International Energy Agency
Secure Sustainable Together

WORLD CO_2 EMISSIONS FROM FUEL COMBUSTION

DATABASE DOCUMENTATION

INTERNATIONAL ENERGY AGENCY

This document provides information regarding the 2016 edition of the IEA *World CO_2 Emissions from Fuel Combustion* database. This document can be found online at:

http://www.iea.org/statistics/topics/CO2emissions/

Please address your inquiries to emissions@iea.org.

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1. CHANGES FROM LAST EDITION

Revisions to data: People's Republic of China

In September 2015, the National Bureau of Statistics of China (NBS) published China's energy statistics for 2013, as well as revised statistics for the years 2000 to 2012. The NBS supplied the IEA with detailed energy balances for 2011 to 2013 and these data were incorporated in the 2015 edition of this publication. In 2016, the NBS supplied the IEA with detailed energy balances for 2000 to 2010 and the IEA revised its 2000-2010 data based on these newly available figures, as published in this document.

For more information, please refer to the relevant country note in the chapter *Geographical Coverage and Country Notes*.

Geographical Coverage

The IEA continues to try to expand the coverage of its statistics reports and encourages more countries to collaborate on data exchange. This year data have become available for Suriname from 2000 to 2014, and have been included in this edition. Therefore Suriname, published separately, has been removed from the region Other non-OECD Americas for those years.

In previous editions of the publication, the country composition of the regional grouping Annex I Kyoto Parties reflected those countries with targets under the first commitment period of the Kyoto Protocol (2008-2012). In this edition, the country composition of this grouping has been updated as per Annex B of the Doha Amendment, to reflect those countries with targets under the second commitment period of the Kyoto Protocol (2013-2020). In addition, the name of this aggregate has been amended to Annex B Kyoto Parties, to account for the fact that Kazakhstan, a non-Annex I country, has adopted a target under the Doha Amendment.

Changes to variables names

Old longname	New longname	Shortname	Old shortname (if changed)
Memo: Annex I Kyoto Parties	Memo: Annex B Kyoto Parties	ANNEXB	
Memo: Economies in Transition	Memo: Annex I Economies in Transition	ANNEXIEIT	

2. DATABASE DESCRIPTION

The *World CO_2 Emissions from Fuel Combustion* database contains annual CO_2 emissions from fuel combustion and related indicators for over 140 countries and regional aggregates. Emissions were calculated using IEA energy databases and the default methods and emission factors given in the *2006 GLs for National Greenhouse Gas Inventories*. This edition includes annual data for 177 countries/regions, generally from 1960-2014 (OECD) and from 1971-2014 (Non-OECD), unless specified differently at the country level.

The *World CO_2 Emissions from Fuel Combustion* database includes the following seven files:
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WORLD_BigCO_2.IVT **CO_2 Emissions from Fuel Combustion (detailed estimates)**

Detailed CO_2 emissions by subsector and by product (47 products; 40 flows).

WORLD_CO_2.IVT **CO_2 Emissions from Fuel Combustion (summary)**

Aggregated CO_2 emissions by sector and by product category (5 product categories, 14 flow categories).

WORLD_CO_2Indic.IVT **CO_2 emissions indicators**

30 CO_2-related, energy and socio-economic indicators

WORLD_CO_2kwh.IVT **CO_2 emissions per kWh**

13 indicators related to CO_2 from electricity and heat production.

Data are available from 1990 to 2014.

WORLD_CO_2Sector.ivt **Allocation of emissions from electricity and heat**

CO_2 emissions after reallocation of emissions from electricity and heat generation to consuming sectors.

WORLD_IPCC2006.ivt **IPCC Fuel Combustion Emissions (2006 Guidelines)**

CO_2 emissions from fuel combustion, with Reference and Sectoral Approach totals, as well as detailed split between emissions across the Energy, and Industrial Processes and Product Use (IPPU) sectors, as recommended in the *2006 GLs*.

WORLD_ NonCO_2.Ivt **Emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6**

CO_2-equivalent emissions of six greenhouse gases across all sectors

Data are available for 1990, 2000, 2005 and 2010.

Detailed definitions of each flow and product are presented in the chapter *Definitions*.

3. DEFINITIONS

CO_2 emissions from fuel combustion (Mt of CO_2)		
Flow	**Short name**	**Definition**
CO_2 Fuel Combustion	CO2FCOMB	*CO_2 Fuel Combustion* presents total CO_2 emissions from fuel combustion. This includes CO_2 emissions from fuel combustion in IPCC Source/Sink Category 1 A Fuel Combustion Activities and those which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*. CO2FCOMB = MAINPROD + AUTOPROD + OTHEN + TOTIND +TOTTRANS + TOTOTHER
Main activity producer of electricity and heat	MAINPROD	*Main activity producer electricity and heat* contains the sum of emissions from main activity producer electricity generation, combined heat and power generation and heat plants. Main activity producers are defined as those undertakings whose primary activity is to supply the public. They may be publicly or privately owned. Emissions from own on-site use of fuel are included. This corresponds to IPCC Source/Sink Category 1 A 1 a.
Main activity electricity plants	MAINELEC	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. Main activity producers generate electricity 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.
Main activity CHP plants	MAINCHP	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. 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.

CO_2 emissions from fuel combustion (Mt of CO_2)		
Flow	**Short name**	**Definition**
Main activity heat plants	MAINHEAT	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. Main activity producers generate 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.
Own use in electricity, CHP and heat plants	EPOWERPLT	Emissions from own on-site use of fuel in electricity, CHP and heat plants. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Unallocated autoproducers	AUTOPROD	*Unallocated autoproducers* contains the emissions from the generation of electricity and/or heat by autoproducers. Autoproducers are defined as undertakings that 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. In the *2006 GLs*, these emissions would normally be distributed between industry, transport and "other" sectors. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Autoproducer electricity plants	AUTOELEC	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. Autoproducer undertakings generate electricity wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.

CO_2 emissions from fuel combustion (Mt of CO_2)		
Flow	**Short name**	**Definition**
Autoproducer CHP plants	AUTOCHP	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. 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 autoproducer's establishment are not included here but are included with figures for the final consumption of fuels in the appropriate consuming sector. 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. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Autoproducer heat plants	AUTOHEAT	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. Autoproducer undertakings generate heat, wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Other energy industry own use	OTHEN	*Other energy industry own use* contains emissions from fuel combusted in oil refineries, for the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries. This corresponds to the IPCC Source/Sink Categories 1 A 1 b and 1 A 1 c. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.

CO_2 emissions from fuel combustion (Mt of CO_2)		
Flow	**Short name**	**Definition**
Manufacturing industries and construction	TOTIND	*Manufacturing industries and construction* contains the emissions from combustion of fuels in industry. The IPCC Source/Sink Category 1 A 2 includes these emissions. However, in the *2006 GLs*, the IPCC category also includes emissions from industry autoproducers that generate electricity and/or heat. The IEA data are not collected in a way that allows the energy consumption to be split by specific end-use and therefore, autoproducers are shown as a separate item (*unallocated autoproducers*). This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Iron and steel	IRONSTL	[ISIC Rev. 4 Group 241 and Class 2431] This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Chemical and petrochemical	CHEMICAL	[ISIC Rev. 4 Divisions 20 and 21]
Non-ferrous metals	NONFERR	[ISIC Rev. 4 Group 242 and Class 2432] Basic industries. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Non-metallic minerals	NONMET	[ISIC Rev. 4 Division 23] Such as glass, ceramic, cement, etc.
Transport equipment	TRANSEQ	[ISIC Rev. 4 Divisions 29 and 30]
Machinery	MACHINE	[ISIC Rev. 4 Divisions 25 to 28] Fabricated metal products, machinery and equipment other than transport equipment.
Mining and quarrying	MINING	[ISIC Rev. 4 Divisions 07 and 08 and Group 099] Mining (excluding fuels) and quarrying.
Food and tobacco	FOODPRO	[ISIC Rev. 4 Divisions 10 to 12]
Paper, pulp and printing	PAPERPRO	[ISIC Rev. 4 Divisions 17 and 18]
Wood and wood Products	WOODPRO	[ISIC Rev. 4 Division 16] Wood and wood products other than pulp and paper.
Construction	CONSTRUC	[ISIC Rev. 4 Division 41 to 43]
Textile and leather	TEXTILES	[ISIC Rev. 4 Divisions 13 to 15]

CO_2 emissions from fuel combustion (Mt of CO_2)		
Flow	**Short name**	**Definition**
Non-specified industry	INONSPEC	[ISIC Rev. 4 Divisions 22, 31 and 32] Any manufacturing industry not included above. 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	TOTTRANS	*Transport* contains emissions from the combustion of fuel for all transport activity, regardless of the sector, except for *international marine bunkers* and *international aviation bunkers*, which are not included in *transport* at a national or regional level (except for World transport emissions). This includes domestic aviation, domestic navigation, road, rail and pipeline transport, and corresponds to IPCC Source/Sink Category 1 A 3. The IEA data are not collected in a way that allows the autoproducer consumption to be split by specific end-use and therefore, this publication shows autoproducers as a separate item (*unallocated autoproducers*). Note: Starting in the 2006 edition, military consumption previously included in *domestic aviation* and in *road* should be in *non-specified other*.
Road	ROAD	*Road* contains the emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on highways. This corresponds to the IPCC Source/Sink Category 1 A 3 b. Excludes emissions from military consumption as well as motor gasoline used in stationary engines and diesel oil for use in tractors that are not for highway use.
Domestic aviation	DOMESAIR	*Domestic aviation* includes emissions from aviation fuels delivered to aircraft for domestic aviation – commercial, private, agriculture, 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 also incorrectly includes fuel used by domestically owned carriers for outbound international traffic.
Rail	RAIL	Includes emissions from rail traffic, including industrial railways.

CO_2 emissions from fuel combustion (Mt of CO_2)		
Flow	**Short name**	**Definition**
Pipeline transport	PIPELINE	Includes emissions from fuels 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 or coal gases, hot water or steam (ISIC Rev. 4 Division 35) from the distributor to final users is excluded and should be reported in other energy industry own use, while the energy used for the final distribution of water (ISIC Rev. 4 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 distribution losses.
Domestic navigation	DOMESNAV	*Domestic navigation* includes emissions from 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 transport	TRNONSPE	Includes all emissions from transport not elsewhere specified. Note: *International marine bunkers* and *international aviation bunkers* are not included in *transport* at a country or regional level (except for World transport emissions).
Other	TOTOTHER	*Other* contains the emissions from commercial/institutional activities, residential, agriculture/forestry, fishing and other emissions not specified elsewhere that are included in the IPCC Source/Sink Categories 1 A 4 and 1 A 5. In the *2006 GLs*, the category also includes emissions from autoproducers in the commercial/public services, residential and agriculture that generate electricity and/or heat. The IEA data are not collected in a way that allows the energy consumption to be split by specific end-use and therefore, autoproducers are shown as a separate item (unallocated autoproducers).
Residential	RESIDENT	*Residential* contains all emissions from fuel combustion in households. This corresponds to IPCC Source/Sink Category 1 A 4 b.
Commercial and public services	COMMPUB	Commercial and public services includes emissions from all activities of ISIC Rev. 4 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.

CO_2 emissions from fuel combustion (Mt of CO_2)		
Flow	**Short name**	**Definition**
Agriculture/forestry	AGRICULT	*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 Rev. 4 Division 03].
Fishing	FISHING	*Fishing* includes emissions from 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 Rev.4 Division 03].
Non-specified other	ONONSPEC	Includes emissions from all fuel use not elsewhere specified as well as consumption in the above-designated categories for which separate figures have not been provided. Emissions from military fuel use for all mobile and stationary consumption are 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.
Memo: International marine bunkers	MARBUNK	*International marine bunkers* contains emissions from fuels burned by 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. Emissions from international marine bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 d i.
Memo: International aviation bunkers	AVBUNK	*International aviation bunkers* contains emissions from fuels used by 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. Emissions from international aviation bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 a i.

Electricity and Heat Output and Emissions per kWh		
Flow	**Short name**	**Definition**
CO_2 per kWh of electricity (gCO_2 per kWh)	CO2KWH	This ratio is expressed in grammes of CO_2 per kWh. It has been calculated using CO_2 emissions from generation of electricity ("main activity producer" and "autoproducer") divided by output of electricity. The CO_2 emissions include emissions from fossil fuels, industrial waste and non-renewable municipal waste that are consumed for electricity generation in the transformation sector and the output includes electricity generated from all fossil and non-fossil sources (excluding pumped hydro). As a result, the emissions per kWh can vary from year to year depending on the generation mix. In order to take account of electricity output from combined heat and power (CHP) plants, it was necessary to allocate the inputs (and thus the emissions) of CHP plants between electricity and heat. Allocation was based on a fixed-heat-efficiency approach and assumed that heat generation within CHP plants had a 90% efficiency. In the ratios of CO_2 emissions per kWh by fuel: • Peat and oil shale are aggregated with *Coal*. • *Oil* includes oil products (and small amounts of crude oil for some countries). • *Gas* represents natural gas. Note: Emissions per kWh should be used with caution due to data quality problems relating to electricity efficiencies for some countries.
Electricity and heat output (TWh)	ELECHEAT	Total output includes electricity and heat generated in the transformation sector using fossil fuels, nuclear, hydro (excluding pumped storage), geothermal, solar, biofuels, etc. Both public and autoproducer plants have been included. For electricity, data include the total number of TWh generated by power plants (including both electricity plants and CHP plants). For heat, data include the total amount of TWh generated by power plants (including both CHP plants and heat plants).
Electricity output (TWh)	ELOUTPUT	Electricity generated shows the total number of TWh generated by thermal power plants separated into electricity plants and CHP plants, as well as production by nuclear and hydro (excluding pumped storage production), geothermal, etc.
Electricity output-main activity producer electricity plants (TWh)	ELMAINE	Electricity plants refer 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. Main activity producers (formerly known as public supply undertakings) 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.

Electricity and Heat Output and Emissions per kWh		
Flow	**Short name**	**Definition**
Electricity output-autoproducer electricity plants (TWh)	ELAUTOE	Electricity plants refer 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. 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.
Electricity output-main activity producer CHP plants (TWh)	ELMAINC	Combined heat and power plants (CHP) 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 is adopted. Main activity producers (formerly known as public supply undertakings) 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.
Electricity output-autoproducer CHP plants (TWh)	ELAUTOC	Combined heat and power plants (CHP) 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 is adopted. 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 autoproducer's establishment are not included here but are included with figures for the final consumption of fuels in the appropriate consuming sector.
Heat output (TWh)	HEATOUT	Heat generated shows the total amount of TWh generated by power plants separated into CHP plants and heat plants.
Heat output-main activity producer CHP plants (TWh)	HEMAINC	Combined heat and power plants (CHP) 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 is adopted. Main activity producers (formerly known as public supply undertakings) 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.

Electricity and Heat Output and Emissions per kWh		
Flow	**Short name**	**Definition**
Heat output-autoproducer CHP plants (TWh)	HEAUTOC	Combined heat and power plants (CHP) 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 is adopted. 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 autoproducer's establishment are not included here but are included with figures for the final consumption of fuels in the appropriate consuming sector. 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.
Heat output-main activity producer heat plants (TWh)	HEMAINH	Heat plants refers to plants (including heat pumps and electric boilers) designed to produce heat only, which is sold to a third party under the provisions of a contract. Main activity producers (formerly known as public supply undertakings) 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.
Heat output-autoproducer heat plants (TWh)	HEAUTOH	Heat plants refers to plants (including heat pumps and electric boilers) designed to produce heat only, which is sold to a third party under the provisions of a contract. 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.

Electricity and Heat Output and Emissions per kWh		
Flow	**Short name**	**Definition**
CO_2 per kWh of electricity and heat (gCO_2 per kWh)	CO2KWHH	This ratio is expressed in grammes of CO_2 per kWh. It has been calculated using CO_2 emissions from electricity and heat ("main activity producer" and "autoproducer"). The CO_2 emissions include emissions from fossil fuels, industrial waste and non-renewable municipal waste that are consumed for electricity and heat generation in the transformation sector and the output includes electricity and heat generated from electricity generated from all fossil and non-fossil sources (excluding pumped hydro). As a result, the emissions per kWh can vary from year to year depending on the generation mix. In the ratios of CO_2 emissions per kWh by fuel: • Peat and oil shale are aggregated with *coal*. • *Oil* includes oil products (and small amounts of crude oil for some countries). • *Gas* represents natural gas. Note: Emissions per kWh should be used with caution due to data quality problems relating to electricity efficiencies for some countries.

Indicators		
Flow	**Short name**	**Notes**
Total primary energy supply (PJ)	TPESPJ	Total primary energy supply from the *IEA World Energy Balances* (converted to PJ). Total primary energy supply (TPES) is made up of production + imports - exports - international marine bunkers - *international aviation bunkers* ± stock changes. The IPCC methodology does not assign any CO_2 emissions to fuel use of biofuels *per se*, only if it is used in an unsustainable way. This is evaluated in the Agriculture, Forestry and Other Land Use module of the *2006 GLs*. So although the inclusion of biomass in the IEA energy data does not alter its CO_2 emission estimates, it gives more insight into the CO_2 intensity of national energy use.
Total primary energy supply (Mtoe)	TPESMTOE	Total primary energy supply from the *IEA World Energy Balances*. Total primary energy supply (TPES) is made up of production + imports - exports - international marine bunkers - *international aviation bunkers* ± stock changes. The IPCC methodology does not assign any CO_2 emissions to fuel use of biofuels *per se*, only if it is used in an unsustainable way. This is evaluated in the Agriculture, Forestry and Other Land Use module of the *2006 GLs*. So although the inclusion of biomass in the IEA energy data does not alter its CO_2 emission estimates, it gives more insight into the CO_2 intensity of national energy use.
Total final consumption (TFC) (PJ)	TFCPJ	Total final consumption from the *IEA World Energy Balances* (converted to PJ). The IPCC methodology does not assign any CO_2 emissions to fuel use of biofuels *per se*, only if it is used in an unsustainable way. This is evaluated in the Agriculture, Forestry and Other Land Use module of the *2006 GLs*. So although the inclusion of biomass in the IEA energy data does not alter its CO_2 emission estimates, it gives more insight into the CO_2 intensity of national energy use.
Total final consumption (TFC) (Mtoe)	TFCMTOE	Total final consumption from the *IEA World Energy Balances*. The IPCC methodology does not assign any CO_2 emissions to fuel use of biofuels *per se*, only if it is used in an unsustainable way. This is evaluated in the Agriculture, Forestry and Other Land Use module of the *2006 GLs*. So although the inclusion of biomass in the IEA energy data does not alter its CO_2 emission estimates, it gives more insight into the CO_2 intensity of national energy use.

Indicators		
Flow	**Short name**	**Notes**
GDP (billion 2010 US dollars)	GDP	**For OECD countries:** The main source of these series for 1970 to 2014 is the OECD *National Accounts Statistics* database [ISSN: 2074-3947 (online)], last published in book format as *National Accounts of OECD Countries, Volume 2015 Issue 2: Main Aggregates*, OECD 2015. GDP data for **Australia**, **France**, **Greece**, **Korea**, **Sweden** and the **United Kingdom** for 1960 to 1969 and **Denmark** for 1966 to 1969 as well as for **Netherlands** for 1969 were taken from the same source. GDP data for 1960 to 1969 for the other countries have been estimated using the growth rates from the series in the *OECD Economic Outlook* No 98 and other data previously published by the OECD. Growth rates from these sources were also used to estimate data for the **Czech Republic** (prior to 1990), **Hungary** (prior to 1991) and **Poland** (prior to 1990) and the **Slovak Republic** (prior to 1992). Data for **Chile** (prior to 1986) and **Estonia** (prior to 1992) are IEA Secretariat estimates based on GDP growth rates from the World Bank. The GDP data have been compiled for individual countries at market prices in local currency and annual rates. These data have been scaled up/down to the price levels of 2010 and then converted to US dollars using the yearly average 2010 exchange rates. **For non-OECD countries:** The main source of the GDP data is *World Development Indicators*, The World Bank, Washington D.C., 2016. GDP figures for **Angola**, **Cuba**, **Democratic People's Republic of Korea, Eritrea**, **Gibraltar**, **Kuwait**, **Myanmar**, **Oman**, **Serbia**, **Former Soviet Union** (before 1990), **Syrian Arab Republic**, **Chinese Taipei**, **Yemen**, **Former Yugoslavia** (before 1990) and a few countries[1] within the regions **Other Africa**, **Other Non-OECD Americas** and **Other Asia** are based on the CHELEM-CEPII online databases, Bureau van Dijk, 2016. For **Curaçao**, GDP figures are based on historical CHELEMCEPII GDP data for Netherlands Antilles before the country's dissolution, and on Curaçao/Sint Maarten nominal GDP ratios calculated based on information received from Curaçao Central bank. For **South Sudan**, GDP figures are based on data from the International Monetary Fund. The GDP data have been compiled for all individual countries at market prices in 2005 US dollars, and scaled to the price levels of 2010 using current US dollars.

1. Due to lack of complete time series, figures for population and for GDP of Other non-OECD Americas do not include the British Virgin Islands, the Cayman Islands, the Falkland Islands (Malvinas), Martinique, Montserrat, Saint Pierre and Miquelon, and the Turks and Caicos Islands, and figures for population and GDP of Other Asia do not include the Cook Islands.

Indicators		
Flow	**Short name**	**Notes**
GDP PPP[2] (billion 2010 US dollars)	GDPPPP	**For OECD countries:** The GDP PPP data have been compiled for individual countries at market prices in local currency and annual rates. These data have been scaled to the price levels of 2010 and then converted to US dollars using the yearly average 2010 purchasing power parities (PPPs). **For non-OECD countries:** The main source of the GDP PPP data for the non-OECD member countries is *World Development Indicators*, The World Bank, Washington, D.C., 2015. However, this source is only available for GDP PPP (constant 2011 USD) from 1980. Therefore, prior to 1980, GDP PPP data have been calculated based on the PPP conversion factor (GDP) to market exchange rate ratio. GDP PPP figures for **Angola**, **Argentina, Cuba, Democratic People's Republic of Korea, Eritrea, Gibraltar, Jamaica, Kosovo, Serbia, Former Soviet Union** (before 1990), **Syrian Arab Republic**, **Chinese Taipei, Former Yugoslavia** (before 1990), **Zimbabwe** and a few countries within the regions **Other Africa**, **Other Non-OECD Americas** and **Other Asia** are based on the PPP conversion factor (GDP) to market exchange rate ratio. For **Gibraltar**, GDP PPP figures are based on historical CHELEMCEPII GDP PPP data and Ministry of Gibraltar national accounts. For **Curaçao**, GDP PPP figures are based on historical CHELEMCEPII GDP data for Netherlands Antilles before its dissolving, and for 2012-2014. GDP PPP is calculated based on historical GDP PPP / GDP ratio. For **South Sudan**, GDP PPP figures are based on International Monetary Fund data. GDP PPP figures for **Bosnia and Herzegovina** (up to 1993) and **Croatia** (up to 1994) have been estimated based on the growth rates of the CHELEM-CEPII online database, Bureau van Dijk, 2016. The GDP PPP data have been converted from GDP using purchasing power parity rates. These data have been scaled to the price levels of 2010. (Description continued overleaf).

2. Purchasing power parities (PPPs) are the rates of currency conversion that equalise the purchasing power of different currencies. A given sum of money, when converted into different currencies at the PPP rates, buys the same basket of goods and services in all countries. In other words, PPPs are the rates of currency conversion which eliminate the differences in price levels between different countries

Indicators		
Flow	**Short name**	**Notes**
GDP PPP (billion 2010 US dollars)	GDPPPP	(Description continued from previous page) The GDP PPP reflect the changes to power purchasing parity rates based on the 2011 International Comparison Program (ICP), published in 2014. The ICP has worked for 6 years to better estimate the value of the PPP 'basket of goods' for all countries for which the World Bank calculates GDP PPP. For many countries this value has significantly changed in comparison to previous ICP exercises. This leads to significant revisions to GDP PPP for many countries compared to previous publications. Please note that the regional totals shown for OECD and other regions were calculated by summing individual countries' GDP data. This calculation yields slightly different results to the GDP totals published by OECD in its national accounts which are derived from chained-linked indices. GDP data from the World Bank have also been summed rather than using chain-linked indices.
TPES / GDP (MJ per 2010 USD)	TPESGDP	This ratio is expressed in megajoules per 2010 US dollar. It has been calculated using total primary energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using exchange rates.
TPES / GDP PPP (MJ per 2010 USD PPP)	TPESGDPPP	This ratio is expressed in megajoules per 2010 US dollar. It has been calculated using total primary energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using purchasing power parities.

Indicators		
Flow	**Short name**	**Notes**
Population (millions)	POP	**For OECD countries:** The main source of these series for 1970 to 2014 is the OECD *National Accounts Statistics* database [ISSN: 2074-3947 (online)], last published in book format as *National Accounts of OECD Countries, Volume 2015 Issue 2: Main Aggregates*, OECD 2015. Data for 1960 to 1969 have been estimated using the growth rates from the population series published in the *OECD Factbook 2015* (online database version). Growth rates from the *OECD Factbook 2015* were also used to estimate data for **Chile** (prior to 1986), **Estonia** (prior to 1993), **Israel** (prior to 1995), the **Slovak Republic** (prior to 1990) and **Slovenia** (prior to 1995). **For non-OECD countries:** The main source of the population data is *World Development Indicators*, The World Bank, Washington D.C., 2016. Population data for **Former Soviet Union** (before 1990), **Chinese Taipei**, **Former Yugoslavia** (before 1990) and for a few countries[1] within the regions **Other Africa, Other Non-OECD Americas** and **Other Asia** are based on the CHELEM-CEPII online database, Bureau van Dijk, Paris, 2016. Population data for **Cyprus**[3] are taken from the Eurostat online database. Population data for **Gibraltar** are taken from the Ministry of Gibraltar *Key Indicators* publication available online.
CO_2 / TPES (tCO_2 per TJ)	CO2TPES	This ratio is expressed in tonnes of CO_2 per terajoule. It has been calculated using the total CO_2 fuel combustion emissions (CO2FCOMB) and total primary energy supply (including biofuels and other non-fossil forms of energy).
CO_2 / TFC (tCO_2 per TJ)	CO2TFC	This ratio is expressed in tonnes of CO_2 per terajoule. It has been calculated using the total CO_2 fuel combustion emissions (CO2FCOMB) and total final consumption (including biofuels and other non-fossil forms of energy).
CO_2 / GDP ($kgCO_2$ per 2010 US dollar)	CO2GDP	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been computed using the total CO_2 fuel combustion (CO2FCOMB) emissions and GDP calculated using exchange rates.
Industry CO_2 / GDP ($kgCO_2$ per 2010 US dollar)	CO2GDP_I	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been computed using *Manufacturing industries and construction* CO_2 emissions (TOTIND) and total GDP calculated using exchange rates.
Transport CO_2 / GDP ($kgCO_2$ per 2010 US dollar)	CO2GDP_T	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been computed using *Transport* CO_2 emissions (TOTTRANS) and total GDP calculated using exchange rates.

3. Refer to country note for Cyprus later in this chapter.

Indicators		
Flow	**Short name**	**Notes**
Services CO_2 / GDP ($kgCO_2$ per 2010 US dollar)	CO2GDP_S	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been computed using *Commercial and public services* CO_2 emissions (COMMPUB) and total GDP calculated using exchange rates.
Residential CO_2 / GDP ($kgCO_2$ per 2010 US dollar)	CO2GDP_R	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been computed using *Residential* CO_2 emissions (RESIDENT) and total GDP calculated using exchange rates.
CO_2 / GDP PPP ($kgCO_2$ per 2010 US dollar)	CO2GDPPP	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been calculated using CO_2 Fuel Combustion emissions (CO2FCOMB) and GDP calculated using purchasing power parities.
Industry CO_2 / GDP PPP ($kgCO_2$ per 2010 US dollar)	CO2GDPPP_I	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been calculated using *Manufacturing industries and construction* CO_2 emissions (TOTIND) and total GDP calculated using purchasing power parities.
Transport CO_2 / GDP PPP ($kgCO_2$ per 2010 US dollar)	CO2GDPPP_T	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been calculated using *Transport* CO_2 emissions (TOTTRANS) and total GDP calculated using purchasing power parities.
Services CO_2 / GDP PPP ($kgCO_2$ per 2010 US dollar)	CO2GDPPP_S	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been calculated using the *Commercial and public services* CO_2 emissions (COMMPUB) and total GDP calculated using purchasing power parities.
Residential CO_2 / GDP PPP ($kgCO_2$ per 2010 US dollar)	CO2GDPPP_R	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been calculated using *Residential* CO_2 emissions (RESIDENT) and total GDP calculated using purchasing power parities.
CO_2 / Population (tCO_2 per capita)	CO2POP	This ratio is expressed in tonnes of CO_2 per capita. It has been calculated using CO_2 Fuel Combustion emissions (CO2FCOMB).
Industry CO_2 / Population (tCO_2 per capita)	CO2POP_I	This ratio is expressed in tonnes of CO_2 per capita. It has been calculated using *Manufacturing industries and construction* CO_2 emissions (TOTIND).
Transport CO_2 / Population (tCO_2 per capita)	CO2POP_T	This ratio is expressed in tonnes of CO_2 per capita. It has been calculated using the *Transport* CO_2 emissions (TOTTRANS).
Services CO_2 / Population (tCO_2 per capita)	CO2POP_S	This ratio is expressed in tonnes of CO_2 per capita. It has been calculated using *Commercial and public services* CO_2 emissions (COMMPUB).
Residential CO_2 / Population (tCO_2 per capita)	CO2POP_R	This ratio is expressed in tonnes of CO_2 per capita. It has been calculated using *Residential* CO_2 emissions (RESIDENT).

Indicators		
Flow	**Short name**	**Notes**
CO_2 emissions index	ICO2EMIS	CO_2 Fuel Combustion emissions (CO2FCOMB) expressed as an index, where the reference year = 100. Aside from the following exceptions, 1990 is used as the reference year: **Bulgaria** (1988), **Cambodia** (1995), **Eritrea** (1992), **Hungary** (average 1985-1987), **Kosovo** (2000), **Montenegro** (2005), **Namibia** (1991), **Niger** (2000), **Poland** (1988), **Romania** (1989), **Slovenia** (1986), **South Sudan** (2012) and **Suriname** (2000).
Population index	IPOP	Population expressed as an index, where the reference year = 100. Aside from the following exceptions, 1990 is used as the reference year: **Bulgaria** (1988), **Cambodia** (1995), **Eritrea** (1992), **Hungary** (average 1985-1987), **Kosovo** (2000), **Montenegro** (2005), **Namibia** (1991), **Niger** (2000), **Poland** (1988), **Romania** (1989), **Slovenia** (1986), **South Sudan** (2012) and **Suriname** (2000). This index can be used as one of the constituents of the Kaya identity, for more information see the chapter *IEA emissions estimates* in the full publication.
GDP per population index	IGDPPOP	GDP PPP / population expressed as an index, where the reference year = 100. Aside from the following exceptions, 1990 is used as the reference year: **Bulgaria** (1988), **Cambodia** (1995), **Eritrea** (1992), **Hungary** (average 1985-1987), **Kosovo** (2000), **Montenegro** (2005), **Namibia** (1991), **Niger** (2000), **Poland** (1988), **Romania** (1989), **Slovenia** (1986), **South Sudan** (2012) and **Suriname** (2000). This index can be used as one of the constituents of the Kaya identity, for more information see the chapter *IEA emissions estimates* in the full publication.
Energy intensity index - TPES/GDP	ITPESGDP	TPES / GDP PPP expressed as an index, where the reference year = 100. Aside from the following exceptions, 1990 is used as the reference year: **Bulgaria** (1988), **Cambodia** (1995), **Eritrea** (1992), **Hungary** (average 1985-1987), **Kosovo** (2000), **Montenegro** (2005), **Namibia** (1991), **Niger** (2000), **Poland** (1988), **Romania** (1989), **Slovenia** (1986), **South Sudan** (2012) and **Suriname** (2000). This index can be used as one of the constituents of the Kaya identity, for more information see the chapter *IEA emissions estimates* in the full publication.

Indicators		
Flow	**Short name**	**Notes**
Carbon intensity index – ESCII: CO_2/TPES	ICO2TPES	CO_2 emissions / TPES expressed as an index, where the reference year = 100. Calculated using CO_2 Fuel Combustion emissions (CO2FCOMB). Aside from the following exceptions, 1990 is used as the reference year: **Bulgaria** (1988), **Cambodia** (1995), **Eritrea** (1992), **Hungary** (average 1985-1987), **Kosovo** (2000), **Montenegro** (2005), **Namibia** (1991), **Niger** (2000), **Poland** (1988), **Romania** (1989), **Slovenia** (1986), **South Sudan** (2012) and **Suriname** (2000). This index can be used as one of the constituents of the Kaya identity, for more information see the chapter *IEA emissions estimates* in the full publication.

Allocation of emissions from electricity/heat		
Flow	**Allocation**	**Definition**
Emissions by sector	NO	Expressed in million tonnes of CO_2. This allocation type shows emissions for the same sectors which are present in the file CO_2 Emissions From Fuel Combustion. In particular, the emissions from electricity and heat production are shown separately and not reallocated.
Emissions with electricity and heat allocated to consuming sectors	YES	Expressed in million tonnes of CO_2. Emissions from electricity and heat generation have been allocated to final consuming sectors in proportion to the electricity and heat consumed.
Per capita emissions by sector	NOP	These ratios are expressed in kilogrammes of CO_2 per capita. This allocation type shows per capita emissions for the same sectors which are present in the file CO_2 Emissions From Fuel Combustion. In particular, the emissions from electricity and heat production are shown separately and not reallocated.
Per capita emissions with electricity and heat allocated to consuming sectors	YESP	These ratios are expressed in kilogrammes of CO_2 per capita. Emissions from electricity and heat generation have been allocated to final consuming sectors in proportion to the electricity and heat consumed.

IPCC Fuel Combustion Emissions (2006 Guidelines)		
Flow	**Short name**	**Definition**
CO2 Fuel Combustion (Energy & IPPU)	CO2FCOMB	*CO_2 Fuel Combustion (Energy & IPPU)* presents total CO_2 emissions from fuel combustion. This includes CO_2 emissions from fuel combustion in IPCC Source/Sink Category 1 A Fuel Combustion Activities and those which may be excluded from the Sectoral Approach and reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use (IPPU) under the *2006 IPCC Guidelines (2006 GLs)*. CO2FCOMB = CO2SA + IPPUFCOMB
CO2 Sectoral Approach (Energy)	CO2SA	*CO_2 Sectoral Approach (Energy)* presents total CO_2 emissions from fuel combustion as calculated using the IPCC Tier 1 Sectoral Approach of the *2006 GLs* and corresponds to IPCC Source/Sink Category 1 A. Under the *2006 GLs*, certain fuel combustion emissions may be excluded from the Sectoral Approach and reallocated to the IPCC Source/Sink Category Industrial Processes and Product Use (IPPU). For the IEA Sectoral Approach calculations, these reallocated emissions have been excluded, and are presented separately (under *IPPU CO2 Fuel combustion – Total reallocated [IPPU]*).
IPPU CO2 Fuel combustion – Total reallocated (IPPU)	IPPUFCOMB	*IPPU CO2 Fuel combustion – Total reallocated (IPPU)* presents the total quantity of CO_2 emissions from fuel combustion which may be excluded from the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. IPPUFCOMB = IPPUIRON + IPPUNFERR + IPPUAUTOP + IPPUEPOWER + IPPUEBLAST
CO2 Reference Approach (Energy)	CO2RA	*CO_2 Reference Approach (Energy)* contains total CO_2 emissions from fuel combustion as calculated using the Reference Approach of the *2006 GLs*. The Reference Approach is based on the supply of energy in a country and as a result, all inventories calculated using this method include fugitive emissions from energy transformation (*e.g.* from oil refineries) which are normally included in Category 1 B. For this reason, Reference Approach estimates are likely to overestimate national CO_2 emissions from fuel combustion. Under the *2006 GLs*, certain fuel combustion emissions are excluded from the Reference Approach as they are accounted for IPCC Source/Sink Categories other than Energy. For the purposes of these IEA Reference Approach estimates, these emissions have been excluded. In these tables, the difference between the Sectoral Approach and the Reference Approach includes statistical differences, product transfers, transformation losses, distribution losses. In addition, some differences between the approaches may occur due to simplifications in the Reference Approach. CO2RA = CO2SA + TRANDIFF + STATDIFF

IPCC Fuel Combustion Emissions (2006 Guidelines)		
Flow	**Short name**	**Definition**
Difference due to losses and/or transformation (Energy)	TRANDIFF	*Differences due to losses and/or transformation* contains emissions that result from the transformation of energy from a primary fuel to a secondary or tertiary fuel. Included here are solid fuel transformation, oil refineries, gas works and other fuel transformation industries. These emissions are normally reported as fugitive emissions in the IPCC Source/Sink Category 1 B, but will be included in 1 A in inventories that are calculated using the IPCC Reference Approach. Theoretically, this category should show relatively small emissions representing the loss of carbon by other ways than combustion, such as evaporation or leakage. Negative emissions for one product and positive emissions for another product would imply a change in the classification of the emission source as a result of an energy transformation between coal and gas, between coal and oil, etc. In practice, however, it often proves difficult to correctly account for all inputs and outputs in energy transformation industries, and to separate energy that is transformed from energy that is combusted. Therefore, *differences due to losses and/or transformation* sometimes shows quite large positive emissions or even negative ones due to problems in the underlying energy data.
Statistical Differences (Energy)	STATDIFF	*Statistical differences* can be due to unexplained discrepancies in the underlying energy data. They can also be caused by differences between emissions calculated using the Reference Approach and the Sectoral Approach.
Memo: IPPU CO2 Fuel combustion – Iron and steel (IPPU)	IPPUIRON	*IPPU CO2 Fuel combustion – Iron and steel (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from the iron and steel sector under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven coke, coke oven gas, blast furnace gas and other recovered gases reported under *Iron and steel*.
Memo: IPPU CO2 Fuel combustion – Non-ferrous metals (IPPU)	IPPUNFERR	*IPPU CO2 Fuel combustion – Non-ferrous metals (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from the non-ferrous metals sector under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven coke reported under *Non-ferrous metals*.

IPCC Fuel Combustion Emissions (2006 Guidelines)		
Flow	**Short name**	**Definition**
Memo: IPPU CO2 Fuel combustion – Autoproducers (IPPU)	IPPUAUTOP	*IPPU CO2 Fuel combustion – Autoproducer (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from the autoproduction sector under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven gas, blast furnace gas and other recovered gases reported under *Unallocated autoproducers*. For the purposes of IEA Sectoral Approach estimates, autoproducer consumption of these gases is assumed to occur within the iron and steel sector.
Memo: IPPU CO2 Fuel combustion – Autoproducer own use (IPPU)	IPPUEPOWER	*IPPU CO2 Fuel combustion – Autoproducer own use (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from autoproducer on-site own use under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven gas, blast furnace gas and other recovered gases reported under *Own on-site use of fuel in electricity, CHP and heat plants*. For the purposes of IEA Sectoral Approach estimates, autoproducer consumption of these gases is assumed to occur within the iron and steel sector.
Memo: IPPU CO2 Fuel combustion – Blast furnace energy (IPPU)	IPPUEBLAST	*IPPU CO2 Fuel combustion – Blast furnace energy (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from energy use in blast furnaces under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven coke, coke oven gas, blast furnace gas and other recovered gases reported under *Energy use in blast furnaces*. For the purposes of IEA Sectoral Approach estimates, energy use in blast furnaces is assumed to occur within the iron and steel sector.
Memo: International marine bunkers	MARBUNK	*International marine bunkers* contains emissions from fuels burned by 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. Emissions from international marine bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 d i.

IPCC Fuel Combustion Emissions (2006 Guidelines)		
Flow	**Short name**	**Definition**
Memo: International aviation bunkers	AVBUNK	*International aviation bunkers* contains emissions from fuels used by 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. Emissions from international aviation bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 a i.

Aggregated product categories for summary file

Flow	Short name	Definition
Coal, peat and oil shale	COAL	Coal, peat and oil shale includes all coal, both primary (hard coal, brown coal, anthracite, coking coal, other bituminous coal, sub-bituminous coal and lignite) and derived fuels (patent fuel, coke oven coke, gas coke, coal tar, BKB, gas works gas, coke oven gas, blast furnace gas and other recovered gases). Peat, peat products and oil shale are also aggregated in this category.
Oil	OIL	Oil includes crude oil, natural gas liquids, refinery feedstocks, additives/blending components, orimulsion, other hydrocarbons, refinery gas, ethane, LPG, motor gasoline excl. biofuels, aviation gasoline, gasoline type jet fuel, kerosene type jet fuel excl. biofuels, kerosene, gas/diesel oil excl. biofuels, fuel oil, naphtha, white spirit, lubricants, bitumen, paraffin waxes, petroleum coke and non-specified oil products.
Natural gas	NATGAS	Gas represents natural gas. It excludes natural gas liquids.
Other	OTHER	Other includes industrial waste and non-renewable municipal waste.
Total	TOTAL	TOTAL = the total of all CO_2 emissions from fuel combustion, *i.e.* COAL + OIL + NATGAS + OTHER.

Coal		
Flow	**Short name**	**Definition**
Hard coal (if no detail)	HARDCOAL	This item is only used if the detailed breakdown is not available. It includes anthracite, coking coal, other bituminous coal.
Brown coal (if no detail)	BROWN	This item is only used if the detailed breakdown is not available. It includes lignite and sub-bituminous coal.
Anthracite	ANTCOAL	Anthracite is a high rank coal used for industrial and residential applications. It is generally less than 10% volatile matter and a high carbon content (about 90% fixed carbon). Its gross calorific value is greater than 24 000 kJ/kg on an ash-free but moist basis.
Coking coal	COKCOAL	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 on an ash-free but moist basis.
Other bituminous coal	BITCOAL	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 usually more than 10% volatile matter and a relatively high carbon content (less than 90% fixed carbon). Its gross calorific value is greater than 24 000 kJ/kg on an ash-free but moist basis.
Sub-bituminous coal	SUBCOAL	Non-agglomerating coals with a gross calorific value between 20 000 kJ/kg and 24 000 kJ/kg containing more than 31% volatile matter on a dry mineral matter free basis.
Lignite	LIGNITE	Lignite is a non-agglomerating coal with a gross calorific value of less than 20 000 kJ/kg, and greater than 31% volatile matter on a dry mineral matter free basis.
Patent Fuel	PATFUEL	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 *energy industry own use*.
Coke oven coke	OVENCOKE	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 energy source and 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 *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 emissions from coke oven coke in the iron and steel industry, the quantities converted into blast furnace gas have to be added (these are aggregated under differences due to transformations and/or losses).

Coal		
Flow	**Short name**	**Definition**
Gas coke	GASCOKE	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. *Energy industry own use* includes the consumption of gas coke at gas works.
Coal tar	COALTAR	Coal tar is a result of the destructive distillation of bituminous coal. Coal tar 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.
BKB	BKB	Brown coal briquettes (braunkohlebriketts) are composition fuels manufactured from lignite, produced by briquetting under high pressure with or without the addition of a binding agent. The heading *energy industry own use* includes consumption by briquetting plants.
Gas works gas	GASWKSGS	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	COKEOVGS	Coke oven gas is obtained as a by-product of the manufacture of coke oven coke for the production of iron and steel.
Blast furnace gas	BLFURGS	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	OGASES	By-product of the production of steel in an oxygen furnace, recovered on leaving the furnace. The gases are also known as converter gas, LD gas or BOS gas. The quantity of recuperated fuel should be reported on a gross calorific value basis. Also covers non-specified manufactured gases not mentioned above, such as combustible gases of solid carbonaceous origin recovered from manufacturing and chemical processes not elsewhere defined.

Peat		
Flow	**Short name**	**Definition**
Peat	PEAT	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	PEATPROD	Products such as peat briquettes derived directly or indirectly from sod peat and milled peat.

Oil shale		
Flow	**Short name**	**Definition**
Oil shale and oil sands	OILSHALE	Oil shale and oil sands are sedimentary rock which contains organic matter in the form of kerogen. Kerogen is a waxy hydrocarbon-rich material regarded as a precursor of petroleum. Oil shale may be burned directly or processed by heating to extract shale oil. Oil shale and tar sands used as inputs for other transformation processes are included here (this includes the portion consumed in the transformation process). Shale oil and other products derived from liquefaction are included in *other hydrocarbons*.

Oil		
Flow	**Short name**	**Definition**
Crude/NGL/ feedstocks (if no detail)	CRNGFEED	This item is only used if the detailed breakdown is not available. It includes crude oil, natural gas liquids, refinery feedstocks, additives/blending components and other hydrocarbons.
Crude oil	CRUDEOIL	Crude oil is a mineral oil consisting of a mixture of hydrocarbons of natural origin and associated impurities, such as sulphur. It exists in the liquid phase under normal surface temperatures 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.
Natural gas liquids	NGL	NGL are the liquid or liquefied hydrocarbons recovered from natural gas in separation facilities or gas processing plants. Natural gas liquids include ethane, propane, butane (normal and iso-), (iso) pentane and pentanes plus (sometimes referred to as natural gasoline or plant condensate).
Refinery feedstocks	REFFEEDS	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. It is transformed into one or more components and/ or finished products. 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 / blending components	ADDITIVE	Additives are non-hydrocarbon substances 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 biomass 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.
Orimulsion	ORIMUL	Emulsified oil made of water and natural bitumen.
Other hydrocarbons	NONCRUDE	This category includes synthetic crude oil from tar sands, shale oil, etc., liquids from coal liquefaction, output of liquids from natural gas conversion into gasoline and hydrogen. Orimulsion and oil shale are presented separately and not included here.
Refinery gas	REFINGAS	Refinery gas is defined as non-condensable gas obtained during distillation of crude oil or treatment of oil products (*e.g.* cracking) in refineries. It consists mainly of hydrogen, methane, ethane and olefins. It also includes gases which are returned from the petrochemical industry.
Ethane	ETHANE	Ethane is a naturally gaseous straight-chain hydrocarbon (C_2H_6). It is a colourless paraffinic gas which is extracted from natural gas and refinery gas streams.

Oil		
Flow	**Short name**	**Definition**
Liquefied petroleum gases	LPG	Liquefied petroleum gases are the light hydrocarbon fraction of the paraffin series, derived from refinery processes, crude oil stabilisation plants and natural gas processing plants, comprising propane (C_3H_8) and butane (C_4H_{10}) or a combination of the two. They could also include propylene, butylene, isobutene and isobutylene. LPG are normally liquefied under pressure for transportation and storage.
Motor gasoline excl. bio	NONBIOGASO	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.
Aviation gasoline	AVGAS	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.
Gasoline type jet fuel	JETGAS	Gasoline type jet fuel includes all light hydrocarbon oils for use in aviation turbine power units, which distil 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 excl. bio	NONBIOJETK	Kerosene type jet fuel is a medium distillate used for aviation turbine power units. It has the same distillation characteristics and flash point as kerosene (between 150°C and 300°C but not generally above 250°C). 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. Kerosene type jet fuel excluding biofuels does not include the liquid biofuels blended with jet kerosene.
Other kerosene	OTHKERO	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.

Oil		
Flow	**Short name**	**Definition**
Gas/diesel oil excl. bio	NONBIODIES	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.
Fuel oil	RESFUEL	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	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.
White spirit & SBP	WHITESP	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, with a temperature difference between 5% volume and 90% volume distillation points, including losses, of not more than 60°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 defined above.
Lubricants	LUBRIC	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	BITUMEN	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	PARWAX	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.

Oil		
Flow	**Short name**	**Definition**
Petroleum coke	PETCOKE	Petroleum coke is defined as a black solid residue, 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 most important qualities are "green coke" and "calcined 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.
Non-specified oil products	ONONSPEC	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.

Gas		
Flow	**Short name**	**Definition**
Natural gas	NATGAS	Natural gas comprises gases, occurring in underground deposits, whether liquefied or gaseous, consisting mainly of methane. It includes both "non-associated" gas originating from fields producing only hydrocarbons in gaseous form, and "associated" gas produced in association with crude oil as well as 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 gas consumed by gas processing plants and gas transported by pipeline. Quantities of gas that are re-injected, vented or flared are excluded.

Other		
Flow	**Short name**	**Definition**
Industrial waste	INDWASTE	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.
Municipal waste (non-renewable)	MUNWASTEN	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 collected by local authorities for incineration at specific installations. Renewable municipal waste is not included here.

4. GEOGRAPHICAL COVERAGE AND COUNTRY NOTES

Countries and regions

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Country/Region	Short name	Definition
World	WORLD	World = OECD Total + Non-OECD Total + international marine bunkers + international aviation bunkers. World = Annex I Parties + Non-Annex I Parties + international marine bunkers and international aviation bunkers. Please note that the following countries have not been considered due to lack of data: Africa: Mayotte, Saint Helena, and Western Sahara; Asia and Oceania: Christmas Island, Nauru, Niue and Tuvalu; Non-OECD Americas: Anguilla; Non-OECD Europe and Eurasia: Andorra and Liechtenstein (except for oil data which is included under Switzerland).
OECD Americas	OECDAM	Includes Canada, Chile, Mexico and the United States.
OECD Asia Oceania	OECDAO	Includes Australia, Israel[4], Japan, Korea and New Zealand.

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.

Countries and regions

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Country/Region	Short name	Definition
OECD Europe	OECDEUR	Includes Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.[5] Estonia and Slovenia are included starting in 1990. Prior to 1990, data for Estonia are included in Former Soviet Union and data for Slovenia in Former Yugoslavia.
Africa	AFRICA	Includes Algeria, Angola, Benin, Botswana (from 1981), Cameroon, Republic of Congo (Congo)[6], Côte d'Ivoire, Democratic Republic of Congo (from 1981), Egypt, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Libya, Mauritius, Morocco, Mozambique, Namibia (from 1991), Niger (from 2000), Nigeria, Senegal, South Africa, South Sudan (from 2012), Sudan, United Republic of Tanzania, Togo, Tunisia, Zambia, Zimbabwe and **Other Africa**.
Non-OECD Americas	LATAMER	Includes Argentina, the Plurinational State of Bolivia (Bolivia), Brazil, Colombia, Costa Rica, Cuba, Curaçao[7], 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) and **Other Non-OECD America**.
Middle East	MIDEAST	Includes Bahrain, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Yemen.
Non-OECD Europe and Eurasia	NOECDEUR	Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus[8], Estonia (prior to 1990), Former Yugoslav Republic of Macedonia, Georgia, Gibraltar, Kazakhstan, Kosovo, Kyrgyzstan, Latvia[5], Lithuania, Malta, Republic of Moldova, Montenegro, Romania, Russian Federation, Serbia, Slovenia (prior to 1990), Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

5. Latvia was not an OECD Member at the time of the preparation of this publication. Accordingly, Latvia does not appear in the list of OECD Members and is not included in the zone aggregates.
6. Country short names are included in parentheses.
7. 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 "Curaçao" 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.
8. Refer to country note for Cyprus later in this chapter.

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Country/Region	Short name	Definition
Asia (excluding China)	ASIA	Includes Bangladesh, Brunei Darussalam, Cambodia (from 1995), DPR of Korea, India, Indonesia, Malaysia, Mongolia (from 1985), Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Chinese Taipei, Thailand, Viet Nam and **Other Asia**.
China (including Hong Kong, China)	CHINAREG	Includes the People's Republic of China[9] and Hong Kong, China but excludes Macau, China.
World Aviation Bunkers	WORLDAV	World Aviation Bunkers represents the sum of International Aviation Bunkers from all countries.
World Marine Bunkers	WORLDMAR	World Marine Bunkers represents the sum of International Marine Bunkers from all countries.
Albania	ALBANIA	
Algeria	ALGERIA	
Angola	ANGOLA	
Argentina	ARGENTINA	
Armenia	ARMENIA	Data for Armenia are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Australia	AUSTRALI	Excludes the overseas territories. Starting with the 2013 edition and following, data for Australia were revised back to 2003 due to the adoption of the National Greenhouse and Energy reporting (NGER) as the main energy consumption data source for the Australian energy Statistics. As a result, there are breaks in the time series for many data between 2002 and 2003. The revisions have also introduced some methodological problems. The national statistics appear to have problems identifying inputs and outputs to certain transformation processes such as gas works plants, electricity plants and CHP plants. Energy industry own use and inputs to the transformation processes are sometimes not reported separately in the correct categories. More detailed information is given in the online data documentation of World Energy Balances, see the chapter on *Country notes and sources*.[10]
Austria	AUSTRIA	

9. For information regarding revisions, and breaks in series, refer to country note for the People's Republic of China later in this chapter.
10. Available at: *www.iea.org/statistics/topics/energybalances.*

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Country/Region	Short name	Definition
Azerbaijan	AZERBAIJAN	Data for Azerbaijan are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Bahrain	BAHRAIN	
Bangladesh	BANGLADESH	Data for Bangladesh are reported on a fiscal year basis. Data for 2014 are for 1 July 2014 – 30 June 2015.
Belarus	BELARUS	Data for Belarus are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Belgium	BELGIUM	
Benin	BENIN	
Bolivia	BOLIVIA	
Bosnia and Herzegovina	BOSNIAHERZ	Data for Bosnia and Herzegovina are available starting in 1990. Prior to that, they are included in Former Yugoslavia. In 2014, the Agency for Statistics of Bosnia and Herzegovina conducted their first survey on oil product consumption. As a result, new data were made available which result in some breaks in time series between 2012 and 2013.
Botswana	BOTSWANA	Data for Botswana are available starting in 1995. Prior to that, they are included in Other Africa.
Brazil	BRAZIL	
Brunei Darussalam	BRUNEI	
Bulgaria	BULGARIA	According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Bulgaria is allowed to use 1988 as the base year.
Cambodia	CAMBODIA	Data for Cambodia are available starting in 1995. Prior to that, they are included in Other Asia. The break in the CO_2/TPES and TPES/GDP time series between 2008 and 2009 is due to a break in the time series for solid biofuels which creates an artificial increase in TPES between those years.
Cameroon	CAMEROON	

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Country/Region	Short name	Definition
Canada	CANADA	In the 2014 and 2015 edition of this publication, the Canadian administration revised time series for 2005 to 2012, using additional data from the Annual Industrial Consumption of Energy, the Annual Survey of Secondary Distributors, the Report on Energy Supply and Demand and the Natural Resources Canada Office of Energy Efficiency. Breaks in time series also between appear 1989 and 1990, due to changes in methodology, incorporated in 2002.
Chile	CHILE	
People's Republic of China	CHINA	In early 2016, the National Bureau of Statistics (NBS) of the People's Republic of China (China) supplied the IEA with detailed energy balances for 2000 to 2010 and the IEA revised its data accordingly. In September 2015, the NBS published China's energy statistics for 2013, as well as revised statistics for the years 2011 and 2012. These were taken into account by the IEA in the 2015 edition of this publication. All revisions show significant changes both on the supply and demand side for a number of energy products, resulting in breaks in time series between 1999 and 2000. Most importantly, the previously significant statistical difference for coal has now been allocated in industrial consumption based on findings from a national economic census. Calorific values used for bituminous coal emissions estimates were also revised in this edition. Net calorific values (NCV) for coal inputs to power generation were modified from 2000 to 2013 by applying assumptions used by China on the average thermal efficiency of coal-fired power stations in these years. NCVs were also modified for bituminous coal production from 2000 to 2013, as well as for inputs to main activity heat plants from 2008 to 2013.
Colombia	COLOMBIA	
Congo	CONGO	The Imboulou Hydro Plant (120MW) began operating in May 2011.
Costa Rica	COSTARICA	
Côte d'Ivoire	COTEIVOIRE	
Croatia	CROATIA	Data for Croatia are available starting in 1990. Prior to that, they are included in Former Yugoslavia.

Countries and regions

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Country/Region	Short name	Definition
Cuba	CUBA	International marine bunkers for residual fuel oil in the period 1971-1983 were estimated on the basis of 1984 figures and the data reported as internal navigation in the energy balance.
Curaçao	CURACAO	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 "Curaçao" up to the end of 2011 still refer to the entire territory of the Netherlands Antilles as it was known prior to 10 October 2010. Data for Curaçao refer only to the island of Curaçao from 2012 onwards. Data for the other islands of the former Netherlands Antilles are included in Other Non-OECD Americas from 2012 onwards.
Cyprus	CYPRUS	**Note by Turkey:** The information in the report 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 report relates to the area under the effective control of the Government of the Republic of Cyprus. At its seventeenth session, the Conference of the Parties decided to amend Annex I to the Convention to include Cyprus (Decision 10/CP.17). The amendment entered into force on 9 January 2013.
Czech Republic	CZECH	
Democratic People's Republic of Korea	KOREADPR	Time series data for 2011 for primary coals were revised based on new information received in 2014. This may lead to breaks in the time series between 2010 and 2011 and differences in trends compared to previous editions for some products.

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Country/Region	Short name	Definition
Democratic Republic of Congo	CONGOREP	
Denmark	DENMARK	Excludes Greenland and the Danish Faroes, 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.
Dominican Republic	DOMINICANR	
Ecuador	ECUADOR	
Egypt	EGYPT	Data for Egypt are reported on a fiscal year basis. Data for 2014 are for 1 July 2014 – 30 June 2015.
El Salvador	ELSALVADOR	
Eritrea	ERITREA	Data for Eritrea are available from 1992. Prior to that, they are included in Ethiopia.
Estonia	ESTONIA	Data for Estonia are available from 1990. Prior to that, they are included in the Former Soviet Union. *Note: Estonia joined the IEA in May 2014.*
Ethiopia	ETHIOPIA	Ethiopia includes Eritrea prior to 1992.
Finland	FINLAND	
Former Yugoslav Rep. of Macedonia	FYROM	Data for Former Yugoslav Rep. of Macedonia are available starting in 1990. Prior to that, they are included in Former Yugoslavia.
France	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. The methodology for calculating main activity electricity and heat production from gas changed in 2000. The breakdown between international marine bunkers and domestic navigation is estimated by the French administration.
Gabon	GABON	
Georgia	GEORGIA	Data for Georgia are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Germany	GERMANY	Includes the new federal states of Germany from 1970 onwards.

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Country/Region	Short name	Definition
Ghana	GHANA	
Gibraltar	GIBRALTAR	
Greece	GREECE	
Guatemala	GUATEMALA	
Haiti	HAITI	
Honduras	HONDURAS	
Hong Kong, China	HONGKONG	
Hungary	HUNGARY	In the 2016 edition, consumption data for several oil products was revised by the Hungarian administration from 2010 in order to reduce breaks appearing as a result of the new energy consumption survey introduced in 2014. However, breaks remain for some products. In particular, information on the energy use of naphtha by the petrochemical industry is only available from 2013 onwards. For prior years, all consumption (except appearing as backflows to the petrochemical sector) is reported under non-energy use, and is excluded from emissions estimates under the 2006 GLs. According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Hungary is allowed to use average 1985-1987 as the base year.
Iceland	ICELAND	
India	INDIA	Data are reported on a fiscal calendar year basis. Data for 2014 are for 1 April 2014 – 31 March 2015.
Indonesia	INDONESIA	
Islamic Republic of Iran	IRAN	Data are reported according to the Iranian calendar year. Data for 2014 correspond to 20 March 2014 – 19 March 2015.
Iraq	IRAQ	
Ireland	IRELAND	
Israel	ISRAEL	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.

Countries and regions

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Country/Region	Short name	Definition
Italy	ITALY	Includes San Marino and the Holy See. Prior to 1990, gas use in commercial/public services was included in residential.
Jamaica	JAMAICA	
Japan	JAPAN	Includes Okinawa. Between 2004 and 2007, the IEA received revisions from the Japanese Administration. The first set of revisions received in 2004 increased the 1990 supply by 5% for coal, 2% for natural gas and 0.7% for oil compared to the previous data. This led to an increase of 2.5% in 1990 CO_2 emissions calculated using the Reference Approach while the Sectoral Approach remained fairly constant. For the 2006 edition, the IEA received revisions to the coal and oil data which had a significant impact on both the energy data and the CO_2 emissions. The most significant revisions occurred for coke oven coke, naphtha, blast furnace gas and petroleum coke. These revisions affected consumption rather than supply in the years concerned. As a result, the sectoral approach CO_2 emissions increased for all the years, however at different rates. For example, the sectoral approach CO_2 emissions for 1990 were 4.6% higher than those calculated for the 2005 edition while the 2003 emissions were 1.1% higher than those of the previous edition. Due to the impact these successive revisions have had on the final energy balance as well as on CO_2 emissions, the IEA was in close contact with the Japanese Administration to better understand the reasons behind these changes. These changes are mainly due to the Government of Japan's efforts to improve the input-output balances in the production of oil products and coal products in response to inquiries from the UNFCCC Secretariat. To cope with this issue, the Japanese Administration established a working group in March 2004. The working group completed its work in April 2006. Many of its conclusions were incorporated in the 2006 edition but some further revisions to the time series (especially in industry and other) were submitted for the 2007 edition.[11]
Jordan	JORDAN	
Kazakhstan	KAZAKHSTAN	Data for Kazakhstan are available starting in 1990. Prior to that they are included in Former Soviet Union.

11. Revisions to Japanese data occurred while the IEA was following the *Revised 1996 IPCC Guidelines*. The impacts of these revisions under the *2006 IPCC Guidelines* may differ from those indicated

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Country/Region	Short name	Definition
Kenya	KENYA	The increase in electricity output from *Other* in 2014 is due to higher output from geothermal sources.
Korea	KOREA	
Kosovo	KOSOVO	Data for Kosovo are available starting in 2000. From 1990-1999, data for Kosovo are included in Serbia. Prior 1990 that, they are included in Former Yugoslavia. For data in the NONCO2 file, from 2000 onwards, all emissions other than CO_2 from fuel combustion are included in Serbia.
Kuwait	KUWAIT	
Kyrgyzstan	KYRGYZSTAN	Data for Kyrgyzstan are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Latvia	LATVIA	Data for Latvia are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Lebanon	LEBANON	
Libya	LIBYA	
Lithuania	LITHUANIA	Data for Lithuania area available starting in 1990. Prior to that, they are included in Former Soviet Union.
Luxembourg	LUXEMBOU	
Malaysia	MALAYSIA	
Malta	MALTA	Revised data were submitted by Malta for 2010 to 2013. This may lead to breaks in time series between 2009 and 2010 for some products and flows. Malta reported the use of motor gasoline in international marine bunkers for the first time in 2011. These data relate to unleaded petrol used by outboard engines in small vessels. In 2011, a new power generation station fuelled by municipal and industrial waste became operation in Malta. This may lead to breaks in time series for some products and flows. At its fifteenth session, the Conference of the Parties decided to amend Annex I to the Convention to include Malta (Decision 3/CP.15). The amendment entered into force on 26 October 2010.
Mauritius	MAURITIUS	

Countries and regions

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Country/Region	Short name	Definition
Mexico	MEXICO	The Mexican administration is currently undertaking major work on revisions of the time series back to 1990. In the 2015 edition, substantial revisions were submitted by Mexico, but only those for 2013 could be incorporated. In this 2016 edition, further revisions have been incorporated, mostly for the period 2003 to 2014, but some revisions track back to 1990. Further revisions to historical data are pending. More detailed information is given in the chapter *Country notes and sources* in the online data documentation of the IEA *World Energy Balances.*[12]
Republic of Moldova	MOLDOVA	Data for the Republic of Moldova are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Mongolia	MONGOLIA	Data for Mongolia are available starting in 1985. Prior to that, they are included in Other Asia. New data became available in 2015 which allowed a disaggregation of coal by type. In addition time series were revised from 2005 forward. Breaks in time series between 2004 and 2005 may result as well as differences in trends from previous editions.
Montenegro	MONTENEGRO	A new survey on energy consumption in industry was conducted by Montenegro in 2014. Due to this newly available data, some breaks in time series may occur between 2013 and 2014. Data for Montenegro are available starting in 2005. From 1990 to 2004, data for Montenegro are included in Serbia. Prior to 1990, data are included in Former Yugoslavia. For data in the NONCO2 file, from 2005 onwards, all emissions other than CO_2 from fuel combustion are included in Serbia.
Morocco	MOROCCO	
Mozambique	MOZAMBIQUE	
Myanmar	MYANMAR	
Namibia	NAMIBIA	Data for Namibia are available starting in 1991. Prior to that, they are included in Other Africa.
Nepal	NEPAL	Data for Nepal are reported on a fiscal year basis.

12. Available at: *www.iea.org/statistics/topics/energybalances.*

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Country/Region	Short name	Definition
Netherlands	NETHLAND	Excludes Suriname, Aruba and the other former the Netherlands Antilles (Bonaire, Curaçao, Saba, Saint Eustatius and Sint Maarten).
New Zealand	NZ	
Nicaragua	NICARAGUA	
Niger	NIGER	Data for Niger are available starting in 2000. Prior to that, they are included in Other Africa. For data in the NONCO2 file only: • For 1990, Other Africa includes Niger for all emissions other than CO_2 from fugitive sources and CO_2 from industrial processes. • For other years, Other Africa includes Niger for all emissions other than CO_2 from fuel combustion, CO_2 from fugitive sources and CO_2 from industrial processes.
Nigeria	NIGERIA	
Norway	NORWAY	Discrepancies between Reference and Sectoral Approach estimates and the difference in the resulting growth rates arise from statistical differences between supply and consumption data for oil and natural gas. For Norway, supply of these fuels is the residual of two very large and opposite terms, production and exports.
Oman	OMAN	
Pakistan	PAKISTAN	
Panama	PANAMA	
Paraguay	PARAGUAY	
Peru	PERU	
Philippines	PHILIPPINES	
Poland	POLAND	According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Poland is allowed to use 1988 as the base year.
Portugal	PORTUGAL	Includes the Azores and Madeira.
Qatar	QATAR	
Romania	ROMANIA	According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Romania is allowed to use 1989 as the base year.

Countries and regions

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Country/Region	Short name	Definition
Russian Federation	RUSSIA	Data for Russian Federation are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Saudi Arabia	SAUDIARABI	
Senegal	SENEGAL	
Serbia	SERBIA	Data for Serbia are available starting in 1990. Prior to that, they are included in Former Yugoslavia. Serbia includes Kosovo from 1990 to 1999 and Montenegro from 1990 to 2004. For data in the NONCO2 file, Serbia includes Kosovo for all emissions other than CO_2 from fuel combustion from 2000 onwards, and Montenegro for all emissions other than CO_2 from fuel combustion from 2005 onwards.
Singapore	SINGAPORE	Due to Singapore's large trade volume in comparison to its final consumption, a slight misalignment of trade figures can have a significant impact on the Energy balance of Singapore. As a result, large discrepancies between the Reference and Sectoral Approach estimates arise from statistical differences between supply and consumption of oil and oil products. The IEA secretariat, the Energy Market Authority and the National Climate Change Secretariat (NCCS) are working closely together on improving data quality for Singapore. Efforts are continuing on this project, therefore breaks in time series between 2008 and 2009 and differences in trends when compared to previous publications may occur for some products. In this edition, the IEA secretariat has revised oil consumption data based on official data for 2011. Further revisions are expected in future editions, as energy data coverage is further extended by Singapore. A new coal-fired power plant started operations in 2013. This might lead to breaks in time series between 2012 and 2013.
Slovak Republic	SLOVAKIA	
Slovenia	SLOVENIA	Data for Slovenia are available from 1990. Prior to that, they are included in Former Yugoslavia in the full publication. According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Slovenia is allowed to use 1986 as the base year.

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Country/Region	Short name	Definition
South Africa	SOUTHAFRIC	Large differences between the Reference and Sectoral Approach estimates are due to losses associated with coal-to-liquid and to a lesser extent gas-to-liquid transformation.
South Sudan	SSUDAN	South Sudan became an independent country on 9 July 2011. Data for South Sudan are available from 2012. Prior to 2012, they are included in Sudan.
Spain	SPAIN	Includes the Canary Islands.
Sri Lanka	SRILANKA	
Sudan	SUDAN	South Sudan became an independent country on 9 July 2011. Data for South Sudan are available from 2012. Prior to 2012, they are included in Sudan.
Sweden	SWEDEN	
Switzerland	SWITLAND	Includes Liechtenstein for the oil data. Data for other fuels do not include Liechtenstein. The sectoral breakdown for gas/diesel oil used in the residential sector before 1978 was estimated on the basis of commercial and residential consumption in 1978 and the data reported as commercial consumption in the energy balance in previous years.
Chinese Taipei	TAIPEI	
Tajikistan	TAJIKISTAN	New information became available in 2016. Breaks in time series may occur between 2011 and 2013, and between 2013 and 2014. Data for Tajikistan are available starting in 1990. Prior to that, they are included in Former Soviet Union.
United Republic of Tanzania	TANZANIA	
Thailand	THAILAND	
Togo	TOGO	Official energy data were submitted by Togo in 2014 for the years 2009-2012. Breaks in time series between 2008 and 2009, or differences in trends compared to previous publications may occur for this reason. The IEA continues to work with the Ministry of Mines and Energy in Togo to better understand the reasons for the breaks in time series and to reassess the historical data.
Trinidad and Tobago	TRINIDAD	
Tunisia	TUNISIA	

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Country/Region	Short name	Definition
Turkey	TURKEY	In the 2016 edition, the Ministry of Energy revised time series for kerosene type jet fuel from 2013 onwards. Sales to foreign airlines, previously accounted for under exports, are now reported under international aviation according to the IEA methodology. Data could not be revised for the preceding years. Exports of kerosene type jet fuel up to 2012 may include consumption in international aviation.
Turkmenistan	TURKMENIST	Data for Turkmenistan are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Ukraine	UKRAINE	Data for Ukraine are available starting in 1990. Prior to that, they are included in Former Soviet Union. To provide a better Reference Approach estimate of CO_2 emissions in 2010, for the purposes of this publication, the IEA Secretariat has adjusted the stock change and statistical difference of natural gas to better match international definitions.
United Arab Emirates	UAE	
United Kingdom	UK	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. For reasons of confidentiality, gas for main activity electricity is included in autoproducers for 1990. Breaks occur in international marine bunkers and domestic navigation time series, as a different bunkers methodology is applied from 2008, in line with UK's National Atmospheric Emissions Inventory. Deliveries to international marine bunkers may be underestimated for previous years

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Country/Region	Short name	Definition
United States	USA	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[13] and the United States Virgin Islands; trade statistics for coal include international trade to and from Puerto Rico and the United States Virgin Islands. End-use energy consumption data for the United States present a break in series with historical data due to a change in methodology in 2014. The break in series occurs between 2011 and 2012 for oil; and between 2001 and 2002 for electricity and natural gas. The new methodology is based on the last historical year of the most recent Annual Energy Outlook (AEO) publication. Changes occur primarily in reported end-use energy consumption in the industrial sector and its subsectors, including the non-manufacturing industries of mining, construction and agriculture. Historical revisions are pending. Due to other changes in reporting methodologies, there are numerous breaks in series for the US data, particularly in 1992, 1999, 2001, 2002 and 2013. Care should be taken when evaluating consumption by sector since inputs of fuel to autoproducers are included in final consumption for some years. No data are available for most energy products in the construction and mining and quarrying industries.
Uruguay	URUGUAY	
Uzbekistan	UZBEKISTAN	Data for Uzbekistan are available starting in 1990. Prior to that, data are included in Former Soviet Union.
Venezuela	VENEZUELA	
Viet Nam	VIETNAM	A detailed sectoral breakdown is available starting in 1980.
Yemen	YEMEN	
Zambia	ZAMBIA	
Zimbabwe	ZIMBABWE	A new mining company was commissioned in 2011, leading to a rapid increase in coal production. Due to the limited availability of coal consumption data, the IEA Secretariat has estimated coal stocks for Zimbabwe. Breaks in time series may occur between 2013 and 2014 because of this.

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

Countries and regions

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Country/Region	Short name	Definition
Former Soviet Union (if no detail)	FSUND	Before 1990, includes Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.
Former Yugoslavia (if no detail)	YUGOND	Before 1990, includes Bosnia and Herzegovina, Croatia, Former Yugoslav Republic of Macedonia, Kosovo, Montenegro, Slovenia, Serbia.
Other Africa	OTHERAFRIC	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 and Uganda. * For data in the NONCO2 file only: • For 1990, Other Africa includes Niger for all emissions other than CO_2 from fugitive sources and CO_2 from industrial processes. • For other years, Other Africa includes Niger for all emissions other than CO_2 from fuel combustion, CO_2 from fugitive sources and CO_2 from industrial processes.
Other Non-OECD Americas	OTHERLATIN	Includes Antigua and Barbuda, Aruba, the Bahamas, Barbados, Belize, Bermuda, Bonaire (from 2012), the British Virgin Islands, the Cayman Islands, Dominica, the Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guyana, Martinique, Montserrat, Puerto Rico (for natural gas and electricity)[14], Saba (from 2012), Saint Eustatius (from 2012), St. Kitts and Nevis, Saint Lucia, Saint Pierre and Miquelon, St. Vincent and the Grenadines, Sint Maarten (from 2012), Suriname (until 1999), and the Turks and Caicos Islands.
Other Asia	OTHERASIA	Includes Afghanistan, Bhutan, Cambodia (until 1994), the Cook Islands, Fiji, French Polynesia, Kiribati, the 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 and Vanuatu.

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

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Country/Region	Short name	Definition
Memo: OECD Total	OECDTOT	Includes Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. Latvia was not an OECD Member at the time of the preparation of this publication. Accordingly, Latvia does not appear in the list of OECD Members and is not included in the zone aggregates. Estonia and Slovenia are included starting in 1990. Prior to 1990, data for Estonia are included in the Former Soviet Union and data for Slovenia in Former Yugoslavia.
Memo: Non-OECD Total	NOECDTOT	Includes Africa; Asia (excluding China); China (P.R. of China, and Hong Kong, China); Non-OECD Americas; Middle East and Non-OECD Europe and Eurasia.
Memo: IEA Total	IEATOT	Includes Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. Estonia is included starting in 1990. Prior to 1990, data for Estonia are included in Former Soviet Union.
Memo: European Union – 28	EU28	Includes Austria, Belgium, Bulgaria, Croatia, Cyprus[15], 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 and the United Kingdom. Please note that in the interest of having comparable data, all of these countries are included since 1990 despite different entry dates into the European Union.
Memo: Former Yugoslavia	MYUGO	Includes Former Yugoslavia (if no detail); Bosnia and Herzegovina; Croatia; the Former Yugoslav Republic of Macedonia; Kosovo; Montenegro; Slovenia and Serbia.

15. Refer to the country note for Cyprus earlier in this chapter.

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Country/Region	Short name	Definition
Memo: Former Soviet Union	MFSU15	Includes the Former Soviet Union with all 15 countries for all years.
Memo: G7	G7	Includes Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.
Memo: G8	G8	Includes Canada, France, Germany, Italy, Japan, Russian Federation, the United Kingdom and the United States.
Memo: G20	G20	Includes Argentina, Australia, Brazil, Canada, China (including Hong Kong, China), India, Indonesia, Japan, Korea, Mexico, Russian Federation, Saudi Arabia, South Africa, Turkey, the United States and the European Union – 28.
Memo: Annex I Parties	ANNEX1	Includes Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Cyprus[15], the Czech Republic[16], Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein (not available in this publication)[17], Lithuania, Luxembourg, Malta, Monaco (included with France), the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, the Slovak Republic[16], Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom and the United States.[18] *The countries that are listed above are included in Annex I of the United Nations Framework Convention on Climate Change as amended on 11 December 1997 by the 12th Plenary meeting of the Third Conference of the Parties in Decision 4/CP.3. This includes the countries that were members of the OECD at the time of the signing of the Convention, the EEC, and fourteen countries in Central and Eastern Europe and the Former Soviet Union that were undergoing the process of transition to market economies. During subsequent sessions, the Conference of the Parties agreed to amend Annex I to the Convention to include Malta (Decision 3/CP.15, effective from 26 October 2010) and Cyprus[15] (Decision 10/CP.17, effective from 9 January 2013).*

16. Czechoslovakia was in the original list of Annex I countries.
17. Oil data for Liechtenstein are included under Switzerland.
18. The European Union is also an Annex I Party in its own right. The EU was assigned an overall reduction target under the Kyoto Protocol, which by agreement, was used to determine the individual targets of the fifteen states that were EU members in 1997 when the Kyoto Protocol was adopted.

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Country/Region	Short name	Definition
Memo: Annex II Parties	ANNEX2	Includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Liechtenstein (not available here), Luxembourg, Monaco (included in France), the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. *According to Decision 26/CP.7 in document FCCC/CP/2001/13/ Add.4, Turkey has been deleted from the list of Annex II countries to the Convention. This amendment entered into force on 28 June 2002.*
Memo: Annex II North America	ANNEX2NA	Includes Canada and the United States.
Memo: Annex II Europe	ANNEX2EU	Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Liechtenstein (not available here), Luxembourg, Monaco (included in France), the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.
Memo: Annex II Asia Oceania	ANNEX2AO	Includes Australia, Japan and New Zealand.
Memo: Annex I Economies in Transition	ANNEX1EIT	Annex I: Economies in Transition (EITs) are those countries in Annex I that are undergoing the process of transition to a market economy. This includes Belarus, Bulgaria, Croatia, the Czech Republic[16], Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russian Federation, the Slovak Republic[16], Slovenia and Ukraine.
Memo: Non-Annex I Parties	NONANNEX1	

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Country/Region	Short name	Definition
Memo: Annex B Kyoto Parties	ANNEXB	Includes Australia, Austria, Belgium, Belarus, Bulgaria, Croatia, Cyprus[19], the Czech Republic[20], Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Liechtenstein (not available in this publication)[21], Lithuania, Luxembourg, Malta, Monaco (included with France), the Netherlands, Norway, Poland, Portugal, Romania, the Slovak Republic[20], Slovenia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom[22]. *Refers to countries with targets under second commitment period (CP) of the Kyoto Protocol (2013-2020) as per the Doha Amendment. This differs from the list of countries with targets under the first CP (2008-2012). Please note that the Doha Amendment has not yet entered into force. Membership of Annex B in the second CP of the Kyoto Protocol differs from that in Annex I. In particular, Annex B excludes, or does not contain targets for Canada, Japan, New Zealand, the Russian Federation, Turkey and the United States (all Annex I member states), but includes Kazakhstan (a non-Annex I member state).*

19. Refer to the country note for Cyprus earlier in this chapter.
20. Czechoslovakia was in the original list of Annex I countries.
21. Oil data for Liechtenstein are included under Switzerland.
22. The European Union is also an Annex I Party in its own right. The EU was assigned an overall reduction target under the Kyoto Protocol, which by agreement, was used to determine the individual targets of the fifteen states that were EU members in 1997 when the Kyoto Protocol was adopted.

5. UNDERSTANDING THE IEA CO_2 EMISSIONS ESTIMATES

The importance of estimating emissions

The ultimate objective of the UNFCCC (the Convention) is the stabilisation of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The Convention also calls for all Parties to commit themselves to the following objectives:

- to develop, update periodically, publish and make available to the Conference of the Parties (COP) their national inventories of anthropogenic emissions by sources and removals by sinks, of all greenhouse gases not controlled by the Montreal Protocol.
- to use comparable methodologies for inventories of GHG emissions and removals, to be agreed upon by the COP.

As a response to the objectives of the UNFCCC, the IEA Secretariat, together with the IPCC, the OECD and numerous international experts, has helped to develop and refine an internationally-agreed methodology for the calculation and reporting of national GHG emissions from fuel combustion. This methodology was published in 1995 in the *IPCC Guidelines for National Greenhouse Gas Inventories*. After the initial dissemination of the methodology, revisions were added to several chapters, and published as the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (*1996 GLs*). In April 2006, the IPCC approved the *2006 Guidelines* at the 25th session of the IPCC in Mauritius. Until 2015, most Parties, as well as the IEA, still calculated their inventories using the *1996 GLs*. In December 2011 in Durban, Parties adopted Decision 15/CP.17 to update their reporting tables so as to implement the *2006 GLs*. The new reporting tables have been mandatory since 15 April 2015.

The IEA estimates of CO_2 emissions from fuel combustion

Energy is at the core of the greenhouse gas estimation. It is estimated that for Annex I Parties energy accounts for 82%[23] of total GHG emissions, while for the world the share is about 60%, although shares vary greatly by country. Within energy, CO_2 from fuel combustion accounts for the largest fraction, 92% for Annex I countries, once again varying depending on the economic structure of the country.

Given its extensive work in global energy data collection and compilation, the IEA is able to produce comparable estimates of CO_2 emissions from fuel combustion across countries and region, providing a reference database for countries with more and less advanced national systems.

The estimates of CO_2 emissions from fuel combustion presented in this publication are calculated using the IEA energy data[24] and the default methods and emission factors from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (*2006 GLs*)[25].

23. Based on data reported to the UNFCCC for 2012, excluding land-use, land-use change and forestry (LULUCF).
24. Published in *World Energy Statistics* and *World Energy Balances*, OECD/IEA, Paris, 2016..
25. See: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html.

Prior to the 2015 edition of this publication, the IEA used methods and emission factors of the *Revised 1996 IPCC Guidelines,* in line with UNFCCC recommendations for the reporting under the Kyoto Protocol. The IEA implementation of the *2006 GLs* in this edition follows the decision of UNFCCC Parties to update their reporting tables and to implement the *2006 GLs* starting on 15 April 2015.

The implications of changes in methods and emissions factors on the IEA emissions estimates for this edition are discussed in the chapter *IEA estimates: Changes under the 2006 IPCC Guidelines*.

Data in this publication and its corresponding database may have been revised with respect to previous editions also because the IEA reviews its energy databases each year. In the light of new assessments, revisions may be made to the energy data time series for any individual country.

CO_2 emissions from fuel combustion: key concepts

The IEA uses the simplest (Tier 1) methodology to estimate CO_2 emissions from fuel combustion based on the *2006 GLs*. The computation follows the concept of conservation of carbon, from the fuel combusted into CO_2. While for the complete methodology the reader should refer to the full IPCC documents, a basic description follows.

Generally, the Tier 1 estimation of CO_2 emissions from fuel combustion for a given fuel can be summarised as follows:

CO_2 emissions from fuel combustion
CO_2 = Fuel consumption * Emission factor

where:

Fuel consumption	= amount of fuel combusted;
Emission factor	= default emission factor

Emissions are then summed across all fuels and all sectors of consumption to obtain national totals. A more detailed explanation of the step by step calculation is presented in the chapter *IEA estimates: Changes under the 2006 IPCC Guidelines*.

IEA estimates vs. UNFCCC submissions

Based on the IEA globally collected energy data, the IEA estimates of CO_2 emissions from fuel combustion are a global database obtained following harmonised definitions and comparable methodologies across countries. They do not represent an official source for national submissions, as national administrations should use the best available country-specific information to complete their emissions reporting.

The IEA CO_2 estimates can be compared with those reported by countries to the UNFCCC Secretariat to highlight possible problems in methods, input data or emission factors. Still, care should be used in interpreting the results of any comparison since the IEA estimates may differ from a country's official submission for many reasons.

For most Annex II countries, the two calculations are expected to be within 5-10%, depending on the coverage of the fuel combustion sector in the national inventory. For some EIT and non-Annex I countries, differences may be larger. If the underlying energy data are different, more work is needed on the collecting and reporting of energy statistics.

In case of systematic biases in the energy data or emission factors, emission trends will usually be more reliable than the absolute emission levels. By comparing trends in the IEA estimates with trends in emissions as reported to the UNFCCC, it should be possible to identify definition problems or methodological differences.

Some of the reasons for these differences are:

- **The IEA uses a Tier 1 method to compute emissions estimates.**

For the calculation of CO_2 emissions from fuel combustion, the IEA uses a Tier 1 method. Countries may be using a more sophisticated Tier 2 or Tier 3 method that takes into account more detailed country-specific information available (*e.g.* on different technologies or processes).

- **Energy activity data based on IEA energy balances may differ from those used for the UNFCCC calculations.**

Countries often have several "official" data sources such as a Ministry, a Central Bureau of Statistics, a nationalised electricity company, etc. Data can also be

collected from the energy suppliers, the energy consumers or customs statistics. The IEA Secretariat tries to collect the most accurate data, but does not necessarily have access to the complete data set that may be available to national experts calculating emission inventories for the UNFCCC. In addition to different sources, the methodology used by the national bodies providing the data to the IEA and to the UNFCCC may differ. For example, general surveys, specific surveys, questionnaires, estimations, combined methods and classifications of data used in national statistics and in their subsequent reclassification according to international standards may result in different series.

- **The IEA uses average net calorific values for oil products.**

To transform fuel consumption data from physical units to energy units, the IEA uses an average net calorific value (NCV) for each secondary oil product. These NCVs are region-specific and constant over time. Country-specific NCVs that can vary over time are used for NGL, refinery feedstocks and additives. Crude oil NCVs are further split into production, imports, exports and average. Different coal types have specific NCVs for production, imports, exports, inputs to main activity power plants and coal used in coke ovens, blast furnaces and industry, and can vary over time for each country.

Country experts may have more detailed data on calorific values available when calculating the energy content of the fuels. This in turn could produce different values than those of the IEA.

- **The IEA uses average carbon content values.**

The IEA uses the default carbon content values given in the *2006 GLs*. Country experts may have better information available, allowing them to use country-specific values.

- **The IEA cannot allocate emissions from autoproducers into the end-use sectors.**

The *2006 GLs* recommend that emissions from autoproduction should be included with emissions from other fuel use by end-consumers. At the same time, the emissions from the autoproduction of electricity and heat should be excluded from the energy transformation source category to avoid double counting. The IEA is not able to allocate the fuel use from autoproducers between industry and *other*. Therefore, this publication shows a category called "Unallocated autoproducers". However, this should not affect the total emissions for a country.

- **Military emissions may be treated differently.**

According to the *2006 GLs*, military emissions should be reported in Source/Sink Category 1 A 5, *Non-Specified*. Previously, the IEA questionnaires requested that warships be included in international marine bunkers and that the military use of aviation fuels be included in domestic air. All other military use should have been reported in *non-specified other*.

At the IEA/Eurostat/UNECE Energy Statistics Working Group meeting (Paris, November 2004), participants decided to harmonise the definitions used to collect energy data on the joint IEA/Eurostat/UNECE questionnaires with those used by the IPCC to report GHG inventories. As a result, starting in the 2006 edition of this publication, all military consumption should be reported in *non-specified other*. Sea-going versus coastal is no longer a criterion for splitting international and domestic navigation.

However, it is not clear whether countries are reporting on the new basis, and if they are, whether they will be able to revise their historical data. The IEA has found that in practice most countries consider information on military consumption as confidential and therefore either combine it with other information or do not include it at all.

- **The IEA estimates include all CO_2 emissions from fuel combustion. Countries may have included parts of these emissions in the IPCC category industrial processes and product use.**

Although emissions totals would not differ, the allocation to the various sub-totals of a national inventory could. National GHG inventories submitted to the UNFCCC divide emissions according to source categories. Two of these IPCC Source/Sink Categories are energy, and industrial processes and product use. Care must be taken not to double count emissions from fuel combustion that occur within certain industrial processes (*e.g.* iron and steel). The IEA estimates in this publication include all the CO_2 emissions from fuel combustion, while countries are asked to report some of them within the industrial processes and product use category under the *2006 GLs*. See a more detailed discussion in the chapter *IEA Estimates: Changes under the 2006 IPCC Guidelines*.

- **The units may be different.**

The *2006 GLs* ask that CO_2 emissions be reported in Gg of CO_2 (1 Gg = 1 kilotonne). A million tonnes of CO_2 is equal to 1 000 Gg of CO_2, so to compare the numbers in this publication with national inventories expressed in Gg, the IEA emissions must be multiplied by 1 000.

Macroeconomic drivers of CO_2 emissions trends

Tables and graphs for drivers refer to the decomposition of CO_2 emissions into four driving factors (Kaya identity)[26], which is generally presented in the form:

Kaya identity
$C = P\ (G/P)\ (E/G)\ (C/E)$

where:

C = CO_2 emissions;
P = population;
G = GDP;
E = primary energy consumption.

The identity expresses, for a given time, CO_2 emissions as the product of population, per capita economic output (G/P), energy intensity of the economy (E/G) and carbon intensity of the energy mix (C/E). Because of possible non-linear interactions between terms, the sum of the percentage changes of the four factors, *e.g.* $(P_y\text{-}P_x)/P_x$, will not generally add up to the percentage change of CO_2 emissions $(C_y\text{-}C_x)/C_x$. However, relative changes of CO_2 emissions in time can be obtained from relative changes of the four factors as follows:

Kaya identity: relative changes in time
$$C_y/C_x = P_y/P_x\ (G/P)_y/(G/P)_x\ (C/E)_y/(C/E)_x$$

where x and y represent for example two different years.

In this publication, the Kaya decomposition is presented as:

CO_2 emissions and drivers
$CO_2 = P\ (GDP/P)\ (TPES/GDP)\ (CO_2/TPES)$

where:

CO_2	=	CO_2 emissions;
P	=	population;
GDP[27]/P	=	GDP/population;
TPES/GDP[27]	=	Total Primary Energy Supply per GDP;
CO_2/TPES	=	CO_2 emissions per unit TPES.

Indices of all terms (1990 = 100 unless otherwise specified) are shown for each country and regional aggregate in Part II of the full publication, both in the Summary tables and in the individual country/region pages (Table 1, Key indicators, and Figure 6, CO_2 emissions and drivers). Note that in its index form, CO_2/TPES corresponds to the Energy Sector Carbon Intensity Index (ESCII)[28].

The Kaya identity can be used to discuss the primary driving forces of CO_2 emissions. For example, it shows that, globally, increases in population and GDP per capita have been driving upwards trends in CO_2 emissions, more than offsetting the reduction in energy intensity. In fact, the carbon intensity of the energy mix is almost unchanged, due to the continued dominance of fossil fuels - particularly coal - in the energy mix, and to the slow uptake of low-carbon technologies.

However, it should be noted that there are important caveats in the use of the Kaya identity. Most important, the four terms on the right-hand side of equation should be considered neither as fundamental driving forces in themselves, nor as generally independent from each other

.

26.Yamaji, K., Matsuhashi, R., Nagata, Y. Kaya, Y., *An integrated system for CO_2/Energy/GNP analysis: case studies on economic measures for CO_2 reduction in Japan*. Workshop on CO_2 reduction and removal: measures for the next century, March 19, 1991, International Institute for Applied Systems Analysis, Laxenburg, Austria.

27. GDP based on purchasing power parities (PPP).
28. See the IEA publication *Tracking Clean Energy Progress 2015*.

Drivers of electricity generation emissions trends

In this edition, new graphs present the change in CO_2 emissions from electricity generation over time decomposed into the respective changes of four driving factors[29]:

CO_2 emissions from electricity generation
C = (C/E) (E/ELF) (ELF/EL) (EL)

where:

C = CO_2 emissions;
E = fossil fuel inputs to thermal generation;
ELF = electricity output from fossil fuels;
EL = total electricity output;

This can be rewritten as:

CO_2 emissions from electricity generation
C = (CF) (EI) (EFS) (EL)

where:

C = CO_2 emissions;
CF = carbon intensity of the fossil fuel mix;
EI = the reciprocal of fossil fuel based electricity generation efficiency;
EFS = share of electricity from fossil fuels;
EL = total electricity output.

This decomposition expresses, for a given time, CO_2 emissions from electricity generation as the product of the carbon intensity of the fossil fuel mix (CF), the reciprocal of fossil fuel based thermal electricity generation efficiency (1/EF), the share of electricity from fossil fuels (EFS) and total electricity output (EL).

However, due to non-linear interactions between terms, if a simple decomposition is used, the sum of the percentage changes of the four factors, *e.g.* $(CF_y\text{-}CF_x)/CF_x$ may not perfectly match the percentage change of total CO_2 emissions $(C_y\text{-}C_x)/C_x$. To avoid this, a more complex decomposition method is required. In this case, the logarithmic mean divisia (LMDI) method proposed by Ang (2004)[30] has been used.

Using this method, the change in total CO_2 emissions from electricity generation (ΔC_{TOT})between year *t* and a base year *0*, can be computed as the sum of the changes in each of the individual factors as follows:

$$C_{TOT} = \Delta C_{CF} + \Delta C_{EI} + \Delta C_{EFS} + \Delta C_{EL}$$

where:

$$\Delta C_{CF} = L(C^t, C^0) ln\left(\frac{CF^t}{CF^0}\right)$$

$$\Delta C_{EI} = L(C^t, C^0) ln\left(\frac{EI^t}{EI^0}\right)$$

$$\Delta C_{EFS} = L(C^t, C^0) ln\left(\frac{EFS^t}{EFS^0}\right)$$

$$\Delta C_{EL} = L(C^t, C^0) ln\left(\frac{EL^t}{EL^0}\right)$$

and:

$$L(x, y) = (y - x)/(ln\, y - ln\, x)$$

This decomposition can be useful when analysing the trends in CO_2 emissions from electricity generation. For instance, it shows that globally, since 1990, the main driver of increased CO_2 emissions from electricity generation has been increased electricity output, with improvements in the overall thermal efficiency, and the CO_2 intensity of the electricity generation mix being offset by an increase in the share of electricity derived from fossil fuel sources.

However, as is the case with the Kaya decomposition, it should be noted that the four terms on the right-hand side of equation should be considered neither as fundamental driving forces in themselves, nor as generally independent from each other. For instance, substituting coal with gas as a source of electricity generation would affect both the CO_2 intensity of the electricity generation mix and the thermal efficiency of generation.

CO_2 emissions per kWh

The indicator: definition

In the total CO_2 emissions per kWh, the numerator presents the CO_2 emissions from fossil fuels consumed for electricity generation, while the denominator presents the total electricity generated, coming from fossil fuels, but also from nuclear, hydro, geothermal, solar, biofuels, etc. As a result, the emissions per kWh vary a lot across countries and from year to year, depending on the generation mix.

29. M. Zhang, X. Liu, W. Wang, M. Zhou. *Decomposition analysis of CO_2 emissions from electricity generation in China.* Energy Policy, 52 (2013), pp. 159–165.
30. B. W. Ang, *Decomposition analysis for policymaking in energy: which is the preferred method?*, Energy Policy, 32 (9) (2004), pp. 1131–1139.

In the CO_2 emissions per kWh **by fuel**:

- Coal includes primary and secondary coal, and coal gases. Peat and oil shale have also been aggregated with coal, where applicable.
- Oil includes oil products (and crude oil for some countries).
- Gas represents natural gas.

Note: Emissions per kWh should be used with caution due to data quality problems relating to electricity efficiencies for some countries.

Methodological choices: electricity-only versus combined electricity and heat

In previous editions of this publication, the IEA had published a combined electricity and heat CO_2 emissions per kWh indicator. The indicator was useful as an overall carbon intensity measure of a country's electricity and heat generating sectors, and it was easy to calculate. However, there were a number of drawbacks. As the efficiency of heat generation is almost always higher than electricity generation, countries with large amounts of district heating (generally colder countries) tended to have a higher efficiency (therefore lower CO_2 intensity) than warmer countries with less district heating. Further, the applications of a combined indicator for electricity and heat are limited; many users have been searching for an electricity-only CO_2 emissions per kWh indicator.

Unfortunately, it is not possible to obtain such an electricity-only indicator directly from IEA energy balance data without any assumption. In fact, for combined heat and power (CHP) plants, there is only one combined input available. While various methods exist to split this input into separate amounts for electricity and heat generation, none had previously been used by the IEA for the purposes of calculating a CO_2 emissions per kWh indicator.

It would be possible to calculate an electricity-only indicator using data for electricity-only plants, which would not encounter the problem of assigning CHP inputs between electricity and heat. However, this would not allow a fair cross-country comparison; some countries get a majority of their electricity from CHP, while others from electricity-only plants. As non-thermal renewables are solely electricity-only plants, and over 99% of non-emitting global nuclear generation is from electricity-only plants, then calculating this electricity-only plants indicator would significantly understate the electricity carbon intensity for many countries.

Electricity-only indicator: allocation of emissions from CHP plants

To allocate the CHP input to electricity and heat separately, the simplest method would be a **proportionality approach,** allocating inputs based on the proportion of electricity and heat in the output, also used by the IEA electricity questionnaire. This is equivalent to fixing the efficiency of electricity and heat to be equal. With the advantage of simplicity and transparency, the proportionality approach however tends to overstate electricity efficiency and to understate heat efficiency. For example, for CHP generation in OECD countries, total efficiency is around 60%. However, total electricity-only plant efficiency is around 41% in OECD countries. Similarly, 60% is quite low for heat generation (given typical heat-only plant efficiencies of 80-95%).

An alternative method to avoid unrealistic efficiencies is a **fixed-heat-efficiency approach,** fixing the efficiency of heat generation to compute the input to heat, and calculating the input to electricity as a residual from the total input. The standard heat efficiency was set to that of a typical heat boiler, 90%.

Implementation problems arise in two cases: i) when the observed efficiency is over 100% (*i.e.* there are problems in data quality), and ii) when the observed efficiency is between 90% and 100% (the total efficiency may be correct or it may be overstated).

In the first case, when the total efficiency is over 100% because the data are not reported correctly, it is not possible to use the fixed-heat-efficiency approach and by default the proportionality approach was used to allocate the inputs based on the output shares.

In the second case, where the total CHP efficiency was 90%100% (which may or may not indicate a data quality problem), assuming a 90% efficiency for heat generation would incorrectly imply that the efficiency of power generation was equal to or higher than that of heat generation. However, as the real heat efficiency cannot be determined, the proportionality approach was used also here by default.

In general, the fixed-heat-efficiency approach attributes larger emissions to electricity than the proportionality approach, with values much closer to those of electricity-only plants. The IEA has used the fixed-heat-efficiency approach for several editions of its *World Energy Outlook*.

Fixed-heat-efficiency approach

$$CO_2kWh = \frac{CO_{2\,ELE} + (CO_{2\,CHP} \times \%\ \text{from elec.}) + OWNUSE_{ELE}}{ELoutput_{ELE} + ELoutput_{CHP}}$$

where:

$$\%\ \text{from elec.} = \frac{CHPinputs - ((HEoutput_{CHP} \times 0.02388) \div EFF_{HEAT})}{CHPinputs}$$

and:

$$OWNUSE_{ELE} = OWNUSE \times \frac{ELoutput}{ELoutput + (HEoutput \div 3.6)}$$

$CO_{2\,ELE}$ = CO_2 emissions from electricity only plants in $ktCO_2$

$CO_{2\,CHP}$ = CO_2 emissions from CHP plants in $ktCO_2$

OWNUSE = CO_2 emissions from own use in electricity, CHP and heat plants in $ktCO_2$

ELoutput = total electricity output from electricity and CHP plants in GWh

$ELoutput_{ELE}$ = electricity output from electricity only plants in GWh

$ELoutput_{CHP}$ = electricity output from CHP plants in GWh

HEoutput = total heat output from CHP and heat plants in TJ

$HEoutput_{CHP}$ = heat output from CHP plants in TJ

CHPinputs = energy inputs to CHP plants in ktoe

EFF_{HEAT} = efficiency of heat generation - assumed to be 0.9 (*i.e.* 90%) except when the observed efficiency of CHP generation is higher than 90%, in which case emissions are allocated using the proportionality approach ($EFF_{HEAT} = EFF_{ELEC} = EFF_{CHP}$).

Comparison between electricity-only and combined electricity and heat ratios

For the majority of OECD countries, the electricity-only indicator is not significantly different from the combined electricity and heat indicator, shown in previous editions of this publication and in the online database. For the OECD total in 2013, the electricity-only indicator is 3% higher, while 19 of the OECD's 34 countries saw a change of 5% or less. Of the 15 countries changing more than 5%, 7 countries had large amounts of non-emitting electricity generation, giving them a small ratio to begin with (thus more prone to change). In addition, non-emitting generation is generally electricity-only, and so when the heat-only and heat CHP emissions are removed from the calculation, greater weight is attached to the non-emitting generation, with a lower level for the final indicator.

The countries in the OECD with larger differences are generally coal-intensive countries with large amounts of heat generation. As mentioned, in general, heat plants are more efficient than electricity-only or CHP plants; therefore, excluding heat plants from the calculation increases CO_2 intensity. The same is true if we allocate a high efficiency to the heat part of CHP generation; this decreases the efficiency of the electricity part and thus increases electricity's carbon intensity. Further, CHP and heat plants are more likely to be powered by CO_2-light natural gas while electricity-only plants tend to be powered by CO_2-heavy coal, making the new ratio more CO_2 intensive for these countries.

Specific country examples

The country with the largest difference between the two ratios within the OECD was **Sweden**; in 2013, the electricity only indicator was 63% lower than the combined electricity and heat indicator. This is due to the high share of non-emitting sources such as hydro (40%) and nuclear (43%) in Sweden's electricity generation mix.

Similarly, the electricity only indicator for **Norway** in 2013 was 41% lower than the combined indicator, as the vast majority of the electricity output (96%) is from non-emitting hydroelectric generation.

Conversely, for **Estonia** in 2013 the electricity-only indicator was 36% higher than the combined electricity and heat indicator. This can be explained by the fact that the majority of electricity-only generation comes from oil shale, a fuel with a relatively high carbon emission factor, while heat plants (with a relatively large share of output) are largely fuelled by natural gas and primary solid biofuels.

Another OECD country with a high ratio increase was **Denmark** (28% higher in 2013). The majority of fossil generation in Denmark is from CHP and the output from these plants is approximately half electricity and half heat. In addition, CHP plants in Denmark have efficiencies of 60-70%. When the heat part of CHP is set to be 90%, the efficiency of the electricity generation is lowered and the indicator is increased.

In many non-member countries, heat data are either zero or not available, which leads to changes of less than 1% in almost 80% of the non-member countries in 2013. The majority of countries which do change are the European and former Soviet Union countries (where district heating is often present).

As **China** has no (reported) CHP generation, the current IEA energy balance shows electricity-only and heat-only plants, not CHP plants. Heat-only plants are in general much more efficient per unit of energy than electricity-only plants and this explains why the electricity-only ratio is 5% higher in 2013.

In the **Russian Federation**, a large amount (25-35% of total power output) comes from heat-only plants, whose relatively efficient generation is excluded from the new ratio. The large amount of heat output generated by CHP plants also explains why the electricity-only ratio is 20% higher in 2013. The electricity only indicators calculated for the following non-member countries are also lower than the combined electricity and heat indicator: **Kyrgyzstan, Latvia** and **Tajikistan**. This is because their electricity production is mainly or exclusively clean hydro, while their CHP and heat-only production is fossil-based. Implementing the electricity-only indicator using the fixed-heat-efficiency approach increased hydro's weight (therefore decreasing the carbon intensity).

Implied carbon emission factors from electricity generation (CO_2 / kWh) for selected products

Average implied carbon emission factors from electricity generation by product are presented below, for selected products. Those values are given as a complement of the CO_2 emissions per kWh from electricity generation by country presented in the Summary tables of Part II of the full publication. The values below represent the average amount of CO_2 per kWh of electricity produced in OECD member countries between 2010 and 2014. As they are very sensitive to the quality of underlying data, including net calorific values, and of reported input/output efficiencies, they should be taken as indicative; actual values may vary considerably.

Product	**gCO_2 / kWh**
Anthracite*	875
Coking coal*	820
Other bituminous coal	870
Sub-bituminous coal	940
Lignite	1030
Gas works gas*	335
Coke oven gas*	390
Blast furnace gas*	2425
Other recovered gases*	1590
Oil shale*	1155
Peat*	765
Natural gas	405
Crude oil*	590
Refinery gas*	450
Liquefied petroleum gases*	525
Kerosene*	625
Gas/diesel oil*	715
Fuel oil	670
Petroleum coke*	930
Municipal waste (non-renew.)*	1200

* The electricity output from these products represents less than 1% of electricity output in the average of OECD member countries for the years 2010-2014. Values will be less reliable and should be used with caution.

6. IEA ESTIMATES: CHANGES UNDER THE 2006 IPCC GUIDELINES

The 2006 IPCC Guidelines methodology: key concepts

This section briefly presents the Tier 1 methodology to estimate CO_2 emissions from fuel combustion based on the *2006 GLs,* outlining the main differences with the *1996 GLs* - used for previous editions of this publication. The focus is on the key points relevant to the IEA estimation. For the complete methodology, the reader should refer to the full IPCC documents.[31]

Generally, the Tier 1 estimation of CO_2 emissions from fuel combustion for a given fuel can be summarised as follows:

CO_2 emissions from fuel combustion
$CO_2 = AD * NCV * CC * COF$

where:

CO_2 = CO_2 emissions from fuel combustion;
AD = Activity data;
NCV = Net calorific value;
CC = Carbon content;
COF = Carbon oxidation factor.

Emissions are then summed over all fuels.

While the basic concept of the calculation - the conservation of carbon - is unchanged, the *2006 GLs* differ from the 1996 *GLs* in the:

- default **net calorific values** by product;
- default **carbon content** by product;
- default **carbon oxidation factors;**
- treatment of fuels used for **non-energy** purposes;
- **allocation** of fuel combustion emissions across the Energy and IPPU categories.

2006 Guidelines: overview of changes

This section describes the key methodological changes *2006 GLs* for a Tier 1 estimation of CO_2 emissions from fuel combustion, with a short assessment of their impact on results.

Net calorific values

Net calorific values (NCVs) are used to convert the activity data for all the different fuels from "physical" units (*e.g.* tonnes) to "energy" units (*e.g.* Joules).

In the *1996 GLs*, country-specific net calorific values were given for primary oil (crude oil and NGL), for primary coal and for a few secondary coal products. These NCVs were based on the average 1990 values of the 1993 edition of the *IEA Energy Balances*.

In the *2006 GLs*, those country-specific NCVs were removed, and one default is provided for each fuel (with upper and lower limits, as done for the carbon content). Large differences were therefore observed for products whose quality varies a lot from country to country, such as primary oil and coal products. Replacing country-specific values with one default value would significantly affect emissions calculations if the default values were used.

31. Both the *1996 GLs* and the *2006 GLs* are available from the IPCC Greenhouse Gas Inventories Programme (*www.ipcc-nggip.iges.or.jp*).

The IEA CO_2 emissions from fuel combustion estimates are based on the IEA energy balances, computed using time-varying country-specific NCVs. Therefore, they are not affected by changes to the default net calorific values of the *2006 GLs*.

Carbon content

Carbon content is the quantity of carbon per unit of energy of a given fuel. Some of the fuel-specific default values for carbon content, called "carbon emission factors" in the *1996 GLs*, were revised in the *2006 GLs*. In addition, values were added for some fuels not directly mentioned in the *1996 GLs*.

As the carbon content may vary considerably for some fuels, the *2006 GLs* introduced ranges of values, *i.e.* providing for each fuel a default value with lower and upper limits. The IEA CO_2 emissions are calculated using the IPCC default values.

A summary of the default carbon content values in the two set of guidelines is shown in Table 1. Relative changes between the 200*6 GLs* and the 199*6 GLs* range between -13.7% (refinery gas) and + 7.3% (blast furnace gas), although for many fuels the variation is minimal, or zero. Such systematic changes are reflected in Tier 1 CO_2 emissions estimates.

Carbon oxidation factors

A small fraction of the carbon contained in fuels entering the combustion process (typically less than 1-2%) is not oxidised. Under the *1996 GLs,* this amount was subtracted from emissions in the calculations by multiplying the calculated carbon content of a fuel by a "fraction of carbon oxidised". The fraction of carbon oxidised had a value of less than 1.0, which had the effect of reducing the emissions estimate. However, in most instances, emissions inventory compilers had no "real" information as to whether this correction was actually applicable.

Therefore, in the *2006 GLs*, it was decided that all carbon is assumed to be emitted by default, unless more specific information is available. Therefore, under the *2006 GLs*, the default carbon oxidation factor is equal to 1 for all fuels.

A summary of the default carbon oxidation factors in the two set of guidelines is shown in Table 2. Relative changes from the *1996 GLs* and the *2006 GLs* are +0.5% for natural gas; +1% for oil, oil products and peat; and +2% for coal. Such changes are reflected in systematic increases in Tier 1 CO_2 emissions estimates.

Table 1. Comparison of default carbon content values*

Kilogrammes / gigajoule

Fuel Type	*1996 Guidelines*	*2006 Guidelines***	Percent Change
Anthracite	26.8	26.8	0.0%
Coking Coal	25.8	25.8	0.0%
Other Bituminous Coal	25.8	25.8	0.0%
Sub-Bituminous Coal	26.2	26.2	0.0%
Lignite	27.6	27.6	0.0%
Patent Fuel	25.8	26.6	+3.1%
Coke oven coke	29.5	29.2	-1.0%
Gas Coke	29.5	29.2	-1.0%
Coal Tar	..	22.0	x
BKB	25.8	26.6	+3.1%
Gas Works Gas	..	12.1	x
Coke Oven Gas	13.0	12.1	-6.9%
Blast Furnace Gas	66.0	70.8	+7.3%
Other recovered gases	..	49.6	x
Peat	28.9	28.9	0.0%
Oil shale	29.1	29.1	0.0%
Natural Gas	15.3	15.3	0.0%
Crude Oil	20.0	20.0	0.0%
Natural Gas Liquids	17.2	17.5	+1.7%
Refinery Feedstocks	20.0	20.0	0.0%
Orimulsion	22.0	21.0	-4.5%
Refinery Gas	18.2	15.7	-13.7%
Ethane	16.8	16.8	0.0%
Liquefied petroleum gases (LPG)	17.2	17.2	0.0%
Motor Gasoline excl. biofuels	18.9	18.9	0.0%
Aviation Gasoline		19.1	+1.1%
Gasoline type jet fuel		19.1	+1.1%
Kerosene type jet fuel excl. bio	19.5	19.5	0.0%
Other Kerosene	19.6	19.6	0.0%
Gas/Diesel Oil excl. biofuels	20.2	20.2	0.0%
Fuel Oil	21.1	21.1	0.0%
Naphtha	20.0	20.0	0.0%
Lubricants	20.0	20.0	0.0%
Bitumen	22.0	22.0	0.0%
Petroleum Coke	27.5	26.6	-3.3%
Non-specified oil products	20.0	20.0	0.0%
Other hydrocarbons			
White Spirit & SBP		20.0	0.0%
Paraffin Waxes		20.0	0.0%
Industrial Waste	..	39.0	x
Municipal Waste (non-renewable)	..	25.0	x

* "Carbon content" was referred to as the "carbon emission factor" in the *1996 GLs*.

** The *2006 GLs* also give the lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions.

Table 2. Comparison of default carbon oxidation factors*

Fuel Type	*1996 Guidelines*	*2006 Guidelines***	Percent Change
Coal	0.980	1.00	+2.0%
Oil and oil products	0.990	1.00	+1.0%
Natural gas	0.995	1.00	+0.5%
Peat **	0.990	1.00	+1.0%

* "Carbon oxidation factor" was referred to as "fraction of carbon oxidised" in the *1996 GLs*.

** The *1996 GLs* specified a carbon oxidation factor for peat used for electricity generation only.

Treatment of fuels used for non-energy purposes

Many hydrocarbons are used for non-energy purposes *e.g.* petrochemical feedstocks, lubricants, solvents, and bitumen. In some of these cases, the carbon in the fuel is quickly oxidised to CO_2, in other cases, it is stored (or sequestered) in the product, sometimes for as long as centuries.

In the *1996 IPCC GLs*, Tier 1 Sectoral Approach emissions included emissions from fuels used for non-energy purposes. The share of carbon assumed to be stored (not emitted) was estimated based on default "fractions of carbon stored" (shown for reference in Table 3).

Table 3. Fraction of Carbon Stored in the *1996 GLs*

Fuel Type	*1996 Guidelines*
Naphtha*	0.8
Lubricants	0.5
Bitumen	1.0
Coal Oils and Tars (from coking coal)	0.75
Natural Gas*	0.33
Gas/Diesel Oil*	0.5
LPG*	0.8
Ethane*	0.8
Other fuels for non-energy use	To be specified

* When used as feedstocks.

Note: this table is included only for reference. CO_2 emissions from fuel combustion in this publication do not include emissions from non-energy use of fuels.

In the *2006 GLs,* all deliveries for non-energy purposes are excluded. Numerically, excluding all non-energy use of fuel from energy sector emissions calculations is equivalent to applying a fraction of carbon stored equal to 1 to all quantities delivered for non-energy purposes.

In the case of a complete greenhouse gas inventory covering all IPCC Source/Sink categories, any emissions associated with non-energy use of fuels would be accounted in another Source/Sink category. However, as this publication only deals with CO_2 emissions from fuel combustion, emissions associated with non-energy use of fuels are no longer included in the IEA CO_2 emissions estimates.

Within the IEA estimates, the effect of this change is mainly noticeable for countries whose petrochemical sectors are large in comparison to the size of their economies, *e.g.* the Netherlands.

Allocation of fuel combustion emissions across the Energy and the IPPU sectors

To avoid possible double counting, the *2006 GLs* state that combustion emissions from fuels obtained directly or indirectly from the feedstock for an Industrial Processes and Product Use (IPPU) process will be allocated to the source category in which the process occurs, unless the derived fuels are transferred for combustion in another source category.

In the case of a complete inventory, this reallocation would not affect total emissions. Still, the effect on individual source categories could be quite significant, especially in countries with large IPPU sectors (*e.g.* the iron and steel, and non-ferrous metals industries).

To provide continuity with previous editions of this publication and to fully account for fuel combustion emissions, the IEA CO_2 emissions from fuel combustion include all emissions from fuel combustion, irrespective of the category of reporting (Energy or IPPU) under the *2006 GLs*.

To ensure comparability with submissions from Parties, an additional online database provides a summary of CO_2 emissions calculated according to the IPCC Reference and Sectoral Approaches, and a breakdown of the fuel combustion emissions which would be reallocated to IPPU under the *2006 GLs*.[32]

Assessing the overall impact of methodological changes on IEA estimates

Table 4 shows a comparison of IEA estimates of total CO_2 emissions from fuel combustion for the most recent year of available data (2013). Emissions are calculated using: i) the *1996 GLs* Sectoral Approach, methodology as in previous publications, and ii) the *2006 GLs*[33] - which correspond to the data published in this edition.

32. Note that the data available to the IEA do not allow assessing whether fuels derived from IPPU processes are transferred for combustion in another source category.

33. Including the emissions which may be reallocated from Energy to IPPU under the *2006 GLs*.

The overall impact of the change in methodology on the IEA estimates of CO_2 emissions from fuel combustion varies from country to country, mainly depending on the underlying fuel mix and on the relative importance of non-energy use of fuels in the total.

Most countries show a decrease in CO_2 emissions levels under the new methodology, as the reductions due to the removal of non-energy use emissions are generally larger than the systematic increase due to changes in the oxidation factor.

For the year 2013, reductions of 1% or greater are observed for about sixty countries, with twelve showing a decrease of 5% or more. The largest relative decreases are observed in countries with high non-energy use of fuels (mainly oil products and natural gas) relative to their total energy consumption: Trinidad and Tobago (-39%), Lithuania (-13%), Singapore (-13%), Gibraltar (-11%), the Netherlands (-10%), Albania (-9%) and Belgium (-8%). As emissions from non-energy use of fuels are not included in energy sector emissions under the 2006 GLs, emissions previously attributed to non-energy use of oil products and natural gas are no longer included in IEA CO_2 emissions from fuel combustion estimates for these countries. One country, Curaçao presented a large increase (24%) in 2013. This was due to the inclusion of emissions from reported energy use of bitumen, which had been excluded (considered carbon stored / non-energy use) under the 1996 GLs.

Within the IEA databases, these changes will also be reflected in all indicators derived from CO_2 emissions totals (*e.g.* CO_2/TPES, CO_2/GDP). Impacts on trends should be visible when the relative weight of the non-energy use of fuels changes in time.

However, as mentioned, most of the methodological changes would not have significant impact in the case of a complete inventory covering all IPCC source/sink categories; in particular, the reallocation of emissions between categories would not affect total emissions estimates, nor the overall trends.

Table 4. Comparison of IEA CO_2 emissions estimates for Non-OECD Countries (2014)

$MtCO_2$

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[32]	Percent Change
World	**32903.3**	**32381.0**	**-1.6%**
Annex I Parties	**12852.2**	**12628.4**	**-2%**
Non-annex I Parties	**18932.1**	**18622.2**	**-2%**
OECD			
Australia	375.2	373.8	-0.4%
Austria	60.8	60.8	0.0%
Belgium	95.0	87.4	-8.0%
Canada	574.6	554.8	-3.4%
Chile	76.4	75.8	-0.8%
Czech Republic	98.4	96.6	-1.8%
Denmark	34.7	34.5	-0.6%
Estonia	17.5	17.5	0.0%
Finland	46.4	45.3	-2.4%
France	295.8	285.7	-3.4%
Germany	734.6	723.3	-1.5%
Greece	66.4	65.9	-0.8%
Hungary	41.3	40.3	-2.4%
Iceland	2.0	2.0	0.0%
Ireland	33.7	33.9	0.6%
Israel	66.3	64.7	-2.4%
Italy	325.7	319.7	-1.8%
Japan	1193.3	1188.6	-0.4%
Korea	589.5	567.8	-3.7%
Luxembourg	9.2	9.2	0.0%
Mexico	432.1	430.9	-0.3%
Netherlands	166.6	148.3	-11.0%
New Zealand	33.2	31.2	-6.0%
Norway	36.9	35.3	-4.3%
Poland	281.3	279.0	-0.8%
Portugal	43.2	42.8	-0.9%
Slovak Republic	29.9	29.3	-2.0%
Slovenia	12.6	12.8	1.6%
Spain	234.8	232.0	-1.2%
Sweden	38.7	37.4	-3.4%
Switzerland	37.7	37.7	0.0%
Turkey	304.8	307.1	0.8%
United Kingdom	409.0	407.8	-0.3%
United States	5235.9	5176.2	-1.1%
OECD Total	**12033.5**	**11855.6**	**-1.5%**

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[32]	Percent Change
Non-OECD Europe and Eurasia			
Albania	4.3	4.1	-4.7%
Armenia	5.2	5.2	0.0%
Azerbaijan	31.3	30.8	-1.6%
Belarus	64.3	57.4	-10.7%
Bosnia and Herzegovina	21.2	21.6	1.9%
Albania	42.2	42.1	-0.2%
Croatia	15.8	15.1	-4.4%
Cyprus [34]	5.7	5.8	1.8%
Georgia	8.0	7.7	-3.8%
Gibraltar	0.6	0.5	-16.7%
Kazakhstan	220.3	223.7	1.5%
Kosovo	7.3	7.4	1.4%
Kyrgyzstan	8.3	8.4	1.2%
Latvia	6.7	6.7	0.0%
Lithuania	12.0	10.3	-14.2%
FYR of Macedonia	7.3	7.4	1.4%
Malta	2.3	2.3	0.0%
Republic of Moldova	7.2	7.2	0.0%
Montenegro	2.2	2.2	0.0%
Romania	69.0	68.2	-1.2%
Russian Federation	1525.3	1467.6	-3.8%
Serbia	37.9	38.1	0.5%
Tajikistan	4.6	4.7	2.2%
Turkmenistan	66.6	67.0	0.6%
Ukraine	239.6	236.5	-1.3%
Uzbekistan	101.0	97.9	-3.1%
Non-OECD Europe and Eurasia	**2516.4**	**2446.1**	**-2.8%**

34. Please refer to the chapter *Geographical coverage and country notes*.

Table 4. Comparison of IEA CO_2 emissions estimates for Non-OECD Countries (2013)

$MtCO_2$

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[32]	Percent Change
Africa			
Algeria	126.4	122.9	-2.8%
Angola	19.5	19.3	-1.0%
Benin	5.7	5.7	0.0%
Botswana	6.8	6.9	1.5%
Cameroon	6.0	6.0	0.0%
Congo	2.7	2.6	-3.7%
Cote d'Ivoire	4.6	4.7	2.2%
Dem. Rep. of Congo	9.3	9.4	1.1%
Egypt	181.1	173.3	-4.3%
Eritrea	0.6	0.6	0.0%
Ethiopia	9.2	9.1	-1.1%
Gabon	3.5	3.5	0.0%
Ghana	13.3	13.1	-1.5%
Kenya	12.3	12.4	0.8%
Libya	48.1	47.9	-0.4%
Mauritius	3.9	4.0	2.6%
Morocco	53.0	53.1	0.2%
Mozambique	3.8	3.9	2.6%
Namibia	3.6	3.6	0.0%
Niger	2.0	2.0	0.0%
Nigeria	61.9	60.2	-2.7%
Senegal	6.4	6.3	-1.6%
South Africa	442.3	437.4	-1.1%
South Sudan	13.9	13.3	-4.3%
Sudan	1.5	1.5	0.0%
United Rep. of Tanzania	10.4	10.4	0.0%
Togo	1.7	1.7	0.0%
Tunisia	25.0	25.0	0.0%
Zambia	3.3	3.2	-3.0%
Zimbabwe	11.4	11.5	0.9%
Other Africa	32.3	31.0	-4.0%
Africa	**1125.6**	**1105.3**	**-1.8%**
Asia (excl. China)			
Bangladesh	63.9	62.3	-2.5%
Brunei Darussalam	7.5	6.7	-10.7%
Cambodia	6.0	6.1	1.7%
DPR of Korea	37.0	37.8	2.2%
India	2038.9	2019.7	-0.9%
Indonesia	442.3	436.5	-1.3%
Malaysia	227.5	220.5	-3.1%
Mongolia	17.8	18.2	2.2%
Myanmar	19.6	19.6	0.0%
Nepal	5.8	5.9	1.7%
Pakistan	141.0	137.4	-2.6%
Philippines	94.5	95.7	1.3%
Singapore	50.9	45.3	-11.0%
Sri Lanka	16.5	16.7	1.2%
Chinese Taipei	260.9	249.7	-4.3%
Thailand	263.1	243.5	-7.4%
Viet Nam	143.7	143.3	-0.3%
Other Asia	41.7	42.1	1.0%
Asia (excl. China)	**3878.8**	**3807.0**	**-1.9%**

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[32]	Percent Change
China			
People's Republic of China	9199.1	9087.0	-1.2%
Hong Kong (China)	47.3	47.9	1.3%
China (incl. Hong Kong)	**9246.4**	**9134.9**	**-1.2%**
Non-OECD Americas			
Argentina	195.3	192.4	-1.5%
Bolivia	18.2	18.3	0.5%
Brazil	492.6	476.0	-3.4%
Colombia	73.0	72.5	-0.7%
Costa Rica	7.1	7.2	1.4%
Cuba	29.6	29.4	-0.7%
Curaçao	3.7	4.7	27.0%
Dominican Republic	19.5	19.3	-1.0%
Ecuador	38.7	38.7	0.0%
El Salvador	5.9	5.9	0.0%
Guatemala	16.1	16.1	0.0%
Haiti	2.7	2.8	3.7%
Honduras	8.7	8.7	0.0%
Jamaica	7.1	7.2	1.4%
Nicaragua	4.5	4.5	0.0%
Panama	10.6	10.6	0.0%
Paraguay	5.2	5.2	0.0%
Peru	48.4	47.8	-1.2%
Suriname	2.0	2.0	0.0%
Trinidad and Tobago	38.0	23.2	-38.9%
Uruguay	6.5	6.3	-3.1%
Venezuela	155.5	155.0	-0.3%
Other Non-OECD Americas	19.9	20.1	1.0%
Non-OECD Americas	**1209.0**	**1173.9**	**-2.9%**
Middle East			
Bahrain	31.8	29.7	-6.6%
Islamic Republic of Iran	576.1	556.1	-3.5%
Iraq	140.2	141.0	0.6%
Jordan	23.9	24.1	0.8%
Kuwait	88.4	86.1	-2.6%
Lebanon	22.1	22.4	1.4%
Oman	63.1	59.9	-5.1%
Qatar	82.7	77.6	-6.2%
Saudi Arabia	521.4	506.6	-2.8%
Syrian Arab Republic	28.1	27.6	-1.8%
United Arab Emirates	175.8	175.4	-0.2%
Yemen	21.1	21.3	0.9%
Middle East	**1774.7**	**1727.8**	**-2.6%**

7. GHG EMISSIONS: SOURCES AND METHODS

The information in Part III (with the exception of CO_2 emissions from fossil fuel combustion) has been provided by Jos G.J. Olivier and Greet Janssens-Maenhout based on the EDGAR 4.2FT2010 dataset except most other sources of CO_2 for which data from EDGAR version 4.3.2 was used. JRC and PBL are responsible for these datasets.

General note on EDGAR

Version 4 of the *Emission Database for Global Atmospheric Research* (*EDGAR4)* has been developed jointly by the European Commission's Joint Research Centre (JRC) and the PBL Netherlands Environmental Assessment Agency and is hosted at *edgar.jrc.ec.europa.eu*. EDGAR4 is providing global anthropogenic emissions of greenhouse gases CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 and of precursor gases and air pollutants CO, NO_x, NMVOC, SO_2 and the aerosols PM_{10}, $PM_{2.5}$, BC, OC, per source category, both at country level as well as on a 0.1°x0.1° grid online to its large community of users. EDGAR data are used for policy applications and scientific studies such as atmospheric modelling and were used for the *Fifth Assessment Report* of the *Intergovernmental Panel on Climate Change* (IPCC, 2014) (Working Group III).

Activity data were mostly taken from international statistics (checked for completeness and consistency and where required gap filled) and greenhouse gas emission factors were selected mostly from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC, 2006) to ensure a consistent approach across countries and complete and consistent time series. It is stressed that the uncertainty in the resulting dataset at national level may be substantial, especially for methane and nitrous oxide, and even more so for the F-gases (see Box 2 for more details). However, this dataset provides a sound basis for comparability with national emissions reports and other studies since the methods used are either IPCC methodologies or comparable to them (see below), global totals are obtained in a transparent way and comply with budgets used in atmospheric studies, and the data were based on international information sources. The EDGAR 4.2 Fast Track 2010 (FT2010 dataset is built on the previous dataset 4.2 (with 1970-2008 time-series by adding emissions for 2009 and 2010. For the GHG update, reports of Annex I countries to the *UN Convention on Climate Change* (UNFCCC) and the recent and significant impact of *Clean Development Mechanism* projects in developing countries to reduce CH_4, N_2O and HFC-23 emissions were taken into account. This applies to sources such as coal mines and landfills (CH_4 recovery), nitric acid and adipic acid production (N_2O) and the production of HCFC-22 (HFC-23).

The EDGAR4.3.2 dataset covers 1970-2012 time-series for all sector-specific and country-specific totals of greenhouse gases. Thereto new activity data statistics (with updated and revised time series) were uploaded [for energy-related emissions using IEA (2014)] and emission factors revised where appropriate. Although this dataset has been constructed with great care, JRC and PBL do not accept any liability from use of the data provided in this report including any inaccuracies or omissions in the data provided. For details on uncertainty and caveats identified in the dataset, as well as more detailed source category estimates, we refer users to the EDGAR 4 website at *edgar.jrc.ec.europa.eu*. Note that estimates for other more recent years than 2010 are also made publicly available through this website. Most recent trends for CO_2 emissions through 2015 are discussed in Olivier et al. (2016).

Box 2: Uncertainty in greenhouse gas emissions.

When considering comparative shares and trends in greenhouse-gas emissions, data on gases and sources other than CO_2 from fuel combustion are much more uncertain. Country-specific estimates of CO_2 from biomass burning and F-gas emissions are particularly difficult to ascertain. The uncertainty in these emissions is caused by the limited accuracy of international activity data used and in particular of emission factors selected for calculating emissions on a country level (Olivier, 2002; Olivier *et al.,* 2005). For a detailed evaluation of emission uncertainties using international statistics and IPCC and other emission factors we refer to the *2006 IPCC Guidelines* (2006), and for comparisons between countries and datasets to Olivier et al (2005, 2010, 2015).

For global total anthropogenic CO_2 emissions the calculated uncertainty in the total ranges from about -10% to +10%, including large-scale biomass burning. For global emissions of CH_4, N_2O and the F-gases uncertainty estimates of 25%, 30% and 20%, respectively, were assumed based on default uncertainty estimates for the 2006 IPCC methodologies (IPCC, 2006), which correspond with emissions estimates inferred from atmospheric concentration measurements (UNEP, 2012).

When considering emission shares and trends of countries one should note that:

CO_2: Fossil fuel combustion, which is often the largest source of CO_2 in a country, is estimated to have an uncertainty of about 5% (95% confidence interval) for OECD countries. However, for many non-OECD countries the uncertainty is estimated at about 10%. This is often regarded as the most accurate source of GHG emissions.

CH_4: Uncertainties are particularly large for methane emissions from fugitive sources (coal mining and from oil and gas production and transmission) and from landfills and wastewater.

N_2O: Uncertainties of most N_2O sources are very large, *e.g.* the uncertainty for agricultural sources may sometimes exceed 100%.

F-gases: Uncertainties in annual emissions of most sources of F-gases are very large, *e.g.* at a country level they may well exceed 100%. Therefore, the figures provided for individual countries should be considered solely as order-of-magnitude estimates.

Source definitions

The source definitions for *Fuel combustion* refer to the categories and codes used in the 2006 IPCC guidelines, Chapter 8 of Vol. 1: *General guidance and reporting* (IPCC, 2006). For other categories and codes the definitions refer to the Revised 1996 IPCC guidelines, Chapter 1 of Vol. 1: *Reporting instructions* (IPCC, 1996).

For carbon dioxide:

Fuel combustion refers to fossil fuel combustion only. Emissions have been estimated by the IEA using the methodology as described in the chapter *IEA estimates: Changes under the 2006 IPCC Guidelines* in Part I. (2006 IPCC Source/Sink Category 1A)

Fugitive refers mainly to flaring of associated gas in oil and gas production (in some cases including indirect CO_2 from methane venting) (IPCC Source/Sink Category 1B).

Industrial Processes refer to production of cement, lime, soda ash, carbides, ammonia, methanol, ethylene and other chemicals, metals and to the use of soda ash, limestone and dolomite, and non-energy use of lubricants and waxes. Emissions exclude *Fuel combustion* emissions. (IPCC Source/Sink Category 2).

Other refers to direct emissions from forest fires and peat fires, emissions from decay (decomposition) of aboveground biomass that remains after logging & deforestation and emissions from the decay of drained peat soils (IPCC Source/Sink Category 5). CO_2 from solvent use (IPCC Source/Sink Category 3), from application of urea and agricultural lime (IPCC Source/Sink Category 4) and from fossil fuel fires (coal fires & the Kuwait oil fires) (IPCC Source/Sink Category 7) is also included here.

For methane:

Energy comprises production, handling, transmission and combustion of fossil fuels and biofuels (IPCC Source/Sink Categories 1A and 1B).

Agriculture comprises enteric fermentation, rice production, manure management, agricultural waste burning (non-energy, on-site) and savannah burning (IPCC Source/Sink Category 4).

Waste comprises landfills, wastewater treatment, wastewater disposal and waste incineration (non-energy) (IPCC Source/Sink Category 6).

Other includes industrial process emissions *e.g.* methanol production, and forest and peat fires and other vegetation fires (IPCC Source/Sink Categories 2 and 5).

For nitrous oxide:

Energy comprises combustion of fossil fuels and bio-fuels (IPCC Source/Sink Categories 1A and 1B).

Agriculture comprises fertiliser use (synthetic and manure), animal waste (manure) management, agricultural waste burning (non-energy, on-site) and savannah burning (IPCC Source/Sink Category 4).

Industrial Processes comprise non-combustion emissions from manufacturing of adipic acid, nitric acid, caprolactam and glyoxal (IPCC Source/Sink Category 2).

Other includes N_2O usage, forest and peat fires (including post-burn decay emissions from remaining biomass) and other vegetation fires, human sewage discharge and waste incineration (non-energy) and indirect N_2O from atmospheric deposition of NO_x and NH_3 from non-agricultural sources (IPCC Source/Sink Categories 3, 5, 6 and 7).

For fluorinated gases:

HFC emissions comprise by-product emissions of HFC-23 from HCFC-22 manufacture and the use of HFCs (IPCC Source/Sink Categories 2E and 2F).

PFC emissions comprise by-product emissions of CF_4 and C_2F_6 from primary aluminium production and the use of PFCs, in particular for the manufacture of semiconductors, flat panel displays and photovoltaic cells) (IPCC Source/Sink Categories 2C, 2E and 2F). *SF_6 emissions* stem from various sources of SF_6 use (mainly manufacturing of Gas Insulated Switchgear (GIS) used in the electricity distribution networks) (IPCC Source/Sink Categories 2C and 2F) and from SF_6 production (Category 2E).

Data sources and methodology for EDGAR 4.2FT2010 and 4.3.2

The **EDGAR 4.2FT2010** has been available online since October 2013[35]. For greenhouse gases, the default emission factors from the *2006 IPCC Guidelines* (IPCC, 2006) were used, except for CH_4 and N_2O from road transport where technology-specific factors were used from the EMEP-EEA emission inventory guidebook (EEA, 2009).

To estimate the trend for the main sources of each greenhouse gas in 2009 and 2010, an emissions trend for each year was used as a proxy. These were taken either from the Common Reporting Format (CRF) files of the National Inventory Reports (NIR) reported to the UNFCCC or from statistics for an activity that was assumed to be a good proxy for that source, such as sectoral CO_2 emissions (IEA, 2012), fossil-fuel production (IEA, 2012), gas flaring of the U.S. National Oceanic and Atmospheric Administration (NOAA), production of steel, aluminium, cement, lime and ammonia of U.S. Geological Survey (USGS) or the World Steel Association (WSA), animal numbers, crop production and nitrogen fertiliser consumption of the Food and Agriculture Organisation (FAO), large-scale biomass burning of the GFED 3 dataset (Van der Werf et al., 2010). The use of the NIR trends allowed accounting of implemented control measures.

For small-scale sources, such as industrial process sources of methane and nitrous oxide from caprolactam production, linear extrapolation of the past trend from 2005 to 2008 was assumed.

The **EDGAR 4.3.2** dataset covers the entire period 1970-2012. CO_2 emissions data from this dataset were used for *Fugitives* and *Industrial Processes*. The methods, data sources and emission factors used for this new dataset are the same as for version 4.2, except that the activity data have been updated, and sometimes revised, through 2012.

Methods and data applied for all years (except 2009 and 2010 in FT2010) are summarised in Part III of last year's report[36]. More details and full references on the EDGAR 4.2 FT2010 dataset can be found in Part III of last year's report[37].

General note

We note that EDGAR 4.2 FT2010 estimates for all sources have been made for all years. For more detailed data of the EDGAR 4.2 FT2010 dataset, including the complete period 1970-2010 and a few small corrections after the release of the dataset for some sources of F-gas emissions in 2010 (HFC-23 from HCFC manufacture and PFCs from solvent use and from PV cell manufacture) and estimates for more recent years we refer to the EDGAR version 4 website at *edgar.jrc.ec.europa.eu*. Here also the new dataset 4.3.2 covering 1970 to 2012 will be available and for CO_2 in Olivier et al. (2016).

35. See *http://edgar.jrc.ec.europa.eu/overview.php?v=42FT2010.*

36. For Part III of that report see: *http://www.pbl.nl/en/publications/co2-emissions-from-fuel-combustion-part-iii-total-greenhouse-gas-emissions-2015-edition.*

37. For Part III of that report see: *http://www.pbl.nl/en/publications/co2-emissions-from-fuel-combustion-2014-edition.*

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8. UNITS AND CONVERSIONS

General conversion factors for energy

To:	TJ	Gcal	Mtoe	MBtu	GWh
From:	multiply by:				
terajoule (TJ)	1	$2.388x10^{2}$	$2.388x10^{-5}$	$9.478x10^{2}$	$2.778x10^{-1}$
gigacalorie (Gcal)	$4.187x10^{-3}$	1	$1.000x10^{-7}$	3.968	$1.163x10^{-3}$
million tonnes of oil equivalent (Mtoe)	$4.187x10^{4}$	$1.000x10^{7}$	1	$3.968x10^{7}$	$1.163x10^{4}$
million British thermal units (MBtu)	$1.055x10^{-3}$	$2.520x10^{-1}$	$2.520x10^{-8}$	1	$2.931x10^{-4}$
gigawatt hour (GWh)	3.600	$8.598x10^{2}$	$8.598x10^{-5}$	$3.412x10^{3}$	1

Conversion factors for mass

To:	kg	t	lt	st	lb
From:	multiply by:				
kilogramme (kg)	1	$1.000x10^{-3}$	$9.842x10^{-4}$	$1.102x10^{-3}$	2.205
tonne (t)	$1.000x10^{3}$	1	$9.842x10^{-1}$	1.102	$2.205x10^{3}$
long ton (lt)	$1.016x10^{3}$	1.016	1	1.120	$2.240x10^{3}$
short ton (st)	$9.072x10^{2}$	$9.072x10^{-1}$	$8.929x10^{-1}$	1	$2.000x10^{3}$
pound (lb)	$4.536x10^{-1}$	$4.536x10^{-4}$	$4.464x10^{-4}$	$5.000x10^{-4}$	1

Conversion factors for volume

To:	gal U.S.	gal U.K.	bbl	ft^3	l	m^3
From:	multiply by:					
U.S. gallon (gal U.S.)	1	$8.327x10^{-1}$	$2.381x10^{-2}$	$1.337x10^{-1}$	3.785	$3.785x10^{-3}$
U.K. gallon (gal U.K.)	1.201	1	$2.859x10^{-2}$	$1.605x10^{-1}$	4.546	$4.546x10^{-3}$
barrel (bbl)	$4.200x10^{1}$	$3.497x10^{1}$	1	5.615	$1.590x10^{2}$	$1.590x10^{-1}$
cubic foot (ft^3)	7.481	6.229	$1.781x10^{-1}$	1	$2.832x10^{1}$	$2.832x10^{-2}$
litre (l)	$2.642x10^{-1}$	$2.200x10^{-1}$	$6.290x10^{-3}$	$3.531x10^{-2}$	1	$1.000x10^{-3}$
cubic metre (m^3)	$2.642x10^{2}$	$2.200x10^{2}$	6.290	$3.531x10^{1}$	$1.000x10^{3}$	1

Decimal prefixes

10^{1}	deca (da)	10^{-1}	deci (d)
10^{2}	hecto (h)	10^{-2}	centi (c)
10^{3}	kilo (k)	10^{-3}	milli (m)
10^{6}	mega (M)	10^{-6}	micro (μ)
10^{9}	giga (G)	10^{-9}	nano (n)
10^{12}	tera (T)	10^{-12}	pico (p)
10^{15}	peta (P)	10^{-15}	femto (f)
10^{18}	exa (E)	10^{-18}	atto (a)

Tonne of CO_2

The *2006 GLs* and the UNFCCC *Reporting Guidelines on Annual Inventories* both ask that CO_2 emissions and removals be reported in Gg (gigagrammes) of CO_2. A million tonnes of CO_2 is equal to 1 000 Gg of CO_2, so to compare the numbers in this publication with national inventories expressed in Gg, multiply the IEA emissions by 1 000.

Other organisations may present CO_2 emissions in tonnes of carbon instead of tonnes of CO_2. To convert from tonnes of carbon, multiply by 44/12, which is the molecular weight ratio of CO_2 to C.

9. ABBREVIATIONS

Btu	British thermal unit
BKB	Brown coal briquettes (braunkohlebriketts)
Gg	gigagramme
GJ	gigajoule
GWh	gigawatt hour
J	joule
kcal	kilocalorie
kg	kilogramme
kt	thousand tonnes
ktoe	thousand tonnes of oil equivalent
kWh	kilowatt hour
MJ	megajoule
Mt	million tonnes
Mtoe	million tonnes of oil equivalent
$MtCO_2$	million tonnes of carbon dioxide
m^3	cubic metre
PJ	petajoule
t	metric ton = tonne = 1 000 kg
tC	tonne of carbon
TJ	terajoule
toe	tonne of oil equivalent = 10^7 kcal
CC	carbon content
CEF	carbon emission factor
COF	carbon oxidation factor
CHP	combined heat and power
GCV	gross calorific value
GDP	gross domestic product
GWP	global warming potential
NCV	net calorific value
PPP	purchasing power parity
TPES	total primary energy supply
Convention	United Nations Framework Convention on Climate Change
COP	Conference of the Parties to the Convention
G20	Group of Twenty (See the chapter *Geographical coverage and country notes*)
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
OECD	Organisation for Economic Co-Operation and Development
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
..	not available
-	nil
x	not applicable
CO_2	carbon dioxide