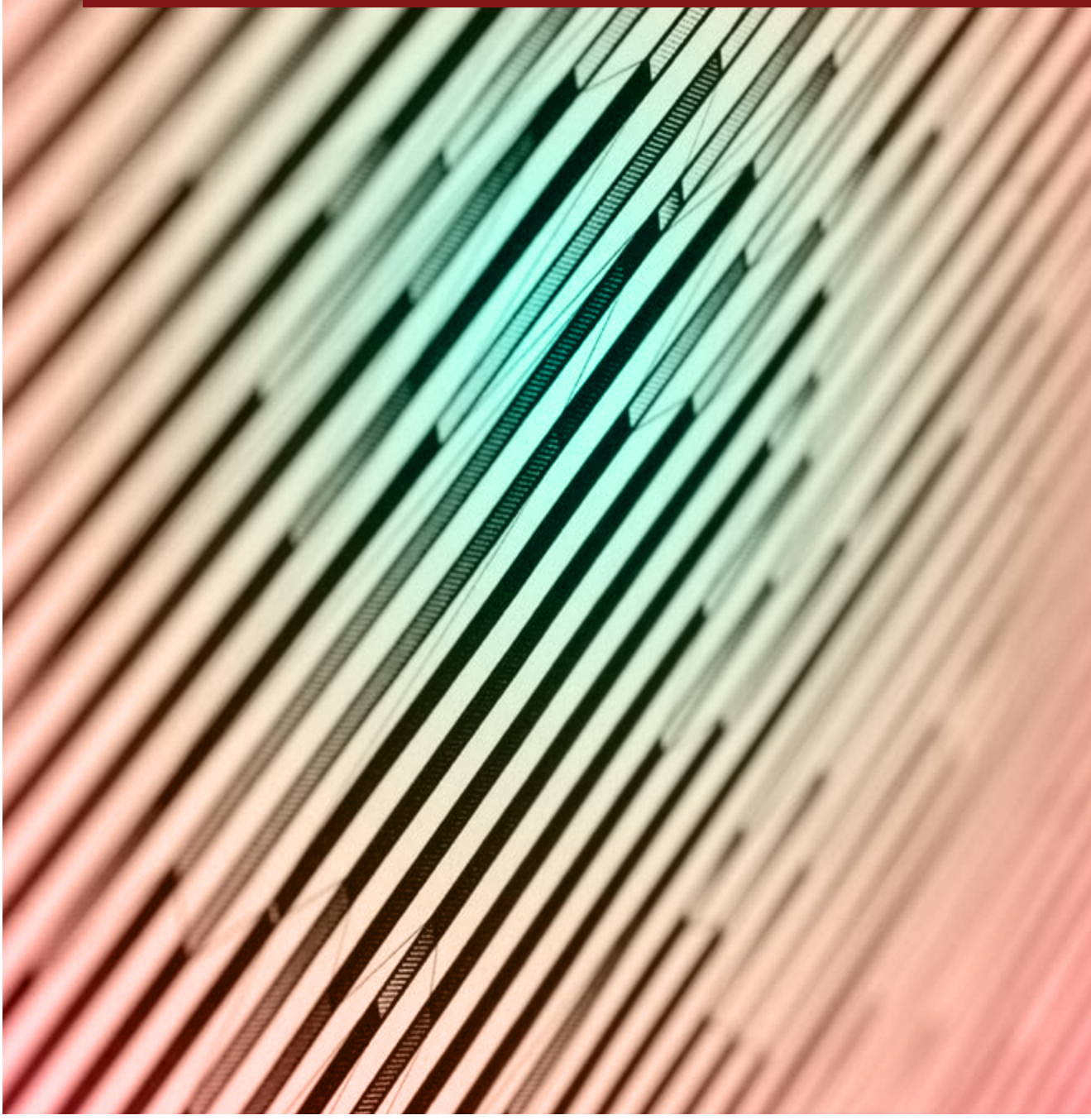
World energy statistics



International Energy Agency
Secure Sustainable Together

2018

World energy statistics

2018

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30 member countries, 7 association countries and beyond.

The four main areas of IEA focus are:

- **Energy Security**: Promoting diversity, efficiency, flexibility and reliability for all fuels and energy sources;
- **Economic Development**: Supporting free markets to foster economic growth and eliminate energy poverty;
- **Environmental Awareness**: Analysing policy options to offset the impact of energy production and use on the environment, especially for tackling climate change and air pollution; and
- **Engagement Worldwide**: Working closely with association and partner countries, especially major emerging economies, to find solutions to shared energy and environmental concerns.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates in the work of the IEA.

International Energy Agency
Secure
Sustainable
Together

© OECD/IEA, 2018

International Energy Agency
Website: ***www.iea.org***

Please note that this publication is subject to specific restrictions that limit its use and distribution. The terms and conditions are available online at *www.iea.org/t&c/*

TABLE OF CONTENTS

© OECD/IEA, 2018

PART III: SUMMARY TIME SERIES

ANNEX: ADDITIONAL STATISTICS

© OECD/IEA, 2018

INTRODUCTION

World Energy Statistics provides detailed statistics on production, trade and consumption for each source of energy for all the world's largest energy producing and consuming countries. It contains statistics for each source of energy for all OECD countries, the seven IEA Association countries, and over 100 other key energy producing and consuming countries, and main geographical regions, including the World. Non-OECD countries cover developing countries in Africa, Latin America and Asia, Central and Eastern European countries, and Eurasia. The consistency and complementarity of OECD and non-OECD countries' data ensure an accurate picture of the global energy situation.

Complementing the data in energy units of the sister publication *World Energy Balances*, this book includes detailed data by country for all energy sources – coal, gas, oil, electricity, renewables and waste - expressed in commodity balance format, for 2016 and provisional 2017 supply for OECD countries, and initial 2017 estimates for non-OECD countries production and trade of natural gas, primary coal and oil.

In this release, energy statistics are displayed for the world and the main geographic regions, then for OECD countries, Association countries, and finally for the other non-OECD countries

This volume has been prepared in close collaboration with other international organisations, including Eurostat, the Economic Commission for Europe of the United Nations (UNECE), the Organización Latinoamericana de Energía (OLADE), the Asia Pacific Energy Research Centre (APERC), the United Nations Statistics Division (UNSD), and the Forestry Department of the Food and Agriculture Organisation of the United Nations (FAO).

While every effort is made to ensure the accuracy of the data, quality is not homogeneous throughout the publication, reflecting the availability of data. In some countries data are based on secondary sources, and where incomplete or unavailable, on estimates. In general, data are likely to be more accurate for production, trade and total consumption than for individual sectors in transformation or final consumption.

General issues of data quality, as well as country notes and sources, should always be consulted when using data. In addition, limited official data are available for 2017 from non-OECD countries, therefore estimations have been used in most cases.

Data were collected by the team in the Energy Data Centre (EDC) of the IEA Secretariat, headed by Duncan Millard.

Within the IEA, for OECD members, data were prepared: by Beatriz Martinez for coal, by Aidan Kennedy, Mark Mateo and Julian Smith for electricity, by Dae Yong Kwon and Samantha Mead for renewables, by Angela Ortega Pastor and Laura Thomson for oil, by Faidon Papadimoulis and Aitor Soler Garcia for natural gas. OECD fuel data were prepared under the responsibility of Vladimir Kubecek and Julian Prime for coal, electricity and renewables, and under the responsibility of Erica Robin for oil and natural gas. OECD energy balances data were prepared by Rémi Gigoux, under the responsibility of Roberta Quadrelli. Non-OECD countries statistics were prepared by Nicolas Coënt, Laila El-Ashmawy, Musa Erdogan, Markus Fager-Pintilä, Julia Guyon, Nikolaos Kordevas, Agnieszka Koscielniak, Dae Yong Kwon and Claire Morel, under the responsibility of Céline Rouquette.

Roberta Quadrelli and Céline Rouquette have the overall responsibility for this report. The publication and its statistics were produced by Musa Erdogan and Rémi Gigoux. Desktop publishing was carried out by Sharon Burghgraeve.

© OECD/IEA, 2018

We would like to thank our numerous contacts world-wide in national administrations and in public and private companies for their helpful co-operation.

Complete supply and consumption data from 1971 to 2016 and selected estimates for 2017 are available on our online data service and on CD-ROM. Moreover, data can also be obtained on a pay-per-view basis. Details are available at www.iea.org/statistics.

Enquiries about data, methodology, or comments and suggestions should be addressed to: stats@iea.org

What's new?

New IEA Member: Mexico

Mexico became the International Energy Agency's 30th member country on 17 February 2018. Accordingly, starting with the 2018 edition, Mexico appears in the list of IEA Members and is included in the IEA zone aggregates for data starting in 1971 and for the entire time series.

New Association country: Brazil

Brazil joined the IEA as an Association country in October 2017. Accordingly, Brazil is now included in the IEA and Accession/Association countries aggregate for data starting in 1971 and for the entire time series.

© OECD/IEA, 2018

PART I

EXPLANATORY NOTES

© OECD/IEA, 2018

ABBREVIATIONS

Btu:	British thermal unit
GWh:	gigawatt hour
kcal:	kilocalorie
kg:	kilogramme
kJ:	kilojoule
Mt:	million tonnes
m^3:	cubic metre
t:	metric ton = tonne = 1000 kg
TJ:	terajoule
toe:	tonne of oil equivalent = 10^7 kcal
CHP:	combined heat and power
GCV:	gross calorific value
GDP:	gross domestic product
HHV:	higher heating value = GCV
LHV:	lower heating value = NCV
NCV:	net calorific value
PPP:	purchasing power parity
TPES:	total primary energy supply
AfDB:	African Development Bank
EU-28:	European Union - 28
FAO:	Food and Agriculture Organisation of the United Nations
IEA:	International Energy Agency
IPCC:	Intergovernmental Panel on Climate Change
ISIC:	International Standard Industrial Classification
OECD:	Organisation for Economic Co-Operation and Development
OLADE:	Organización Latinoamericana de Energía
UN:	United Nations
UNIPEDE:	International Union of Producers and Distributors of Electrical Energy
c	confidential
e	estimated
..	not available
-	nil
x	not applicable

© OECD/IEA, 2018

1. DEFINITIONS OF PRODUCTS AND FLOWS

The energy statistics tables provide a set of commodity balances for all sources of energy ("products"): primary coal and coal products, peat, natural gas, primary oil and oil products, solid biofuels, liquid biofuels, biogases, waste, as well as electricity and heat, which are derived from various sources.

Each commodity balance is divided into three main blocks of "*flows*": from top to bottom, the first showing *supply*, the second showing the *transformation processes* and *energy industries*, and the third showing *final consumption*, broken down into the various end-use sectors.

The definitions of products and flows presented in this chapter are based on those of *the Joint IEA/Eurostat/UNECE annual energy questionnaires*[1], and on the United Nations *International Recommendations on Energy Statistics*.[2]

Products

Coal

With the exception of the coal gases, the fuels in this section are expressed in thousand tonnes. The coal gases are expressed in terajoules on a **gross calorific value** basis.

Coking coal

Coking coal refers to bituminous coal with a quality that allows the production of a coke suitable to support a blast furnace charge. Its gross calorific value is equal to or greater than 24 000 kJ/kg (5 732 kcal/kg) on an ash-free but moist basis.

Other bituminous coal and anthracite

Other bituminous coal is used mainly for steam raising and space heating purposes and includes all bituminous coal that is not included under coking coal nor anthracite. It is characterized by higher volatile matter than anthracite (more than 10%) and lower carbon content (less than 90% fixed carbon). Its gross calorific value is equal to or greater than 24 000 kJ/kg (5 732 kcal/kg) on an ash-free but moist basis.

Anthracite is a high rank coal used for industrial and residential applications. It has generally less than 10% volatile matter and a high carbon content (about 90% fixed carbon). Its gross calorific value is equal to or greater than 24 000 kJ/kg (5 732 kcal/kg) on an ash-free but moist basis.

Sub-bituminous coal

Non-agglomerating coals with a gross calorific value equal to or greater than 20 000 kJ/kg (4 777 kcal/kg) and less than 24 000 kJ/kg (5 732 kcal/kg) containing more than 31% volatile matter on a dry mineral matter free basis.

Lignite

Lignite is a non-agglomerating coal with a gross calorific value of less than 20 000 kJ/kg (4 777 kcal/kg), and greater than 31% volatile matter on a dry mineral matter free basis.

Note: oil shale is presented separately and not included with lignite.

1. www.iea.org/statistics/resources/questionnaires/annual/.
2. https://unstats.un.org/UNSD/energy/ires/default.htm

© OECD/IEA, 2018

Coke oven coke, gas coke and coal tar

Coke oven coke is the solid product obtained from the carbonisation of coal, principally coking coal, at high temperature. It is low in moisture content and volatile matter. Coke oven coke is used mainly in the iron and steel industry, acting as an energy source and a chemical agent. Also included are semi-coke (a solid product obtained from the carbonisation of coal at a low temperature), lignite coke (a semi-coke made from lignite), coke breeze and foundry coke. The heading *other energy industry own use* includes the consumption at the coking plants themselves. Consumption in the *iron and steel industry* does not include coke converted into blast furnace gas. To obtain the total consumption of coke oven coke in the iron and steel industry, the quantities converted into blast furnace gas have to be added (these are included in *blast furnaces*).

Gas coke is a by-product of hard coal used for the *production* of town gas in gas works. Gas coke is used for heating purposes. *Other energy industry own use* includes the consumption of gas coke at gas works.

Coal tar is a result of the destructive distillation of bituminous or of the low-temperature carbonisation of brown coal. Coal tar from bituminous coal is the liquid by-product of the distillation of coal to make coke in the coke oven process. Coal tar can be further distilled into different organic products (e.g. benzene, toluene, naphthalene), which normally would be reported as a feedstock to the petrochemical industry.

Patent fuel and brown coal briquettes (BKB)

Patent fuel is a composition fuel manufactured from hard coal fines with the addition of a binding agent. The amount of patent fuel produced may, therefore, be slightly higher than the actual amount of coal consumed in the transformation process. Consumption of patent fuels during the patent fuel manufacturing process is included under *other energy industry own use*.

BKB is a composition fuel manufactured from lignite or sub-bituminous coal, produced by briquetting under high pressure with or without the addition of a binding agent. These figures include peat briquettes, dried lignite fines and dust. The heading *other energy industry own use* includes consumption by briquetting plants.

Gas works gas

Gas works gas covers all types of gas produced in public utility or private plants, whose main purpose is the manufacture, transport and distribution of gas. It includes gas produced by carbonisation (including gas produced by coke ovens and transferred to gas works), by total gasification (with or without enrichment with oil products) and by reforming and simple mixing of gases and/or air.

Coke oven gas

Coke oven gas is obtained as a by-product of the manufacture of coke oven coke for the production of iron and steel.

Recovered gases

Blast furnace gas is produced during the combustion of coke in blast furnaces in the iron and steel industry. It is recovered and used as a fuel, partly within the plant and partly in other steel industry processes or in power stations equipped to burn it.

Other recovered gases are obtained as a by-product of the production of steel in an oxygen furnace and are recovered on leaving the furnace. The gases are also known as converter gas, LD gas or BOS gas.

Peat

Peat and peat products

Peat is a combustible soft, porous or compressed, fossil sedimentary deposit of plant origin with high water content (up to 90% in the raw state), easily cut, of light to dark brown colour. Peat used for non-energy purposes is not included here. Milled peat is included here.

Peat products are products such as peat briquettes derived directly or indirectly from sod peat and milled peat**.**

Note: for presentational purposes, in the statistics tables, the column of peat also includes data for oil shale, where applicable.

Oil shale

Oil shale and oil sands

Oil shale and oil sands produced and combusted directly are included in this category. Oil shale and oil sands used as inputs for other transformation processes are also included here (this includes the portion consumed in the transformation process). Shale oil and other products derived from liquefaction are included in *from other sources* under crude oil (*other hydrocarbons*).

© OECD/IEA, 2018

For presentational purposes, in the statistics tables, data for oil shale have been included within the column of peat, where applicable.

Natural gas

Natural gas is expressed in terajoules on a **gross calorific value** basis.

Natural gas comprises gases, occurring in underground deposits, whether liquefied or gaseous, consisting mainly of methane. It includes: "non-associated" gas originating from fields producing hydrocarbons only in gaseous form; "associated" gas produced in association with crude oil; and methane recovered from coal mines (colliery gas) or from coal seams (coal seam gas).

Production represents dry marketable production within national boundaries, including offshore production and is measured after purification and extraction of NGL and sulphur. It includes quantities used within the natural gas industry; in gas extraction, pipeline systems and processing plants. Quantities of gas that are re-injected, vented or flared are excluded.

Crude oil, NGL, refinery feedstocks

The fuels in this section are expressed in thousand tonnes.

Crude oil

Crude oil is a mineral oil of natural origin consisting of a mixture of hydrocarbons of natural origin and associated impurities, such as sulphur. It exists in the liquid phase under normal surface temperature and pressure and its physical characteristics (density, viscosity, etc.) are highly variable. It includes field or lease condensates (separator liquids) which are recovered from associated and non-associated gas where it is commingled with the commercial crude oil stream.

Other hydrocarbons, including synthetic crude oil from tar sands, shale oil, etc., liquids from coal liquefaction, output of liquids from natural gas conversion into gasoline, hydrogen and emulsified oils (e.g. Orimulsion), are included here. This aggregation differs from the presentation of other hydrocarbons in the Oil Information publication.

Natural gas liquids (NGLs)

NGLs are the liquid or liquefied hydrocarbons recovered from natural gas in separation facilities or gas processing plants. NGLs include ethane, propane, (normal and iso-) butane, (iso-) pentane and pentanes plus (sometimes referred to as natural gasoline or plant condensates).

Refinery feedstocks

A refinery feedstock is a processed oil destined for further processing (e.g. straight run fuel oil or vacuum gas oil) other than blending in the refining industry. With further processing, it will be transformed into one or more components and/or finished products. This definition also covers returns from the petrochemical industry to the refining industry (e.g. pyrolysis gasoline, C4 fractions, gasoil and fuel oil fractions).

Additives

Additives are non-hydrocarbon compounds added to or blended with a product to modify its properties, for example, to improve its combustion characteristics. Alcohols and ethers (MTBE, methyl tertiary-butyl ether) and chemical alloys such as tetraethyl lead are included here. The biofuel fractions of biogasoline, biodiesel and ethanol are not included here, but under liquid biofuels. This differs from the presentation of additives in the *Oil Information* publication.

Oil products

The fuels in this section are expressed in thousand tonnes.

Oil products are any oil-based products which can be obtained by distillation and are normally used outside the refining industry. The exceptions to this are those finished products which are classified as refinery feedstocks.

Refinery gas (not liquefied)

Refinery gas includes a mixture of non-condensed gases mainly consisting of hydrogen, methane, ethane and olefins obtained during distillation of crude oil or treatment of oil products (e.g. cracking) in refineries. It also includes gases which are returned from the petrochemical industry. Refinery gas production refers to gross production. Own consumption is shown separately under *oil refineries* in *energy industry own use*.

Liquefied petroleum gases (LPG) and ethane

LPGs are light paraffinic hydrocarbons derived from refinery processes, crude oil stabilisation plants and natural gas processing plants. They consist mainly of propane (C_3H_8) and butane (C_4H_{10}) or a combination of the two. They could also include propylene, butylene,

© OECD/IEA, 2018

isobutene and isobutylene. LPGs are normally liquefied under pressure for transportation and storage.

Ethane is a naturally gaseous straight-chain hydrocarbon (C_2H_6) which is extracted from natural gas and refinery gas streams.

Motor gasoline excluding biofuels

Motor gasoline is light hydrocarbon oil for use in internal combustion engines such as motor vehicles, excluding aircraft. Motor gasoline is distilled between 35°C and 215°C and is used as a fuel for land based spark ignition engines. Motor gasoline may include additives, oxygenates and octane enhancers, including lead compounds such as TEL (tetraethyl lead) and TML (tetramethyl lead). Motor gasoline excluding biofuels does not include the liquid biofuel or ethanol blended with gasoline - see liquid biofuels. This differs from the presentation of motor gasoline in the *Oil Information* publication.

Aviation fuels

Aviation fuels comprise gasoline and kerosene type jet fuels meeting specifications for use in aviation turbine power units as well as small amounts of aviation gasoline.

Gasoline-type jet fuel includes all light hydrocarbon oils for use in aviation turbine power units, distilling between 100°C and 250°C. This fuel is obtained by blending kerosenes and gasoline or naphthas in such a way that the aromatic content does not exceed 25% in volume, and the vapour pressure is between 13.7 kPa and 20.6 kPa. Additives can be included to improve fuel stability and combustibility.

Kerosene-type jet fuel is a medium distillate used for aviation turbine power units. It has the same distillation characteristics (between 150°C and 300°C but not generally above 250°C) and flash point as kerosene. In addition, it has particular specifications (such as freezing point) which are established by the International Air Transport Association (IATA). It includes kerosene blending components.

This aggregation differs from the presentation of aviation fuels in the *Oil Information* publication.

Aviation gasoline is motor spirit prepared especially for aviation piston engines, with an octane number suited to the engine, a freezing point of -60°C, and a distillation range usually within the limits of 30°C and 180°C.

Other kerosene

Kerosene (other than kerosene used for aircraft transport which is included with aviation fuels) comprises refined petroleum distillate intermediate in volatility between gasoline and gas/diesel oil. It is a medium oil distilling between 150°C and 300°C.

Gas/diesel oil (distillate fuel oil) excluding biofuels

Gas/diesel oil includes heavy gas oils. Gas oils are obtained from the lowest fraction from atmospheric distillation of crude oil, while heavy gas oils are obtained by vacuum redistillation of the residual from atmospheric distillation. Gas/diesel oil distils between 180°C and 380°C. Several grades are available depending on uses: diesel oil for diesel compression ignition (cars, trucks, marine, etc.), light heating oil for industrial and commercial uses, and other gas oil including heavy gas oils which distil between 380°C and 540°C and which are used as petrochemical feedstocks. Gas/diesel oil excluding biofuels does not include the liquid biofuels blended with gas/diesel oil – see liquid biofuels. This differs from the presentation of gas/diesel oil in the *Oil Information* publication.

Fuel oil

Fuel oil defines oils that make up the distillation residue. It comprises all residual fuel oils, including those obtained by blending. Its kinematic viscosity is above 10 cSt at 80°C. The flash point is always above 50°C and the density is always higher than 0.90 kg/l.

Naphtha

Naphtha is a feedstock destined either for the petrochemical industry (e.g. ethylene manufacture or aromatics production) or for gasoline production by reforming or isomerisation within the refinery. Naphtha comprises material that distils between 30°C and 210°C. Naphtha imported for blending is shown as an import of naphtha, and then shown in the transfers row as a negative entry for naphtha and a positive entry for the corresponding finished product (e.g. gasoline).

Petroleum coke

Petroleum coke is a black solid by-product, obtained mainly by cracking and carbonising of petroleum derived feedstocks, vacuum bottoms, tar and pitches in processes such as delayed coking or fluid coking. It consists mainly of carbon (90 to 95%) and has a low ash content. It is used as a feedstock in coke ovens for the steel industry, for heating purposes, for electrode manufacture and for production of chemicals. The two

© OECD/IEA, 2018

most important qualities are "green coke" and "calcinated coke". This category also includes "catalyst coke" deposited on the catalyst during refining processes: this coke is not recoverable and is usually burned as refinery fuel.

Other oil products

In this publication, the category *other oil products* groups together white spirit and SBP, lubricants, bitumen, paraffin waxes and others.

White spirit and SBP are refined distillate intermediates with a distillation in the naphtha/kerosene range. White spirit has a flash point above 30°C and a distillation range of 135°C to 200°C. Industrial spirit (SBP) comprises light oils distilling between 30°C and 200°C. In other words, SBP is a light oil of narrower cut than motor spirit. There are seven or eight grades of industrial spirit, depending on the position of the cut in the distillation range. The grades are defined according to the temperature difference between the 5% volume and 90% volume distillation points (not more than 60°C).

Lubricants are hydrocarbons produced from distillate or residue; they are mainly used to reduce friction between bearing surfaces. This category includes all finished grades of lubricating oil, from spindle oil to cylinder oil, and those used in greases, including motor oils and all grades of lubricating oil base stocks.

Bitumen is a solid, semi-solid or viscous hydrocarbon with a colloidal structure that is brown to black in colour. It is obtained by vacuum distillation of oil residues from atmospheric distillation of crude oil. Bitumen is often referred to as asphalt and is primarily used for surfacing of roads and for roofing material. This category includes fluidised and cut-back bitumen.

Paraffin waxes are saturated aliphatic hydrocarbons. These waxes are residues extracted when dewaxing lubricant oils, and they have a crystalline structure which is more or less fine according to the grade. Their main characteristics are that they are colourless, odourless and translucent, with a melting point above 45°C.

Other oil products not classified above (e.g. tar, sulphur and grease) are included here. This category also includes aromatics (e.g. BTX or benzene, toluene and xylene) and olefins (e.g. propylene) produced within refineries.

Biofuels and Waste

The fuels in this section are expressed in terajoules on a **net calorific value** basis, with the exception of liquid biofuels and charcoal, which are in thousand tonnes.

Note that for biomass commodities, only the amounts specifically used for energy purposes (a small part of the total) are included in the energy statistics. Therefore, the non-energy use of biomass is not taken into consideration and the quantities are null by definition.

Solid biofuels

Solid biofuels are defined as any plant matter used directly as fuel or converted into other forms before combustion. This covers a multitude of woody materials generated by industrial process or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, sulphite lyes also known as black liquor, animal materials/wastes and other solid biofuels).

Charcoal produced from solid biofuels is also included here. Since charcoal is a secondary product, its treatment is slightly different than that of the other primary biofuels. Production of charcoal (an output in the transformation process) is offset by the inputs of primary biofuels into the charcoal production process. The losses from this process are included in the row *other transformation*. Other supply (e.g. trade and stock changes) as well as consumption are aggregated directly with the primary biofuels. In most countries, only the primary biofuels are reported.

Biogases

Biogases are gases arising from the anaerobic fermentation of biomass and the gasification of solid biomass (including biomass in wastes). The biogases from anaerobic fermentation are composed principally of methane and carbon dioxide and comprise landfill gas, sewage sludge gas and other biogases from anaerobic fermentation.

Biogases can also be produced from thermal processes (by gasification or pyrolysis) of biomass and are mixtures containing hydrogen and carbon monoxide (usually known as syngas) along with other components. These gases may be further processed to modify their composition and can be further processed to produce substitute natural gas.

Biogases are used mainly as a fuel but can be used as a chemical feedstock.

Liquid biofuels

Liquid biofuels include the liquid biofuels that are blended into gasoline and gas/diesel oil and other liquid biofuels. It does not include the total volume of gasoline or diesel into which the biofuels are blended.

© OECD/IEA, 2018

Biogasoline includes bioethanol (ethanol produced from biomass and/or the biodegradable fraction of waste), biomethanol (methanol produced from biomass and/or the biodegradable fraction of waste), bioETBE (ethyl-tertio-butyl-ether produced on the basis of bioethanol; the percentage by volume of bioETBE that is calculated as biofuel is 47%) and bioMTBE (methyl-tertio-butyl-ether produced on the basis of biomethanol: the percentage by volume of bioMTBE that is calculated as biofuel is 36%).

Biodiesels includes biodiesel (a methyl-ester produced from vegetable or animal oil, of diesel quality), biodimethylether (dimethylether produced from biomass), Fischer Tropsh (Fischer Tropsh produced from biomass), cold pressed bio-oil (oil produced from oil seed through mechanical processing only) and all other liquid biofuels which are added to, blended with or used straight as transport diesel or for electricity and heat generation.

Other liquid biofuels include liquid biofuels used directly as fuel, not reported in either biogasoline or biodiesels.

Waste and other non-specified

Municipal waste consists of products that are combusted directly to produce heat and/or power and comprises wastes produced by households, industry, hospitals and the tertiary sector that are mainly collected by local authorities for incineration at specific installations.

Industrial waste of non-renewable origin consists of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power. Renewable industrial waste is not included here, but with solid biofuels, biogases or liquid biofuels.

Electricity and heat

Electricity is expressed in gigawatt hours and heat is expressed in terajoules.

Electricity

Gross electricity production is measured at the terminals of all alternator sets in a station; it therefore includes the energy taken by station auxiliaries and losses in transformers that are considered integral parts of the station.

The difference between gross and net production is generally estimated as 7% for conventional thermal stations, 1% for hydro stations, and 6% for nuclear, geothermal and solar stations. Production in hydro stations includes production from pumped storage plants.

Heat

Heat production includes all heat produced by main activity producer CHP and heat plants, as well as heat sold by autoproducer CHP and heat plants to third parties.

Fuels used to produce quantities of heat for sale are included in transformation processes under the rows *CHP plants* and *heat plants*. The use of fuels for heat which is not sold is included under the sectors in which the fuel use occurs. Data on heat have become available in different years for different countries and thus any aggregated data should be used with caution.

Hydro energy

Hydro energy represents the potential and kinetic energy of water converted into electricity in hydroelectric plants.

Geothermal energy

Geothermal energy is the energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam. It is exploited at suitable sites:

- for electricity generation using dry stream or high enthalpy brine after flashing
- directly as heat for district heating, agriculture, etc.

Solar energy

Solar energy is the solar radiation exploited for hot water production and electricity generation, by:

- flat plate collectors, mainly of the thermosyphon type, for domestic hot water or for the seasonal heating of swimming pools
- photovoltaic cells
- solar thermal-electric plants

Passive solar energy for the direct heating, cooling and lighting of dwellings or other buildings is not included.

Tide/wave/ocean energy

Tide, wave and ocean represent the mechanical energy derived from tidal movement, wave motion or ocean current and exploited for electricity generation.

Wind energy

Wind energy represents the kinetic energy of wind exploited for electricity generation in wind turbines.

© OECD/IEA, 2018

Flows

Supply

The first block of the energy commodity balances shows the following elements of supply:

Production
\+ *From other sources*
\+ *Imports*
\- *Exports*
\- *International marine bunkers*
\- *International aviation bunkers*
± *Stock changes*
= *Domestic supply*

Note, exports, bunkers and stock changes incorporate the algebraic sign directly in the number.

Production

Production refers to the quantities of fuels extracted or produced, calculated after any operation for removal of inert matter or impurities (e.g. sulphur from natural gas). For "other hydrocarbons" (shown with crude oil), production includes synthetic crude oil (including mineral oil extracted from bituminous minerals such as oil shale and tar sands, etc.). Production of secondary oil products represents the gross refinery output. Secondary coal products (including coal gases) represent the output from coke ovens, gas works, blast furnaces and other transformation processes.

From other sources

From other sources refers to both primary energy that has not been accounted for under production and secondary energy that has been accounted for in the production of another fuel. For example, under additives: benzol, alcohol and methanol produced from natural gas; under refinery feedstocks: backflows from the petrochemical industry used as refinery feedstocks; under "other hydrocarbons" (included with crude oil): liquids obtained from coal liquefaction and GTL plants; under primary coal: recovered slurries, middlings, recuperated coal dust and other low-grade coal products that cannot be classified according to type of coal from which they are obtained; under gas works gas: natural gas, refinery gas, and LPG, that are treated or mixed in gas works (i.e. gas works gas produced from sources other than coal).

The presentation of production from other sources differs in the *Oil Information* publication.

Imports and exports

Imports and exports comprise amounts having crossed the national territorial boundaries of the country whether or not customs clearance has taken place.

For coal: Imports and exports comprise the amount of fuels obtained from or supplied to other countries, whether or not there is an economic or customs union between the relevant countries. Coal in transit should not be included.

For oil and natural gas: Quantities of crude oil and oil products imported or exported under processing agreements (i.e. refining on account) are included. Quantities of oil in transit are excluded. Crude oil, NGL and natural gas are reported as coming from the country of origin; refinery feedstocks and oil products are reported as coming from the country of last consignment. Re-exports of oil imported for processing within bonded areas are shown as an export of product from the processing country to the final destination. Imported LNG which is exported to another country after regasification is considered both as an import and as an export of gas.

For electricity: Amounts are considered as imported or exported when they have crossed the national territorial boundaries of the country. If electricity is "wheeled" or transited through a country, the amount is shown as both an import and an export.

International marine bunkers

International marine bunkers covers those quantities delivered to ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation is excluded. The domestic/international split is determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. Consumption by fishing vessels and by military forces is also excluded. See definitions of *transport*, *fishing*, and *other non-specified*.

International aviation bunkers

International aviation bunkers includes deliveries of aviation fuels to aircraft for international aviation. Fuels used by airlines for their road vehicles are excluded. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. For many countries this

© OECD/IEA, 2018

incorrectly excludes fuel used by domestically owned carriers for their international departures.

Note that international marine bunkers and international aviation bunkers are subtracted out of supply in agreement with the definitions of the United Nations International Recommendations on Energy Statistics (IRES). This differs from the treatment of international aviation bunkers in the annual oil statistics published in the Oil Information publication.

Stock changes

Stock changes reflects the difference between opening stock levels on the first day of the year and closing levels on the last day of the year of stocks on national territory held by producers, importers, energy transformation industries and large consumers. Oil and gas stock changes in pipelines are not taken into account. With the exception of large users mentioned above, changes in final users' stocks are not taken into account. A stock build is shown as a negative number, and a stock draw as a positive number.

Domestic supply

Domestic supply is defined as *production + from other sources + imports - exports - international marine bunkers - international aviation bunkers ± stock changes*. Note, exports, bunkers and stock changes incorporate the algebraic sign directly in the number.

Transfers

Transfers comprises *interproduct transfers, products transferred* and *recycled products*.

Interproduct transfers results from reclassification of products either because their specification has changed or because they are blended into another product, e.g. kerosene may be reclassified as gasoil after blending with the latter in order to meet its winter diesel specification. The net balance of *interproduct transfers* is zero.

Products transferred is intended for oil products imported for further processing in refineries. For example, fuel oil imported for upgrading in a refinery is transferred to the feedstocks category.

Recycled products are finished products which pass a second time through the marketing network, **after** having been once delivered to final consumers (e.g. used lubricants which are reprocessed).

This aggregation differs from the presentation of the transfers categories in the *Oil Information* publication.

Statistical difference

Statistical differences are essentially the difference between supply and demand. They include the sum of the unexplained statistical differences for individual fuels, as they appear in the basic energy statistics. They also include the statistical differences that arise because of the variety of conversion factors in the coal and oil columns.

Statistical difference is defined as deliveries to *final consumption* + use for *transformation processes* + consumption by *energy industry own use* + *losses* - *domestic supply* - *transfers*. Statistical differences arise because the data for the individual components of supply and demand are often derived from different data sources by the national administration. Furthermore, the inclusion of changes in some large consumers' stocks in the supply part of the balance introduces distortions which also contribute to the statistical differences.

Transformation processes

Transformation processes comprise the conversion of primary forms of energy to secondary and further transformation (e.g. coking coal to coke, crude oil to oil products, and fuel oil to electricity).

Electricity plants

Electricity plants refers to plants which are designed to produce electricity only. If one or more units of the plant is a CHP unit (and the inputs and outputs cannot be distinguished on a unit basis) then the whole plant is designated as a CHP plant. Both main activity producer[3] and autoproducer[4] plants are included here. Heat from chemical processes for electricity generation is also included here.

Combined heat and power plants

Combined heat and power plants refers to plants which are designed to produce both heat and electricity (sometimes referred to as co-generation power stations). If possible, fuel inputs and electricity/heat outputs are on a unit basis rather than on a plant basis. However, if data are not available on a unit basis, the convention for defining a CHP plant noted above should be adopted. Both main activity producer and

3. Main activity producers generate electricity and/or heat for sale to third parties, *as their primary activity*. They may be privately or publicly owned. Note that the sale need not take place through the public grid.

4. Autoproducer undertakings generate electricity and/or heat, wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned.

© OECD/IEA, 2018

autoproducer plants are included here. *Note that for autoproducer CHP plants, all fuel inputs to electricity production are taken into account, while only the part of fuel inputs to heat **sold** is shown. Fuel inputs for the production of heat consumed within the auto-producer's establishment are **not** included here but are included with figures for the final consumption of fuels in the appropriate consuming sector.*

Heat plants

Heat plants refers to plants (including heat pumps and electric boilers) designed to produce heat only and who sell heat to a third party (e.g. residential, commercial or industrial consumers) under the provisions of a contract. Both main activity producer and auto-producer plants are included here. Heat pumps that are operated within the residential sector where the heat is not sold are not considered a transformation process and are not included here – the electricity consumption would appear as residential use.

Blast furnaces

Blast furnaces covers the quantities of fuels used for the production of recovered gases (e.g. blast furnace gas and oxygen steel furnace gas). The production of pig-iron from iron ore in blast furnaces uses fuels for supporting the blast furnace charge and providing heat and carbon for the reduction of the iron ore. Accounting for the calorific content of the fuels entering the process is a complex matter as transformation (into blast furnace gas) and consumption (heat of combustion) occur simultaneously. Some carbon is also retained in the pig-iron; almost all of this reappears later in the oxygen steel furnace gas (or converter gas) when the pig-iron is converted to steel. In the 1992/1993 annual questionnaires, Member Countries were asked for the first time to report in *transformation processes* the quantities of all fuels (e.g. pulverised coal injection [PCI] coal, coke oven coke, natural gas and oil) entering blast furnaces and the quantity of blast furnace gas and oxygen steel furnace gas produced. The IEA Secretariat then needed to split these inputs into the transformation and consumption components. The transformation component is shown in the row *blast furnaces* in the column appropriate for the fuel, and the consumption component is shown in the row *iron and steel*, in the column appropriate for the fuel. Originally, the IEA Secretariat assumed that there was a transformation efficiency of 100%, which meant that the energy going into the transformation process was equal to the energy coming out i.e. equivalent to the energy content of the gases produced). However, when the IEA data were used to calculate CO_2 emissions from fuel combustion using the Intergovernmental Panel on Climate Change (IPCC) methodology, as published in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*,[5] the blast furnaces were showing a carbon gain. Starting with the 1998 edition, the IEA Secretariat decided to assume a transformation efficiency such that the carbon input into the blast furnaces should equal the carbon output. This is roughly equivalent to assuming an energy transformation efficiency of 40%.

Gas works

Gas works covers the quantities of fuels used for the production of town gas. Note, this item also includes other gases blended with natural gas.

Coke/patent fuel/BKB/PB plants

Coke/patent fuel/BKB/PB plants covers the use of fuels for the manufacture of coke, coke oven gas, patent fuels, BKB and peat briquettes (PB).

Oil refineries

Oil refineries covers the transformation of hydrocarbons for the manufacture of finished oil products.

Petrochemical plants

Petrochemical plants covers backflows returned from the petrochemical industry. Note that backflows from oil products that are used for non-energy purposes (i.e. white spirit and lubricants) are not included here, but in non-energy use.

Liquefaction plants

Liquefaction plants includes diverse liquefaction processes, such as coal liquefaction plants and gas-to-liquid plants.

Other transformation

Other transformation includes the transformation of primary solid biofuels into charcoal, the transformation of natural gas for hydrogen manufacture, and other non-specified transformation.

Energy industry own use

Energy industry own use covers the amount of fuels used by the energy producing industries (e.g. for heating, lighting and operation of all equipment used in

5. The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* are available from the IPCC National Greenhouse Gas Inventories Programme at www.ipcc-nggip.iges.or.jp.

© OECD/IEA, 2018

the extraction process, for traction and for distribution). It includes energy consumed by energy industries for heating, pumping, traction and lighting purposes [ISIC[6] Divisions 05, 06, 19 and 35, Group 091 and Classes 0892 and 0721].

Fuel mining and extraction

Fuel mining and extraction includes both coal mining and oil and gas extraction. For hard coal and lignite mining, this represents the energy which is used directly within the coal industry. It excludes coal burned in pithead power stations (included under electricity plants in transformation processes) and free allocations to miners and their families (considered as part of household consumption and therefore included under residential). For oil and gas extraction, flared gas is not included.

Oil refineries

Energy consumed in refineries for the operation of equipment, heating and lighting.

Electricity, CHP and heat plants

Energy use in electricity, CHP and heat plants.

Pumped storage plants

Pumped storage plants (electricity consumed in hydroelectric plants).

Other energy industry own use

Other energy industry own use (including own consumption in patent fuel plants, coke ovens, gas works, blast furnaces, BKB, peat briquette and lignite coke plants, coal liquefaction plants, gas-to-liquids plants, charcoal production plants, nuclear plants as well as use in non-specified energy industries).

Losses

Losses includes losses in energy distribution, transmission and transport.

Final consumption

Final consumption is the sum of the consumption in the end-use sectors and for non-energy use. Energy used for transformation processes and for own use of the energy producing industries is excluded. Final consumption reflects for the most part deliveries to consumers (see note on *stock changes*).

Backflows from the petrochemical industry are not included in final consumption (see *from other sources* under supply and *petrochemical plants* in transformation).

Industry

Industry consumption is specified by sub-sector as listed below. Energy used for transport by industry is not included here but is reported under transport. *Non-energy use* in industry is excluded from *industry* and reported separately, and this treatment differs from the *Oil Information* publication.

Iron and steel industry

Iron and steel industry [ISIC Group 241 and Class 2431];

Chemical and petrochemical industry

Chemical and petrochemical industry [ISIC Divisions 20 and 21] excluding petrochemical feedstocks;

Non-ferrous metals

Non-ferrous metals basic industries [ISIC Group 242 and Class 2432];

Non-metallic minerals

Non-metallic minerals such as glass, ceramic, cement, etc. [ISIC Division 23];

Transport equipment

Transport equipment [ISIC Divisions 29 and 30];

Machinery

Machinery: fabricated metal products, machinery and equipment other than transport equipment [ISIC Divisions 25 to 28];

Mining and quarrying

Mining (excluding fuels) and quarrying [ISIC Divisions 07 and 08 and Group 099];

Food and tobacco

Food and tobacco [ISIC Divisions 10 to 12];

Paper, pulp and printing

Paper, pulp and printing [ISIC Divisions 17 and 18];

Wood and wood products

Wood and wood products (other than pulp and paper) [ISIC Division 16];

6. International Standard Industrial Classification of All Economic Activities, Series M, No. 4/Rev. 4, United Nations, New York, 2008.

© OECD/IEA, 2018

Construction

Construction [ISIC Divisions 41 to 43];

Textile and leather

Textile and leather [ISIC Divisions 13 to 15];

Non-specified

Non-specified (any manufacturing industry not included above) [ISIC Divisions 22, 31 and 32].

Note: Most countries have difficulties supplying an industrial breakdown for all fuels. In these cases, the *non-specified* industry row has been used. Regional aggregates of industrial consumption should therefore be used with caution.

Transport

Consumption in transport covers all transport activity (in mobile engines) regardless of the economic sector to which it is contributing [ISIC Divisions 49 to 51], and is specified below. *Non-energy use* in transport is excluded from *transport* and reported separately, and this treatment differs from the *Oil Information* publication.

Domestic aviation

Domestic aviation includes deliveries of aviation fuels to aircraft for domestic aviation - commercial, private, agricultural, etc. It includes use for purposes other than flying, e.g. bench testing of engines, but not airline use of fuel for road transport. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. Note that this may include journeys of considerable length between two airports in a country (e.g. San Francisco to Honolulu). For many countries this incorrectly includes fuel used by domestically owned carriers for outbound international traffic (see *international aviation bunkers*).

Road

Road includes fuels used in road vehicles as well as agricultural and industrial highway use. It excludes military consumption as well as motor gasoline used in stationary engines and diesel oil for use in tractors that are not for highway use.

Rail

Rail includes quantities used in rail traffic, including industrial railways, and in rail transport laid in public roads as part of urban or suburban transport systems (trams, metro, etc.).

Pipeline transport

Pipeline transport includes energy used in the support and operation of pipelines transporting gases, liquids, slurries and other commodities, including the energy used for pump stations and maintenance of the pipeline. Energy for the pipeline distribution of natural gas or coal gases, hot water or steam (ISIC Division 35) from the distributor to final users is excluded and should be reported in *energy industry own use*, while the energy used for the final distribution of water (ISIC Division 36) to household, industrial, commercial and other users should be included in *commercial/public services*. Losses occurring during the transport between distributor and final users should be reported as *losses*.

Domestic navigation

Domestic navigation includes fuels delivered to vessels of all flags not engaged in international navigation (see *international marine bunkers*). The domestic/international split should be determined on the basis of port of departure and port of arrival and not by the flag or nationality of the ship. Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu). Fuel used for ocean, coastal and inland fishing and military consumption are excluded.

Non-specified

Non-specified includes all transport not elsewhere specified.

Note: *International marine bunkers* and *international aviation bunkers* are shown in *Supply* and are not included in transport as part of final consumption.

Other

Residential

Residential includes consumption by households, excluding fuels used for transport. It includes households with employed persons [ISIC Divisions 97 and 98] which is a small part of total residential consumption.

Commercial and public services

Commercial and public services [ISIC Divisions 33, 36-39, 45-47, 52, 53, 55, 56, 58-66, 68-75, 77-82, 84 (excluding Class 8422), 85-88, 90-96 and 99].

© OECD/IEA, 2018

Agriculture/forestry

Agriculture/forestry includes deliveries to users classified as agriculture, hunting and forestry by the ISIC, and therefore includes energy consumed by such users whether for traction (excluding agricultural highway use), power or heating (agricultural and domestic) [ISIC Divisions 01 and 02].

Fishing

Fishing includes fuels used for inland, coastal and deep-sea fishing. Fishing covers fuels delivered to ships of all flags that have refuelled in the country (including international fishing) as well as energy used in the fishing industry [ISIC Division 03]. *Prior to the 2007 edition, fishing was included with agriculture/forestry and this may continue to be the case for some countries*.

Non-specified

Non-specified includes all fuel use not elsewhere specified as well as consumption in the above-designated categories for which separate figures have not been provided. Military fuel use for all mobile and stationary consumption is included here (e.g. ships, aircraft, road and energy used in living quarters) regardless of whether the fuel delivered is for the military of that country or for the military of another country.

Non-energy use

Non-energy use covers those fuels that are used as raw materials in the different sectors and are not consumed as a fuel or transformed into another fuel. Non-energy use is shown separately within final consumption.

Note that for biofuels, only the amounts of biomass specifically used for energy purposes (a small part of the total) are included in the energy statistics. Therefore, the non-energy use of biomass is not taken into consideration and the quantities are null by definition.

of which: chemical/petrochemical. Fuels used for chemical feedstocks and non–energy products in the petrochemical industry, which includes cracking and reforming processes for the purpose of producing ethylene, propylene, butylene, synthesis gas, aromatics, butadiene and other hydrocarbon-based raw materials in processes such as steam cracking, aromatics plants and steam reforming [part of ISIC Group 201].

© OECD/IEA, 2018

2. NOTES ON DATA QUALITY

Methodology

For OECD Member countries, the data shown in this publication are derived from information provided in the five annual OECD questionnaires[1]: "Oil", "Natural Gas", "Solid Fossil Fuels and Manufactured Gases", "Renewables" and "Electricity and Heat" completed by the national administrations. For the member countries of the European Union (EU), of the Economic Commission for Europe of the United Nations (UNECE) and a few others, the data shown in this publication are mostly based on information provided by the national administrations through the same annual questionnaires. The commodity balances for all other countries are based on national energy data of heterogeneous nature, converted and adapted to fit the IEA format and methodology.

Considerable effort has been made to ensure that the data presented in this publication adhere to the IEA definitions reported in the section on Methodological notes. These definitions, based on the *United Nations International Recommendations on Energy Statistics*[2], are used by most of the international organisations that collect energy statistics.

Nevertheless, energy statistics at the national level are often collected using criteria and definitions which differ, sometimes considerably, from those of international organisations. This is especially true for non-OECD countries, who voluntarily submit data to the IEA. The IEA secretariat has identified most of these differences and, where possible, adjusted the data to meet international definitions.

Recognised anomalies occurring in specific countries are presented in the section on Country notes and sources. Country notes present the most important deviations from the IEA methodology, and are by no means a comprehensive list of anomalies by country.

Estimation

In addition to adjustments addressing differences in definitions, estimations[3] are sometimes required to complete major aggregates, when key statistics are missing.

The IEA secretariat has attempted to provide all the elements of energy balances down to the level of final consumption, for all countries and years. Providing all the elements of supply, as well as all inputs and outputs of the main transformation activities (such as oil refining and electricity generation), has often required estimations. Estimations have been generally made after consultation with national statistical offices, oil companies, electricity utilities and national energy experts.

Time series and political changes

The IEA secretariat reviews its databases each year. In the light of new assessments, important revisions may be made to time series of individual countries during the course of this review. Therefore, some data in this publication have been substantially revised with respect to previous editions. Please always consult the section on Country notes and sources.

It is also the case that energy statistics for some countries undergo continuous changes in their coverage or

1. See link to the annual questionnaires: www.iea.org/statistics/resources/questionnaires/annual/.
2. https://unstats.un.org/UNSD/energy/ires/default.htm
3. Data may not include all informal and/or illegal trade, production or consumption of energy products, although the IEA Secretariat makes efforts to estimate these where reliable information is available.

© OECD/IEA, 2018

methodology. Consequently, breaks in time series are considered to be unavoidable.

For example, energy balances for the individual countries of the Former Soviet Union and the Former Yugoslavia have been constructed since 1990 and are not available for previous years. These balances are generally based on official submissions, but estimations also have been made by the IEA secretariat. The section on Country notes and sources describes in detail these elements country by country.

Classification of fuel uses

National statistical sources often lack adequate information on the consumption of fuels in different categories of end use. Many countries do not conduct annual surveys of consumption in the main sectors of economic activity, and published data may be based on out-of-date surveys. Therefore, sectoral disaggregation of consumption should generally be interpreted with caution.

In many countries of non-OECD Europe and Eurasia and in China, the sectoral classification of fuel consumption before the reforms of the 1990's significantly differed from that of market economies. Sectoral consumption was defined according to the economic branch of the user, rather than according to the purpose or use of the fuel. For example, consumption of gasoline in the vehicle fleet of an enterprise attached to the economic branch 'Iron and steel' was classified as consumption in the 'Iron and steel' industry itself.

Where possible, data have been adjusted to fit international classifications, for example by assuming that most gasoline is consumed in transport. However, it has not been possible to reclassify products other than gasoline and jet fuel as easily, and few other adjustments have been made to other products.

Imports and exports

For a given product, imports and exports may not sum up to zero at the world level for a number of reasons. Fuels may be classified differently (i.e. fuel oil exports may be reported as refinery feedstocks by the importing country; NGL exports may be reported as LPG by the importing country, etc.). Other possible reasons include discrepancies in conversion factors, inclusion of international bunkers in exports, timing differences, data reported on a fiscal year basis instead of calendar year for certain countries, and under-reporting of imports and exports for fiscal reasons.

Specific issues by fuel

Coal

Data on sectoral coal consumption are usually reported in metric tonnes. Net calorific values of different coal types used in different end use sectors are not always available. In the absence of specific information, the IEA secretariat estimates end use net calorific values based on the available net calorific values for production, imports and exports.

Oil

The IEA secretariat collects comprehensive statistics for oil supply and use, including oil for own use of refineries, oil delivered to international bunkers, and oil used as petrochemical feedstock. National statistics often do not report all these amounts.

Reported production of refined products may refer to net rather than gross refinery output; consumption of oil products may be limited to sales to domestic markets and may not include deliveries to international shipping or aircraft. Oil consumed as petrochemical feedstock in integrated refinery/petrochemical complexes is often not included in available official statistics.

Where possible, the IEA secretariat has estimated those unreported data, in consultation with the oil industry. In the absence of any other indication, refinery fuel use is estimated to be a percentage (e.g. 5%) of refinery throughput, and where possible, split between refinery gas and fuel oil. For a description of some adjustments made to the sectoral consumption of oil products, see the above section 'Classification of fuel uses'.

Natural gas

Natural gas should be comprised mainly of methane; other gases, such as ethane and heavier hydrocarbons, should be reported under the heading of 'oil'. The IEA defines natural gas production as the marketable production, i.e. net of field losses, flaring, venting and re-injection.

However, the lack of adequate definitions makes it difficult or impossible to identify all quantities of gas at all different stages of its separation into dry gas (methane) and heavier fractions. National data for natural gas do not always explicitly show separate quantities for field losses, flaring, venting and re-injection.

Natural gas supply and demand statistics are normally reported in volumetric units and it is difficult to obtain accurate data on the calorific value. In the absence of

© OECD/IEA, 2018

specific information, the IEA generally applies an average gross calorific value of 38 TJ/million m^3.

Reliable consumption data for natural gas at a disaggregated level are often difficult to find. This is especially true for some of the largest natural gas consuming countries in the Middle East. Therefore, industrial use of natural gas for these countries is frequently missing from the data published here.

Electricity

The IEA classification shows "main activity producers" separately from "autoproducers" of electricity and heat. For non-OECD countries, data on autoproducers are not always reported. In such cases, the quantities of fuels used as input to electricity are included under the appropriate end-use sector.

When statistics of production of electricity from biofuels and waste are available, they are included in total electricity production. However, these data are not comprehensive; e.g. some generation from waste biomass in sugar refining may be unreported.

When unreported, inputs of fuels for electricity generation are estimated using information on electricity output, fuel efficiency and type of generation capacity.

Off-grid electricity generation may be still underreported due to measurements difficulties, especially in developing countries.

Heat

For heat, transition economies (countries of non-OECD Europe and Eurasia) and China used to adopt a different methodology from that adopted in market economies. They allocated the transformation of primary fuels (coal, oil and gas) by industry into heat *for consumption on site* to the transformation activity '*heat production'*, ***not*** to industrial consumption, as in the IEA methodology[4]. The transformation output of *Heat* was then allocated to the various end use sectors. The losses occurring in the transformation of fuels into heat in industry were not included in final consumption of industry.

Although a number of countries have switched to the practice of international organisations, this important issue reduces the possibility of cross-country comparisons for sectoral end use consumption between transition economies and market economies.

4. For autoproducer plants, the international methodology restricts the inclusion of heat in transformation processes to that sold to third parties.

Biofuels and waste

The IEA publishes data on production, domestic supply and consumption of biofuels and waste for all countries and all regions.

Data for non-OECD countries are often based on secondary sources and may be of variable quality, which makes comparisons between countries difficult. For many countries, historical data are derived from surveys which were often irregular, irreconcilable and conducted at a local rather than national level.

Where historical series were incomplete or unavailable, they were estimated using a methodology consistent with the projection framework of the IEA's 1998 edition of *World Energy Outlook* (September 1998). First, nation-wide domestic supply per capita of biofuels and wastes was compiled or estimated for 1995. Then, per capita supply for the years 1971 to 1994 was estimated using a log/log equation with either GDP per capita or percentage of urban population as exogenous variables, depending on the region. Finally, supply of total biofuels and waste after 1996 was estimated assuming a growth rate either constant, equal to the population growth rate, or based on the 1971-1994 trend.

Those estimated time series should be treated very cautiously. The chart below provides a broad indication of the estimation methodology and of the data quality by region.

Region	Main source of data	Data quality	Exogenous variables
Africa	FAO database and AfDB	low	population growth rate
Non-OECD Americas	national and OLADE	high	none
Asia	surveys	high to low	population growth rate
Non-OECD Europe and Eurasia	questionnaires and FAO	high to medium	none
Middle East	FAO	medium to low	none

Given the importance of vegetal fuels in the energy picture of many developing countries, balances down to final consumption by end-use for individual products or product categories have been compiled for all countries.

The IEA hopes that the inclusion of these data will encourage national administrations and other agencies active in the field to enhance the level and quality of data collection and coverage for biofuels and waste. More details on the methodology used by each country may be provided on request and comments are welcome.

© OECD/IEA, 2018

© OECD/IEA, 2018

3. GEOGRAPHICAL COVERAGE

In this publication:

World includes OECD Total; Africa; Non-OECD Americas; Non-OECD Asia (excluding China); China (People's Republic of China and Hong Kong, China); Non-OECD Europe and Eurasia; Middle East; World aviation bunkers and World marine bunkers. It is also the sum of Africa, Americas, Asia, Europe, Oceania, World aviation bunkers and World marine bunkers.

Africa includes Algeria; Angola; Benin; Botswana; Burkina Faso; Burundi; Cabo Verde; Cameroon; Central African Republic; Chad; Comoros; the Republic of the Congo (Congo); Côte d'Ivoire; the Democratic Republic of the Congo; Djibouti; Egypt; Equatorial Guinea; Eritrea; Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Libya; Madagascar; Malawi; Mali; Mauritania; Mauritius; Morocco; Mozambique; Namibia; Niger; Nigeria; Réunion; Rwanda; Sao Tome and Principe; Senegal; the Seychelles; Sierra Leone; Somalia; South Africa; South Sudan (from 2012); Sudan; Swaziland; the United Republic of Tanzania (Tanzania); Togo; Tunisia; Uganda; Zambia; Zimbabwe.

Americas includes Antigua and Barbuda; Argentina; Aruba; the Bahamas; Barbados; Belize; Bermuda; the Plurinational State of Bolivia (Bolivia); Bonaire (from 2012); the British Virgin Islands; Brazil; Canada; the Cayman Islands; Chile; Colombia; Costa Rica; Cuba; Curaçao[1]; Dominica; the Dominican Republic; Ecuador; El Salvador; the Falkland Islands (Malvinas); Guatemala; the French Guiana; Grenada; Guadeloupe; Guyana; Haiti; Honduras; Jamaica; Martinique; Mexico; Montserrat; Nicaragua; Panama; Paraguay; Peru; Puerto Rico (for natural gas and electricity) [2]; Saba (from 2012); Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Sint Eustatius (from 2012); Sint Maarten (from 2012); Suriname; Trinidad and Tobago; the Turks and Caicos Islands; the United States; Uruguay; the Bolivarian Republic of Venezuela (Venezuela).

Asia (from 1990) includes Afghanistan; Armenia; Azerbaijan; Bahrain; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; the People's Republic of China; Cyprus[3]; Georgia; Hong Kong, China; India; Indonesia; the Islamic Republic of Iran; Iraq; Israel[4]; Japan; Jordan; the Democratic People's Republic of Korea; Korea; Kazakhstan; Kuwait; Kyrgyzstan; Lao People's Democratic Republic; Lebanon; Macau, China; Malaysia; the Maldives; Mongolia; Myanmar; Nepal; Oman; Pakistan; the Philippines; Qatar; Saudi Arabia; Singapore; Sri Lanka; the Syrian Arab Republic; Tajikistan; Chinese Taipei; Thailand; Timor-Leste;

1. The Netherlands Antilles was dissolved on 10 October 2010 resulting in two new "constituent countries" (Curaçao and Sint Maarten) with the other islands joining The Netherlands as "special municipalities". However, due to lack of detailed data the IEA Secretariat's data and estimates under the "Netherlands Antilles" still refer to the whole territory of the Netherlands Antilles as it was known prior to 10 October 2010 up to the end of 2011. Data refer only to the island of Curaçao from 2012. The other islands of the former Netherlands Antilles are added to Other non-OECD Americas from 2012.

2. Oil statistics as well as coal trade statistics for Puerto Rico are included under the United States.

3. **Note by Turkey:**
The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
Note by all the European Union member states of the OECD and the European Union:
The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

4. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

© OECD/IEA, 2018

Turkey; Turkmenistan; the United Arab Emirates; Uzbekistan; Viet Nam; and Yemen.

Europe (from 1990) includes Albania; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; the Czech Republic; Denmark; Estonia; Finland; the Former Yugoslav Republic of Macedonia; France; Germany; Gibraltar; Greece; Hungary; Iceland; Ireland; Italy; Kosovo[5]; Latvia; Lithuania; Luxembourg; Malta; the Republic of Moldova (Moldova); Montenegro; the Netherlands; Norway; Poland; Portugal; Romania; the Russian Federation; Serbia[6]; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Ukraine; the United Kingdom.

Oceania includes Australia; New Zealand; Cook Islands; Fiji; French Polynesia; Kiribati; New Caledonia; Palau; Papua New Guinea; Samoa; the Solomon Islands; Tonga; Vanuatu.

The **International Energy Agency (IEA)** includes Australia; Austria; Belgium; Canada; the Czech Republic; Denmark; Estonia[7]; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Japan; Korea; Luxembourg; Mexico; the Netherlands; New Zealand; Norway; Poland; Portugal; the Slovak Republic; Spain; Sweden; Switzerland; Turkey; the United Kingdom; the United States.

The **IEA and Accession/Association countries** includes: IEA member countries: Australia; Austria; Belgium; Canada; the Czech Republic; Denmark; Estonia[7]; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Japan; Korea; Luxembourg; Mexico; the Netherlands; New Zealand; Norway; Poland; Portugal; the Slovak Republic; Spain; Sweden; Switzerland; Turkey; the United Kingdom and the United States; Accession country: Chile; Association countries: Brazil; the People's Republic of China; India; Indonesia; Morocco; Singapore; Thailand.

The **Organisation for Economic Co-Operation and Development (OECD)** includes Australia; Austria; Belgium; Canada; Chile; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Korea; Latvia[8]; Luxembourg; Mexico; the Netherlands; New Zealand; Norway; Poland; Portugal; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Turkey; the United Kingdom; the United States.

Lithuania was not an OECD Member at the time of preparation of this publication. Accordingly, Lithuania does not appear in the list of OECD Members and is not included in the zone aggregates.

OECD Americas includes Canada; Chile; Mexico; the United States.

OECD Asia Oceania includes Australia; Israel; Japan; Korea; New Zealand.

OECD Europe includes Austria; Belgium; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia[8]; Luxembourg; the Netherlands; Norway; Poland; Portugal; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Turkey; the United Kingdom.

Estonia, Latvia and Slovenia are included starting in 1990. Prior to 1990, Estonia and Latvia are included in Former Soviet Union and Slovenia is included in Former Yugoslavia.

Within the **OECD**:

- **Australia** excludes the overseas territories;
- **Denmark** excludes Greenland and the Faroe Islands, except prior to 1990, where data on oil for Greenland were included with the Danish statistics. The administration is planning to revise the series back to 1974 to exclude these amounts;
- **France** includes Monaco and excludes the following overseas departments: Guadeloupe; French Guiana; Martinique; Mayotte; and Réunion; and collectivities: New Caledonia; French Polynesia; Saint Barthélemy; Saint Martin; Saint Pierre and Miquelon; and Wallis and Futuna;
- **Germany** includes the new federal states of Germany from 1970 onwards;
- The statistical data for **Israel** are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is

5. This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo's declaration of independence.

6. Serbia includes Montenegro until 2004 and Kosovo until 1999.

7. Estonia is included starting in 1990. Prior to 1990, data for Estonia are included in Former Soviet Union.

8. Latvia is included starting in 1990. Prior to 1990, data for Latvia are included in Former Soviet Union.

© OECD/IEA, 2018

without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

- **Italy** includes San Marino and the Holy See;
- **Japan** includes Okinawa;
- **Netherlands** excludes Suriname, Aruba and the other former Netherlands Antilles (Bonaire, Curaçao, Saba, Saint Eustatius and Sint Maarten);
- **Portugal** includes the Azores and Madeira;
- **Spain** includes the Canary Islands;
- **Switzerland** includes Liechtenstein for oil data; data for other fuels do not include Liechtenstein;
- Shipments of coal and oil to the Channel Islands and the Isle of Man from the **United Kingdom** are not classed as exports. Supplies of coal and oil to these islands are, therefore, included as part of UK supply. Exports of natural gas to the Isle of Man are included with the exports to Ireland;
- **United States** includes the 50 states and the District of Columbia but generally excludes all territories, and all trade between the U.S. and its territories. Oil statistics include Guam, Puerto Rico[9] and the United States Virgin Islands; trade statistics for coal include international trade to and from Puerto Rico and the United States Virgin Islands.

Non-OECD Europe and Eurasia includes Albania; Armenia; Azerbaijan; Belarus; Bosnia and Herzegovina; Bulgaria; Croatia; Cyprus[3]; the Former Yugoslav Republic of Macedonia; Georgia; Gibraltar; Kazakhstan; Kosovo[5]; Kyrgyzstan; Lithuania[10]; Malta; the Republic of Moldova (Moldova); Montenegro; Romania; the Russian Federation; Serbia[6]; Tajikistan; Turkmenistan; Ukraine; Uzbekistan; the Former Soviet Union; the Former Yugoslavia.

Non-OECD Asia excluding China includes Bangladesh; Brunei Darussalam; Cambodia (from 1995); India; Indonesia; the Democratic People's Republic of Korea; Malaysia; Mongolia (from 1985); Myanmar; Nepal; Pakistan; the Philippines; Singapore; Sri Lanka; Chinese Taipei; Thailand; Viet Nam; **Other non-OECD Asia**.

China includes the (People's Republic of) China; Hong Kong, China.

Non-OECD Americas includes Argentina; the Plurinational State of Bolivia (Bolivia); Brazil; Colombia; Costa Rica; Cuba; Curaçao[1]; the Dominican Republic; Ecuador; El Salvador; Guatemala; Haiti; Honduras; Jamaica; Nicaragua; Panama; Paraguay; Peru; Suriname (from 2000), Trinidad and Tobago; Uruguay; the Bolivarian Republic of Venezuela (Venezuela); **Other non-OECD Americas**.

Middle East includes Bahrain; the Islamic Republic of Iran; Iraq; Jordan; Kuwait; Lebanon; Oman; Qatar; Saudi Arabia; the Syrian Arab Republic; the United Arab Emirates; Yemen.

Other Africa includes Botswana (until 1980); Burkina Faso; Burundi; Cabo Verde; Central African Republic; Chad; Comoros; Djibouti; Equatorial Guinea; Gambia; Guinea; Guinea-Bissau; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Namibia (until 1990); Niger (until 1999); Réunion; Rwanda; Sao Tome and Principe; the Seychelles; Sierra Leone; Somalia; Swaziland; Uganda.

Other non-OECD Americas includes Anguilla; Antigua and Barbuda; Aruba; the Bahamas; Barbados; Belize; Bermuda; Bonaire (from 2012); the British Virgin Islands; the Cayman Islands; Dominica; the Falkland Islands (Malvinas); the French Guiana; Grenada; Guadeloupe; Guyana; Martinique; Montserrat; Puerto Rico (for natural gas and electricity)[9]; Saba (from 2012); Saint Eustatius (from 2012); Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Sint Maarten (from 2012); Suriname (until 1999); the Turks and Caicos Islands.

Other non-OECD Asia includes Afghanistan; Bhutan; Cambodia (until 1994); Cook Islands; Fiji; French Polynesia; Kiribati; Lao People's Democratic Republic; Macau, China; the Maldives; Mongolia (until 1984); New Caledonia; Palau (from 1994); Papua New Guinea; Samoa; the Solomon Islands; Timor-Leste; Tonga; Vanuatu.

The **European Union - 28 (EU-28)** (from 1990) includes Austria; Belgium; Bulgaria; Croatia; Cyprus[3]; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; the Netherlands; Poland; Portugal; Romania; the Slovak Republic; Slovenia; Spain; Sweden; the United Kingdom.

9. Natural gas and electricity data for Puerto Rico are included under Other non-OECD Americas.

10. Lithuania was not an OECD Member at the time of preparation of this publication. Accordingly, Lithuania does not appear in the list of OECD Members and is still included in the non-OECD aggregates.

© OECD/IEA, 2018

Please note that in the interest of having comparable data, all these countries are included since 1990 despite different entry dates into the European Union.

G7 includes Canada; France; Germany; Italy; Japan; United Kingdom; the United States.

G8 includes Canada; France; Germany; Italy; Japan; the Russian Federation; the United Kingdom; the United States.

G20 includes Argentina; Australia; Brazil; Canada; China (including Hong Kong, China); India; Indonesia; Japan; Korea; Mexico; the Russian Federation; Saudi Arabia; South Africa; Turkey; the United States; the European Union – 28.

The **Organisation of the Petroleum Exporting Countries (OPEC)** includes Algeria; Angola; Ecuador; Gabon; the Islamic Republic of Iran; Iraq; Kuwait; Libya; Nigeria; Qatar; Saudi Arabia; the United Arab Emirates; the Bolivarian Republic of Venezuela (Venezuela). [11]

Please note that the following countries have not been considered:

- **Non-OECD Europe and Eurasia**: Andorra; Faroe Islands (after 1990); Liechtenstein[12] (except for oil data); the Palestinian Authority; Svalbard; Jan Mayen Islands;
- **Africa:** British Indian Ocean Territory; French Southern and Antarctic Lands; Mayotte; Saint Helena; Western Sahara;
- **Non-OECD Americas**: Bouvet Island; Saint Barthélemy; Greenland (after 1990); Saint Martin (French Part); South Georgia and the South Sandwich Islands;
- Antarctica;
- **Non-OECD Asia excluding China:** American Samoa; Cocos (Keeling) Islands; Christmas Island; Heard Island and McDonald Islands; Marshall Islands; Micronesia (Federated States of); Nauru; Niue; Norfolk Island; Northern Mariana Islands; Pitcairn; Tokelau; Tuvalu; United States Minor Outlying Islands; Wallis and Futuna Islands.

11. Data for Gabon, that re-joined OPEC in July 2016, are included in the OPEC aggregate starting with the 2017 edition Data for Equatorial Guinea, that joined OPEC in May 2017, and for Congo, that joined OPEC in June 2018, are not included in the OPEC aggregate in this edition.

12. Oil data for Liechtenstein are included under Switzerland.

© OECD/IEA, 2018