National Projections Questionnaire

Compiler's Guide

Updated: April 2026

International Energy Agency

This document provides information and instructions for data compilers regarding the International Energy Agency (IEA) *National Projections Questionnaire*. Please share with NationalProjections@iea.org any questions or comments you may have on this document or the underlying data compilation, as soon as they emerge.

Table of Contents

1. Introduction

Considering the complexities of the related socio-economic factors, energy policy and planning requires adopting a long-term perspective. Building energy infrastructure takes time and decisions made right now can shape the structure and outcomes of our choices for many decades. It takes a considerable amount of time for new energy technologies to develop and mature and reach their desired market share. Hence, long-term perspectives are essential in analysing and planning the energy system and its corresponding socio-economic and environmental impacts in order to accelerate energy transitions.

National projections will become more and more relevant within the evolving landscape of energy transitions. Governments and other data users benefit from these projections for planning and monitoring the progress towards national energy and climate targets, refining energy models and informing policy reviews and recommendations. The data submitted to the International Energy Agency (IEA) in this questionnaire are the basis for an international compilation of national projections and are disseminated through the Energy Projections of IEA Countries – National Data database.

To ensure clarity to users, data compilers are requested to select the specific scenario category that best corresponds to the national scenario underlying the reported data; projections corresponding to different scenarios can be reported in different files. Please refer to *Section 4 – Guidelines for the completion of the questionnaire* for more details.

The projections refer to three years: 2030, 2040 and 2050. To support compilation, the IEA will prefill energy time series of balances for the last three historical years, based on previous country reporting.

Data collected also cover the emissions savings from carbon capture, utilization and storage (CCUS) across sectors, which is not currently collected in the annual questionnaires

The list of sheets and tables to be filled is presented in *Section 3 – Content of the questionnaire*.

2. Changes from last cycle

This section presents the changes of the questionnaire structure/content as well as amendments to this document compared to the previous submission cycles.

Amendments to contact information

The email address to contact the team managing the energy projects database has changed from SLT@iea.org to NationalProjections@iea.org.

Amendments to file names

The file name of the Excel questionnaire has been changed to remove the reference to "SLT". Additionally, the names of CSVs required for data import have been changed; this is reflected in the guidance at the end of *Section 4.*

Amendments to product, flow and indicators

The long names of products and flows in the questionnaire and this document have been updated to improve harmonisation across IEA datasets. **No short names have been changed.** Flows and products that had their long names updated are shown in the tables below:

Products

Row	Original long name	Updated long name
A	Coal	Coal and coal products
B	Peat	Peat and peat products
C	Oil	Oil and Oil products
F	Hydro	Hydropower
J	Tide, etc.	Tide, wave and ocean, and other energy sources
L	Non-renewable waste	Total waste, non-renewable portion

Flows

Row	Original long name	Updated long name
A	Production	Indigenous production
F	Stock changes	Stock changes (national territory)
H	Transformation processes and energy industry own use	Transformation processes and own use
K	Own use and losses	Energy industry own use and distribution losses
P	Of which: Residential	Residential
S	Of which: Commercial and public services	Commercial and public services
U	Of which chemical/petrochemical	Non-energy use - chemical/petrochemical
V	Electricity generated excluding pumped storage	Electricity output (TWh)
W	Heat generated (PJ)	Heat output (PJ)
X	Memo: Electrical capacities (MW)	Memo: Installed Electrical capacities (MW)

Some flow descriptions in this guide have been updated as well to provide additional detail for reporting.

In the questionnaire, some indicators that are no longer published in the dataset have been removed from the "Indicators" tab.

Amendments to geographical coverage

The geographical coverage section has been removed from this guide. Please refer to the database documentation for the geographical coverage of the national projections database.

New section for common reporting questions

Section 4.4 has been added to provide further detail and guidance on questions commonly received about energy balance reporting in Table 1 of the questionnaire. In future editions, some or all of this guidance will be incorporated into Section 4.3.

3. Content of the questionnaire

This section describes the overall structure of the file, with focus on the sheets to be filled by data compilers: the scenario information and three statistical tables.

The file includes 12 worksheets with different colour coding. When opening the file, a sheet called the **"Start"** tab is visible. By clicking on the button on this sheet the remaining sheets are populated. The green tabs include the **"Intro"** sheet which provides general guidance on using the tool, the **"Data Import & Export"** sheet which provides functionalities to import and/or export data using CSVs as well as the **"20XX"** sheet which is pre-filled by the IEA with the latest available historical data. The blue tabs correspond to the **"Energy Balance Time Series"** and **"Indicators"** sheets, which are data visualisation tools populated automatically providing a means to verify the submitted data.

The orange tabs are to be filled by the data compliers and include a **"Scenario"** sheet, **"Table 1"** sheets (for years 2030, 2040 and 2050), **"Table 2"** and **"Table 3"** sheets. This section includes visual representation of the above orange sheets. For details on how to report the data corresponding to each sheet please refer to *Section 4 – Guidelines for compiling the questionnaire*.

Please note that you can submit more than one file if you wish to share information corresponding to different scenario categories. In the case where projections have not be updated, you can opt for copying previously submitted information in the statistical tables – please still ensure to provide the information on the underlying scenario.

List of data inputs to be filled by compilers

Scenario: Sheet to select the category of scenario and provide additional information

Table 1: Energy balances for 2030, 2040 and 2050.

Table 2: Supplementary data

Table 3: Emissions savings from CCUS

Scenario sheet

A. Scenario selection	**Main category**	**Sub category**
The objective of this section is to assist in categorising the national scenario which is the basis of the projections data submitted in Tables 1, 2, 3.	Business as Usual	Please provide details in the table below

Instructions

Please indicate above which one of the following scenario categories correspond to the submitted projections data.

1. Business as Usual	Baseline scenarios (e.g. fixed with a specific base year for benchmarking)
2. Stated Policies	Scenarios taking into account measures which have been already adopted, together with pertinent policy proposals and announced commitments
3. Beyond Stated Policies (Aspirational)	Scenarios which set a pathway consistent with specific target(s) or other desired outcomes
a) Achieving national targets	Examples include net zero scenarios and Paris Agreement compliant (2 or 1.5 ºC temperature increase) scenarios
b) Achieving defined outcomes	Examples include SDG compliant scenarios, energy access and/or energy security related scenarios
4. Other	Scenarios which do not fall under any of the above general categories

Note: if multiple scenarios are available, please save this questionnaire / extract the corresponding csv, then change the scenario and report the data for the alternative scenario (s)

For more detailed instructions on scenario selection, please refer to the Compiler Guide.

B. Qualitative information
• **Source institution for modelling and collaborating institutions**
• **Short description of the methodology (and model used for the scenario)**
• **Main assumptions of the scenario: specific targets (e.g. net zero, SDGs, 1.5C); desired outcomes (e.g. energy access, energy security); other relevant information**
• **Frequency of projections update**
• **Please provide links to any documentation, reports, or website**
• **Any other comments if applicable**

Table 1 – Energy Balance (Mtoe)

		Coal and coal products	Peat and peat products	Oil and oil products	Natural gas	Nuclear	Hydropower	Wind	Geothermal	Solar	Tide, wave and ocean, and other energy sources
		A	B	C	D	E	F	G	H	I	J
Indigenous production (+)	A	-	-	-	-	-	-	-	-	-	-
Imports (+)	B	-	-	-	-						
Exports (-)	C	-	-	-	-						
International marine bunkers (-)	D	-	-	-	-						
International aviation bunkers (-)	E	-	-	-	-						
Stock change (national territory) (±)	F	-	-	-	-						
Total Energy Supply	G	-	-	-	-	-	-	-	-	-	-
Transformation processes and own use	H	-	-	-	-	-	-	-	-	-	-
Electricity, CHP & heat plants (±)	I	-	-	-	-	-	-	-	-	-	-
Other transformation processes (±)	J	-	-	-	-						
Energy industry own use and distribution losses (-)	K	-	-	-	-				-	-	-
Statistical differences (±)	L	-	-	-	-				-	-	-
Total Final Consumption	M	-	-	-	-				-	-	-
Industry (+)	N	-	-	-	-				-	-	-
Transport (+)	O	-	-	-	-						
Road (+)	P	-	-	-	-						
Other (+)	Q	-	-	-	-				-	-	-
Residential (+)	R	-	-	-	-				-	-	-
Commercial and public services (+)	S	-	-	-	-				-	-	-
Non-energy use (+)	T	-	-	-	-						
Non-energy use - chemical/petrochemical (+)	U	-	-	-	-						
Electricity output (TWh) (+)	V	-	-	-	-	-	-	-	-	-	-
Heat output (PJ) (+)	W	-	-	-	-	-			-	-	-
Memo: Installed electrical capacity (MW) (+)	X	-	-	-	-	-	-	-	-	-	-
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-	-	-	-						
Memo: Input to heat pumps (-)	Z										

Table 1 – Energy Balance (Mtoe) (continued)

		Biofuels & renewable waste	Total waste, non-renewable portion	Electricity	Heat	Total	Memo: Offshore wind	Memo: Hydrogen & synthetic fuels	Memo: Heat pump
		K	L	M	N	O	P	Q	R
Indigenous production (+)	A	-	-		-	-	-		-
Imports (+)	B	-	-	-	-	-		-	
Exports (-)	C	-	-	-	-	-		-	
International marine bunkers (-)	D	-	-			-		-	
International aviation bunkers (-)	E	-	-			-		-	
Stock change (national territory) (±)	F	-	-			-		-	
Total Energy Supply	G	-	-	-	-	-	-	-	-
Transformation processes and own use	H	-	-	-	-	-	-	-	-
Electricity, CHP & heat plants (±)	I	-	-	-	-	-	-	-	-
Other transformation processes (±)	J	-	-	-	-	-		-	
Energy industry own use and distribution losses (-)	K	-	-	-	-	-		-	-
Statistical differences (±)	L	-	-	-	-	-		-	-
Total Final Consumption	M	-	-	-	-	-		-	-
Industry (+)	N	-	-	-	-	-		-	-
Transport (+)	O	-	-	-	-	-		-	
Road (+)	P	-	-	-	-	-		-	
Other (+)	Q	-	-	-	-	-		-	-
Residential (+)	R	-	-	-	-	-		-	-
Commercial and public services (+)	S	-	-	-	-	-		-	-
Non-energy use (+)	T					-		-	
Non-energy use - chemical/petrochemical (+)	U					-		-	
Electricity output (TWh) (+)	V	-	-		-	-	-	-	-
Heat output (PJ) (+)	W	-	-	-	-	-		-	-
Memo: Installed electrical capacity (MW) (+)	X	-	-		-	-	-		
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-	-	-		-			
Memo: Input to heat pumps (-)	Z			-	-	-			

Table 2 – Supplementary data

	Historical Data				Data submission This Cycle			Last Cycle Projections		
	2021	2022	2023	2024	2030	2040	2050	2030.LC	2040.LC	2050.LC
GDP Growth Rates (%)(1)	-	-	-	-	0%	0%	0%	-	-	-
Population (Millions)(2)	-	-	-	-	-	-	-	-	-	-
GDP (Billion USD 2020)(1)(2)	-	-	-	-	-	-	-	-	-	-

(1) Refers to GDP in constant 2020 prices

(1) The annual growth rates (which refer to GDP in constant 2020 prices) should be calculated in the following way:

For 2030 report the GDP 2030/GDP 2020 average annual rate.

For 2040 report the GDP 2040/GDP 2030 average annual rate.

For 2050 report the GDP 2050/GDP 2040 average annual rate.

(2) Before publication, the Secretariat will update the provisional 2024 GDP and population figures submitted with those published in OECD National Accounts.

Table 3 – Emissions savings from CCUS[1]

	Historical Data				Data submission This Cycle			Last Cycle Projections		
Mass of CO_2 captured ($ktCO_2$)	2021	2022	2023	2024	2030	2040	2050	2030.LC	2040.LC	2050.LC
Total	-	-	-	-	-	-	-	-	-	-
Natural gas processing					-	-	-	-	-	-
Manufacturing					-	-	-	-	-	-
Electricity and heat generation					-	-	-	-	-	-
Hydrogen and synthetic fuel production					-	-	-	-	-	-
Other					-	-	-	-	-	-

[1] CCUS refers to carbon capture, utilisation and storage

4. Guidelines for compiling the questionnaire

This section provides general guidelines for completing the questionnaire, from the scenario selection, to the new CSV import and export functionalities that can be used.

4.1 Scenario categorisation

It is important to clearly communicate the purpose and context of the scenarios to avoid misinterpretation. The objective of this section is to assist data compilers in categorising the national scenario(s), which are the basis of the projections data submitted in the National Projections Questionnaire, into one of the general categories described below. Understanding the category of the scenarios and their underlying methodology is of great value, because it facilitates the comparison and analysis of the submitted projections data.

Note that completion of the **"Scenario"** sheet is a requirement to ensure that data included in statistical tables are interpreted correctly; this information will be assessed during the questionnaire validation process.

To assist data compilers in categorising the national scenario used for each of the submissions, the **"Scenario"** sheet includes a menu and a few qualitative questions. It will be important to i) select a scenario category and ii) in response to the questions, include key information on assumptions and methodologies, as well as links to available reference documentation.

This section briefly introduces the typical scenario categories used across institutions for long-term energy planning, which correspond to the selectable scenarios in the **"Scenario"** sheet of the questionnaire.

1. **Business as usual scenarios:**

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.

2. Stated policies scenarios:

The Stated Policy 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 optimising 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.

3. Beyond stated policies (Aspirational) scenarios:

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.

The Aspirational scenarios may be divided into the following sub-categories:

a) Achieving national targets scenarios:

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 scenarios:

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.

4. Other

Scenarios which do not fall under any of the above general categories can be reported under this option. A short description of the methodology and model used, and any

underlying assumptions would be essential to help with the clarity of the submitted projections data.

4.2 Energy balance concepts

The energy balance is a presentation of the basic supply and demand data for all fuels, all expressed in a common energy unit. The format of the IEA energy balance is based on the International Recommendations on Energy Statistics (IRES)[2], which is a comprehensive framework on the scope of energy statistics, including classifications, units and methodologies.

Energy data are generally collected independently across different commodities. Energy statistics are the simplest format to present all the data together, assembling the individual balances of all products, each expressed in its own physical unit (e.g. TJ for natural gas, kt for coal, etc). These are called commodity balances. However, energy products can be converted into one another through a number of transformation processes. Therefore, it is useful to develop one comprehensive national energy balance to understand how products are transformed into one another, and to highlight the various relationships among them.

By presenting all the data in a common energy unit, the energy balance allows users to see the total amount of energy used and the relative contribution of each different source to the whole economy and individual consumption sectors. Further, the energy balance allows the computation of different fuel transformation efficiencies and various indicators. The energy balance is a natural starting point to study the evolution of the domestic energy market, forecast energy demand, monitor impacts of energy policies and assess potential areas for action. Finally, the energy balance can be used as a high-level check on the data accuracy, because large statistical differences in energy units, apparent energy gains or large losses in transformation processes, or large unexplained variations in shares or in high-level indicators may all indicate underlying data problems.

Table 1 is a simplified version of the IEA energy balance. An example of how to complete this table can be found by clicking the button "Sample latest historical year Energy Balance" included on the **"Intro"** sheet. This will direct you to a table which contains a simplified energy balance for the latest historical year. The data in this table have been prefilled by the IEA based on the data submitted through the annual questionnaires and can be used as a guide for filling Table 1 for projections.

This section outlines a general guide for completing the energy balances tables. Please refer to the IEA World Energy Balances documentation file for more details on the methodology for developing an energy balance based on energy statistics.

[2] The report on International Recommendations on Energy Statistics (IRES) is available at https://unstats.un.org/unsd/energystats/methodology/ires/.

4.3 Table 1

Columns

Column A: "Coal and coal products" includes: All coal and coal products, both primary and derived, such as anthracite, coking coal, other bituminous coal, sub-bituminous coal, lignite, oil shale (primary product – however, note that the secondary product shale oil should be included under oil), 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 that peat should not be included in this column.

Column B: "Peat and peat products" includes peat burned for energy. Peat used for non-energy purposes should not be included.

Column C: "Oil and oil products" includes:

1. Crude oil, refinery feedstocks, natural gas liquids, and 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, coal liquefaction) are transferred into the **"Oil and oil products"** column from the appropriate cells. For example, liquefied coal would be shown as coal consumed (and therefore negative) in *Cell JA* of Table 1 and as secondary oil production (and therefore positive) in *Cell JC*. Similarly, hydrogen or other synthetic fuels produced from natural gas would be shown as natural gas consumed in *Cell JD* and as secondary oil production in *Cell JC*.

Column D: "Natural gas" includes natural gas (excluding natural gas liquids) and import and exports of gaseous synthetic fuels, including hydrogen.

Column E: **"Nuclear "**. Please refer to the *Units and Conversion* section below.

Column F: "Hydropower". Please refer to the *Units and Conversion* section below. Note that only natural flow hydro generation should be included**.** The electricity losses associated with pumped storage electricity should be included in the quantities given in *Cell KM* under the row **"Energy industry own use and distribution losses"**.

Column G: "Wind". Please refer to the *Units and Conversion* section below.

Column H: "Geothermal". Please refer to the *Units and Conversion* section below.

Column I: "Solar". Please refer to the *Units and Conversion* section below.

Column J: "Tide, wave and ocean, and other energy sources". Please refer to the *Units and Conversion* section below for more details about tide, wave, and ocean sources.

For the historical year, this product aggregates the "other energy source" product from the annual questionnaires (defined in the World Energy Balances documentation) with tide, wave, and ocean energy. Examples of "other energy sources" are mainly waste heat, but for some countries include fuel cells or batteries.

If you report an "other energy source" for the projection years under this column, and it is not included in other product categories, please provide remarks explaining what the source is and how it is used.

Column K: "Biofuels and renewable waste" includes primary solid biofuels, biogases, biogasoline, biodiesels, bio jet kerosene, other liquid biofuels, charcoal and the 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.

Column L: "Total waste, non-renewable portion" 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 sector that are collected by local authorities for incineration at specific installations.

Column M: "Electricity" shows the trade and final consumption of electricity (which is counted at the same heat value as electricity in final consumption i.e., 1 TWh = 0.086 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 can be reported under electricity, while accounting for the conversion losses. For example assuming a 3 Mtoe input of natural gas to an electricity plant, 2/3 efficiency for electricity generation using natural gas and 50% efficiency for the power to gas process, -3 should be reported in *Cell ID*, while 2 should be reported in *Cell IM*, -1 in *Cell KM* and 1 in *Cell RM* (assuming hydrogen consumption in household heating).

Column N: "Heat" permits the reporting of (a) the generation and consumption of heat for sale and (b) heat extracted from ambient air and water by heat pumps. The generation of heat for sale is reported as a transformation sector activity and the corresponding inputs should be included in the row **"Electricity, CHP & heat plants"**. Heat consumed at the point of production which is generated from fuels reported elsewhere in the balance, is not reported since this would be double counting.

The ambient heat input to heat pumps should be reported under this column and the row **"Indigenous production".** Only the portion of ambient heat that contributes to heat sold should be reported here.

If reporting the use of waste or recovered heat (e.g. from an industrial process) that is purchased and used elsewhere (e.g. for district heating), please explain where in the balance it is reported. If unsure how to report it, please reach out to the Secretariat. Guidance on the reporting of waste/recovered heat in projections is being developed by the Secretariat.

If projections incorporate the use of recovered heat within the facilities in which it was generated in (i.e. not sold), please include remarks about where in the balance this occurs.

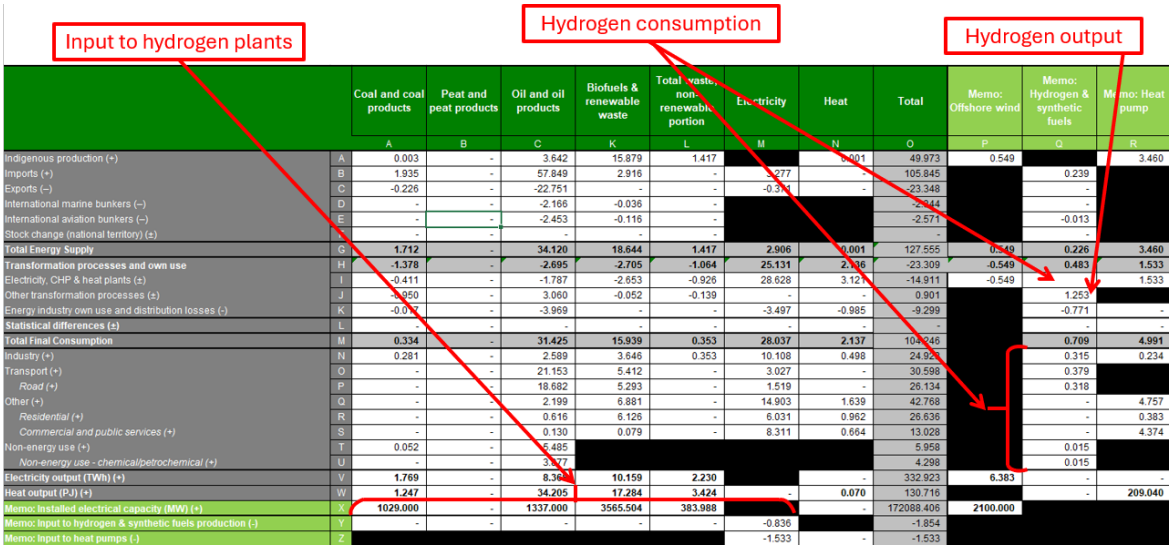
Column O: "Total" is the sum of *columns A to N*.

Column P: "Memo: Offshore wind" is a memo category outside the current main structure of the energy balance. This product is a subcomponent of the **"Wind"** element. The total wind production (including both onshore and offshore) is still to be reported under the product "**Wind"***.* Please refer to the *Units and Conversion* section below.

Column Q: "Memo: Hydrogen & synthetic fuels" is a memo category outside the current main structure of the energy balance. This memo product has been added to allow reporting the data corresponding to hydrogen and synthetic fuels (ammonia and E-fuels) in a more visible manner. See section 2.3 of the annual reporting guidance for more information about the definitions of these fuels and what hydrogen is reported.

However, the reporting under this Memo category should not impact the existing means of reporting hydrogen and synthetic fuels supply and consumption as part of the main energy balance. Refer to *Column C (***"Oil and oil products"***)*, *Column D (***"Natural gas"***)* and *Column M (***"Electricity"***)* for details on how to report these products in the main structure of the energy balance.

For general guidance on reporting under this memo category, please refer to the snapshot provided below. Production of hydrogen and synthetic fuels should be reported under the row **"Other transformation processes"**. The consumption of hydrogen and synthetic fuels should be reported under the corresponding sectors. This could be inputs to electricity and/or heat plants or final consumption sectors including non-energy use. The input figures should be reported as negative numbers. The fuel or electricity inputs should be reported under the corresponding column in *Row Y (***"Memo: Input to Hydrogen & synthetic fuels production"***)*. Refer to *Row Y* in the next section for more details.

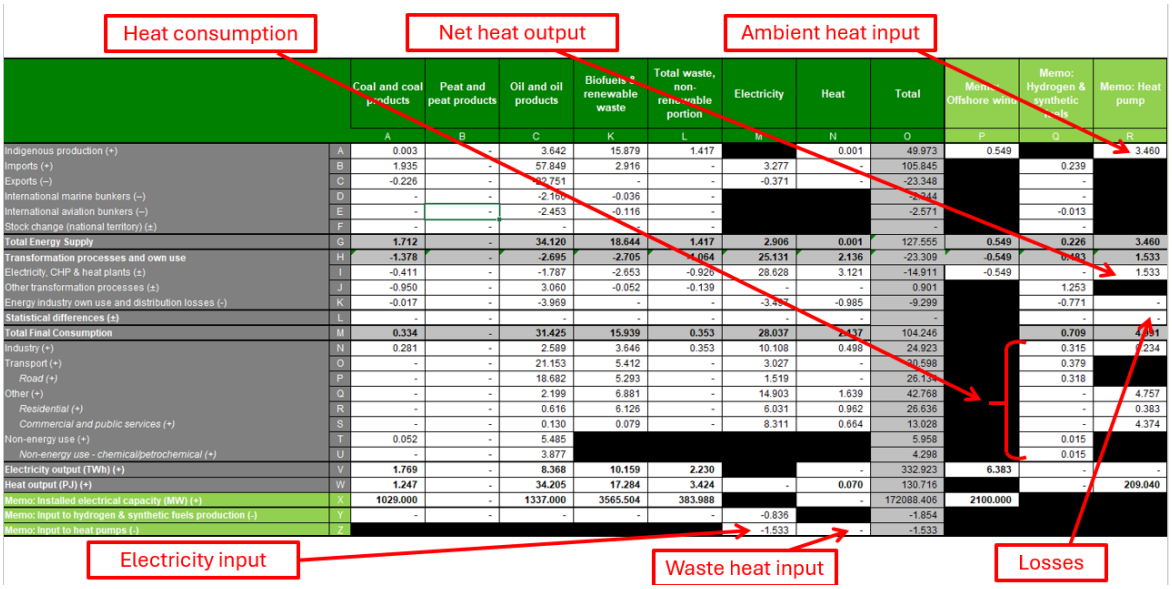


		Coal and coal products	Peat and peat products	Oil and oil products	Biofuels & renewable waste	Total waste, non-renewable portion	Electricity	Heat	Total	Memo: Offshore wind	Memo: Hydrogen & synthetic fuels	Memo: Heat pump
		A	B	C	K	L	M	N	O	P	Q	R
Indigenous production (+)	A	0.003	-	3.642	15.879	1.417		0.001	49.973	0.549		3.460
Imports (+)	B	1.935	-	57.849	2.916	-	0.277		105.845		0.239	
Exports (–)	C	-0.226	-	-22.751	-	-	-0.371	-	-23.348		-	
International marine bunkers (–)	D	-	-	-2.166	-0.036	-			-2.244		-	
International aviation bunkers (–)	E	-	-	-2.453	-0.116	-			-2.571		-0.013	
Stock change (national territory) (±)	F	-	-	-	-	-			-		-	
Total Energy Supply	G	**1.712**	-	**34.120**	**18.644**	**1.417**	**2.906**	**0.001**	127.555	0.549	**0.226**	**3.460**
Transformation processes and own use	H	**-1.378**	-	**-2.695**	**-2.705**	**-1.064**	**25.131**	**2.136**	-23.309	**-0.549**	**0.483**	**1.533**
Electricity, CHP & heat plants (±)	I	-0.411	-	-1.787	-2.653	-0.926	28.628	3.121	-14.911	-0.549		1.533
Other transformation processes (±)	J	-0.950	-	3.060	-0.052	-0.139	-	-	0.901		1.253	
Energy industry own use and distribution losses (-)	K	-0.017	-	-3.969	-	-	-3.497	-0.985	-9.299		-0.771	-
Statistical differences (±)	L	-	-	-	-	-	-	-	-		-	-
Total Final Consumption	M	**0.334**	-	**31.425**	**15.939**	**0.353**	**28.037**	**2.137**	104.246		**0.709**	**4.991**
Industry (+)	N	0.281	-	2.589	3.646	0.353	10.108	0.498	24.924		0.315	0.234
Transport (+)	O	-	-	21.153	5.412	-	3.027	-	30.598		0.379	
Road (+)	P	-	-	18.682	5.293	-	1.519	-	26.134		0.318	
Other (+)	Q	-	-	2.199	6.881	-	14.903	1.639	42.768		-	4.757
Residential (+)	R	-	-	0.616	6.126	-	6.031	0.962	26.636		-	0.383
Commercial and public services (+)	S	-	-	0.130	0.079	-	8.311	0.664	13.028		-	4.374
Non-energy use (+)	T	0.052	-	5.485					5.958		0.015	
Non-energy use - chemical/petrochemical (+)	U	-	-	3.977					4.298		0.015	
Electricity output (TWh) (+)	V	**1.769**	-	**8.361**	**10.159**	**2.230**		-	332.923	**6.383**	-	-
Heat output (PJ) (+)	W	**1.247**	-	**34.205**	**17.284**	**3.424**	-	**0.070**	130.716		-	**209.040**
Memo: Installed electrical capacity (MW) (+)	X	**1029.000**	-	**1337.000**	**3565.504**	**383.988**		-	172088.406	**2100.000**		
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-	-	-	-	-	-0.836		-1.854			
Memo: Input to heat pumps (-)	Z						-1.533	-	-1.533			

Hydrogen and synthetic fuels reporting is being reviewed within the IEA Secretariat across the teams working on energy balance data. As guidance is finalised, it will be communicated to compilers.

Column R: "Memo: Heat pumps" is a memo category outside the current main structure of the energy balance. The addition of this memo item allows the reporting of ambient heat input data corresponding to all types of heat pumps and not only large-scale units used for selling heat which are currently reported in the main balance. The reporting under this Memo category should not impact the existing means of reporting data corresponding to heat pumps as part of the main energy balance. Refer to *Row A (***"Indigenous production"***)*, *Row K (***"Energy industry own use and distribution losses"***)*, *Row I (***"Electricity, CHP and heat plants"***) and Row W (***"Heat output"***)* for details on how to report heat pumps as part of the main structure of the energy balance.

For general guidance on reporting under this memo category, please refer to the snapshot provided below. The ambient heat extracted from the environment should be reported under **"Indigenous production"**. The net heat output (gross output - ambient heat), which in the case of no losses equals the electricity and waste heat input, should be reported under the item **"Electricity, CHP and heat plants"**. If data about losses are collected, they should be reported under the item **"Energy industry own use and distribution losses".** Otherwise, it can be left blank if losses are not collected. The consumption of heat from the heat pumps should be reported under the specific sector(s). The electricity and non-ambient heat (e.g. recovered heat) inputs should be reported under the corresponding columns in *Row Z (***"Memo: Input to heat pumps"***)* as negative numbers. Refer to *Row Z* in the next section for more details.



		Coal and coal products	Peat and peat products	Oil and oil products	Biofuels & renewable waste	Total waste, non-renewable portion	Electricity	Heat	Total	Memo: Offshore wind	Memo: Hydrogen & synthetic fuels	Memo: Heat pump
		A	B	C	K	L	M	N	O	P	Q	R
Indigenous production (+)	A	0.003	-	3.642	15.879	1.417		0.001	49.973	0.549		3.460
Imports (+)	B	1.935	-	57.849	2.916	-	3.277	-	105.845		0.239	
Exports (–)	C	-0.226	-	-32.751	-	-	-0.371	-	-23.348		-	
International marine bunkers (–)	D	-	-	-2.160	-0.036	-			-2.344		-	
International aviation bunkers (–)	E	-	-	-2.453	-0.116	-			-2.571		-0.013	
Stock change (national territory) (±)	F	-	-	-	-	-			-		-	
Total Energy Supply	G	**1.712**	-	**34.120**	**18.644**	**1.417**	**2.906**	**0.001**	127.555	**0.549**	**0.226**	**3.460**
Transformation processes and own use	H	**-1.378**	-	**-2.695**	**-2.705**	**-1.064**	**25.131**	**2.136**	-23.309	**-0.549**	**0.483**	**1.533**
Electricity, CHP & heat plants (±)	I	-0.411	-	-1.787	-2.653	-0.926	28.628	3.121	-14.911	-0.549	-	1.533
Other transformation processes (±)	J	-0.950	-	3.060	-0.052	-0.139	-	-	0.901		1.253	
Energy industry own use and distribution losses (-)	K	-0.017	-	-3.969	-	-	-3.497	-0.985	-9.299		-0.771	-
Statistical differences (±)	L	-	-	-	-	-	-	-	-		-	-
Total Final Consumption	M	**0.334**	-	**31.425**	**15.939**	**0.353**	**28.037**	**2.137**	104.246		**0.709**	**4.991**
Industry (+)	N	0.281	-	2.589	3.646	0.353	10.108	0.498	24.923		0.315	0.234
Transport (+)	O	-	-	21.153	5.412	-	3.027	-	30.598		0.379	
Road (+)	P	-	-	18.682	5.293	-	1.519	-	26.134		0.318	
Other (+)	Q	-	-	2.199	6.881	-	14.903	1.639	42.768		-	4.757
Residential (+)	R	-	-	0.616	6.126	-	6.031	0.962	26.636		-	0.383
Commercial and public services (+)	S	-	-	0.130	0.079	-	8.311	0.664	13.028		-	4.374
Non-energy use (+)	T	0.052	-	5.485					5.958		0.015	
Non-energy use - chemical/petrochemical (+)	U	-	-	3.877					4.298		0.015	
Electricity output (TWh) (+)	V	**1.769**	-	**8.368**	**10.159**	**2.230**		-	332.923	**6.383**	-	-
Heat output (PJ) (+)	W	**1.247**	-	**34.205**	**17.284**	**3.424**	-	**0.070**	130.716		-	**209.040**
Memo: Installed electrical capacity (MW) (+)	X	**1029.000**	-	**1337.000**	**3565.504**	**383.988**		-	172088.406	**2100.000**		
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-	-	-	-	-	-0.836		-1.854			
Memo: Input to heat pumps (-)	Z						-1.533	-	-1.533			

Rows

Row A: "Indigenous production" shows only production of primary energy, i.e. hard coal and lignite, oil shale, peat, biofuels and renewable waste (see product definition above), non-renewable waste, crude oil and natural gas liquid (NGL), natural gas, as well as electricity and heat from nuclear, hydropower, tidal, wave, geothermal, wind and solar plants. Note that:

(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 should be shown in *Column C (***"Oil and oil products"***)*.

(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 for transportation of the gas by pipeline.

(c) Heat from heat pumps (which sell heat to third parties) that is extracted from the ambient air is included in the "**Heat**" column under this category.

Row B/C: "Imports " and "Exports " show trade in primary and secondary forms of energy. Note that liquified petroleum gas (LPG) traded should be placed in *Column C (***"Oil**

and oil products"*)*. Nuclear fuel trade is not shown in the balance. Trade in electricity is counted at the same heat value as in final consumption (1 TWh = 0.086 Mtoe). For countries trading across common borders, actual import and export figures should be given instead of a net trade balance.

Row D: "International marine bunkers" includes those quantities of fuel 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. The domestic/international split is determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. Consumption by ships engaged in domestic navigation is not covered here but should be included in *Row O* (**"Transport"**).

Row E: "International aviation bunkers" 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. Consumption by aircraft engaged in domestic aviation are not covered here but should be included in *Row O (***"Transport"***)*.

Row F: "Stock changes (national territory)" show additions to stocks as negative and lowering of stock levels as positive. For the projection years, stock changes are conventionally zero. However, countries may report the data if available. The reporting of this category is optional and not part of the mandatory reporting for projection years.

Row G: "Total energy supply" (TES) is made up of **"Indigenous production"** (*Row A, positive*), **"Imports"** (*Row B*, positive), **"Exports"** (*Row C*, negative), **"International marine bunkers"** (*Row D*, negative), **"International aviation bunkers"** (*Row E*, negative) and **"Stock changes (national territory)"** (*Row F,* either positive or negative).

Note that when no stock change data is submitted (optional reporting), the TES is still populated with the assumption of a zero value for the stock change figure.

Row H: "Transformation processes and own use" shows the total of the energy transformation processes (*Rows I* and *J*), as well as energy used by energy-producing industries and losses in energy distribution, transmission and transport (*Row K*).

Row I: "Electricity, CHP and heat plants" should contain inputs of each fuel for the production of electricity and heat as negative entries in *Cells IA to IL*. This row includes both main activity producer[3] and autoproducer[4] plants. Gross outputs of electricity and heat appear as a positive number in *Cell IM* and *Cell IN*, respectively. Transformation losses are shown as negative numbers in the **"Total"** column, *Cell IO*.

For autoproducers, all fuel inputs to electricity production are taken into account, while only the part of fuel inputs used to sell heat are considered. Fuel inputs to produce 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.

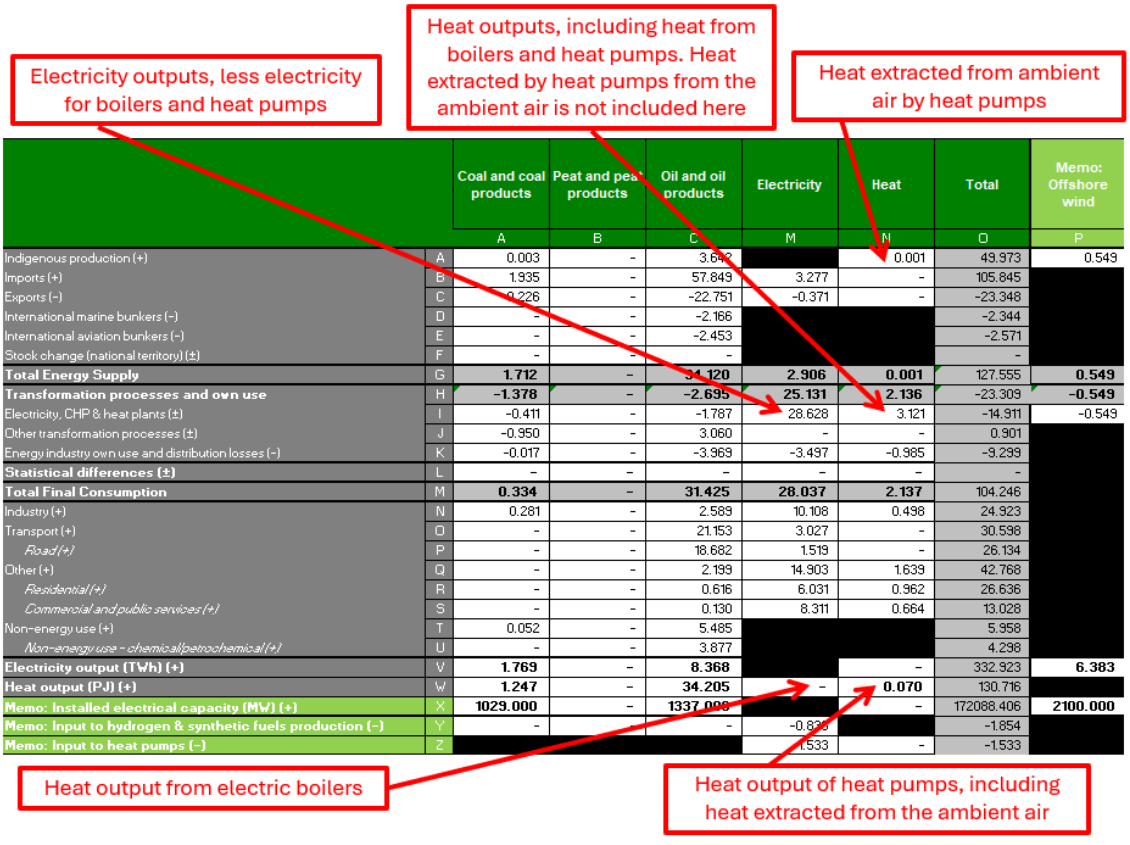
[3] Main activity producers generate electricity and/or heat for sale to third parties *as their primary activity*. They may be privately or publicly owned. Note that the sale need not take place through the public grid.

[4] Autoproducer undertakings generate electricity and/or heat, wholly or partly, as an activity which *supports* their primary activity. They may be privately or publicly owned.

Note that if electricity is being used to produce heat in heat pumps or electric boilers, the electricity inputs should be subtracted from the total electricity output reported in Cell IM. The corresponding net heat output of boilers and heat pumps (gross output – heat extracted from ambient air for heat pumps) should be reported in *Cell IN*. The gross output of heat produced in electric boilers should be reported in *Cell WM*, and for heat pumps this value is reported in *Cell WN*. When the heat produced in heat pumps and electric boilers is not sold, the electricity used to produce this heat is not subtracted from the electricity output in *Cell IM*. The electricity consumption is shown in the final consumption sectors under the **"Electricity"** column. This only applies for autoproducers.

For the reporting of heat extracted from the ambient air by heat pumps in *Cell AN*, this value should only include the portion extracted for heat that is sold. (again, only for autoproducers).

Note that Gross electricity produced should contain total electricity generation in Mtoe calculated on the basis of 1 TWh = 0.086 Mtoe. Gross generation from hydro plants should not include that generated by pumped storage. The energy absorbed for pumped storage should be accounted for under **"Energy industry own use and distribution losses"**, *Row K*. Refer to *Column F* (**"Hydropower"**) above for more details.



		Coal and coal products	Peat and peat products	Oil and oil products	Electricity	Heat	Total	Memo: Offshore wind
		A	B	C	M	N	O	P
Indigenous production (+)	A	0.003	-	3.667		0.001	43.973	0.549
Imports (+)	B	1.935	-	57.849	3.277	-	105.845	
Exports (-)	C	-0.226	-	-22.751	-0.371	-	-23.348	
International marine bunkers (-)	D	-	-	-2.166			-2.344	
International aviation bunkers (-)	E	-	-	-2.453			-2.571	
Stock change (national territory) (±)	F	-	-	-			-	
Total Energy Supply	G	**1.712**	-	**34.120**	**2.906**	**0.001**	127.555	**0.549**
Transformation processes and own use	H	**-1.378**	-	**-2.695**	**25.131**	**2.136**	-23.309	**-0.549**
Electricity, CHP & heat plants (±)	I	-0.411	-	-1.787	28.628	3.121	-14.911	-0.549
Other transformation processes (±)	J	-0.950	-	3.060	-	-	0.901	
Energy industry own use and distribution losses (-)	K	-0.017	-	-3.969	-3.497	-0.985	-9.299	
Statistical differences (±)	L	-	-	-	-	-	-	
Total Final Consumption	M	**0.334**	-	**31.425**	**28.037**	**2.137**	104.246	
Industry (+)	N	0.281	-	2.589	10.108	0.498	24.923	
Transport (+)	O	-	-	21.153	3.027	-	30.598	
Road (+)	P	-	-	18.682	1.519	-	26.134	
Other (+)	Q	-	-	2.199	14.903	1.639	42.768	
Residential (+)	R	-	-	0.616	6.031	0.962	26.636	
Commercial and public services (+)	S	-	-	0.130	8.311	0.664	13.028	
Non-energy use (+)	T	0.052	-	5.485			5.958	
Non-energy use - chemical/petrochemical (+)	U	-	-	3.877			4.298	
Electricity output (TWh) (+)	V	**1.769**	-	**8.368**		-	332.923	**6.383**
Heat output (PJ) (+)	W	**1.247**	-	**34.205**	-	**0.070**	130.716	
Memo: Installed electrical capacity (MW) (+)	X	**1029.000**	-	**1337.000**		-	172088.406	**2100.000**
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-		-	-0.839		-1.854	
Memo: Input to heat pumps (-)	Z				-1.533	-	-1.533	

Row J: "Other transformation processes" includes the transformation of energy products not captured elsewhere in the balance. For example, transformations in gas manufacture, oil refineries, coke ovens and blast furnaces, liquefaction, and other non-specified transformations.

This flow can include both inputs (negative) and outputs (positive). For example, the input of coking coal to coke ovens and the produced coke oven gas are summed in this row under **"Coal and coal products."**

Hydrogen or other synthetic fuels produced from hydrocarbons (e.g. natural gas), would be shown as secondary oil production in *Cell JC*. Refer to *Column C (***"Oil and oil products"***)* above for more details.

Row K: "Energy industry own use and distribution 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. Also included are losses from gas distribution, electricity transmission and coal transport. Note the following:

(a) Fuels used for pipeline transport should be included in the **"Transport"** row.

(b) The electricity generation losses appear in the **"Electricity, CHP and heat plants"** row.

(c) If hydrogen or synthetic fuels are produced through power to gas process by consumption of electricity, the conversion losses should be accounted under **"Energy industry own use and distribution losses"**. This is due to the current absence of these products in the main structure of the energy balance. Refer to *Column M (***"Electricity"***)* above for more details.

Row L: "Statistical differences". In principle, the figure for total requirements (supply) should equal the sum of deliveries to final consumption sectors, the transformation sector, and own-use plus losses within the energy sector. However, in practice this is rarely the case, and the difference is shown as **"Statistical differences"**. This arises because the data for the individual components of supply and demand are often derived from different data sources by the national administrations. Furthermore, the inclusion of changes in some large consumers' stocks in the supply part of the balance introduces distortions which contribute to the statistical difference.

Row M: "Total Final Consumption" (TFC) is the sum of consumption by the different end-use sectors, including non-energy use. Backflows from the petrochemical industry are not included in final consumption. TFC can be derived from both formulas below:

TFC = industry + transport + other + non-energy use, and

TFC = TES + transformation processes and own use + statistical differences.

Row N: "Industry" should cover all activity in mining, manufacturing and construction, except for fuel production and transformation sectors. The industry's use of energy for its own transport should be included under the **"Transport"** category.

The use of coke oven and blast furnace gas by the iron and steel industry appears in the **"Industry"** row under **"Coal and coal products"** and not under **"Natural gas"**. The generation of coke oven and blast furnace gas is reported as a positive value under the **"Other transformation processes"** row. See *Row J* for more details.

Feedstocks to the chemical/petrochemical industry should not be included in this category. Refer to *Row T (***"Non-energy use"***)* below for more details.

Row O: "Transport" includes all fuels used for transportation regardless of sector, except international marine bunkers and international aviation bunkers. Fuels used for pipeline transport should be included here.

Row P: "Road" includes all fuels for road transport regardless of sector. This includes fuels used in road vehicles as well as agricultural and industrial highway use. This category excludes military consumption and diesel oil for use in tractors that are not for highway use.

Row Q: "Other" covers the sum of consumption in residential, commercial/public services, agriculture/forestry, fishing and military use.

Row R: " Residential" includes consumption by households, excluding fuels used for transport.

Row S: " Commercial and public services" includes consumption corresponding to commercial and public services.

Row T: "Non-energy use" includes coal, oil and natural gas that are used for non-energy purposes, such as bitumen, lubricants, waxes, white spirit and the part of petroleum coke which cannot be used for energy purposes. Non-energy use of peat and biomass should not be included here. The use of petrochemical feedstocks in the chemical/petrochemical industry should be included here and not under industry.

Note that natural gas used for ammonia production which converts to hydrogen during the process, should be reported under this category.

Row U: " Non-energy use - chemical/petrochemical" covers the use of petrochemical feedstocks in the chemical/petrochemical industry.

Row V: "Electricity output (TWh)" shows total quantities of gross electricity generated in TWh by all electricity and CHP plants. Electricity generated from pumped storage should not be included. Refer to *Row I (***"Electricity, CHP, and heat plants"***)* above for more details.

Row W: "Heat output (PJ)" shows quantities of heat produced for sale by CHP and heat plants. Heat produced in electric boilers should be reported under the product **"Electricity"** and total heat produced by heat pumps, including heat extracted from the ambient air, should be reported under the product **"Heat"**.

Row X: "Memo: Installed electrical capacities (MW)" represents the net maximum capacity, which is the maximum active power that can be supplied, continuously, at the point of outlet (i.e. after taking account of the power supplies for the station auxiliaries and allowing for the losses in those transformers considered integral to the station) with all plants running. Please refer to the Annual electricity data questionnaire instructions[5] for more details.

Row Y: "Memo: Input to Hydrogen & synthetic fuels production" is a memo category outside the current main structure of the energy balance. This memo flow has been added to allow reporting the data corresponding to fuel/electricity inputs for hydrogen and synthetic fuels production in a more visible manner. However, the reporting under this memo category should not impact the existing means of reporting inputs to hydrogen and

[5] https://iea.blob.core.windows.net/assets/d71fa9fe-6a5d-4c59-b8a9-3edc05769f2f/Electricity_Heat-Questionnaire_Instructions.pdf.

synthetic fuels production as part of the main energy balance. Refer to *Column A (***"Coal and coal products"***)*, *Column D (***"Natural gas"***)* and *Column M (***"Electricity"***)* for details on how to report these inputs in the main structure of the energy balance.

For reporting under this memo category, the input for the production of synthetic fuels should be reported under the respective column as negative numbers. For example, the coal input should be reported in *Cell YA*. If hydrogen production is from natural gas reforming, then the input should be reported in *Cell YD*. Similarly, for power to gas processes (e.g. electrolysers), the electricity input should be reported under the product **"Electricity"** *in Cell YM*. More details about power to gas reporting in the main balance can be found under *Column M (***"Electricity"***).* The production and consumption of hydrogen and synthetic fuels should be reported under the *Column Q (***"Memo: Hydrogen & synthetic fuels"***)*. For details refer to *Column Q* above.

Row Z: "Memo: Input to heat pump" is a memo category outside the current main structure of the energy balance. The addition of this memo item allows the reporting of input data corresponding to all types of heat pumps. The reporting under this Memo category should not impact the existing means of reporting the input corresponding to heat pumps as part of the main energy balance. Refer to *Row A (***"Indigenous production"***)* and *Row I (***"Electricity, CHP and heat plants"***)* for details on how to report heat pumps inputs as part of the main structure of the energy balance.

For reporting under this memo category, the electricity used to generate heat in all types of heat pumps, including the small-scale residential ones not used for commercial purposes, should be reported under *Column M* (***"Electricity"***). Moreover, any non-ambient heat (e.g. recovered heat) used as an input to heat pumps should be reported under *Column N (***"Heat"***).* The ambient heat input, the net heat output and consumption of heat produced from the heat pumps should be reported under the memo product **"Memo: Heat pumps"**. For more details, please refer to *Column R (***"Memo: Heat pump"***)* above.

4.4 Common reporting questions

Table of contents

General note

Where applicable, each question lists the relevant product or flow in the where additional guidance can be found in the Table 1 section.

When questions affect reporting in the main balance and a memo category, the description in the question separates between reporting in each place. Please note, the memo categories are a disaggregation of what is in the main balance, so all values reported in the memo category should be reported in the main balance. Further explanation of what the main balance and memo categories are can be found in the webinar recording here, timestamped to the discussion of the questionnaire.

Cell references are those associated with the labelling inside the questionnaire table and do not refer to Excel's cell referencing. When reading a Cell reference, the row is listed first and the column second (e.g., Cell IM means row I and column M).

Inputs to the main balance are reported in units of million (mega) tonnes of oil equivalents (Mtoe), except for electricity and heat output, which are reported in TWh and PJ respectively.

Question 1: How to report values for electric boilers?

Table 1 reference

Row I: "Electricity, CHP and heat plants"

Answer

Reporting conventions for energy balances make a distinction between heat plants whose objective is mainly to sell their outputs to the market (e.g., district heat plants) and those who produce them to directly drive another activity without a commercial transaction. Where to report values for electric boilers, like with heat pumps, depends on this distinction.

The heat output from electric boilers, **where the heat is sold**, should appear in Cells IN and WM. If only the electricity input to boilers is known, the input should be reported as a heat output in Cells IN and WM, assuming a 100% conversion efficiency between electricity and heat. To avoid double-counting, the total electricity generation from all sources reported

in Cell IM should not include the electricity used for electric boilers. If it does, the heat output reported in Cell IN should be subtracted from the total electricity output in Cell IM. In the case of heat sold, the final consumption is reported under "Heat" and not "Electricity."

How to report a 1 Mtoe electricity input to electric boilers is shown in the picture below (Cell WM is in units of PJ), assuming the electricity input was included in the total generation reported in Cell IM and the heat is sold to the industrial sector.

		Electricity	Heat
		M	N
Transformation processes and own use	H	**-**	**1.000**
Electricity, CHP & heat plants (±)	I	Total Electricity Output - 1	1.000
Other transformation processes (±)	J	-	-
Energy industry own use and distribution losses (-)	K	-	-
Statistical differences (±)	L	**-**	**-**
Total Final Consumption	M	**-**	**1.000**
Industry (+)	N	-	1.000
Transport (+)	O	-	-
Road (+)	P	-	-
Other (+)	Q	-	-
Residential (+)	R	-	-
Commercial and public services (+)	S	-	-
Non-energy use (+)	T		
Non-energy use - chemical/petrochemical (+)	U		
Electricity output (TWh) (+)	V		**-**
Heat output (PJ) (+)	W	**41.876**	**-**

For heat from electric boilers **that is not sold**, the electricity input to the electric boilers should appear as final consumption under "Electricity" in the relevant sector. If in the example for sold heat above, the electric boilers were located on the industrial site and supplied heat without a commercial transaction, then 1 Mtoe would be added to Cell NM instead.

Question 2: How to report hydrogen and synthetic fuel production?

Table 1 reference

For reporting in the main balance:

- *Column C: "Oil and oil products"* for hydrogen and synthetic fuels derived from coal and natural gas
- *Column D: "Natural gas"* for import and export of hydrogen and synthetic fuels
- *Column M: "Electricity"* for hydrogen and synthetic fuels derived from power to gas processes

For reporting under the memo category:

Column Q: "Memo: Hydrogen & synthetic fuels" and *Row Y: "Memo: Input to Hydrogen & synthetic fuels production"*

Answer

Note

Hydrogen and synthetic fuels reporting is being reviewed within the IEA Secretariat across the teams working on energy balance data. As any new guidance is finalised, it will be communicated to compilers.

Main balance

For the main balance, where to report hydrogen and synthetic fuels depends on what energy product they were produced from. For hydrogen and synthetic fuels produced from coal or natural gas, the output is reported as a positive value under "Oil and oil products" in Cell JC and the input as a negative value under "Other transformation processes" (Row J) for the relevant energy product. For example, synthetic fuel produced from 4 Mtoe of natural gas with an efficiency of 75% would be reported as shown below.

		Oil and oil products	Natural gas
		C	D
Transformation processes and own use	H	**3.000**	**-4.000**
Electricity, CHP & heat plants (±)	I	-	-
Other transformation processes (±)	J	3.000	-4.000
Energy industry own use and distribution losses (-)	K	-	-

For hydrogen or synthetic fuels produced through the consumption of electricity, values appear under "Electricity" (Column M). The electricity input to the process is added as a positive value in Cell IM, the losses of the power to gas process are tracked as negative values in Cell KM, and the final consumption of the hydrogen or synthetic fuel is reported in Column M under the relevant sector. In this sense, we are treating hydrogen and synthetic fuels as electricity until the energy balance framework is updated to better account for hydrogen.

As an example, the picture below shows a 2 Mtoe input of electricity to electrolysers with an efficiency of 50%, where the produced hydrogen is used in hydrogen fuel cell vehicles.

		Electricity
		M
Transformation processes and own use	H	**1.000**
Electricity, CHP & heat plants (±)	I	2.000
Other transformation processes (±)	J	-
Energy industry own use and distribution losses (-)	K	-1.000
Statistical differences (±)	L	**-**
Total Final Consumption	M	**1.000**
Industry (+)	N	-
Transport (+)	O	1.000
Road (+)	P	1.000

Be careful not to double count the electricity input. If the electricity produced for the electrolyser is already reported in Cell IM as part of total electricity generation from all sources, it does not need to be added again.

Memo Category

Inputs to the production of hydrogen or synthetic fuels are reported in Row Y, the corresponding output from all processes is reported in Cell JQ, and final consumption in Rows N to U. Using the same example as above, a 2 Mtoe input of electricity to electrolysers with an efficiency of 50%, and final consumption in fuel cell vehicles, would be reported as shown below.

		Electricity	Memo: Hydrogen & synthetic fuels
		M	Q
Transformation processes and own use	H	**-**	**1.000**
Electricity, CHP & heat plants (±)	I	-	-
Other transformation processes (±)	J	-	1.000
Energy industry own use and distribution losses (-)	K	-	-
Statistical differences (±)	L	**-**	**-**
Total Final Consumption	M	**-**	**1.000**
Industry (+)	N	-	-
Transport (+)	O	-	1.000
Road (+)	P	-	1.000
Other (+)	Q	-	-
Residential (+)	R	-	-
Commercial and public services (+)	S	-	-
Non-energy use (+)	T		-
Non-energy use - chemical/petrochemical (+)	U		-
Electricity output (TWh) (+)	V		**-**
Heat output (PJ) (+)	W	**-**	**-**
Memo: Installed electrical capacity (MW) (+)	X		
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-2.000	
Memo: Input to heat pumps (-)	Z	-	

Note that the main balance values are not included in the above picture; in a submission, they should be reported in the main balance and memo category.

Question 2.1: How to report hydrogen or synthetic fuels used to produce electricity?

Main balance

Where to report hydrogen and synthetic fuels used to produce electricity depends on whether the fuel was produced from natural gas and coal or electricity. For hydrogen and synthetic fuels produced from coal and natural gas, their output is reported as a positive value in Cell JC. Whatever portion of this output used as an input for electricity production should be reported in Cell IC as a negative value. The electricity produced would be added as positive values in Cells IM and VC. If all the synthetic fuel produced from natural gas in **question 2** was combusted for electricity generation with a 50% efficiency, the reporting would be as shown below (note the unit for Cell VC is TWh). The electricity is assumed to be consumed in the residential sector.

		Oil and oil products	Natural gas	Electricity
		C	D	M
Transformation processes and own use	H	**-**	**-4.000**	**1.500**
Electricity, CHP & heat plants (±)	I	-3.000	-	1.500
Other transformation processes (±)	J	3.000	-4.000	-
Energy industry own use and distribution losses (-)	K	-	-	-
Statistical differences (±)	L	**-**	**-**	**-**
Total Final Consumption	M	**-**	**-**	**1.500**
Industry (+)	N	-	-	-
Transport (+)	O	-	-	-
Road (+)	P	-	-	-
Other (+)	Q	-	-	1.500
Residential (+)	R	-	-	1.500
Commercial and public services (+)	S	-	-	-
Non-energy use (+)	T	-	-	
Non-energy use - chemical/petrochemical (+)	U	-	-	
Electricity output (TWh) (+)	V	**17.442**	**-**	

For hydrogen or synthetic fuels produced through the consumption of electricity, values appear under "Electricity" (Column M). **See Question 2 above for details**. If this hydrogen or synthetic fuel is used to generate electricity, Cell KM is used to track the conversion losses of this transformation.

If all the produced electrolytic hydrogen from **question 2** was used in fuel cells to generate electricity at a 75% efficiency for industry instead of for use in the transport sector, the reporting would be as shown below.

		Electricity
		M
Transformation processes and own use	H	**0.750**
Electricity, CHP & heat plants (±)	I	2.000
Other transformation processes (±)	J	-
Energy industry own use and distribution losses (-)	K	-1.250
Statistical differences (±)	L	**-**
Total Final Consumption	M	**0.750**
Industry (+)	N	0.750

Cell KM now contains the losses for the electrolysers (-1 Mtoe) and the hydrogen fuel cells producing the electricity (-0.25).

Memo category

The memo category reports inputs of hydrogen and synthetic fuels for electricity production under Row I as a negative value, no matter the source of the hydrogen. For example, if hydrogen is produced from 2 Mtoe of natural gas and 2 Mtoe electricity, both with efficiencies of 50%, the combined output appears in Cell JQ. If all this produced hydrogen is used for electricity generation at a 50% efficiency, both the input of hydrogen (-2 Mtoe) **and** corresponding electricity production (1 Mtoe) are summed in Cell IQ. This reporting is shown in the picture below assuming the electricity produced from the hydrogen is used in the commercial sector.

		Natural gas	Electricity	Memo: Hydrogen & synthetic fuels
		D	M	Q
Transformation processes and own use	H	-	-	**1.000**
Electricity, CHP & heat plants (±)	I	-	-	-1.000
Other transformation processes (±)	J	-	-	2.000
Energy industry own use and distribution losses (-)	K	-	-	-
Statistical differences (±)	L	-	-	-
Total Final Consumption	M	-	-	**1.000**
Industry (+)	N	-	-	-
Transport (+)	O	-	-	-
Road (+)	P	-	-	-
Other (+)	Q	-	-	1.000
Residential (+)	R	-	-	-
Commercial and public services (+)	S	-	-	1.000
Non-energy use (+)	T	-		-
Non-energy use - chemical/petrochemical (+)	U	-		-
Electricity output (TWh) (+)	V	-		**11.628**
Heat output (PJ) (+)	W	-	-	-
Memo: Installed electrical capacity (MW) (+)	X	-		
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-2.000	-2.000	
Memo: Input to heat pumps (-)	Z		-	

The picture shows that the 1 Mtoe of electricity produced is also reported in units of TWh in Cell VQ. Note that the main balance values are not included in the above picture; in a submission, they should be reported in the main balance and memo category.

Question 3: How to report ambient heat extracted by heat pumps?

Table 1 reference

For reporting in the main balance: *Row I: "Electricity, CHP and heat plants"* and *Row A: "Indigenous production"*

For reporting under the memo category: *Column R: "Memo: Heat pumps"* and *Row Z: "Memo: Input to heat pump"*.

Answer

When reporting for heat pumps, it is important to understand that reporting conventions for energy balances make a distinction between heat plants whose objective is mainly to sell their outputs to the market (e.g., district heat plants) and those who produce them to directly drive another activity without a commercial transaction. Where to report values for heat pumps, like with electric boilers, depends on this distinction.

Main balance

Ambient heat extracted by heat pumps, **where the heat is sold**, is reported in "Indigenous production" (Row A) under "Heat" (Column N). In the same way, the net output (gross heat minus ambient heat extracted) of heat pumps reported in Cell IN and the gross output (in PJ) reported in Cell WN are only for sold heat. To avoid double-counting, the total electricity generation from all sources reported in Cell IM should not include the electricity used for

heat pumps. If it does, the heat output reported in Cell IN should be subtracted from the total electricity output in Cell IM. In the case of heat sold, the final consumption is reported under "Heat" and not "Electricity."

How to report a 1 Mtoe electricity input to heat pumps with a coefficient of performance of 3 is shown in the picture below (Cell WN is in units of PJ), assuming the electricity input was included in the total generation reported in Cell IM and the heat is sold to the industrial sector.

		Electricity	Heat
		M	N
Indigenous production (+)	A		2.000
Imports (+)	B	-	-
Exports (–)	C	-	-
International marine bunkers (–)	D		
International aviation bunkers (–)	E		
Stock change (national territory) (±)	F		
Total Energy Supply	G	**-**	**2.000**
Transformation processes and own use	H	**-**	**1.000**
Electricity, CHP & heat plants (±)	I	Total Electricity Output - 1	1.000
Other transformation processes (±)	J	-	-
Energy industry own use and distribution losses (-)	K	-	-
Statistical differences (±)	L	**-**	**-**
Total Final Consumption	M	**-**	**3.000**
Industry (+)	N	-	3.000
Transport (+)	O	-	-
Road (+)	P	-	-
Other (+)	Q	-	-
Residential (+)	R	-	-
Commercial and public services (+)	S	-	-
Non-energy use (+)	T		
Non-energy use - chemical/petrochemical (+)	U		
Electricity output (TWh) (+)	V		**-**
Heat output (PJ) (+)	W	**-**	**125.628**

Heat generated by heat pumps **that is not sold**, appears as electricity final consumption under the relevant sector. If in the example for sold heat, the heat pumps were located on the industrial site and supplied heat without a commercial transaction, then 1 Mtoe would be added to Cell NM instead.

Memo category

The reporting under the memo category uses the same rows as the reporting in the main balance, except for the electricity input, which is tracked separately in Cell ZM. The memo category captures all heat pump values, whether the heat is sold or not. Taking the same example as the main balance above, a 1 Mtoe electricity input to heat pumps selling heat to industry would be reported as shown below (assuming again a coefficient of performance of 3).

		Electricity	Memo: Heat pump
		M	R
Indigenous production (+)	A		2.000
Imports (+)	B	-	
Exports (–)	C	-	
International marine bunkers (–)	D		
International aviation bunkers (–)	E		
Stock change (national territory) (±)	F		
Total Energy Supply	G	**-**	**2.000**
Transformation processes and own use	H	**-**	**1.000**
Electricity, CHP & heat plants (±)	I	-	1.000
Other transformation processes (±)	J	-	
Energy industry own use and distribution losses (-)	K	-	-
Statistical differences (±)	L	**-**	**-**
Total Final Consumption	M	**-**	**3.000**
Industry (+)	N	-	3.000
Transport (+)	O	-	
Road (+)	P	-	
Other (+)	Q	-	-
Residential (+)	R	-	-
Commercial and public services (+)	S	-	-
Non-energy use (+)	T		
Non-energy use - chemical/petrochemical (+)	U		
Electricity output (TWh) (+)	V		**-**
Heat output (PJ) (+)	W	**-**	**125.628**
Memo: Installed electrical capacity (MW) (+)	X		
Memo: Input to hydrogen & synthetic fuels production (-)	Y	-	
Memo: Input to heat pumps (-)	Z	-1.000	

Note that the main balance values are not included in the above picture; in a submission, they should be reported in the main balance and memo category.

Question 3.1: How to report heat pumps using waste heat as a source?

The memo category has a dedicated cell for waste heat input to heat pumps: Cell ZN. In the main balance, the same value would be added in the transformation sector in Cell IN as a positive value.

Question 4: How to report projections for waste heat?

Guidance on the reporting of waste/recovered heat in is being developed by the Secretariat and will be communicated to compilers when it is finalised.

If projecting the use of waste/recovered heat, whether it is purchased/sold or used on-site, please email NationalProjections@iea.org for further guidance or provide remarks about where the waste heat is being reported in the energy balance.

For now, general guidance is to report the use of waste/recovered heat as final consumption under the relevant energy product (source of the waste heat) and end-use sector (where the waste heat is used).

4.5 Units and conversions

This section outlines the units and conversion factors which should be used when completing the energy balance (Table 1). The full methodological details on how to complete Table 1 is detailed in the section "Table 1- Energy Balances" above.

The energy balances should be completed in millions of tonnes (metric tons) of oil equivalent (Mtoe). 1 Mtoe = 41.868 Petajoules (10 Petacalories). In converting fuels to Mtoe for the purpose of the energy balances and other tables, respondents should use the factors outlined below.

Oil and oil products

The same default net calorific values used to convert oil products in reporting through the Annual Oil Questionnaire should be used for conversion. These figures are region-specific and are expressed in kJ/kg as shown below:

Default NCVs (kJ/kg)			
Product	**Europe**	**America**	**Asia Oceania**
Refinery gas	49 500	48 100	48 100
Ethane	49 500	49 400	49 400
LPG	46 000	47 300	47 700
Aviation gasoline	44 000	44 800	44 600
Motor gasoline	44 000	44 800	44 600
Jet gasoline	43 000	44 800	44 600
Jet kerosene	43 000	44 600	44 500
Other kerosene	43 000	43 800	42 900
Naphtha	44 000	45 000	43 200
Gas/diesel oil	42 600	42 600	42 600
Fuel oil	40 000	40 200	42 600
Petroleum coke	32 000	32 000	33 800
White spirit	43 600	43 000	43 000
Lubricants	42 000	42 000	42 900
Bitumen	39 000	40 000	38 800
Other oil products	40 000	40 000	40 000

Crude oil (including NGL, refinery feedstocks, additives and "other hydrocarbons") production, imports and direct use should be converted using the specific net calorific value of the crude oil(s), NGL, feedstocks, additives and "other hydrocarbons" for the country concerned. The NCVs used should be the same as those reported on the Annual Oil

Questionnaire. If you are unable to get a copy of what was submitted, please contact NationalProjections@iea.org.

Coal and coal products

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.

The net calorific values used for the various coal and coal products that make up production, trade and consumption should be the same as those given in the Coal (solid fossil fuels and manufactured gases) Annual Questionnaire. If you are unable to get a copy of what was submitted, please contact NationalProjections@iea.org. As data for gas derived from coal are usually provided in TJ, the problem of specific net calorific values does not arise.

Note that the data for the coal gases in Mtoe should be derived from net heat values. To calculate the net heat content of a gas from its gross heat content, multiply the gross heat content by the appropriate factor in the below table.

Gas works gas	0.9
Coke oven gas	0.9
Blast furnace gas	1.0
Other recovered gases	1.0

Natural gas

Gas data provided in joules should be converted as follows: 1 Mtoe = 41 868 TJ.

Data should be converted from 1000 m^3 to Terajoules using the country-specific factors given in the Natural Gas Annual Questionnaire. [The average net heat value of 1000 m^3 of gas = 0.034 Terajoules.]

To calculate the net heat content of natural gas from its gross heat content, the gross heat content should be multiplied by 0.9.

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. The calculation to be carried out is the following: Gross electricity generation in TWh x 0.086 / 0.33 = primary energy equivalent in Mtoe.

Heat sold by nuclear power plants should be shown as an output in the **"Heat"** column (positive number in *Cell IN*), with an identical input in the nuclear column (negative number in *Cell IE).*

Hydropower

The primary energy value ascribed to hydroelectricity is the energy content of the gross electricity generation from the natural flow of the water course. The calculation of electricity generation from hydroelectric plants, which excludes pumped storage plants, is as follows: Gross electricity generation in TWh x 0.086 = primary energy equivalent in Mtoe.

Wind

The primary energy value ascribed to electricity produced from the wind's kinetic energy is taken to be the physical energy content of the gross electricity generation; it is calculated as follows: Gross electricity generation in TWh x 0.086 = primary energy equivalent in Mtoe.

Geothermal

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. The calculation to be carried out is the following: Gross electricity generation in TWh x 0.086 / 0.10 = primary energy equivalent in Mtoe.

For heat production, the indigenous production of geothermal is the difference between the enthalpy of the fluid produced in the production borehole and that of the fluid eventually disposed of (reinjection borehole). Heat sold by geothermal plants should be shown as an output in the **"Heat"** column (positive number in *Cell IN*), with the input in the **"Geothermal"** column (negative number in *Cell IH*). If the actual geothermal plant 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 x 0.00002388 / 0.50 = primary energy equivalent in Mtoe.

Solar

Solar includes both solar photovoltaic electricity generation and solar thermal electricity and heat generation.

The primary energy value ascribed to electricity produced from solar photovoltaics 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 electricity produced from solar thermal heat, unless the actual efficiency is known, the primary equivalent is calculated assuming an efficiency of 33%. The calculation to be carried out is the following: Gross electricity generation in TWh x 0.086 / 0.33 = primary energy equivalent in Mtoe. For heat produced in a solar thermal plant, the primary equivalent is equal to the heat consumed, i.e. 1 TJ = 0.00002388 Mtoe.

Tide, wave and ocean and other energy sources

The primary energy value ascribed to electricity produced from tide, wave and ocean and other non-thermal sources is taken to be the physical energy content of the gross electricity generation: Gross electricity generation in TWh x 0.086 = primary energy equivalent in Mtoe.

Biofuels and renewable waste

Data that are provided in joules in the Renewables and Waste Annual Questionnaire should be converted as follows: 1 Mtoe = 41 868 TJ.

Data for charcoal and liquid biofuels (both reported in 1 000 tonnes) should be converted using an appropriate country-specific factor.

Total waste, non-renewable portion

Data that are provided in joules in the Renewables and Waste Annual Questionnaire should be converted as follows: 1 Mtoe = 41 868 TJ.

Electricity

Electricity is converted as follows: 1 TWh = 0.086 Mtoe.

Heat

Heat is converted as follows: 1 Mtoe = 41 868 TJ.

Memo: Offshore Wind

As for the total Wind, the primary energy value ascribed to electricity produced from wind's kinetic energy 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

As hydrogen and other synthetic fuels produced through transformation and consumed across sectors are typically in their pure form rather than a mixture, their calorific values can be easily identified based on their respective chemical formula. For hydrogen, a net calorific value of 120 MJ/kg should be used for the purpose of reporting. The net calorific values used for these fuels should be the same as those used when submitting the respective data in the Oil and Natural Gas Annual Questionnaires. If you are unable to get a copy of what was submitted, please contact NationalProjections@iea.org.

Memo: Heat pumps

Heat is converted as follows: 1 Mtoe = 41 868 TJ.

4.6 Table 2 – Supplementary data

This table includes macroeconomic data and is should be submitted for the provisional year and projection years. The included categories are detailed below:

"GDP growth rates (%)" represents the average annual growth rates of GDP. The annual growth rates refer to GDP in constant prices and should be calculated as detailed below:

- For historical and provisional year report the GDP $_{year}$/GDP $_{year-1}$ annual rate.
- For the projections years report the GDP $_{year}$/GDP $_{year-10}$ average annual rate. Note that this average should be calculated as a geometric mean. For instance, the 2020 to 2030 period the average growth rates is calculated as:

$$Average\ annual\ GDP\ growth\ rate\ _{2030/2020} = (\frac{GDP\ _{2030}}{GDP\ _{2020}})^{(\frac{1}{10})} - 1$$

"Population (millions)" represents the national population in millions.

"GDP (billion USD 2020)" represents GDP in constant 2020 prices.

Note: The Secretariat will update the GDP and population figures submitted with those published in OECD National Accounts prior to the publication of the database.

4.7 Table 3 – Emissions savings from CCUS

Decarbonizing the energy system can only be achieved with a broad suite of technologies. Carbon capture, utilization and storage (CCUS) is considered one of the components of the future technology mix as it will allow reducing emissions across hard-to-abate sectors. Hence, CCUS has become a critical part of long-term strategies for achieving energy and climate targets. This table should be used to report any emissions savings associated with CCUS across the energy supply, transformation and consumption sectors. The data should be reported for the last three historical years, the provisional year and the projection years.

Data should be reported in kilo tonnes of CO_2 avoided ($ktCO_2$). The table includes the following categories:

"Total" represents the total emissions savings through CCUS across the energy landscape.

"Natural gas processing" represents the emissions savings through CCUS at natural gas processing plants.

"Manufacturing" represents the emissions savings associated with CCUS across the manufacturing sectors, including ammonia production, iron and steel and cement.

"Electricity and heat generation" represents the emissions savings associated with CCUS in power generation.

"Hydrogen and synthetic fuel production" represents the emissions savings associated with CCUS in the production of blue hydrogen and other synthetic fuels.

"Other" represents the emissions savings associated with CCUS in other areas of the energy supply, transformation and consumption sectors not defined above.

4.8 CSV Import and Export

The data compliers have an option to import and export the data in CSV format. This could be a useful tool to automate the data import and easily extract the data in a desired format. The details on how to use these functions are outlined below.

Note: **if multiple scenarios are available**, the user can save the questionnaire, extract the corresponding CSV, and then change the scenario and report the data for the alternative scenario(s). The scenario information will be included in the exported CSV files.

Importing projections data from CSVs

The data providers can load data from a CSV file to fill the projection year tables. The CSV import function is included on the **"Data Import & Export"** tab.

In order to import the data using this function, the CSVs prepared for import should include the data with code names which match the structure of the data included in the questionnaire. The table below lists the corresponding codes for all of the flows and products included in all three tables of the questionnaire.

FLOWS	
Table 1	
Long name	**Code**
Indigenous Production (+)	INDPROD
Imports (+)	IMPORTS
Exports (–)	EXPORTS
International marine bunkers (–)	MARBUNK
International aviation bunkers (–)	AVBUNK
Stock change (national territory) (±)	STOCKCHA
Total energy supply	TES
Transformation processes and own use	TRANENER
Electricity, CHP & heat plants (±)	ELECHEAT
Other transformation processes (±)	TRANOTH
Energy industry own use and distribution losses (–)	OWNUSE
Statistical differences (±)	STATDIFF
Total Final Consumption	TFC
Industry (+)	TOTIND
Transport (+)	TOTTRANS

Road (+)	ROAD
Other (+)	TOTOTHER
Residential (+)	RESIDENT
Commercial and public services (+)	COMMPUB
Non-energy use (+)	NONENUSE
non-energy use - chemical/petrochemical (+)	NECHEM
Electricity output (TWh) (+)	ELOUTPUT
Heat output (PJ) (+)	HEATOUT
Memo: Installed electrical capacity (MW) (+)	ELECAP
Memo: Input to hydrogen & synthetic fuels production	INH2PROD
Memo: Input to heat pumps	INHEATPUMP

Table 2

Long name	**Code**
GDP Growth Rates (%)	GDPGR
Population (Millions)	POPULATION
GDP (billion USD 2020)	GDP

Table 3

Long name	**Code**
Total	CCTOTAL
Natural gas processing	CCNGPROC
Manufacturing	CCMANUFACT
Electricity and heat generation	CCELECHEAT
Hydrogen and synthetic fuel production	CCH2PROD
Other	CCOTHER

PRODUCTS

Table 1

Long name	**Code**
Coal and coal products	COAL
Peat and peat products	PEAT

Oil and oil products	OIL
Natural gas	NATGAS
Nuclear	NUCLEAR
Hydropower	HYDRO
Wind	WIND
Geothermal	GEOTHERM
Solar	SOLAR
Tide, wave and ocean, and other energy sources.	TIDEOTHER
Biofuels & renewable waste	COMRENEW
Total waste, non-renewable portion	NRENWASTE
Electricity	ELECTR
Heat	HEAT
Total	TOTAL
Memo: Offshore wind	MWINDOFF
Memo: Hydrogen & Synthetic fuels	MH2SYNFUEL
Memo: Heat pump	MHEATPUMP

Table 2

Long name	**Code**
N/A	TOTAL

Table 3

Long name	**Code**
N/A	TOTAL

The table below lists the corresponding codes for the Scenarios:

SCENARIOS	
Long name	**Code**
Business as usual	BAU
Stated policies	STEPS
Aspirational – achieving national targets	ASPTARGET
Aspirational – achieving defined outcomes	ASPOUTCOME
Other	OTHER

The CSV file name used for importing data should be in the following format: *"Country_Scenario.csv", e.g. "AUSTRALIA_BAU.csv".*

In order to use the CSV import function, the steps listed below should be followed:

For importing the projections data corresponding to Table 1 and Table 3:

- On the **"Data Import & Export"** tab and in cell B10, indicate the import file path (the folder where the file is located and not the full file path) in the following format: *"C:/xxx/xxxx", e.g. "C:/Users/Dupont/Documents".*

- On the "Data Import & Export" tab and in cell B11, indicate the country name using capital letters.

- On the "Data Import & Export" tab and in cell B12, select the scenario category from the provided drop-down list.

- Prepare, and place in the location indicated in cell B10, a CSV file which includes the projections data corresponding to Table 1 and Table 3 in the following format using the codes in the tables above:

  "Country","Scenario","Product","Flow","2030","2040","2050"

  e.g. "AUSTRALIA","BAU","COAL","INDPROD","100","60","30"
  e.g. "AUSTRALIA","BAU","TOTAL","CCTOTAL","1200","800","1600"

- Click on the **"Import energy projections (Table 1 & 3)"** button.

For importing the projections data corresponding to Table 2:

- On the "Data Import & Export" tab and in cell B10, indicate the import file path (the folder where the file is located and not the full file path) in the following format: "C:/xxx/xxxx", e.g. "C:/Users/Dupont/Documents".

- On the "Data Import & Export" tab and in cell B11, indicate the country name using capital letters.

- On the "Data Import & Export" tab and in cell B12, select the scenario category from the provided drop-down list.

- Prepare, and place in the location indicated in cell B10, a CSV file which includes the projections data corresponding to Table 2 in the following format using the codes in the tables above:

  "Country","Scenario","Product","Flow","2030","2040","2050"

  e.g. "AUSTRALIA","BAU","TOTAL","GDPGR","2","3","4"

- Click on the **"Import macro-economic projections (Table 2)"** button.

Following the above steps, the forecast data will be copied in the three data tables.

Exporting projections data in CSVs

Similarly, the data providers can export the data corresponding to the projections data in a CSV format. This includes the respective data included in all three tables. The CSV export function is included on the **"Data Import & Export"** tab. In order to use this function the steps listed below should be followed:

- On the **"Data Import & Export"** tab and in cell B14, indicate the export file path in the following format: *"C:/xxx/xxxx/", e.g. "C:/Users/Dupont/Documents/".*
- Click on the **"Export all data"** button.

Following the above steps, a CSV which includes all the projections data in the three tables will be saved in the indicated location, under the name *"Country_Scenario.csv", e.g. "AUSTRALIA_BAU.csv".*

5. Energy transitions indicators and graphs

The questionnaire calculates various indicators based on the inputted data and plots them. These plots can be used to support data validation and better tracking across historical and projection periods.

Accurate and up-to-date indicators are essential to assess how countries energy systems are evolving and to identify gaps and opportunities for policy decisions. No single indicator can fully capture the complexity of energy transitions; however, if taken together, a set of indicators can unpack the underlying drivers of energy supply and demand changes, and the energy sector's contribution to greenhouse gas (GHG) emissions.

This section describes the underlying methodology for deriving the transition indicators presented within the questionnaire on the **"Indicators"** sheet.

The calculated indicators and their graphical representations are divided into three main categories: i) Energy production and consumption; ii) GHG emissions from fuel combustion; iii) Electricity/heat generation and emissions. Please note that GHG emissions estimations are only provided as benchmarks and do not replace official national submissions.

By clicking on the respective links located on the top left-hand side of the **"Indicators"** sheet, users can navigate through the page to view the corresponding tables and graphical representations included for each indicator.

Energy production and consumption

This section includes a set of transition indicators, with sectoral disaggregation, which correspond to energy supply and consumption.

The indicators listed below are taken directly from the data submitted in Table 1. However, the energy units have been converted to units of joules in an effort to facilitate analysis and comparison with other sources.

- **Production by source (TJ)**
- **Total Energy Supply (TES) by source (TJ)**
- **Total Final Energy Consumption (TFEC) by fuel (TJ)**
- **Total consumption by sector (TJ)**
- **Industry energy consumption by source (TJ)**
- **Transport energy consumption by source (TJ)**
- **Road transport energy consumption by source (TJ)**
- **Other sectors energy consumption by source (TJ)**
- **Residential energy consumption by source (TJ)**
- **Commercial and public services energy consumption by source (TJ)**
- **Non-energy use by source (TJ)**
- **Electricity consumption by sector (TJ)**
- **Heat consumption by sector (TJ)**
- **Total input to electricity, CHP & heat plants (TJ)**

The following production and consumption indicators are derived from the data submitted in Table 1 and Table 2 as detailed below:

- **Energy intensity index (MJ per USD)**

Similar to the Sustainable Development Goal (SDG) 7.3.1 indicator, this indicator is measured in terms of primary energy supply and GDP; it is a proxy for energy efficiency. Note that due the availability of the data submitted in the questionnaire, the GDP used for deriving this indicator is represented in constant terms at exchange rates. However, the official SDG 7.3.1 indicator is measured in constant terms at purchasing power parities[6].

This indicator is calculated as:

$$Energy\ intensity = \frac{TES}{GDP}$$

Where:

TES: Total energy supply (reported in Table 1)
GDP: Gross domestic product (extrapolated based on the average annual growth rate reported in Table 2 and the latest available absolute figure available from the OECD National Accounts).

- **Total final consumption per unit of GDP (MJ per USD)**

This indicator is calculated as:

$$Final\ consumption\ per\ GDP = \frac{TFC}{GDP}$$

Where:

TFC: Total final consumption (reported in Table 1)
GDP: Gross domestic product (extrapolated based on the average annual growth rate reported in Table 2 and the latest available absolute figure available from the OECD National accounts).

- **Total energy supply per capita (GJ per Capita)**

This indicator is calculated as:

$$Energy\ supply\ per\ capita = \frac{TES}{Population}$$

Where:

TES: Total energy supply (reported in Table 1)
$Population$: National population (reported in Table 2)

[6] For more information on the methodology, please refer to the official SDG 7.3.1 metadata available at: https://unstats.un.org/sdgs/metadata/files/Metadata-07-03-01.pdf.

- **Total final consumption per capita (GJ per Capita)**

This indicator is calculated as:

$$Final\ consumption\ per\ capita = \frac{TFC}{Population}$$

Where:

TFC: Total final consumption (reported in Table 1)
$Population$: National population (reported in Table 2)

- **Other non-specified energy consumption by source (TJ)**

This indicator represents the final energy consumption excluding industry, transport, residential and commercial and public services sectors. In other words, it includes the energy consumption corresponding to agriculture/forestry, fishing and final consumption not elsewhere specified.

The indicator is derived as:

$$\begin{aligned} Other\ non-specified\ energy\ consumption_{\ p} \\ = Other\ sectors\ energy\ consumption_{\ p} \\ - \big(Residential\ energy\ consumption_{\ p} \\ + Commerical\ and\ public\ services\ energy\ consumption_{\ p}\big) \end{aligned}$$

Where:

$Other\ sectors\ energy\ consumption_{\ p}$*:* Final consumption of all end-use sectors besides Industry and transport of energy product *p* (reported in Table 1)

$Residential\ energy\ consumption_{\ p}$*:*Residential consumption of energy product *p* (reported in Table 1)

$Commerical\ and\ public\ services\ energy\ consumption_{\ p}$: Commercial and public services consumption of energy product *p* (reported in Table 1)

- **Energy self-sufficiency (%)**

Self-sufficiency is an indicator representing the portion of the total energy demand which is met by the indigenous production and can be used as a proxy to understand the country's dependence on energy imports.

This indicator is calculated as:

$$Self\ sufficiency_p = \frac{Prodution_p}{TES_p}$$

Where:

$Production_p$: Indigenous production of energy product *p. This indicator is calculated for "Oil and oil products", "Coal & peat", "Natural gas" and "Total"* (reported in Table 1). Note, that the "*coal & peat*" indicator combines the production of coal and peat and their products

TES_p: Total energy supply of energy product *p* (reported in Table 1)

- **Share of renewables in total energy supply (%)**

This indicator represents the share of renewable energy sources in total energy supply and is calculated as:

$$\%TES_{RES} = \frac{TES_{RES}}{TES_{TOTAL}}$$

Where:

TES_{Total}: Total energy supply of all energy products (reported in Table 1)
TEC_{RES}: Total energy supply of renewable energy sources, which include: "*Hydropower*", "*Wind*", "*Solar*", "*Geothermal*", "*Tide, wave and ocean, and other energy sources*" and "*biofuels and renewable waste*" (reported in Table 1)

- **Share of renewables in total final energy consumption (%)**

This indicator is used to track progress towards SDG 7.2, which is to increase substantially the share of renewable energy in the global energy mix by 2030. The indicator is derived using the same methodology corresponding to the official SDG 7.2.1 indicator, which is defined as the share of renewable energy in total final energy consumption (TFEC).

The denominator is the total final energy consumption of all energy products (as defined in Table 1) while the numerator, the renewable energy consumption, is a series of calculations defined as: the direct consumption of renewable energy sources plus the final consumption of gross electricity and heat that is estimated to have come from renewable sources. This estimation allocates the amount of electricity and heat consumption to renewable sources based on the share of renewables in gross production[7].

This indicator is calculated as:

$$\%TFEC_{RES} = \frac{TFEC_{RES} + \left(TFEC_{ELE} \times \frac{ELE_{RES}}{ELE_{TOTAL}}\right) + \left(TFEC_{HEAT} \times \frac{HEAT_{RES}}{HEAT_{TOTAL}}\right)}{TFEC_{TOTAL}}$$

Where:

$TFEC_{TOTAL}$: Total final energy consumption is the sum of final energy consumption in the transport, industry, and other sectors (also equivalent to the total final consumption minus non-energy use)
$TFEC_{RES}$: Direct final energy consumption of renewable energy sources which include: "*Hydropower*", "*Wind*", "*Solar*", "*Geothermal*", "*Tide, wave and ocean, and other energy sources*" and "*biofuels and renewable waste*" (reported in Table 1)
$TFEC_{ELE}$: Final consumption of gross electricity (reported in Table 1)
$TFEC_{HEAT}$: Final consumption of gross heat (reported in Table 1)
ELE: Gross electricity production (reported in Table 1)
$HEAT$: Gross heat production (reported in Table 1)

[7] For more information on the methodology, please refer to the official SDG 7.2.1 metadata available at: https://unstats.un.org/sdgs/metadata/files/Metadata-07-02-01.pdf.

- **Share of fossil fuels in total energy supply (%)**

This indicator represents the share of fossil fuels in total energy supply and is calculated as:

$$\%TES_{FOS} = \frac{TES_{FOS}}{TES_{TOTAL}}$$

Where:

TES_{Total}: Total energy supply of all energy products (reported in Table 1)
TEC_{FOS}: Total energy supply of fossil fuels, which includes the following: *"Coal and coal products", "Peat and peat products", "Oil and oil products", "Natural gas" and "Total waste, non-renewable portion"* (reported in Table 1)

- **Share of fossil fuels in total final energy consumption (%):**

This indicator is calculated as

$$\%TFEC_{FOS} = \frac{TFEC_{FOS} + \left(TFEC_{ELE} \times \frac{ELE_{FOS}}{ELE_{TOTAL}}\right) + \left(TFEC_{HEAT} \times \frac{HEAT_{FOS}}{HEAT_{TOTAL}}\right)}{TFEC_{TOTAL}}$$

Where:

$TFEC_{TOTAL}$: Total final energy consumption is the sum of final energy consumption in the transport, industry, and other sectors (also equivalent to the total final consumption minus non-energy use)
$TFEC_{FOS}$: Direct final energy consumption of fossil fuels, which includes the following: *"Coal and coal products", "Peat and peat products", "Oil and oil products", "Natural gas" and "total waste, non-renewable portion"* (reported in Table 1)
$TFEC_{ELE}$: Final consumption of gross electricity (reported in Table 1)
$TFEC_{HEAT}$: Final consumption of gross heat (reported in Table 1)
ELE: Gross electricity production (reported in Table 1)
$HEAT$: Gross heat production (reported in Table 1)

Greenhouse gas (GHG) emissions from fuel combustion

This section includes GHG emissions estimates and a set of related transition indicators.

The included historical GHG emissions from fuel combustion are taken directly from the IEA global database of greenhouse gas emissions from energy. These estimates are obtained following harmonised definitions and comparable methodologies across countries. They do not represent an official source for national submissions, as national administrations should use the best available country specific information to complete their emissions reporting.

The estimated emissions figures for projection years are derived from the submitted total energy supply data by fuel category in the questionnaire. More details are provided in the following sections.

The following indicators are derived from the data submitted in Table 1 and Table 2:

- **CO_2 and GHG emissions from fuel combustion by source (Mt CO_2 and Mt CO_{2eq})**

CO_2 from fuel combustion presents total CO_2 emissions from fuel combustion. This includes CO_2 emissions from fuel combustion in *IPCC Source/Sink Category 1 A Fuel Combustion Activities* and those, which may be reallocated to *IPCC Source/Sink Category 2 Industrial Processes and Product Use* under the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Similarly, GHG from fuel combustion presents total greenhouse gas emissions from fuel combustion, including CO_2, CH_4 and N_2O, and corresponds to the same IPCC categories.

Note that according to the *2006 IPCC Guidelines*, CO_2 emissions from combustion of biofuels and renewable waste are not included in the emissions estimates from energy; the associated non-CO_2 (CH_4 and N_2O) emissions are taken into account. However, the GHG estimates included in this tool exclude the non-CO_2 emissions from combustion of renewable sources, which, in the case of the IEA member countries, correspond to a minor percentage of total emissions from fuel combustion.

For the historical years, the estimates are demand-based estimates from the IEA global database of greenhouse gas emissions from energy, where the IEA uses the (Tier 1) methodology to estimate GHG emissions from fuel combustion based on the *2006 IPCC Guidelines*. For more details on the underlying methodology please refer to the respective database documentation file.

However, for the projection years, and due to the absence of demand side data, the indicators are derived based on the submitted total energy supply data by fuel category in the questionnaire and the respective average fuel-specific carbon intensities for the last three historical years as detailed below:

$$CO_2 \text{ or } GHG \text{ emissions from fuel combustion by source} = \sum_p TES_p \times EF_{p,y} \quad (1)$$

Where:

$Emissions$: Total GHG emissions (expressed in Mt CO_{2eq}) or CO_2 only emissions (expressed in Mt CO_2)

EF_p: Emissions factor of fossil energy product *p* expressed in CO_2 / TJ or in CO_{2eq} / TJ
However, given that the fossil energy products *"Oil and oil products", "Coal and coal products", "Peat and peat products"* and *"Total waste, non-renewable portion"* reported in the questionnaire aggregate different products with various emissions factors, an average emissions factor based on the average mix of products from the last three historical years is calculated according to the following formula:

$$EF_{p,y} = \frac{1}{3}\sum_i \left[\left(\frac{Emissions_{p,y-1}}{TES_{p,y-1}}\right) + \left(\frac{Emissions_{p,y-2}}{TES_{p,y-2}}\right) + \left(\frac{Emissions_{p,y-3}}{TES_{p,y-3}}\right)\right]$$

Where:

$EF_{p,y}$: Average emissions factor for product *p* (applied in equation (1) for projection years)
p: Aggregate products: *"Oil and oil products", "Coal & peat"* and *"Total waste, non-renewable portion".* Note that the *"Coal & peat"* aggregate combines the emissions and TES of coal and peat and their products. Furthermore, the "*Natural gas*" product refers to one single standard emissions factor in the *2006 IPCC Guidelines* and is not calculated using the above equation
$Emissions_{p,y-1/y-2/y-3}$: Total GHG (or CO_2 only) demand-based emissions estimate of the aggregated fuel *p* from the last three historical years
$TES_{p,y-1/y-2/y-3}$: Total energy supply of aggregated fuel *p* from the last three historical years

- **CO_2 and GHG emissions from fuel combustion by final consumption sectors (Mt CO_2 and Mt CO_{2eq})**

Similar to the total CO_2 (GHG) from fuel combustion as outlined above, the sectoral emissions include emissions corresponding to *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 estimates are demand-based estimates from the IEA global database of greenhouse gas emissions from energy, where the IEA uses the (Tier 1) methodology to estimate GHG emissions from fuel combustion based on the *2006 IPCC Guidelines* and the sectoral consumption data.

However, for the projection years, the indicators are derived based on the submitted sectoral consumption data by fuel category in the questionnaire, and the respective sectoral average carbon intensities for the last three historical years.

$$Emissions_i = \sum_p FC_{i,p} * EF_{p,y} \quad (2)$$

Where:

$FC_{i,p}$: Final consumption of fossil energy product *p* in sector *i* (from Table 1).
$EF_{p,y}$: Average emissions factor for product *p* (applied in equation (2) for the last three historical years) calculated as follows:

$$EF_{p,y} = \frac{1}{3}\sum_p \left[\left(\frac{Emissions_{p,y-1}}{FC_{p,y-1}}\right) + \left(\frac{Emissions_{p,y-2}}{FC_{p,y-2}}\right) + \left(\frac{Emissions_{p,y-3}}{FC_{p,y-3}}\right)\right]$$

Where:

p: Aggregate products: *"Oil and oil products", "Coal & peat"* and *"Total waste, non-renewable portion".* Note that the *"Coal & peat"* aggregate combines the emissions and final consumption of coal and peat and their products. Furthermore, the "*Natural gas*" product refers to one single standard emissions factor in the *2006 IPCC Guidelines* and is not calculated using the above equation
$Emissions_{p,y-1/y-2/y-3}$: Sectoral GHG (or CO_2 only) demand-based emissions estimate of the aggregated fuel *p* from the last three historical years.
$FC_{p,y-1/y-2/y-3}$: Final sectoral consumption of aggregated fuel *p* from the last three historical years

- **CO_2 and GHG emissions from fuel combustion per capita (tonnes CO_2 per capita and tonnes CO_{2eq} per capita)**

This indicator is calculated as

$$Emissions\ per\ capita = \frac{Emissions}{Population}$$

Where:

$Emissions$: Total GHG (expressed in Mt CO_{2eq}) or CO_2 emissions (expressed in Mt CO_2) from fuel combustion (estimated per above methodology)
$Population$: National population in millions (reported in Table 2)

- **CO_2 and GHG emissions from fuel combustion per unit of GDP (kg CO_2/USD and kg CO_{2eq}/USD)**

This indicator is calculated as

$$Emissions\ per\ GDP = \frac{Emissions}{GDP}$$

Where:

$Emissions$: Total GHG (expressed in Mt CO_{2eq}) or CO_2 emissions (expressed in Mt CO_2) from fuel combustion (estimated per above methodology)
GDP: Gross domestic product in billion USD 2020 (extrapolated based on the average annual growth rate reported in Table 2 and the latest available absolute figure available from the OECD National Accounts).

- **CO_2 and GHG emissions per unit of TES (tonnes CO_2/TJ and tonnes CO_{2eq}/TJ)**

$$Emissions\ intensity\ of\ the\ energy\ mix = \frac{Emissions}{TES_{Total}}$$

Where:

$Emissions$: Total GHG (expressed in Mt CO_{2eq}) or CO_2 emissions (expressed in Mt CO_2) from fuel combustion (estimated per above methodology)
TES_{Total}: Total energy supply of all energy products (reported in Table 1)

- **CO_2 emissions, drivers indices and LMDI decomposition**

LMDI indicators are no longer reported for national projections. This section is for information only.

Decomposition of CO_2 emissions from fuel combustion into four driving factors (Kaya decomposition), can be represented as below. 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.

$$C = P \times \frac{GDP}{P} \times \frac{TES}{GDP} \times \frac{C}{TES}$$

Where:

C: Total CO_2 emissions form fuel combustion

P: National population (reported in Table 2)

$\frac{GDP}{P}$: GDP/population

$\frac{TES}{GDP}$: Total energy supply per GDP (energy intensity of the economy)

$\frac{C}{TES}$: Emissions intensity of the energy mix

The kaya identity expresses, for a given time, CO_2 emissions as the product of population, per capita economic output (GDP/P), energy intensity of the economy (TES/GDP) and carbon intensity of the energy mix (C/TES). For the purpose of this example analysis, the driving forces are represented as indices (2000=100). Because of possible non-linear interactions between terms, the sum of the percentage changes of the four factors, e.g. $(P_y\text{-}P_x)/P_x$, will not generally add up to the percentage change of CO_2 emissions $(C_y\text{-}C_x)/C_x$. However, relative changes of CO_2 emissions in time can be obtained from relative changes of the four factors as follows:

$$\frac{C_y}{C_x} = \frac{p_y}{p_x} \times \frac{(\frac{GDP}{P})_y}{(\frac{GDP}{P})_x} \times \frac{(\frac{TES}{GDP})_y}{(\frac{TES}{GDP})_x} \times \frac{(\frac{C}{TES})_y}{(\frac{C}{TES})_x}$$

Where:

x and y represent two different years.

The effect of each coefficient can then be expressed in units of CO_2 emissions (Mt CO_2) by applying the logarithmic mean divisia (LMDI) method proposed by Ang (2004)[8]. Using this method, the change in total CO_2 emissions from fuel combustion (ΔC_{Total}) between year t

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

and a base year 0, can be computed as the sum of the changes in each of the individual factors as follows:

$$\Delta C_{Total} = \Delta C_p + \Delta C_{GDP/P} + \Delta C_{TES/GDP} + \Delta C_{C/TES}$$

The effect of the variation of each coefficient on the total emissions is then calculated by applying the LMDI formula:

$$\Delta C = \sum_i w_{i,t} \ln\left(\frac{A_{i,t}}{A_{i,0}}\right)$$

with $w_{i,t} = L(Emissions_{i,0}, Emissions_{i,t})$

Where:

$A_{i,t}$: level of coefficient *i* at time *t*

$$L(X_1, X_2) = \frac{X_2 - X_1}{\ln\left(\frac{X_2}{X_1}\right)}) \; if X_1 \neq X_2 \; and \; L(X_1, X_1) = X_1$$

In this decomposition, each effect can therefore be calculated as

$$\Delta C_p = L(C^t, C^0) \ln (\frac{p^t}{p^0})$$

$$\Delta C_{GDP/P} = L(C^t, C^0) \ln (\frac{(\frac{GDP}{P})^t}{(\frac{GDP}{P})^0})$$

$$\Delta C_{TES/GDP} = L(C^t, C^0) \ln (\frac{(\frac{TES}{GDP})^t}{(\frac{TES}{GDP})^0})$$

$$\Delta C_{C/TES} = L(C^t, C^0) \ln (\frac{(\frac{C}{TES})^t}{(\frac{C}{TES})^0})$$

Where:

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

Electricity/heat generation and emissions

This section includes electricity and heat generation transition indicators as well as emissions, and emissions indicators, from electricity and heat generation.

The two indicators listed below are taken directly from the data submitted in Table 1.

- **Electricity output by source (TWh)**
- **Heat output by source (PJ)**

The following indicators are derived from the data submitted in Table 1 as detailed below:

- **Share of renewables in electricity and heat generation (%)**

The below two indicators represent the share of renewable energy sources in electricity and heat generation respectively, and are calculated as

$$Renewable\ share_{ELE} = \frac{ELE_{RES}}{ELE_{TOTAL}} \text{ and } Renewable\ share_{HEAT} = \frac{HEAT_{RES}}{HEAT_{TOTAL}}$$

Where:

ELE_{TOTAL}: Total electricity generation excluding pumped storage (reported in Table 1)
ELE_{RES}: Electricity generation from renewable energy sources (reported in Table 1)
$HEAT_{TOTAL}$: Total heat generation (reported in Table 1)
$HEAT_{RES}$: Heat generation from renewable energy sources (reported in Table 1)
RES: Renewable Energy Sources, which include the following: "*Hydropower*", "*Wind*", "*Geothermal*", "*Solar*", "*Tide, wave and ocean, and other energy sources.*" and "*Biofuels & renewable waste*"

- **Share of low carbon sources in electricity and heat generation (%)**

The below two indicators, represent the share of low carbon sources in electricity and heat generation respectively, and are calculated as

$$Low\ carbon\ share_{ELE} = \frac{ELE_{Low\ carbon}}{ELE_{TOTAL}} \text{ and } Low\ carbon\ share_{HEAT} = \frac{HEAT_{Low\ carbon}}{HEAT_{TOTAL}}$$

Where:

ELE_{TOTAL}: Total electricity generation excluding pumped storage (reported in Table 1)
$ELE_{LowCarbon}$: Electricity generation from low carbon energy sources (reported in Table 1)
$HEAT_{TOTAL}$: Total heat generation (reported in Table 1)
$HEAT_{LowCarbon}$: Heat generation from low carbon energy sources (reported in Table 1)
$Low\ carbon$: Low carbon energy sources, which include all renewable energy sources as defined above plus "*Nuclear*"

- **Electricity and heat generation CO_2 and GHG emissions from fuel combustion (Mt CO_2 and Mt CO_{2eq})**

Similar to the total and sectoral CO_2 (GHG) from fuel combustion outlined above, the electricity and heat generation emissions include emissions corresponding to *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 estimates are demand-based estimates from the IEA global database of greenhouse gas emissions from energy, where the IEA uses the (Tier 1) methodology to estimate GHG emissions from fuel combustion based on the *2006 IPCC Guidelines* and the inputs to the power generation plants.

However, for the projection years, and due to the absence of demand-side data, the indicators are derived based on the submitted input to generation plants by fuel category in the questionnaire, as well as the respective power generation average carbon intensities for the last three historical years.

$$Emissions_p = \sum_p C_p * EF_{p,y} \ (3)$$

Where:

C_p: Inputs of electricity, CHP and heat plants from aggregated fossil product *p* (from Table 1)
$EF_{p,y}$: Average power generation emissions factor for product *p* (applied in equation (3) for projection years)

$$EF_{p,y} = \frac{1}{3}\sum_p \left[\left(\frac{Emissions_{p,y-1}}{C_{p,y-1}}\right) + \left(\frac{Emissions_{p,y-2}}{C_{p,y-2}}\right) + \left(\frac{Emissions_{p,y-3}}{C_{p,y-3}}\right)\right]$$

Where:

p: Aggregate products: *"Oil and oil products", "Coal & peat"* and *"Total waste, non-renewable portion".* Note that the *"Coal & peat"* aggregate combines the emissions and electricity/heat inputs of coal and peat and their products. Furthermore, the "*Natural gas*" product refers to one single standard emissions factor in the *2006 IPCC Guidelines* and is not calculated using the above equation
$Emissions_{p,y-1/y-2/y-3}$: Power generation GHG (or CO_2 only) demand-based emissions estimate of the aggregated fuel *p* from the last three historical years.
$C_{p,y-1/y-2/y-3}$: Inputs of electricity, CHP and heat plants from aggregated fossil product *p* from the last three historical years

- **Intensity of electricity and heat generation (grams/kWh)**

This indicator is derived from the fuel combustion emissions associated with electricity and heat generation, as well as the electricity and heat output from the plants.

For **historical** years, the intensity is calculated as:

$$Intensity_{Electricity\ \&\ heat} = \frac{\sum_p electricity\ and\ heat\ emissions_p}{Output_{Electricity\ \&\ heat}}$$

Where:

$Electricity\ and\ heat\ emissions_p$: Demand-based estimates from the IEA global database of greenhouse gas emissions from energy for aggregated product *p*
$Output_{Electricity\ \&\ heat}$: Total output of electricity and heat plants from all sources

For **projection** years:

$$Intensity_{Electricity\ \&\ heat} = \frac{\sum_p (Input_{electricity,CHP\ \&\ heat\ plants,p} \times EF_p)}{Output_{Electricity\ \&\ heat}} \quad (4)$$

Where:

$Input_{\ electricity,CHP\ \&\ heat\ plants,p}$: Input of aggregated product p into electricity, CHP & heat plants
$Output_{Electricity\ \&\ heat}$: Total output of electricity and heat plants from all sources
$EF_{p,y}$: Average emissions factor for product *p* (applied in equation (4) for projection years)

$$EF_{p,y} = \frac{1}{3}\sum_i \left[\left(\frac{Emissions_{p,y-1}}{C_{p,y-1}}\right) + \left(\frac{Emissions_{p,y-2}}{C_{p,y-2}}\right) + \left(\frac{Emissions_{p,y-3}}{C_{p,y-3}}\right)\right]$$

Where:

p: Aggregate products: *"Oil and oil products", "Coal & peat"* and *"Total waste, non-renewable portion".* Note that the *"Coal & peat"* aggregate combines the emissions and electricity/heat inputs of coal and peat and their products. Furthermore, the "*Natural gas*" product refers to one single standard emissions factor in the *2006 IPCC Guidelines* and is not calculated using the above equation
$Emissions_{p,y-1/y-2/y-3}$: Electricity and heat generation GHG (or CO_2 only) demand-based emissions estimate of the aggregated fuel *p* from the last three historical years
$C_{p,y-1/y-2/y-3}$: Input of aggregated fuel *p* into electricity, CHP & heat plants from the last three historical years

- **Electricity and heat emissions, drivers indices and LMDI decomposition**

LMDI indicators are no longer reported for national projections. This section is for information only.

Similar to the indicators derived for total emissions from fuel combustion, the following Kaya identity can be used to decompose the evolution of the emissions related to electricity and heat generation into four main factors. 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 and heat generation efficiency ($1/EI$), the share of electricity from fossil fuels (FS) and total electricity and heat output (EH).

$$C\ =\ (CF)\ (EI)\ (FS)\ (EH)$$

Where:

$C = Emissions_{Electricity\ \&\ heat}$: Emissions from electricity and heat generation

$CF = \sum_p \frac{Input\ _{electricity,\ CHP\ \&\ heat\ plants,p} \times EF_p}{Input\ _{electricity,CHP\ \&\ heat\ plants,p}}$: Carbon intensity of the fossil fuel mix

$EI = \sum_p \frac{Input\ _{electricity,CHP\ \&\ heat\ plants,p}}{Output_{Electricity\ \&\ heat,p}}$: The reciprocal of fossil fuel based electricity and heat generation efficiency

$FS = \frac{Output_{Electricity\ \&\ heat,fossil}}{Output_{Electricity\ \&\ heat}}$: Share of electricity and heat from fossil fuel and non-renewable waste

$EH = Output_{Electricity\&Heat}$: Total electricity and heat output

Due to non-linear interactions between terms, if a simple decomposition is used, the sum of the percentage changes of the four factors may not perfectly match the percentage change of total CO_2 emissions. To avoid this, a more complex decomposition method is required. In this case, like with the Kaya identity expressed for total fuel combustion emissions, the logarithmic mean divisia (LMDI) method proposed by Ang (2004)[9] can be used. Using this method, the change in total CO_2 emissions from electricity and heat generation (ΔC_{Total}) 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:

$$\Delta C_{Total} = \Delta C_{CF} + \Delta C_{EI} + \Delta C_{FS} + \Delta C_{EH}$$

The effect of the variation of each coefficient on the total emissions is then calculated by applying the LMDI formula:

$$\Delta C = \sum_i w_{i,t} \ln\left(\frac{A_{i,t}}{A_{i,0}}\right)$$

$$\text{with } w_{i,t} = L(Emissions_{i,0}, Emissions_{i,t})$$

Where:

$A_{i,t}$: level of coefficient *i* at time *t*

$$L(X_1, X_2) = \frac{X_2 - X_1}{\ln\left(\frac{X_2}{X_1}\right)}) \; if X_1 \neq X_2 \; and \; L(X_1, X_1) = X_1$$

In this decomposition, each effect can therefore be calculated as

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

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

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

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

Where:

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

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

6. Appendix

Conversion factors

General conversion factors for energy

To	TJ	Gcal	Mtoe	MBtu	GWh
From:	multiply by:				
terajoule (TJ)	1	2.3885×10^{2}	2.3885×10^{-5}	9.478×10^{2}	2.778×10^{-1}
gigacalorie (Gcal)	4.1868×10^{-3}	1	1.000×10^{-7}	3.968	1.163×10^{-3}
million tonnes of oil equivalent (Mtoe)	4.1868×10^{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}

To	gal U.S.	gal U.K.	bbl	ft^3	l	m^3
litre (l)	$2.642x10^{-1}$	$2.200x10^{-1}$	$6.290x10^{-3}$	$3.531x10^{-2}$	1	$1.000x10^{-3}$
cubic metre (m^3)	$2.642x10^{2}$	$2.200x10^{2}$	6.290	$3.531x10^{1}$	$1.000x10^{3}$	1

Decimal prefixes

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

Abbreviations

Btu: British thermal unit

CCUS: carbon capture, utilisation and storage

GWh: gigawatt hour

kcal: kilocalorie

kg: kilogramme

kJ: kilojoule

Mt: million tonnes

m3: cubic metre

PJ: petajoule

t: metric ton

TWh: terawatt hour

TJ: terajoule

toe: tonne of oil equivalent

GCV: gross calorific value

GHGs: greenhouse gases

HHV: higher heating value = GCV

LHV: lower heating value = NCV

NCV: net calorific value

CHP: combined heat and power

PPP: purchasing power parity

TES: total energy supply

IEA: International Energy Agency

OECD: Organisation for Economic Co-operation and Development

SDG: Sustainable Development Goals

IEA Publications

International Energy Agency

Website: www.iea.org

Contact information: www.iea.org/about/contact

Typeset in France by IEA – January 2026

Cover design: IEA