CONCEPTS AND DEFINITIONS

INTRODUCTION

Concept of energy balances. The energy balance is an accounting framework for compilation and reconciliation of data on all energy products entering, exiting and used within a country or area during a reference period (in this publication, a year). Such a balance must necessarily express all forms of energy in a common accounting unit, and show the relationship between the inputs to and the outputs from the energy transformation processes. Energy balances should be as complete as possible so that all energy flows are, in principle, accounted for.

Balances can be compiled also for any particular energy product (energy commodity) and, in these cases, they are referred to as (energy) commodity balances. Apart from a few presentational differences such as showing secondary production together with primary production, commodity balances follow the general structure of energy balances (for more details, see IRES[3] Chapter 6).

Purpose of energy balances. The energy balance is a multipurpose tool to:

(a) Enhance the relevance of energy statistics by providing comprehensive and reconciled data on the energy situation on a national territory basis;

(b) Provide comprehensive information on the energy supply and demand on the national territory in order to understand the energy security situation, the effective functioning of energy markets and other relevant policy goals, as well as to formulate energy policies;

(c) Serve as a quality tool to ensure completeness, consistency and comparability of basic statistics;

(d) Ensure comparability between different reference periods and between different countries;

(e) Provide data for estimation of CO_2 emissions with respect to the national territory;

(f) Provide the basis for indicators of each energy product's role in the country's economy;

(g) Calculate efficiencies of transformation processes occurring in the country (e.g., refining, electricity production by combustion of fuels, etc.);

(h) Calculate the relative shares of the supply/consumption of various products (including renewables versus non-renewables) of the country's total supply/consumption;

(i) Provide an input for modeling and forecasting.

The multipurpose nature of the energy balance can also be increased by the development of supplementary tables which combine information from the balance with additional information on particular issues that are not explicitly reflected in the balance itself, for example combining total energy supply with population or national income data to obtain energy indicators.

Detailed and aggregated energy balances. Energy balances can be presented in both detailed and aggregated formats. The degree of detail depends on the policy concern, data and resource availability, and the underlying classifications used. In this publication, the aggregated (or simplified) format is used for countries of small size and/or for which the types of energy flows are few and far between, and as a result can be summarised without much information loss.

SCOPE AND GENERAL PRINCIPLES OF ENERGY BALANCE COMPILATION

The scope of an energy balance. The scope of an energy balance is determined, inter alia, by the territory, product and flow boundaries (see IRES for details on these boundaries):

(a) Territory boundary – defined by the boundary of the national territory of the compiling country or the equivalent concept for other areas that do not constitute a country;

(b) Product boundary – defined by the scope of all energy products shown in the balance columns (see pages xiii-xxi for details);

(c) Flow boundary – defined by the scope of energy flows shown in the balance rows (see pages ix-xiii for details).

[3] Available at unstats.un.org/unsd/energystats/methodology/ires/

CONCEPTS AND DEFINITIONS

The scope of an energy balance does not include:

(a) Passive energy such as the heat gain of buildings and solar energy falling on the land to grow crops, etc;

(b) Deposits of energy resources and reserves (which can be nevertheless considered in additional tables);

(c) Extraction of any materials not covered in primary energy production

(d) Peat, waste and biomass used for non-energy purposes.

When compiling an energy balance, some **general principles on the coverage and structure of the balance** should be taken into account. These principles are as follows:

(a) The energy balance is compiled with respect to a clearly defined reference period (this publication displays annual balances considering calendar years, unless otherwise specified).

(b) The energy balance is a matrix represented by rows and columns;

(c) Columns represent groups of energy products that are available for use in the national territory or equivalent area;

(d) The column "Total" contains cells which provide the sum of the data entries in the corresponding row; however, the meaning of the cells in the "Total" column is not the same for all rows of the balance (see below);

(e) Rows represent energy flows;

(f) A separate row is reserved for statistical difference, calculated as the numerical difference between the total supply of a fuel, electricity or heat and the total use of it;

(g) Rows and columns should contain homogeneous information (refer to the same products and flows as defined in their headers);

(h) The detailed energy balance should contain sufficient rows and columns to show clearly the relationship between the inputs to and outputs from transformation processes (production of secondary energy products);

(i) All entries should be expressed in one energy unit (here, Terajoules are used); the conversion between energy units should be through the application of appropriate conversion factors (see pages xxiii-xxxiv);

(j) Net calorific values should be used for measuring the energy content of energy products;

(k) Production of primary and secondary energy as well as external trade in energy products, stock changes, final energy consumption and non-energy use should be clearly separated to better reflect the structure and relationships between energy flows and to avoid double-counting.

(l) To give a primary energy equivalent to electricity produced from non-combustible energy sources the "physical energy content" method should be used. According to this method the normal physical energy value of the primary energy form is used for the production figure. This is in contrast to the "partial substitution method" which requires assigning to such electricity a primary energy value equal to the hypothetical amount of fuel required to generate an identical amount of electricity in a thermal power station using combustible fuels.

In the "physical energy content" method, the normal physical energy value of the primary energy form is used for the production figure. For primary electricity, this is simply the gross generation figure for the source. Care is needed when expressing the percentage contributions from the various sources of national electricity production. As there is no transformation process recognized within the balances for the production of primary electricity, the respective percentage contributions from thermal and primary electricity cannot be calculated using a "fuel input" basis. Instead, the various contributions should be calculated from the amounts of electricity generated from the power stations classified by energy source (coal, nuclear, hydro, etc.).

Which energy product is primary and which is secondary is determined by the principle of multiple uses: the primary energy form should be the first energy form downstream in the production process for which multiple energy uses are practical. For example, in the case of nuclear energy, the choice is between the

energy content of the nuclear fuel, the heat generated in the reactors and the electricity produced. Nuclear fuels are outside the scope of energy balances, as they do not fit the multiple energy uses criterion. On the other hand, nuclear electricity is not primary because the nuclear heat from the atomic fission that moves the turbines can also be used as heat. As a result of this principle, nuclear heat is chosen as the primary form.

For electricity and heat, the application of this principle leads to the choice of the following primary energy forms:

- Heat for nuclear, geothermal and solar thermal;
- Electricity for hydro, wind, tide, wave and other marine, and solar photovoltaic.

In the case of electricity generation from primary heat (nuclear, geothermal and solar thermal), it can be difficult to obtain measurements of the heat flow to the turbines. As a result, an estimate of the heat input is often used based on an efficiency of 33% for nuclear and solar thermal, and 10% for geothermal. This means that, in the absence of measurements of heat input, the equivalent primary nuclear heat and solar thermal heat is estimated as 3 times the nuclear electricity and solar thermal electricity produced, respectively, and the equivalent geothermal heat is estimated as 10 times the geothermal electricity output.

Where there is direct use of geothermal heat, the primary energy is equivalent to the use; whereas heat coming from geothermal heat plants is considered the output of a conversion process with a 50% efficiency in relation to its geothermal heat input. This means that in the latter case the primary energy is equivalent to twice the heat produced. This stems from the generally low quality of the heat from geothermal sources.

DESCRIPTION OF THE ROWS OF THE ENERGY BALANCE

Top block – Energy supply

The top block of an energy balance – *Energy supply* – is intended to show flows representing energy entering the national territory for the first time, energy removed from the national territory and stock changes. The entering flows consist of production of primary energy products and imports of both primary and secondary energy products. The flows removing energy from the national territory are exports of primary and secondary energy products and international bunkers.

The balance item of the flows described above and the changes in stock represents the amount of energy which is available on the national territory during the reference period. This aggregate is named **Total energy supply**.

Primary production (row 1) refers to production of primary energy, which in turn is defined as the capture or extraction of fuels or energy from natural energy flows, the biosphere and natural reserves of fossil fuels within the national territory in a form suitable for use. Inert matter removed from the extracted fuels and quantities reinjected, flared or vented are not included. The resulting products are referred to as "primary" products.

Secondary production, that is, the manufacture of energy products through the process of transformation of primary fuels or energy, is not displayed under this item, but in Transformation.

Some conventions are used to account for primary production of electricity and heat consistently with IRES, and are described in the previous section.

Production of **Biomass** and **wastes**, as well as **Peat**, includes only that portion used for energy purposes.

Imports (row 2) of energy products comprise all fuel and other energy products entering the national territory. Goods simply being transported through a country (goods in transit) and goods temporarily admitted are excluded but re-imports, which are domestic goods exported but subsequently readmitted, are included. The bunkering of fuel outside the reference territory by national merchant ships and civil aircraft engaged in international travel is excluded from imports.

Exports (row 3) of energy products comprise all fuel and other energy products leaving the national territory with the exception that exports exclude quantities of fuels delivered for use by merchant (including passenger) ships and civil aircraft, of all nationalities, during international transport of goods and passengers. Goods simply being transported through a country (goods in transit) and goods temporarily withdrawn are excluded but re-exports, foreign goods

exported in the same state as previously imported, are included.

For electricity, trade data include "goods in transit", i.e. electricity transmitted through the country from one neighbour to another, as there is no practical way of discerning which quantities are re-exported and which are consumed by the transit country.

In the energy balance format, imports are positive numbers, while exports are negative numbers and carry a negative sign (-).

International marine bunkers (row 4) are quantities of fuels delivered to merchant (including passenger) ships, of any nationality, for consumption during international voyages transporting goods or passengers. International voyages take place when the ports of departure and arrival are in different national territories. Fuels delivered for consumption by ships during domestic transportation, fishing or military uses are not included here. For the purposes of energy statistics International Marine Bunkers are not included in exports. In the energy balance format, International Marine Bunkers are negative numbers and carry a negative sign (-).

International aviation bunkers (row 5) are quantities of fuels delivered to civil aircraft, of any nationality, for consumption during international flights transporting goods or passengers. International flights take place when the ports of departure and arrival are in different national territories. Fuels delivered for consumption by aircraft undertaking domestic or military flights are not included here. For the purposes of energy statistics International Aviation Bunkers are not included in exports. In the energy balance format, International Aviation Bunkers are negative numbers and carry a negative sign (-).

Stocks – For the purposes of energy statistics, stocks are quantities of energy products that are held on the national territory and can be used to: (a) maintain service under conditions where supply and demand are variable in their timing or amount due to normal market fluctuations, or (b) supplement supply in the case of a supply disruption. Stocks used to manage a supply disruption may be called "strategic" or "emergency" stocks and are often held separately from stocks designed to meet normal market fluctuations. **Stock changes** (row 6) are defined as the increase (stock build) or decrease (stock draw) in the quantity of stock over the reporting period and are thus calculated as the difference between the closing and opening stocks.

A positive number indicates a reduction in stocks and thus an increase in available energy; the negative sign (-) indicates a net increase in stocks and thus a decrease in energy available for consumption.

Total energy supply (row 7) reflects, for each group of products, the supply of energy embodied in the energy products included in that particular group. The total supply of energy on the national territory is shown under the column "Total".

It is computed as: Total energy supply = primary production (row 1) + imports (row 2) + exports (row 3) + international marine bunkers (row 4) + international aviation bunkers (row 5) + stock changes (row 6).[4]

Statistical difference (row 8) in the energy balance is the numerical difference between the total supply of the group of energy products described by the respective column and the total use of it. It is calculated by subtracting latter from the former, as follows: Statistical difference = total energy supply (row 6) + transfers (row 9) + transformation (row 10) + energy industries own use + losses – final consumption.

The statistical difference is a discrepancy that arises from various practical limitations and problems related to the collection of the data which make up supply and demand. The data may be subject to sampling or other collection errors, and/or be taken from different data sources which use different time periods, different spatial coverage, different fuel specifications or different conversions from volume to mass or from mass to energy content in the supply and demand sides of the balance.

The middle block

The main purpose of the middle block of an energy balance is to show transfers, energy transformation, energy industries own use and losses.

Transfers (row 9) are essentially statistical devices to overcome practical classification and presentation issues resulting from changes in use or identity of a product. Transfers comprise products

[4] Because of the sign convention in energy balances, where quantities that contribute to the supply receive positive signs while those that are removed receive negative signs, these parts can be straightly added up.

transferred and interproduct transfers. Products transferred refer to the reclassification (renaming) of products which is necessary when finished oil products are used as feedstock in refineries. Interproduct transfers refer to the movements of fuels between product categories because of reclassification of a product which no longer meets its original specification. The transferred product (negative sign) is often blended with its host (positive sign). Where a product belonging to a column group is transferred out (negative sign) and another belonging to the same column group receives transfers in (positive sign), the resulting net transfers are displayed.

Transformation (row 10) describes the processes that convert an energy product into another energy product which, in general, is more suitable for specific uses. It occurs when part or all of the energy content of a product entering a process moves from this product to one or more different products leaving the process (e.g., coking coal to coke, crude oil to oil products, and fuel oil to electricity).

Energy entering transformation processes are shown with a negative sign to represent the input and energy which is an output of transformation activities is shown as a positive number. The sum of cells in each row appearing in the column "Total" should therefore be negative as transformation always results in a certain loss of energy when expressed in energy units. Depending on the level of aggregation, there are instances when only a residual negative number is displayed, for example in the total coal column (of the simplified format) where both a negative coking coal input and a positive coke oven coke output are collated.

Transformation is broken down into 11 types of processes in the detailed energy balance format, whereas the simplified energy balance format displays a breakdown of just three types. These processes are described as follows:

• **Electricity plants** refer to plants producing only electricity. The electricity may be obtained directly from natural sources such as hydro, geothermal, wind, tidal, marine, solar energy or from fuel cells, or from the heat obtained from the combustion of fuels or nuclear reactions. For the simplified balance format, Electricity plants include CHP and Heat plants.

• **CHP plants** (Combined Heat and Power) refer to plants which produce both heat and electricity from at least one generating unit in the plant. They are sometimes referred to as "co-generation" plants.

• **Heat plants** refer to plants (including heat pumps and electric boilers) designed to produce heat only, for deliveries to third parties. Deliveries of fuels for heat generated by an autoproducer (which are enterprises whose principal activity is NOT heat production) for its own purposes are classified within the part of final consumption where they are consumed, and not as part of transformation.

• **Coke ovens** are large ovens within which coke oven coke, coke oven gas and coal tars are produced by high temperature carbonisation of coking coal.

• **Briquetting plants** comprise Patent fuel plants, Brown coal briquette plants and Peat briquette plants. **Patent fuel plants** are plants manufacturing patent fuels. **Brown coal briquette plants** are plants manufacturing brown coal briquettes (BKB). **Peat briquette plants** are plants manufacturing peat briquettes (included here are plants producing all kinds of peat products from primary peat).

• **Liquefaction plants** comprise Coal liquefaction plants and Gas to liquid (GTL) plants. **Coal liquefaction plants** are plants where coal is used as a feedstock to produce liquid fuels by hydrogenation or carbonisation. They are also known as coal-to-liquid (CTL) plants. **Gas-to-liquid (GTL) plants** are plants in which natural gas is used as a feedstock for the production of liquid fuels. The liquid fuels are usually used as vehicle fuels. Note that the gas-to-liquid plants are quite different from LNG plants which convert gaseous natural gas into liquid natural gas.

• **Gas works** (and other conversion to gases) are plants manufacturing gases for distribution to the public either directly or after blending with natural gas. Note that the gases are collectively referred to as "Gas Works Gas and other manufactured gases for distribution'; short name - gas works gas. Some gas works may produce coke as well as gas.

• **Blast furnaces** are furnaces which produce blast furnace gas as a by-product when making pig iron from iron ore. During the process, carbon, mainly in the form of coke, is added to the blast furnace to support and reduce the iron oxide charge and provide heat.

• **NGL plants and gas blending** comprise Natural gas liquids (NGL) separation plants and Natural

gas blending plants. **Natural gas liquids (NGL) separation plants** are plants involved in the separation of water, impurities and natural gas liquids from natural gas. In addition, the activities of these plants may also involve fractionation of the recovered natural gas liquids. **Natural gas blending plants** are plants, separate from gas works, in which substitute natural gas (see gas works gas), petroleum gases or biogases are mixed with natural gas for distribution in the gas mains. Where blending of substitute natural gas with natural gas takes place within gas works the blending is considered part of the gas works process.

• **Oil refineries** are plants which transform crude oil and other hydrocarbons (together with additives, feedstocks and natural gas liquids) into finished oil products. Typical finished products are liquefied petroleum gases, naphtha, motor gasoline, gas oils, aviation fuels and other kerosene, and fuel oils.

• **Charcoal plants** are plants in which wood or other vegetal matter is carbonised through slow pyrolysis to produce charcoal. Charcoal plants are shown separately in the simplified balance format, but they are grouped with "Other transformation" in the detailed balance.

• **Other transformation**: In the detailed balance format, it comprises Charcoal plants, Petrochemical plants and Other transformation processes not elsewhere classified. In the simplified balance format, it comprises all transformation processes other than: Electricity plants, CHP plants, Heat plants and Charcoal plants. **Petrochemical plants** are plants which convert hydrocarbon feedstock into organic chemicals, intermediate compounds and finished products such as plastics, fibres, solvents and surfactants.

Energy industries own use refers to consumption of fuels and energy for the direct support of the production, and preparation for use of fuels and energy. Quantities of fuels which are transformed into other fuels or energy are not included here but within transformation. Neither are quantities which are used for transportation purposes in the energy industry. These quantities are reported within final consumption, more specifically in Transport. The negative sign is used for entries under this item.

Losses refer to losses during the transmission, distribution and transport of fuels, heat and electricity. Losses also include venting and flaring of manufactured gases, losses of geothermal heat after production and pilferage of fuels or electricity. Production of secondary gases includes quantities subsequently vented or flared. This ensures that a balance can be constructed between the use of the primary fuels from which the gases are derived and the production of the gases. The losses carry a negative sign.

The bottom block - Final consumption

The bottom block of an energy balance - *final consumption* - covers *final energy consumption*, as well as *non-energy use* of energy products. It excludes deliveries of fuel and other energy products for use in transformation processes (covered in the middle block) and the use of energy products for energy needs of the energy industries (also covered in the middle block).

Energy consumers are grouped into three main categories: (i) Manufacturing, construction and non-fuel mining industries, (ii) Transport and (iii) Other, and further disaggregated as applicable.

Final consumption refers to all fuel and energy that is delivered to users for both their energy and non-energy uses which do not involve a transformation process.

Final energy consumption refers to the consumption of primary and secondary energy by Manufacturing, construction and non-fuel mining, by Transport, and by Others (agriculture, forestry and fishing, commerce and public services, households, and other consumers).

Manufacturing, construction and mining refers to final energy consumption by manufacturing, construction and non-fuel mining industries. The final consumption recorded under this category covers the use of energy products for energy purposes by economic units belonging to the industry groups listed below (excluding the use of energy products for transport, which is recorded under Transport in its respective row).

- Iron and steel
- Chemical and petrochemical
- Non-ferrous metals
- Non-metallic minerals
- Transport equipment
- Machinery
- Mining and quarrying
- Food and tobacco
- Paper, pulp and print
- Wood and wood products (other than pulp and paper)

- Textile and leather
- Construction
- Industries, not elsewhere specified

The breakdown into these groups is available only for the detailed energy balance format.

Transport refers to the consumption of energy products by any economic entity to transport goods or persons between points of departure and destination within the national territory. Quantities of fuels delivered to merchant (including passenger) ships and civil aircraft, of any nationality, for consumption during international voyages transporting goods or passengers are not included here, but in international bunkers.

The category "transport" is subdivided into the following modes of transport:

- Road
- Rail
- Domestic aviation
- Domestic navigation
- Pipeline transport
- Transport not elsewhere specified

In the simplified energy balance format, Rail and Pipeline transport are grouped with Transport not elsewhere specified into the category "Other transport".

Energy used at compressor and/or pumping stations in pipeline transport (fuels and electricity) within the national territory or equivalent area is included in transport. However, it is recognized that some countries or areas with a large production of oil and gas find it difficult to split between energy for pipeline transport and other fuels consumed in the oil and gas extraction industries.

Other: This group consists of energy consumers not classified in Manufacturing, construction and non-fuel mining industries, and is subdivided into the following subgroups:

- Agriculture, Forestry, Fishing
- Commerce and public services
- Households
- Not elsewhere specified

Fuels used in tractors for the purpose of farming, transport by military vehicles and fishing are not considered, by convention, as fuels for transport purposes and are included here. Fuels and other energy products' consumption in fishing covers all fishing vessels, including those engaged in deep-sea fishing.

Non-Energy Use consists of the use of energy products as raw materials for the manufacture of products outside the scope of SIEC, as well as for direct uses that do not involve using the products as a source of energy, nor as a transformation input. Examples are lubrication, sealing, preservation, road surfacing, and use as a solvent.

DESCRIPTION OF THE COLUMNS OF THE ENERGY BALANCE

The description of the energy balance columns is done in two parts: first, for both energy balance formats the products grouped under each column are listed; then, the products themselves are defined.

Detailed energy balance format

Column 1 (Primary coal and peat) includes Hard coal, Brown coal, Peat and Oil shale.

Column 2 (Coal and peat products) includes Coal coke, Patent fuel, Brown coal briquettes (BKB), Coal tar, Coke oven gas, Gas works gas, Recovered gases, Other coal products and Peat products.

Column 3 (Primary oil) includes Conventional crude oil, Natural gas liquids (NGL), Additives and oxygenates, and Other hydrocarbons.

Column 4 (Oil products) includes Feedstocks, Refinery gas, Ethane, Liquefied petroleum gases (LPG), Naphtha, Aviation gasoline, Motor gasoline, Gasoline-type jet fuel, Kerosene-type jet fuel, Other kerosene, Gas oil/diesel oil, Fuel oil, White spirit and SBP industrial spirits, Lubricants, Paraffin waxes, Petroleum coke, Bitumen, and Other oil products n.e.c..

Column 5 (Natural gas) includes Natural gas. Other gases (e.g., Biogas, LPG or Manufactured gas) are included only when blended with Natural gas, their quantities appearing as outputs of the respective transformation process (or in the transfers row in some cases).

Column 6 (Biofuels and waste) includes Fuelwood, wood residues and by-products, Bagasse, Animal waste, Black liquor, Other vegetal material and residues, Charcoal, Biogasoline, Biodiesels, Bio jet kerosene, Other liquid biofuels, Biogases, Industrial waste, and Municipal waste.

Column 7 (Nuclear) includes Heat from nuclear sources as well as the primary heat equivalent of electricity production from nuclear sources.

Column 8 (Electricity) includes Electricity.

Column 9 (Heat) includes Heat produced for sale and the primary heat equivalent of electricity production from geothermal and solar thermal sources. It also includes direct use of solar thermal heat and geothermal heat.

For columns 7, 8 and 9, see pages viii and ix for the choice of the primary energy for each source and respective notional efficiencies used to back calculate this primary energy from electricity and heat generation. In the case of electricity sources whose primary energy equivalent is displayed under heat and nuclear, the electricity production is secondary and as such shown under transformation (electricity plants or CHP plants). The equivalent primary energy is shown as a transformation input (negative sign) on the same row under the appropriate column.

Nuclear is displayed separately from electricity and heat to distinguish it from the renewable primary energy production from other sources.

Column 10 (Total energy) aggregates columns 1 to 9, summarising, among other flows, Primary energy production, Energy imports and exports, Total energy supply, Transformation losses, and Final consumption.

Column 11 (of which: renewables) distinguishes the part of Total energy that comes from renewable sources as recommended in IRES. From Column 6, it includes Fuelwood, wood residues and by-products, Bagasse, Animal waste, Black liquor, Other vegetal material and residues, Charcoal, Biogasoline, Biodiesels, Bio jet kerosene, Other liquid biofuels, Biogases, and 50% of Municipal waste[5]. It does not include Industrial waste and 50% of Municipal waste. From Column 8, it includes all primary production of Electricity, as well the secondary production when coming from solar thermal and geothermal sources (secondary production is shown in Transformation, according to energy balance conventions). From Column 9, it includes all primary production of Heat, including primary Heat calculated from geothermal and solar thermal electricity production based on notional efficiencies[6], as well as the direct use of geothermal and solar thermal heat.

Apart from Primary production, figures from Column 11 should be taken with caution. For electricity and heat, by the nature of these energy products, the percentage of renewable imports and exports can rarely be determined. The same happens with consumption/use when the production of electricity and heat from renewable sources is mixed with that from non-renewable sources (for example, if hydroelectricity and electricity from the combustion of coal are distributed through the same network). Because of these practical limitations, no attempt is made at determining the renewable share for these cases. As a result, no part of imports and exports of heat or electricity, nor their consumption, losses or own use, is considered as renewable in Column 11. The exception is Direct use of geothermal heat and solar thermal heat, for which data are available primarily on the consumption side and thus can be distinguished as renewable.

Simplified energy balance format

Column 1 (All coal) is an aggregation of columns 1 and 2 of the detailed format, including Hard coal, Brown coal, Peat, Oil shale, Coal coke, Patent fuel, Brown coal briquettes (BKB), Coal tar, Coke oven gas, Gas works gas, Recovered gases, Other coal products and Peat products.

Column 2 (All oil) is an aggregation of columns 3 and 4 of the detailed format, including Conventional crude oil, Natural gas liquids (NGL), Additives and oxygenates, Other hydrocarbons, Feedstocks, Refinery gas, Ethane, Liquefied petroleum gases (LPG), Naphtha, Aviation gasoline, Motor gasoline, Gasoline-type jet fuel, Kerosene-type jet fuel, Other kerosene, Gas oil/diesel oil, Fuel oil, White spirit and SBP industrial spirits, Lubricants, Paraffin waxes, Petroleum coke, Bitumen, and Other oil products n.e.c..

Column 3 (Natural gas) includes Natural gas. Other gases (e.g., Biogas, LPG or Manufactured gas) are included only when blended with Natural gas, their quantities appearing as outputs of the respective transformation process (or in the transfers row in some cases).

[5] In the absence of details on what percentage of Municipal waste comes from biomass and what percentage does not (which is the criterion to distinguish between renewable and non-renewable Municipal waste defined in IRES), a 50-50 split is used.

[6] This calculated primary Heat input to electricity production from geothermal and solar thermal sources appears with a positive sign in Primary production and with a negative sign in Transformation, so as to depict its conversion into electricity.

Column 4 (Primary biofuels / Waste) includes Fuelwood, wood residues and by-products, Bagasse, Animal waste, Black liquor, Other vegetal material and residues, Biogasoline, Biodiesels, Bio jet kerosene, Other liquid biofuels, Biogases, Industrial waste, and Municipal waste. It is similar to column 6 of the detailed format, the difference being that it does not include Charcoal (which is a secondary biofuel).

Column 5 (Charcoal) includes Charcoal.

Column 6 (Electricity) is an aggregation of columns 7, 8 and 9 of the detailed balance format, including Heat and Electricity, including from nuclear sources (see the explanation of those columns for reference). The countries and areas chosen to have their balances displayed in the simplified format in general do not have significant heat or nuclear production.

Column 7 (Total energy) aggregates columns 1 to 6, summarising, among other flows, Primary energy production, Energy imports and exports, Total energy supply, Transformation losses, and Final consumption. It includes the same products as column 10 of the detailed format.

Column 8 (of which: renewables) makes an attempt at distinguishing the part of Total energy that comes from renewable sources of energy, as recommended in IRES. It includes the same products as column 11 of the detailed format, as well as the same flows (but in less detail).

Product definitions

Hard coal – coals with a gross calorific value (moist, ash-free basis) which is not less than 24 MJ/kg or which is less than 24 MJ/kg provided that the coal has a vitrinite mean random reflectance greater than or equal to 0.6 per cent. Hard coal comprises anthracite and bituminous coals.

Brown coal – coals with a gross calorific value (moist, ash-free basis) less than 24 MJ/ kg and a vitrinite mean random reflectance less than 0.6 per cent. Brown coal comprises sub-bituminous coal and lignite.

Peat – a solid fuel formed from the partial decomposition of dead vegetation under conditions of high humidity and limited air access (initial stage of coalification). It is available in two forms for use as a fuel, sod peat and milled peat. Only peat used as fuel is included.

Oil shale – A sedimentary rock which contains organic matter in the form of kerogen. Kerogen is a waxy hydrocarbon-rich material regarded as a precursor of petroleum. Oil shale may be burned directly or processed by heating to extract shale oil.

Coal coke – This group includes the solid, cellular, infusible material remaining after the carbonisation of certain coals. Various cokes are defined according to the type of coal carbonised and their conditions of carbonisation or use: coke oven coke, gas coke, coke breeze and semi cokes.

Patent fuel – A composition fuel made by moulding hard coal fines into briquette shapes with the addition of a binding agent such as pitch.

Brown coal briquettes (**BKB**) – A composition fuel made of brown coal produced by briquetting under high pressure with or without the addition of a binding agent. Either sub-bituminous coal or lignite may be used, including dried lignite fines and dust.

Coal tar – The liquid by-product of the carbonization of coal in coke ovens. Coal tar may be separated by distillation into several liquid products which may be used for pharmaceutical or wood preservative purposes.

Other coal products – coal products not elsewhere specified (if any).

Coke oven gas – A gas produced from coke ovens during the manufacture of coke oven coke.

Gas works gas (and other manufactured gases for distribution) – This includes gases obtained from the carbonisation or gasification of carbonaceous material of fossil or biomass origins in Gas Works. The gases comprise: (a) gases obtained from carbonisation or gasification of coals, cokes, biomass or waste; and (b) substitute natural gas (a methane-rich gas) made from synthesis gas[7].

Recovered gases – Combustible gases of solid carbonaceous origin recovered from manufacturing and chemical processes of which the principal purpose

[7] Synthesis gas is a mixture of mainly hydrogen and carbon monoxide obtained by cracking hydrocarbons with high temperature steam.

is other than the production of fuel. This includes gases containing carbon monoxide resulting from the partial oxidation of (a) carbon present as coke acting as a reductant in the process, (b) carbon anodes, or (c) carbon dissolved in iron. Examples are: Blast furnace gas (the by-product gas of blast furnace operation consisting mainly of nitrogen, carbon dioxide and carbon monoxide); Basic oxygen steel furnace gas (the by-product gas of the production of steel in a basic oxygen furnace); and Other recovered gases (combustible gases of solid carbonaceous origin recovered from manufacturing and chemical processes not elsewhere defined, such as from the production of zinc, tin, lead, ferroalloys, phosphorus and silicon carbide).

Other coal products – coal products not elsewhere classified

Peat products – This includes products such as peat briquettes derived directly or indirectly from sod peat and milled peat.

Conventional crude oil – A mineral oil of fossil origin extracted by conventional means from underground reservoirs, and comprises liquid or near-liquid hydrocarbons and associated impurities such as sulphur and metals. Conventional crude oil exists in the liquid phase under normal surface temperature and pressure, and usually flows to the surface under the pressure of the reservoir. This is termed "conventional" extraction. Crude oil includes condensate from condensate fields, and "field" or "lease" condensate extracted with the crude oil.

The various crude oils may be classified according to their sulphur content ("sweet" or "sour") and API gravity ("heavy" or "light"). There are no rigorous specifications for the classifications but a heavy crude oil may be assumed to have an API gravity of less than 20º and a sweet crude oil may be assumed to have less than 0.5% sulphur content.

Natural gas liquids (**NGL**) – Natural gas liquids are a mixture of ethane, propane, butane (normal and iso), (iso) pentane and a few higher alkanes collectively referred to as pentanes plus.

NGL are produced in association with oil or natural gas. They are removed in field facilities or gas separation plants before sale of the gas. All of the components of NGL except ethane are either liquid at the surface or are liquefied for disposal.

The definition given above is the most commonly used. However, there is some use of terms based on the vapour pressure of the components which are liquid at the surface or can be easily liquefied. The three resulting groups are in order of increasing vapour pressure: condensates, natural gasoline and liquefied petroleum gas.

NGL may be distilled with crude oil in refineries, blended with refined oil products or used directly. NGL differs from LNG (liquefied natural gas) which is obtained by liquefying natural gas from which the NGL has been removed.

Additives and oxygenates – Compounds added to or blended with oil products to modify their properties (octane, cetane, cold properties, etc.). Examples are: (a) oxygenates such as alcohols (methanol, ethanol) and ethers [MTBE (methyl tertiary butyl ether), ETBE (ethyl tertiary butyl ether), TAME (tertiary amyl methyl ether)]; (b) esters (e.g., rapeseed or dimethylester, etc.); and (c) chemical compounds (such as TML, TEL and detergents). Some additives/oxygenates may be derived from biomass while others may be of fossil hydrocarbon origin.

Other hydrocarbons – This includes non-conventional oils and hydrogen. Non-conventional oils refer to oils obtained by non-conventional production techniques, that is oils which are extracted from reservoirs containing extra heavy oils or oil sands which need heating or treatment (e.g., emulsification) in situ before they can be brought to the surface for refining/processing. They also include the oils extracted from oil sands, extra heavy oils, coal and oil shale which are at, or can be brought to, the surface without treatment and require processing after mining (ex situ processing). Non-conventional oils may also be produced from natural gas.

The oils may be divided into two groups: (i) oils for transformation (e.g., synthetic crudes extracted from extra heavy oils, oil sands, coal and oil shale); and (ii) oils for direct use (e.g., emulsified oils such as orimulsion and GTL liquids). Oil sands are also known as tar sands. Extra heavy oils are also known as bitumen. This is not the oil product of the same name which is made from vacuum distillation residue. Although not a hydrocarbon, hydrogen is included here unless it is a component of another gas.

Oil products – Products obtained from crude oil, non-conventional oils or gases from oil and gas fields.

They may be produced through the refining of conventional crude and non-conventional oils or during the separation of natural gas from gases extracted from oil or gas fields. This category includes Feedstocks, Refinery gas, Ethane, Liquefied petroleum gases (LPG), Naphtha, Aviation gasoline, Motor gasoline, Gasoline-type jet fuel, Kerosene-type jet fuel, Other kerosene, Gas oil/diesel oil, Fuel oil, White spirit and SBP industrial spirits, Lubricants, Paraffin waxes, Petroleum coke, Bitumen, and Other oil products n.e.c.

Feedstocks – This includes refinery feedstocks, i.e. oils or gases from crude oil refining or the processing of hydrocarbons in the petrochemical industry which are destined for further processing in the refinery excluding blending. Typical feedstocks include naphthas, middle distillates, pyrolysis gasoline and heavy oils from vacuum distillation and petrochemical plants.

Refinery gas – Includes a mixture of non-condensable gases mainly consisting of hydrogen, methane, ethane and olefins obtained during distillation of crude oil or treatment of oil products (e.g., cracking) in refineries or from nearby petrochemical plants. It is used mainly as a fuel within the refinery.

Ethane – A naturally straight-chain hydrocarbon (C_2H_6). Ethane is obtained at gas separation plants or from the refining of crude oil. It is a valuable feedstock for petrochemical manufacture.

Liquefied petroleum gases (LPG) – LPG refers to liquefied propane (C_3H_8) and butane (C_4H_{10}) or mixtures of both. Commercial grades are usually mixtures of the gases with small amounts of propylene, butylene, isobutene and isobutylene stored under pressure in containers.

The mixture of propane and butane used varies according to purpose and season of the year. The gases may be extracted from natural gas at gas separation plants or at plants re-gasifying imported liquefied natural gas. They are also obtained during the refining of crude oil. LPG may be used for heating and as a vehicle fuel.

See also the definition for natural gas liquids. Certain oil field practices also use the term LPG to describe the high vapour pressure components of natural gas liquids.

Naphtha – Light or medium oils distilling between 30ºC and 210ºC which do not meet the specification for motor gasoline. Different naphthas are distinguished by their density and the content of paraffins, isoparaffins, olefins, naphthenes and aromatics. The main uses for naphthas are as feedstock for high octane gasolines and the manufacture of olefins in the petrochemical industry.

Aviation gasoline – Gasoline prepared especially for aviation piston engines with additives which assure performance under flight conditions. Aviation gasolines are predominantly alkylates (obtained by combining C_4 and C_5 isoparaffins with C_3, C_4 and C_5 olefins) with the possible addition of more aromatic components including toluene. The distillation range is 25ºC to 170ºC.

Motor gasoline – A mixture of some aromatics (e.g., benzene and toluene) and aliphatic hydrocarbons in the C_5 to C_{12} range. The distillation range is 25ºC to 220ºC.

Additives are blended to improve octane rating, improve combustion performance, reduce oxidation during storage, maintain cleanliness of the engine and improve capture of pollutants by catalytic converters in the exhaust system. Motor gasoline may also contain biogasoline products when blended.

Gasoline-type jet fuel – Light hydrocarbons for use in aviation turbine power units, distilling between 100ºC and 250ºC. They are obtained by blending kerosene and gasoline or naphtha in such a way that the aromatic content does not exceed 25 per cent in volume, and the vapour pressure is between 13.7 kPa and 20.6 kPa. Gasoline-type jet fuel is also known as “aviation turbine fuel”.

Kerosene – Mixtures of hydrocarbons in the range C_9 to C_{16} and distilling over the temperature interval 145ºC to 300°C, but not usually above 250ºC and with a flash point above 38ºC.

The chemical compositions of kerosenes depend on the nature of the crude oils from which they are derived and the refinery processes that they have undergone. Kerosenes obtained from crude oil by atmospheric distillation are known as straight-run kerosenes. Such streams may be treated by a variety of processes to produce kerosenes that are acceptable for blending as jet fuels. Kerosenes are primarily used as jet fuels. They are also used as domestic heating and cooking fuels, and as solvents. Kerosenes may include

components or additives derived from biomass when blended.

Kerosene-type jet fuel – A blend of kerosenes suited to flight conditions with particular specifications, such as freezing point.

The specifications are set down by a small number of national standards committees, most notably ASTM (U.S.), MOD (UK), GOST (Russia).

Other kerosene – Kerosene which is used for heating, cooking, lighting, solvents and internal combustion engines. Other names for this product are burning oil, vaporizing oil, power kerosene and illuminating oil.

Gas oil/diesel oil – Gas oils are middle distillates, predominantly of carbon number range C_{11} to C_{25} and with a distillation range of 160ºC to 420°C. The principal marketed products are fuels for diesel engines (diesel oil), heating oils and marine fuel. Gas oils are also used as middle distillate feedstock for the petrochemical industry and as solvents. Also included here is heavy gasoil, which is a mixture of predominantly gas oil and fuel oil which distills in the range of approximately 380ºC to 540ºC.

Fuel oil – Comprises residual fuel oil and heavy fuel oil. Residual fuel oils have a distillation range of 350ºC to 650ºC and a kinematic viscosity in the range 6 to 55 cSt at 100ºC. Their flash point is always above 60ºC and their specific gravity is above 0.95. Heavy fuel oil is a general term describing a blended product based on the residues from various refinery processes. Other names commonly used to describe fuel oil include: bunker fuel, bunker C, fuel oil No. 6, industrial fuel oil, marine fuel oil and black oil.

Residual and heavy fuel oil are used in medium to large industrial plants, marine applications and power stations in combustion equipment such as boilers, furnaces and diesel engines. Residual fuel oil is also used as fuel within the refinery.

White spirit and SBP industrial spirits – White spirit and special boiling point industrial spirits (SBP) are refined distillate intermediates with a distillation in the naphtha/kerosene range. They are mainly used for non-fuel purposes and sub-divided as: (a) white spirit - an industrial spirit with a flash point above 30ºC and a distillation range of 135ºC to 200ºC; and (b) industrial spirit (SBP) - light oils distilling between 30ºC and 200ºC.

There are 7 or 8 grades of industrial spirits, depending on the position of the cut in the distillation range. The grades are defined according to the temperature difference between the 5 per cent and 90 per cent volume distillation points (which is not more than 60ºC). White spirit and Industrial spirits are mostly used as thinners and solvents.

Lubricants – Oils, produced from crude oil, for which the principal use is to reduce friction between sliding surfaces and during metal cutting operations.

Lubricant base stocks are obtained from vacuum distillates which result from further distillation of the residue from atmospheric distillation of crude oil. The lubricant base stocks are then further processed to produce lubricants with the desired properties.

Paraffin waxes – Residues extracted when dewaxing lubricant oils. The waxes have a crystalline structure which varies in fineness according to the grade, and are colourless, odourless and translucent, with a melting point above 45ºC.

Petroleum coke – Petroleum coke is a black solid obtained mainly by cracking and carbonizing heavy hydrocarbon oils, tars and pitches. It consists mainly of carbon (90 to 95 per cent) and has a low ash content.

The two most important categories are "green coke" and "calcined coke".

Green coke (raw coke) is the primary solid carbonization product from high boiling hydrocarbon fractions obtained at temperatures below 630ºC. It contains 4-15 per cent by weight of matter that can be released as volatiles during subsequent heat treatment at temperatures up to approximately 1330ºC.

Calcined coke is a petroleum coke or coal-derived pitch coke obtained by heat treatment of green coke to about 1330ºC. It will normally have a hydrogen content of less than 0.1 per cent by weight.

In many catalytic operations (e.g., catalytic cracking) carbon or catalytic coke is deposited on the catalyst, thus deactivating it. The catalyst is reactivated by burning off the coke which is used as a fuel in the

refining process. The coke is not recoverable in a concentrated form.

Bitumen – A solid, semi-solid or viscous hydrocarbon with a colloidal structure, being brown to black in colour. It is obtained as a residue in the distillation of crude oil and by vacuum distillation of oil residues from atmospheric distillation. It should not be confused with the non-conventional primary extra heavy oils which may also be referred to as bitumen.

In addition to its major use for road pavements, bitumen is also used as an adhesive, a waterproofing agent for roof coverings and as a binder in the manufacture of patent fuel. It may also be used for electricity generation in specially designed power plants.

Bitumen is also known in some countries as asphalt but in others asphalt describes the mixture of bitumen and stone aggregate used for road pavements.

Other oil products n.e.c. – Products (including partly refined products) from the refining of crude oil and feedstocks which are not specified above. These products will include basic chemicals and organic chemicals destined for use within the refinery or for sale to or processing in the chemical industry such as propylene, benzene, toluene and xylene.

Natural gas – A mixture of gaseous hydrocarbons, primarily methane, but generally also including ethane, propane and higher hydrocarbons in much smaller amounts and some non-combustible gases such as nitrogen and carbon dioxide.

The majority of natural gas is separated from both "non-associated" gas originating from fields producing hydrocarbons only in gaseous form, and "associated" gas produced in association with crude oil.

The separation process produces natural gas by removing or reducing the hydrocarbons other than methane to levels which are acceptable in the marketable gas. The natural gas liquids (NGL) removed in the process are distributed separately.

Natural gas also includes methane recovered from coal mines (colliery gas) or from coal seams (coal seam gas) and shale gas. When distributed it may also contain methane from anaerobic fermentation or the methanation of biomass.

Natural gas may be liquefied (LNG) by reducing its temperature in order to simplify storage and transportation when production sites are remote from centres of consumption and pipeline transportation is not economically practicable.

Biofuels – Fuels derived directly or indirectly from biomass. Fuels produced from animal fats, by-products and residues obtain their calorific value indirectly from the plants eaten by the animals.

Solid biofuels – Solid fuels derived from biomass.

Fuelwood, wood residues and by-products – Fuelwood or firewood (in log, brushwood, pellet or chip form) obtained from natural or managed forests or isolated trees. Also included are wood residues used as fuel and in which the original composition of wood is retained. Charcoal and black liquor are excluded.

Bagasse – The fuel obtained from the fibre which remains after juice extraction in sugar cane processing. It is often used as a fuel within the sugar milling industry.

Animal waste – Excreta of animals, meat and fish residues which, when dry, are used directly as a fuel.

This excludes waste used in anaerobic fermentation plants. Fuel gases from these plants are included under biogases.

Black liquor – The alkaline-spent liquor obtained from the digesters during the production of sulphate or soda pulp required for paper manufacture. The lignin contained in the liquor burns to release heat when the concentrated liquor is sprayed into a recovery furnace and heated with hot gases at 900ºC. Black liquor is used as a fuel in the pulping process.

Other vegetal material and residues – Refers to solid primary biofuels not specified elsewhere, including straw, vegetable husks, ground nut shells, pruning brushwood, olive pomace and other wastes arising from the maintenance, cropping and processing of plants.

Charcoal – The solid residue from the carbonisation of wood or other vegetal matter through slow pyrolysis.

CONCEPTS AND DEFINITIONS

Liquid biofuels – Liquids derived from biomass and used as fuels. Liquid biofuels comprise biogasoline, biodiesels, bio jet kerosene and other liquid biofuels. They are used for transport, electricity generation and stationary engines.

Biogasoline – Liquid fuels derived from biomass and used in spark-ignition internal combustion engines.

Common examples are: bioethanol (including both hydrous and anhydrous ethanol); biomethanol; biobutanol; bio ETBE (ethyl-tertio-butyl-ether); and bio MTBE (methyl-tertio-butyl-ether). Biogasoline may be blended with petroleum gasoline or used directly in engines. The blending may take place in refineries or at or near the point of sale.

Biodiesels – Liquid biofuels derived from biomass and used in diesel engines.

Biodiesels obtained by chemical modification are a linear alkyl ester made by transesterification of vegetable oils or animal fats with methanol. The transesterification distinguishes biodiesel from straight vegetable and waste oils. Biodiesel has a flash point of around 150°C and a density of about 0.88 kg/litre. Biological sources of biodiesel include, but are not limited to, vegetable oils made from canola (rapeseed), soybeans, corn, oil palm, peanut or sunflower. Some liquid biofuels (straight vegetable oils) may be used without chemical modification and their use usually requires modification of the engine.

A further category of diesel fuels can be produced by a range of thermal processes (including for example gasification followed by Fischer Tropsch synthesis, pyrolysis followed by hydrogenation, or conversion of sugar to hydrocarbons using microorganisms (e.g. yeast)). A wide range of biomass feedstocks, including cellulosic materials and algal biomass could be used in such processes.

Biodiesels may be blended with petroleum diesel or used directly in diesel engines.

Bio jet kerosene – Liquid biofuels derived from biomass and blended with or replacing jet kerosene. Bio jet kerosene can be produced by a range of thermal processes (including for example gasification followed by Fischer-Tropsch synthesis, pyrolysis followed by hydrogenation, or conversion of sugar to hydrocarbons using microorganisms (e.g. yeast). A wide range of biomass feedstocks, including cellulosic materials and algal biomass could be used in such processes.

Other liquid biofuels – Includes liquid biofuels not elsewhere specified.

Biogases – Gases arising from the anaerobic fermentation of biomass and the gasification of solid biomass (including biomass in wastes).

The biogases from anaerobic fermentation are composed principally of methane and carbon dioxide and comprise landfill gas, sewage sludge gas and other biogases from anaerobic fermentation.

Biogases can also be produced from thermal processes (by gasification or pyrolysis) of biomass and are mixtures containing hydrogen and carbon monoxide (usually known as syngas) along with other components. These gases may be further processed to modify their composition and can be further processed to produce substitute natural gas.

The gases are divided into two groups according to their production: biogases from anaerobic fermentation and biogases from thermal processes.

Biogases are used mainly as a fuel but can be used as a chemical feedstock.

Industrial waste – Non-renewable waste which is combusted with heat recovery in plants other than those used for the incineration of municipal waste.

Examples are used tires, specific residues from the chemical industry and hazardous wastes from health care. Combustion includes co-firing with other fuels.

The renewable portions of waste of industrial origin which are combusted with heat recovery are classified according to the biofuels which best describe them.

Municipal waste – Household waste and waste from companies and public services that resembles household waste and which is collected at installations specifically designed for the disposal of mixed wastes with recovery of combustible liquids, gases or heat.

Municipal wastes can be divided into renewable and non-renewable fractions.

CONCEPTS AND DEFINITIONS

Nuclear – refers to heat obtained from nuclear reactions, whether to produce Heat or Electricity as an energy product. If the output is Electricity, Nuclear refers to the theoretical primary heat input assuming a 33% efficiency from converting such primary nuclear heat into the secondary nuclear electricity. As such, the corresponding conversion is reflected in the transformation rows of the balance.

Electricity – The transfer of energy through the physical phenomena involving electric charges and their effects when at rest and in motion.

Electricity can be generated through different processes such as: the conversion of energy contained in falling or streaming water, wind or waves; the direct conversion of solar radiation through photovoltaic processes in semiconductor devices (solar cells); or by the combustion of fuels.

Electricity production in the energy balances refers to gross production, which is the sum of the electrical energy production by all the generating units/installations concerned (but excluding from pumped storage) measured at the output terminals of the main generators.

Primary electricity refers to electrical energy from hydro, solar photovoltaics, wind, tide, wave and ocean sources. Electricity production from these sources appears in the row Primary production.

Secondary electricity is defined as electricity derived from a product already accounted for within energy statistics. This includes electricity generated from combustible fuels, in addition to electricity coming from solar heat, nuclear heat, geothermal heat and heat from chemical sources. Electricity production from these sources appears in the same Transformation rows (Electricity Plants, CHP plants) as the transformation inputs (combustible fuels, nuclear heat or other types of heat).

Heat – The energy obtained from the translational, rotational and vibrational motion of the constituents of matter, as well as changes in its physical state.

Heat can be produced by different production processes, both primary and secondary. It is usually sold in the form of steam or hot water, and for the purposes of energy statistics it is important to note that heat only represents quantities of energy for sale (or generated and consumed directly by direct use of solar thermal or geothermal). This means that any quantities “generated” at an end-use site (for example through the combustion of coal to power a boiler, or an electric filament heating a kettle) are not considered within the scope of heat production.