



# **EMISSION FACTORS 2023**

# **DATABASE DOCUMENTATION**

This document contains a description of the 2023 edition of the IEA Emissions factors data package. This Excel file includes ten Excel sheets with a set of carbon emission factors for electricity and electricity/heat generation. The factors are described below:

- CO<sub>2</sub> emission factors for electricity and heat generation for world countries (in CO<sub>2</sub> per kWh, 1990 to 2021). (Sheet CO2 KWH ELE & HEAT)
- Provisional 2022 CO<sub>2</sub> emission factors for electricity and electricity/heat generation, based on provisional electricity generation data (for all OECD countries and selected non-OECD countries). (Sheets CO2 KWH ELE & HEAT and CO2KWH ELE)
- CO<sub>2</sub> emission factors for electricity only generation (CHP electricity included) for world countries (in CO<sub>2</sub> per kWh, 1990 to 2021). (Sheet CO2KWH ELE)

Note: the above emission factors are given for electricity and electricity/heat generation for: total electricity generation; generation from oil, coal, gas and from non-renewable wastes, as well as from biofuels. (Sheets CO2 KWH ELE & HEAT and CO2KWH ELE)

- CH<sub>4</sub> and N<sub>2</sub>O emission factors for electricity generation (based on default IPCC factors) (in CO<sub>2</sub>eq per kWh, 1990 to 2021). (Sheets CH4 factors and N2O factors)
- Adjustment factors for indirect emissions induced by electricity trade between countries (for OECD countries, 1990 to 2021). (Sheet Trade adjustment)
- Adjustment factors for emissions associated to transmission and distribution losses of electricity in the grid (for countries with available data, 1990 to 2021). (Sheet T&D losses adjustment)
- Emission factors by fuel from direct combustion in final consumption sectors, other than electricity and heat production (1990 to 2021). (Sheet Direct combustion factors)

Note: The following additional data will be included in this database by October 2023, to provide more information on upstream emissions factors (pilot version):

- Total upstream emission factors for world countries (in CO<sub>2</sub>eq per kWh, 2021) (Sheet Total upstream factors)
  - Fuel-cycle emission factors (in CO<sub>2</sub>eq per kWh, 2021) (Sheet Fuel-cycle factors)
- Adjustment factors for emissions associated to transmission and distribution losses of electricity in the grid from a life cycle perspective (for countries with available data, 2021). (Sheet Total T&D factors).

Please address your inquiries to [emissions@iea.org](mailto:emissions@iea.org)

*Please note that all IEA data are subject to the following Terms and Conditions found on the IEA's website at:*  
<https://www.iea.org/terms>.

*A list of answers to frequently asked questions on this product and its uses is available at:*  
[https://iea.blob.core.windows.net/assets/1020982c-3b26-4eab-bf05-c877c64c9a62/EmissionsFactors\\_FAQ\\_vf.pdf](https://iea.blob.core.windows.net/assets/1020982c-3b26-4eab-bf05-c877c64c9a62/EmissionsFactors_FAQ_vf.pdf)

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# 1. WHAT'S NEW

## Upcoming: Upstream Life cycle Emission Factors

The IEA is planning to disseminate a new pilot database including the life cycle emission factors corresponding to national electricity grids. The pilot database assesses and compiles reliable data to provide a global harmonized database, in near future on an annual basis. This database has been developed by merging data from multiple sources, namely: IEA statistics, IEA modelling work, IEA-performed LCA harmonization, alongside a [life cycle assessment project](#) carried out by the US National Renewable Energy Laboratory (NREL).

The pilot database (*IEA Life Cycle Upstream Emission Factors*) will be released free of charge by October 2023. Following the release of this database, the *Emissions Factors* database will be amended to include the factors published in the pilot database. The emission intensities included in the pilot database are listed below:

### 1. Total upstream emission factors (in CO<sub>2</sub>eq per kWh):

Correspond to the total upstream emissions intensity associated with the national electricity generation. This is computed using the overall life cycle footprint of the electricity generation technologies/fuels excluding direct emissions from combustion of the fuels at the generation point and the respective share of all fuels/technologies in the generation mix. Data cover all world countries for year 2021. Additionally, 2022 figures will be included for OECD countries and selected non-OECD countries based on provisional electricity generation data.

### 2. Fuel-cycle emission factors (in CO<sub>2</sub>eq per kWh):

Correspond to the fuel-cycle emissions intensity associated with the national electricity generation. This is computed using the life cycle emissions intensity corresponding to the fossil fuels, uranium and biofuels fuel-cycles and the respective share of all fuels/technologies in the generation mix. The non-fuel cycle life cycle emissions and the direct emissions from combustion of the fuels at the generation point are excluded. Data cover world countries for year 2021. Additionally, 2022 figures will be included for OECD countries and selected non-OECD countries based on provisional electricity generation data.

### 3. Life cycle adjustment factors for transmission and distribution losses (in CO<sub>2</sub>eq per kWh):

Include the adjustments to emission intensities associated with transmission and distribution losses of electricity in the grid developed from a life cycle perspective. Data will be included for world countries for year 2021.

## Frequently asked questions

Frequently asked questions on different topics covering product description, data content, geographical coverage, purchase and licensing for the IEA Emissions Factors database are now available at the following link:

[https://iea.blob.core.windows.net/assets/1020982c-3b26-4eab-bf05-c877c64c9a62/EmissionsFactors\\_FAQ\\_vf.pdf](https://iea.blob.core.windows.net/assets/1020982c-3b26-4eab-bf05-c877c64c9a62/EmissionsFactors_FAQ_vf.pdf)

For questions not covered in the FAQs, please contact us at [emissions@iea.org](mailto:emissions@iea.org)

## Geographical coverage

Lithuania joined the IEA in February 2022; accordingly, starting with this edition, Lithuania is included in the IEA member countries aggregate (IEA Total) for data starting in 1990.

Latvia, which is currently seeking accession to full IEA membership (Accession country), and Kenya and Senegal, which joined the IEA as Association countries in June 2023, are now included in the IEA and Accession/Association countries aggregate (IEA Family).

The IEA continues to expand the coverage of its statistics reports and encourages more countries to collaborate on data exchange. For this 2023 edition, the IEA Secretariat has made detailed data available for Burkina Faso, Chad, Greenland, Mali, Mauritania and the Palestinian Authority. Greenland has now been included as an additional memo country. The other five countries were already covered by this database as part of the supplementary countries not covered explicitly in the IEA World energy balances, based on more aggregated energy data from the United Nations Statistics Division (UNSD) Energy Balances publication. With the availability of the energy data to the IEA as of this year, the emission estimates corresponding to these countries are now based on the IEA World energy balances data. As a result of this change in source which also corresponds to a change in the methodology to estimate the emissions, there are notable revisions to the respective historical emission estimates.

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

Old longname	New longname	Shortname	Old shortname (if changed)
Memo*: Burkina Faso	Memo: Burkina Faso	MBURKINAF	
Memo*: Chad	Memo: Chad	MCHAD	
Memo*: Mali	Memo: Mali	MMALI	
Memo*: Palestinian Authority	Memo: Palestinian Authority	MPALESTINE	
Memo*: Mauritania	Memo: Mauritania	MMAURITANI	

## Geographical coverage for the provisional year

In the 2023 edition, provisional 2022 data for selected non-OECD countries are added to those for OECD countries.

Below is the list of the datapoints added, by country and type of indicator.

Flow	Countries
Emissions per kWh of electricity only (gCO <sub>2</sub> eq per kWh)	Argentina, Azerbaijan, Bangladesh, Benin, Plurinational State of Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, People's Republic of China, Cote d'Ivoire, Croatia, Cyprus, Ecuador, Egypt, El Salvador, Georgia, India, Indonesia, Kenya, Kosovo, Kyrgyzstan, Malta, Mauritius, Republic of Moldova, Montenegro, Morocco, Namibia, Republic of North Macedonia, Romania, Serbia, Singapore, South Africa, United Republic of Tanzania, Thailand, Tunisia, Zambia, Zimbabwe
Emissions per kWh of electricity and heat (gCO <sub>2</sub> per kWh)	Argentina, Azerbaijan, Bosnia and Herzegovina, Brazil, Bulgaria, Croatia, Cyprus, Georgia, Kosovo, Malta, Republic of Moldova, Montenegro, Morocco, Republic of North Macedonia, Romania, Serbia, Tunisia.

## 2. DEFINITIONS

Electricity and Heat Output and Emissions per kWh	
Flow	Definition
Emissions per kWh of electricity only (gCO <sub>2eq</sub> per kWh)	<p>This ratio is expressed in grammes of CO<sub>2eq</sub> per kWh.</p> <p>Characteristics This ratio is based on total emissions from fossil fuels consumed for electricity generation, in both electricity-only and combined heat and power plants (CHP), divided by output of electricity generated from all fossil and non-fossil sources. Both main activity producers and autoproducers have been included in the calculation.</p> <p>The calculation methodology is available in part III.</p>
Emissions per kWh of electricity and heat (gCO <sub>2eq</sub> per kWh)	<p>This ratio is based on total GHG emissions from fossil fuels consumed for electricity and heat generation divided by the output of electricity and heat (in kWh) from all fossil and non-fossil sources. It includes electricity-only plants, combined heat and power plants, and heat-only plants.</p> <p>Both main activity producers and autoproducers have been included in the calculation.</p> <p>The calculation methodology is available in part III.</p>
Trade adjustment (gCO <sub>2</sub> /kWh)	<p>Part of the electricity consumed in one country may have been generated in another one. Similarly, part of the electricity generated in one country can be exported to other countries. Therefore, adjustments may be done to the emission factors calculated above to account for electricity trade. Such adjustments are based on the share of electricity that is imported or exported compared to the domestic supply. The data needed to calculate such adjustment are only available for OECD countries. This adjustment can be positive or negative.</p> <p>The calculation methodology is available in part III.</p>
Transmission and distribution losses adjustment (gCO <sub>2</sub> /kWh)	<p>As electricity is transmitted through a grid from the generation point to the consumption point, losses can occur for different reasons - they usually represent between 5 and 15% of the energy transmitted, mainly depending on the distance of the lines. Basically, for each kWh being consumed, a higher amount had to be generated.</p> <p>The calculation methodology is available in part III.</p>
Direct combustion factors (kgCO <sub>2eq</sub> /m <sup>3</sup> or gCO <sub>2eq</sub> /m <sup>3</sup> or kgCO <sub>2eq</sub> /kg or gCO <sub>2eq</sub> /kg)	<p>These factors are computed as weighted average of the consumption across all sectors excluding electricity generation. The included sectors comprise of energy industry own use, industry, transport, residential, commercial and public services, agriculture/forestry, fishing and other non-specified final consumption sector.</p>

<b>Electricity and Heat Output and Emissions per kWh</b>	
<b>Flow</b>	<b>Definition</b>
Total upstream emission factors (CO <sub>2eq</sub> per kWh)	<p>Correspond to the total upstream emissions intensity associated with the electricity generation. This is equal to the overall life cycle footprint of the electricity generation technology excluding direct emissions from combustion of the fuels at the generation point.</p> <p>Note: This flow will be added to the database following the release of the pilot database called IEA Life Cycle Upstream Emission Factors by October 2023.</p>
Fuel-cycle emission factors (CO <sub>2eq</sub> per kWh)	<p>Include the life cycle emissions intensity corresponding to the fuel cycle including fossil fuels, uranium and biofuels. The non-fuel cycle life cycle emissions and the direct emissions from combustion of the fuels at the generation point are excluded.</p> <p>Note: This flow will be added to the database following the release of the pilot database called IEA Life Cycle Upstream Emission by October 2023.</p>
Life cycle adjustment factors for transmission and distribution losses (CO <sub>2eq</sub> per kWh)	<p>Include the emission intensities associated with transmission and distribution losses of electricity in the grid developed from a life cycle perspective.</p> <p>Note: This flow will be added to the database following the release of the pilot database called IEA Life Cycle Upstream Emission Factors by October 2023.</p>



GHG		
GHG	Short name	Definition
CO2	CO2	
CH4	CH4	The emission factors are converted from gCH <sub>4</sub> and gN <sub>2</sub> O to gCO <sub>2eq</sub> using the 100-year Global Warming Potential (GWP). For the purpose of comparability with international data submission guidelines, the factors from the 4th Assessment of the IPCC are used. 1gCH <sub>4</sub> = 25 gCO <sub>2eq</sub>
N2O	N2O	The emission factors are converted from gCH <sub>4</sub> and gN <sub>2</sub> O to gCO <sub>2eq</sub> using the 100-year Global Warming Potential (GWP). For the purpose of comparability with international data submission guidelines, the factors from the 4th Assessment of the IPCC are used. 1gN <sub>2</sub> O = 298 gCO <sub>2eq</sub>

Aggregated product categories		
Flow	Short name	Definition
Total	TOTAL	TOTAL = the total of all CO <sub>2</sub> emissions from fuel combustion, <i>i.e.</i> COAL + OIL + NATGAS + OTHER.
Coal, peat and oil shale	COAL	Coal, peat and oil shale includes all coal, both primary (hard coal, brown coal, anthracite, coking coal, other bituminous coal, sub-bituminous coal and lignite) and derived fuels (patent fuel, coke oven coke, gas coke, coal tar, BKB, gas works gas, coke oven gas, blast furnace gas and other recovered gases). Peat, peat products and oil shale are also aggregated in this category.
Oil	OIL	Oil includes crude oil, natural gas liquids, refinery feedstocks, additives/blending components, orimulsion, other hydrocarbons, refinery gas, ethane, LPG, motor gasoline excl. biofuels, aviation gasoline, gasoline type jet fuel, kerosene type jet fuel excl. biofuels, kerosene, gas/diesel oil excl. biofuels, fuel oil, naphtha, white spirit, lubricants, bitumen, paraffin waxes, petroleum coke and non-specified oil products.
Natural gas	NATGAS	Gas represents natural gas. It excludes natural gas liquids.
Non-renewables wastes	OTHER	Other includes industrial waste and non-renewable municipal waste.
Memo: Biofuels and renewable wastes	BIOPROD	Includes biofuels (primary solid biofuels, biogases, biogasoline, biodiesels, bio jet kerosene and other liquid biofuels) and renewable wastes.

### 3. GEOGRAPHICAL COVERAGE AND COUNTRY NOTES

#### Countries and regions

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

Country/Region	Short name	Definition
World	WORLD	Includes OECD Total; Africa; non-OECD Asia (excluding China); China (P.R. of China and Hong Kong, China); Non-OECD Americas; Middle East; Non-OECD Europe and Eurasia; World aviation bunkers and World marine bunkers. It is also the sum of Africa (UN), Americas (UN), Asia (UN), Europe (UN), Oceania (UN), World aviation bunkers and World marine bunkers.  It is also the sum of Africa, Americas, Asia, Europe, Oceania, World aviation bunkers and World marine bunkers.
Memo: OECD Total	OECDTOT	Includes Australia; Austria; Belgium; Canada; Chile; Colombia; Costa Rica; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Korea; Latvia; Lithuania; Luxembourg; Mexico; the Netherlands; New Zealand; Norway; Poland; Portugal; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; the Republic of Türkiye; the United Kingdom and the United States  Estonia, Latvia, Lithuania and Slovenia are included starting in 1990. Prior to 1990, data for Estonia, Latvia and Lithuania are included in Former Soviet Union and data for Slovenia in Former Yugoslavia.
OECD Americas	OECDAM	Includes Canada; Chile; Colombia; Costa Rica; Mexico and the United States.
OECD Asia Oceania	OECDAO	Includes Australia, Israel <sup>1</sup> , Japan, Korea and New Zealand.

<sup>1</sup>. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

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Country/Region	Short name	Definition
OECD Europe	OECD EUR	Includes Austria; Belgium; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Lithuania; Luxembourg; the Netherlands; Norway; Poland; Portugal; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; the Republic of Türkiye and the United Kingdom.  Estonia, Latvia, Lithuania and Slovenia are included starting in 1990. Prior to 1990, data for Estonia, Latvia and Lithuania are included in Former Soviet Union and data for Slovenia in Former Yugoslavia.
Africa	AFRICA	Includes Algeria, Angola, Benin, Botswana, Cameroon, Republic of Congo (Congo) <sup>2</sup> , Côte d'Ivoire, Democratic Republic of Congo, Egypt, Equatorial Guinea, Eritrea, the Kingdom of Eswatini; Ethiopia, Gabon, Ghana, Kenya, Libya, Madagascar, Mauritius, Morocco, Mozambique, Namibia (from 1991), Niger, Nigeria, Rwanda; Senegal, South Africa, South Sudan (from 2012), Sudan, United Republic of Tanzania, Uganda; Togo, Tunisia, Zambia, Zimbabwe and <b>Other Africa</b> .  Note that Africa is identical to Memo: Africa (UN).
Non-OECD Americas	LATAMER	Includes Argentina; Plurinational State of Bolivia (Bolivia); Brazil; Colombia; Costa Rica; Cuba; Curaçao <sup>3</sup> ; Dominican Republic; Ecuador; El Salvador; Guatemala; Guyana; Haiti; Honduras; Jamaica; Nicaragua; Panama; Paraguay; Peru; Suriname (from 2000); Trinidad and Tobago; Uruguay; Bolivarian Republic of Venezuela (Venezuela) and <b>Other non-OECD Americas</b> .
Middle East	MIDEAST	Includes Bahrain, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Yemen.

<sup>2</sup>. Country short names are included in parentheses.

<sup>3</sup>. Netherlands Antilles was dissolved on 10 October 2010, resulting in two new constituent countries, Curaçao and Sint Maarten, with the remaining islands joining the Netherlands as special municipalities. From 2012 onwards, data now account for the energy statistics of Curaçao Island only. Prior to 2012, data remain unchanged and still cover the entire territory of the former Netherlands Antilles.

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Country/Region	Short name	Definition
Non-OECD Europe and Eurasia	EURASIA	Includes Albania; Armenia; Azerbaijan; Belarus; Bosnia and Herzegovina; Bulgaria; Croatia; Cyprus <sup>4</sup> ; Georgia; Gibraltar; Kazakhstan; Kosovo <sup>5</sup> ; Kyrgyzstan; Malta; Republic of Moldova (Moldova); Montenegro; the Republic of North Macedonia (North Macedonia); Romania; Russian Federation; Serbia <sup>6</sup> ; Tajikistan; Turkmenistan; Ukraine; Uzbekistan; Former Soviet Union (prior to 1990) and Former Yugoslavia (prior to 1990). Prior to 1990, data for Estonia, Latvia and Lithuania are included in Former Soviet Union and data for Slovenia in Former Yugoslavia.
Non-OECD Asia (excluding China)	ASIA	Includes Bangladesh, Brunei Darussalam, Cambodia (from 1995), DPR of Korea, India, Indonesia, Lao People’s Democratic Republic (from 2000); Malaysia, Mongolia (from 1985), Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Chinese Taipei, Thailand, Viet Nam and <b>Other non-OECD Asia</b> .
China (including Hong Kong, China)	CHINAREG	Includes the People's Republic of China and Hong Kong, China.
World Aviation Bunkers	WORLDAV	World aviation bunkers represents the sum of International Aviation Bunkers from all countries.
World Marine Bunkers	WORLDMAR	World marine bunkers represents the sum of International Marine Bunkers from all countries.
Albania	ALBANIA	
Algeria	ALGERIA	
Angola	ANGOLA	

**4. Note by Turkey:**

*The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the “Cyprus issue”.*

**Note by all the European Union Member States of the OECD and the European Union:**

*The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.*

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

<sup>6</sup> Serbia includes Montenegro until 2004 and Kosovo until 1999.

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Country/Region	Short name	Definition
Argentina	ARGENTINA	Argentina is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Armenia	ARMENIA	Data for Armenia are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Australia	AUSTRALI	Excludes the overseas territories. Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y-1 and ends on 30 June Y are labelled as year Y.
Austria	AUSTRIA	
Azerbaijan	AZERBAIJAN	Data for Azerbaijan are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Bahrain	BAHRAIN	
Bangladesh	BANGLADESH	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y-1 and ends on 30 June Y are labelled as year Y.
Belarus	BELARUS	Data for Belarus are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Belgium	BELGIUM	
Benin	BENIN	
Bolivia	BOLIVIA	
Bosnia and Herzegovina	BOSNIAHERZ	Data for Bosnia and Herzegovina are available starting in 1990. Prior to that, they are included in Former Yugoslavia.
Botswana	BOTSWANA	
Brazil	BRAZIL	Brazil is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Brunei Darussalam	BRUNEI	
Bulgaria	BULGARIA	According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Bulgaria is allowed to use 1988 as the base year.

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Country/Region	Short name	Definition
Cambodia	CAMBODIA	Data for Cambodia are available starting in 1995. Prior to that, they are included in Other non-OECD Asia.
Cameroon	CAMEROON	
Canada	CANADA	
Chile	CHILE	Data start in 1971. Chile is currently seeking accession to full IEA membership (Accession country), therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
People’s Republic of China	CHINA	People’s Republic of China is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Colombia	COLOMBIA	Colombia is currently seeking accession to full IEA membership (Accession country), therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family), for data starting in 1971 and for the entire time series.
Congo	CONGO	
Costa Rica	COSTARICA	Costa Rica joined the OECD in May 2021; data are now included in the applicable OECD aggregates.
Côte d’Ivoire	COTEIVOIRE	
Croatia	CROATIA	Data for Croatia are available starting in 1990. Prior to that, they are included in Former Yugoslavia.
Cuba	CUBA	
Curaçao	CURACAO	The Netherlands Antilles was dissolved on 10 October 2010, resulting in two new constituent countries, Curaçao and Sint Maarten, with the remaining islands joining the Netherlands as special municipalities. From 2012 onwards, data now account for the energy statistics of Curaçao Island only. Prior to 2012, data remain unchanged and still cover the entire territory of the former Netherlands Antilles.

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Country/Region	Short name	Definition
Cyprus	CYPRUS	<p><b>Note by the Republic of Türkiye (Türkiye):</b> The information in the report with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the “Cyprus” issue.</p> <p><b>Note by all the European Union Member States of the OECD and the European Union:</b> The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this report relates to the area under the effective control of the Government of the Republic of Cyprus.</p> <p>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.</p>
Czech Republic	CZECH	Data start in 1971.
Democratic People’s Republic of Korea	KOREADPR	
Democratic Republic of Congo	CONGOREP	
Denmark	DENMARK	Excludes Greenland and the Danish Faroes, except prior to 1990, where data on oil for Greenland were included with the Danish statistics.
Dominican Republic	DOMINICANR	
Ecuador	ECUADOR	
Egypt	EGYPT	By convention, data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y. Egypt is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
El Salvador	ELSALVADOR	

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Country/Region	Short name	Definition
Equatorial Guinea	EQGUINEA	Data start in 1981.
Eritrea	ERITREA	Data for Eritrea are available from 1992. Prior to that, they are included in Ethiopia.
Estonia	ESTONIA	Data start in 1990. Prior to that, they are included within Former Soviet Union.
Ethiopia	ETHIOPIA	Data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
Kingdom of Eswatini	ESWATINI	
Finland	FINLAND	
France	FRANCE	Includes Monaco and excludes the overseas collectivities: New Caledonia; French Polynesia; Saint Barthélemy; Saint Martin; Saint Pierre and Miquelon; and Wallis and Futuna. Energy data for the following overseas departments: Guadeloupe; French Guiana; Martinique; Mayotte; and Réunion are included for the years from 2011 onwards, and excluded for earlier years.
Gabon	GABON	
Georgia	GEORGIA	Data for Georgia are available starting in 1990. Prior to that, they are included in Former Soviet Union.
Germany	GERMANY	Includes the new federal states of Germany from 1970 onwards.
Ghana	GHANA	
Gibraltar	GIBRALTAR	
Greece	GREECE	
Guatemala	GUATEMALA	
Guyana	GUYANA	
Haiti	HAITI	
Honduras	HONDURAS	
Hong Kong, China	HONGKONG	



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Country/Region	Short name	Definition
Hungary	HUNGARY	Data starts in 1965. According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Hungary is allowed to use average 1985-1987 as the base year.
Iceland	ICELAND	
India	INDIA	Data are reported on a fiscal year basis. By convention, data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y. This convention is different from the one used by Government of India, whereby fiscal year starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y+1. India is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Indonesia	INDONESIA	Indonesia is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Islamic Republic of Iran	IRAN	Data are reported on the Iranian fiscal year basis. Data for the fiscal year that starts on 20 March Y and ends on 19 March Y+1 are labelled as year Y.
Iraq	IRAQ	
Ireland	IRELAND	
Israel	ISRAEL	The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law. Israel is currently seeking accession to full IEA membership (Accession country), therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Italy	ITALY	Includes San Marino and the Holy See.
Jamaica	JAMAICA	

## Countries and regions

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Country/Region	Short name	Definition
Japan	JAPAN	Includes Okinawa. Starting 1990, data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y.
Jordan	JORDAN	
Kazakhstan	KAZAKHSTAN	Data for Kazakhstan are available starting in 1990. Prior to that they are included in Former Soviet Union.
Kenya	KENYA	Kenya joined the IEA as an Association country in June 2023. Accordingly, it is included in the IEA and Accession/Association countries aggregate (IEA Family)
Korea	KOREA	
Kosovo	KOSOVO	This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo’s declaration of independence. Data for Kosovo are available starting in 2000. From 1990-1999, data for Kosovo are included in Serbia. Prior 1990 that, they are included in Former Yugoslavia.
Kuwait	KUWAIT	
Kyrgyzstan	KYRGYZSTAN	
Latvia	LATVIA	
Lao People's Democratic Republic	LAO	Data start in 2000. Prior to that, they are included in the Other non-OECD Asia region.
Lebanon	LEBANON	
Libya	LIBYA	
Lithuania	LITHUANIA	Lithuania joined the IEA in February 2022; however, its data have not been included in the IEA member countries aggregate (IEA total) for this edition. They are included in the IEA and Accession/Association countries aggregate (IEA Family).

## Countries and regions

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Country/Region	Short name	Definition
Luxembourg	LUXEMBOU	
Madagascar	MADAGASCAR	
Malaysia	MALAYSIA	
Malta	MALTA	At its fifteenth session, the Conference of the Parties decided to amend Annex I to the Convention to include Malta (Decision 3/CP.15). The amendment entered into force on 26 October 2010.
Mauritius	MAURITIUS	
Mexico	MEXICO	
Republic of Moldova	MOLDOVA	
Mongolia	MONGOLIA	
Montenegro	MONTENEGRO	Data for Montenegro are available starting in 2005. From 1990 to 2004, data for Montenegro are included in Serbia. Prior to 1990, data are included in Former Yugoslavia.
Morocco	MOROCCO	Morocco is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Mozambique	MOZAMBIQUE	
Myanmar	MYANMAR	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y
Namibia	NAMIBIA	Electricity data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 31 June Y+1 are labelled as year Y. Data for Namibia are available starting in 1991. Prior to that, they are included in Other Africa.
Nepal	NEPAL	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
Netherlands	NETHLAND	Excludes Suriname, Aruba and the other former the Netherlands Antilles (Bonaire, Curaçao, Saba, Saint Eustatius and Sint Maarten).

## Countries and regions

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Country/Region	Short name	Definition
New Zealand	NZ	
Nicaragua	NICARAGUA	
Niger	NIGER	
Nigeria	NIGERIA	
Republic of North Macedonia	NORTHMACED	.
Norway	NORWAY	Discrepancies between Reference and Sectoral Approach estimates and the difference in the resulting growth rates arise from statistical differences between supply and consumption data for oil and natural gas. For Norway, supply of these fuels is the residual of two very large and opposite terms, production and exports.
Oman	OMAN	
Pakistan	PAKISTAN	Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y and ends on 30 June Y+1 are labelled as year Y.
Panama	PANAMA	
Paraguay	PARAGUAY	
Peru	PERU	
Philippines	PHILIPPINES	
Poland	POLAND	According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Poland is allowed to use 1988 as the base year.
Portugal	PORTUGAL	Includes the Azores and Madeira.
Qatar	QATAR	
Romania	ROMANIA	According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Romania is allowed to use 1989 as the base year.
Russian Federation	RUSSIA	
Rwanda	RWANDA	
Saudi Arabia	SAUDIARABI	

## Countries and regions

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Country/Region	Short name	Definition
Senegal	SENEGAL	Senegal joined the IEA as an Association country in June 2023. Accordingly, it is included in the IEA and Accession/Association countries aggregate (IEA Family)
Serbia	SERBIA	. Serbia includes Kosovo from 1990 to 1999 and Montenegro from 1990 to 2004.
Singapore	SINGAPORE	Singapore is currently an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Slovak Republic	SLOVAKIA	
Slovenia	SLOVENIA	Data for Slovenia are available from 1990. Prior to that, they are included in Former Yugoslavia in the full publication. According to the provisions of Article 4.6 of the Convention and Decisions 9/CP.2 and 11/CP.4, Slovenia is allowed to use 1986 as the base year.
South Africa	SOUTHAFRIC	Nuclear data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y. South Africa is currently an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
South Sudan	SSUDAN	Data for South Sudan are available starting in 2012. Prior to that, they are included in Sudan.
Spain	SPAIN	Includes the Canary Islands.
Sri Lanka	SRILANKA	
Sudan	SUDAN	South Sudan became an independent country on 9 July 2011. Data for South Sudan are available from 2012. Prior to 2012, they are included in Sudan.
Suriname	SURINAME	Data for Suriname are available from 2000. Prior to 2000, data for Suriname are presented in Other non-OECD Americas.
Sweden	SWEDEN	

## Countries and regions

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Country/Region	Short name	Definition
Switzerland	SWITLAND	Includes Liechtenstein for the oil data. Data for other fuels do not include Liechtenstein.
Chinese Taipei	TAIPEI	
Tajikistan	TAJIKISTAN	
United Republic of Tanzania	TANZANIA	
Thailand	THAILAND	Thailand is an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
Togo	TOGO	
Trinidad and Tobago	TRINIDAD	
Tunisia	TUNISIA	
Republic of Türkiye	TURKEY	
Turkmenistan	TURKMENIST	
Ukraine	UKRAINE	Ukraine is currently an IEA Association country, therefore it is included in the IEA and Accession/Association countries aggregate (IEA Family).
United Arab Emirates	UAE	
Uganda	UGANDA	
United Kingdom	UK	Shipments of coal and oil to the Channel Islands and the Isle of Man from the United Kingdom are not classed as exports. Supplies of coal and oil to these islands are, therefore, included as part of UK supply. Exports of natural gas to the Isle of Man are included with the exports to Ireland.  As of the 1st of February 2020, the United Kingdom (UK) is no longer part of the European Union (EU) and was into a transition period until 31 December 2020.  The UK is excluded from the EU27 2020 aggregate, but still included in the EU28 aggregate for reference.

## Countries and regions

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Country/Region	Short name	Definition
United States	USA	Includes the 50 states and the District of Columbia but generally excludes all territories, and all trade between the U.S. and its territories. Oil statistics include Guam, Puerto Rico <sup>7</sup> and the United States Virgin Islands; trade statistics for coal include international trade to and from Puerto Rico and the United States Virgin Islands. Starting with 2017 data, inputs to and outputs from electricity and heat generation include Puerto Rico.
Uruguay	URUGUAY	
Uzbekistan	UZBEKISTAN	
Venezuela	VENEZUELA	
Viet Nam	VIETNAM	
Yemen	YEMEN	
Zambia	ZAMBIA	
Zimbabwe	ZIMBABWE	
Former Soviet Union (if no detail)	FSUND	Before 1990, includes Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.
Former Yugoslavia (if no detail)	YUGOND	
Other Africa	OTHERAFRIC	Includes Burkina Faso; Burundi; Cape Verde; Central African Republic; Chad; Comoros; Djibouti; Gambia; Guinea; Guinea-Bissau; Lesotho; Liberia; Malawi; Mali; Mauritania; Namibia (until 1990); Réunion (until 2010); Sao Tome and Principe; Seychelles; Sierra Leone and Somalia.

<sup>7</sup>. Inputs to and outputs from electricity and heat generation up to 2016, and natural gas data for the entire time series for Puerto Rico are included under Other non-OECD Americas.

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Country/Region	Short name	Definition
Other non-OECD Americas	OTHERLATIN	Includes Anguilla, Antigua and Barbuda; Aruba; the Bahamas; Barbados; Belize; Bermuda; Bonaire (from 2012); the British Virgin Islands; the Cayman Islands; Dominica; the Falkland Islands (Malvinas); French Guiana (until 2010); Grenada; Guadeloupe (until 2010); Martinique (until 2010); Montserrat; Puerto Rico (for natural gas and – up to 2016 data - electricity) <sup>11</sup> ; Saba (from 2012); Saint Eustatius (from 2012); Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Sint Maarten (from 2012); Suriname (until 1999); the Turks and Caicos Islands.
Other non-OECD Asia	OTHERASIA	Includes Afghanistan; Bhutan; Cambodia (until 1994); Cook Islands; Fiji; French Polynesia; Kiribati; Lao People’s Democratic Republic (until 1999); Macau, China; Maldives; Mongolia (until 1984); New Caledonia; Palau (from 1994); Papua New Guinea; Samoa; Solomon Islands; Timor Leste; Tonga and Vanuatu.
Burkina Faso*	MBURKINFA	Burkina Faso data are also included in the Other Africa region.
Chad*	MCHAD	Chad data are also included in the Other Africa region.
Greenland*	MGREENLAND	Data starts in 2004. Prior to 1990, data on oil for Greenland were included with the Danish statistics, within the OECD region. They are not included in any region after 1990.
Mauritania*	MAURITANIA	
Mali*	MALI	
Palestinian Authority*	MPALESTINE	
Memo: ASEAN	MASEAN	Data starts in 2000. Includes: Brunei; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; and Viet Nam.



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Country/Region	Short name	Definition
Memo: Africa (UN)	UNAFRICA	<p>Includes Algeria; Angola; Benin; Botswana; Burkina Faso; Burundi; Cabo Verde; Cameroon; Central African Republic; Chad; Comoros; the Republic of the Congo (Congo); Côte d'Ivoire; the Democratic Republic of the Congo; Djibouti; Egypt; Equatorial Guinea; Eritrea; the Kingdom of Eswatini; Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Libya; Madagascar; Malawi; Mali; Mauritania; Mauritius; Morocco; Mozambique; Namibia; Niger; Nigeria; Réunion (until 2010); Rwanda; Sao Tome and Principe; Senegal; the Seychelles; Sierra Leone; Somalia; South Africa; South Sudan (from 2012), Sudan; the United Republic of Tanzania (Tanzania); Togo; Tunisia; Uganda; Zambia; Zimbabwe.</p> <p>Note that Memo: Africa (UN) is identical to Africa.</p>
Memo: Americas (UN)	UNAMERICAS	<p>Includes Antigua and Barbuda; Argentina; Aruba; the Bahamas; Barbados; Belize; Bermuda; the Plurinational State of Bolivia (Bolivia); Bonaire (from 2012); the British Virgin Islands; Brazil; Canada; the Cayman Islands; Chile; Colombia; Costa Rica; Cuba; Curaçao<sup>8</sup>; Dominica; the Dominican Republic; Ecuador; El Salvador; the Falkland Islands (Malvinas); Guatemala; French Guiana (until 2010); Grenada; Guadeloupe (until 2010); Guyana; Haiti; Honduras; Jamaica; Martinique (until 2010); Mexico; Montserrat; Nicaragua; Panama; Paraguay; Peru; Puerto Rico (for natural gas)<sup>9</sup>; Saba (from 2012); Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Sint Eustatius (from 2012); Sint Maarten (from 2012); Suriname; Trinidad and Tobago; the Turks and Caicos Islands; the United States; Uruguay; the Bolivarian Republic of Venezuela (Venezuela).</p>

<sup>8</sup>. The Netherlands Antilles was dissolved on 10 October 2010 resulting in two new ‘constituent countries’ (Curaçao and Sint Maarten) with the other islands joining The Netherlands as ‘special municipalities’. However, due to lack of detailed data the IEA Secretariat’s data and estimates under the ‘Netherlands Antilles’ still refer to the whole territory of the Netherlands Antilles as it was known prior to 10 October 2010 up to the end of 2011. Data refer only to the island of Curaçao from 2012. The other islands of the former Netherlands Antilles are added to Other non-OECD Americas from 2012.

<sup>9</sup>. Oil statistics as well as coal trade statistics for Puerto Rico are included under the United States.

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Country/Region	Short name	Definition
Memo: Asia (UN)	UNASIATOT	Data for Asia (UN) are available from 1990. Includes Afghanistan; Armenia; Azerbaijan; Bahrain; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; the People’s Republic of China; Cyprus <sup>10</sup> ; Georgia; Hong Kong, China; India; Indonesia; the Islamic Republic of Iran; Iraq; Israel <sup>11</sup> ; Japan; Jordan; the Democratic People’s Republic of Korea; Korea; Kazakhstan; Kuwait; Kyrgyzstan; Lao People’s Democratic Republic; Lebanon; Macau, China; Malaysia; the Maldives; Mongolia; Myanmar; Nepal; Oman; Pakistan; the Philippines; Qatar; Saudi Arabia; Singapore; Sri Lanka; the Syrian Arab Republic; Tajikistan; Chinese Taipei; Thailand; Timor-Leste; Turkey; Turkmenistan; the United Arab Emirates; Uzbekistan; Viet Nam; and Yemen.
Memo: Europe (UN)	UNEUROPE	Data for Europe (UN) are available from 1990. Includes Albania; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; the Czech Republic; Denmark; Estonia; Finland; the Republic of North Macedonia (North Macedonia); France; Germany; Gibraltar; Greece; Hungary; Iceland; Ireland; Italy; Kosovo <sup>12</sup> ; Latvia; Lithuania; Luxembourg; Malta; the Republic of Moldova (Moldova); Montenegro; the Netherlands; Norway; Poland; Portugal; Romania; the Russian Federation; Serbia <sup>13</sup> ; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Ukraine; the United Kingdom.
Memo: Oceania (UN)	UNOCEANIA	Includes Australia; New Zealand; Cook Islands; Fiji; French Polynesia; Kiribati; New Caledonia; Palau; Papua New Guinea; Samoa; the Solomon Islands; Tonga; Vanuatu.

<sup>10</sup>. Refer to the country note for Cyprus earlier in this section.

<sup>11</sup>. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

<sup>12</sup>. This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo’s declaration of independence.

<sup>13</sup>. Serbia includes Montenegro until 2004 and Kosovo until 1999.

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Country/Region	Short name	Definition
Memo: non-OECD total	NOECDTOT	Includes Africa; Non OECD Asia (excluding China); China (P.R. of China and Hong Kong, China); Non-OECD Americas; Middle East and Non-OECD Europe and Eurasia.
Memo: IEA Total	IEATOT	Includes Australia; Austria; Belgium; Canada; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Japan; Korea; Luxembourg; Mexico <sup>14</sup> ; the Netherlands; New Zealand; Norway; Poland; Portugal; the Slovak Republic; Spain; Sweden; Switzerland; the Republic of Türkiye; the United Kingdom and the United States.  Estonia is included starting in 1990. Prior to 1990, data for Estonia are included in Former Soviet Union.  Lithuania joined the IEA in February 2022; however, its data have not been included in this aggregate for this edition.
Memo: IEA and Accession/Association countries	IEAFAMILY	Includes: IEA member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, the Republic of Türkiye, the United Kingdom and the United States; Accession countries: Chile, Colombia, Israel and Latvia; Association countries: Argentina, Brazil, the People’s Republic of China, Egypt, India, Indonesia, Morocco, Singapore, South Africa, Thailand, Ukraine, Kenya and Senegal

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Country/Region	Short name	Definition
Memo: European Union – 28	EU28	Refers to the EU27 with the addition of the United Kingdom .  Includes Austria; Belgium; Bulgaria; Croatia; Cyprus; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; the Netherlands; Poland; Portugal; Romania; the Slovak Republic; Slovenia; Spain, Sweden, and the United Kingdom. Please note that in the interest of having comparable data, all of these countries are included since 1990 despite different entry dates into the European Union.
Memo: European Union - 27	EU27	Includes Austria, Belgium, Bulgaria, Croatia, Cyprus , the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, and Sweden.  Please note that in the interest of having comparable data, all of these countries are included since 1990 despite different entry dates into the European Union.
Memo: Former Yugoslavia	MYUGO	Includes Former Yugoslavia (if no detail); Bosnia and Herzegovina; Croatia; the Republic of North Macedonia (North Macedonia); Kosovo; Montenegro; Slovenia and Serbia
Memo: Former Soviet Union	MFSU15	Includes the Former Soviet Union with all 15 countries for all years.
Memo: OPEC	OPEC	Includes Algeria; Angola; Republic of the Congo; Equatorial Guinea; Gabon; the Islamic Republic of Iran; Iraq; Kuwait; Libya; Nigeria; Saudi Arabia; the United Arab Emirates; the Bolivarian Republic of Venezuela (Venezuela).
Memo: G7	MG7	Includes Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.
Memo: G8	MG8	Includes Canada, France, Germany, Italy, Japan, Russian Federation, the United Kingdom and the United States.

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Country/Region	Short name	Definition
Memo: G20	MG20	Includes Argentina, Australia, Brazil, Canada, China (including Hong Kong, China), India, Indonesia, Japan, Korea, Mexico, Russian Federation, Saudi Arabia, South Africa, the Republic of Türkiye, the United States and the European Union – 28.
Memo: Annex I Parties	ANNEX1	<p>Includes Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Cyprus<sup>15</sup>, the Czech Republic<sup>16,17</sup>, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein (not available in this publication)<sup>18</sup>, Lithuania, Luxembourg, Malta, Monaco (included with France), the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, the Slovak Republic<sup>19</sup>, Slovenia, Spain, Sweden, Switzerland, the Republic of Türkiye, Ukraine, the United Kingdom and the United States.<sup>20</sup></p> <p><i>The countries that are listed above are included in Annex I of the United Nations Framework Convention on Climate Change as amended on 11 December 1997 by the 12<sup>th</sup> Plenary meeting of the Third Conference of the Parties in Decision 4/CP.3. This includes the countries that were members of the OECD at the time of the signing of the Convention, the EEC, and fourteen countries in Central and Eastern Europe and the Former Soviet Union that were undergoing the process of transition to market economies. During subsequent sessions, the Conference of the Parties agreed to amend Annex I to the Convention to include Malta (Decision 3/CP.15, effective from 26 October 2010) and Cyprus (Decision 10/CP.17, effective from 9 January 2013).</i></p>

<sup>15</sup>. Refer to the country note for Cyprus earlier in this section.

<sup>16</sup>. Czechia in official UN documents.

<sup>17</sup>. Czechoslovakia was in the original list of Annex I countries.

<sup>18</sup>. Oil data for Liechtenstein are included under Switzerland.

<sup>19</sup>. Slovakia in official UN documents.

<sup>20</sup>. The European Union is also an Annex I Party in its own right. The EU was assigned an overall reduction target under the Kyoto Protocol, which by agreement, was used to determine the individual targets of the fifteen states that were EU members in 1997 when the Kyoto Protocol was adopted.

## Countries and regions

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Country/Region	Short name	Definition
Memo: Annex II Parties	ANNEX2	Includes Australia, Austria, Belgium, Canada, Denmark, Finland, France <sup>21</sup> , Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland <sup>22</sup> , the United Kingdom and the United States.  <i>According to Decision 26/CP.7 in document FCCC/CP/2001/13/Add.4, the Republic of Türkiye has been deleted from the list of Annex II countries to the Convention. This amendment entered into force on 28 June 2002.</i>
Memo: Annex II North America	ANNEX2NA	Includes Canada and the United States.
Memo: Annex II Europe	ANNEX2EU	Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.
Memo: Annex II Asia Oceania	ANNEX2AO	Includes Australia, Japan and New Zealand.
Memo: Annex I Economies in Transition	ANNEX1EIT	Annex I: Economies in Transition (EITs) are those countries in Annex I that are undergoing the process of transition to a market economy. This includes Belarus, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russian Federation, the Slovak Republic, Slovenia and Ukraine.
Memo: Non-Annex I Parties	NONANNEX1	

<sup>21</sup>. In IEA data, France also includes Monaco, which is not in the list of Annex II Parties.

<sup>22</sup>. In IEA data, Switzerland includes Oil data for Liechtenstein, which is not in the list of Annex II Parties.

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Country/Region	Short name	Definition
Memo: Annex B Kyoto Parties	ANNEXB	<p>Includes Australia, Austria, Belgium, Belarus, Bulgaria, Croatia, Cyprus<sup>23</sup>, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Liechtenstein (not available in this publication), Lithuania, Luxembourg, Malta, Monaco (included with France), the Netherlands, Norway, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom.<sup>24</sup></p> <p><i>Refers to countries with emission targets under the second commitment period (CP) of the Kyoto Protocol (2013-2020) as per the Doha Amendment. This differs from the list of countries with targets under the first CP (2008-2012). Please note that the Doha Amendment has not yet entered into force. Membership of Annex B in the second CP of the Kyoto Protocol differs from that in Annex I. In particular, Annex B excludes, or does not contain targets for Canada, Japan, New Zealand, the Russian Federation, the Republic of Türkiye and the United States (all Annex I member states), but includes Kazakhstan (a non-Annex I Party under the Convention, but an Annex I Party under the Kyoto Protocol (as per decision 9/CMP.8).</i></p>

Please note that the following countries have not been considered:

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

<sup>23</sup>. Refer to the country note for Cyprus earlier in this section.

<sup>24</sup>. The European Union is also an Annex I Party in its own right. The EU was assigned an overall reduction target under the Kyoto Protocol, which by agreement, was used to determine the individual targets of the fifteen states that were EU members in 1997 when the Kyoto Protocol was adopted.



## Supplementary countries

With the objective to increase the geographical coverage of the information provided, the IEA has estimated emission factors for electricity and heat generation for over sixty supplementary countries<sup>25</sup> not covered explicitly in the *IEA World energy balances*, using a simplified approach based on more aggregated<sup>26</sup> energy data from the United Nations Statistics Division (UNSD) *2018 Energy Balances* publication (<https://unstats.un.org/unsd/energystats/pubs/balance>). For these set of countries, emissions estimates are available starting with 1990.

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

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Country/Region	Short name	Definition
Afghanistan*	MAFGHANIST	
Anguilla*	MANGUILLA	
Antigua and Barbuda*	MANTIGUABA	
Aruba*	MARUBA	
Bahamas*	MBAHAMAS	
Barbados*	MBARBADOS	
Belize*	MBELIZE	
Bhutan*	MBHUTAN	
Burundi*	MBURUNDI	
Cabo Verde*	MCABOVERDE	
Central African Republic*	MCENTRAFRI	
Comoros*	MCOMOROS	
Cook Islands*	MCOOKISLA	
Djibouti*	MDJIBOUTI	
Dominica*	MDOMINICA	
Fiji*	MFIJI	

<sup>25</sup> Please consider that the data for such countries (based on UNSD energy data), may not add up to the respective regional totals based on IEA energy data (Other Africa, Other non-OECD America and Other non-OECD Asia), as they are independently treated.

<sup>26</sup> Such data are available for the following list of aggregated product categories (primary coal, secondary coal, oil products and crude/NGL/feedstocks)..



## Supplementary countries

With the objective to increase the geographical coverage of the information provided, the IEA has estimated emission factors for electricity and heat generation for over sixty supplementary countries<sup>25</sup> not covered explicitly in the *IEA World energy balances*, using a simplified approach based on more aggregated<sup>26</sup> energy data from the United Nations Statistics Division (UNSD) *2018 Energy Balances* publication (<https://unstats.un.org/unsd/energystats/pubs/balance>). For these set of countries, emissions estimates are available starting with 1990.

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

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Country/Region	Short name	Definition
Gambia*	MGAMBIA	
Grenada*	MGRENADA	
Guinea *	MGUINEA	
Guinea-Bissau *	MGUINEABIS	
Kiribati*	MKIRIBATI	
Lesotho*	MLESOTHO	
Liberia*	MLIBERIA	
Malawi*	MMALAWI	
Maldives*	MMALDIVES	
Marshall Islands*	MMARSHALL	
Micronesia (Federated States of)*	MMICRONES	
Nauru*	MNAURU	
Niue*	MNIUE	
Palau*	MPALAU	
Papua New Guinea*	MPAPUANG	
Puerto Rico*	MPUERTORIC	
Saint Kitts and Nevis*	MSTKITTISNE	

## Supplementary countries

With the objective to increase the geographical coverage of the information provided, the IEA has estimated emission factors for electricity and heat generation for over sixty supplementary countries<sup>25</sup> not covered explicitly in the *IEA World energy balances*, using a simplified approach based on more aggregated<sup>26</sup> energy data from the United Nations Statistics Division (UNSD) *2018 Energy Balances* publication (<https://unstats.un.org/unsd/energystats/pubs/balance>). For these set of countries, emissions estimates are available starting with 1990.

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

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Country/Region	Short name	Definition
Saint Lucia*	MSTLUCIA	
Saint Vincent and the Grenadines*	MSTVINCENT	
Samoa*	MSAMOA	
Sao Tome and Principe*	MSAOTOME	
Seychelles*	MSEYCHELLE	
Sierra Leone*	MSIERRALEO	
Solomon Islands*	MSOLOMONIS	
Somalia*	MSOMALIA	
Timor-Leste*	MTIMORLES	
Tonga*	MTONGA	
Tuvalu*	MTUVALU	
Vanuatu*	MVANUATU	

## Fiscal year

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

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

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

## Fiscal year

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

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Country/Region	Short name	Definition
South Africa	SOUTHAFRIC	Nuclear data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 April Y and ends on 31 March Y+1 are labelled as year Y.

## 4. METHODOLOGY: GHG/KWH EMISSION FACTORS

### Data source

The estimates of GHG emissions in this publication are based on the *2006 IPCC Guidelines* and the IEA *World Energy Balances* data; they represent the total emissions from fuel combustion.

For OECD Member countries, these figures are derived based on information provided in the five annual OECD questionnaires completed by the national administrations. For the member countries of the Economic Commission for Europe of the United Nations (UNECE) and a few others, the data shown are mostly based on information provided by the national administrations through the same annual questionnaires. The commodity balances for all other countries are based on national energy data of heterogeneous nature, converted and adapted to fit the IEA format and methodology.

Considerable effort has been made to ensure that the data presented adhere to the IEA definitions reported in the section on Methodological notes in the general documentation<sup>27</sup>. These definitions, based on the *United Nations International Recommendations on Energy Statistics*<sup>28</sup>, are used by most of the international organisations that collect energy statistics.

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

### The indicator: definition

In the **total CO<sub>2</sub>** emissions per kWh, for electricity or for electricity and heat generation, the numerator presents the CO<sub>2</sub> emissions from fossil fuels consumed for electricity generation, while the denominator presents the total electricity generated, coming from fossil fuels, but also from nuclear, hydro, geothermal, solar, biofuels, etc. As a result, the emissions per kWh vary a lot across countries and from year to year, depending on the generation mix.

The above factors reflect annual average intensities of the national grid and can be used for the estimation of location-based Scope 2 emissions corresponding to consumption of purchased electricity under the GHG protocol.

In the **CO<sub>2</sub> emissions per kWh by fuel** the numerator and denominator only refer to the electricity generation from a given fuel:

- Coal includes primary and secondary coal, and coal gases. Peat and oil shale have also been aggregated with coal, where applicable.
- Oil includes oil products (and crude oil for some countries).
- Gas represents natural gas.
- Non-renewable wastes includes industrial waste and non-renewable municipal waste.
- Biofuels includes both biofuels and renewable wastes. Note that these emission factors, for the CO<sub>2</sub> gas, are not accounted for in the total CO<sub>2</sub> emissions of the energy sector according to the IPCC guidelines.

27. <https://www.iea.org/data-and-statistics/data-product/greenhouse-gas-emissions-from-energy#documentation>

28. [http://unstats.un.org/unsd/energy/ires/IRES\\_Whitecover.pdf](http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf).

## Electricity-only carbon emission factors: allocation of emissions from CHP plants

Calculating emission factors for electricity-only generation from the IEA energy balances require specific assumptions, as for combined heat and power (CHP) plants only data for a combined input are available.

The IEA adopts the **fixed-heat-efficiency approach**, which consist in fixing the efficiency of heat generation to compute the input to heat, and calculating the input to electricity as a residual from the total input. The standard heat efficiency was set to that of a typical heat boiler, 90%.

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

In general, the fixed-heat-efficiency approach attributes larger emissions to electricity than the proportionality approach, with values much closer to those of electricity-only plants. While the fixed-heat-efficiency approach has proven to provide sensible results in most cases, implementation problems arise in two cases:

- i) When the observed efficiency is over 100% (i.e. there are problems in data quality).
- ii) When the observed efficiency is between 90% and 100% (the total efficiency may be correct or it may be overstated).

In both cases, it is not possible to use the fixed-heat-efficiency approach and, by default, the proportionality approach is used to allocate the inputs based on the output shares.

## Calculation of the carbon emission factor

CO<sub>2</sub>kWh for electricity and heat generation =

$$\frac{\sum_{fuels} \langle (Input_{Electricity\ plants} + Input_{CHP\ plants} + Input_{Heat\ plants} + Own\ use_{plants}) \times EF_{fuel} \rangle}{Ele_{Inland} + Heat_{Inland}}$$

Where:

- CO<sub>2</sub>kWh : Carbon factors (in CO<sub>2</sub>/kWh) calculated at the generation point
- $\sum_{fuels}$  : Sum over the fuels.
- $Input_{plants}$  : Fuel input into the plants (both main activity and autoproducer) expressed in energy unit.
- $EF_{fuel}$  : Default emission factors as provided in the *2006 IPCC Guidelines*.
- $Ele_{Inland} + Heat_{Inland}$  :
  - For the total emission factor: includes the generation from all sources (i.e. as well the non-emitting sources).
  - For the emission factors by fuel (oil, coal, gas, non-renewable waste and Memo: biofuels): includes only the electricity generated by the corresponding fuel.

CO<sub>2</sub>kWh for electricity generation =

$$= \frac{\sum_{fuels} \langle (Input_{Electricity\ plants} + Input_{CHP\ plants/Ele} + Own\ use_{plants/Ele}) \times EF_{fuel} \rangle}{Ele_{Inland}}$$

Where:

- CO<sub>2</sub>kWh : Carbon factors (in CO<sub>2</sub>/kWh) calculated at the generation point
- $\sum_{fuels}$  : Sum over the fuels.
- $Input_{plants}$  : Fuel input into the plants (both main activity and autoproducer) expressed in energy unit.
- $Input_{CHP\ plants/Ele} = Input_{CHP\ plants} - \frac{Heat\ output}{\eta_{heat}}$
- $\eta_{heat}$  efficiency of heat generation - assumed to be 0.9 (i.e. 90%) except when the observed efficiency of CHP generation is higher than 90%, in which case emissions are allocated using the proportionality approach ( $EFF_{HEAT} = EFF_{ELEC} = EFF_{CHP}$ ).
- $Own\ use_{plants/Ele} = Own\ use_{plants} \times \frac{Total\ electricity\ output}{Total\ electricity\ output + Total\ heat\ output}$
- $EF_{fuel}$  : default emission factors as provided in the *2006 IPCC Guidelines*.
- $Ele_{Inland}$  :
  - For the total emission factor: includes the generation from all sources (i.e. as well the non-emitting sources).
  - For the emission factors by fuel (oil, coal, gas, non-renewable waste and Memo: biofuels): includes only the electricity generated by the corresponding fuel.

Note that in some cases, when the output of electricity is very small for a given fuel, rounding effects can cause the corresponding emission factor to appear very high. It is advised to disregard these emission factors which are clearly out of the range.

## Provisional carbon emission factors

While the methodology previously described refers to time series up to the year Y-1, the factors for the latest year (Y) provided for OECD countries and selected non-OECD countries are based on a simplified methodology. The available data for the year Y only include the breakdown of electricity generated by fuel, but not the fuel input to plant. The assumption used is that there was no change in the efficiency of plants and in the energy content of the input products compared to the year Y-1.

With these assumptions, the factor was derived as follows:

$$CO_2kWh(Y) = \frac{\sum_{fuels} (CO_2kWh_{fuel}(Y-1) \times Ele_{Inland_{fuel}}(Y))}{Ele_{Inland}(Y)}$$

Please note that data for the provisional year may be subject to revisions more often as better information become available in further editions of the product.

For the provisional year, only the total carbon emission factor is included.

## CH<sub>4</sub> and N<sub>2</sub>O emissions for electricity generation

If CO<sub>2</sub> represent a large majority in term of greenhouse gas emissions from fuel combustion, it is not the only one.

Emission factors for CH<sub>4</sub> and N<sub>2</sub>O were calculated using the same methodology as for the CO<sub>2</sub> per kWh, using the Tier 1 methodology and the default emission factors of the *2006 IPCC Guidelines*, including also emissions from biofuels in this case (as opposed to CO<sub>2</sub> only emissions). The emission factors are converted from gCH<sub>4</sub> and gN<sub>2</sub>O

to gCO<sub>2</sub>eq using the 100-year Global Warming Potential (GWP) given below. For the purpose of comparability with international data submission guidelines, the factors from the 4<sup>th</sup> Assessment of the IPCC (AR4) are used.

Designation or Name	Chemical formula	100-Year GWP
Carbon dioxide	CO <sub>2</sub>	1
Methane	CH <sub>4</sub>	25
Nitrous oxide	N <sub>2</sub> O	298

Note that the uncertainty associated with CH<sub>4</sub> and N<sub>2</sub>O emissions factors is very large, therefore these emission factors are provided as an indication when no better information is available. Please see the *2006 IPCC guidelines*<sup>29</sup> for more information about the uncertainty associated to emission factors.

## Comparison between electricity-only and combined electricity and heat ratios

For the majority of OECD countries, the electricity-only indicator is not significantly different from the combined electricity and heat indicator, shown in previous editions of this publication and in the online database. For the OECD total in 2014, the electricity-only indicator is 4% higher, while 19 of the OECD's 34 countries saw a difference of 5% or less. Of the 15 countries with differences of more than 5%, 7 countries had large amounts of non-emitting electricity generation, giving them a small ratio to begin with (thus more prone to change). In addition, non-emitting generation is generally electricity-only, and so when the heat-only and heat CHP emissions are removed from the calculation, greater weight is attached to the non-emitting generation, with a lower level for the final indicator.

The countries in the OECD with larger differences are generally coal-intensive countries with large amounts of heat generation. As mentioned, in general, heat plants are more efficient than electricity-only or CHP plants; therefore, excluding heat plants from the calculation increases CO<sub>2</sub> intensity. The same is true if we allocate a high efficiency to the heat part of CHP generation; this decreases the efficiency of the electricity part and thus increases electricity's carbon intensity. Further, CHP and heat plants are more likely to be powered by CO<sub>2</sub>-light natural gas while electricity-only plants tend to be powered by CO<sub>2</sub>-heavy coal, making the new ratio more CO<sub>2</sub> intensive for these countries.

29. [http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2\\_Volume2/V2\\_2\\_Ch2\\_Stationary\\_Combustion.pdf](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf)



## 5. METHODOLOGY: OTHER FACTORS

### Correction factor for electricity trade

Part of the electricity consumed in one country may have been generated in another one. Similarly, part of the electricity generated in one country can be exported to other countries. Therefore, adjustments may be done to the emission factors calculated above to account for electricity trade. Such adjustments are based on the share of electricity that is imported or exported compared to the domestic supply. The data needed to calculate such adjustment (i.e. the breakdown of electricity import by trade partner) are only available for OECD countries. This adjustment can be positive or negative, and is calculated as follows:

$$CO_2kWh_{trade} = \frac{C_{Indigenous} + C_{Imported} - C_{Exported}}{Net\ electricity} - CO_2kWh$$

With

$$C_{Indigenous} = Ele_{Inland} * CO_2kWh$$

And

$$C_{Imported} = \sum_{partner} Ele_{Imports_{partner}} * CO_2kWh_{partner}$$

And

$$C_{Exported} = Ele_{Exports} * \frac{C_{Indigenous} + C_{Imported}}{Ele_{Inland} + Ele_{Imports}}$$

Where

- $CO_2kWh_{trade}$ : Adjustment of the carbon factor (in  $CO_2/kWh$ ) for emissions induced by the trade of electricity with partner countries.
- $CO_2kWh_{partner}$ : Carbon emission factor for electricity generation of the partner country.
- $Net\ electricity$ :  $Ele_{Inland} + Ele_{Imports} - Ele_{Exports}$

Note that for a given country, trade data are those reported by the country for which the factor is calculated, which in some cases can differ from those reported from trade partners. Also, since the emission factors from trading partners are used, the quality of this adjustment depends not only on the quality of the data reported by the country, but also on the quality of the data reported by the trading partners. Moreover, in some cases, country report imports from non-specified countries. In such cases, assumptions were made based on transmission grid and data reported by potential partners.

This adjustment does not take into account geographically localized connections between countries. For example, Luxembourg reports trade from Germany, which is mostly related to electricity from the Vianden hydro plant; however the trade adjustment would be calculated using the nationally averaged carbon emission factor for Germany. As this case was known, the figure was set as “not available”. But other similar issue may occur.

### Correction factor for electricity T&D losses

As electricity is transmitted through a grid from the generation point to the consumption point, losses can occur for different reasons - they usually represent between 5 and 15% of the energy transmitted, mainly depending on the distance of the lines. Basically, for each kWh being consumed, a higher amount had to be generated.

The adjustment due to losses was calculated as follows:

$$CO_2kWh_{loss} = CO_2kWh \times loss\ factor$$

Where

- $CO_2kWh_{loss}$  : Adjustment (in  $CO_2/kWh$ ) for emission induced by the losses of electricity in transmission and distribution.
- $loss\ factor = \frac{Losses}{Total\ grid}$

Where

- $Losses$  : Total transmission and distribution losses in the grid.
- $Total\ grid$  : Total amount of electricity transiting through the country electricity grid, calculated as gross electricity generation – own use in plant + imports.

Note that data quality for electricity transmission and distribution losses may be very variable across countries.

## Use of the adjustment indicators

In order to allow more flexibility for the users depending on their reporting needs, the  $CO_2$  emission factors are presented in a disaggregated manner. Since the  $CO_2$  emission per kWh represents the emissions at the generation point, this factor can be completed by adding the transmission and distribution losses factor, and the correction for electricity trade. By adding these figures one can obtain a closer figure to the  $CO_2$  per kWh at the final user point. These factors can be applied for location-based Scope 2 emissions reporting under the GHG protocol. The factors can also be completed with the  $CH_4$  and  $N_2O$  figures to obtain more complete greenhouse gas per kWh indicators. As stipulated above, these figures are to be taken with caution due to the uncertainty associated with the corresponding IPCC emission factors. The  $CH_4$  and  $N_2O$  adjustment for trade and losses are not provided here due to the negligible impact compared to the uncertainty associated with the figure.

Please note that for reporting Scope 3 emissions associated with the consumption of purchased electricity, the life cycle upstream emission factors are required. These factors will be amended to this database following the release of the pilot database called IEA Life Cycle Upstream Emission Factors in the following weeks.

## Direct combustion factors for individual fuels

In most cases fuels are combusted directly for other purposes than electricity generation, within all sectors of final consumption. The Direct combustion factors vary according to the fuel used, and are computed as weighted average of the consumption across all final consumption sectors for a given country. These factors can be applied for reporting Scope 1 emissions associated with direct combustion of fuels under the GHG protocol and are computed as follows:

$$DCF = \frac{E_{Industry} + E_{Transport} + E_{Others}}{FC_{Industry} + FC_{Transport} + FC_{Others}}$$

Where:

- DCF : Direct combustion factors for fuel combustion other than for electricity and heat generation, in mass  $CO_{2eq}$  / kg of fuel and mass  $CO_{2eq}$  /  $m^3$  for natural gas (the mass of  $CO_{2eq}$  is in units of kilograms for the  $CO_2$  factors and in units of grams for the included non- $CO_2$  factors).
- $E_{Industry}$  : Total  $CO_{2eq}$  emissions from fuel combustion in the *Industry* sector plus emission in the *Energy* sector except electricity and CHP plants in kg  $CO_{2eq}$ .
- $E_{Transport}$  : Total  $CO_{2eq}$  emissions from fuel combustion in the *Transport* sector in kg  $CO_{2eq}$ .
- $E_{Others}$  : Total  $CO_{2eq}$  emissions from fuel combustion in the *Residential, Commercial and Public services, Agriculture/Forestry, Fishing and Other non-specified* sectors in kg  $CO_{2eq}$ .
- $FC_{sector}$  : Total fuel consumption in the respective sector, expressed in kg.

Which is equivalent to:

$$DCF = \frac{(FC_{Industry} \times NCV_{Industry} + FC_{Transport} \times NCV_{Transport} + FC_{Others} \times NCV_{Others}) \times EF_{fuel}}{FC_{Industry} + FC_{Transport} + FC_{Others}}$$

Where:

- $NCV_{Sector}$ : Net Calorific Value, which is product-, country-, sector- and time-specific.

These emission factors are presented for individual and for some average fuels described below:

- For coal: individual primary products (anthracite, coking coal, other bituminous coal, sub-bituminous coal and lignite); as well as the weighted average coal mix;
- For oil: individual secondary products (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, bitumen, petroleum coke and non-specified oil products); as well as the weighted average oil product mix.
- For natural gas

When no data is reported for a fuel and year, the data is marked as X: Not applicable.

Similar to the emission factors corresponding to electricity generation, the non-CO<sub>2</sub> direct combustion emission factors are converted from gCH<sub>4</sub> and gN<sub>2</sub>O to gCO<sub>2eq</sub> using the 100-year GWP from AR4.

## Total upstream emission factors

The methodology for estimating these factors will be available following the release of the pilot database called IEA Life Cycle Upstream Emission Factors by October 2023 weeks and the amendment of the Emission Factors database to include these factors.

## Fuel-cycle emission factors

The methodology for estimating these factors will be available following the release of the pilot database called IEA Life Cycle Upstream Emission Factors by October 2023 weeks and the amendment of the Emission Factors database to include these factors.

## Life cycle adjustment factors for T&D losses

The methodology for estimating these factors will be available following the release of the pilot database called IEA Life Cycle Upstream Emission Factors by October 2023 weeks and the amendment of the Emission Factors database to include these factors.

## 6. UNITS AND CONVERSIONS

### General conversion factors for energy

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

### Conversion factors for mass

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

### Conversion factors for volume

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

## Decimal prefixes

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

## Tonne of CO<sub>2</sub>

The *2006 GLs* and the *UNFCCC Reporting Guidelines on Annual Inventories* both ask that CO<sub>2</sub> emissions and removals be reported in Gg (gigagrammes) of CO<sub>2</sub>. A million tonnes of CO<sub>2</sub> is equal to 1 000 Gg of CO<sub>2</sub>, 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<sub>2</sub> emissions in tonnes of carbon instead of tonnes of CO<sub>2</sub>. To convert from tonnes of carbon, multiply by 44/12, which is the molecular weight ratio of CO<sub>2</sub> to C.

## 7. ABBREVIATIONS

CO <sub>2</sub>	carbon dioxide
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 <sub>2</sub>	million tonnes of carbon dioxide
m <sup>3</sup>	cubic metre
PJ	petajoule
t	metric ton = tonne = 1 000 kg
tC	tonne of carbon
TJ	terajoule
toe	tonne of oil equivalent = 10 <sup>7</sup> kcal
CC	carbon content
CEF	carbon emission factor
COF	carbon oxidation factor
CHP	combined heat and power
GCV	gross calorific value
GDP	gross domestic product
GWP	global warming potential
NCV	net calorific value
TES	total energy supply
Convention	United Nations Framework Convention on Climate Change
COP	Conference of the Parties to the Convention
G20	Group of Twenty (See the section <i>Geographical coverage and country notes</i> )
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
OECD	Organisation for Economic Co-Operation and Development
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
..	not available
x	not applicable
c	confidential