CO_2 EMISSIONS FROM FUEL COMBUSTION
FEBRUARY 2020 EDITION
(SELECTED ECONOMIES)

DATABASE DOCUMENTATION

In an effort to provide users with more timely information, with the February 2020 edition of the CO2 Emissions from Fuel Combustion database the IEA is releasing CO2 emissions for those selected economies of the OECD and beyond for which data up to 2018 have been already received and validated.

This document provides information on the February 2020 edition of the IEA CO2 Emissions from Fuel Combustion database (selected economies). Further 2020 editions are expected to include a progressively broader coverage: the April 2020 edition will cover the full set of OECD plus other selected emerging economies; the September edition will cover the global set of data.

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: www.iea.org/t&c/termsandconditions/.

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1. CHANGES FROM LAST EDITION

In an effort to enhance timeliness of data, the IEA is pleased to include full coverage of selected OECD and emerging economies in this early release. The countries included are:

OECD: Austria, Belgium, France, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovenia, United Kingdom and United States

Non-OECD: Algeria, Belarus, Brazil, Bulgaria, Croatia, Cyprus, Ecuador, Guatemala, Indonesia, Montenegro, Romania, Serbia, Tunisia, Uruguay

Flows

A new industry sector aggregate ("Manufacturing") has been added. To accommodate this change, the industry sub-sectors have been reordered.

The aggregated flow "Other" is removed from the database. The sub-sectors previously aggregated to form it, namely "Residential", "Commercial and public services", "Agriculture/forestry", "Fishing", "Non-specified (other)", are still shown separately in the database. The flow "Non-specified (other)" is renamed as "Final Consumption not elsewhere specified".

In accordance with the OECD *National Accounts Statistics* database, the base year for the constant GDP and GDP PPP time series was changed from 2010 to 2015.

Old longname	New longname	Shortname	Old shortname (if changed)
	Manufacturing	MANUFACT	
Other			TOTOTHER
Non-specified (other)	Final Consumption not elsewhere specified	ONONSPEC	
GDP (billion 2010 USD using exchange rates)	GDP (billion USD 2015 prices and ex rates)	GDP	

GDP (billion 2010 USD using PPPs)	GDP (billion USD 2015 prices and PPPs)	GDPPPP	

2. DATABASE STRUCTURE

The *CO_2 Emissions from Fuel Combustion February 2020 edition* database contains annual CO_2 emissions from fuel combustion and related indicators for selected economies. Emissions were calculated using IEA energy databases and the default methods and emission factors given in the *2006 GLs for National Greenhouse Gas Inventories*. This edition includes annual data for 28 countries (see section 5: *Geographical coverage*) , generally from 1960-2018, unless specified differently at the country level.

The *CO_2 Emissions from Fuel Combustion February 2020 edition* database includes the following five files:

EARLY_BigCO_2.IVT **CO_2 Emissions from fuel combustion (detailed estimates)**

Detailed CO_2 emissions by subsector and by product (47 products; 42 flows).

EARLY_CO_2.IVT **CO_2 Emissions from fuel combustion (summary)**

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

EARLY_CO_2Indic.IVT **CO_2 Emissions indicators**

30 CO_2-related, energy and socio-economic indicators

EARLY_CO_2Sector.ivt **CO_2 Direct and indirect emissions by sector**

CO_2 emissions split in the different sectors, before and after reallocating emissions from electricity and heat generation to final sectors. Total and per capita figures are provided.
(4 allocations, 13 flow categories).

EARLY_IPCC2006.ivt **IPCC Fuel combustion emissions (2006 Guidelines)**

CO_2 emissions from fuel combustion, with Reference and Sectoral Approach totals, as well as detailed split between emissions across the Energy, and Industrial Processes and Product Use (IPPU) sectors, as recommended in the *2006 GLs*.
(5 product categories, 13 flow categories).

Detailed definitions of each flow and product are presented in Chapter 3, *Definitions*.

3. DEFINITIONS

CO_2 emissions from fuel combustion ($MtCO_2$)		
Flow	**Short name**	**Definition**
CO_2 Fuel combustion	CO2FCOMB	*CO_2 Fuel Combustion* presents total CO_2 emissions from fuel combustion. This includes CO_2 emissions from fuel combustion in IPCC Source/Sink Category 1 A Fuel Combustion Activities and those which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*. CO2FCOMB = MAINPROD + AUTOPROD + OTHEN + TOTIND +TOTTRANS + TOTOTHER+ ONONSPEC
Main activity producer of electricity and heat	MAINPROD	*Main activity producer electricity and heat* contains the sum of emissions from main activity producer electricity generation, combined heat and power generation and heat plants. Main activity producers are defined as those undertakings whose primary activity is to supply the public. They may be publicly or privately owned. Emissions from own on-site use of fuel are included. This corresponds to IPCC Source/Sink Category 1 A 1 a.
Main activity electricity plants	MAINELEC	Refers to plants which are designed to produce electricity only. If one or more units of the plant is a CHP unit (and the inputs and outputs cannot be distinguished on a unit basis) then the whole plant is designated as a CHP plant. Main activity producers generate electricity for sale to third parties, as their primary activity. They may be privately or publicly owned. Note that the sale need not take place through the public grid.
Main activity CHP plants	MAINCHP	Refers to plants which are designed to produce both heat and electricity (sometimes referred to as co-generation power stations). If possible, fuel inputs and electricity/heat outputs are on a unit basis rather than on a plant basis. However, if data are not available on a unit basis, the convention for defining a CHP plant noted above should be adopted. Main activity producers generate electricity and/or heat for sale to third parties, as their primary activity. They may be privately or publicly owned. Note that the sale need not take place through the public grid.

CO_2 emissions from fuel combustion ($MtCO_2$)		
Flow	**Short name**	**Definition**
Main activity heat plants	MAINHEAT	Refers to plants (including heat pumps and electric boilers) designed to produce heat only and who sell heat to a third party (e.g. residential, commercial or industrial consumers) under the provisions of a contract. Main activity producers generate heat for sale to third parties, as their primary activity. They may be privately or publicly owned. Note that the sale need not take place through the public grid.
Own use in electricity, CHP and heat plants	EPOWERPLT	Emissions from own on-site use of fuel in electricity, CHP and heat plants. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs.*
Unallocated autoproducers	AUTOPROD	*Unallocated autoproducers* contains the emissions from the generation of electricity and/or heat by autoproducers. Autoproducers are defined as undertakings that generate electricity and/or heat, wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned. In the *2006 GLs*, these emissions would normally be distributed between industry, transport and "other" sectors.This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Autoproducer electricity plants	AUTOELEC	Refers to plants which are designed to produce electricity only. If one or more units of the plant is a CHP unit (and the inputs and outputs cannot be distinguished on a unit basis) then the whole plant is designated as a CHP plant. Autoproducer undertakings generate electricity wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.

CO_2 emissions from fuel combustion ($MtCO_2$)

Flow	Short name	Definition
Autoproducer CHP plants	AUTOCHP	Refers to plants which are designed to produce both heat and electricity (sometimes referred to as co-generation power stations). If possible, fuel inputs and electricity/heat outputs are on a unit basis rather than on a plant basis. However, if data are not available on a unit basis, the convention for defining a CHP plant noted above should be adopted. Note that for autoproducer CHP plants, all fuel inputs to electricity production are taken into account, while only the part of fuel inputs to heat sold is shown. Fuel inputs for the production of heat consumed within the auto-producer's establishment are not included here but are included with figures for the final consumption of fuels in the appropriate consuming sector. Autoproducer undertakings generate electricity and/or heat, wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Autoproducer heat plants	AUTOHEAT	Refers to plants (including heat pumps and electric boilers) designed to produce heat only and who sell heat to a third party (e.g. residential, commercial or industrial consumers) under the provisions of a contract. Autoproducer undertakings generate heat, wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Other energy industry own use	OTHEN	*Other energy industry own use* contains emissions from fuel combusted in oil refineries, for the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries. This corresponds to the IPCC Source/Sink Categories 1 A 1 b and 1 A 1 c. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.

CO_2 emissions from fuel combustion ($MtCO_2$)

Flow	Short name	Definition
Manufacturing industries and construction	TOTIND	*Manufacturing industries and construction* contains the emissions from combustion of fuels in industry. The IPCC Source/Sink Category 1 A 2 includes these emissions. However, in the *2006 GLs*, the IPCC category also includes emissions from industry autoproducers that generate electricity and/or heat. The IEA data are not collected in a way that allows the energy consumption to be split by specific end-use and therefore, autoproducers are shown as a separate item (*unallocated autoproducers*). This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Mining and quarrying	MINING	[ISIC Rev. 4 Divisions 07 and 08 and Group 099] Mining (excluding fuels) and quarrying.
Construction	CONSTRUC	[ISIC Rev. 4 Division 41 to 43]
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 • Not elsewhere specified (industry) Definitions of the sub-sectors can be found under the listing for each respective sub-sector below.
Iron and steel	IRONSTL	[ISIC Rev. 4 Group 241 and Class 2431] This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Chemical and petrochemical	CHEMICAL	[ISIC Rev. 4 Divisions 20 and 21]
Non-ferrous metals	NONFERR	[ISIC Rev. 4 Group 242 and Class 2432] Basic industries. This includes CO_2 emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the *2006 GLs*.
Non-metallic minerals	NONMET	[ISIC Rev. 4 Division 23] Such as glass, ceramic, cement, etc.

CO_2 emissions from fuel combustion ($MtCO_2$)		
Flow	**Short name**	**Definition**
Transport equipment	TRANSEQ	[ISIC Rev. 4 Divisions 29 and 30]
Machinery	MACHINE	[ISIC Rev. 4 Divisions 25 to 28] Fabricated metal products, machinery and equipment other than transport equipment.
Food and tobacco	FOODPRO	[ISIC Rev. 4 Divisions 10 to 12]
Paper, pulp and printing	PAPERPRO	[ISIC Rev. 4 Divisions 17 and 18]
Wood and wood Products	WOODPRO	[ISIC Rev. 4 Division 16] Wood and wood products other than pulp and paper.
Textile and leather	TEXTILES	[ISIC Rev. 4 Divisions 13 to 15]
Non-specified industry	INONSPEC	[ISIC Rev. 4 Divisions 22, 31 and 32] Any manufacturing industry not included above. Note: Most countries have difficulties supplying an industrial breakdown for all fuels. In these cases, the *non-specified* industry row has been used. Regional aggregates of industrial consumption should therefore be used with caution.
Transport	TOTTRANS	*Transport* contains emissions from the combustion of fuel for all transport activity, regardless of the sector, except for *international marine bunkers* and *international aviation bunkers*, which are not included in *transport* at a national or regional level (except for World transport emissions). This includes domestic aviation, domestic navigation, road, rail and pipeline transport, and corresponds to IPCC Source/Sink Category 1 A 3. The IEA data are not collected in a way that allows the autoproducer consumption to be split by specific end-use and therefore, this publication shows autoproducers as a separate item (*unallocated autoproducers*). Note: Starting in the 2006 edition, military consumption previously included in *domestic aviation* and in *road* should be in *non-specified other*.
Road	ROAD	*Road* contains the emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on highways. This corresponds to the IPCC Source/Sink Category 1 A 3 b. Excludes emissions from military consumption as well as motor gasoline used in stationary engines and diesel oil for use in tractors that are not for highway use.

CO_2 emissions from fuel combustion ($MtCO_2$)		
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.
Rail	RAIL	Includes emissions from rail traffic, including industrial railways.
Pipeline transport	PIPELINE	Includes emissions from fuels used in the support and operation of pipelines transporting gases, liquids, slurries and other commodities, including the energy used for pump stations and maintenance of the pipeline. Energy for the pipeline distribution of natural or coal gases, hot water or steam (ISIC Rev. 4 Division 35) from the distributor to final users is excluded and should be reported in other energy industry own use, while the energy used for the final distribution of water (ISIC Rev. 4 Division 36) to household, industrial, commercial and other users should be included in commercial/public services. Losses occurring during the transport between distributor and final users should be reported as distribution losses.
Domestic navigation	DOMESNAV	*Domestic navigation* includes emissions from fuels delivered to vessels of all flags not engaged in international navigation (see international marine bunkers). The domestic/international split should be determined on the basis of port of departure and port of arrival and not by the flag or nationality of the ship. Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu). Fuel used for ocean, coastal and inland fishing and military consumption are excluded.
Non-specified transport	TRNONSPE	Includes all emissions from transport not elsewhere specified. Note: *International marine bunkers* and *international aviation bunkers* are not included in *transport* at a country or regional level (except for World transport emissions).

CO_2 emissions from fuel combustion ($MtCO_2$)		
Flow	**Short name**	**Definition**
Other	TOTOTHER	*Other* contains the emissions from commercial/institutional activities, residential, agriculture/forestry, fishing and other emissions not specified elsewhere that are included in the IPCC Source/Sink Categories 1 A 4 and 1 A 5. In the *2006 GLs*, the category also includes emissions from autoproducers in the commercial/public services, residential and agriculture that generate electricity and/or heat. The IEA data are not collected in a way that allows the energy consumption to be split by specific end-use and therefore, autoproducers are shown as a separate item (unallocated autoproducers).
Residential	RESIDENT	*Residential* contains all emissions from fuel combustion in households. This corresponds to IPCC Source/Sink Category 1 A 4 b.
Commercial and public services	COMMPUB	*Commercial and public services* includes emissions from all activities of ISIC Rev. 4 Divisions 33, 36-39, 45-47, 52, 53, 55-56, 58-66, 68-75, 77-82, 84 (excluding Class 8422), 85-88, 90-96 and 99. This corresponds to IPCC Source/Sink Category 1 A 4 a.
Agriculture/forestry	AGRICULT	*Agriculture/forestry* includes deliveries to users classified as agriculture, hunting and forestry by the ISIC, and therefore includes energy consumed by such users whether for traction (excluding agricultural highway use), power or heating (agricultural and domestic) [ISIC Rev. 4 Division 03].
Fishing	FISHING	*Fishing* includes emissions from fuels used for inland, coastal and deep-sea fishing. Fishing covers fuels delivered to ships of all flags that have refuelled in the country (including international fishing) as well as energy used in the fishing industry [ISIC Rev.4 Division 03].
Non-specified other	ONONSPEC	Includes emissions from all fuel use not elsewhere specified as well as consumption in the above-designated categories for which separate figures have not been provided. Emissions from military fuel use for all mobile and stationary consumption are included here (e.g. ships, aircraft, road and energy used in living quarters) regardless of whether the fuel delivered is for the military of that country or for the military of another country.
Memo: International marine bunkers	MARBUNK	*International marine bunkers* contains emissions from fuels burned by ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation is excluded. The domestic/international split is determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. Consumption by fishing vessels and by military forces is also excluded. Emissions from international marine bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 d i.

CO_2 emissions from fuel combustion ($MtCO_2$)		
Flow	**Short name**	**Definition**
Memo: International aviation bunkers	AVBUNK	*International aviation bunkers* contains emissions from fuels used by aircraft for international aviation. Fuels used by airlines for their road vehicles are excluded. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. Emissions from international aviation bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 a i.

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

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<tr><td>GDP
(billion 2015
US dollars)</td><td>GDP</td><td>For OECD Countries:

The main source of these series for 1970 to 2018 is the OECD National Accounts Statistics database [ISSN: 2221-433X (online)], last published in book format as National Accounts of OECD Countries, Volume 2019 Issue2: Detailed Tables, OECD 2019. GDP data for France and the United Kingdom for 1960 to 1969 were taken from the same source. GDP data for 1960 to 1969 for the other countries have been estimated using the growth rates from the series in the OECD Economic Outlook No 98 and other data previously published by the OECD. Growth rates from these sources were also used to estimate data for Hungary (prior to 1991) and Poland (prior to 1990).

The GDP data have been compiled for all individual countries at market prices in 2015 US dollars.

For non-OECD Countries:

The main source of the GDP data is World Development Indicators, The World Bank, Washington D.C., 2019.

GDP figures for Bulgaria (1971-1979), Croatia (1990-1994), Cyprus (1971-1974), Romania (1971-1989) and Serbia (1990-1994) have been estimated based on the growth rates of the CHELEM-CEPII online database, Bureau van Dijk, 2019.

The GDP data have been compiled for all individual countries at market prices in 2015 US dollars.</td></tr>
</table>

Indicators		
Flow	**Short name**	**Notes**
GDP PPP (billion 2015 US dollars)	GDPPPP	**For OECD Countries:** Purchasing power parities are the rates of currency conversion that equalise the purchasing power of different currencies. A given sum of money, when converted into different currencies at the PPP rates, buys the same basket of goods and services in all countries. In other words, PPPs are the rates of currency conversion which eliminate the differences in price levels between different countries. The PPPs selected to convert the GDP from national currencies to US dollars were aggregated using the Èltetö, Köves and Szulc (EKS) Eurostat-OECD method and rebased on the United States. For a more detailed description of the methodology please see *Eurostat-OECD Methodological Manual on Purchasing Power Parities*, 2012 edition, European Union / OECD 2012. See GDP *using exchange rates* for sources. Note that Data for Latvia (prior to 1995) and Lithuania (prior to 1995) are IEA secretariat estimates based on GDP growth rates from the World Bank or from data previously published by OECD. **For non-OECD Countries:** The main source of the GDP PPP data is *World Development Indicators*, The World Bank, Washington, D.C., 2019. However, this source is available for GDP PPP (constant 2011 US dollars scaled to the levels of 2015 using current PPP US dollars) only from 1990. Therefore, prior to 1990 GDP PPP data have been calculated based on the PPP conversion factor (GDP) to market exchange rate ratio. The GDP PPP data have been converted from GDP using purchasing power parity rates. These data have been scaled to the price levels of 2015. GDP PPP figure for **Croatia** (1900- 1994), has been estimated using the ratio of GDP PPP and GDP data based on CHELEM-CEPII online database, Bureau van Dijk, 2019. The data have been scaled to the price levels of 2015. The GDP PPP reflect the changes to power purchasing parity rates based on the 2011 International Comparison Program (ICP), published in 2014. The ICP has worked for 6 years to better estimate the value of the PPP ‘basket of goods’ for all countries for which the World Bank calculates GDP PPP. For many countries, this value has significantly changed in comparison to previous ICP exercises. This leads to significant revisions to GDP PPP for many countries compared to previous publications.
TPES / GDP (MJ per 2015 USD)	TPESGDP	This ratio is expressed in megajoules per 2015 US dollar. It has been calculated using total primary energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using exchange rates.

Indicators		
Flow	**Short name**	**Notes**
TPES / GDP PPP (MJ per 2015USD PPP)	TPESGDPPPP	This ratio is expressed in megajoules per 2015 US dollar. It has been calculated using total primary energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using purchasing power parities.
Population (millions)	POP	**For OECD Countries:** The main source of these series for 1970 to 2018 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 2019 Issue 2: Detailed Tables*, OECD 2019. 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 **Slovenia** (prior to 1995). Data for **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., 2019. Population data for **Cyprus** are taken from the Eurostat online database.
CO_2 / TPES (tCO_2 per TJ)	CO2TPES	This ratio is expressed in tonnes of CO_2 per terajoule. It has been calculated using the total CO_2 fuel combustion emissions (CO2FCOMB) and total primary energy supply (including biofuels and other non-fossil forms of energy).
CO_2 / TFC (tCO_2 per TJ)	CO2TFC	This ratio is expressed in tonnes of CO_2 per terajoule. It has been calculated using the total CO_2 fuel combustion emissions (CO2FCOMB) and total final consumption (including biofuels and other non-fossil forms of energy).
CO_2 / GDP ($kgCO_2$ per 2015 US dollar)	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 US dollar)	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 US dollar)	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 US dollar)	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.

Indicators		
Flow	**Short name**	**Notes**
Residential CO_2 / GDP ($kgCO_2$ per 2015 US dollar)	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 US dollar)	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 US dollar)	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 2015 US dollar)	CO2GDPPP_T	This ratio is expressed in kilogrammes of CO_2 per 2015 US dollar. It has been calculated using *Transport* CO_2 emissions (TOTTRANS) and total GDP calculated using purchasing power parities.
Services CO_2 / GDP PPP ($kgCO_2$ per 2010 US dollar)	CO2GDPPP_S	This ratio is expressed in kilogrammes of CO_2 per 2010 US dollar. It has been calculated using the *Commercial and public services* CO_2 emissions (COMMPUB) and total GDP calculated using purchasing power parities.
Residential CO_2 / GDP PPP ($kgCO_2$ per 2015 US dollar)	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 exceptions, 1990 is used as the reference year: **Hungary** (average 1985-1987), **Poland** (1988) and **Slovenia** (1986).

Indicators

Flow	Short name	Notes
Population index	IPOP	Population expressed as an index, where the reference year = 100. Aside from the following exceptions, 1990 is used as the reference year: **Hungary** (average 1985-1987), **Poland** (1988) and **Slovenia** (1986). This index can be used as one of the constituents of the Kaya identity, for more information see Chapter 5, *IEA emissions estimates* of the full publication.
GDP per population index	IGDPPOP	GDP PPP / population expressed as an index, where the reference year = 100. Aside from the following exceptions, 1990 is used as the reference year: **Hungary** (average 1985-1987), **Poland** (1988) and **Slovenia** (1986). This index can be used as one of the constituents of the Kaya identity, for more information see Chapter 5, *IEA emissions estimates* of the full publication.
Energy intensity index - TPES/GDP	ITPESGDP	TPES / GDP PPP expressed as an index, where the reference year = 100. Aside from the following exceptions, 1990 is used as the reference year: **Hungary** (average 1985-1987), **Poland** (1988) and **Slovenia** (1986). This index can be used as one of the constituents of the Kaya identity, for more information see Chapter 5, *IEA emissions estimates* of the full publication.
Carbon intensity index – ESCII: CO_2/TPES	ICO2TPES	CO_2 emissions / TPES expressed as an index, where the reference year = 100. Calculated using CO_2 Fuel Combustion emissions (CO2FCOMB). Aside from the following exceptions, 1990 is used as the reference year: **Hungary** (average 1985-1987), **Poland** (1988) and **Slovenia** (1986). This index can be used as one of the constituents of the Kaya identity, for more information see Chapter 5, *IEA emissions estimates* of the full publication.

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

IPCC Fuel combustion emissions (2006 Guidelines)

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

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

IPCC Fuel combustion emissions (2006 Guidelines)

Flow	Short name	Definition
Memo: IPPU CO2 Fuel combustion – Autoproducers (IPPU)	IPPUAUTOP	*IPPU CO2 Fuel combustion – Autoproducer (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from the autoproduction sector under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven gas, blast furnace gas and other recovered gases reported under *Unallocated autoproducers*. For the purposes of IEA Sectoral Approach estimates, autoproducer consumption of these gases is assumed to occur within the iron and steel sector.
Memo: IPPU CO2 Fuel combustion – Autoproducer own use (IPPU)	IPPUEPOWER	*IPPU CO2 Fuel combustion – Autoproducer own use (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from autoproducer on-site own use under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven gas, blast furnace gas and other recovered gases reported under *Own on-site use of fuel in electricity, CHP and heat plants*. For the purposes of IEA Sectoral Approach estimates, autoproducer consumption of these gases is assumed to occur within the iron and steel sector.
Memo: IPPU CO2 Fuel combustion – Blast furnace energy (IPPU)	IPPUEBLAST	*IPPU CO2 Fuel combustion – Blast furnace energy (IPPU)* presents the CO_2 emissions from fuel combustion which may be excluded from energy use in blast furnaces under the Sectoral Approach and reallocated to IPCC Source/Sink Category Industrial Processes and Product Use (IPPU) under the *2006 GLs*. This contains emissions from coke oven coke, coke oven gas, blast furnace gas and other recovered gases reported under *Energy use in blast furnaces*. For the purposes of IEA Sectoral Approach estimates, energy use in blast furnaces is assumed to occur within the iron and steel sector.
Memo: International marine bunkers	MARBUNK	*International marine bunkers* contains emissions from fuels burned by ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation is excluded. The domestic/international split is determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. Consumption by fishing vessels and by military forces is also excluded. Emissions from international marine bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 d i.

IPCC Fuel combustion emissions (2006 Guidelines)		
Flow	**Short name**	**Definition**
Memo: International aviation bunkers	AVBUNK	*International aviation bunkers* contains emissions from fuels used by aircraft for international aviation. Fuels used by airlines for their road vehicles are excluded. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. Emissions from international aviation bunkers should be excluded from the national totals. This corresponds to IPCC Source/Sink Category 1 A 3 a i.

Aggregated product categories for summary file

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

Coal		
Flow	**Short name**	**Definition**
Hard coal (if no detail)	HARDCOAL	This item is only used if the detailed breakdown is not available. It includes anthracite, coking coal, other bituminous coal.
Brown coal (if no detail)	BROWN	This item is only used if the detailed breakdown is not available. It includes lignite and sub-bituminous coal.
Anthracite	ANTCOAL	Anthracite is a high rank coal used for industrial and residential applications. It is generally less than 10% volatile matter and a high carbon content (about 90% fixed carbon). Its gross calorific value is greater than 24 000 kJ/kg on an ash-free but moist basis.
Coking coal	COKCOAL	Coking coal refers to bituminous coal with a quality that allows the production of a coke suitable to support a blast furnace charge. Its gross calorific value is equal to or greater than 24 000 kJ/kg on an ash-free but moist basis.
Other bituminous coal	BITCOAL	Other bituminous coal is used mainly for steam raising and space heating purposes and includes all bituminous coal that is not included under coking coal nor anthracite. It is usually more than 10% volatile matter and a relatively high carbon content (less than 90% fixed carbon). Its gross calorific value is greater than 24 000 kJ/kg on an ash-free but moist basis.
Sub-bituminous coal	SUBCOAL	Non-agglomerating coals with a gross calorific value between 20 000 kJ/kg and 24 000 kJ/kg containing more than 31% volatile matter on a dry mineral matter free basis.
Lignite	LIGNITE	Lignite is a non-agglomerating coal with a gross calorific value of less than 20 000 kJ/kg, and greater than 31% volatile matter on a dry mineral matter free basis.
Patent Fuel	PATFUEL	Patent fuel is a composition fuel manufactured from hard coal fines with the addition of a binding agent. The amount of patent fuel produced may, therefore, be slightly higher than the actual amount of coal consumed in the transformation process. Consumption of patent fuels during the patent fuel manufacturing process is included under *energy industry own use*.
Coke oven coke	OVENCOKE	Coke oven coke is the solid product obtained from the carbonisation of coal, principally coking coal, at high temperature. It is low in moisture content and volatile matter. Coke oven coke is used mainly in the iron and steel industry, acting as energy source and chemical agent. Also included are semi-coke (a solid product obtained from the carbonisation of coal at a low temperature), lignite coke (a semi-coke made from lignite), coke breeze and foundry coke. The heading *energy industry own use* includes the consumption at the coking plants themselves. Consumption in the *iron and steel industry* does not include coke converted into blast furnace gas. To obtain the total emissions from coke oven coke in the iron and steel industry, the quantities converted into blast furnace gas have to be added (these are aggregated under differences due to transformations and/or losses).

Coal

Flow	Short name	Definition
Gas coke	GASCOKE	Gas coke is a by-product of hard coal used for the production of town gas in gas works. Gas coke is used for heating purposes. *Energy industry own use* includes the consumption of gas coke at gas works.
Coal tar	COALTAR	Coal tar is a result of the destructive distillation of bituminous coal. Coal tar is the liquid by-product of the distillation of coal to make coke in the coke oven process. Coal tar can be further distilled into different organic products (e.g. benzene, toluene, naphthalene), which normally would be reported as a feedstock to the petrochemical industry.
BKB	BKB	Brown coal briquettes (braunkohlebriketts) are composition fuels manufactured from lignite, produced by briquetting under high pressure with or without the addition of a binding agent. The heading *energy industry own use* includes consumption by briquetting plants.
Gas works gas	GASWKSGS	Gas works gas covers all types of gas produced in public utility or private plants, whose main purpose is the manufacture, transport and distribution of gas. It includes gas produced by carbonisation (including gas produced by coke ovens and transferred to gas works), by total gasification (with or without enrichment with oil products) and by reforming and simple mixing of gases and/or air.
Coke oven gas	COKEOVGS	Coke oven gas is obtained as a by-product of the manufacture of coke oven coke for the production of iron and steel.
Blast furnace gas	BLFURGS	Blast furnace gas is produced during the combustion of coke in blast furnaces in the iron and steel industry. It is recovered and used as a fuel, partly within the plant and partly in other steel industry processes or in power stations equipped to burn it.
Other recovered gases	OGASES	By-product of the production of steel in an oxygen furnace, recovered on leaving the furnace. The gases are also known as converter gas, LD gas or BOS gas. The quantity of recuperated fuel should be reported on a gross calorific value basis. Also covers non-specified manufactured gases not mentioned above, such as combustible gases of solid carbonaceous origin recovered from manufacturing and chemical processes not elsewhere defined.

Peat

Flow	Short name	Definition
Peat	PEAT	Peat is a combustible soft, porous or compressed, fossil sedimentary deposit of plant origin with high water content (up to 90% in the raw state), easily cut, of light to dark brown colour. Peat used for non-energy purposes is not included here. Milled peat is included here.
Peat products	PEATPROD	Products such as peat briquettes derived directly or indirectly from sod peat and milled peat.

Oil shale

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

Oil

Flow	Short name	Definition
Crude/NGL/ feedstocks (if no detail)	CRNGFEED	This item is only used if the detailed breakdown is not available. It includes crude oil, natural gas liquids, refinery feedstocks, additives/blending components and other hydrocarbons.
Crude oil	CRUDEOIL	Crude oil is a mineral oil consisting of a mixture of hydrocarbons of natural origin and associated impurities, such as sulphur. It exists in the liquid phase under normal surface temperatures and pressure and its physical characteristics (density, viscosity, etc.) are highly variable. It includes field or lease condensates (separator liquids) which are recovered from associated and non-associated gas where it is commingled with the commercial crude oil stream.
Natural gas liquids	NGL	NGL are the liquid or liquefied hydrocarbons recovered from natural gas in separation facilities or gas processing plants. Natural gas liquids include ethane, propane, butane (normal and iso-), (iso) pentane and pentanes plus (sometimes referred to as natural gasoline or plant condensate).
Refinery feedstocks	REFFEEDS	A refinery feedstock is a processed oil destined for further processing (e.g. straight run fuel oil or vacuum gas oil) other than blending in the refining industry. It is transformed into one or more components and/ or finished products. With further processing, it will be transformed into one or more components and/or finished products. This definition also covers returns from the petrochemical industry to the refining industry (e.g. pyrolysis gasoline, C4 fractions, gasoil and fuel oil fractions).
Additives / blending components	ADDITIVE	Additives are non-hydrocarbon substances added to or blended with a product to modify its properties, for example, to improve its combustion characteristics. Alcohols and ethers (MTBE, methyl tertiary-butyl ether) and chemical alloys such as tetraethyl lead are included here. The biomass fractions of biogasoline, biodiesel and ethanol are not included here, but under liquid biofuels. This differs from the presentation of additives in the *Oil Information* publication.
Orimulsion	ORIMUL	Emulsified oil made of water and natural bitumen.
Other hydrocarbons	NONCRUDE	This category includes synthetic crude oil from tar sands, shale oil, etc., liquids from coal liquefaction, output of liquids from natural gas conversion into gasoline and hydrogen. Orimulsion and oil shale are presented separately and not included here.
Refinery gas	REFINGAS	Refinery gas is defined as non-condensable gas obtained during distillation of crude oil or treatment of oil products (e.g. cracking) in refineries. It consists mainly of hydrogen, methane, ethane and olefins. It also includes gases which are returned from the petrochemical industry.
Ethane	ETHANE	Ethane is a naturally gaseous straight-chain hydrocarbon (C_2H_6). It is a colourless paraffinic gas which is extracted from natural gas and refinery gas streams.

Oil

Flow	Short name	Definition
Liquefied petroleum gases	LPG	Liquefied petroleum gases are the light hydrocarbon fraction of the paraffin series, derived from refinery processes, crude oil stabilisation plants and natural gas processing plants, comprising propane (C_3H_8) and butane (C_4H_{10}) or a combination of the two. They could also include propylene, butylene, isobutene and isobutylene. LPG are normally liquefied under pressure for transportation and storage.
Motor gasoline excl. bio	NONBIOGASO	Motor gasoline is light hydrocarbon oil for use in internal combustion engines such as motor vehicles, excluding aircraft. Motor gasoline is distilled between 35°C and 215°C and is used as a fuel for land based spark ignition engines. Motor gasoline may include additives, oxygenates and octane enhancers, including lead compounds such as TEL (tetraethyl lead) and TML (tetramethyl lead). Motor gasoline excluding biofuels does not include the liquid biofuel or ethanol blended with gasoline - see liquid biofuels.
Aviation gasoline	AVGAS	Aviation gasoline is motor spirit prepared especially for aviation piston engines, with an octane number suited to the engine, a freezing point of -60°C, and a distillation range usually within the limits of 30°C and 180°C.
Gasoline type jet fuel	JETGAS	Gasoline type jet fuel includes all light hydrocarbon oils for use in aviation turbine power units, which distil between 100°C and 250°C. This fuel is obtained by blending kerosenes and gasoline or naphthas in such a way that the aromatic content does not exceed 25% in volume, and the vapour pressure is between 13.7 kPa and 20.6 kPa. Additives can be included to improve fuel stability and combustibility.
Kerosene type jet fuel excl. bio	NONBIOJETK	Kerosene type jet fuel is a medium distillate used for aviation turbine power units. It has the same distillation characteristics and flash point as kerosene (between 150°C and 300°C but not generally above 250°C). In addition, it has particular specifications (such as freezing point) which are established by the International Air Transport Association (IATA). It includes kerosene blending components. Kerosene type jet fuel excluding biofuels does not include the liquid biofuels blended with jet kerosene.
Other kerosene	OTHKERO	Kerosene (other than kerosene used for aircraft transport which is included with aviation fuels) comprises refined petroleum distillate intermediate in volatility between gasoline and gas/diesel oil. It is a medium oil distilling between 150°C and 300°C.

Oil		
Flow	**Short name**	**Definition**
Gas/diesel oil excl. bio	NONBIODIES	Gas/diesel oil includes heavy gas oils. Gas oils are obtained from the lowest fraction from atmospheric distillation of crude oil, while heavy gas oils are obtained by vacuum redistillation of the residual from atmospheric distillation. Gas/diesel oil distils between 180^{o}C and 380^{o}C. Several grades are available depending on uses: diesel oil for diesel compression ignition (cars, trucks, marine, etc.), light heating oil for industrial and commercial uses, and other gas oil including heavy gas oils which distil between 380^{o}C and 540^{o}C and which are used as petrochemical feedstocks. Gas/diesel oil excluding biofuels does not include the liquid biofuels blended with gas/diesel oil – see liquid biofuels.
Fuel oil	RESFUEL	Fuel oil defines oils that make up the distillation residue. It comprises all residual fuel oils, including those obtained by blending. Its kinematic viscosity is above 10 cSt at 80^{o}C. The flash point is always above 50^{o}C and the density is always higher than 0.90 kg/l.
Naphtha	NAPHTHA	Naphtha is a feedstock destined either for the petrochemical industry (e.g. ethylene manufacture or aromatics production) or for gasoline production by reforming or isomerisation within the refinery. Naphtha comprises material that distils between 30^{o}C and 210^{o}C.
White spirit & SBP	WHITESP	White spirit and SBP are refined distillate intermediates with a distillation in the naphtha/kerosene range. White Spirit has a flash point above 30^{o}C and a distillation range of 135^{o}C to 200^{o}C. ***Industrial Spirit (SBP) comprises*** light oils distilling between 30^{o}C and 200^{o}C, with a temperature difference between 5% volume and 90% volume distillation points, including losses, of not more than 60^{o}C. In other words, SBP is a light oil of narrower cut than motor spirit. There are seven or eight grades of industrial spirit, depending on the position of the cut in the distillation range defined above.
Lubricants	LUBRIC	Lubricants are hydrocarbons produced from distillate or residue; they are mainly used to reduce friction between bearing surfaces. This category includes all finished grades of lubricating oil, from spindle oil to cylinder oil, and those used in greases, including motor oils and all grades of lubricating oil base stocks.
Bitumen	BITUMEN	Bitumen is a solid, semi-solid or viscous hydrocarbon with a colloidal structure that is brown to black in colour. It is obtained by vacuum distillation of oil residues from atmospheric distillation of crude oil. Bitumen is often referred to as asphalt and is primarily used for surfacing of roads and for roofing material. This category includes fluidised and cut back bitumen.
Paraffin waxes	PARWAX	Paraffin waxes are saturated aliphatic hydrocarbons. These waxes are residues extracted when dewaxing lubricant oils, and they have a crystalline structure which is more or less fine according to the grade. Their main characteristics are that they are colourless, odourless and translucent, with a melting point above 45^{o}C.

Oil		
Flow	**Short name**	**Definition**
Petroleum coke	PETCOKE	Petroleum coke is defined as a black solid residue, obtained mainly by cracking and carbonising of petroleum derived feedstocks, vacuum bottoms, tar and pitches in processes such as delayed coking or fluid coking. It consists mainly of carbon (90 to 95%) and has a low ash content. It is used as a feedstock in coke ovens for the steel industry, for heating purposes, for electrode manufacture and for production of chemicals. The two most important qualities are "green coke" and "calcined coke". This category also includes "catalyst coke" deposited on the catalyst during refining processes: this coke is not recoverable and is usually burned as refinery fuel.
Non-specified oil products	ONONSPEC	Other oil products not classified above (e.g. tar, sulphur and grease) are included here. This category also includes aromatics (e.g. BTX or benzene, toluene and xylene) and olefins (e.g. propylene) produced within refineries.

Gas

Flow	Short name	Definition
Natural gas	NATGAS	Natural gas comprises gases, occurring in underground deposits, whether liquefied or gaseous, consisting mainly of methane. It includes both "non-associated" gas originating from fields producing only hydrocarbons in gaseous form, and "associated" gas produced in association with crude oil as well as methane recovered from coal mines (colliery gas) or from coal seams (coal seam gas). Production represents dry marketable production within national boundaries, including offshore production and is measured after purification and extraction of NGL and sulphur. It includes gas consumed by gas processing plants and gas transported by pipeline. Quantities of gas that are re-injected, vented or flared are excluded.

Other

Flow	Short name	Definition
Industrial waste	INDWASTE	Industrial waste of non-renewable origin consists of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power. Renewable industrial waste is not included here.
Municipal waste (non-renewable)	MUNWASTEN	Municipal waste consists of products that are combusted directly to produce heat and/or power and comprises wastes produced by households, industry, hospitals and the tertiary sector that are collected by local authorities for incineration at specific installations. Renewable municipal waste is not included here.

4. GEOGRAPHICAL COVERAGE AND COUNTRY NOTES

Countries 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 the case may be.

Country/Region	Short name	Definition
Algeria	ALGERIA	
Austria	AUSTRIA	
Belarus	BELARUS	Data for Belarus are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Belgium	BELGIUM	
Brazil	BRAZIL	Brazil joined the IEA as an Association country in October 2017.
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.
Croatia	CROATIA	Data for Croatia are available starting in 1990. Prior to that, they are included in Former Yugoslavia

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In this publication, "country" refers to country or territory, as the case may be.

Country/Region	Short name	Definition
Cyprus	CYPRUS	**Note by Turkey:** The information in the report with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus" issue. **Note by all the European Union Member States of the OECD and the European Union:** The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this report relates to the area under the effective control of the Government of the Republic of Cyprus. At its seventeenth session, the Conference of the Parties decided to amend Annex I to the Convention to include Cyprus (Decision 10/CP.17). The amendment entered into force on 9 January 2013.
Ecuador	ECUADOR	
France	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 2011-2018, and excluded for earlier years. Economic indicators data for France includes the aforementioned overseas departments for the whole time series.
Guatemala	GUATEMALA	
Hungary	HUNGARY	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. Data are available starting in 1965. The Hungarian administration submitted questionnaires to the IEA Secretariat for the first time with 1993 data.
Indonesia	INDONESIA	Indonesia joined the IEA as an Association country in November 2015.
Ireland	IRELAND	
Italy	ITALY	Includes San Marino and the Holy See. .

Countries 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 the case may be.		
Country/Region	**Short name**	**Definition**
Latvia	LATVIA	Lithuania became an OECD Member in July 2018. Accordingly, Lithuania appears in the list of OECD Members and is included in the zone aggregates for data starting in 1990, starting with the 2019 edition. Prior to 1990, data for Lithuania are included in Former Soviet Union.
Lithuania	LITHUANIA	Lithuania became an OECD Member in July 2018. Accordingly, Lithuania appears in the list of OECD Members and is not included in the non-OECD aggregates for data from 1990, starting with the 2019 edition. Data for Lithuania are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Luxembourg	LUXEMBOU	
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. For data in the NONCO2 file, from 2005 onwards, all emissions other than CO2 from fuel combustion are included in Serbia.
Poland	POLAND	According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Poland is allowed to use 1988 as the base year.
Portugal	PORTUGAL	Includes the Azores and Madeira.
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.
Serbia	SERBIA	Data for Serbia are available starting in 1990. Prior to that, they are included in Former Yugoslavia. Serbia includes Kosovo from 1990 to 1999 and Montenegro from 1990 to 2004. For data in the NONCO2 file, Serbia includes Kosovo for all emissions other than CO2 from fuel combustion from 2000 onwards, and Montenegro for all emissions other than CO2 from fuel combustion from 2005 onwards.
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. A new energy data collection system was implemented in January 2001, causing some breaks in time series between 1999 and 2000.
Tunisia	TUNISIA	
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.
Uruguay	URUGUAY	

Countries

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 the case may be.

Country/Region	Short name	Definition
United States	USA	Includes the 50 states and the District of Columbia. Oil statistics as well as coal trade statistics also include Puerto Rico[1], Guam, the United States Virgin Islands, American Samoa, Johnston Atoll, Midway Islands, Wake Island and the Northern Mariana Islands. Starting with 2017 data, inputs to and outputs from electricity and heat generation include Puerto Rico.

1. Natural gas and electricity data for Puerto Rico are included under Other Non-OECD Americas in the full publication.

5. UNDERSTANDING THE IEA CO_2 EMISSIONS ESTIMATES

The importance of estimating emissions

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

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

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

The IEA estimates of CO_2 emissions from fuel combustion

Energy is at the core of the greenhouse gas estimation. It is estimated that for Annex I Parties energy accounts for 82%[1] of total GHG emissions, while for the world the share is about 60%, although shares vary greatly by country. Within energy, CO_2 from fuel combustion accounts for the largest fraction, 92% for Annex I countries, once again varying depending on the economic structure of the country.

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

The estimates of CO_2 emissions from fuel combustion presented in this publication are calculated using the IEA energy data[2] and the default methods and emission factors from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (*2006 GLs*)[3].

1. Based on data reported to the UNFCCC for 2012, excluding land-use, land-use change and forestry (LULUCF).
2. Published in World Energy Statistics (preliminary), World Energy Balances (preliminary), IEA, Paris, 2017.
3. See: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html.

Prior to 2015 the IEA used the methods and emission factors of the *Revised 1996 IPCC Guidelines*, in line with the UNFCCC recommendations for reporting under the Kyoto Protocol. The IEA implementation of the *2006 GLs* follows the decision of the 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 are discussed in Chapter 3: *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 because the IEA reviews its energy databases each year. In the light of new assessments, revisions may be made to the energy data time series for any individual country.

CO_2 emissions from fuel combustion: key concepts

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

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

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

where:

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

Emissions are then summed across all fuels and all sectors of consumption to obtain national totals. A more detailed explanation of the step by step calculation is presented in Chapter 3: *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 Chapter 3: *IEA Estimates: Changes under the 2006 IPCC Guidelines*.

- **The units may be different.**

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

Macroeconomic drivers of CO_2 emissions trends

Tables and graphs for drivers refer to the decomposition of CO_2 emissions into four driving factors (Kaya identity)[1], which is generally presented in the form:

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

where:

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

The identity expresses, for a given time, CO_2 emissions as the product of population, per capita economic output (G/P), energy intensity of the economy (E/G) and carbon intensity of the energy mix (C/E). Because of possible non-linear interactions between terms, the sum of the percentage changes of the four factors, *e.g.* $(P_y-P_x)/P_x$, 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
$$C_y/C_x = P_y/P_x \, (G/P)_y/(G/P)_x \, (C/E)_y/(C/E)_x$$

where x and y represent for example two different years.

In this publication, the Kaya decomposition is presented as:

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

where:

CO_2 = CO_2 emissions;
P = population;
GDP[2]/P = GDP/population;
TPES/GDP2 = Total Primary Energy Supply per GDP;
CO_2/TPES = CO_2 emissions per unit TPES.

Indices of all terms (1990 = 100 unless otherwise specified) are shown for each country and regional aggregate in Part II of the full publication, both in the Summary tables and in the individual country/region pages (Table 1, Key indicators, and Figure 6, CO_2 emissions and drivers). Note that in its index form, CO_2/TPES corresponds to the Energy Sector Carbon Intensity Index (ESCII)[3].

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

.

1. 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.

2. GDP based on purchasing power parities (PPP).
3. See the IEA publication Tracking Clean Energy Progress 2015.

Drivers of electricity generation emissions trends

In the full publication, graphs present the change in CO_2 emissions from electricity generation over time decomposed into the respective changes of four driving factors[1]:

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

where:

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

This can be rewritten as:

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

where:

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

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

However, due to non-linear interactions between terms, if a simple decomposition is used, the sum of the percentage changes of the four factors, e.g. $(CF_y\text{-}CF_x)/CF_x$ may not perfectly match the percentage change of total CO_2 emissions $(C_y\text{-}C_x)/C_x$. To avoid this, a more complex decomposition method is required. In this case, the logarithmic mean divisia (LMDI) method proposed by Ang (2004)[2] has been used.

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

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

where:

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

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

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

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

and:

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

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

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

1. 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.

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

6. IEA ESTIMATES: CHANGES UNDER THE 2006 IPCC GUIDELINES

The 2006 IPCC Guidelines methodology: key concepts

This section briefly presents the Tier 1 methodology to estimate CO_2 emissions from fuel combustion using the *2006 GLs*, outlining the main differences with the *1996 GLs* - used prior to the 2015 edition 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.[1]

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

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

where:

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

Emissions are then summed over all fuels.

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

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

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

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 2006 *GLs* and the 1996 *GLs* range between -13.7% (refinery gas) and + 7.3% (blast furnace gas), although for many fuels the variation is minimal, or zero. Such systematic changes are reflected in Tier 1 CO_2 emissions estimates.

Carbon oxidation factors

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

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

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

Table 1. Comparison of default carbon content values*

Kilogrammes / gigajoule

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

* "Carbon content" was referred to as the "carbon emission factor" in the *1996 GLs*.
** The *2006 GLs* also give the lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions.

Table 2. Comparison of default carbon oxidation factors*

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

* "Carbon oxidation factor" was referred to as "fraction of carbon oxidised" in the *1996 GLs*.
** The *1996 GLs* specified a carbon oxidation factor for peat used for electricity generation only.

Treatment of fuels used for non-energy purposes

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

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

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

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

* When used as feedstocks.

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

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

In the case of a complete greenhouse gas inventory covering all IPCC Source/Sink categories, any emissions associated with non-energy use of fuels would be accounted in another Source/Sink category. However, as this publication only deals with CO_2 emissions from fuel combustion, emissions associated with non-energy use of fuels are not any 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*.[1]

Assessing the overall impact of methodological changes on IEA estimates

Table 4 shows a comparison of IEA estimates of total CO_2 emissions from fuel combustion for the most recent year of available data (2014). Emissions are calculated using: i) the *1996 GLs* Sectoral Approach methodology (used prior to the 2015 edition of this publication), and ii) the *2006 GLs*[2] - which correspond to the data published in this edition.

1. 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.
2. Including the emissions which may be reallocated from Energy to IPPU under the *2006 GLs*.

Table 4. Comparison of IEA CO_2 emissions estimates for OECD countries (2014)

$MtCO_2$

Country	1996 GLs CO_2 Sectoral Approach	2006 GLs CO_2 Fuel Combustion[5]	Percent Change
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	81.6	81.5	-0.2%
Czech Republic	98.4	96.6	-1.8%
Denmark	34.7	34.5	-0.4%
Estonia	17.5	17.5	0.3%
Finland	46.4	45.3	-2.4%
France	295.8	285.7	-3.4%
Germany	734.6	723.3	-1.5%
Greece	66.4	65.9	-0.8%
Hungary	41.3	40.3	-2.6%
Iceland	2.0	2.0	0.7%
Ireland	33.7	33.9	0.5%
Israel	66.7	65.1	-2.4%
Italy	325.7	319.7	-1.8%
Japan	1 193.3	1 188.5	-0.4%
Korea	587.9	566.2	-3.7%
Luxembourg	9.2	9.2	0.9%
Mexico	432.1	430.9	-0.3%
Netherlands	166.6	148.3	-11.0%
New Zealand	33.2	31.2	-5.9%
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	-1.9%
Slovenia	12.6	12.8	1.1%
Spain	234.8	232.0	-1.2%
Sweden	38.7	37.4	-3.3%
Switzerland	37.7	37.7	0.1%
Turkey	304.8	307.1	0.8%
United Kingdom	409.0	407.8	-0.3%
United States	5 257.5	5 198.0	-1.1%
OECD Total	12 059.1	11 881.7	-1.5%

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 seventeen OECD countries, with three 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: the Netherlands (-11%) and Belgium (-8%). As emissions from non-energy use of fuels are not included in energy sector emissions under the 2006 GLs, emissions previously attributed to non-energy use of oil products and natural gas are no longer included in IEA CO_2 emissions from fuel combustion estimates for these countries. Eight countries, presented an increase in emissions of 1% or less in 2014. This occurred in countries where reported non-energy use of fuels was comparatively lower, and had a smaller influence on total emissions. As a result, impact of assuming 100% oxidation under the 2006 GLs (previously 98-99.5% under the 1996 GLs) was observed.

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

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

7. UNITS AND CONVERSIONS

General conversion factors for energy

To:	TJ	Gcal	Mtoe	MBtu	GWh
From:	multiply by:				
terajoule (TJ)	1	2.388×10^{2}	2.388×10^{-5}	9.478×10^{2}	2.778×10^{-1}
gigacalorie (Gcal)	4.187×10^{-3}	1	1.000×10^{-7}	3.968	1.163×10^{-3}
million tonnes of oil equivalent (Mtoe)	4.187×10^{4}	1.000×10^{7}	1	3.968×10^{7}	1.163×10^{4}
million British thermal units (MBtu)	1.055×10^{-3}	2.520×10^{-1}	2.520×10^{-8}	1	2.931×10^{-4}
gigawatt hour (GWh)	3.600	8.598×10^{2}	8.598×10^{-5}	3.412×10^{3}	1

Conversion factors for mass

To:	kg	T	lt	st	lb
From:	multiply by:				
kilogramme (kg)	1	1.000×10^{-3}	9.842×10^{-4}	1.102×10^{-3}	2.205
tonne (t)	1.000×10^{3}	1	9.842×10^{-1}	1.102	2.205×10^{3}
long ton (lt)	1.016×10^{3}	1.016	1	1.120	2.240×10^{3}
short ton (st)	9.072×10^{2}	9.072×10^{-1}	8.929×10^{-1}	1	2.000×10^{3}
pound (lb)	4.536×10^{-1}	4.536×10^{-4}	4.464×10^{-4}	5.000×10^{-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	8.327×10^{-1}	2.381×10^{-2}	1.337×10^{-1}	3.785	3.785×10^{-3}
U.K. gallon (gal U.K.)	1.201	1	2.859×10^{-2}	1.605×10^{-1}	4.546	4.546×10^{-3}
barrel (bbl)	4.200×10^{1}	3.497×10^{1}	1	5.615	1.590×10^{2}	1.590×10^{-1}
cubic foot (ft^3)	7.481	6.229	1.781×10^{-1}	1	2.832×10^{1}	2.832×10^{-2}
litre (l)	2.642×10^{-1}	2.200×10^{-1}	6.290×10^{-3}	3.531×10^{-2}	1	1.000×10^{-3}
cubic metre (m^3)	2.642×10^{2}	2.200×10^{2}	6.290	3.531×10^{1}	1.000×10^{3}	1

Decimal prefixes

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

Tonne of CO_2

The reporting guidance in the *2006 GLs* asks that CO_2 emissions and removals generally 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.

8. ABBREVIATIONS

Btu	British thermal unit
BKB	Brown coal briquettes (braunkohlebriketts)
Gg	gigagramme
GJ	gigajoule
GWh	gigawatt hour
J	joule
kcal	kilocalorie
kg	kilogramme
kt	thousand tonnes
ktoe	thousand tonnes of oil equivalent
kWh	kilowatt hour
MJ	megajoule
Mt	million tonnes
Mtoe	million tonnes of oil equivalent
$MtCO_2$	million tonnes of carbon dioxide
m^3	cubic metre
PJ	petajoule
t	metric ton = tonne = 1 000 kg
tC	tonne of carbon
TJ	terajoule
toe	tonne of oil equivalent = 10^7 kcal
CC	carbon content
CEF	carbon emission factor
COF	carbon oxidation factor
CHP	combined heat and power
GCV	gross calorific value
GDP	gross domestic product
NCV	net calorific value
PPP	purchasing power parity
TPES	total primary energy supply
Convention	United Nations Framework Convention on Climate Change
COP	Conference of the Parties to the Convention
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
e	estimated
..	not available
x	not applicable
+	growth greater than 1 000%
CO_2	carbon dioxide