Energy Projections of IEA Countries – with Extended Transitions Indicators 2022

Database documentation

International Energy Agency

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INTERNATIONAL ENERGY AGENCY

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This documentation provides support information for the *Energy Projections of IEA Countries – with Extended Transitions Indicators* database,

This database includes: i) energy system projections to 2030, 2040 and 2050 based on national scenario modelling in the format of simplified balances, where available, for twenty-five among IEA member countries, accession countries, and the European Union, as collected from national administrations; together with summary balances for historical years for all IEA member countries; ii) a set of transition indicators (e.g., greenhouse gas emission estimates, intensities, emissions factors, etc) developed based on the data collected from countries, consistently with the methodologies adopted by the IEA in the relevant historical databases.

Note that this product includes all the content of the pre-existing *Energy Policies of IEA Countries*, and additionally includes projections for a broader set of indicators such as GHG emissions, intensities, emissions factors.

This document can be found online at: http://www.iea.org/data-and-statistics/data-product/energy-projections-of-iea-countries-with-extended-transitions-indicators.

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Please note that all IEA data is subject to the following terms and conditions found on the IEA's website: *https://www.iea.org/terms.*

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Energy Projections of IEA Countries – with Extended Indicators: introduction

National projections have become more and more relevant within the evolving landscape of commitments taken by many countries globally. To accelerate energy transitions, long-term perspectives are essential in planning national energy systems and analysing their socio-economic and environmental impacts. Governments and other data users benefit from these projections for monitoring the progress towards national energy and climate targets, refining energy models and informing policy reviews and recommendations.

The IEA has historically collected information on energy balances projections from its members, with data up to the year 2050[1]. This data collection has supported the IEA In-depth reviews of energy policies, under the guidance of the Standing Group for Long-Term Cooperation (SLT) committee, and has been the basis for the annual *Energy Policies of IEA Countries* database.

To better support policy assessment in an evolving energy landscape, such data collection was upgraded over the last year through an extensive consultation of national administrations' data providers and other experts, and the feedback from the SLT committee. The main upgrades of the questionnaire were the definition of four categories of scenarios, with an associated request to countries to share multiple projections when available; and the addition of data for new and emerging technologies within the projections of energy balances. The Secretariat also improved the questionnaire functionalities and developed a broader set of transitions indicators with the objective of facilitating overall tracking to countries and data users alike.

[1] The SLT energy projections questionnaire and its associated *Questionnaire Compiler's Guide* are available at: https://www.iea.org/areas-of-work/data-and-statistics/questionnaires.

In line with the recent revamp of the projections questionnaire, *Energy Projections of IEA Countries - with Extended Transitions Indicators* is a newly designed IEA database comprising national projections of upgraded energy balances, and a new extended set of transitions indicators developed by the Secretariat based on the projections of national energy balances of the database above.

Database structure

This database includes annual data for:

- countries: IEA member and Accession countries and European Union (see sections *Data availability, Geographical coverage* and *Country notes* for details on availability of projections by country);
- years: historical: 1960, 1970, 1980, 1990, 2000, 2010, 2015, 2016, 2017, 2018, 2019, 2020 and projections: 2030, 2040 and 2050, unless otherwise specified. Note: data for historical years are available for all countries described above; data for projections are available for a smaller set.
- scenarios: up to five scenario categories, where available (see sections *Data availability and Country notes* for details on availability of scenarios by country);

The database includes the following two files:

Balances.IVT **Energy balances**
Energy balances in matrix form (19 product categories; 25 flows) (Mtoe).

Extended indicators.IVT **Transition Indicators**
85 energy, economic and coupled indicators (various units).

Detailed definitions of each flow and product are presented in sections *Flow definitions* and *Product definitions*.

The historical energy balances data (up to year 2020 are derived from the IEA *World energy balances (2022 edition*) publication, while some of the historical transition indicators are derived from the IEA *Greenhouse Gas Emissions from Energy (2022 edition)* database. Projections based on national scenario modelling in the format of simplified balances, where available, are collected directly from the member countries and are used to develop the corresponding transition indicators for the projection years.

Energy Projections of IEA Countries - with Extended Transitions Indicators new database: what it includes

This database includes projections for energy balances, and a new broad set of energy transitions indicators developed based on the data submitted by national administrations.

The set of indicators, useful for monitoring energy transitions and climate objectives, is presented in the table below. It includes greenhouse gas (GHG) emissions by product and sector; various intensities [e.g., CO_2/TES, CO_2/GDP], various socio-economic indicators among other relevant indicators.

Carbon capture, utilization and storage (CCUS) is considered a key component of the future technology mix as it may allow reducing emissions across hard-to-abate sectors. Hence, CCUS may become a critical part of long-term strategies for achieving energy and climate targets. Six indicators related to CCUS have been included, to represent the mass of CO_2 expected to be captured via CCUS technologies across sectors.

Old longname	New longname	Shortname	Old shortname (if changed)
	Total CO_2 captured by CCUS (ktCO2)	CCTOTAL	
	CO_2 captured from natural gas processing by CCUS ($ktCO_2$)	CCNGPROC	
	CO_2 captured from manufacturing by CCUS ($ktCO_2$)	CCMANUFACT	
	CO_2 captured from electricity and heat generation by CCUS ($ktCO_2$)	CCELECHEAT	
	CO_2 captured from hydrogen and synthetic fuel production by CCUS ($ktCO_2$)	CCH2PROD	
	CO_2 captured from other sources by CCUS ($ktCO_2$)	CCOTHER	

	Population (millions)	POP	
	GDP (billion USD, 2015 prices and ex rates)	GDP	
	GDP (billion USD, 2015 prices and PPPs)	GDPPPP	
	Total energy supply (TJ)	TES	
	Total final consumption (TJ)	TFC	
	TES/GDP (MJ per 2015 USD)	TESGDP	
	TES/population (GJ per capita)	TESPOP	
	TFC/population (GJ per capita)	TFCPOP	
	TFC/GDP (MJ per 2015 USD)	TFCGDP	
	TES/GDP (MJ per 2015 USD)	TESGDP	
	TES/GDP (MJ per 2015 USD PPP)	TESGDPPPP	
	TFC/GDP (MJ per 2015 USD PPP)	TFCGDPPPP	
	Total self-sufficiency	TOTSELF	
	Coal self-sufficiency	COALSELF	
	Oil self-sufficiency	OILSELF	
	Gas self-sufficiency	GASSELF	
	Share of renewables in total energy supply (%)	RENTES	
	Share of renewables in total final energy consumption – SDG 7.2.1 (%)	RENTFEC	
	Share of fossil fuels in total energy supply (%)	FFTES	
	Share of fossil fuels in total final energy consumption (%)	FFTFEC	
	Coal CO_2 fuel combustion (MtCO2)	COALCO2	
	Oil CO_2 fuel combustion (MtCO2)	OILCO2	
	Gas CO_2 fuel combustion (MtCO2)	GASCO2	

	Other CO_2 fuel combustion (MtCO2)	OTHERCO2	
	Total GHG fuel combustion (MtCO2eq)	GHGFUEL	
	Coal GHG fuel combustion (MtCO2eq)	COALGHG	
	Oil GHG fuel combustion (MtCO2eq)	OILGHG	
	Gas GHG fuel combustion (MtCO2eq)	GASGHG	
	Other GHG fuel combustion (MtCO2eq)	OTHERGHG	
	Transport CO_2 emissions ($MtCO_2$)	TOTTRANCO2	
	Industry CO_2 emissions ($MtCO_2$)	TOTINDCO2	
	Residential CO_2 emissions ($MtCO_2$)	RESIDENCO2	
	Commercial and public services CO_2 emissions ($MtCO_2$)	COMMPUBCO2	
	Other final sectors CO_2 emissions ($MtCO_2$)	OTHERFCCO2	
	Buildings CO_2 emissions ($MtCO_2$)	TOTBUILCO2	
	Transport GHG emissions ($MtCO_{2eq}$)	TOTTRANGHG	
	Industry GHG emissions ($MtCO_{2eq}$)	TOTINDGHG	
	Residential GHG emissions ($MtCO_{2eq}$)	RESIDENGHG	
	Commercial and public services GHG emissions ($MtCO_{2eq}$)	COMMPUBGHG	
	Other final sectors GHG emissions ($MtCO_{2eq}$)	OTHERFCGHG	
	Buildings GHG emissions ($MtCO_{2eq}$)	TOTBUILGHG	
	CO_2 / TES (tCO_2 per TJ)	CO2TES	
	GHG / TES (tCO_{2eq} per TJ)	GHGTES	
	CO_2 / GDP ($kgCO_2$ per 2015 USD)	CO2GDP	
	CO_2 / GDP PPP ($kgCO_2$ per 2015 USD)	CO2GDPPP	
	GHG / GDP ($kgCO_{2eq}$ per 2015 USD)	GHGGDP	

	GHG / GDP PPP (kgCO_{2eq} per 2015 USD)	GHGGDPPP	
	CO_2 / population (tCO_2 per capita)	CO2POP	
	GHG / population (tCO_{2eq} per capita)	GHGPOP	
	CO_2 emissions index (2017=100)	ICO2EMIS	
	Population index (2017=100)	IPOP	
	GDP per population index (2017=100)	IGDPPOP	
	Energy intensity index - TES / GDP (2017=100)	ITESGDP	
	Carbon intensity index - CO_2 / TES (2017=100)	ICO2TES	
	Share of renewables in electricity generation (%)	RENELE	
	Share of low carbon sources in electricity generation (%)	LOWCARBELE	
	Share of renewables in heat generation (%)	RENHEAT	
	Share of low carbon sources in heat generation (%)	LOWCARBHEAT	
	Total electricity and heat generation CO_2 emissions (MtCO_2)	ELEHCO2	
	Coal electricity and heat generation CO_2 emissions (MtCO_2)	ELEHCCO2	
	Oil electricity and heat generation CO_2 emissions (MtCO_2)	ELEHOCO2	
	Gas electricity and heat generation CO_2 emissions (MtCO_2)	ELEHGCO2	
	Other electricity and heat generation CO_2 emissions (MtCO_2)	ELEHOTCO2	
	Total electricity and heat generation GHG emissions (MtCO_{2eq})	ELEHGHG	
	Coal electricity and heat generation GHG emissions (MtCO_{2eq})	ELEHCGHG	
	Oil electricity and heat generation GHG emissions (MtCO_{2eq})	ELEHOGHG	
	Gas electricity and heat generation GHG emissions (MtCO_{2eq})	ELEHGGHG	
	Other electricity and heat generation GHG emissions (MtCO_{2eq})	ELEHOTGHG	

	CO_2 Intensity of electricity and heat generation (gCO_2/kWh)	CO2KWHH	
	GHG Intensity of electricity and heat generation (gCO_{2eq}/kWh)	GHGKWHH	
	Electricity and heat output in GWh index (2017=100)	ELEHOUTPUT	
	Share of electricity and heat output from fossil fuels index (2017=100)	FOSSILELEH	
	CO_2 intensity of fossil fuel mix index (2017=100)	CO2INTMIX	
	Thermal efficiency of electricity and heat plants (including CHP) index (2017=100)	THERMELEH	
	CO_2 emissions from electricity and heat generation (including CHP) index (2017=100)	CO2ELEH	
	Total GHG fuel combustion - CCUS adjusted ($MtCO_{2eq}$)	GHGFUELCC	
	Total CO_2 fuel combustion - CCUS adjusted ($MtCO_2$)	CO2FUELCC	

Definitions

Scenario dimension

The database includes projections data corresponding to multiple scenario categories, if available at national level, for example corresponding to different pathways (business as usual, more or less ambitious targets, etc).

The "scenario" dimension includes different scenario categories including: business as usual, stated policies, achieving national targets, achieving defined outcomes and other.

The scenario categories, do not correspond to the included historical data. Hence, for all countries, the historical data have been disseminated under the scenario categories corresponding to the submitted projections data. If projections data are not submitted, the historical data have been disseminated under the "business as usual" category. Additionally, In a handful of cases, where the projections data submitted to the IEA, doesn't correspond to the 2021/2022 submission cycle and due to the absence of information regarding the category of the underlying scenario, the figures are disseminated under the "business as usual" category.

If projections data corresponding to multiple scenarios have been collected from a country, while the country has classified more than one of the submitted scenarios under the same scenario cluster, one of the two scenarios has been disseminated under the "other" category to allow differentiation in between the two sets of data.

Please refer to the *scenario categorisation* section for additional details.

Scenario	Short name	Definition
Business as usual	BAU	The "business as usual" scenario category aims to capture scenarios that include only government policies which have been already adopted, and therefore project how the national

		energy landscape may evolve if the existing structures in energy supply and demand remain unchanged.
Stated policies	STEPS	The “stated policies” scenario category aims to capture scenarios that take into account national climate and/or energy-related policies and measures which have been already adopted by the government, together with pertinent policy proposals, announced commitments and plans which have been announced but are yet to be formally adopted.
Aspirational - achieving national targets	ASPTARGET	Scenarios within this category set an energy pathway consistent with specific target(s). By this means, they demonstrate what should be achieved across sectors and by various actors and by when, for the targets to be achieved. For example, a net zero scenario could set out a pathway for the national energy sector to achieve net zero emissions by a certain year. Or a Paris Agreement compliant scenario demonstrates a pathway consistent with the goal of limiting the global increase in temperature to 2 or 1.5°C (with a certain probability).
Aspirational - achieving defined outcomes	ASPOUTCOME	Scenarios within this category set an energy pathway consistent with particular desired outcome(s). By this means, they demonstrate what should be achieved across sectors and by various actors and by when, for the outcome(s) to be achieved. Examples include scenarios consistent with achieving affordability of energy sources or long/short-term energy security purposes. Some scenarios could have multiple desired outcomes.
Other	OTHER	Scenarios which do not fall under any of the above general categories can be reported under this option.

Flow dimension

The flows corresponding to the energy balance file are detailed in the table below:

Balances.IVT

Flow	Short name	Definition
Production	INDPROD	"Indigenous production" shows only production of primary energy, i.e. hard coal and lignite, oil shale, peat, biofuels and wastes (see product definitions), crude oil and NGL, natural gas, and electricity and heat from nuclear, hydro, tidal, wave, geothermal, wind and solar plants. Heat from heat pumps that is extracted from the ambient air is included in the heat column. (a) where synthetic liquid or gas hydrocarbons are produced directly as a result of "in place extraction" they should be regarded as primary fuels and included under production. For example, oil from tar sands and shale are shown in the oil column. (b) production of natural gas should exclude gas reinjected, vented or flared but should include gas subsequently used in the gas extraction and drying processes as well as transportation of the gas by pipeline.
Imports	IMPORTS	"Imports" (+) show trade in primary and secondary forms of energy. Imports comprise amounts having crossed the national territorial boundaries of the country whether or not customs clearance has taken place. *For oil and gas*: Note in particular that LPG traded should be placed in the "oil" column. *For nuclear:* Nuclear fuel trade is not shown in the balance. *For electricity:* Trade in electricity is counted at the same heat value as in final consumption (Data in TWh x 0.086 = Data in Mtoe). For countries trading across common borders, actual import and export figures should be given, not net trade balance.
Exports	EXPORTS	"Exports" (-) show trade in primary and secondary forms of energy. Exports comprise amounts having crossed the national territorial boundaries of the country whether or not customs clearance has taken place. *For oil and gas:* Note in particular that LPG traded should be placed in the "oil" column. *For nuclear:* Nuclear fuel trade is not shown in the balance. *For electricity:* Trade in electricity is counted at the same heat value as in final consumption (Data in TWh x 0.086 = Data in Mtoe). For countries trading across common borders, actual import and export figures should be given, not net trade balance.
International marine bunkers	MARBUNK	Covers those quantities delivered to ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation is excluded. The domestic/international split is

Flow	Short name	Definition
		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.
International aviation bunkers	AVBUNK	Includes deliveries of aviation fuels to aircraft for international aviation. Fuels used by airlines for their road vehicles are excluded. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. For many countries this incorrectly excludes fuel used by domestically owned carriers for their international departures.
Stock changes	STOCKCHA	"Stock changes" show additions to stocks as negative, and lowering of stock levels as positive. In energy balance projections, stock changes are conventionally zero. However, countries may report them if they wish.
Total energy supply	TES	"Total energy supply" (TES) is made up of indigenous production (positive), imports (positive), exports (negative), international marine and aviation bunkers (negative) and stock changes (either positive or negative).
Transformation processes and own use	TRANSFER	Shows the total of the energy transformation activities ("Electricity, CHP and heat plants" and "Other transformation") and energy used by energy-producing plants and losses ("Own use and losses").
Electricity, CHP and heat plants	ELECHEAT	"Electricity, CHP and heat plants" should contain inputs of each fuel for the production of electricity and heat as negative entries. This row includes both main activity producers and autoproducer plants. However, for autoproducers all fuel inputs to electricity production are taken into account, while only the part of fuel inputs to heat sold is shown. Fuel inputs for the production of heat consumed within the autoproducer's establishment are not included here but are included with figures for the final consumption of fuels in the appropriate consuming sector. Outputs of electricity appear as a positive number under the product "Electricity" and the heat that is sold to outside users appears as a positive number under "Heat". Transformation losses are shown under "Total". Notes: 1. Gross electricity produced should contain total electricity generation in Mtoe calculated on the basis of Data in TWh x 0.086 = Data in Mtoe. Gross generation from hydro plants should not include that generated by pumped storage. The energy absorbed for pumped storage is accounted for under "own use and losses" (see "Hydro electricity" product definition). 2. If electricity is being used to produce heat in heat pumps or electric boilers, the electricity inputs are subtracted from the electricity production shown under "Electricity". 3. Main activity producers generate electricity and/or heat for sale to third parties, as their primary activity. They may be privately or publicly owned. Note that the sale does not need to take place through the public grid. 4. Autoproducer undertakings generate electricity and/or heat, wholly or partly for their own use as an activity which

Flow	Short name	Definition
		supports their primary activity. They may be privately or publicly owned.
Other transformation processes	TRANOTH	"Other transformation" includes conversion losses in gas manufacture, oil refineries, coke ovens and blast furnaces, liquefaction, and other non-specified transformation.
Own use and losses	OWNUSE	"Own use and losses" contains the primary and secondary energy consumed by transformation industries for heating, pumping, traction and lighting purposes. These are shown as negative numbers. Included here are, for example, coal mines' own use of energy, power plants' own consumption (which includes net electricity consumed for pumped storage) and energy used for oil and gas extraction. "Own use and losses" also includes losses in gas distribution, electricity transmission and coal transport. Fuels used for pipeline transport are included in transport. Note that electricity generation losses appear in the electricity, CHP and heat plants.
Statistical differences	STATDIFF	"Statistical differences". In principle, the figure for total requirements should equal the sum of deliveries to final consumption, use for transformation and energy industry own use. However, in practice this is rarely the case and the difference is shown as statistical difference. This arises because the data for the individual components of supply are often derived from different data sources by the national administration. Furthermore, the inclusion of changes in some large consumers' stocks in the supply part of the balance introduces distortions which also contribute to the statistical difference.
Total final consumption	TFC	TFC is the sum of the consumption in the end-use sectors and for non-energy use. Energy used for transformation processes and for own use of the energy producing industries is excluded. Final consumption reflects for the most part deliveries to consumers. Note that *international aviation bunkers* and *international marine bunkers* are not included in final consumption.
Industry	TOTIND	"Total industry" should cover all activity in mining, manufacturing and construction except for fuel production and transformation. The industry's use of energy for transport is included in the "Total transport" flow. The use of coke oven gas and blast furnace gas by the iron and steel industry appears in the form of coal and coal products consumption. Feedstocks to the chemical/petrochemical industry should *not* be included in this category. Indeed, non-energy use in industry is excluded from industry and reported separately. Please refer to non-energy use below.
Transport	TOTTRANS	"Transport" includes all fuels for transport regardless of sector, except international marine and aviation bunkers. Fuels used for pipeline transport should be included here. Non-energy use in transport is excluded from transport and

Flow	Short name	Definition
		reported separately. Please refer to non-energy use below.
of which: road	ROAD	Includes fuels used in road vehicles as well as agricultural and industrial highway use. Excludes military consumption as well as motor gasoline used in stationary engines and diesel oil for use in tractors that are not for highway use.
Residential	RESIDENT	Includes consumption by households, excluding fuels used for transport.
Commercial and Public Services	COMMPUB	Includes consumption corresponding to commercial and public services.
Non-energy use	NONENUSE	"Non-energy use" covers those fuels that are used as raw materials in the different sectors and are not consumed as a fuel or transformed into another fuel. Non-energy use is shown separately in final consumption under the heading "non-energy use". Non-energy use of peat and biomass should not be included here (indeed, they should not figure in these tables at all unless they are used for energy purposes).
of which: chemical/petrochemical	NECHEM	Fuels used for chemical feedstocks and non-energy products in the petro-chemical industry are included here and *not* in industry. *Note: this flow was called "of which: petrochemical feedstocks"*
Electricity generated (TWh)	ELOUTPUT	"Electricity generated (TWh)" shows total quantities of gross electricity generated in TWh by all electricity and CHP plants (see the notes on "Electricity, CHP and heat plants"). Electricity generated from pumped storage should not be included.
Heat generated (PJ)	HEATOUT	"Heat generated (PJ)" shows quantities of heat produced for sale by CHP and heat plants. Heat produced in electric boilers is reported under "Electricity" and heat produced in heat pumps is reported under "Heat".
Memo: Electrical capacities (MW)	ELECAP	Represents the net maximum capacity which is the maximum active power that can be supplied, continuously, with all plant running, at the point of outlet (i.e. after taking the power supplies for the station auxiliaries and allowing for the losses in those transformers considered integral to the station).
Memo: Input to hydrogen and synthetic fuels production	INH2PROD	Includes the data corresponding to fuel/electricity inputs for hydrogen and synthetic fuels production.
Memo: Input to heat pumps	INHEATPUMP	Includes the data corresponding to electricity and/or recovered heat (non-ambient) inputs to all types of heat pumps including small-scale residential ones.

The flows corresponding to the Extended Indicators file are detailed in the following table:

Extended Indicators.IVT

Flow	Short name	Notes
Total energy supply	TES	"Total energy supply" (TES) is made up of indigenous production (positive), imports (positive), exports (negative), international marine and aviation bunkers (negative) and stock changes (either positive or negative).
Total final consumption	TFC	TFC is the sum of the consumption in the end-use sectors and for non-energy use. Energy used for transformation processes and for own use of the energy producing industries is excluded. Final consumption reflects for the most part deliveries to consumers. *Note that international aviation bunkers and international marine bunkers are not included in final consumption*
GDP (billion 2015 USD using exchange rates)	GDP	Please note that sources for GDP were changed from previous editions. This can impact derived indicators. GDP data are derived from three sources: - International Monetary Fund. 2021. World Economic Outlook: War Sets Back the Global Recovery. Washington, DC, October. (IMF WEO) - World Development Indicators. 2022. Washington, D.C. :The World Bank. (WB WDI) - CEPII – CHELEM database. 2022. (CHELEM) Data from IMF WEO are used as a primary source for the period starting in 1980; if not available, data gaps are filled based on the other sources, based on data availability and the hierarchy described below: 1. Data from IMF WEO 2. WDI growth rates applied to IMF WEO data 3. Data from WB WDI for countries not included in IMF WEO for any year 4. CHELEM growth rates applied to IMF WEO data 5. Data from CHELEM Data in year n are rebased to 2015 using nominal GDP figures, GDP deflators and market exchange rates using following formula: $GDP_n = \frac{GDP\_Nominal\_NC_n}{Exchange\_rate_{base\_year}} * \frac{deflator_{base\_year}}{deflator_n}$ Please note that the regional totals shown for OECD and other regions were calculated by summing individual countries' GDP data. This calculation yields slightly different results to the GDP totals published by primary sources.
GDP (billion USD, 2015 prices and PPPs)	GDPPPP	Please note that sources for GDP were changed from previous editions. This can impact derived indicators. GDPPPP figures are derived using same sources and methodology as for GDP USD. Data in year *n* are rebased to 2015 using nominal GDP figures, GDP deflators and PPP rates using following formula: $GDPPPP_n = \frac{GDP\_Nominal\_NC_n}{PPP_{base\_year}} * \frac{deflator_{base\_year}}{deflator_n}$

Flow	Short name	Notes
		International price comparisons based on exchange rates may not reflect the relative purchasing power in each currency. PPPs are the rates of currency conversion that equalize the purchasing power of different currencies by eliminating the differences in price levels between countries. In their simplest form, PPPs are simply price relatives that show the ratio of the prices in national currencies of the same good or service in different countries. **Please note that the regional totals shown for European Union was calculated by summing individual countries' GDP data. This calculation yields slightly different results to the GDP totals published by OECD in its national accounts which are derived from chained-linked indices. GDP data from the World Bank have also been summed rather than using chain-linked indices.**
Population (millions)	POP	The main source of these series for 1970 to 2020 when available is the OECD *National Accounts Statistics* database [ISSN: 2221-433X (online)], last published in book format as *National Accounts of OECD Countries, Volume 2021 Issue 1: Detailed Tables*, OECD 2021. Data for 1960 to 1969 have been estimated using the growth rates from the population series published in the *OECD Factbook 2015* (online database version). Growth rates from the *OECD Factbook 2015* were also used to estimate data for, **Estonia** (prior to 1993), the **Slovak Republic** (prior to 1990). Data for **Colombia** (prior to 1985) and **Lithuania** (prior to 1995) are IEA Secretariat estimates based on GDP growth rates from the World Bank.
TES/GDP (MJ per 2015 USD)	TESGDP	This ratio is expressed in megajoules per 2015 US dollar. It has been calculated using total energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using exchange rates
TES/GDP (MJ per 2015 USD PPP)	TESGDPPPP	This ratio is expressed in megajoules per 2015 US dollar. It has been calculated using total energy supply (including biofuels and other non-fossil forms of energy) and GDP calculated using purchasing power parities.
TES/population (GJ per capita)	TESPOP	Ratio of total energy supply per capita expressed as GJ per capita.
TFC/population (GJ per capita)	TFCPOP	Ratio of total final consumption per capita expressed as GJ per capita.
TFC/GDP (MJ per 2015 USD)	TFCGDP	Ratio of total final consumption to GDP expressed as MJ per USD (2015 prices and ex. rates). Based on national GDP.
TFC/GDP (MJ per 2015 USD PPP)	TFCGDPPPP	Ratio of total final consumption to GDP expressed as MJ per USD (2015 prices and purchasing power parities).
Total self-sufficiency	TOTSELF	Production divided by TES expressed as a ratio.
Coal self-sufficiency	COALSELF	Coal production divided by TES expressed as a ratio. Includes coal, peat and oil shale.
Oil self-sufficiency	OILSELF	Oil production divided by TES expressed as a ratio.
Gas self-sufficiency	GASSELF	Natural gas production divided by TES expressed as a ratio.

Flow	Short name	Notes
Share of renewables in total energy supply (%)	RENTES	Renewable sources TES divided by total TES, expressed as a ratio. Renewable sources include hydro, geothermal, solar, wind, tide, wave, biofuels and the renewable fraction of municipal waste.
Share of renewables in total final energy consumption – SDG 7.2.1 (%)	RENTFEC	Final energy consumption from all renewable sources divided by total final energy consumption. Renewable energy consumption is derived as the sum of direct final consumption of renewable sources plus the components of electricity and heat consumption estimated to be derived from renewable sources based on generation shares. Renewable sources include hydro, geothermal, solar, wind, tide, wave, biofuels and the renewable fraction of municipal waste. *Note: This indicator is developed based on the same methodology used to derive the official SDG 7.2.1 indicator.*
Share of fossil fuels in total energy supply (%)	FFTES	Fossil fuel sources TES divided by total TES, expressed as a ratio. Fossil fuel sources include coal (including peat and oil shale), oil, natural gas, industrial waste and the non-renewable fraction of municipal waste.
Share of fossil fuels in total final energy consumption (%)	FFTFEC	Final energy consumption from all fossil fuel sources divided by total final energy consumption. Fossil energy consumption is derived as the sum of direct final consumption of fossil sources plus the components of electricity and heat consumption estimated to be derived from fossil sources based on generation shares. Fossil fuel sources include coal (including peat and oil shale), oil, natural gas, industrial waste and the non-renewable fraction of municipal waste.
Share of renewables in electricity generation (%)	RENELE	Output of electricity produced from renewable sources divided by total output of electricity, expressed as a ratio. Renewable sources include electricity from hydro, geothermal, solar, wind, tide, wave, biofuels and the renewable fraction of municipal waste.
Share of low carbon sources in electricity generation (%)	LOWCARBELE	Output of electricity produced from low carbon sources divided by total output of electricity, expressed as a ratio. Low carbon sources include electricity from hydro, geothermal, solar, wind, tide, wave, biofuels, the renewable fraction of municipal waste and nuclear.
Share of renewables in heat generation (%)	RENHEAT	Output of heat produced from renewable sources divided by total output of heat, expressed as a ratio. Renewable sources include heat from geothermal, solar thermal, biofuels and the renewable fraction of municipal waste.
Share of low carbon sources in heat generation (%)	LOWCARBHEAT	Output of heat produced from low carbon sources divided by total output of heat, expressed as a ratio. Low carbon sources include heat from geothermal, solar thermal, biofuels, the renewable fraction of municipal waste and nuclear.
Total CO_2 fuel combustion ($MtCO_2$)	CO2FUEL	*Presents* the 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 IPCC Guidelines*. For the historical years, the CO_2 emissions are estimated according to the 2006 IPCC Guidelines (sectoral approach). For the projection years as well as the most recent year available (provisional year), this value is estimated based on projections or provisional data for TES by fuel category, and on their average carbon intensities for the latest three years, according to the following equation:

Flow	Short name	Notes
		$$CO2_y = \sum_i \left[\left(\frac{CO2_{y-1,i}}{TES_{y-1,i}}\right) + \left(\frac{CO2_{y-2,i}}{TES_{y-2,i}}\right) + \left(\frac{CO2_{y-3,i}}{TES_{y-3,i}}\right)\right] /3 \times TES_{y,i}$$ Where: y: projections or provisional year i: fuel category: coal, oil, natural gas, other (industrial waste+ non-renewable municipal waste) $CO2_{y-1}$, $CO2_{y-2}$ and $CO2_{y-3}$: previous years CO_2 emissions from fuel combustion, calculated according to the 2006 IPCC Guidelines
Total CO_2 fuel combustion - CCUS adjusted ($MtCO_2$)	CO2FUELCC	This indicator is derived by subtracting the total mass of CO_2 captured by CCUS from the total CO_2 emissions from fuel combustion: CO2FUELCC = CO2FUEL - CCTOTAL
Coal CO_2 fuel combustion ($MtCO_2$)	COALCO2	Includes CO_2 emissions from coal combustion (including peat and oil shale).
Oil CO_2 fuel combustion ($MtCO_2$)	OILCO2	Includes CO_2 emissions from oil combustion
Gas CO_2 fuel combustion ($MtCO_2$)	GASCO2	Includes CO_2 emissions from natural gas combustion
Other CO_2 fuel combustion ($MtCO_2$)	OTHERCO2	Includes CO_2 emissions from industrial waste and non-renewable municipal waste combustion
Total GHG fuel combustion ($MtCO_{2eq}$)	GHGFUEL	Presents the total GHG emissions from fuel combustion including CO_2, CH_4 and N_2O.This includes GHG emissions from fuel combustion in IPCC Source/Sink Category 1 A Fuel Combustion Activities and those, which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the 2006 IPCC Guidelines. For the historical years, the GHG emissions are estimated according to the 2006 IPCC Guidelines (sectoral approach). For the projection years as well as the most recent year available (provisional year), this value is estimated based on projections or provisional data for TES by fuel category, and on their average carbon intensities for the latest three years, according to the following equation: $$GHG_y = \sum_i \left[\left(\frac{GHG_{y-1,i}}{TES_{y-1,i}}\right) + \left(\frac{GHG_{y-2,i}}{TES_{y-2,i}}\right) + \left(\frac{GHG_{y-3,i}}{TES_{y-3,i}}\right)\right] /3 \times TES_{y,i}$$ Where: y: projections or provisional year i : fuel category: coal, oil, natural gas, other (industrial waste+ non-renewable municipal waste) and biofuels and renewable municipal waste (only for non-CO_2 emissions)

Flow	Short name	Notes
		GHG_{y-1}, GHG_{y-2} and GHG_{y-3}: previous years GHG emissions from fuel combustion, calculated according to the 2006 IPCC Guidelines
Total GHG fuel combustion - CCUS adjusted ($MtCO_{2eq}$)	GHGFUELCC	This indicator is derived by subtracting the total mass of CO_2 captured by CCUS from the total GHG emissions from fuel combustion: GHGFUELCC = GHGFUEL - CCTOTAL
Coal GHG fuel combustion ($MtCO_{2eq}$)	COALGHG	Includes total greenhouse gas emissions from coal (including peat and oil shale) combustion including CO_2, CH_4 and N_2O.
Oil GHG fuel combustion ($MtCO_{2eq}$)	OILGHG	Includes total greenhouse gas emissions from oil combustion including CO_2, CH_4 and N_2O.
Gas GHG fuel combustion ($MtCO_{2eq}$)	GASGHG	Includes total greenhouse gas emissions from natural gas combustion including CO_2, CH_4 and N_2O.
Other GHG fuel combustion ($MtCO_{2eq}$)	OTHERGHG	Includes total greenhouse gas emissions from industrial waste and non-renewable municipal waste combustion including CO_2, CH_4 and N_2O.
Transport CO_2 emissions ($MtCO_2$)	TOTTRANCO2	This indicator contains CO_2 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. This includes domestic aviation, domestic navigation, road, rail and pipeline transport, and corresponds to IPCC Source/Sink Category 1 A 3.
Industry CO_2 emissions ($MtCO_2$)	TOTINDCO2	This indicator contains the CO_2 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. Additionally, this flow includes GHG emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the 2006 IPCC Guidelines for GHG inventories.
Residential CO_2 emissions ($MtCO_2$)	RESIDENCO2	This indicator contains CO_2 emissions from fuel combustion in households. This corresponds to IPCC Source/Sink Category 1 A 4 b.
Commercial and public services CO_2 emissions ($MtCO_2$)	COMMPUBCO2	This indicator includes CO_2 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.
Buildings CO_2 emissions ($MtCO_2$)	TOTBUILCO2	Includes the sum of "Residential " and "Commercial and public services" CO_2 emissions from fuel combustion.
Other final sectors CO_2	OTHERFCCO2	This indicator includes CO_2 emissions from deliveries to users classified as agriculture, hunting and forestry by the ISIC, and therefore includes energy

Flow	Short name	Notes
emissions ($MtCO_2$)		consumed by such users whether for traction (excluding agricultural highway use), power or heating (agricultural and domestic). As well as emissions from fuels used for inland, coastal and deep-sea fishing. This 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. On top of the above emissions from final sectors not specified above are also included in this category, which includes emissions from military fuel use for all mobile and stationary consumption (e.g. ships, aircraft, road and energy used in living quarters).
CO_2 from international marine bunkers ($MtCO_2$)	MARCO2	CO_2 emissions from international marine bunkers in million tonnes of CO_2. These amounts are not included in the national totals.
CO_2 from international aviation bunkers ($MtCO_2$)	AVCO2	CO2 emissions from international aviation bunkers in million tonnes of CO_2. These amounts are not included in the national totals.
Transport GHG emissions ($MtCO_{2eq}$)	TOTTRANGHG	This indicator contains GHG emissions from the combustion of fuel including CO_2, CH_4 and N_2O 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. This includes domestic aviation, domestic navigation, road, rail and pipeline transport, and corresponds to IPCC Source/Sink Category 1 A 3.
Industry GHG emissions ($MtCO_{2eq}$)	TOTINDGHG	This indicator contains the GHG emissions from the combustion of fuel including CO_2, CH_4 and N_2O 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. Additionally, this flow includes GHG emissions from fuel combustion which may be reallocated to IPCC Source/Sink Category 2 Industrial Processes and Product Use under the 2006 IPCC Guidelines for GHG inventories.
Residential GHG emissions ($MtCO_{2eq}$)	RESIDENGHG	This indicator contains GHG emissions from the combustion of fuel including CO_2, CH_4 and N_2O in households. This corresponds to IPCC Source/Sink Category 1 A 4 b.
Commercial and public services GHG emissions ($MtCO_{2eq}$)	COMMPUBGHG	This indicator includes GHG emissions from the combustion of fuel including CO_2, CH_4 and N_2O 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.
Buildings GHG emissions ($MtCO_{2eq}$)	TOTBUILGHG	Includes the sum of "Residential " and "Commercial and public services" GHG emissions from the combustion of fuel including CO_2, CH_4 and N_2O.
Other final sectors GHG emissions ($MtCO_{2eq}$)	OTHERFCGHG	This indicator includes GHG emissions from the combustion of fuel including CO_2, CH_4 and N_2O from 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). As well as emissions from fuels used for inland, coastal and deep-sea fishing. This covers fuels delivered to ships of

Flow	Short name	Notes
		all flags that have refuelled in the country (including international fishing) as well as energy used in the fishing industry. On top of the above emissions from final sectors not specified above are also included in this category, which includes emissions from military fuel use for all mobile and stationary consumption (e.g. ships, aircraft, road and energy used in living quarters).
Total electricity and heat generation CO_2 emissions ($MtCO_2$)	ELEHCO2	Represents the sum of fuel combustion CO_2 emissions from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Coal electricity and heat generation CO_2 emissions ($MtCO_2$)	ELEHCCO2	Represents the sum of coal (including peat and oil shale) combustion CO_2 emissions from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Oil electricity and heat generation CO_2 emissions ($MtCO_2$)	ELEHOCO2	Represents the sum of oil combustion CO_2 emissions from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Gas electricity and heat generation CO_2 emissions ($MtCO_2$)	ELEHGCO2	Represents the sum of natural gas combustion CO_2 emissions from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Other electricity and heat generation CO_2 emissions ($MtCO_2$)	ELEHOTCO2	Represents the sum of industrial waste and non-renewable municipal waste combustion CO_2 emissions from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Total electricity and heat generation GHG emissions ($MtCO_{2eq}$)	ELEHGHG	Represents the sum of fuel combustion GHG emissions including CO_2, CH_4 and N_2O from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Coal electricity and heat generation GHG emissions ($MtCO_{2eq}$)	ELEHCGHG	Represents the sum of coal (including peat and oil shale) combustion GHG emissions including CO_2, CH_4 and N_2O from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Oil electricity and heat generation GHG emissions ($MtCO_{2eq}$)	ELEHOGHG	Represents the sum of oil combustion GHG emissions including CO_2, CH_4 and N_2O from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Gas electricity	ELEHGGHG	Represents the sum of natural gas combustion GHG emissions including

Flow	Short name	Notes
and heat generation GHG emissions ($MtCO_{2eq}$)		CO_2, CH_4 and N_2O from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
Other electricity and heat generation GHG emissions ($MtCO_{2eq}$)	ELEHOTGHG	Represents the sum of industrial waste and non-renewable municipal waste combustion GHG emissions including CO_2, CH_4 and N_2O from electricity production, combined heat and power plants and heat plants. It is the sum of main activity producers and autoproducers. Emissions from own on-site use of fuel are included.
CO_2 Intensity of electricity and heat generation (gCO_2/kWh)	CO2KWHH	This ratio is based on CO_2 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. Both main activity producers and autoproducers have been included in the calculation. For the historical years the indicator has been calculated based on the following equation: $\frac{\sum_{fuels} \langle (Input_{Electricity\ plants} + Input_{CHP\ plants} + Input_{Heat\ plants} + Own\ use_{Plants}) \times EF_{fuel} \rangle}{Ele_{Inland} + Heat_{Inland}}$ Where: • $\sum_{fuels}$: 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*. • $Ele_{Inland} + Heat_{Inland}$: electricity and heat generation from all sources (including non-emitting sources) Please refer to the IEA Emission Factors database documentation[2] file for the complete methodology. For the projection years, the figures are estimated by dividing the estimated emissions corresponding to electricity and heat generation by the total electricity and heat generation from all sources. The emissions corresponding to electricity and heat generation (the numerator) is calculated using the projections for input to the plants and 3-year average fuel specific emission factors as detailed in section on *Projections and provisional greenhouse gas emissions from fuel combustion.*
GHG Intensity of electricity and heat generation (gCO_{2eq}/kWh)	GHGKWHH	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. Both main activity producers and autoproducers have been included in the calculation. For the historical years the indicator has been calculated based

[2] The IEA Emission Factors database documentation can be accessed at: https://iea.blob.core.windows.net/assets/631bfd9a-fea7-4ef3-8cc0-a11ab416805d/CO2KWH_Methodology.pdf

Flow	Short name	Notes
		on the following equation: $$\frac{\sum_{fuels,gases}\left(\left(Input_{Electricity\ plants} + Input_{CHP\ plants} + Input_{Heat\ plants} + Own\ use_{Plants}\right) \times EF_{fuel,gas}\right)}{Ele_{Inland} + Heat_{Inland}}$$ Where: • $\sum_{fuels,gases}$: Sum over the fuels and GHG gases (CO_2, CH_4, N_2O) • $Input_{plants}$: 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*. • $Ele_{Inland} + Heat_{Inland}$: electricity and heat generation from all sources (including non-emitting sources) Please refer to the IEA Emission Factors database documentation[1] file for the complete methodology For the projection years, the figures are estimated by dividing the estimated emissions corresponding to electricity and heat generation by the total electricity and heat generation from all sources. The emissions corresponding to electricity and heat generation (the numerator) is calculated using the projections for input to the plants and 3-year average fuel specific emission factors as detailed in section on *Projections and provisional greenhouse gas emissions from fuel combustion*.
Total CO_2 captured by CCUS ($ktCO_2$)	CCTOTAL	Represents the total emission savings through CCUS across the energy landscape.
CO_2 captured from electricity and heat generation by CCUS ($ktCO_2$)	CCELECHEAT	Represents the emission savings associated with CCUS in power generation.
CO_2 captured from hydrogen and synthetic fuel production by CCUS ($ktCO_2$)	CCH2PROD	Represents the emission savings associated with CCUS in the production of blue hydrogen and other synthetic fuels.
CO_2 captured from manufacturing by CCUS ($ktCO_2$)	CCMANUFACT	Represents the emission savings associated with CCUS across the manufacturing sectors, including ammonia production, Iron and steel and cement production.
CO_2 captured from natural gas processing by CCUS ($ktCO_2$)	CCNGPROC	Represents the emission savings through CCUS at natural gas processing plants.
CO_2 captured	CCOTHER	Represents the emission savings associated with CCUS in other areas of the

Flow	Short name	Notes
from other sectors by CCUS ($ktCO_2$)		energy supply, transformation and consumption not defined above.
CO_2 / TES (tCO_2 per TJ)	CO2TES	This ratio is expressed in tonnes of CO_2 per terajoule. It has been calculated using the total CO_2 fuel combustion emissions (CO2FUEL) and total energy supply (including biofuels and other non-fossil forms of energy).
CO_2 / GDP ($kgCO_2$ per 2015 USD)	CO2GDP	This ratio is expressed in kilogrammes of CO_2 per 2015 US dollar. It has been computed using the total CO_2 fuel combustion (CO2FUEL) emissions and GDP calculated using exchange rates.
CO_2 / GDP PPP ($kgCO_2$ per 2015 USD)	CO2GDPPP	This ratio is expressed in kilogrammes of CO_2 per 2015 US dollar. It has been calculated using CO_2 fuel combustion emissions (CO2FUEL) and 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 (CO2FUEL).
GHG / TES (tCO_{2eq} per TJ)	GHGTES	This ratio is expressed in tonnes of GHG per terajoule. It has been calculated using the total GHG fuel combustion emissions (GHGFUEL) and total energy supply (including biofuels and other non-fossil forms of energy).
GHG / GDP ($kgCO_{2eq}$ per 2015 USD)	GHGGDP	This ratio is expressed in kilogrammes of GHG per 2015 US dollar. It has been computed using the total GHG fuel combustion (GHGFUEL) emissions and GDP calculated using exchange rates.
GHG / GDP PPP ($kgCO_{2eq}$ per 2015 USD)	GHGGDPPP	This ratio is expressed in kilogrammes of GHG per 2015 US dollar. It has been calculated using GHG fuel combustion emissions (GHGFUEL) and GDP calculated using purchasing power parities.
GHG / population (tCO_{2eq} per capita)	GHGPOP	This ratio is expressed in tonnes of GHG per capita. It has been calculated using GHG fuel combustion emissions (GHGFUEL).
CO_2 emissions index (2017=100)	ICO2EMIS	CO_2 fuel combustion emissions (CO2FUEL) expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
Population index (2017=100)	IPOP	Population expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
GDP per population index (2017=100)	IGDPPOP	GDP PPP / population expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
Energy intensity index	ITESGDP	TES / GDP PPP expressed as an index, where the reference year = 100. Year 2017 is used as the reference year.

Flow	Short name	Notes
- TES / GDP (2017=100)		This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
Carbon intensity index - CO_2 / TES (2017=100)	ICO2TES	CO_2 emissions / TES expressed as an index, where the reference year = 100. Calculated using CO_2 fuel combustion emissions (CO2FUEL). This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
CO_2 emissions from electricity and heat generation (including CHP) index (2017=100)	CO2ELEH	Total electricity and heat generation CO_2 emissions (ELEHCO2) expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
Electricity and heat output in GWh index (2017=100)	ELEHOUTPUT	Electricity and heat output expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
Share of electricity and heat output from fossil fuels index (2017=100)	FOSSILELEH	Share of electricity and heat output from fossil fuels expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. The share has been derived by dividing the electricity and heat output from fossil sources by the total electricity and heat output. This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
CO_2 intensity of fossil fuel mix index (2017=100)	CO2INTMIX'	CO_2 intensity of the fossil fuel mix expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. The intensity has been derived by dividing the total CO_2 emissions from electricity and heat generation by the total input to electricity, heat and CHP plants. This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.
Thermal efficiency of electricity and heat plants including CHP index (2017=100)	THERMELEH	Thermal efficiency of electricity and heat plants (including CHP), expressed as an index, where the reference year = 100. Year 2017 is used as the reference year. The efficiency has been derived by dividing the total electricity and heat output from fossil plants by the overall input to these generation plants, This index can be used as one of the constituents of the Kaya identity, for more information refer to the section on Kaya identity.

Product dimension

Energy balances table

Product	Short name	Definition
Coal	COAL	Coal includes all coal and coal products both primary and derived, such as anthracite, coking coal, other bituminous coal, sub-bituminous coal, lignite, patent fuel, coke oven coke (including semi-coke), gas coke, coal tar, brown coal briquettes as well as coke oven gas, gas works gas, blast furnace gas and other recovered gases. *Note: in this database, oil shale is aggregated with coal (however the secondary product shale oil is included under oil).*
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 should not be included. Peat includes derived peat products.
Oil	OIL	Oil includes: 1. Crude oil, refinery feedstocks, natural gas liquids, additives as well as non-crude hydrocarbons (tar sands, shale oils, etc.) and orimulsion. Imports and exports of liquefied synthetic fuels should also be shown here. 2. Oil products including liquefied petroleum gas and refinery gas. Synthesised liquid hydrocarbons from other sources (e.g. hydrogen produced from natural gas and coal liquefaction, biomass, methanol, alcohol) are transferred under "Oil" from the appropriate cells. For example, liquefied coal would be shown as coal consumed (and therefore negative) under "Coal", "Other transformation" and as oil production (and therefore positive) under "Oil", "Other transformation".
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. Imports and exports of gaseous synthetic fuels including hydrogen are also reported under this product.
Nuclear	NUCLEAR	The primary energy value ascribed to nuclear electricity is calculated from the gross generation by assuming that only 33% of the primary energy content appears as electricity. Heat sold by nuclear power plants is shown as an output

Product	Short name	Definition
		under "Heat", "Electricity, CHP and heat plants" (positive number), with an identical input under "Nuclear", "Electricity, CHP and heat plants" (negative number).
Hydro	HYDRO	The primary energy value ascribed to hydro electricity is the energy content of the gross electricity generation from the natural flow of the water course. The electricity losses associated with pumped storage electricity are included in the quantities given under "Electricity", "Own use and losses".
Wind	WIND	The primary energy value ascribed to electricity produced from wind is taken to be the physical energy content of the gross generation: Gross electricity generation in TWh x 0.086 = primary energy equivalent in Mtoe.
Geothermal	GEOTHERM	If information on geothermal heat inputs to electricity generation is not available, then the primary energy value ascribed to geothermal electricity is calculated from the gross generation by assuming that only 10% of the primary energy content appears as electricity. Heat sold by geothermal plants is shown as an output under "Heat", "Electricity, CHP and heat plants", with an input under "Geothermal", "Electricity, CHP and heat plants". The default efficiency for geothermal heat is 50%.
Solar	SOLAR	The primary energy value ascribed to electricity produced from solar photovoltaic is taken to be the physical energy content of the gross generation: Gross electricity generation in TWh x 0.086 = primary energy equivalent in Mtoe. The primary energy equivalent for solar thermal energy is the heat available to the heat transfer medium, i.e. the incident solar energy less the optical, collectors and other eventual losses. It should be reported as indigenous production. The quantity of heat consumed should be entered in the relevant final sectors. For solar thermal electricity, a default of 33% is used if the actual efficiency is not known. If the heat is distributed in the transformation sector, then the default efficiency is 100% for solar thermal heat.
Tide, etc	TIDEOTHER	Tide, wave and ocean represents the mechanical energy derived from tidal movement, wave motion or ocean current and exploited for electricity generation. Other sources includes production not included elsewhere such as fuel cells.
Biofuels and waste	COMRENEW	Solid biofuels, liquid biofuels, biogases and the renewable fraction of municipal waste. This includes primary solid biofuels, biogases, biogasoline, biodiesels, bio jet kerosene, other liquid biofuels, charcoal and renewable fraction of municipal waste produced by households, industry, hospitals and the tertiary sector that are collected by local authorities for incineration at specific installations.
Non-renewable waste	NRENWASTE	Includes industrial waste of non-renewable origin consisting of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power and the non-renewable fraction of municipal waste produced by households, industry, hospitals and the tertiary

Product	Short name	Definition
		sector that are collected by local authorities for incineration at specific installations.
Electricity	ELECTR	"Electricity" shows trade and final consumption in electricity (which is counted at the same heat value as electricity in final consumption i.e. Data in TWh x 0.086 = Data in Mtoe). If hydrogen or synthetic fuels are produced through power to gas processes by consumption of electricity, and due to the current absence of these products in the main structure of the energy balance, the final consumption of these fuels may be reported under electricity, while accounting for the conversion losses.
Heat	HEAT	"Heat" permits the reporting of (a) the generation and consumption of heat for sale and (b) heat extracted from ambient air and water by large-scale industrial heat pumps used for selling heat to third parties. The generation of heat for sale is reported as a transformation activity. Heat consumed at the point of production, which is generated from fuels reported elsewhere in the balance, is not reported. The fuels consumed for the production of heat are included in the quantities of the fuels shown as consumed by the final sectors.
Total	TOTAL	Total is the total of all energy sources.
Memo: Offshore wind	MWINDOFF	This product is a subcomponent of the “Wind” element. The primary energy value ascribed to electricity produced from wind is taken to be the physical energy content of the gross generation: Gross electricity generation in TWh x 0.086 = primary energy equivalent in Mtoe.
Memo: Hydrogen & Synthetic fuels	MH2SYNFUEL	This product includes data corresponding to hydrogen and synthetic fuels.
Memo: Heat pump	MHEATPUMP	This product is for reporting of heat data corresponding to all types of heat pumps including small-scale residential ones.

Geographical coverage

Geographical coverage

Country/Region	Short name	Definition
Australia	AUSTRALI	Excludes the overseas territories. Data are reported on a fiscal year basis. By convention data for the fiscal year that starts on 1 July Y-1 and ends on 30 June Y are labelled as year Y.
Austria	AUSTRIA	
Belgium	BELGIUM	
Canada	CANADA	
Colombia	COLOMBIA	Colombia is currently seeking accession to full IEA membership
Czech Republic	CZECH	Data start in 1980.
Denmark	DENMARK	Excludes Greenland and the Faroe Islands, except prior to 1990, where data on oil for Greenland were included with the Danish statistics.
Estonia	ESTONIA	Data start in 1990.
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.
Germany	GERMANY	Includes the new federal states of Germany from 1970 onwards.
Greece	GREECE	
Hungary	HUNGARY	Data start in 1970.
Ireland	IRELAND	
Italy	ITALY	Includes San Marino and the Holy See.
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.
Korea	KOREA	Data start in 1980.
Lithuania	LITHUANIA	Data for Lithuania are available starting in 1990. Lithuania

Country/Region	Short name	Definition
		joined the IEA in February 2022.
Luxembourg	LUXEMBOU	
Mexico	MEXICO	Data start in 1980.
Netherlands	NETHLAND	Excludes Suriname, Aruba and the other former Netherland Antilles (Bonaire, Curaçao, Saba, Saint Eustatius and Sint Maarten).
New Zealand	NZ	
Norway	NORWAY	
Poland	POLAND	
Portugal	PORTUGAL	Includes the Azores and Madeira.
Slovak Republic	SLOVAKIA	Data start in 1980.
Spain	SPAIN	Includes the Canary Islands.
Sweden	SWEDEN	
Switzerland	SWITLAND	Includes Liechtenstein for the oil data. Data for other fuels do not include Liechtenstein.
Turkey	TURKEY	
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 has entered into a transition period until 31 December 2020. The UK is excluded from the EU27 aggregate
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 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.
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 these countries are included since 1990 despite different entry dates into the European Union.

Methodological notes

Scenario categorisation

It is important to clearly communicate the purpose and context of the scenarios underlying the projections data to avoid misinterpretation. This section describes the general categories of scenarios which have been selected as the basis of the projections data included in this database. Understanding the category of the scenarios and their underlying methodology is of great value and facilitates the comparison and analysis of the projections data. Please refer to the *Country notes* section for detailed information corresponding to the country-specific scenarios.

Business as usual

The "business as usual" scenario category aims to capture scenarios that include only government policies which have been already adopted, and therefore project how the national energy landscape may evolve if the existing structures in energy supply and demand remain unchanged.

Scenarios with the "business as usual" category provide a baseline to compare alternative scenarios and a starting point for the understanding and analysis of the energy system by assuming a general continuation of historical trends into the future. The assumption is that the structure of the system remains unchanged or responds in pre-determined forms.

Examples include the European Commission's EU Reference Scenario 2020, the IEA Current Policies Scenario, the EIA's Annual Energy Outlook Reference Case and Canada's Energy Future Current Policies Scenario.

Stated policies

The "stated policies" scenario category aims to capture scenarios that take into account national climate and/or energy-related policies and measures which have been already adopted by the government, together with pertinent policy proposals, announced commitments and plans which have been announced but are yet to be formally adopted.

A cautious view of the extent and timing to which policy proposals are projected to be implemented and objectives achieved are key in defining this type of scenarios. The aim of scenarios in this category is to provide a sense of where today's policy ambitions seem likely to drive the energy landscape.

In other words, this scenario type is a policy-based forecast, not a hypothetical scenario which is based on optimizing policy for a desired outcome.

It is typical to set out the gap in between the outcome of these types of scenario and targets such as efforts to limit global temperature increase to 1.5 Cº, or wider Paris Agreement objectives. Examples include the IEA Stated Policies Scenario (STEPS) and the EU's With Additional Measures (WAM) scenarios.

Beyond stated policies (aspirational)

Scenarios within this category set an energy pathway consistent with specific target(s) or other particular desired outcomes. By this means, they demonstrate what should be achieved across sectors and by various actors and by when, for the targets or outcomes to be achieved.

Examples include the European Commission's REG and MIX and the IEA Net Zero Emissions by 2050 (NZE) and Sustainable Development (SDS) scenarios.

For the purpose of this publication, the "aspirational" scenarios have been be divided into the following two sub-categories:

a. Achieving national targets:

This type of scenarios could set out a pathway for the national (or regional) energy sector to achieve a specific target. For example, a net zero scenario could set out a pathway for the national energy sector to achieve net zero emissions by a certain year. Or a Paris Agreement compliant scenario demonstrates a pathway consistent with the goal of limiting the global increase in temperature to 2 or 1.5°C (with a certain probability). Additionally, scenarios consistent with achieving certain sustainable development goals fall within this category.

b. Achieving defined outcomes:

This category of scenarios is consistent with defined outcomes rather than targets. Examples include scenarios consistent with achieving affordability of energy sources or long/short-term energy security purposes. Some scenarios could have multiple desired outcomes.

Other

Scenarios which do not fall under any of the above general categories have been reported under this option. You may refer to the *Country notes* section for detailed information corresponding to the methodology and model used and any underlying assumptions corresponding to scenarios identified under this category.

Note: If projections data corresponding to multiple scenarios have been collected from a country, while the country has classified more than one of the submitted scenarios under the same scenario cluster, one of the two scenarios has been disseminated under the “other” category to allow differentiation in between the two sets of data.

Energy balance: key concepts

Energy statistics expressed in physical units in the form of commodity balances, balances of supply and use of each energy commodity, are a simple way to assemble the main statistics so that key data are easily obtained, and that data completeness can be quickly assessed. However, because energy products are mainly bought for their heat-raising properties and can be converted into other energy products, presenting data in energy units is very powerful. The format adopted is called energy balance.

The energy balance takes the form of a matrix, where columns present all the different energy sources and rows represent all the different "flows", grouped in three main blocks: energy supply, transformation/energy use and final consumption.

To develop an energy balance from the set of energy commodity balances, the two main steps are: i) all the data are converted to a common energy unit – and also a " total" product is computed; and ii) some re-formatting is performed to avoid double counting when summing products together. For example, while the production of secondary products (e.g. motor gasoline) is shown in the production row in commodity balances, it is reported as an output of the relevant transformation (e.g. oil refineries) in an energy balance, where the production row only refers to production of primary products (e.g. crude oil).

The methodological assumptions underlying energy balances discussed in the next section are particularly important to understand differences across balances formulated by different organisations starting from the same energy commodity data.

IEA energy balances methodology

The unit adopted by the IEA is the mega joules (MJ). Conversion of the IEA energy balances to other energy units would be straightforward.

The main methodological choices underlying energy balances that can differentiate balances across organisations are: i) "net" versus "gross" energy content; ii) calorific values; and iii) primary energy conventions.

Net versus gross energy content

The IEA energy balances are based on a “**net**” energy content, which excludes the energy lost to produce water vapour during combustion. All the elements of the energy balance are expressed on the same net basis to ensure comparability. Even elements (e.g. natural gas) that in commodity balances may be already in energy units but on a different basis (e.g. “gross”) are converted (e.g. from “gross” to “net”).

The difference between the "net" and the "gross" calorific value for each fuel is the latent heat of vaporisation of the water produced during combustion of the fuel. For coal and oil, the net calorific value is about 5% less than gross, for most forms of natural and manufactured gas the difference is 9-10%, while for electricity and heat there is no difference as the concept has no meaning in this case.

Calorific values

Generally, the IEA adopts country-specific, time-varying, and for some products flow-dependent, net calorific values supplied by national administrations for most products; and regional default values (in conjunction with Eurostat for the European countries) for the oil products. More detailed explanations on the IEA conversion to energy units for the different energy sources are given in section 8 *Units and Conversions*.

Primary energy conventions

A very important methodological choice is the definition of the “**primary energy equivalent**” for the electricity and heat produced from non-combustible sources, such as nuclear, geothermal, solar, hydro, wind. The information collected is generally the amount of electricity and heat produced, represented in the balance as an output of transformation. Conventions are needed to compute the most appropriate corresponding primary energy, input to the transformation, both in form and in amount.

The principle adopted by the IEA is that the **primary energy form** is *the first energy form downstream in the production process for which multiple energy uses are practical*. For example, the first energy form that can be used as energy in the case of nuclear is the nuclear heat of the reactor, most of which is then transformed into electricity. The application of this principle leads to the choice of the following primary energy forms:

- **Electricity** for primary electricity (hydro, wind, tide/wave/ocean and solar photovoltaic).
- **Heat** for heat and secondary electricity (nuclear, geothermal and solar thermal).

Once the primary energy form is identified for all electricity and heat generated from non-combustible sources, the IEA adopts the **physical energy content method** to compute the corresponding primary energy equivalent amounts: the primary energy equivalent is simply the physical energy content of the corresponding primary energy form.

For primary electricity, such as hydro and solar PV, as electricity is identified as the primary energy form, the primary energy equivalent is simply the gross electricity generated in the plant.

For nuclear electricity, the primary energy equivalent is the quantity of heat generated in the reactors. In the absence of country-specific information, the IEA estimates the primary energy equivalent from the electricity generated by assuming an efficiency of 33%, derived as the average efficiency of nuclear power plants across Europe. Note that the principle of using the heat from nuclear reactors as the primary energy form for the energy statistics has an important effect on any indicators of energy supply dependence. Under the present convention, the primary nuclear heat appears as an indigenous resource. However, the majority of countries using nuclear power import their nuclear fuel, and if this fact could be taken into account, it would lead to an increase in the supply dependence on other countries.

For geothermal electricity, the primary energy equivalent is the quantity of heat and a similar back-calculation is used where the quantities of steam supplied to the plant are not measured, assuming a thermal efficiency of 10%. This figure is only approximate and reflects the fact that the steam from geothermal sources is generally of low quality. If data for the steam input to geothermal power plants are available, they are used directly as primary energy equivalent.

Similarly, for solar thermal plants the heat supply is back-calculated assuming a 33% efficiency of conversion of heat into electricity, reflecting relatively low working temperatures, although central receiver systems can reach higher temperatures and therefore higher efficiencies.

In summary, for geothermal and solar thermal, if no country-specific information is reported, the primary energy equivalent is calculated as follows:

- 10% for geothermal electricity;

- 50% for geothermal heat;
- 33% for solar thermal electricity;
- 100% for solar thermal heat.

Alternative methods to the physical energy content method exist, such as the **partial substitution method**, used in the past by the IEA. In this case, the primary energy equivalent of the above sources of electricity generation would be computed as the hypothetical amount of energy necessary to generate an identical amount of electricity in conventional thermal power plants, considering an average generating efficiency. The principle was abandoned by the IEA and many other international organisations because it had little meaning for countries in which hydro electricity generation was a significant supply source, and because the actual substitution values were hard to establish as they depended on the marginal electricity production efficiencies. Partial substitution also had unreal effects on the energy balance as transformation losses appeared which had no physical basis.

Since the two methods differ significantly in the treatment of electricity from solar, hydro, wind, etc., the share of renewables in total energy supply will appear to be very different depending on the method used. To interpret shares of various energy sources in total supply, it is important to understand the underlying conventions used to calculate the primary energy supply.

The IEA estimates of GHG emissions methodology

Historical CO_2 emissions from fuel combustion

The IEA uses the simplest (Tier 1) methodology to estimate historical CO_2 emissions from fuel combustion based on the *2006 IPCC Guidelines*[3]. The computation follows the concept of conservation of carbon. 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.

The IEA historical estimates of CO_2 emissions from fuel combustion are obtained following harmonised definitions and comparable methodologies across countries. However, 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. Please note that the IEA historical emissions estimations are only provided as benchmark estimate and do not replace official national submissions.

Please refer to the IEA Greenhouse Gas Emissions from Energy database documentation for additional information.

[3] The 2006 IPCC Guidelines for National Greenhouse Gas Inventories is available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Historical non-CO_2 greenhouse gas emissions from fuel combustion

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

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

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

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

The emissions figures are converted from gCH_4 and gN_2O to gCO_{2eq} using the 100-year Global warming potential (GWP). For the purpose of comparability with international data submission guidelines and based on Decision 24/CP.19

from UNFCCC's Measurement, Reporting and Verification (MRV) framework, the factors from the 4th Assessment of the IPCC are used.

Please refer to the IEA Greenhouse Gas Emissions from Energy database documentation for additional information.

Projections and provisional greenhouse gas emissions from fuel combustion

For the projection years as well as the most recent year available (provisional year), the emissions estimates are based on projections or provisional energy data by fuel category, and on their average carbon intensities for the latest three years, according to the following equation:

$$GHG_y = \sum_i \left[\left(\frac{GHG_{y-1,i}}{E_{y-1,i}} \right) + \left(\frac{GHG_{y-2,i}}{E_{y-2,i}} \right) + \left(\frac{GHG_{y-3,i}}{E_{y-3,i}} \right) \right] / (3 \times E_{y,i})$$

Where:

y: projections or provisional year

i : fuel category: coal, oil, natural gas, other (industrial waste+ non-renewable municipal waste) and biofuels and renewable municipal waste (only for non-CO_2 emissions)

E: energy data. For total emissions this corresponds to total energy supply (TES), while for sectoral estimates this corresponds to the respective final consumption figures and for electricity and heat generation, these figures correspond to the inputs to the generation plants.

GHG_{y-1}, GHG_{y-2}, GHG_{y-3} : previous years GHG emissions from fuel combustion, calculated according to the 2006 IPCC Guidelines

Macroeconomic drivers of CO_2 emissions trends

The indicators include decomposition of CO_2 emissions into four driving factors (Kaya identity)[4], which is generally presented in the form below:

[4] Additional information available at: Yamaji, K., Matsuhashi, R., Nagata, Y. Kaya, Y., An integrated system for CO2/Energy/GNP analysis: case studies on economic measures for CO2 reduction in Japan. Workshop on CO2 reduction and removal: measures for the next century, March 19, 1991, International Institute for Applied Systems Analysis, Laxenburg, Austria.

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. (Py-Px)/Px, will not generally add up to the percentage change of CO_2 emissions (Cy-Cx)/Cx. However, relative changes of CO_2 emissions in time can be obtained from relative changes of the four factors as follows:

Kaya identity: relative changes in time

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

where x and y represent for example two different years.

In this publication, the Kaya decomposition is presented as:

CO_2 emissions and drivers

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

where:

CO_2	= CO_2 emissions;
P	= population;
GDP/P	= GDP/population;
TES/GDP	= Total energy supply per GDP;

CO_2/TES = CO_2 emissions per unit TES.

For the purpose of this publication, the terms are represented as indices (2017 = 100)

The Kaya identity can be used to discuss the primary driving forces of CO_2 emissions. However, it should be noted that there are important caveats in the use of the Kaya identity. Most important, the four terms on the right-hand side of equation should be considered neither as fundamental driving forces in themselves, nor as generally independent from each other.

Drivers of electricity and heat generation emissions trends

The indicators included in the *Projections: Energy Policies of IEA Countries – with transitions indicators dataset* also include the change in CO_2 emissions from electricity and heat generation over time decomposed into the respective changes of four driving factors:

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

where:

C = CO_2 emissions;

E = fossil fuel inputs to thermal generation;

ELF = electricity and heat output from fossil fuels;

EL = total electricity and heat output;

This can be rewritten as:

CO_2 emissions from electricity and heat 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 and heat generation efficiency;

EFS = share of electricity and heat from fossil fuels;

EL = total electricity and heat output.

This decomposition expresses, for a given time, CO_2 emissions from electricity and heat 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 and heat from fossil fuels (EFS) and total electricity and heat 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. (CFy-CFx)/CFx may not perfectly match the percentage change of total CO_2 emissions (Cy-Cx)/Cx. To avoid this, a more complex decomposition method is required. In this case, the logarithmic mean divisia (LMDI) method proposed by Ang (2004)[5] has been used.

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

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

where:

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

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

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

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

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

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. 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 and heat generation would affect both the CO_2 intensity of the generation mix and the thermal efficiency of generation.

Data availability

Table below represents the details of availability of data corresponding to the main structure of the energy balances for each year, the number of scenarios as well as the date of the latest submission to IEA.

Projections availability for energy balances data

Country	2030	2040	2050	Number of scenarios	Latest submission to the IEA
Australia	p	..	..	1	2021/2022
Austria	✓	✓	✓	1	2021/2022
Belgium	p	p	..	2	2021/2022
Canada	✓	✓	✓	2	2021/2022
Colombia	✓	✓	✓	1	2021/2022
Czech Republic	✓	✓	✓	1	2017/2018
Denmark	✓	✓	..	1	2021/2022
Estonia	✓	✓	✓	1	2021/2022
Finland	✓	✓	..	1	2021/2022
France	p	p	p	1	2021/2022
Germany	✓	✓	..	1	2021/2022
Greece	..	..	..	N/A	N/A
Hungary	✓	✓	✓	3	2021/2022
Ireland	✓	✓	✓	1	2021/2022
Italy	✓	✓	✓*	2	2021/2022
Japan	p	..	..	1	2021/2022
Korea	p	p	..	1	2019/2020
Lithuania	p	..	..	1	2021/2022
Luxembourg	..	..	..	N/A	N/A
Mexico	..	..	..	N/A	N/A
Netherlands	✓	✓	..	2	2021/2022

Country	2030	2040	2050	Number of scenarios	Latest submission to the IEA
New Zealand	✓	✓	✓	1	2021/2022
Norway	..	..	..	N/A	N/A
Poland	✓	..	..	1	2016/2017
Portugal	✓	✓	..	1	2021/2022
Slovak Republic	✓	✓	✓	1	2021/2022
Spain	✓	..	..	1	2021/2022
Sweden	✓	✓	✓	1	2021/2022
Switzerland	✓	✓	✓	1	2021/2022
Turkey	..	..	..	N/A	N/A
United Kingdom	..	..	..	N/A	N/A
United States	✓	✓	✓	2	2021/2022
European Union - 27	..	..	..	N/A	N/A

Note: ✓ indicates that the projections data are available; **p** indicates that the projections data are partially available; .. indicates that projections are not available.

The table below presents the details of availability of the recently introduced granular data corresponding to the emerging fuels and technologies which are expected to have a prominent role in the upcoming decades.

Projections availability for emerging fuels and technologies

Country	CCUS	Hydrogen and synthetic fuels	Heat pumps
Australia	..	..	..
Austria	..	..	..
Belgium	..	..	..
Canada	✓	✓	..
Colombia	..	..	..
Czech Republic	..	..	..

Country	CCUS	Hydrogen and synthetic fuels	Heat pumps
Denmark	✓	✓	..
Estonia	..	..	..
Finland	..	..	✓
France	✓	..	..
Germany	✓	✓	✓
Greece	..	..	..
Hungary	✓	p	p
Ireland	..	..	✓
Italy	✓	✓	✓
Japan	..	..	..
Korea	..	..	..
Lithuania	..	..	..
Luxembourg	..	..	..
Mexico	..	..	..
Netherlands	✓	..	✓
New Zealand	..	..	..
Norway	..	..	..
Poland	..	..	..
Portugal	..	✓	✓
Slovak Republic	..	p	..
Spain	..	..	..
Sweden	..	..	..
Switzerland	✓	✓	✓
Turkey	..	..	..
United Kingdom	..	..	..
United States	✓	..	..
European Union - 27	..	..	..

Note: ✓ indicates that the projections data are available; **p** indicates that the projections data are partially available; .. indicates that projections are not available.

Country notes

This section includes the country notes corresponding to the included projections data in the database. Please refer to the IEA World Energy Balances, documentation for the country notes related to the included historical data.

Australia

Source(s)

Department of Industry, Science, Energy and Resources.

Scenario(s)

Business as usual

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for 2040 and 2050 are not available.

The projections are updated on an annual basis.

All data except GDP and population data refer to the fiscal year July to June (e.g. 2030 implies 1 July 2029 to 30 June 2030).

Country does not currently develop official long term energy projections up to 2050. Electricity generation and capacity data, as well as transport sector energy consumption, GDP growth rate and population figure for 2030 are based on the Australian government's 2021 *Australian Emissions Projections assumptions* data, available at: Australia’s emissions projections 2021

GDP growth rates and population data for years 2040 and 2050 are sourced from the *2021 Intergenerational Report* published by the Australian Government Treasury, available at: https://treasury.gov.au/publication/2021-intergenerational-report

Austria

Source(s)

Republic of Austria - Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

Scenario(s)

Business as usual

General notes

All projections data are based on the 2021/22 submission to the IEA.

Frequency of the projection updates are expected to be biannually.

The projections have been developed in relation to the development of the National Energy and Climate Plan (NECP) which has been submitted to the European Commission in December 2019. The corresponding reports are available at:

https://www.umweltbundesamt.at/energie/energieszenarien/energieszenarien2019

https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2380&cHash=ea613d8c56d727831c1418f84f84d345

Note that since the submission of the above projections, there has been updates to the country's climate targets (e.g., achieving climate neutrality by 2040), which is had not been reflected in the above-mentioned developed projections. Due to the newly defined and planned policies and measures the country is currently in the process of updating the projections for multiple scenarios. However, the results are expected to be available in 2023.

Belgium

Source(s)

FPS Health, Food Chain Safety and Environment (DG Environment, Climate Change Section), FPS Economy (DG Energy), Bruxelles Environnement, Vlaams Energie- en Klimaatagentschap, Service Public de

Wallonie and Federal Planning Bureau

Scenario(s)

Business as usual

Aspirational – achieving defined outcomes

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available.

For the "business as usual" scenario, all policies and measures (EU, federal and regional) that have been implemented and adopted by the end of 2019 have been considered.

For the "aspirational – achieving defined outcomes" scenario, planned policies and measures (EU, federal and regional), not yet implemented nor adopted by the end of 2019 have been considered.

More information on the underlying methodology corresponding to both scenarios is available at:

https://reportnet.europa.eu/public/dataflow/113

The projections do not include the breakdown of the supply side for fossil fuels. Since there is no local production of fossil fuels in Belgium, the gross inland production has been reported as imports for all fossil fuels. This figure includes the imports, exports and stock changes. However, it does not take into account the international marine bunkers consumption.

For year 2040, the projections do not provide a disaggregation of data corresponding to different renewable sources, hence an aggregated figure is reported under the biofuels and renewable waste product.

Projections for GDP growth rates are not available.

Canada

Source(s)

Natural Resources Canada, Ottawa

Canada Energy Regulator (CER)

Scenario(s)

Business as usual

Other

General notes

All projections data are based on the 2021/22 submission to the IEA.

The projections are updated on an annual basis.

The projections are based on forecasts provided by the Canada Energy Regulator (CER) and are featured in the annual CER publication, *Canada's Energy Future 2021: Energy Supply and Demand Projections to 2050 ("EF2021")*, available at:

https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/index.html

Natural Resources Canada (NRCan) accesses this information through the CER's Open Data, Annexes and other including provision of unpublished aggregates. These projections are then used in combination with energy balance figures previously reported to the IEA by NRCan through the annual questionnaire submissions.

The projections reported in this questionnaire are obtained by applying the percentage growth rates forecast in the CER's EF2021 to baseline IEA energy balance submissions for Canada. When there is no clear concordance between a specific flow/product from the IEA Projections questionnaire with the CER's publication, best efforts are made to identify the most appropriate donor.

Growth projections are based upon two core scenarios modelled by the CER: the "Evolving Policies Scenario" and the "Current Policies Scenario". The central premise to these scenarios is based on the level of future climate action, both globally and domestically (which are briefly elaborated upon below, and again in greater detail in the appendix).

For the purposes of the publication, the CER projections from the Current Policies scenario have been matched to the "business as usual" Scenario. Likewise, the CER's Evolving Policies scenario is matched to the "other" scenario category. The decision to equate the EF2021 scenarios along these lines was made following consultation with the CER and was guided by two main factors. Foremost, the Users Guide provided by the IEA to the data providers, cites EF2021's Current Policies scenario as a suitable analogue to the "business as usual" Scenario. Likewise, while the "stated policies" and "aspirational" scenarios deal with enforcing specific targets and ambitions, the Evolving Policies Scenario extrapolates past any specific policy framework and is more open ended in its assumptions surrounding decarbonisation, thereby making the "other" category a more suitable fit.

The core premise of the Evolving Policies Scenario is that action to reduce the GHG intensity of energy system continues to increase at a pace similar to recent history, in both Canada and the world. Relative to a scenario with less action to reduce GHG emissions, this evolution implies less global demand for fossil fuels, and greater adoption of low-carbon technologies. In contrast, the Current Policies Scenario assumes that there is generally no additional action to reduce GHGs beyond those policies in place today, implying relatively higher global demand for fossil fuels and less adoption of low-carbon technologies. Consistent with these implications, the Evolving Policies Scenario assumes lower international prices for fossil fuels and a higher pace of technological change over the projection period, compared to the Current Policies Scenario. The Evolving and Current Policies scenarios do not explicitly model climate goals or targets. Given its static policy framework, the Current Policies Scenario is extremely unlikely to lead to the significant GHG reductions needed to meet Canada's Paris commitments. In the Evolving Policies Scenario, significant GHG emission reductions will be realized, but ambitious goals such as net-zero by 2050 are unlikely to be met.

A more detailed distinction of the assumptions between scenarios is found in Appendix A. Key Differences Between Scenario Assumptions, available at: https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/scenarios-and-assumptions.html

Colombia

Source(s)

UPME, MME, MADS, Minhacienda, IEA, Irena, gsnova, E&Y, ANM, ANH, BM, DANE, DNP, Woodmac, Promigas, SSPD, Universidad Nacional, Mintransporte

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

Frequency of the projection updates are biannual.

The projections data are based on the "Modernization scenario", which brings together the initiatives that would imply a technological leap in demand and an energy change giving greater importance to fuel gases, as a transitory path towards country's decarbonization. For this scenario, an expected GDP growth of 3.1% is assumed in the long term. This scenario is distinguished by the adoption of technologies with the best energy yields in the world in 2050 and a greater degree of ambition in mitigating climate change, leveraged mainly by the use of fuel gases. Regarding the energy supply, the "Modernization scenario" contemplates Colombia's position as a net importer of liquid fuels and natural gas, the increase in blends in biofuels, a higher percentage of participation of wind and solar generation, the entry of other renewables such as offshore wind power and biogas. Similarly, greater penetration of distributed generation and improvement in energy efficiency in thermal generation are considered. Additional information is available at: https://www1.upme.gov.co/DemandayEficiencia/Paginas/PEN.aspx

Some additional detailed assumption corresponding o the scenario are also listed below:

- **Historical energy consumption:** The historical consumption information used in the simulation model corresponds to what is recorded in the Colombian Energy Balance - BECO for the period between 2010 and 2019 (UPME, 2020).
- **Service coverage Assumption:** In all scenarios, a coverage level of 100% of electricity is assumed in 2030. Full adoption of the most efficient

technology available in Colombia or internationally in a given year is assumed.

- **Residential Assumptions:**

  a. Reduction of firewood consumption and substitution for LPG in rural areas.

  b. Replacement of inefficient luminaires with LED

  c. Electrification of urban homes

  d. Replacement of inefficient lighting with LED and low-pressure sodium technologies

- **Transportation Assumptions:**

  a. Total fleet projection of 29 million fleet by 2050.

  b. Full adoption of the most efficient technology available in Colombia or internationally in a given year.

  c. Gradual entry of zero and low emission vehicles in the light fleet.

  d. Gradual entry of zero and low emission vehicles in the passenger fleet

  and penetration of natural gas (compressed and liquefied) and LPG in cargo transportation.

  F. Electrification of the motorcycle fleet

  g. LPG penetration in river navigation

  h. Increase in air travel.

  i. Entry of new electric mass transport trains (metros, commuter trains).

  j. According to economic and population projections, by 2050, country's GDP per capita will be between 10,000 and 20,000 USD (similar to the current Chilean), so the number of vehicles per thousand inhabitants could be up to 250.

  k. Achieve the maximum efficiencies postulated in the Useful Energy Balance study - BEU (UPME, 2019).

l. A gradual inclusion of zero and low emission vehicles in the light fleet (cars, campers, taxis and vans).

- **Oil and derivatives Assumptions:**

  a. Medium and low oil production scenarios according to current official information (UPME, 2020).

  b. Refining capacity and composition of the refinery diet remain at the same levels as in the base years.

  c. Mixture of biofuels in accordance with current regulations and assumptions of increase

  d. Increased efficiency in refineries e. supply of liquid fuels subject to increases in efficiency and/or technological substitution in sectors of final consumption, particularly transport.

- **Electricity assumptions:**

  a. FNCER installed capacity according to the scenario

  b. Installation of new technology capacity for the Colombian context (geothermal, nuclear, etc.)

  c. Progressive development between resource scenarios distributed according to the area available for installation

  d. Impact modeling of Smart Grids and microgrids through the demand curve.

Czech Republic

Source(s)

Ministry of Industry and Trade of the Czech Republic.

Scenario(s)

Information not available.

General notes

There has been no submission of projections data to the IEA for the past three years. All projections data are based on the 2017/18 submission to the IEA.

Denmark

Source(s)

Danish Energy Agency.

Scenario(s)

Business as usual

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available.

The projections are updated on an annual basis.

The projections are based on several optimization and simulation models. More information on the underlying methodology can be accessed at: https://ens.dk/service/fremskrivninger-analyser-modeller/klimastatus-og-fremskrivning-2022

Ambient heat from heat pumps reported under product 'heat", may contain production from residential units which is typically not accounted for within the main structure of the IEA balance.

Estonia

Source(s)

Ministry of Economic Affairs and Communications.

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

The projections are based on the Estonian National Energy Sector Development plan 2030+, published in year 2017. Additional information is available at:

https://www.energiatalgud.ee/ENMAK%3AAjakava_ja_tegevused?category=1690

Note that the country is currently developing updated scenario projections which are expected to be finalized by end of 2025.

Oil shale is included under Coal and shale oil under Oil.

Projection figures for non-energy use are not available.

Due to the high production of oil shales and the special treatment of this product within the energy balance, which results in a high uncertainty of supply-based emissions estimate, GHG emissions as well as the corresponding indicators have not been developed for the projection years.

Finland

Source(s)

Ministry of Economic Affairs and Employment, VTT Technical Research Centre, Finnish Environment Institute, Natural Resources Institute Finland and Merit Economics)

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available.

Minor updated to the projections are on an annual basis, when new policy measures are adopted and new statistical data are available. Major updates are scheduled once every four years, when new energy and climate plans and strategies are published.

The scenario describes the development of the energy system with the energy and climate policy measures of the new national climate and energy strategy in place. The energy balances are preliminary because the climate and energy strategy is not yet finally approved and some adjustments may still be done. The strategy is expected to be submitted to the Parliament at the end of June. Finland's target is climate neutrality in 2035. The policy measures that are presented in the strategy takes Finland close to the target but depending on in particular the industries' investments in new carbon free technology some more measures may still be needed. Additional information is available at: https://cris.vtt.fi/en/publications/p%C3%A4%C3%A4ministeri-sanna-marinin-hallituksen-ilmasto-ja-energiapoliitti

https://www.hiisi2035.fi/raportit/

Some power plants located at the industrial sites are owned by energy companies, while other are owned by the industry. Due to the absence of the granular data providing this differentiation, the sold heat vs own heat production is roughly estimated. Additionally, the division of fuels for heat production is indicatively shared between the transformation sector and final consumption of the industry sector.

The data reported under the product “Memo: heat pump”, include data corresponding to small-scale heat pumps used in the residential and commercial public services sectors. Data corresponding to large-scale heat pumps has been excluded, as the models do not include the granular data corresponding to the ambient heat input to these large-scale heat pumps.

France

Source(s)

Ministry of Energy Transition, General Directorate for Energy and Climate

Scenario(s)

Aspirational – achieving national targets

General notes

All projections data are based on the 2021/22 submission to the IEA.

The frequency of the projections update is once every five years.

Projections are based on the single scenario "With additional measures (WAM)", on which the long-term strategy and national carbon budgets are based. The WAM scenario is currently under revision. Additional information is available at:

(https://www.ecologie.gouv.fr/sites/default/files/Synth%C3%A8se%20sc%C3%A9nario%20de%20r%C3%A9f%C3%A9rence%20SNBC-PPE.pdf).

https://cdr.eionet.europa.eu/fr/eu/mmr/art04-13-14_lcds_pams_projections/projections/envxogvwg/

https://www.ecologie.gouv.fr/strategie-nationale-bas-carbone-snbc

For the projections, different sectoral models have been used. Following that, the results have been aggregated to ensure the global results are consistent with the country's national energy and climate statistics.

The projection figures do not include data corresponding to electricity and heat generation output per product. Additionally, data corresponding to nuclear, hydro, wind, and solar are not available for years 2040 and 2050. As a result of this partial availability of data, the related flows from balances and the respective indicators are not available.

For the projection years, imports data represent net imports.

Germany

Source(s)

Öko-Institut (lead), Fraunhofer ISI, IREES

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available.

Frequency of the projection updates are once every two years.

Projections are based on bottom-up modeling using sectoral models and the policies and measure implemented until end of August 2020. Additional information is available at: https://www.bmuv.de/download/projektionsbericht-der-bundesregierung-2021

Greece

Source(s)

Ministry for Environment & Energy

Scenario(s)

Not applicable.

General notes

Projections are not available.

Hungary

Source(s)

Ministry for Innovation and Technology, Regional Centre for Energy Policy Research (REKK), Global Green Growth Institute (GGGI)

Scenario(s)

Business as usual

Aspirational - achieving national targets

Other

Note: The country has submitted two different scenarios both corresponding to the “aspirational - achieving national targets” category as defined in this database. Hence, for the purpose of this publication one of the two scenarios has been disseminated under the “other” category to allow differentiation in between the two sets of data. The “Early action (EA) climate neutrality” scenario has been included under the “aspirational - achieving national targets” category, while the “Late action (LA) climate neutrality” scenario has been included under the “other category”. Additional information regarding the differences in between the two scenario is listed in the general notes section below.

General notes

All projections data are based on the 2021/22 submission to the IEA.

For developing the projections, an integrated modeling approach was used to explore the specificities of the sectors as well as the system-wide and cross-sectoral dynamics of the decarbonization process. More information is available at: https://unfccc.int/sites/default/files/resource/LTS_1_Hungary_2021_EN.pdf

The development of projections has been assisted by applying two models as outlined below:

1) The Green Economy Model (GEM) is an intersectoral model that uses system dynamics as its foundation. This methodology supports the estimation of the macroeconomic outcomes of decarbonization, including the economic evaluation of several social and environmental externalities in addition to changes in the labour market.

2) The HU-TIMES model was used iteratively with the GEM to simulate the energy sector and to outline the emission routes of the energy and industrial sectors. This model is a bottom-up, partial equilibrium optimization model used to analyse the different pathways of energy flow within the energy subsectors.

Three main scenarios for greenhouse gas emissions up to 2050 have been developed and analysed as detailed below:

1) Business-as-usual (BAU) scenario: The emission trajectory of the BAU scenario follows current trends, assuming that all existing sectoral policy strategies and measures remain in effect, and that there will be no new interventions.

2) Late action (LA) climate neutrality scenario: This scenario aims to reduce emissions in the energy sector at a delayed and slower pace until 2045, and then with an increased effort until 2050. This allows the lower cost levels of low and zero emission technologies to be exploited. The scenario assumes that, in line with the targets set in the climate act, the final energy consumption could reach a maximum of 785 petajoules (PJ) in 2030, with the share of renewable energy increasing to at least 21%. After 2030, non-waste sectors will be on the lowest cost trajectory toward climate neutrality until 2050, which will result in accelerated emission reductions by 2050, due to the postponement of investments pending on a decrease in technology costs.

3) Early action (EA) climate neutrality scenario: the EA approach envisages achieving climate neutrality by 2050 while considering the short- and medium-term benefits of job creation and a reduction of environmental

externalities, the economic potential of the first mover, improved productivity, and higher GDP growth. The EA scenario assumes that Hungary's final energy consumption in 2030 will be a maximum of 734 PJ, and that renewable energy penetration will reach 27%. The emission reduction trajectories for industry; land-use, land-use change and forestry (LULUCF); waste management; and agriculture are the same as in the LA scenario. Between 2030 and 2050, emissions will follow a linear trajectory to reach net zero emissions.

In both the LA and EA scenarios, CCUS technologies will become commercially viable in the energy and industrial sectors after 2030. According to the modeling results, GHG emissions in the BAU scenario will decrease to only 56 million tons of CO_2 equivalent (CO_{2eq})/year, from 2019 levels. Therefore, a considerably stronger effort will be needed to achieve the 2050 climate neutrality target than the policies and measures currently in effect. According to both climate neutrality scenarios, net zero emissions will be reached by mid-century. However, the clean energy transition will vary based on different assumptions, and the generation of socioeconomic benefits will differ in their development pathways.

Supply and transformation data corresponding to fossil fuels, biofuels & waste, and non-renewable waste are not available as the disaggregated figures for these flows are not available from the scenario modelings. Hence, the corresponding flows in the balance and the related indicators are not available for the projections.

Ireland

Source(s)

Sustainable Energy Authority of Ireland (SEAI)

Collaborating institutions: Economic and Social Research Institute (ESRI), Environmental Protection Agency (EPA)

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

The projections are updated on an annual basis.

SEAI's National Energy Modelling Framework (NEMF) is a full national energy-economy model that assesses the impacts of packages of energy policies and measures (PaMs) on energy supply and demand. It combines several SEAI sectoral models with data from the ESRI's Ireland Environment, Energy and Economy (I3E) macroeconomic model to produce policy-rich outlooks for the whole energy system.

The NEMF contains data on 680 individual heat demand archetypes, which provide a detailed description of demand in residential, services and industry sectors, as well as agricultural energy use. The electricity module simulates the scheduling of resources (generation, storage, interconnection and demand side management) to meet electricity demand at an hourly resolution. The transport module assesses the impact of relevant PaMs on the underlining macroeconomic transport demand. Additional information are available at: https://www.seai.ie/publications/Annex-Model-Description.pdf

https://www.seai.ie/data-and-insights/seai-statistics/energy-data/

The scenario projections are based on the following main assumptions:

a. Implemented and adopted policies from the Climate Action Plan 2021.
b. A varying carbon tax that increases by €7.50 per annum and reaches €100 per tonne by 2030.
c. A varying Emissions Trading Scheme (ETS) price that increases annually to €100 per tonne by 2030 and €150 per tonne by 2050.
d. Fossil fuel price trajectory used is the UK Department for Business, Energy & Industrial Strategy (BEIS) medium price projection (2019).

Projection figures for non-energy use are not available.

Italy

Source(s)

Ministry of Economic Development, Ricerca Sistema Energetico (RSE),

Scenario(s)

Aspirational - achieving national targets

Other

Note: The country has submitted two different scenarios both corresponding to the "aspirational - achieving national targets" category as defined in this database. Hence, for the purpose of this publication one of the two scenarios has been disseminated under the "other" category to allow differentiation in between the two sets of data. The "National energy and Climate Plan (NECP) " scenario has been included under the "aspirational - achieving national targets" category, while the "Long-Term Strategy (LTS)" scenario has been included under the "other category". Additional information regarding the differences in between the two scenario is listed in the general notes section below.

General note

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available for the "aspirational - achieving national targets" while the 2050 projections are available for the "other" scenario.

The frequency of projection update is once every four years for the official National energy and Climate Plan (NECP) scenario, while RSE usually updates the energy projections to 2050 every 1-2 years. The official scenario is public only up to 2040.

The energy scenario has been developed by RSE n year 2018/2019, in a working group with ISPRA, GSE, ENEA and under the guidance of Ministero dello Sviluppo Economico and with support of Ministero dell'Ambiente e della Tutela del Territorio e del Mare e Ministero delle Infrastrutture e dei Trasporti, Ministero delle Politiche agricole, Alimentari e Forestali.

For the scenario projections, the TIMES-RSE model, an energy model of the Markal TIMES family has been used. TIMES (The Integrated MARKAL-EFOM System) is a model generator developed within the IEA-ETSAP (Energy Technology Systems Analysis Program), an international research network using energy scenarios modeling to carry out detailed energy and environmental analyses. In this framework, RSE has developed the TIMES-RSE model, which represents the entire Italian energy system.

Using the TIMES-RSE model, the best mix of energy sources and technologies that allows to meet the projected demand for energy services over the entire time horizon, and to achieve the goal of a complete decarbonization by 2050 at a minimum system cost has been identified. A predominantly renewable-based energy mix is essential to decarbonize most of the final energy consumption. However, the strong increase of non-programmable renewable sources requires particular attention to power system management and new flexibility resources. Therefore, this work followed a two-step approach: first, setting out the total electricity demand and indicative generation mix for the overall Italian energy system developed with the TIMES_RSE national energy model; then, using the outputs and constraints from the national model as inputs for a detailed study of the impact on the Italian power system and its specific requirements were carried out with a dedicated simulation model, the sMTSIM model, developed by RSE.

The projections have been submitted for two different scenarios, as detailed below:

1) The NECP scenario was created by RSE with a backcasting approach, imposing the directive target at 2030 (and emission target at 2050 equal to net zero emissions). The phase-out from coal in the power sector by 2025 was also considered. Additional information is available at: https://www.rse-web.it/rapporti/studi-a-supporto-della-governance-del-sistema-elettrico-ed-energetico-nazionale
https://ieeexplore.ieee.org/abstract/document/8469966

   https://energy.ec.europa.eu/system/files/2020-02/it_final_necp_main_en_0.pdf Italian National Energy and Climate Plan

2) The Long-Term Strategy (LTS) scenario, roughly reproduces the objectives, in percentage terms of the NECP scenario, but the levels are different as the LTS scenario is implemented with a set of drivers other than the NECP. Additional information is available at:https://www.rse-web.it/rapporti/scenari-di-neutralita-climatica-a-supporto-della-long-term-strategy/

   https://www.mdpi.com/1996-1073/15/1/46/htm

   https://ec.europa.eu/clima/sites/lts/lts_it_sum_en.pdf https://ec.europa.eu/clima/sites/lts/lts_it_it.pdf

The reported figures for own use and losses the “other” scenario, reported for your 2050, include electricity consumption by electrolysers, hence the large increase.

Japan

Source(s)

Agency of National Resources and Energy, Ministry of Economy, Trade and Industry, Japan

Scenario(s)

Aspirational - achieving national targets

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for years 2040 and 2050 are not available.

The frequency of updated to the projections are typically once every three years.

For 2030, partial information on primary energy supply and electricity generation by product, electricity generation capacities and final consumption of electricity and total final consumption by sector isavailable. Hence, the rest of the flows in the energy balance as well as all relevant indicators are not available for this country.

The projections are based on an econometrics method, which estimates energy demand from macroeconomic indicators. The underlying assumption are consistent with Japan’s Nationally Determined Contribution (NDC) of 46% reduction in GHG emissions from the 2013 levels by 2030.

Korea

Source(s)

Korea Energy Economics Institute (KEEI)

Scenario(s)

Information is not available.

General notes

There has been no submission of projections data to the IEA for the past two years. All projections data are based on the 2019/20 submission to the IEA.

Projections for year 2050 are not available.

Projections are partially available for demand and consumption for years 2030 and 2040.

Lithuania

Source(s)

Statistics Lithuania, Lithuanian energy agency

Scenario(s)

Business as usual

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available.

Projections are partially available for demand and electricity generation for years 2030 and 2040. Hence, the rest of the flows in the energy balance as well as all relevant indicators are not available for this country. Additionally, projections for macroeconomic data are not available.

Luxembourg

Source(s)

STATEC, Institut national de la statistique et des études économiques du Grand-Duché du Luxembourg.

Scenario(s)

Not applicable.

General notes

Projections are not available.

Mexico

Source(s)

Secretaría de Energía

Scenario(s)

Not applicable.

General notes

Projections are not available.

Netherlands

Source(s)

Netherlands Environmental Assessment Agency (Dutch: 'Planbureau voor de Leefomgeving' (PBL), TNO Energy Transition, Statistics Netherlands (CBS) and the National Institute for Public Health and the Environment (RIVM), Netherlands Enterprise Agency (RVO), Wageningen University and Research (WUR)

Scenario(s)

Business as usual

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available.

The projections are updated on an annual basis.

Updated projections are reported annually in the Climate and Energy Outlook (KEV), as required by the national climate act since 2019. The KEV-report describes policies and measures in place or planned and which are included in the projections with regard to energy savings, renewable energy and greenhouse gas emission reductions in the Netherlands as a whole, as well as for various sectors. The KEV includes the policy variants 'with existing measures' (WEM) and 'with additional measures' (WAM), matching the IEA categories of, respectively, the "business as usual" and "stated policies" scenarios. The KEV published in 2021 includes a projection horizon up to 2040.

These projections are developed by the Netherlands Environmental Assessment Agency (PBL) which is an independent governmental agency, in cooperation with Statistics Netherlands (CBS), TNO Energy Transition, the National Institute for Public Health and the Environment (RIVM) and the Netherlands Enterprise Agency (RVO). PBL has overall responsibility for the KEV and for the projections and the evaluative aspects in the report in specific (including the final editing of the report). This fits with their role in the Netherlands as independent planning agencies and guarantees an independent evaluative view. CBS provides various statistics such as related to economic development and energy balances.

Projections of energy consumption and production levels in the KEV are, in general, calculated with a suite of sectoral models using parameters on economic (volume) development of sectors and prices of energy commodities and technologies. These parameters are selected by the experts at PBL using the best available official data at that time. The models are interlinked ensuring consistency and enabling supply and demand interactions. These models are developed over many years and are described in the background reports of the KEV. Additional information is available at:

https://www.pbl.nl/kev

https://www.pbl.nl/sites/default/files/downloads/pbl-2021-netherlands-climate-and-energy-outlook_2021-summary-4709.pdf (The English summary of the Climate and Energy Outlook 2021)

https://www.pbl.nl/kev/modellen

https://www.pbl.nl/publicaties/overzicht-van-uitgangspunten-scenario-aannames-en-beleid-in-de-kev-2020

In the KEV 2021 it is acknowledged that the ambitions of European and national energy and climate policy up to and including 2050, and the necessary policy preparations resulting from this, increasingly require insights into Dutch energy and emission developments after 2030. In order to get a better picture thereof, it is considered that these developments would best be outlined within the context of different scenarios. However, the KEV methodology is characterized by the use of only one reference path for the expected developments for exogenous factors (such as developments in demographics, macroeconomics and energy prices). This method is therefore less suitable for describing the broader range of possible distant future developments up to 2050. In the KEV 2021 they therefore limited themselves to extending the estimates to 2040, although PBL is currently exploring the possible paths to climate neutrality in 2050 in another study. Consequently, it should be noted that the data corresponding to year 2050 is not available. Likewise, the granular data corresponding to hydrogen and synthetic fuels is not currently available as hydrogen has only just been included in the KEV 2021 and is as yet considered incomplete. However, hydrogen will be expanded upon for the KEV 2022 so this data could become available in near future.

New Zealand

Source(s)

Ministry of Business, Innovation & Employment

Scenario(s)

Other

General notes

All projections data are based on the 2021/22 submission to the IEA.

The projections are updated on an annual basis.

The projections have been developed through a combination of econometric, financial and optimisation models to consider different future scenarios and sensitivities for the energy sector. The submitted scenario corresponds to a "business as usual" scenario complimented with a carbon price reaching NZD $250 per tonne by 2050, hence identified under the "other" scenario category. Additional information are available at: https://www.mbie.govt.nz/assets/739f0bf5df/energy-modelling-technical-guide-august-2016.pdf

Norway

Source(s)

Statistics Norway

Scenario(s)

Not applicable.

General Notes

Projections are not available.

Poland

Source(s)

Ministry of Economy

Scenario(s)

Information is not available.

General notes

There has been no submission of projections data to the IEA for the past five years. All projections data are based on the 2016/17 submission.

Projections are not available for years 2040 and 2050.

Portugal

Source(s)

Directorate General for Energy and Geology (DGEG)

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections for year 2050 are not available.

DGEG has prepared several scenarios to base the decisions by the Government regarding strategy, targets, and measures, for the Portuguese National Energy and Climate Plan (NECP 2030). The scenarios have been developed with the national model JANUS, which is implemented over a LEAP platform. For the purpose of this publication, the "With Additional Measures" (WAM) scenario, which is aligned with the “stated policies” category has been selected.

NECP targets are policy decisions and not directly the outcomes of the energy modelling. In general, targets are more conservative than the modelling, as they take into account other information and concerns (e.g., security of supply). The projections were developed with backcasting techniques and awareness of policy trends, stakeholder perceptions, and recent R&D results; not forward-looking and finding cost-optimal paths considering cost and efficiency curves of technology, fuels and emissions as it is done for instance by the Carbon Neutrality Roadmap 2050. Additional information is available at: https://files.dre.pt/1s/2020/07/13300/0000200158.pdf

https://www.dgeg.gov.pt/pt/areas-setoriais/energia/planeamento-energetico-e-seguranca-de-abastecimento/planeamento-e-politica-energetica/estrategias-e-politica-energetica/

The projections are updated on a regular basis, as they are supporting the decisions regarding NECP 2030. As it is defined in the Regulation (EU) 2018/1999 of the European Parliament and Council on the Governance of the Energy Union and Climate Action, the NECP must be updated until the end of

June 2024 (the final version, but a draft proposal should be submitted to the European Commission until the end of June 2023). Projections could be updated outside this timeframe only if reasons such as development of new national strategies/policies may impact the energy system significantly.

Slovak Republic

Source(s)

Ministry of Economy of the Slovak Republic, the Ministry of Environment of the Slovak Republik, the Statistical Office of the Slovak Republic, the Hydrogen Initiative of the clean energy ministerial

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

Spain

Source(s)

Ministry for the Ecological Transition and the Demographic Challenge

Scenario(s)

Aspirational - achieving national targets

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections data submitted for 2040 and 2050 correspond to the figures for total final consumption (TFC). These figures are Spain's only long-term scenario public data for 2040 and 2050:

https://ec.europa.eu/clima/sites/lts/lts_es_summary_en.pdf (English summary). Additionally, macroeconomic data are also available.

The projections are based on Spain's Long-term low greenhouse gas emission development strategies (LT-LEDS). Additional information is available at: https://www.miteco.gob.es/es/prensa/anexoelp2050_tcm30-516147.pdf

Sweden

Source(s)

Swedish Energy Agency in collaboration with other governmental institutions.

Scenario(s)

Stated policies

General notes

All projections data are based on the 2021/22 submission to the IEA.

The projections are updated once every two years.

The projections are based on the reference scenario used for calculating projections of greenhouse gas emissions according to Regulation (EU) No 525/2013 - European Union Greenhouse gas Monitoring Mechanism Regulation (MMR). Hence, the "stated policies" scenario category has been selected. Additional information is available at: https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=185971

For the projections all production of solar power is allocated to the energy industry (and not in part to other sectors).

There are no forecasts for the import/export of oil products, hence oil imports should be interpreted as "net imports of crude oil and oil products".

Switzerland

Source(s)

Swiss Federal Office of Energy

Modelling partners: Prognos AG, TEP Energy GmbH, Infras AG

Scenario(s)

Aspirational - achieving national targets

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections are updated unregularly, typically once every five to ten years.

The projections are based the main scenario used for the Swiss long-term climate strategy to 2050 and for the submission of the strategy to the UN Climate Change Secretariat. The target scenario is based on net-zero emissions in 2050; nuclear phase out by 2034 and the annual electricity balance in 2050. Additional information is available at: https://www.bfe.admin.ch/bfe/de/home/politik/energieperspektiven-2050-plus.html

Projections of imports are net imports and are not available for exports.

Data reported under the “biofuels and renewable waste” product includes power-to-X and Power-to-hydrogen figures from renewable sources and biogenic fuels.

The “electricity” figures reported under the “own use and losses” flow include electricity consumption by electrolysers and carbon capture and storage (CCS). The “heat” figures reported under the “own use and losses” flow, include the heat consumption by CCS.

Turkey

Source(s)

Ministry of Energy and Natural Resources.

Scenario(s)

Not applicable.

General notes

Projections are not available.

United Kingdom

Source(s)

Department for Business, Energy and Industrial Strategy (BEIS).

Scenario(s)

No information is available.

General notes

Projections are not available at the time of this publication but are expected to be submitted the IEA before the end of year 2022.

United States

Source(s)

U.S. Energy Information Administration (EIA)

Scenario(s)

Business as usual

Other

General notes

All projections data are based on the 2021/22 submission to the IEA.

Projections are updated on an annual basis.

The National Energy Modeling System (NEMS) has been used to generate the projections in the Annual Energy Outlook 2022. This included general features of the model structure, assumptions concerning energy markets, and the key input data and parameters that were critical to formulating the model results. The EIA develops projections in NEMS by using a market-based approach, subject to regulations and standards. For each fuel and consuming sector, NEMS balances energy supply and demand, accounting for economic competition across the various energy fuels and sources. The projection period in NEMS currently extends to 2050. Additional information is available at: https://www.eia.gov/outlooks/aeo/

https://www.eia.gov/outlooks/aeo/tables_ref.php

https://www.eia.gov/outlooks/aeo/nems/documentation/

For the purpose of this publication, data corresponding to two scenarios are included. The "reference" case is based on already adopted regulations and standards and is in alignment with the "business as usual" scenario category. The "high economic growth" scenario, is one of the few scenarios developed to reflect the uncertainty in projections of economic growth. In this scenario, real GDP grows at an average annual rate of 2.7 percent from 2021 to 2050. This scenario has been identified under the "other" category for the purpose of this publication.

Heat generation and consumption data is not included for forecast years, as a resulted the corresponding energy balances flows and respective indicators are not available.

European Union

Source(s)

European Commission

Scenario(s)

No information is available.

General notes

Projections are not available.

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)

Energy content

Coal

Coal has separate net calorific values for production, imports, exports, inputs to electricity/heat generation and coal used in coke ovens, blast furnaces and industry.

For electricity/heat generation, coal inputs to each type of plant (i.e. main activity electricity plant, autoproducer electricity plant, main activity CHP plant, autoproducer CHP plant, main activity heat plant, autoproducer heat plant) are converted to energy units using average factors calculated from the Annual Electricity Questionnaire. All other flows are converted using an average net calorific value.

Crude oil

Country-specific net calorific values (NCV) for production, imports and exports by country are used to calculate the balances. The average value is used to convert all the other flows to heat values.

Gases

World Energy Statistics expresses the following gases in terajoules, using their gross calorific value.

To calculate the net heat content of a gas from its gross heat content, multiply the gross heat content by the appropriate following factor.

Gas	Ratio NCV to GCV
Natural gas	0.9
Gas works gas	0.9
Coke oven gas	0.9
Blast furnace gas	1.0
Other recovered gases	1.0

Biofuels and waste

The heat content of primary solid biofuels, biogases, municipal waste and industrial waste, expressed in terajoules on a net calorific value basis, is presented in *World Energy Statistics.* The Secretariat does not receive information on volumes and other characteristics of these fuels.

Data for charcoal are converted from tonnes using the average net calorific values given in the electronic tables.

Unless country-specific information has been provided, data for biogasoline are converted from tonnes using 26 800 kJ/kg. Biodiesels and other liquid biofuels are assumed to have a net calorific value of 36 700 kJ/kg unless otherwise specified.

Oil products

For oil products, the IEA applies regional net calorific values (in conjunction with Eurostat for the European countries), except for the individual countries listed in the table at the end of this section.

Electricity

Figures for electricity production, trade, and final consumption are calculated using the energy content of the electricity. Electricity is converted as follows: Data in TWh x 3600 = data in TJ.

Hydro-electricity production (excluding pumped storage) and electricity produced by other non-thermal means (wind, tide/wave/ocean, solar PV, etc.) are accounted for similarly. Gross electricity generation in TWh x 3600= primary energy equivalent in TJ.

The primary energy equivalent of nuclear electricity is calculated from the gross generation by assuming a 33% conversion efficiency. The calculation to be carried out is the following: gross electricity generation in TWh x 3600/ 0.33 = primary energy equivalent in TJ.

In the case of electricity produced from geothermal heat, if the actual geothermal efficiency is not known, then the primary equivalent is calculated assuming an efficiency of 10%. The calculation to be carried out is the following: gross electricity generation in TWh x 3600/0.10 = primary energy equivalent in TJ.

For electricity produced from solar thermal heat, the primary equivalent is calculated assuming an efficiency of 33% unless the actual efficiency is known. The calculation to be carried out is the following: gross electricity generation in TWh x 3600/0.33 = primary energy equivalent in TJ.

Heat

In the case of heat produced in a geothermal plant, if the actual geothermal efficiency is not known, then the primary equivalent is calculated assuming an efficiency of 50%. The calculation to be carried out is the following: Heat production in TJ / 0.50 = primary energy equivalent in TJ.

For heat produced in a solar thermal plant, the primary equivalent is equal to the heat consumed.

For direct use of geothermal and solar thermal heat, all the heat consumed is accounted for in production and consumption.

Examples

The following examples indicate how to calculate the net calorific content (in ktoe) of the quantities expressed in original units in *World Energy Statistics*.

From original units	To Mtoe (on a NCV basis)
Coking coal production (Poland) for 2018 in thousand tonnes	divide by 41 868 and then multiply by 29.646
Natural gas in terajoules (gross)	multiply by 2.38846×10^{-5} and then multiply by 0.9
Motor gasoline (Poland) in thousand tonnes	divide by 41 868 and then multiply by 44.000
Heat in terajoules (net)	multiply by 2.38846×10^{-5}

Abbreviations

Btu:	British thermal unit
GWh:	gigawatt hou
kcal:	kilocalorie
kg:	kilogramme
kJ:	kilojoule
Mt:	million tonnes
m^3:	cubic metre
t:	metric ton = tonne = 1,000 kg
TJ:	terajoule
toe:	tonne of oil equivalent = 10^7 kcal
CHP:	combined heat and power
GCV:	gross calorific value
GDP:	gross domestic product
HHV:	higher heating value = GCV
LHV:	lower heating value = NCV
NCV:	net calorific value
PPP:	purchasing power parity
TES:	total energy supply
EU:	European Union
SLT:	Standing Group for Long-Term Cooperation
IEA:	International Energy Agency
IPCC:	Intergovernmental Panel on Climate Change
ISIC:	International Standard Industrial Classification
OECD:	Organisation for Economic Co-Operation and Development
OLADE:	Organización Latinoamericana de Energía
UN:	United Nations
UNIPEDE:	International Union of Producers and Distributors of Electrical Energy
c	confidential
..	not available
x	not applicable

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