Greenhouse Gas Emissions from Energy 2022

Database documentation

International Energy Agency

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 31 member countries, 11 association countries and beyond.

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This document provides information regarding the 2022 edition of the IEA *Greenhouse gas emissions from energy* database – which has replaced the IEA *CO_2 emissions from fuel combustion* database with expanded content as of last year. This document can be found online at: https://www.iea.org/data-and-statistics/data-product/greenhouse-gas-emissions-from-energy. Selected data from the 2021 edition are available at: *Greenhouse gas emissions from energy highlights*

Please address your inquiries to emissions@iea.org.

Please note that all IEA data are subject to the following Terms and Conditions found on the IEA's website: http://www.iea.org/t&c/termsandconditions/.

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Changes from last edition

Note: this section refers to changes of the database as compared to the 2021 edition of the IEA *Greenhouse gas emissions from energy* database.

Geographical coverage

Lithuania joined the IEA in February 2022; however, its data have not been included in the IEA member countries aggregate (IEA total) for this edition. They are included in the IEA and Accession/Association countries aggregate (IEA family), for data starting in 1990 and for the entire time series.

The IEA continues to expand the coverage of its statistics reports and encourages more countries to collaborate on data exchange. As detailed data have become consistently available for the Kingdom of Eswatini, Madagascar, Rwanda and Uganda, the associated time series are now shown explicitly in the main list of countries and have been removed from the Other Africa region

For further details, please refer to the section on *Geographical coverage*.

Old longname	New longname	Shortname	Old shortname (if changed)
	Kingdom of Eswatini	ESWATINI	
Memo: Madagascar	Madagascar	MADAGASCAR	MMADAGASCA
Memo: Rwanda	Rwanda	RWANDA	MRWANDA
Memo: Uganda	Uganda	UGANDA	MUGANDA
Turkey	Republic of Türkiye	TURKEY	

Revisions of GDP time series

The sources of GDP data used to derive selected energy indicators have been changed from previous editions to move to a homogenous source across OECD and non-OECD countries. The current sources are:

- International Monetary Fund. 2021. World Economic Outlook: War Sets Back the Global Recovery. Washington, DC, October. (IMF WEO)

- World Development Indicators. 2022. Washington, D.C. :The World Bank. (WB WDI)
- CEPII – CHELEM database. 2022. (CHELEM)

This change has impact on the indicators derived from GDP (e.g. total energy supply/GDP), with variable levels depending on the country. For more information on sources, please refer to the *Definitions* section.

Database description

The *Greenhouse gas emissions from energy* database includes annual data for:

- countries: 203 countries and 41 regional aggregates (see section *Geographical coverage*);
- years: 1960-2020 (OECD countries and regions);
  1971-2020 (non-OECD countries and regions; world);
  1990-2020 (indicators);
  2021 (provisional data for selected elements).

The database includes the following seven files:

World_BigCO_2.ivt CO_2 Emissions from fuel combustion (detailed estimates)
Detailed CO_2 emissions by subsector and by product. This data file includes four dimensions of “product”, “flow”, “time” and “country”.

World_GHG.ivt GHG Emissions from energy (summary)
Aggregated GHG emissions by sector and by product category. This data file includes five dimensions of “gas”, “product”, “flow”, “time” and “country”.

World_CO_2Indic.ivt CO_2 emissions indicators
Thirty five emissions related, energy and socio-economic indicators. This data file includes three dimensions of “flow”, “time” and “country”.

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. This data file includes four dimensions of “flow”, “allocation”, “time” and “country”.

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 IPCC Guidelines for GHG inventories*. This data file includes four dimensions of “product”, “flow”, “time” and “country”.

World_CO_2Timeseries.ivt CO_2 emissions from fuel combustion starting in 1751
Total CO_2 emissions from fuel combustion, for 17 regions, for years starting in 1751. This data file includes four dimensions of “product”, “flow”, “time” and “country”.

World_ EDGARNonCO_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, based on EDGAR information. Data are available for 1990, 1995, 2000, 2005, 2010 2012 and 2015. Detailed definitions of each flow and product are presented in the section *Definitions*. This data file includes four dimensions of “gas”, “time” and “country”.

Definitions

Gas dimension

Gas

Gas	Short name	Definition
Carbon dioxide	CO_2	
Methane	CH_4	The emissions figures are converted from gCH_4 to gCO_{2eq} using the 100-year Global Warming Potential (GWP). For the purpose of comparability with international data submission guidelines, the factors from the 4th Assessment of the IPCC are used. 1gCH4 = 25 gCO2eq
Nitrous oxide	N_2O	The emissions figures are converted from gN_2O to gCO_{2eq} using the 100-year Global Warming Potential (GWP). For the purpose of comparability with international data submission guidelines, the factors from the 4th Assessment of the IPCC are used. 1gCH4 = 25 gCO2eq
Carbon dioxide equivalent	CO_{2eq}	

Flow dimension

GHG emissions from fuel combustion (kt of CO_{2eq})

Flow	Short name	Definition
GHG from fuel combustion	GHGFCOMB	*GHG from fuel combustion* presents total greenhouse gas emissions from fuel combustion including CO_2, CH_4 and N_2O. This includes GHG 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*. GHGFCOMB = MAINPROD + AUTOPROD + OTHEN + TOTIND +TOTTRANS + RESIDENT+ COMMPUB + AGRICULT + FISHING + ONONSPEC. For the most recent year available, this value is estimated based on provisional data. Please refer to the section *Provisional year estimates* for more information on this methodology.
CO_2 fuel combustion	CO2FCOMB	*CO_2 from fuel combustion* presents total CO_2 emissions from fuel combustion. This includes CO_2 emissions from fuel

Flow	Short name	Definition
		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 + RESIDENT+ COMMPUB + AGRICULT + FISHING + ONONSPEC. For the most recent year available, this value is estimated based on provisional data. Please refer to the section *IEA Provisional year estimates* for more information on this methodology. In the file CO_2 emissions from fuel combustion starting in 1751, values for years starting in 1751 have been estimated following sources and methodology described in *Estimates for years starting 1751*
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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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

Flow	Short name	Definition
		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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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 IPCC Guidelines for GHG inventories*. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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 IPCC Guidelines for GHG inventories*, 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 IPCC Guidelines for GHG inventories*. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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 IPCC Guidelines for GHG inventories*. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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

Flow	Short name	Definition
		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 IPCC Guidelines for GHG inventories*. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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 IPCC Guidelines for GHG inventories*. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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 IPCC Guidelines for GHG inventories.*
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 GHG emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 IPCC Guidelines for GHG inventories*.
Mining and quarrying	MINING	[ISIC Rev. 4 Divisions 07 and 08 and Group 099] Mining (excluding fuels) and quarrying. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*

Flow	Short name	Definition
Construction	CONSTRUC	[ISIC Rev. 4 Divisions 41 to 43] *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Manufacturing	MANUFACT	Manufacturing refers to the sum of the following industrial sub-sectors: • Iron and Steel • Chemical and petrochemical • Non-ferrous metals • Non-metallic minerals • Transport equipment • Machinery • Food and tobacco • Paper, pulp and printing • Wood and wood products • Textile and leather Definitions of the sub-sectors are below. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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*. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Chemical and petrochemical	CHEMICAL	[ISIC Rev. 4 Divisions 20 and 21] *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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 IPCC Guidelines for GHG inventories*. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Non-metallic minerals	NONMET	[ISIC Rev. 4 Division 23] Such as glass, ceramic, cement, etc. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Transport equipment	TRANSEQ	[ISIC Rev. 4 Divisions 29 and 30] *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Machinery	MACHINE	[ISIC Rev. 4 Divisions 25 to 28] Fabricated metal products,

Flow	Short name	Definition
		machinery and equipment other than transport equipment. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Food and tobacco	FOODPRO	[ISIC Rev. 4 Divisions 10 to 12] *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Paper, pulp and printing	PAPERPRO	[ISIC Rev. 4 Divisions 17 and 18] *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Wood and wood Products	WOODPRO	[ISIC Rev. 4 Division 16] Wood and wood products other than pulp and paper. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Textile and leather	TEXTILES	[ISIC Rev. 4 Divisions 13 to 15] *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Non-specified industry	INONSPEC	Including but not limited to:[ISIC Rev. 4 Divisions 22, 31 and 32] Any 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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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.

Flow	Short name	Definition
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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
Rail	RAIL	Includes emissions from rail traffic, including industrial railways. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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. *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*
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). *Note: This flow is included for CO_2 emissions from fuel combustion and excludes non-CO_2 greenhouse gases.*

Flow	Short name	Definition
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.
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].
Final consumption not elsewhere specified	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.
Memo: Total final consumption	TFC	*Total final consumption* contains the emissions from the end-use sectors (industry, transport, commercial/institutional activities, residential, agriculture/forestry, fishing and other emissions not specified). Emissions related to the energy used for transformation processes and for own use of the

Flow	Short name	Definition
		energy producing industries are excluded. Final consumption emissions reflect for the most part emissions at the consumer level. Note that *international marine bunkers* and *international aviation bunkers* are not included at a national or regional level (except for World emissions). In the *2006 GLs*, the sub-categories also include emissions from autoproducers that generate electricity and/or heat. 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*).
Memo: electricity and heat production	ELECHEAT	Electricity and heat production contains the sum of emissions from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included. In the summary file *World_GHG.ivt*, this is not a memo item and the long-name adopted is: Electricity and heat generation. For the most recent year available, this value is estimated based on provisional data. Please refer to the section Provisional year estimates for more information on this methodology.

Fugitive GHG emissions and energy-related GHG emissions

The following flows are expressed in thousand tonnes of CO2eq, converted using the 100-year Global Warming Potential (GWP).

Flow	Short name	Definition
Fugitive GHG emissions	GHGFUGITI	*Fugitive GHG emissions* presents the fugitive CO_2 and CH_4 emissions from energy. This includes GHG emissions in IPCC Source/Sink Category 1 B under the *2006 GLs*.
Of which: production	FUGPRODUC	It includes methane accidental emissions from upstream processes other than venting and flaring. This corresponds to IPCC Source/Sink Category 1 B 2 a iii 1, 1 B 2 a iii 2 (oil), 1B 2 b iii 1 and 1B 2 b iii 2 (natural gas).
Of which: flared	FUGFLARED	It includes CO_2 from flaring or CH_4 emissions from incomplete combustion of flares. This corresponds to IPCC Source/Sink Category 1 B 2 a ii and 1 B 2 b ii (oil).
Of which: vented	FUGVENTED	It includes methane emissions from venting. This corresponds to IPCC Source/Sink Category 1 B 1 a (coal), 1 B 2 a i (oil) and 1 B 2 b i (natural gas).
Of which: transmission and distribution (accidental)	FUGTRADIS	It includes methane accidental emissions from downstream processes. This corresponds to IPCC Source/Sink Category 1 B 2 a iii 3, 1 B 2 a.iii 4 and 1 B 2 a iii 5 (oil), 1 B 2 b iii 4 and 1 B 2 b iii 5 (natural gas).

Of which: distribution losses (deliberate)	FUGDISLOS	It includes methane deliberate emissions from downstream processes. This corresponds to IPCC Source/Sink Category 1 B 2 a iii 5 (oil) and 1 B 2 b iii 5 (natural gas).
GHG emissions from energy	GHGENERGY	*GHG emissions from energy* presents energy-related GHG emissions, including total GHG emissions from fuel combustion plus CO_2 and CH_4 fugitive emissions from energy, representing the bulk of the energy-related emissions, as in IPCC Source/Sink Category 1 with minor exceptions as detailed below: GHGENERGY = GHGFCOMB + GHGFUGITI Exclusions from IPCC Source/Sink Category 1B: For fugitive emissions from *Oil and Gas:* o *N_2O emissions from waste gas flaring* o *CO_2 flared from Natural Gas industry* o *CO_2 vented* For fugitive emissions from *Coal:* o *Flared CH_4* o *All fugitive CO_2, including from flaring CH_4 and uncontrolled burning of coal dumps* Emissions from IPCC Source/Sink Category 1C - CO_2 capture and storage are not included.

Indicators

Flow	Short name	Notes
Total energy supply (PJ)	TESPJ	Total energy supply from the *IEA World Energy Balances* (converted to PJ). Total energy supply (TES) 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 energy supply (Mtoe)	TESMTOE	Total energy supply from the *IEA World Energy Balances*. Total energy supply (TES) 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

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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.
GDP (billion USD, 2015 prices and ex rates)	GDP	Please note that sources for GDP were changed from previous editions. This can impact derived indicators. GDP data are derived from three sources: - *International Monetary Fund. 2021. World Economic Outlook: War Sets Back the Global Recovery. Washington, DC, October*. (IMF WEO) - *World Development Indicators. 2022. Washington, D.C. :The World Bank*. (WB WDI) - *CEPII – CHELEM database. 2022*. (CHELEM) Data from IMF WEO are used as a primary source for the period starting in 1980; if not available, data gaps are filled based on the other sources, based on data availability and the hierarchy described below: 1. Data from IMF WEO 2. WDI growth rates applied to IMF WEO data 3. Data from WB WDI for countries not included in IMF WEO for any year 4. CHELEM growth rates applied to IMF WEO data 5. Data from CHELEM Data in year *n* are rebased to 2015 using nominal GDP figures, GDP deflators and market exchange rates using following formula: $$\mathrm{GDP_n} = \frac{\mathrm{GDP\_Nominal\_NC_n}}{\mathrm{Exchange\_rate_{base\_year}}} * \frac{\mathrm{deflator_{base\_year}}}{\mathrm{deflator_n}}$$ 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 primary sources.
GDP (billion USD,	GDPPPP	Please note that sources for GDP were changed from previous

Flow	Short name	Notes
2015 prices and PPPs)		editions. This can impact derived indicators. GDPPPP figures are derived using same sources and methodology as for GDP USD. Data in year *n* are rebased to 2015 using nominal GDP figures, GDP deflators and PPP rates using following formula: $$\mathrm{GDPPPP_n} = \frac{\mathrm{GDP\_Nominal\_NC_n}}{\mathrm{PPP_{base\_year}}} * \frac{\mathrm{deflator_{base\_year}}}{\mathrm{deflator_n}}$$ International price comparisons based on exchange rates may not reflect the relative purchasing power in each currency. PPPs are the rates of currency conversion that equalize the purchasing power of different currencies by eliminating the differences in price levels between countries. In their simplest form, PPPs are simply price relatives that show the ratio of the prices in national currencies of the same good or service in different countries.**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.**
TES / GDP (MJ per 2015 USD)	TESGDP	This ratio is expressed in megajoules per 20150 US dollar. It has been calculated using total energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using exchange rates.
TES / GDP PPP (MJ per 2015 USD PPP)	TESGDPPP	This ratio is expressed in megajoules per 2015 US dollar. It has been calculated using total energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using purchasing power parities.
Population (millions)	POP	**For OECD countries:** The main source of these series for 1970 to 2020 when available is the OECD *National Accounts Statistics* database [ISSN: 2221-433X (online)], last published in book format as *National Accounts of OECD Countries, Volume 2021 Issue 1: Detailed Tables*, OECD 2021. 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). Data for **Colombia** (prior to 1985), **Latvia** (prior to 1995) and **Lithuania** (prior to 1995) are IEA Secretariat estimates based on GDP growth rates from the World Bank. **For non-OECD countries:** The main source of the population data is *World Development Indicators*, The World Bank, Washington D.C., 2021. Population data for **Former Soviet Union** (before 1990), **Chinese Taipei, Former Yugoslavia** (before 1990), **Eritrea** (2012-2020), **Kuwait** (1992-1994), **Palestinian Authority** and for a few countries within the regions Other Africa, Other non-

Flow	Short name	Notes
		OECD Americas and Other non-OECD Asia are based on the CHELEM-CEPII online database, Bureau van Dijk, Paris, 2022. Population data for Cyprus1 are taken from the Eurostat online database.
CO_2 / TES (tCO_2 per TJ)	CO2TES	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 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 2015 USD)	CO2GDP	This ratio is expressed in kilogrammes of CO_2 per 2015 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 2015 USD)	CO2GDP_I	This ratio is expressed in kilogrammes of CO_2 per 2015 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 2015 USD)	CO2GDP_T	This ratio is expressed in kilogrammes of CO_2 per 2015 US dollar. It has been computed using *Transport* CO_2 emissions (TOTTRANS) and total GDP calculated using exchange rates.
Services CO_2 / GDP ($kgCO_2$ per 2015 USD)	CO2GDP_S	This ratio is expressed in kilogrammes of CO_2 per 2015 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 2015 USD)	CO2GDP_R	This ratio is expressed in kilogrammes of CO_2 per 2015 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 2015 USD PPP)	CO2GDPPP	This ratio is expressed in kilogrammes of CO_2 per 2015 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 2015 USD PPP)	CO2GDPPP_I	This ratio is expressed in kilogrammes of CO_2 per 2015 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	CO2GDPPP_T	This ratio is expressed in kilogrammes of CO_2 per 2015US dollar. It has been calculated using *Transport* CO_2 emissions

[1] Please refer to the section on Geographical coverage.

Flow	Short name	Notes
2015 USD PPP)		(TOTTRANS) and total GDP calculated using purchasing power parities.
Services CO_2 / GDP PPP ($kgCO_2$ per 2015 USD PPP)	CO2GDPPP_S	This ratio is expressed in kilogrammes of CO_2 per 2015 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 2015 USD PPP)	CO2GDPPP_R	This ratio is expressed in kilogrammes of CO_2 per 2015 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).
CO_2 emissions index	ICO2EMIS	CO_2 fuel combustion emissions (CO2FCOMB) expressed as an index, where the reference year = 100. Aside from the following exception, 2000 is used as the reference year: **Montenegro** (2005).
Population index	IPOP	Population expressed as an index, where the reference year = 100. Aside from the following exception, 2000 is used as the reference year: **Montenegro** (2005) This index can be used as one of the constituents of the Kaya identity, for more information see the section *Understanding the IEA CO_2 emissions estimates*.
GDP per population index	IGDPPOP	GDP PPP / population expressed as an index, where the reference year = 100. Aside from the following exception, 2000 is used as the reference year: **Montenegro** (2005) This index can be used as one of the constituents of the Kaya identity, for more information see the section *Understanding the IEA CO_2 emissions estimates.*

Flow	Short name	Notes
Energy intensity index - TES/GDP	ITESGDP	TES / GDP PPP expressed as an index, where the reference year = 100. Aside from the following exception, 2000 is used as the reference year: **Montenegro** (2005) This index can be used as one of the constituents of the Kaya identity, for more information see the section *Understanding the IEA CO_2 emissions estimates*.
Carbon intensity index – ESCII: CO_2/TES	ICO2TES	CO_2 emissions / TES expressed as an index, where the reference year = 100. Calculated using CO_2 Fuel Combustion emissions (CO2FCOMB). Aside from the following exception, 2000 is used as the reference year: **Montenegro** (2005) This index can be used as one of the constituents of the Kaya identity, for more information see the section *Understanding the IEA CO_2 emissions estimates*.
GHG Energy/TES (tCO_2 per TJ)	GHGTES	This ratio is expressed in tonnes of CO_{2eq} per terajoule. It has been calculated using the total GHG Energy emissions (GHGENERGY) and total energy supply (including biofuels and other non-fossil forms of energy).
GHG Energy/TFC (tCO_2 per TJ)	GHGTFC	This ratio is expressed in tonnes of CO_{2eq} per terajoule. It has been calculated using the total GHG Energy emissions (GHGENERGY) and total final consumption (including biofuels and other non-fossil forms of energy).
GHG Energy/GDP ($kgCO_2$ per 2015 USD)	GHGGDP	This ratio is expressed in kilogrammes of CO_{2eq} per 2015 US dollar. It has been computed using the total GHG Energy (GHGENERGY) emissions and GDP calculated using exchange rates.
GHG Energy/GDP PPP ($kgCO_2$ per 2015 USD PPP)	GHGGDPPP	This ratio is expressed in kilogrammes of CO_{2eq} per 2015 US dollar. It has been computed using the total GHG Energy (GHGENERGY) emissions and GDP calculated using purchasing power parities.
GHG Energy/Population (tCO_2 per capita)	GHGPOP	This ratio is expressed in tonnes of CO_{2eq} per capita. It has been computed using the total GHG Energy (GHGENERGY) emissions).

Allocation of CO_2 emissions from electricity/heat

Flow	Allocation	Definition
Emissions by sector	NO	Expressed in thousand 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	YES	Expressed in thousand tonnes of CO_2.

electricity and heat allocated to consuming sectors		Emissions from electricity and heat generation have been allocated to final consuming sectors multiplying the amounts of electricity and heat consumed per electricity/heat country-specific carbon intensities. IEA data does not capture the autoproduction by sub-sector, but only the total. Therefore cautious is needed while using the sub-sectoral disaggregation of *Manufacturing industries and construction.*
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 multiplying the amounts of electricity and heat consumed per electricity/heat country-specific carbon intensities. IEA data does not capture the autoproduction by sub-sector, but only the total. Therefore cautious is needed while using the sub-sectoral disaggregation of *Manufacturing industries and construction.*

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.
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

Flow	Short name	Definition
		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*.
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	IPPUEBLAST	*IPPU CO2 fuel combustion – Blast furnace energy (IPPU)*

Flow	Short name	Definition
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.
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.

Product dimension

Aggregated product categories

Product	Short name	Definition
Total	TOTAL	TOTAL = the total of all GHG emissions from fuel combustion from across products; for CO_2, TOTAL = COAL + OIL + NATGAS + OTHER, for CH_4 and N_2O, TOTAL = COAL + OIL + NATGAS + OTHER + BIOPROD.
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.
Non-renewables wastes	OTHER	Other includes industrial waste and non-renewable municipal waste.
Memo: Biofuels and renewable wastes	BIOPROD	Includes biofuels (primary solid biofuels, biogases, biogasoline, biodiesels, bio jet kerosene and other liquid biofuels) and renewable wastes.

Coal

Product	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).
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.

Product	Short name	Definition
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

Product	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

product	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

Product	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	NONCRUDE	This category includes synthetic crude oil from tar sands, shale

Product	Short name	Definition
hydrocarbons		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.
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 35ºC and 215ºC 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 -60ºC, and a distillation range usually within the limits of 30ºC and 180ºC.
Gasoline type jet fuel	JETGAS	Gasoline type jet fuel includes all light hydrocarbon oils for use in aviation turbine power units, which distil between 100ºC and 250ºC. 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 150ºC and 300ºC but not generally above 250ºC). 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 150ºC and 300ºC.

Product	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 180ºC and 380ºC. 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 380ºC and 540ºC 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 80ºC. The flash point is always above 50ºC 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 30ºC and 210ºC.
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 30ºC and a distillation range of 135ºC to 200ºC. Industrial Spirit (SBP) comprises light oils distilling between 30ºC and 200ºC, with a temperature difference between 5% volume and 90% volume distillation points, including losses, of not more than 60ºC. 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 45ºC.
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

Product	Short name	Definition
		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

Product	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

Product	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.

Biofuels

Product	Short name	Definition
Memo: Primary solid biofuels	PRIMSBIO	Primary solid biofuels is defined as any plant matter used directly as fuel or converted into other forms before combustion. This covers a multitude of woody materials generated by industrial process or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, sulphite lyes also known as black liquor, animal materials/wastes and other solid biofuels). Note that for biofuels, only the amounts of biomass specifically used for energy purposes (a small part of the total) are included in the energy statistics. Therefore, the non-energy use of biomass is not taken into consideration and the quantities are null by definition.
Memo: Biogases	BIOGASES	Biogases are gases arising from the anaerobic fermentation of biomass and the gasification of solid biomass (including biomass in wastes). The biogases from anaerobic fermentation are composed principally of methane and carbon dioxide and comprise landfill gas, sewage sludge gas and other biogases from anaerobic fermentation. Biogases can also be produced from thermal processes (by gasification or pyrolysis) of biomass and are mixtures containing hydrogen and carbon monoxide (usually known as syngas) along with other components. These gases may be further processed to modify their composition and can be further processed to produce substitute natural gas. Biogases are used mainly as a fuel but can be used as a chemical feedstock.
Memo: Biogasoline	BIOGASOL	Biogasoline includes bioethanol (ethanol produced from biomass and/or the biodegradable fraction of waste), biomethanol (methanol produced from biomass and/or the biodegradable fraction of waste), bioETBE (ethyl-tertio-butyl-ether produced on the basis of bioethanol; the percentage by volume of bioETBE that is calculated as biofuel is 47%) and bioMTBE (methyl-tertio-butyl-ether produced on the basis of biomethanol: the percentage by volume of bioMTBE that is calculated as biofuel is 36%). Biogasoline includes the amounts that are blended into the gasoline - it does not include the total volume of gasoline into which the biogasoline is blended.
Memo: Biodiesels	BIODIESEL	Biodiesels includes biodiesel (a methyl-ester produced from vegetable or animal oil, of diesel quality), biodimethylether (dimethylether produced from biomass), Fischer Tropsch (Fischer Tropsch produced from biomass), cold pressed bio-oil (oil produced from oil seed through mechanical processing only) and all other liquid biofuels which are added to, blended with or used straight as transport diesel. Biodiesels includes the amounts that are blended into the diesel - it does not include the total volume of diesel into which the biodiesel is blended.
Memo: Other liquid biofuels	OBIOLIQ	Other liquid biofuels includes liquid biofuels not reported in either biogasoline or biodiesels.
Memo: Non-specified primary biofuels & waste	RENEWNS	This item is used when the detailed breakdown for primary biofuels and waste is not available.

Memo: Charcoal	CHARCOAL	It covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.

Geographical coverage and country notes

Countries and regions

This document is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area. In this publication, 'country' refers to country or territory, as case may be. Data start in 1960 for OECD countries and regions, and in 1971 for non-OECD countries and regions, unless otherwise specified.

Country/Region	Short name	Definition
World	WORLD	Includes OECD Total; Africa; non-OECD Asia (excluding China); China (P.R. of China and Hong Kong, China); Non-OECD Americas; Middle East; Non-OECD Europe and Eurasia; World aviation bunkers and World marine bunkers. It is also the sum of Africa (UN), Americas (UN), Asia (UN), Europe (UN), Oceania (UN), World aviation bunkers and World marine bunkers. Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting in 1751*.
Memo: OECD Total	OECDTOT	Includes Australia; Austria; Belgium; Canada; Chile; Colombia; Costa Rica; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Korea; Latvia; Lithuania; Luxembourg; Mexico; the Netherlands; New Zealand; Norway; Poland; Portugal; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; the Republic of Türkiye; the United Kingdom and the United States.[2] Estonia, Latvia, Lithuania and Slovenia are included starting in 1990. Prior to 1990, data for Estonia, Latvia and Lithuania are included in Former Soviet Union and data for Slovenia in Former Yugoslavia. Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting in 1751*.
OECD Americas	OECDAM	Includes Canada; Chile; Colombia; Costa Rica; Mexico and the United States.
OECD Asia Oceania	OECDAO	Includes Australia; Israel[3]; Japan; Korea and New Zealand.

[3]. 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.

Country/Region	Short name	Definition
OECD Europe	OECDEUR	Includes Austria; Belgium; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Lithuania; Luxembourg; the Netherlands; Norway; Poland; Portugal; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; the Republic of Türkiye and the United Kingdom. Estonia, Latvia, Lithuania and Slovenia are included starting in 1990. Prior to 1990, data for Estonia, Latvia and Lithuania are included in Former Soviet Union and data for Slovenia in Former Yugoslavia.
Africa	AFRICA	Includes Algeria, Angola, Benin, Botswana, Cameroon, Republic of Congo (Congo)[4], Côte d'Ivoire, Democratic Republic of Congo (from 1981), Egypt, Equatorial Guinea, Eritrea, the Kingdom of Eswatini; Ethiopia, Gabon, Ghana, Kenya, Libya, Madagascar, Mauritius, Morocco, Mozambique, Namibia (from 1991), Niger, Nigeria, Rwanda; Senegal, South Africa, South Sudan (from 2012), Sudan, United Republic of Tanzania, Uganda; Togo, Tunisia, Zambia, Zimbabwe and **Other Africa**. Note that Africa is identical to Memo: Africa (UN). Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting in 1751*.
Non-OECD Americas	LATAMER	Includes Argentina; Plurinational State of Bolivia (Bolivia); Brazil; Colombia[5]; Costa Rica; Cuba; Curaçao [6]; Dominican Republic; Ecuador; El Salvador; Guatemala; Guyana; Haiti; Honduras; Jamaica; Nicaragua; Panama; Paraguay; Peru; Suriname (from 2000); Trinidad and Tobago; Uruguay; Bolivarian Republic of Venezuela (Venezuela) and **Other non-OECD Americas**. Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting in 1751*.
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. Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting in 1751*.

[4]. Country short names are included in parentheses.

[5]..

[6]. Netherlands Antilles was dissolved on 10 October 2010, resulting in two new constituent countries, Curaçao and Sint Maarten, with the remaining islands joining the Netherlands as special municipalities. From 2012 onwards, data now account for the energy statistics of Curaçao Island only. Prior to 2012, data remain unchanged and still cover the entire territory of the former Netherlands Antilles.

Country/Region	Short name	Definition
Non-OECD Europe and Eurasia	EURASIA	Includes Albania; Armenia; Azerbaijan; Belarus; Bosnia and Herzegovina; Bulgaria; Croatia; Cyprus[7]; Georgia; Gibraltar; Kazakhstan; Kosovo[8]; Kyrgyzstan; Malta; Republic of Moldova (Moldova); Montenegro; the Republic of North Macedonia (North Macedonia); Romania; Russian Federation; Serbia[9]; Tajikistan; Turkmenistan; Ukraine; Uzbekistan; Former Soviet Union (prior to 1990) and Former Yugoslavia (prior to 1990). Prior to 1990, data for Estonia, Latvia and Lithuania are included in Former Soviet Union and data for Slovenia in Former Yugoslavia. Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting in 1751*.
Non-OECD Asia (excluding China)	ASIA	Includes Bangladesh, Brunei Darussalam, Cambodia (from 1995), DPR of Korea, India, Indonesia, Lao People's Democratic Republic (from 2000); Malaysia, Mongolia (from 1985), Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Chinese Taipei, Thailand, Viet Nam and **Other non-OECD Asia**. Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting 1751*.
China (including Hong Kong, China)	CHINAREG	Includes the People's Republic of China and Hong Kong, China. Pre-1971 values have been estimated in accordance with the methodology described in the section *Estimates for years starting in 1751*.
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	Argentina is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Armenia	ARMENIA	Data for Armenia are available starting in 1990. Prior to that, they are included in Former Soviet Union.

[7]. Note by **the Republic of Türkiye (Türkiye)**:
The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. *Türkiye* recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, *Türkiye* 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 *Türkiye*. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.
[8]. This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo's declaration of independence.
[9]. Serbia includes Montenegro until 2004 and Kosovo until 1999.

Country/Region	Short name	Definition
Australia	AUSTRALI	Excludes the overseas territories. Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y-1 and ends on 30 June Y are labelled as year Y.
Austria	AUSTRIA	
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 are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y-1 and ends on 30 June Y are labelled as year Y.
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.
Botswana	BOTSWANA	
Brazil	BRAZIL	Brazil is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
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 non-OECD Asia.
Cameroon	CAMEROON	
Canada	CANADA	
Chile	CHILE	Data start in 1971. Chile is currently seeking accession to full IEA membership (Accession country), therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
People's Republic of China	CHINA	People's Republic of China is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Colombia	COLOMBIA	Colombia is currently seeking accession to full IEA membership

Country/Region	Short name	Definition
		(Accession country), therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Congo	CONGO	
Costa Rica	COSTARICA	Costa Rica joined the OECD in May 2021; data are now included in the applicable OECD aggregates.
Côte d'Ivoire	COTEIVOIRE	
Croatia	CROATIA	Data for Croatia are available starting in 1990. Prior to that, they are included in Former Yugoslavia.
Cuba	CUBA	
Curaçao	CURACAO	The Netherlands Antilles was dissolved on 10 October 2010, resulting in two new constituent countries, Curaçao and Sint Maarten, with the remaining islands joining the Netherlands as special municipalities. From 2012 onwards, data now account for the energy statistics of Curaçao Island only. Prior to 2012, data remain unchanged and still cover the entire territory of the former Netherlands Antilles.
Cyprus	CYPRUS	**Note by the Republic of Türkiye (Türkiye):** 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. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye 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 Türkiye. 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	Data start in 1971.
Democratic People's Republic of Korea	KOREADPR	
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.
Dominican Republic	DOMINICANR	

Country/Region	Short name	Definition
Ecuador	ECUADOR	
Egypt	EGYPT	Data for Egypt are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y. Egypt is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
El Salvador	ELSALVADOR	
Equatorial Guinea	EQGUINEA	Data start in 1981.
Eritrea	ERITREA	Data for Eritrea are available from 1992. Prior to that, they are included in Ethiopia.
Estonia	ESTONIA	Data start in 1990. Prior to that, they are included within Former Soviet Union.
Kingdom of Eswatini	ESWATINI	
Ethiopia	ETHIOPIA	Data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
Finland	FINLAND	
France	FRANCE	Includes Monaco and excludes the overseas collectivities: New Caledonia; French Polynesia; Saint Barthélemy; Saint Martin; Saint Pierre and Miquelon; and Wallis and Futuna. Energy data for the following overseas departments: Guadeloupe; French Guiana; Martinique; Mayotte; and Réunion are included for the years from 2011 onwards, and excluded for earlier years.
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.
Ghana	GHANA	
Gibraltar	GIBRALTAR	
Greece	GREECE	
Guatemala	GUATEMALA	
Guyana	GUYANA	
Haiti	HAITI	
Honduras	HONDURAS	
Hong Kong, China	HONGKONG	

Country/Region	Short name	Definition
Hungary	HUNGARY	Data start in 1965. 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 year basis. By convention, data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y. This convention is different from the one used by Government of India, whereby fiscal year starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y+1. India is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Indonesia	INDONESIA	Indonesia is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Islamic Republic of Iran	IRAN	Data are reported on the Iranian fiscal year basis. Data for the fiscal year that starts on 20 March Y and ends on 19 March Y+1 are labelled as year Y.
Iraq	IRAQ	
Ireland	IRELAND	
Israel	ISRAEL	Data start in 1971. 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. Data start in 1971. Israel is currently seeking accession to full IEA membership (Accession country), therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Italy	ITALY	Includes San Marino and the Holy See.
Jamaica	JAMAICA	
Japan	JAPAN	Includes Okinawa. Starting 1990, data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y.
Jordan	JORDAN	
Kazakhstan	KAZAKHSTAN	Data for Kazakhstan are available starting in 1990. Prior to that they are included in Former Soviet Union.
Kenya	KENYA	
Korea	KOREA	Data start in 1971.

Country/Region	Short name	Definition
Kosovo	KOSOVO	This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo's declaration of independence. 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.
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.
Lao People's Democratic Republic	LAO	Data start in 2000. Prior to that, they are included in the Other non-OECD Asia region.
Lebanon	LEBANON	
Libya	LIBYA	
Lithuania	LITHUANIA	Lithuania joined the IEA in February 2022; however, its data have not been included in the IEA member countries aggregate (IEA total) for this edition. They are included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1990 and for the entire time series. Data for Lithuania are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Luxembourg	LUXEMBOU	
Madagascar	MADAGASCAR	
Malaysia	MALAYSIA	
Malta	MALTA	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	
Mexico	MEXICO	Data start in 1971.
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.
Montenegro	MONTENEGRO	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.
Morocco	MOROCCO	Morocco is an IEA Association country, therefore it is included

Country/Region	Short name	Definition
		in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Mozambique	MOZAMBIQUE	
Myanmar	MYANMAR	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y
Namibia	NAMIBIA	Electricity data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 31 June Y+1 are labelled as year Y. Data for Namibia are available starting in 1991. Prior to that, they are included in Other Africa.
Nepal	NEPAL	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
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	
Nigeria	NIGERIA	
Republic of North Macedonia	NORTHMACED	Data for the Republic of North Macedonia (North Macedonia) are available starting in 1990. Prior to that, they are included in Former Yugoslavia.
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	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
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.

Country/Region	Short name	Definition
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.
Russian Federation	RUSSIA	Data for Russian Federation are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Rwanda	RWANDA	
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.
Singapore	SINGAPORE	Due to Singapore 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. Singapore is currently an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Slovak Republic	SLOVAKIA	Data start in 1971.
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.
South Africa	SOUTHAFRIC	Nuclear data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y. 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 Africa is currently an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
South Sudan	SSUDAN	Data for South Sudan are available starting in 2012. Prior to that, they are included in Sudan.
Spain	SPAIN	Includes the Canary Islands.

Country/Region	Short name	Definition
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.
Suriname	SURINAME	Data for Suriname are available from 2000. Prior to 2000, data for Suriname are presented in Other non-OECD Americas.
Sweden	SWEDEN	
Switzerland	SWITLAND	Includes Liechtenstein for the oil data. Data for other fuels do not include Liechtenstein.
Chinese Taipei	TAIPEI	
Tajikistan	TAJIKISTAN	Data for Tajikistan are available starting in 1990. Prior to that, they are included in Former Soviet Union.
United Republic of Tanzania	TANZANIA	Oil data are reported on a fiscal year basis, beginning on the 1 July Y and ending on the 30 June Y+1.
Thailand	THAILAND	Thailand is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Togo	TOGO	
Trinidad and Tobago	TRINIDAD	
Tunisia	TUNISIA	
Republic of Türkiye	TURKEY	
Turkmenistan	TURKMENIST	Data for Turkmenistan are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Uganda	UGANDA	
Ukraine	UKRAINE	Data for Ukraine are available starting in 1990. Prior to that, they are included in Former Soviet Union. Ukraine is currently an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1990 and for the entire time series.
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. As of the 1st of February 2020, the United Kingdom (UK) is no longer part of the European Union (EU) and was into a transition period until 31 December 2020. The UK is excluded from the EU27 2020 aggregate, but still

Country/Region	Short name	Definition
		included in the EU28 aggregate for reference.
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[10] and the United States Virgin Islands; trade statistics for coal include international trade to and from Puerto Rico and the United States Virgin Islands. Starting with 2017 data, inputs to and outputs from electricity and heat generation include Puerto Rico.
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	
Yemen	YEMEN	
Zambia	ZAMBIA	
Zimbabwe	ZIMBABWE	
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; Kosovo; Montenegro; Republic of North Macedonia (North Macedonia); Slovenia and Serbia.
Other Africa	OTHERAFRIC	Includes Burkina Faso; Burundi; Cape Verde; Central African Republic; Chad; Comoros; Djibouti; Gambia; Guinea; Guinea-Bissau; Lesotho; Liberia; Malawi; Mali; Mauritania; Namibia (until 1990); Réunion (until 2010); Sao Tome and Principe; Seychelles; Sierra Leone and Somalia.
Other non-OECD Americas	OTHERLATIN	Includes Anguilla, Antigua and Barbuda; Aruba; the Bahamas; Barbados; Belize; Bermuda; Bonaire (from 2012); the British Virgin Islands; the Cayman Islands; Dominica; the Falkland Islands (Malvinas); French Guiana (until 2010); Grenada; Guadeloupe (until 2010); Martinique (until 2010); Montserrat; Puerto Rico (for natural gas and – up to 2016 data - electricity)11; Saba (from 2012); Saint Eustatius (from 2012); Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Sint Maarten (from 2012); Suriname (until 1999); the Turks and Caicos Islands.

[10]. Inputs to and outputs from electricity and heat generation up to 2016, and natural gas data for the entire time series for Puerto Rico are included under Other non-OECD Americas.

Country/Region	Short name	Definition
Other non-OECD Asia	OTHERASIA	Includes Afghanistan; Bhutan; Cambodia (until 1994); Cook Islands; Fiji; French Polynesia; Kiribati; Lao People's Democratic Republic (until 1999); Macau, China; Maldives; Mongolia (until 1984); New Caledonia; Palau (from 1994); Papua New Guinea; Samoa; Solomon Islands; Timor Leste; Tonga and Vanuatu.
Memo: ASEAN	MASEAN	Data start in 2000. Includes: Brunei; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; and Viet Nam.
Memo: Africa (UN)	UNAFRICA	Includes Algeria; Angola; Benin; Botswana; Burkina Faso; Burundi; Cabo Verde; Cameroon; Central African Republic; Chad; Comoros; the Republic of the Congo (Congo); Côte d'Ivoire; the Democratic Republic of the Congo; Djibouti; Egypt; Equatorial Guinea; Eritrea; the Kingdom of Eswatini; Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Libya; Madagascar; Malawi; Mali; Mauritania; Mauritius; Morocco; Mozambique; Namibia; Niger; Nigeria; Réunion (until 2010); Rwanda; Sao Tome and Principe; Senegal; the Seychelles; Sierra Leone; Somalia; South Africa; South Sudan (from 2012), Sudan; the United Republic of Tanzania (Tanzania); Togo; Tunisia; Uganda; Zambia; Zimbabwe. Note that Memo: Africa (UN) is identical to Africa.
Memo: Americas (UN)	UNAMERICAS	Includes Antigua and Barbuda; Argentina; Aruba; the Bahamas; Barbados; Belize; Bermuda; the Plurinational State of Bolivia (Bolivia); Bonaire (from 2012); the British Virgin Islands; Brazil; Canada; the Cayman Islands; Chile; Colombia; Costa Rica; Cuba; Curaçao[11]; Dominica; the Dominican Republic; Ecuador; El Salvador; the Falkland Islands (Malvinas); Guatemala; French Guiana (until 2010); Grenada; Guadeloupe (until 2010); Guyana; Haiti; Honduras; Jamaica; Martinique (until 2010); Mexico; Montserrat; Nicaragua; Panama; Paraguay; Peru; Puerto Rico (for natural gas) [12]; Saba (from 2012); Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Sint Eustatius (from 2012); Sint Maarten (from 2012); Suriname; Trinidad and Tobago; the Turks and Caicos Islands; the United States; Uruguay; the Bolivarian Republic of Venezuela (Venezuela).
Memo: Asia (UN)	UNASIATOT	Data for Asia (UN) are available from 1990. Includes Afghanistan; Armenia; Azerbaijan; Bahrain; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; the People's Republic of China; Cyprus[13]; Georgia; Hong Kong,

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

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

[13]. Refer to the country note for Cyprus earlier in this section.

Country/Region	Short name	Definition
		China; India; Indonesia; the Islamic Republic of Iran; Iraq; Israel[14]; Japan; Jordan; the Democratic People's Republic of Korea; Korea; Kazakhstan; Kuwait; Kyrgyzstan; Lao People's Democratic Republic; Lebanon; Macau, China; Malaysia; the Maldives; Mongolia; Myanmar; Nepal; Oman; Pakistan; the Philippines; Qatar; Saudi Arabia; Singapore; Sri Lanka; the Syrian Arab Republic; Tajikistan; Chinese Taipei; Thailand; Timor-Leste; the Republic of Türkiye; Turkmenistan; the United Arab Emirates; Uzbekistan; Viet Nam; and Yemen. Pre-1990 values have been estimated in accordance with the methodology described in *Estimates for years starting 1751*.
Memo: Europe (UN)	UNEUROPE	Data for Europe (UN) are available from 1990. Includes Albania; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; the Czech Republic; Denmark; Estonia; Finland; the Republic of North Macedonia (North Macedonia); France; Germany; Gibraltar; Greece; Hungary; Iceland; Ireland; Italy; Kosovo[15]; Latvia; Lithuania; Luxembourg; Malta; the Republic of Moldova (Moldova); Montenegro; the Netherlands; Norway; Poland; Portugal; Romania; the Russian Federation; Serbia[16]; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Ukraine; the United Kingdom. Pre-1990 values have been estimated in accordance with the methodology described in *Estimates for years starting 1751*.
Memo: Oceania (UN)	UNOCEANIA	Includes Australia; New Zealand; Cook Islands; Fiji; French Polynesia; Kiribati; New Caledonia; Palau; Papua New Guinea; Samoa; the Solomon Islands; Tonga; Vanuatu. Pre-1971 values have been estimated in accordance with the methodology described in *Estimates for years starting 1751*.
Memo: non-OECD total	NOECDTOT	Includes Africa; Non OECD 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; Mexico[17]; the Netherlands; New Zealand; Norway; Poland; Portugal; the Slovak Republic; Spain; Sweden; Switzerland; the Republic of Türkiye; 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. Lithuania joined the IEA in February 2022; however, its data have not been included in this aggregate for this edition.
Memo: IEA and Accession/Association countries	IEAFAMILY	Includes: IEA member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan,

[14]. 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.
[15]. This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo's declaration of independence.
[16]. Serbia includes Montenegro until 2004 and Kosovo until 1999.
[17]. Mexico became the 30th IEA Member country in February 2018. Accordingly, starting with the 2018 preliminary edition, Mexico now appears in the list of IEA Members and is included in the IEA zone aggregate for the entire time series.

Country/Region	Short name	Definition
		Korea, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, the Republic of Türkiye, the United Kingdom and the United States; Accession countries: Chile, Colombia and Israel; Association countries: Argentina; Brazil; the People's Republic of China; Egypt; India; Indonesia; Morocco; Singapore; South Africa; Thailand and Ukraine. Pre-1971 values have been estimated in accordance with the methodology described in *Estimates for years starting 1751*.
Memo: European Union - 27	EU27	Includes Austria, Belgium, Bulgaria, Croatia, Cyprus[18], 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, and Sweden. 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: European Union – 28	EU28	Refers to the EU27 with the addition of the United Kingdom[19]. Includes Austria; Belgium; Bulgaria; Croatia; Cyprus; 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 Republic of North Macedonia (North Macedonia); Kosovo; Montenegro; Slovenia and Serbia
Memo: Former Soviet Union	MFSU15	Includes the Former Soviet Union with all 15 countries for all years.
Memo: OPEC	OPEC	Includes Algeria; Angola; Republic of the Congo; Equatorial Guinea; Gabon; the Islamic Republic of Iran; Iraq; Kuwait; Libya; Nigeria; Saudi Arabia; the United Arab Emirates; the Bolivarian Republic of Venezuela (Venezuela).
Memo: G7	MG7	Includes Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. Pre-1960 values have been estimated in accordance with the methodology described in *Estimates for years starting 1751*
Memo: G8	MG8	Includes Canada, France, Germany, Italy, Japan, Russian Federation, the United Kingdom and the United States.
Memo: G20	MG20	Includes Argentina, Australia, Brazil, Canada, China (including Hong Kong, China), India, Indonesia, Japan, Korea, Mexico, Russian Federation, Saudi Arabia, South Africa, the Republic of Türkiye, the United States and the European Union – 28.

[18]. Refer to the country note for Cyprus earlier in this section.
[19]. As of the 1st of February 2020, the United Kingdom (UK) is no longer part of the European Union (EU) and has entered into a transition period until 31 December 2020.

Country/Region	Short name	Definition
Memo: Annex I Parties	ANNEX1	Includes Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Cyprus[20], the Czech Republic[21,22], Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein (not available in this publication)[23], Lithuania, Luxembourg, Malta, Monaco (included with France), the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, the Slovak Republic[24], Slovenia, Spain, Sweden, Switzerland, the Republic of Türkiye, Ukraine, the United Kingdom and the United States.[25] *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 (Decision 10/CP.17, effective from 9 January 2013)*. Pre-1990 values have been estimated in accordance with the methodology described in *Estimates for years starting 1751*.
Memo: Annex II Parties	ANNEX2	Includes Australia, Austria, Belgium, Canada, Denmark, Finland, France[26], Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland[27], the United Kingdom and the United States. *According to Decision 26/CP.7 in document FCCC/CP/2001/13/Add.4,* , the Republic of Türkiye *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, Luxembourg, 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	ANNEX1EIT	Annex I: Economies in Transition (EITs) are those countries in

[20]. Refer to the country note for Cyprus earlier in this section.
[21]. Czechia in official UN documents.
[22]. Czechoslovakia was in the original list of Annex I countries.
[23]. Oil data for Liechtenstein are included under Switzerland.
[24]. Slovakia in official UN documents.
[25]. 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.
[26]. In IEA data, France also includes Monaco, which is not in the list of Annex II Parties.
[27]. In IEA data, Switzerland includes Oil data for Liechtenstein, which is not in the list of Annex II Parties.

Country/Region	Short name	Definition
Economies in Transition		Annex I that are undergoing the process of transition to a market economy. This includes Belarus, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russian Federation, the Slovak Republic, Slovenia and Ukraine.
Memo: Non-Annex I Parties	NONANNEX1	
Memo: Annex B Kyoto Parties	ANNEXB	Includes Australia, Austria, Belgium, Belarus, Bulgaria, Croatia, Cyprus[28], the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Liechtenstein (not available in this publication), Lithuania, Luxembourg, Malta, Monaco (included with France), the Netherlands, Norway, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom.[29] *Refers to countries with emission targets under the 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,* , the Republic of Türkiye *and the United States (all Annex I member states), but includes Kazakhstan (a non-Annex I Party under the Convention, but an Annex I Party under the Kyoto Protocol (as per decision 9/CMP.8).*

Please note that the following countries have not been considered:

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

Supplementary countries

[28]. Refer to the country note for Cyprus earlier in this section.

[29]. 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.

With the objective to increase the geographical coverage of the statistical information provided, the IEA has estimated the total and sectoral emissions for fifty supplementary countries[30] not covered explicitly in the *IEA World energy balances*, based on more aggregated[31] energy data from the United Nations Statistics Division (UNSD) *2019 Energy Balances* publication. For these set of countries, emissions estimates are available starting with 1990.

As for the other countries covered in the database, such estimations are based on a Tier 1 methodology of the *2006 IPCC Guidelines for National Greenhouse Gas Inventories,* using weighted average emission factors for the aggregated product categories of the energy data which reflect for each country the mix of the relevant region in the IEA *World energy balances* database (Other non-OECD America, Other Africa or Other non-OECD Asia).

This document is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area. In this publication, 'country' refers to country or territory, as case may be. Data start in 1990 for this set of countries unless otherwise specified.

Country/Region	Short name	Definition
Memo*: Afghanistan	MAFGHANIST	
Memo*: Anguilla	MANGUILLA	
Memo*: Antigua and Barbuda	MANTIGUABA	
Memo*: Aruba	MARUBA	
Memo*: Bahamas	MBAHAMAS	
Memo*: Barbados	MBARBADOS	
Memo*: Belize	MBELIZE	
Memo*: Bhutan	MBHUTAN	
Memo*: Burkina Faso	MBURKINAFA	
Memo*: Burundi	MBURUNDI	
Memo*: Cabo Verde	MCABOVERDE	
Memo*: Central African Republic	MCENTRAFRI	

[30]. Please consider that the data for such countries (based on UNSD energy data), may not add up to the respective regional totals based on IEA energy data (Other Africa, Other non-OECD America and Other non-OECD Asia), as they are independently treated.

[31]. Such data are available for the following list of aggregated product categories (primary coal, secondary coal, oil products and crude/NGL/feedstocks). Note that the flow 'Fishing' is not available in the UNSD energy data and is included as part of an aggregated flow with 'Agriculture/forestry'.

Country/Region	Short name	Definition
Memo*: Chad	MCHAD	
Memo*: Comoros	MCOMOROS	
Memo*: Cook Islands	MCOOKISLA	
Memo*: Djibouti	MDJIBOUTI	
Memo*: Dominica	MDOMINICA	
Memo*: Fiji	MFIJI	
Memo*: Gambia	MGAMBIA	
Memo*: Grenada	MGRENADA	
Memo*: Guinea	MGUINEA	
Memo*: Guinea-Bissau	MGUINEABIS	
Memo*: Kiribati	MKIRIBATI	
Memo*: Lesotho	MLESOTHO	
Memo*: Liberia	MLIBERIA	
Memo*: Malawi	MMALAWI	
Memo*: Maldives	MMALDIVES	
Memo*: Mali	MMALI	
Memo*: Marshall Islands	MMARSHALL	
Memo*: Mauritania	MMAURITANI	
Memo*: Micronesia (Federated States of)	MMICRONES	
Memo*: Nauru	MNAURU	
Memo*: Niue	MNIUE	
Memo*: Palau	MPALAU	
Memo*: Palestinian Authority	MPALESTINE	
Memo*: Papua New Guinea	MPAPUANG	
Memo*: Puerto Rico	MPUERTORIC	
Memo*: Saint Kitts and Nevis	MSTKITTSNE	
Memo*: Saint Lucia	MSTLUCIA	
Memo*: Saint Vincent and the Grenadines	MSTVINCENT	

Country/Region	Short name	Definition
Memo*: Samoa	MSAMOA	
Memo*: Sao Tome and Principe	MSAOTOME	
Memo*: Seychelles	MSEYCHELLE	
Memo*: Sierra Leone	MSIERRALEO	
Memo*: Solomon Islands	MSOLOMONIS	
Memo*: Somalia	MSOMALIA	
Memo*: Timor-Leste	MTIMORLES	
Memo*: Tonga	MTONGA	
Memo*: Tuvalu	MTUVALU	
Memo*: Vanuatu	MVANUATU	

Fiscal year

This table lists the countries for which data are reported on a fiscal year basis. More information on beginning and end of fiscal years by country is reported in the column 'Definition'.

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Country/Region	Short name	Definition
Australia	AUSTRALI	Data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 July Y-1 and ends on 30 June Y are labelled as year Y.
Bangladesh	BANGLADESH	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y-1 and ends on 30 June Y are labelled as year Y.
Egypt	EGYPT	Data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
Ethiopia	ETHIOPIA	Data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
India	INDIA	Data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y. This convention is different from the one used by Government of India, whereby fiscal year starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y+1.
Islamic Republic of Iran	IRAN	Data are reported according to the Iranian calendar year. By convention data for the year that starts on 20 March Y and ends on 19 March Y+1 are labelled as year Y.
Japan	JAPAN	Starting 1990, data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y.
Myanmar	MYANMAR	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y.
Namibia	NAMIBIA	Electricity data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 31 June Y+1 are labelled as year Y.
Nepal	NEPAL	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
Pakistan	PAKISTAN	Data are reported on a fiscal year basis. By convention fiscal year Y/Y+1 is labelled as year Y.

South Africa	SOUTHAFRIC	Nuclear data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y.
United Republic of Tanzania	TANZANIA	Oil data are reported on a fiscal year basis, beginning on the 1 July Y and ending on the 30 June Y+1.

Understanding the IEA estimates of CO_2 emissions from fuel combustion

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 over 80%[32] of total GHG emissions, while for the world the share is around three quarters, 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[33] and the default methods and emission factors from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (*2006 GLs*)[34].

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 section *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.

[32]. Based on data reported to the UNFCCC, excluding land-use, land-use change and forestry (LULUCF).
[33]. Published in World Energy Statistics and World Energy Balances, IEA, Paris.
[34]. See: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html.

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 section *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 section *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 presented online and in the overview for drivers refer to the decomposition of CO_2 emissions into four driving factors (Kaya identity)[35], which is generally presented in the form:

Kaya identity

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

where:

C = CO_2 emissions;

P = population;

[35]. 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.

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. $(P_y-P_x)/P_x$, will not generally add up to the percentage change of CO_2 emissions $(C_y-C_x)/C_x$. 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

$$C_y/C_x = P_y/P_x\ (G/P)_y/(G/P)_x\ (E/G)_y/(E/G)_x\ (C/E)_y/(C/E)_x$$

where x and y represent for example two different years.

In this publication, the Kaya decomposition is presented as:

CO_2 emissions and drivers

$$CO_2 = P\ (GDP/P)\ (TES/GDP)\ (CO_2/TES)$$

where:

CO_2 = CO_2 emissions;

P = population;

GDP[36]/P = GDP/population;

TES/GDP[36] = Total energy supply per GDP;

CO_2/TES = CO_2 emissions per unit TES.

Indices of all terms (2000 = 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

[36]. GDP based on purchasing power parities (PPP).

drivers). Note that in its index form, CO_2/TES corresponds to the Energy Sector Carbon Intensity Index (ESCII)[37].

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.

Drivers of electricity generation emissions trends

Graphs present also the change in CO_2 emissions from electricity generation over time decomposed into the respective changes of four driving factors[38]:

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:

[37]. See the IEA publication Tracking Clean Energy Progress 2015.
[38]. 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.

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)[39] has been used.

Using this method, the change in total CO_2 emissions from electricity generation (ΔC) 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:

$$\Delta C = \Delta CF + \Delta EI + \Delta EFS + \Delta EL$$

where:

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

[39]. B. W. Ang, Decomposition analysis for policymaking in energy: which is the preferred method?, Energy Policy, 32 (9) (2004), pp. 1131–1139.

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

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

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

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.

Allocating indirect emissions

Indirect emissions are emissions deriving from the generation of electricity and heat which then are consumed by end use sectors. IEA includes all the emissions related to electricity and heat production into the transformation sector. In order to reallocate emissions of the transformation to end-use sectors the IEA has developed an internal methodology making use of the available data, which consisted in allocating emissions based on the total amount of electricity and heat consumed by each end use sector.

Starting with the 2020 edition, the IEA has adopted a new methodology which relies on multiplying electricity and heat consumption by electricity and heat specific emission factors. The new approach resolves some drawbacks existing in the previous methodology. In particular this new methodology allows assigning different emission factors to electricity and heat.

Specific emission factors are calculated by dividing the carbon dioxide emissions produced by the generation of electricity or heat by the electricity or heat consumed across all sectors, excluding transmission and distribution losses:

$$EF_{o,c,t} = \frac{\sum_{f,p}(I_{o,c,t,f,p} \cdot CC_{f})}{\left(\sum_{i} E_{i,o,c,t}\right)}$$

where:

EF = emission factor per unit of electricity or heat consumed, expressed in gCO_2/kWh

I: energy inputs to generate electricity or heat. Note that the IEA energy balances include only the data for combined input to CHP plants. Thus, the IEA adopts the fixed-heat-efficiency approach, which is based on 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. Please refer to the documentation file of the IEA *'Emission factors 2020 edition'*, section 4 for more details.

CC: default carbon content in tons of CO_2 per unit of energy (please refer to section 'CO_2 emissions from fuel combustion: key concepts' for more details)

E: electricity and heat used by end use sector *i* across final consumption and energy producing sectors

o: electricity or heat

i: end use sector, e.g. industry, transport, residential…

c: country

t: time

f: fuel type

Then, the indirect emissions are calculated as:

$$IE_{i,c,t} = \sum_{o} EF_{o,c,t} \cdot E_{i,o,c,t}$$

where:

E: electricity and heat used by, country *c,* year *t* and end use sector *I across* final consumption and energy producing sectors

And the total emissions are calculated as:

$$TE_{i,c,t} = DE_{i,c,t} + IE_{i,c,t}$$

Provisional year estimates

With the objective of increasing the timeliness of IEA greenhouse gas emission estimates, the IEA publishes provisional year estimates for total emissions from fuel combustion and emissions from electricity and heat production, based on a simplified methodology relying on provisional data for supply, as demand side data is not generally available for the most recent year.

Values are calculated based on provisional data for total energy supply (TES) by fuel category, and on their average carbon intensities for the latest two years, according to the following equation:

Provisional year GHG emissions from fuel combustion

$$GHG_y = \sum_i \left[\left(\frac{GHG_{y-1,i}}{TES_{y-1,i}} \right) + \left(\frac{GHG_{y-2,i}}{TES_{y-2,i}} \right) \right] / 2 \cdot TES_{y,i}$$

Where:

y: Provisional year

i: fuel category: coal, oil, natural gas, other (industrial waste + non-renewable municipal waste)

GHG_{y-1} *and* GHG_{y-2} : Previous years emissions from fuel combustion, calculated according to the 2006 GLs (sectoral approach).

For electricity and heat emissions, the data for the year Y includes for selected countries the breakdown of electricity generation by fuel type, but not the associated fuel inputs. The assumption used is that generation efficiency is constant compared to the year Y-1, as in the following equation:

Provisional year electricity and heat production emissions

$$ELECHEAT_{i,y} = (ELOUTPUT_{i,y} + HEATOUT_{i,y}) \times \mathbf{CO_2kWh}_{i,y-1}$$

Where:

CO2kWh*:* Carbon emission factors (in CO2/kWh) for electricity and heat combined, for y-1***;***

ELOUTPUT + HEATOUT*:* total electricity plus heat output (GWh);

i: fuel type, e.g. anthracite, diesel, natural gas.

The table below summarises the countries for which provisional year estimates have been published in the 2021 edition, by flow:

Table 5. Geographical coverage for the provisional year

Flow	Countries
GHG Emissions from fuel combustion	OECD countries, Morocco, Albania, Argentina, Armenia, Azerbaijan, Bulgaria, Brazil, Croatia, Bosnia and Herzegovina, Cyprus, Georgia, Kosovo, Malta, Republic of Moldova, Republic of North Macedonia, Romania, Russian Federation, Serbia, Ukraine.
Electricity and heat production emissions	OECD countries, Morocco, Albania, Argentina, Armenia, Azerbaijan, Bulgaria, Brazil, Croatia, Bosnia and Herzegovina, Cyprus, Georgia, Kosovo, Malta, Republic of Moldova, Republic of North Macedonia, Romania, Russian Federation, Serbia.

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.[40]

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;

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

- 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.

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

Fuel Type	*1996 Guidelines*	*2006 Guidelines***	Percent Change
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	18.9	19.1	+1.1%
Gasoline type jet fuel	18.9	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	20.0	20.0	0.0%
White Spirit & SBP	20.0	20.0	0.0%
Paraffin Waxes	20.0	20.0	0.0%

Fuel Type	*1996 Guidelines*	*2006 Guidelines***	Percent Change
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*.[41]

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 2014 data (from the 2016 edition). Emissions are calculated using: i) the *1996 GLs* Sectoral Approach, methodology as in previous publications, and ii) the *2006 GLs*[42] - which correspond to the data published in this edition.

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 2014, reductions of 1% or greater are observed for sixty-five countries, with thirteen 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%), Gibraltar (-17%), Lithuania (-14%), and Singapore (-13%), the Netherlands, Belarus and Brunei Darussalam (all 11%). 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

[41]. 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.
[42]. Including the emissions which may be reallocated from Energy to IPPU under the *2006 GLs*.

countries. One country, Curaçao presented a large increase (27%) in 2014. 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/TES, 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 data, 2016 edition)

$MtCO_2$

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[41]	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%

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[41]	Percent Change
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%
, the Republic of Türkiye	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*[41]	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 [43]	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%

[43]. Please refer to the section Geographical coverage and country notes.

Non-OECD Europe and Eurasia	**2516.4**	**2446.1**	**-2.8%**

Table 4. Comparison of IEA CO_2 emissions estimates for Non-OECD Countries (2014 data, 2016 edition)

$MtCO_2$

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[41]	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.	10.4	10.4	0.0%

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[41]	Percent Change
of Tanzania			
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[41]*	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%
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%

Country	*1996 GLs CO_2 Sectoral Approach*	*2006 GLs CO_2 Fuel Combustion*[41]	Percent Change
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%**

Estimates for years starting in 1751

Because of historical reasons, mostly related to the creation of the OECD, the time series of IEA energy balances, basis for the IEA emissions calculation, cover the years as far back as 1960/1971, depending on the country. With the objective of providing users with time series going as far back in time as possible, the IEA has also included global and regional estimates for the period pre-1960/1971, based on complementary sources for energy and emissions data.

The new time series have been estimated based on, and ensuring consistency with, data from the Carbon Dioxide Information Analysis Center (CDIAC) and the Appalachian State University, that provide emissions estimates for a large timespan, from 1751 until recent years[44]. Such datasets include CO_2 emissions from fuel combustion for all countries, as well as emissions from gas flaring and cement production.

Further to differences in underlying energy data, differences between IEA and CDIAC methodologies to calculate emissions, include but are not limited to:

- IEA estimates emissions based on energy demand data; conversely CDIAC uses energy supply data.
- IEA applies fuel-specific *Tier 1* carbon emission factors based on the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, while CDIAC groups fuels in categories, i.e. liquid, gaseous and solid (two types), and uses average emission factors, mostly based on data for the United States.
- IEA excludes emissions from quantities of non-energy uses of fuels, available from the IEA energy balances, consistent with the *2006 IPCC Guidelines*; while CDIAC adopts oxidation factors to remove non fuel uses, apart from data for latest years, when non energy amounts for liquid fuels have been removed directly from the underlying energy data. [45]

[44]. Time series are available for years until 2014 on the CDIAC website (https://cdiac.ess-dive.lbl.gov/#), and until 2016 (as per July 2020) in the dataset maintained by the Appalachian State University (https://energy.appstate.edu/research/work-areas/cdiac-appstate).

[45]. More detailed information on CDIAC methodology and sources of differences with the IEA methodology can be found in:
• Andres, R. J., Fielding, D. J., Marland, G., Boden, T. A., Kumar, N., & Kearney, A. T. (1999). Carbon dioxide emissions from fossil-fuel use, 1751–1950. Tellus.
• Boden, T., Marland, G., & Andres, R. (1995). Estimates of Global, Regional, and National Annual CO2 emissions from fossil-fuel burning, hydraulic cement production, and gas flaring: 1950-1992. ORNL/CDIAC.
• Etemad, B., Luciani, J., Bairoch, P., & Toutain, J.-C. (1991). World energy production 1800–1985. Geneva: Librairie Marland, G., Andres, R. J., Boden, T. A. and Johnston, C.
• Marland, G., & Rotty, R. M. (1984). Carbon dioxide emissions from fossil fuels: a procedure for estimation and results for 1950-1982. Tellus.

To create consistent time series, as discrepancies for country-level data may range 1-10% for most countries, the IEA has:

1. re-scaled CDIAC data by country for liquid and solid fuels based on the average CDIAC-IEA differences for the first overlapping ten years (1971-1980 for most countries); and
2. aggregated country data into eighteen selected regions to compensate for country-level fluctuations. Please refer to the section *Geographical coverage and country notes* for more details on such regions as well as on time availability.

We hope that the inclusion of these additional data will allow users to benefit from the detailed IEA CO_2 emission figures from 1960 onward, while also accessing consistent emissions time series for the world and key regions since the beginning of the industrial era.

• Robbie M. Andrew (2020). A comparison of estimates of global carbon dioxide emissions from fossil carbon sources.[46]. Accessible at: https://www.iea.org/reports/methane-tracker-2021.

Non-CO_2 greenhouse gas emissions from fuel combustion

With the objective to increase the scope of greenhouse gas emissions reported, the IEA has included estimates for non-CO_2 greenhouse gases from fuel combustion in the 2021 edition of this publication.

Similar to the estimates for the CO_2 emissions from fuel combustion and considering the type and level of disaggregation of activity data available at country level, the Tier 1 methodology from the *2006 IPCC Guidelines for GHG inventories* have been adopted for the purpose of these estimates.

Unlike CO_2, the non-CO_2 greenhouse gas emissions from fuel combustion are strongly dependent on the technology used. Since the set of technologies, applied in each sector vary considerably, the guidelines do not provide default emission factors for these gases on the basis of fuels only. However, sector-specific Tier 1 default emission factors can provide a reasonable estimate for these emissions.

For estimating the emissions corresponding to stationary combustion, the default Tier 1 non-CO_2 emission factors provided in the 2006 GLs, assume effective combustion in high temperature. As such, the factors are good representation for steady and optimal conditions and do not take into account the impact of start-ups, shut downs or combustion with partial loads. The emission factors provided for CH_4 and N_2O in the 2006 GLs, are based on the 1996 IPCC Guidelines and have been established by a large group of inventory experts. However, due to the absence of sufficient measurements and since the concept of conservation of carbon does not apply in the case of non-CO_2 gases, the uncertainty range associated with these estimates are set at a factor of three.

Similarly and for mobile combustion, the non-CO_2 emission factors are more difficult to estimate accurately than those for CO_2, as they will depend on vehicle technology, fuel and operating characteristics. The distance-based activity data (i.e vehicle-kilometres travelled) and information corresponding to disaggregated fuel combustion are typically less accurate. Moreover, the CH_4 and N_2O emission rates are largely dependent on the combustion and emission control system of the vehicles. As a result, default fuel-based emission factors are highly uncertain. However, the Tier 1 method does allow using fuel-based emission factors if it is not possible to estimate fuel consumption by vehicle type.

The emissions figures are converted from gCH_4 and gN_2O to gCO_{2eq} using the 100-year Global warming potential (GWP). For the purpose of comparability with international data submission guidelines and based on Decision 24/CP.19 from UNFCCC's Meaurement, Reporting and Verification (MRV) framework, the factors from the 4th Assessment of the IPCC are used.

Table 5 below summarizes the non-CO_2 Tier 1 emission factors used by IEA for the purpose of these estimates. Users can refer to chapters 2 and 3 of the 2006 GLs for the complete methodology and underlying assumptions.

Table 5. Sources of non-CO2 emission factors for the IEA estimates

Sector	Chapter	Table	Notes
Energy Industries (including electricity and heat production)	Chapter 2 – Stationary Combustion	Table 2.2	Default sector-specific emission factors
Manufacturing industries and construction	Chapter 2 – Stationary Combustion	Table 2.3	Default sector-specific emission factors
Commercial and public services	Chapter 2 – Stationary Combustion	Table 2.4	Default sector-specific emission factors
Residential	Chapter 2 – Stationary Combustion	Table 2.5	Default sector-specific emission factors
Agriculture and forestry	Chapter 2 – Stationary Combustion	Table 2.5	Default sector-specific emission factors
Fishing	Chapter 2 – Stationary Combustion	Table 2.5	Default sector-specific emission factors
Final consumption non elsewhere specified	Chapter 2 – Stationary Combustion	N/A	Estimated based on the global weighted average of final sectors and the respective default sector-specific emission factors
Road	Chapter 3 – Mobile Combustion	Table 3.2.2	Default sector-specific emission factors*
Rail	Chapter 3 – Mobile Combustion	Table 3.4.1	Default sector-specific emission factors**
Internal navigation	Chapter 3 – Mobile Combustion	Table 3.5.3	Default sector-specific emission factors

Sector	Chapter	Table	Notes
Dometic aviation	Chapter 3 – Mobile Combustion	Table 3.6.5	Default sector-specific emission factors
Transport non elsewhere specified	Chapter 3 – Mobile Combustion	N/A	Estimated based on the global weighted average of transport modes and the respective default sector-specific emission factors
Marine bunkers	Chapter 3 – Mobile Combustion	Table 3.5.3	Default sector-specific emission factors
Aviation bunkers	Chapter 3 – Mobile Combustion	Table 3.6.5	Default sector-specific emission factors

* Based on the following assumptions: 1) A 50% split between the uncontrolled and oxidation catalyst combustion for the motor gasoline fleet. 2) Similar emission factors as diesel for kerosene, white spirit, lubricants and bitumen. 3) For biodiesel and biogasoline, the EPA emission factors for light duty vehicles and the fuel economy figures provided in the 2006 IPCC Guidelines are used to estimate the emission factors.

** Based on the following assumptions: 1) Similar emission factor as other bituminous coal for all coal products 2) Simialr emission facto as diesel for all oil products 3) Similar emission factor as Commercial and public services for solid bio fuels.

Fugitive emissions

With the objective to increase the scope of greenhouse gas emissions reported, the IEA has included estimates for carbon dioxide and methane emissions for the category 1.B of the 2006 IPCC Guidelines for GHG inventories, for recent years. Data were derived from the ongoing IEA work on methane emissions[46]. For detailed information on methodologies and definitions, please consult the 2022 IEA *Global Methane Tracker* documentation[47].The approach adopted to estimating methane and carbon dioxide emissions from global coal, oil and gas operations is bottom-up: country-specific and production type-specific emission intensities are applied to production and consumption data. For the case of oil and gas related fugitive emissions, the starting points were emission intensities for upstream and downstream oil and gas in the United States, based on the 2021 greenhouse gas inventory of the United States along with a range of other data sources, including an IEA survey of companies and countries. The United States intensities were then scaled to obtain intensities for all other countries, based upon a range of auxiliary country-specific data and information[49]. Scaling factors were finally applied to production (for upstream emissions) or consumption (for downstream emissions) of oil and gas within each country.

For the case of coal related fugitive emissions, the US Environmental Protection Agency's Greenhouse Gas Reporting Program and separate data sources providing disaggregated estimates for China and India were used as starting points**Error! Bookmark not defined.**. The mine-level estimates generated are then aggregated and verified against the country-based estimates taken from satellite-based measurements. From there, additional criteria including coal quality, mine depth and regulatory oversight were used as key factors to estimate emission intensities for mine in other countries for which there are no reliable direct measurements.

Additionally, the 2022 *Global Methane Tracker* integrates results from publicly-reported, credible sources where data has become available incldluing emissions detected by satellites. Changes in the atmospheric concentration of methane can be used to estimate the rate of emissions from a source that would have caused such a change. This is done based on data processing by Kayrros, an earth observation firm, to convert readings of concentrations to identify large sources of emissions from oil and gas operations. Reported emissions encompass individual methane sources above 5 tonnes per hour as well as clusters of smaller sources in dense areas (e.g. shale plays). Estimates are also provided using "basin-

[46]. Accessible at: https://www.iea.org/reports/methane-tracker-2021.

[47] Available at: https://iea.blob.core.windows.net/assets/b5f6bb13-76ce-48ea-8fdb-3d4f8b58c838/GlobalMethaneTracker_documentation.pdf.

level inversions", which use satellite readings to assess methane emissions across a wider oil and gas production region; the same approach is also used to measure the methane footprint of coal basins. More information is available on the IEA Global Methane Tracker documentation[47].

The emissions figures are converted from gCH_4 using the 100-year Global warming potential (GWP). For the purpose of comparability with international data submission guidelines and based on Decision 24/CP.19 from UNFCCC's Meaurement, Reporting and Verification (MRV) framework, the factors from the 4th Assessment of the IPCC are used.

Fugitive emissions estimates are available for 93 countries covering 97% of the World's fugitive emissions. The IEA also provides estimates for 18 regions, including World. A detailed list covering geographical availability can be found down below.

Table 6. Geographical availability for fugitive emissions

Country/Region
Countries: Australia, Canada, Chile, Colombia, Denmark, Estonia, France, Germany, Israel, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Slovenia, Sweden, United Kingdom, United States, Algeria, Angola, Benin, Botswana, Cameroon, Republic of the Congo, Democratic Republic of the Congo, Cote d'Ivoire, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Libya, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, South Africa, South Sudan, Sudan, United Republic of Tanzania, Togo, Tunisia, Argentina, Plurinational State of Bolivia, Brazil, Cuba, Ecuador, Guyana, Paraguay, Peru, Trinidad and Tobago, Uruguay, Bolivarian Republic of Venezuela, Bangladesh, Brunei Darussalam, India, Indonesia, Malaysia, Pakistan, Philippines, Thailand, Viet Nam, People's Republic of China, Azerbaijan, Kazakhstan, Romania, Russian Federation, Turkmenistan, Ukraine, Uzbekistan, Bahrain, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen. **Regions**: World, Memo: OECD Total, OECD Americas, OECD Asia Oceania, OECD Europe, Non-OECD Total, Africa, Non-OECD Americas, Non-OECD Asia (excluding China), China (including Hong Kong, China), Non-OECD Europe and Eurasia, Middle East, Memo: OPEC, Memo: European Union - 27, Memo: European Union - 28, Memo: G7, Memo: G8, Memo: Africa (UN), Memo: Americas (UN),

GHG emissions beyond energy (EDGAR)

Greenhouse gas emissions from fuel combustion represent the majority of anthropogenic GHG emissions. However, comprehensive analysis of emission trends considers other sources of emissions, knowing that 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.

To complement work regarding the emissions of GHG emissions from fuel combustion and fugitive emissions from energy, the IEA also included EDGAR data on other CO_2 sources and on five other greenhouse gases; methane (CH_4), nitrous oxide (N_2O) and the fluorinated gases (or "F-gases") HFCs, PFCs and SF_6, all gases addressed by the Kyoto Protocol.

The information for GHG emissions (with the exception of CO_2 emissions from fuel combustion) has been provided by Monica Crippa and Diego Guizzardi from the Joint Research Centre (JRC) of the European Commission and Jos G.J. Olivier from the PBL Netherlands Environmental Assessment Agency, using the EDGAR database (version 4.3.2_FT2016 for CO_2, version 5.0 for CH_4 and N_2O emissions and 4.2FT2010 for the F-gases) developed jointly by JRC and PBL.

In this edition, the global warming potentials (GWP-100) for the non-CO_2 gases are taken from the IPCC Fourth Assessment Report and no longer from the second. The data in this dataset may differ from previous editions also due to changes in the methodology used for the accounting of large-scale biomass burning (including mainly savannah fires). Therefore, no complete estimates of the land use, land use change and forestry sector emissions are currently provided by the EDGAR database.

Please note that the GHG emissions totals presented here will differ from those shown in countries' official national inventory submissions to the UNFCCC, primarily due to differences in coverage for the category Other. Differences may also occur due to differences in allocation, methodologies and underlying data sources for activities and emission factors, as specified in Part III. Details on possible differences between IEA and UNFCCC CO_2 emissions from fuel combustion estimates can be found in Part I.

The information or GHG emissions (with the exception of CO_2 emissions from fossil fuel combustion) has been provided by Monica Crippa, Diego Guizzardi and Jos G.J. Olivier based on the EDGAR version 4.3.2_FT2016 for CO2, version 4.4 for CH4 and N2O emissions and 4.2FT2010 for the F-gases. JRC and PBL are responsible for these datasets.

General note on EDGAR

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. EDGAR v4.3.2 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 x 0.1° 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. For recent estimates of the GHG emissions, 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 EDGAR v4.3.2 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 (2017), for agriculture related activities till 2015 using the latest FAO statistics (FAOSTAT, 2018) 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 to Janssens-Maenhout et al. (2017a) and the EDGAR v4.3.2 website at http://edgar.jrc.ec.europa.eu/overview.php?v=432&SECURE=123. Note that estimates for other more recent years than 2012 are also made publicly available through this website. Most recent trends for CO_2 emissions through 2016 are discussed in Olivier et al. (2017) and Janssens-Maenhout et al. (2017b).

Box 1: 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).

Note that the IPCC guidelines are sometimes ambiguous in where to report emissions from particular sources e.g when reporting to the UNFCCC, countries may opt to report CO_2 emissions from integrated steel plants (including coke ovens and blast furnaces), wholly under IPCC Source/Sink Category 1A, or also under 1B1 and 2C.

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 section 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 CO_2 emissions refer to direct emissions 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). It does not include the significant amount of large scale biomass burning emissions, as these are part of

the land use, land-use change and forestry sector, for which a different methodology and use of satellite is required.

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 biofuels (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 v4.3.2 FT2016 and EDGAR v4.2FT2010

The EDGAR v4.2FT2010 has been available online since October 2013[48] and EDGAR v4.3.2_FT2016 since July 2017[49]. 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).

The EDGAR v4.3.2_FT2016 dataset covers the entire period 1970-2016 and is largely based on IEA(2014) energy statistics and FAOSTAT (2018) agriculture statistics. The EDGAR v4.3.2_FT2016 dataset was used in this publication as data input for the CO_2 emissions for Fugitives and Industrial Processes, the CH_4 emissions and the N_2O emissions. Updated activity data using the latest FAO statistics for agriculture (FAOSTAT, 2018) were included to estimate CH_4 and N_2O emissions from agriculture. The emissions of the F-gases are taken from the EDGAR v4.2FT2010 dataset. The methods, data sources and emission factors used for this new dataset are documented in Janssens-Maenhout et al. (2017a,b). For the documentation of the EDGAR v4.2FT2010 dataset we refer to a previous publication of this report (part III) in 2015.

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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

		101	deca (da)	10-1	deci (d)
102	hecto (h)	10-2	centi (c)		
		103	kilo (k)	10-3	milli (m)
106	mega (M)	10-6	micro (µ)		
		109	giga (G)	10-9	nano (n)
1012	tera (T)	10-12	pico (p)		
		1015	peta (P)	10-15	femto (f)
1018	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.

Abbreviations

CO_2	carbon dioxide
CH_4	Methane
N_2O	Nitrous oxide
CO_{2eq}	Carbon dioxide equivalent
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
TES	total energy supply
Convention	United Nations Framework Convention on Climate Change
COP	Conference of the Parties to the Convention
G20	Group of Twenty (See the section *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
x	not applicable

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