IEA Bioenergy Countries' Report – Update 2018

Bioenergy policies and status of implementation

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INTRODUCTION TO NATIONAL COUNTRY REPORTS

This report, together with the separate country reports, was prepared from IEA statistical data[1], combined with data and information provided by the IEA Bioenergy Executive Committee and its Tasks. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content.

The individual country reports are available as separate reports. Reports are available for Australia, Austria, Belgium, Brazil, Canada, Croatia, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, South Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, the United Kingdom, the United States, as well as the European Union (as a whole, with 28 member countries).

In the first section of each country report, national renewable energy targets are presented (first table in each country report), and the main pieces of national legislation are discussed.

In the second section of each country report the total primary energy supply (TPES) by resources and the contribution of bioenergy are presented. All data is taken from IEA statistics for the year 2016. It is worth noting that data reported in national statistics can differ from the IEA data presented, as the reporting categories and definitions may be different.

The first figure presents the total primary energy supply by source. TPES is defined as production plus imports minus exports minus marine and aviation bunkers and plus/minus stock changes (see definition section). Thus, according to the IEA definition of TPES, because of imports, both primary and secondary energy carriers are displayed. Nevertheless, this figure depicts the share of fossil energy carriers in the country's energy mix, with the drawback that the source of imported electricity is unknown. Resource categories displayed include coal and coal products; crude oil, natural gas liquid (NGL) and oil products; natural gas; nuclear; waste (non-renewable); renewable energy-bioenergy; renewable energy-other; and electricity (imported minus exported).

The second figure focuses on the share that different renewable energy sources provide to the total primary energy supply. Several renewable sources such as hydropower; geothermal; solar PV; solar thermal; tidal, wave and ocean; wind; and bioenergy are taken into consideration.

In the third figure, the contribution of different bioenergy carriers is presented in detail. These include primary solid biofuels, renewable municipal wastes (MSW), biogases, biogasoline, biodiesels and other liquid biofuels. It is worth noting that biogasoline includes all types of biofuels being used in Otto engines, and biodiesel includes all types of biofuels being used in Diesel engines, see definitions in next section for details.

The fourth figure presents the trend in the evolution of bioenergy for each country from the year 1990 to 2016. Values presented are total primary energy supply in each of the categories solid biofuels, renewable municipal wastes, biogases and liquid biofuels. The share of bioenergy is calculated from the total TPES as depicted in Figure 1 of the country report.

1 World Energy Balances – 2018 Edition © OECD/IEA
IEA statistical data is collated from national bodies on a joint annual questionnaire (with Eurostat and the United Nations), so that the data is the same as reported in e.g. Eurostat. However, data is presented as summarised data, and the way it is displayed or categorised differs from the way in which Eurostat and others display their data. The details of how IEA data is collated and displayed are explained in the IEA Energy Statistics Manual which is available from the IEA website in many different languages. Also available on the IEA website are the balance definitions, part of which are displayed in Annex. For more definitions please check http://www.iea.org/statistics/resources/balancedefinitions/.

The second table presents Total Primary Energy Supply in 2016 per unit population, as well as the energy that bioenergy in total and solid biofuels, renewable MSW, biogas and liquid biofuels provide to this.

The third table presents the share of bioenergy and other renewable energy in national electricity production, in transport energy consumption, and in the overall consumption of fuels and heat[2].

For European countries, the renewable energy shares in gross final energy consumption for heating and cooling, electricity and transport, as reported in Eurostat, are also mentioned.

In the third section of each country report, the research focus related to bioenergy is discussed. Relevant funding programs, major research institutes and projects are described.

In the fourth section, recent major bioenergy developments are described.

Finally, in the fifth section, links to sources of information are provided.

All individual country reports are available at: https://www.ieabioenergy.com/iea-publications/country-reports/2018-country-reports/

The following paragraph presents a comparative overview of the results for the different countries for the role of bioenergy in TPES (relative and expressed per capita), in electricity production, in transport energy consumption and in total heat/fuel consumption.

2 This includes fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.

DATA OVERVIEW

Role of Bioenergy in Total Primary Energy Supply (TPES)

An overview of the percentage of renewable energy and bioenergy in the total primary energy supply in 2016 for all investigated countries is presented in Figure 1. Norway, New Zealand and Brazil have the highest shares of renewable energy (40-50% of TPES), mainly coming from hydropower in Norway, from geothermal energy and hydropower in New Zealand and from bioenergy in Brazil. The share of bioenergy in TPES varies from a few % up to 30%. Brazil, Finland, Sweden and Denmark have bioenergy shares of over 20%; Austria, Croatia and Estonia follow with shares between 15 and 20%.

Role of bioenergy and other renewable energy in 2016 Total Primary Energy Supply (TPES)

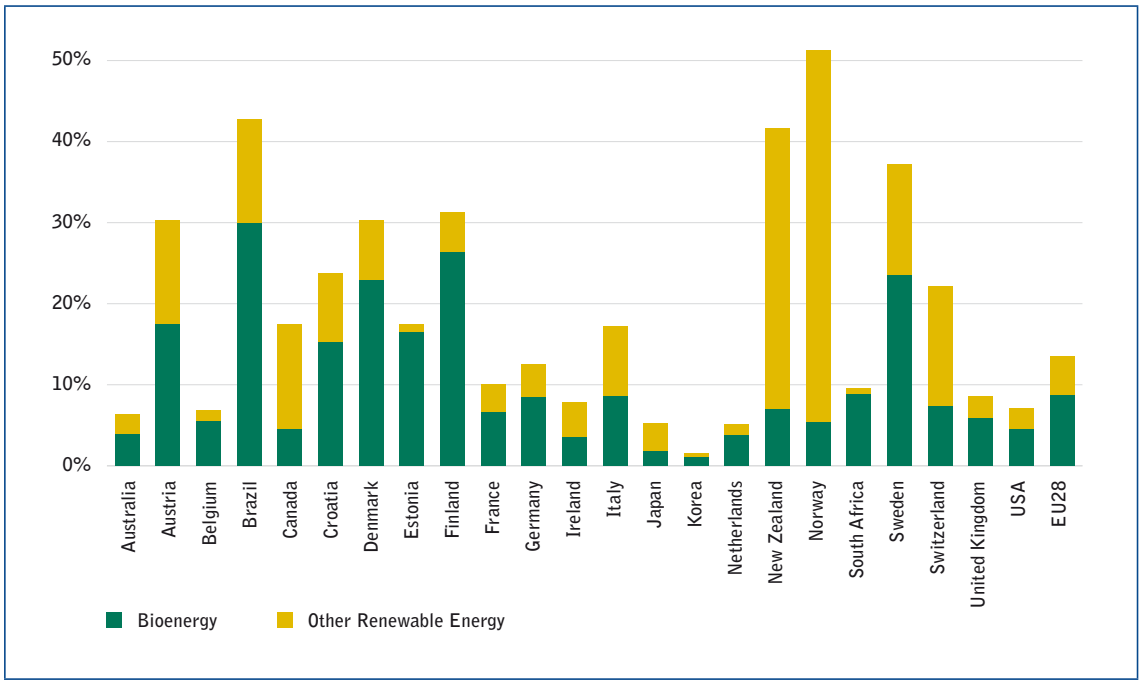

Figure 1: Percentage of renewable energy in TPES in year 2016 (Source: World Energy Balances © OECD/IEA 2018)

The absolute amounts of bioenergy for each country, expressed per capita, are displayed in Figure 2. Finland is by far the leader, with Sweden ranked second. Bioenergy is dominated by solid biomass (up to 63 GJ/capita in Finland), with a smaller role for renewable MSW, biogas and liquid biofuels. Renewable MSW is highest in Denmark, Sweden, Switzerland, the Netherlands and Finland (with TPES values higher than 2 GJ/capita), related to the development of waste management and the deployment of thermal energy from waste. Biogas has been most developed in Germany (4 GJ/capita), with the United Kingdom, Denmark, Austria, Italy following a little behind with around 1.5 GJ/capita. In absolute terms, the use of liquid biofuels is highest in the United States (5 GJ/capita), followed by Sweden, Brazil and Austria. The share of liquid biofuels in relative terms (compared to overall energy use in transport) will be discussed further.

TPES from bioenergy per capita (2016)

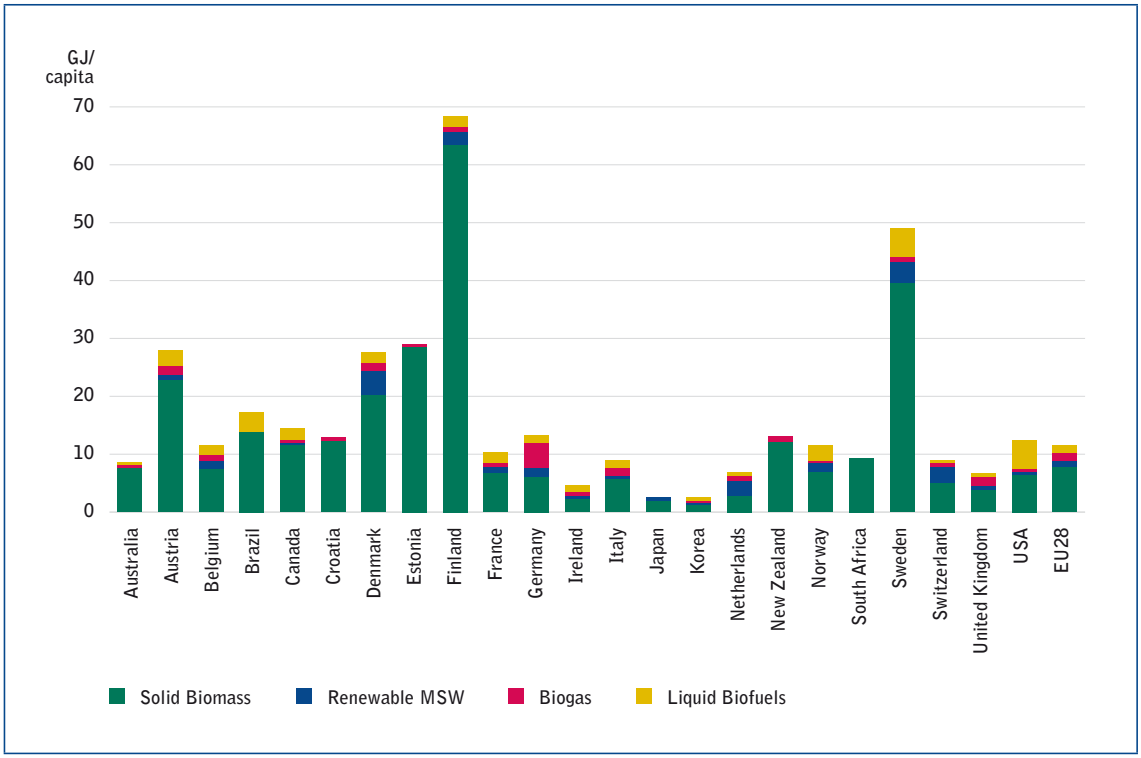

Figure 2: TPES from bioenergy per capita in year 2016 (Source: World Energy Balances © OECD/IEA 2018)

ROLE OF BIOENERGY IN DIFFERENT SECTORS

Electricity output

The role of renewable energy in domestic electricity production is shown in Figure 3. Various countries (Norway, Brazil, Austria, New Zealand, Canada, Croatia, Switzerland) have a high base of hydropower, representing more than 50% of domestic electricity production (almost 100% in Norway). This is strongly related to their topographical conditions.

The role of bioenergy in non-hydro renewable electricity production varies. In Finland and Denmark bioenergy represents more than 15% of electricity production (predominantly via CHP), while for countries like the United Kingdom, Brazil, Germany, Sweden, Estonia, Austria, Italy and Belgium biomass based electricity represents around 6 to 8% of total electricity production.

Role of hydropower, bioenergy and other renewable energy in total electricity production (2016)

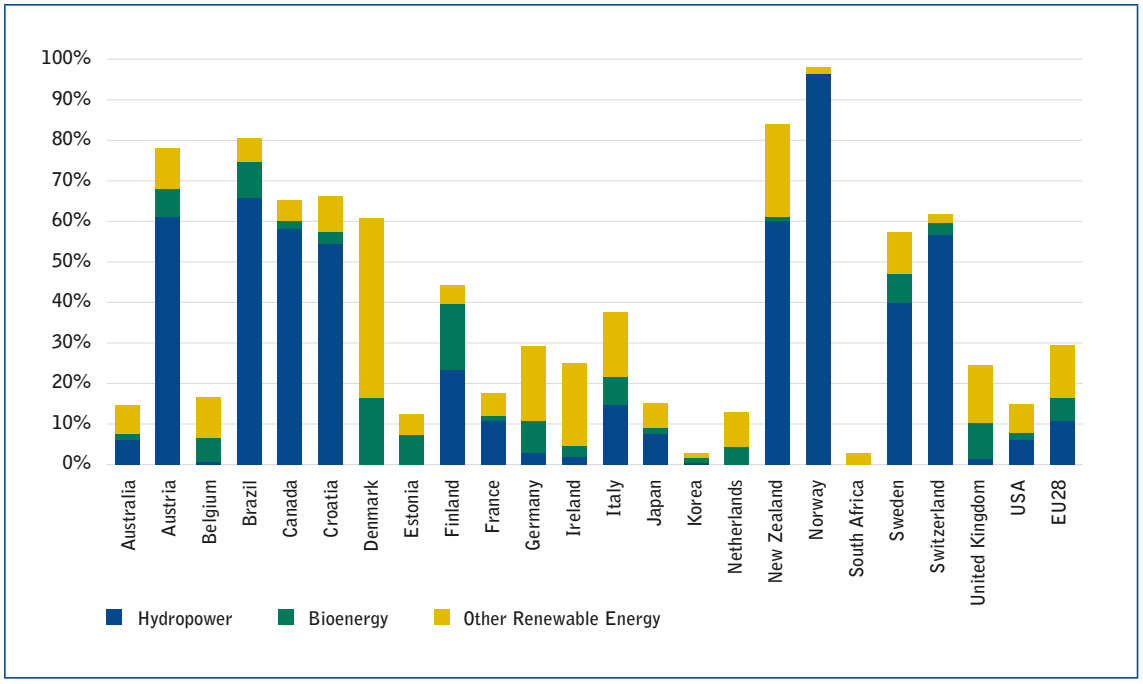

Figure 3: The role of hydropower, bioenergy and other renewable energy sources in total electricity production, in year 2016 (Source: World Energy Balances © OECD/IEA 2018)

Energy consumption in transport[3]

Biofuels are the most important type of renewable energy in transport. Renewable electricity is currently limited, and mostly linked to public transport (railways), but can be expected to rise in future related to the introduction of electric vehicles.

Brazil reached the highest share of biofuels, with over 20%; Sweden follows with around 16%. Finland had a temporary drop in biofuels consumption in 2016 (after reaching a share of 12% in 2015), but is expected to reach more than 10% again in 2017. Other countries – Norway, France, Austria, Denmark, the United States, Belgium, Germany – reach biofuel shares between 4 and 7%.

Role of renewable energy in transport energy consumption (2016)

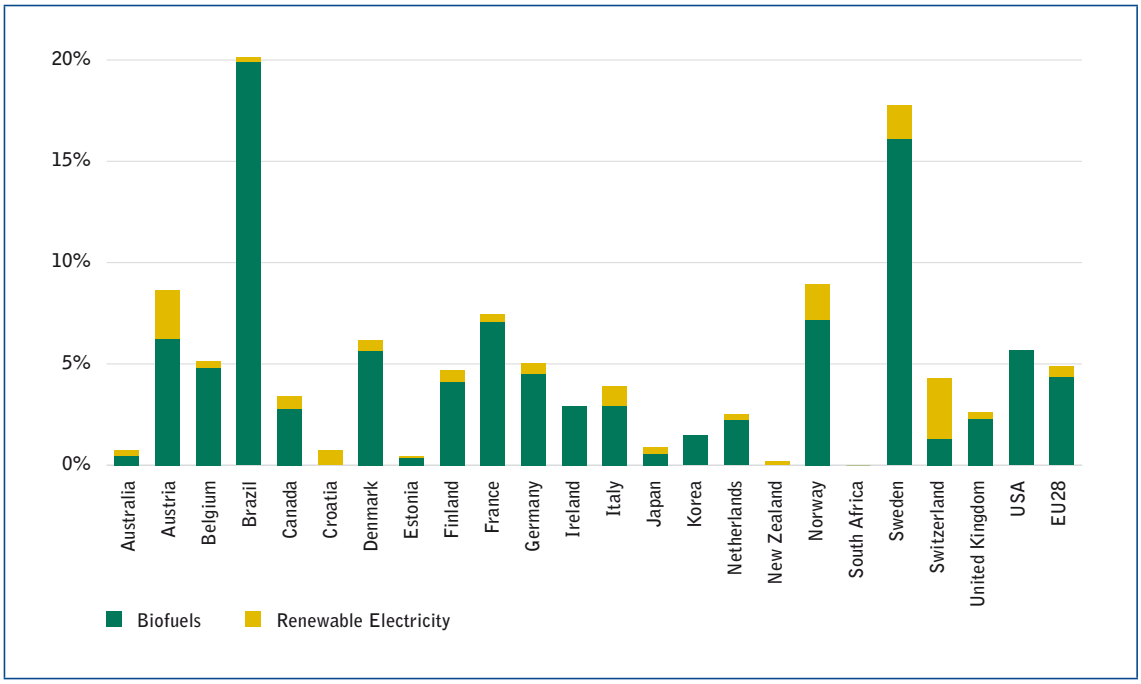

Figure 4: The role of biofuels and renewable electricity in transport energy consumption, in year 2016. Source: 2018 World Energy Balances © OECD/IEA

3 Transport includes road, rail, domestic aviation, domestic navigation and pipeline transport.

Fuel and heat consumption

Here final consumption[4] of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry is considered. A distinction is made between direct use of biomass, consumption of biobased heat (delivered through a heat distribution network), and other renewable energy sources[5]. Biomass is clearly the dominant source of renewable energy for heat provision. Particularly in Scandinavian countries, district heating is highly developed, and biomass plays an important role.

Overall, Sweden reaches a biomass based share in fuel and heat provision of almost 70%, followed by Finland, Brazil, Estonia, Denmark, Croatia and Austria.

Role of bioenergy and other renewable energy in total fuel and heat consumption (2016)

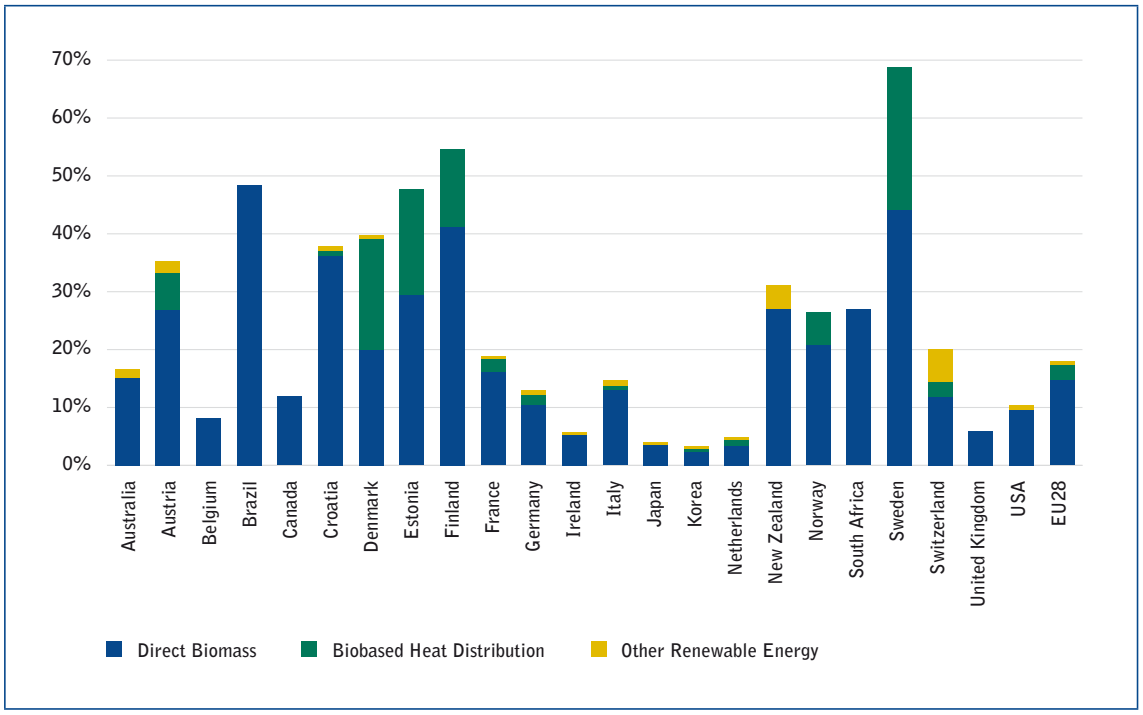

Figure 5: The role of bioenergy overall fuel and heat provision, in year 2016 (Source: World Energy Balances © OECD/IEA 2018)

4 Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.

5 Heat pumps or electric boilers that are operated within the residential sector where the heat is not sold are not included here – this is included as electricity consumption for residential use.

ANNEX

Definitions

IEA statistical data is collated from national bodies on a joint annual questionnaire (with Eurostat and the United Nations), so that the data is the same as reported in e.g. Eurostat. However, data is presented as summarised data, and the way it is displayed or categorised differs from the way in which Eurostat and others display their data. The details of how IEA data is collated and displayed are explained in the IEA Energy Statistics Manual which is available from the IEA website in many different languages. Also available on the IEA website are the balance definitions, part of which are displayed below. For more definitions please check http://www.iea.org/statistics/resources/balancedefinitions/.

Total Primary Energy Supply

is made up of:

+ Indigenous production

+ imports

– exports

– international marine bunkers

– international aviation bunkers

+/– stock changes.

Production

Production refers to the production of primary energy, i.e. hard coal, lignite, peat, crude oil, NGL, natural gas, combustible renewables and waste, nuclear, hydro, geothermal, solar and the heat from heat pumps that is extracted from the ambient environment[6]. Production is calculated after removal of impurities (e.g. sulphur from natural gas).

Calculation of production of hydro, geothermal, etc. and nuclear electricity is explained in the Energy Statistics Manual available for free download on the IEA website.

Imports and Exports

Imports and exports comprise amounts having crossed the national territorial boundaries of the country, whether or not customs clearance has taken place.

International marine bunkers

International marine bunkers covers those quantities delivered to ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation is excluded. The domestic/international split is determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. Consumption by fishing vessels and by military forces is also excluded.

International aviation bunkers

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. For many countries this incorrectly excludes fuel used by domestically owned carriers for their international departures.

Stock Changes

Stock changes reflect the difference between opening stock levels at the first day of the year and closing levels on the last day of the year of stocks on national territory held by producers, importers, energy transformation industries and large consumers. A stock build-up is shown as a negative number, and a stock drawdown as a positive number.

6 Heat pumps that are operated within the residential sector where the heat is not sold are not considered a transformation process and are not included here – the electricity consumption appears as residential use.

Biofuels and Waste

Biofuels & waste is comprised of solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Note that for biomass commodities, only the amounts specifically used for energy purposes (a small part of the total) are included in the energy statistics. Therefore, the non-energy use of biomass is not taken into consideration and quantities are null by definition. Data under this heading are often based on small sample surveys or other incomplete information. Thus the data give only a broad impression of developments, and are not strictly comparable between countries. In some cases complete categories of vegetal fuel are omitted through lack of information. For more information on a fuel type, please see the following list:

Biogases

Biogases are 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 to produce substitute natural gas.

Liquid biofuels

Liquid biofuels includes biogasoline, biodiesel and other liquid biofuels. It does not include the total volume of gasoline or diesel into which the biofuels are blended.

Biogasoline includes bioethanol (ethanol produced from biomass and/or the biodegradable fraction of waste), biomethanol (methanol produced from biomass and/or the biodegradable fraction of waste), bio-ETBE (ethyl-tertio-butyl-ether produced on the basis of bioethanol; the percentage by volume of bio-ETBE that is calculated as biofuel is 47%) and bio-MTBE (methyl-tertio-butyl-ether produced on the basis of biomethanol: the percentage by volume of bio-MTBE that is calculated as biofuel is 36%).

Biodiesels includes biodiesel (a methyl-ester produced from vegetable or animal oil, of diesel quality), bio-DME (dimethylether produced from biomass), Fischer Tropsh (Fischer Tropsh produced from biomass), cold pressed bio-oil (oil produced from oil seed through mechanical processing only) and all other liquid biofuels which are added to, blended with or used straight (unblended) as transport diesel.

Other liquid biofuels includes liquid biofuels not reported in either biogasoline or biodiesels.

Industrial waste

Industrial waste of non-renewable origin consists of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power. Renewable industrial waste is not included here, but with solid biofuels, biogas or liquid biofuels.

Municipal waste

Municipal waste consists of products that are combusted directly to produce heat and/or power and comprises wastes produced by households, industry, hospitals and the tertiary sector that are collected by local authorities for incineration at specific installations.

Primary solid biofuels and charcoal

Primary solid biofuels and charcoal are defined as any plant matter used directly as fuel or converted into other forms before combustion. This covers a multitude of woody materials generated by industrial processes or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, sulphite lyes also known as black liquor, animal materials/wastes and other solid biomass).

Charcoal produced from solid biomass is also included here. Since charcoal is a secondary product, its treatment is slightly different than that of the other primary solid biofuels. Production of charcoal (an output in the transformation process) is offset by the inputs of primary solid biofuels into the charcoal production process. The losses from this process are included in the row 'other transformation'. Other supply (e.g. trade and stock changes) as well as consumption are aggregated directly with the primary solid biofuels. In most countries, only the primary solid biofuels are reported.

Hydro/solar PV/wind energy/tide, wave, ocean

For hydro, solar, wind and tide/wave/ocean energy, the energy content of the electricity produced is considered in TPES*. Other sources for electricity also have waste heat which is counted in the TPES (e.g. 'Nuclear' shows the primary heat equivalent of the electricity produced by a nuclear power plant with an average thermal efficiency of 33%). So care should be taken when using TPES to compare the role of the different energy sources as this overestimates the role of resources producing electricity with a high share of unused waste heat.

* When it comes to electricity from non-combustible sources, the IEA, in line with IRES, adopts a coherent principle across sources – the "physical content method" – by measuring the primary energy equivalent at the first point downstream in the production process for which multiple energy uses are practical. This means that hydro, wind and solar become "energy products" in the statistical sense at the point of generation of electricity, and that their "primary energy equivalent" is computed as the electricity generated in the plant, while the kinetic energy of the wind or the water does not enter the "energy balance", although being "energy" in a scientific sense.

The IEA had at a point used the "partial substitution method", based on the assumption that hydro, wind, solar electricity had displaced thermal generation. This involved using an average thermal conversion efficiency (e.g. 36%) to back-compute their corresponding "primary energy equivalent". This made their shares in the primary energy supply greater (around three times as much). However, the principle was abandoned as it relied on arbitrary conversion factors and was creating some transformation losses inside the energy balance that did not really exist.

https://www.iea.org/newsroom/news/2017/september/commentary-understanding-and-using-the-energy-balance.html

UNITS

The standard unit converter of the International Energy Agency was used. (https://www.iea.org/statistics/resources/unitconverter/)

kilo (k):	10^3
mega (M):	10^6
giga (G):	10^9
tera (T):	10^{12}
peta (P):	10^{15}
exa (E):	10^{18}

Most figures in the country reports are expressed in PJ (petajoule).

1 PJ = 23884.6 toe (tonne of oil equivalent)
= 0.2778 TWh (terawatt hour) (*mostly relevant for electricity production*)
= 947817.12 million Btu (British thermal unit) (*commonly used in the United States*)

SYMBOLS AND ABBREVIATIONS

CHP: Combined Heat and Power

CO_2: carbon dioxide

DME: dimethylether

ETBE: ethyl-tertio-butyl-ether

ETS: Emission Trading System

EU: European Union

GHG: Greenhouse gases

IEA: International Energy Agency

IRES: International Recommendations for Energy Statistics

MSW: municipal solid waste

MTBE: methyl-tertio-butyl-ether

NGL: natural gas liquid

NREAP: National Renewable Energy Action Plans

OECD: Organisation for Economic Co-operation and Development

RES: Renewable Energy Sources

TPES: total primary energy supply

US/USA: United States of America

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Further Information

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