Manual on the Basic Set of Environment Statistics of the FDES 2013

Energy Resources Statistics

(Sub-component 2.2 Energy Resources
of the Basic Set of Environment Statistics of the FDES 2013)

Elaborated by the Environment Statistics Section
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in collaboration with the
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1. Statistics in Sub-Component 2.2 Energy Resources

Component 2: Environmental Resources and their Use				
Sub-component 2.2: Energy Resources				
Statistics and Related Information (**Bold Text - Core Set/Tier 1**; Regular Text - Tier 2; *Italicized Text - Tier 3*)		**Category of Measurement**	**Potential Aggregations and Scales**	**Methodological Guidance**
Topic 2.2.1: Stocks and changes of energy resources				
a.	Energy resources		▪ By resource (e.g., natural gas, crude oil and natural gas liquids, oil shale, and extra heavy oil (includes oil extracted from oil sands), coal and lignite, peat, non-metallic minerals except for coal or peat, uranium and thorium ores) ▪ National ▪ Sub-national	▪ UNSD: International Recommendations for Energy Statistics (IRES) ▪ International Energy Agency (IEA) Energy Statistics Manual ▪ SEEA Central Framework (2012) asset and physical flow accounts ▪ UNFC-2009 ▪ ISIC Rev. 4, Section B, Divisions 05-09 ▪ HS 2012, Section V, Chapter 27
	1. **Stocks of commercially recoverable resources**	Mass, Volume		
	2. New discoveries	Mass, Volume		
	3. *Upward reappraisals*	Mass, Volume		
	4. *Upward reclassifications*	Mass, Volume		
	5. **Extraction**	Mass, Volume		
	6. *Catastrophic losses*	Mass, Volume		
	7. *Downward reappraisals*	Mass, Volume		
	8. *Downward reclassifications*	Mass, Volume		
	9. Stocks of potentially commercially recoverable resources	Mass, Volume		
	10. *Stocks of non-commercial and other known resources*	Mass, Volume		
Topic 2.2.2: Production, trade and consumption of energy				
a.	Production of energy		▪ By non-renewable resource (e.g., petroleum, natural gas, coal, nuclear fuels, non-sustainable firewood, waste, other non-renewables) ▪ By renewable resource (e.g., solar, hydroelectric, geothermal, tidal action, wave action, marine, wind, biomass) ▪ National ▪ Sub-national	▪ UNSD: IRES ▪ IEA Energy Statistics Manual ▪ Joint Wood Energy Enquiry (UNECE-FAO Forestry and Timber Section)
	1. **Total production**	Energy unit, Mass, Volume		
	2. **Production from non-renewable sources**	Energy unit, Mass, Volume		
	3. **Production from renewable sources**	Energy unit, Mass, Volume		
	4. **Primary energy production**	Energy unit, Mass, Volume	▪ By primary energy resource (e.g., petroleum, natural gas, coal, hydroenergy, geothermal,	
	5. Imports of energy	Energy unit, Mass, Volume		

	6. Exports of energy	Energy unit, Mass, Volume	nuclear fuels, cane products, other primary)	
	7. **Secondary energy production**	Energy unit, Mass, Volume	▪ By secondary energy product (e.g., electricity, liquefied petroleum gas, gasoline/alcohol, kerosene, diesel oil, fuel oil, coke, charcoal, gases, other secondary) ▪ National ▪ Sub-national	
b.	**Total energy supply**	Energy unit, Mass, Volume	▪ By energy product	
c.	**Final consumption of energy**	Energy unit, Mass, Volume	▪ By households ▪ By ISIC economic activity ▪ By tourists ▪ National ▪ Sub-national	

2. Introduction/ Relevance

Energy resources and their use are key to development and to sustainability. Energy is indispensable to all ecosystems and is a necessary input for human-controlled processes. Energy incorporates the concept of the transformation of "available energy" into "unavailable energy" (e.g. burning of hydrocarbons) and conversion from an "unusable" to a "usable" form (e.g. hydropower to electricity). Unlike all other natural resources, energy is not a material substance but rather the capacity of a physical system to perform work.

For statistical purposes, energy is measured in its "usable form" embedded in energy products. Although physically speaking there would be no such thing as "energy production" or "energy consumption", in statistics these terms refer to the extraction/manufacturing and use of energy products (energy commodities), respectively.

Non-renewable energy resources, like fossil energy resources, are mineral resources. However, due to their significance, they are discussed separately in the Framework for the Development of Environment Statistics (FDES) and therefore are presented in this methodology sheet rather than in the methodology sheet on mineral resources.

The main environmental issues related to energy production and consumption are: (i) the depletion of non-renewable energy resources; (ii) the destruction of the environment (landscape) by the extraction of energy resources and the production and distribution of energy, and (iii) the pollution (air, water and soil) and waste generated by the production and consumption of energy.

Firstly, modern societies are heavily dependent on energy, and even though some improvements have been made in term of developing renewable energy resources, most of the energy used is produced from non-renewable, mainly fossil, resources, and as energy resources are extracted, depletion occurs. In order to manage these non-renewable resources in a sustainable way, statistics about the available stocks and the depletion of these resources are necessary.

The second issue is related to the destruction of the environment resulting from the extraction of energy resources, their transformation and distribution. Extraction of energy resources involves mining operations which disturb ecosystems, restructure the land, and remove soil and water.

Finally, the third issue is related to the emission of residuals (air, water and soil pollution, as well as the generation of waste) resulting from all processes, extraction, transformation, distribution and use, of energy. The burning of fossil fuels pollutes the air, affects human health, and results in significant greenhouse gas (GHG) emissions.

Renewable energy does not face the depletion problem of fossil energy resources, but the capture of renewable energy can also affect the natural environment, particularly in large hydro energy facilities or wind turbines. Regardless of how energy is produced, its distribution requires facilities which can also change the landscape and affect natural areas.

This sub-component is focused on energy resources and their use. It covers statistics related to the environmental issue of the depletion of energy resources and the use of renewable resources which can ease the stress on non-renewable resources. The statistics about the destruction of the environment related to the extraction of energy resources are included in Sub-Component 1.2: Land Cover, Ecosystems and Biodiversity and Sub-Component 2.3: Land. Statistics on the generation, management and discharge of residuals related to the extraction and use of energy resources are covered in Component 3: Residuals.

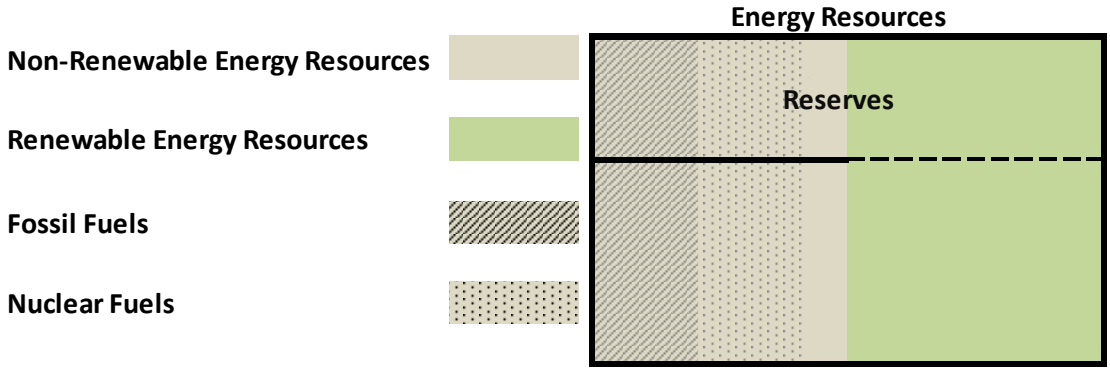
3. Definitions and description of the statistics

An **energy resource** is a source of energy: that is anything that can be employed to produce energy. Energy resources can be divided in two categories, renewable energy resources and non-renewable energy resources. This concept is quite broad and includes all known sources of energy, from wind to petroleum.

Energy reserves are the part of energy resources that can be economically exploited. They can theoretically apply to both renewables and non-renewables. However there is no methodology to evaluate the renewable energy reserves. The term "reserve" applies mostly to non-renewables and is defined as the part of the non-renewable energy resources which could be recovered and for which extraction is justified to some extent.

Energy resources can be renewable or non-renewable. Energy from renewable sources is captured from sources that replenish themselves. Renewable energy resources includes solar (photovoltaic and thermal), hydroelectric, geothermal, tidal action, wave action, marine (non-tidal currents, temperature differences and salinity gradients), wind and biomass energy. All are replenished naturally, although their flow may be limited.[1] The most common non-renewable energy resources are fossil fuels and nuclear fuels. Fossil energy resources are those which are derived from the remains of ancient plant and animal life.[2] Fossil fuels refer to coal, peat, crude oil and natural gas, even though the inclusion of peat in fossil fuels is not universally accepted.[3] Nuclear fuels, which include uranium and thorium ores, are also part of the mineral energy resources.

Figure 3.1 The different kinds of Energy Resources



A deposit is a concentration of a solid commodity (or product) in the subsoil. The equivalent term for petroleum (oil and natural gas in the UNFC methodology) is accumulation.[4] However later in this chapter deposit will be used for all mineral energy resources, as in the UNFC-2009.

[1] United Nations Statistics Division (2016) *Framework for Development of Environment Statistics* (FDES 2013) , http://unstats.un.org/unsd/ENVIRONMENT/fdes.htm (accessed 3 February 2016)
[2] United Nations (1997) *Glossary of Environment Statistics.* ST/ESA/STAT/SER.F/67. New York, http://unstats.un.org/unsd/publication/SeriesF/SeriesF_67E.pdf (accessed 1 March 2016)
[3] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[4] UNECE (2004) *United Nations Framework Classification for Fossil Energy and Mineral Resources* (2004), http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/UNFCemr.pdf (accessed 1 March 2016)

FDES Sub-component 2.2 Energy Resources is separated in two topics: Topic 2.2.1 Stocks and changes of energy resources and Topic 2.2.2 Production, trade and consumption of energy. Topic 2.2.1, Stocks and changes of energy resources, focuses on energy in the environment. It covers only non-renewable sources of energy, as stocks of renewable energy resources are not relevant from the point of view of resource depletion and are difficult or even impossible to measure. For this topic statistics on the stocks and flows of non-renewable energy resources are required.

Topic 2.2.2. Production, trade and consumption of energy focuses on energy in the economy. Thus statistics about the production and use of energy from different perspectives (production from renewable and non-renewable sources, primary and secondary energy production, and energy use) are required to describe this relation.

3A. Stocks and changes of energy resources (Topic 2.2.1)

This topic describes the stocks of non-renewable energy resources and the changes in the stock due to extraction and other flow changes. They are environmental resources that cannot be renewed in any human timescale, so their extraction and use in the economy depletes the resource, limiting its availability for future generations. Statistics on the magnitude of their stocks through time are required to assist in the sustainable management of these resources.

The stocks of available non-renewable energy resources are subject to change over time because they are being exploited, or due to new discoveries or reclassification of previously unrecoverable resources, or catastrophic losses. To estimate the total amount of these resources over time, the approach of stocks and flows is usually used. Statistics start with opening balances of the stock at the beginning of the observation period; extractions and diminishing flows are subtracted; occurring increments to the stocks that are added, giving the final closing balance of the stock of the resource at the end of the observation period. The stocks and flows approach usually considers all changes to the stock during a year.

Renewable energy resources are not subject to depletion in the same way as non-renewable energy resources. Additionally, their stocks are difficult to define accurately, except for biomass, and it is only sensible to measure resources with slow replenishment rates (such as wood). Thus, stocks of renewable energy resources are not included in the statistics of the Basic Set of Environment Statistics (BSES) of the FDES. However, the production of energy from renewable energy resources can be measured by flows of energy produced (e.g., hydroelectric power, solar energy generation, wind energy production, etc.), which are included in the BSES of the FDES.

Stocks of energy resources refer to the amount of the resource by type of resources and type of categories (see section 4A1). In this sub-component, stocks of resources correspond to stocks of non-renewable energy resources. They are defined as the amount of known deposits of fossil and mineral energy resources measured at a point in time. They include fossil fuels (e.g., natural gas, crude oil and natural gas liquids, oil shale, natural bitumen and extra heavy oil, coal, lignite and peat, uranium and thorium ores (nuclear fuels). Classes of known mineral energy resources follow the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009)[5]. In the SEEA Central Framework, classes of known mineral and energy resources are defined according to combinations of criteria from the UNFC-2009. FDES 2013 uses the same classes as the SEEA. These classes are defined below.

(A) *Commercially recoverable resources* are subject to exploitation projects that have been confirmed to be technically, economically and socially feasible. Energy reserves often, but not always, refer to the commercially recoverable resources.

[5] UNECE (2010) *United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009.* ECE Energy Series No. 39, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/unfc2009/UNFC2009_ES39_e.pdf (accessed 1 March 2016)

(B) *Potential commercially recoverable resources* are subject to exploitation projects that are expected to be developed in the foreseeable future, in that the quantities are assessed to have reasonable prospects for eventual economic extraction, but technical and/or commercial feasibility has not yet been confirmed. Consequently, not all potentially commercial projects may be developed.

(C) *Non-commercial and other known deposits* are either part of projects that are at an early stage of evaluation in addition to those that are considered unlikely to become commercially feasible developments within the foreseeable future, or may become recoverable in the future as technological development occurs.[6] For more information, see section 4A1 which gives a detailed description of the different classes in the UNFC-2009.

3A1. Stocks

Stocks of commercially recoverable resources (FDES 2.2.1.a.1)

Amount (in mass or volume) of energy resources corresponding to Class A of known deposits. See section 4A1 for more details.

Stocks of potentially commercially recoverable resources (FDES 2.2.1.a.9)

Amount (in mass or volume) of energy resources corresponding to Class B of known deposits. See section 4A1 for more details.

Stocks of non-commercial and other known resources (FDES 2.2.1.a.10)

Amount (in mass or volume) of energy resources corresponding to Class C of known deposits. See section 4A1 for more details.

The difference between the opening and closing stocks of non-renewable energy resources for a particular year results largely from extraction. New discoveries, reappraisals and reclassifications of stocks, as well as catastrophic losses, can also influence the difference between opening and closing stocks. In the BSES, these statistics are only for commercially recoverable resources. However, they can also be provided for the other classes of known deposits if relevant. For details on Classes A, B or C see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 4A1).

3A2. Additions to stocks

New discoveries (FDES 2.2.1.a.2)

Discoveries (in mass or volume) of new energy resources refer to previously unknown findings of fossil fuel or nuclear fuel resources. Discoveries should incorporate estimates of the quantity of new deposits found during an accounting period, and should be recorded by type of resource and by class of resource.[7]

Remark:

- To be recorded as a discovery the new deposit must be a known deposit – i.e. in Class A, B or C.[8] In the BSES, new discoveries correspond only to Class A resources (commercially recoverable resources). However, statistics about new discoveries of resources in Classes B and C can also be relevant.

[6] UNECE (2010) *United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009.* ECE Energy Series No. 39, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/unfc2009/UNFC2009_ES39_e.pdf (accessed 1 March 2016)

[7] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 161, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

[8] The classes of known fossil and mineral energy resources are defined according to combinations of criteria from the "United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009" (UNFC-2009) are: i) Class A: Commercially Recoverable Resources. This class includes deposits for projects that fall in the categories E1and F1 and where the level of confidence in the geological knowledge is either high (G1), moderate (G2), or low (G3). ii) Class B: Potentially Commercially Recoverable Resources. This class includes deposits for those projects that fall in the category E2 (or eventually E1) and at the same time in F2.1 or F2.2 and where the level of confidence in the geological knowledge is

- For more details on Classes A, B or C, see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 4A1).

Upward reappraisals (FDES 2.2.1.a.3)

Reappraisals (in mass or volume) pertain only to known deposits and refer to reappraisals of the quantity of the resource. Upward reappraisals of energy resources occur whenever there is an addition in the estimated available stock of a specific deposit or whenever there are changes in the categorization of specific deposits between Classes A, B or C resulting in an increment in the estimated available stock, based on changes in geological information, technology, product price or a combination of these factors.[9]

Remark:

- In the BSES, upward reappraisals correspond only to Class A resources (commercially recoverable resources). However statistics about upward reappraisals to Classes B and C resources can also be relevant.
- For more details on classes A, B or C, see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 4A1).

Upward reclassifications (2.2.1.a.4)

Upward reclassifications (in mass or volume) occur when certain deposits are opened to exploitation operations due to regulatory (government) decisions concerning the access rights to a deposit. All other increments in the quantity of known deposits should be considered reappraisals.[10]

Remark:

- In the BSES, upward reclassifications correspond to Class A resources (commercially recoverable resources). It cannot refer to Classes B and C.
- For more details on Class A, see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 4A1).

3A3. Reductions of stocks

Extraction (FDES 2.2.1.a.5)

Extraction of energy from non-renewable resources is the quantity (in mass or volume) of the resource physically removed from the deposit during a period of time, usually one year. The difference between the opening and closing stocks of energy resources for a particular year are mostly the result of extraction. It should exclude mining overburden, i.e. the quantity of soil and other material moved in order to extract the resource. Additionally, the quantity should be estimated before any refinement or processing of the resource is undertaken. Estimates of extraction should include estimates of illegal extraction, either by residents or non-residents, as these amounts reduce the availability of the resource.[11]

Energy resources are extracted from the environment through mining activities corresponding to ISIC Rev. 4: Section B Mining and Quarrying, Divisions 05 Mining of coal and lignite, 06 Extraction of crude petroleum and natural gas, Division 07 (Class 0721) Mining of uranium and thorium ores, Division 08 (Class 0892) Extraction of Peat, and 09 (Group 091) support activities for petroleum and gas extraction. For details see section 4A3 Classifications.

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either high (G1), moderate (G2), or low (G3). iii) Class C: Non-Commercial and Other Known Deposits are resources for those projects that fall in E3 and for which the feasibility is categorised as F2.2, F2.3 or F4 and where the level of confidence in the geological knowledge is either high (G1), moderate (G2), or low (G3).

[9] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 164, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

[10] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 165, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

[11] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 165, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

Remark:

- Extraction can only refer to Class A resources (commercially recoverable resources). It cannot refer to resources in classes B or C.
- For more details on Class A, see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 4A1).

Catastrophic losses (FDES 2.2.1.a.6)

Catastrophic losses (in mass or volume) of energy resources may occur as a result of sudden events such as fires, earthquakes, volcanic eruptions, and other extreme events, as well as wars. Losses due to catastrophic events are very rare in energy resources. If a natural disaster changes the accessibility or conditions for extracting the natural resource this should be recorded as reappraisals and not as catastrophic losses.

In some cases, flooding and collapsing of mines does occur but the deposits continue to exist and can, in principle, be recovered. In these cases, the issue is one of economic viability of extraction rather than actual loss of the resource itself. An exception to this general principle concerns oil wells that can be destroyed by fire or become unstable for other reasons, leading to significant losses of oil resources. Losses of oil and related resources in this situation should be considered catastrophic losses.[12]

Remark:

- In the BSES, catastrophic losses correspond only to Class A resources (commercially recoverable resources). However, statistics about catastrophic losses of Classes B and C resources can also be relevant.
- For more details on Classes A, B or C, see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 4A1).

Downward reappraisals (FDES 2.2.1.a.7)

Reappraisals (in mass or volume) pertain only to known deposits and refer to reappraisals of the quantity of the resource. Downward reappraisals of fossil energy resources occur whenever there is a reduction in the estimated available stock of a specific deposit or whenever there are changes in the categorization of specific deposits between class A, B or C[13] resulting in the reduction of the estimated available stock based on changes in geological information, technology, product price or a combination of these factors. [14]

Remark:

- In the BSES, downward reappraisals correspond only to Class A resources (commercially recoverable resources). However, statistics about downward reappraisals of Classes B and C resources can also be relevant.
- For more details on classes A, B or C, see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 4A1).

[12] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 165, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

[13] UNECE (2010) *United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009.* ECE Energy Series No. 39, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/unfc2009/UNFC2009_ES39_e.pdf (accessed 1 March 2016) Classes of known resources include "A: Commercially recoverable resources; class B: Potentially commercially recoverable resources; or class C: Non-commercial and other known deposits".

[14] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 164, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

Downward reclassifications (FDES 2.2.1.a.8)
Downward reclassifications (in mass or volume) occur when certain deposits are closed to exploitation operations due to regulatory (government) decisions concerning the access rights to a deposit. All other reductions in the quantity of known deposits should be considered reappraisals.[15]

Remark:

- In the BSES, downward reclassifications correspond to Class A (commercially recoverable resources) only. It does not refer to resources in Classes B or C.
- For more details on class A, see UNFC-2009 classification for fossil energy and mineral reserves and resources (section 3A1).

3B. Production, trade and consumption of energy (Topic 2.2.2)

This topic organizes information about energy produced both from renewable and non-renewable sources, information about primary and secondary energy production, trade and supply, as well as final energy consumption. The statistics within Topic 2.2.2.a do not contain mutually exclusive categories, but present distinct perspectives on the measurement of energy production according to type of source and level of transformation that are important from an environmental and sustainability perspective.

Production of energy is defined as the capture, extraction or manufacture of fuels or other energy products in forms which are ready for general consumption. In energy statistics, two types of production are distinguished, primary and secondary.[16] Energy production corresponds to the production of energy products.

For statistical purposes, understanding the different types of energy products or commodities is necessary. Energy is embedded in these products which are the result of extraction or harvesting of energy resources. Different approaches can be used to measure the types of energy products.

Energy products are a subset of products. The term "products" is understood in the same way as in economic statistics and refers to all goods and services which are the result of production. As a general guideline, it is recommended that energy products refer to products exclusively or mainly used as a source of energy. They include energy in forms suitable for direct use (e.g., electricity and heat) and energy products which release energy while undergoing some chemical or other process (combustion, etc.). By convention, energy products include biomass and waste (i.e. solid or liquid) that are combusted for the production of electricity and/or heat".[17] Energy products are also denominated as energy commodities.

Energy production from non-renewable and renewable sources
Statistics about **energy production from non-renewable and renewable sources** are very important from the environmental and sustainability perspectives. Energy products can be obtained from both non-renewable (e.g. coal, crude oil, etc.) and renewable (e.g. solar, biomass, etc.) sources. It is important for both energy planning and environmental concerns to distinguish between energy production from non-renewable and renewable sources, as well as to distinguish "infinite" renewable sources such as solar, from cyclical renewable sources such as biomass.[18]

[15] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 165, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

[16] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.71, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[17] United Nations (2016*) International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.23, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[18] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.25, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

Non-renewable energy sources have a zero or minute rate of replenishment relative to their depletion by humans,[19] and as such, reliance on non-renewable energy is unsustainable.[20] Additionally, many forms of non-renewable energy sources emit high levels of CO_2, with coal, crude oil and natural gas being the highest contributors to GHGs globally in 2010.[21] Non-renewable energy sources provide a high proportion of global energy production today, though energy from renewable sources are expected to be able to meet an increasing proportion of global energy consumption needs into the future.[22]

Energy products from renewable sources are transformed from sources that replenish themselves or that flow continuously from their source. Renewable energy is also considered cleaner than energy from non-renewable sources from the point of view of GHG emissions, since its carbon content is substantially lesser than fossil fuel energies.

The following list presents the different renewable energy sources[23]

- Hydro power
- Geothermal
- Solar energy
- Tide, wave, ocean
- Wind
- Municipal waste (renewable waste only)
- Solid biofuels (include part of renewable industrial waste)
- Biogases (include part of renewable industrial waste)
- Liquid biofuels (include part of renewable industrial waste)

Primary and secondary energy products

Since a number of energy products may be or have to be transformed into other kinds of energy products prior to their consumption, a distinction is made between **primary and secondary energy products**. This distinction is necessary for various analytical purposes including to avoid double counting energy production in the energy balances.[24]

Primary energy products are extracted or captured directly from natural resources such as crude oil, coal and natural gas. Secondary energy products are produced by transforming primary products. Secondary energy comes from the transformation of primary or secondary energy.[25]

A transformation process is the movement of part or all of the energy content of a product entering the process to one or more different products leaving the process (e.g., coking coal to coke, crude oil to petroleum products, and fuel oil to electricity). [26]

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[19] United Nations Statistics Division (2007) *Renewable vs. non-renewable energy sources, forms and technologies*., http://unstats.un.org/unsd/envaccounting/londongroup/meeting13/LG13_13a.pdf

[20] International Energy Agency (2007) *International Standards to Develop and Promote Energy Efficiency and Renewable Energy Resources*, http://www.iea.org/publications/freepublications/publication/Standards-1.pdf

[21] International Energy Agency (2012) *CO_2 Emissions from Fuel Combustion – Highlights,* http://www.iea.org/co2highlights/co2highlights.pdf

[22] International Energy Agency (2012) *World Energy Outlook 2012 – Renewable Energy Outlook*, http://www.worldenergyoutlook.org/media/weowebsite/2012/WEO2012_Renewables.pdf

[23] International Energy Agency (2013) *The Renewables Annual Questionnaire 2013 and Historical Revisions,* http://ec.europa.eu/eurostat/documents/38154/4956296/AQ2013-RENEWABLES-instructions.pdf/8c95af50-fbb1-4b9a-a741-808c34814550

[24] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.23, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

[25] Examples include the generation of electricity by burning fuel oil, petroleum products (secondary) from crude oil (primary), coke-oven coke (secondary) from coking coal (primary), charcoal (secondary) from fuelwood (primary). Both electricity and heat may be produced in a primary or secondary form. Primary heat is the capture of heat from natural sources (solar panels, geothermal reservoirs) and represents the arrival of "new" energy into the national supply of energy products. Secondary heat is derived from the use of energy commodities already captured or produced and recorded as part of the national supply (heat from a combined heat and power plant, for instance).

[26] United Nations (2016*) International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.79, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

In turn, both primary and secondary energy products may also be divided into non-renewable and renewable energy products depending on whether the source used for their production is non-renewable or renewable, as presented below.

Figure 3.2 Cross-classification of primary/secondary and renewable/non-renewable energy products[27]

	Primary products	**Secondary products**
Non-renewables	01 - Hard coal 02 - Brown coal 11 - Peat 20 - Oil shale 30 - Natural gas 41 - Conventional crude oil 42 - Natural gas liquids (NGL) 44 - Additives and oxygenates 61 - Industrial waste 62 (partially) - Municipal waste Nuclear Heat Heat from chemical processes	03 - Coal products 12 - Peat products 43 - Refinery feedstocks 46 - Oil products Electricity and heat from combusted fuels of fossil origin Electricity derived from heat from chemical processes and nuclear heat Any other product derived from primary/secondary non-renewable products
Renewables	5 - Biofuels (except charcoal) 62 (partially) - Municipal waste Heat from renewable sources, except from combusted biofuels Electricity from renewable sources, except from geothermal, solar thermal or combusted biofuels	516 - Charcoal Electricity and heat from combusted biofuels Electricity from geothermal and solar thermal Any other product derived from primary/secondary renewable products

For each specific energy product, the issue of the boundary between primary/secondary and renewable/non-renewable is not always clear[28] and requires careful consideration for statistics production.

The definitions for individual energy products can be seen in the list of internationally agreed definitions of the products in the Standard International Energy Product Classification (SIEC) of the International Recommendations for Energy Statistics (IRES), chapter 3.

For all the statistics in this topic it is recommended to measure the amount in mass or volume, and also energy unit.

Production of energy (FDES 2.2.2.a)
Covers the statistics total production, production from non-renewable sources, production from renewable sources, primary energy production, secondary energy production, imports of energy and exports of energy.

[27] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93. Annex A Primary and Secondary products; Renewables and non-renewables.http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016).
[28] For example electricity can be considered primary when it is produced from photovoltaic or hydro sources, while it would be secondary when produced by burning fossil fuels. In the same way, heat would be primary when produced from nuclear power and secondary when originating from burning petroleum. Additionally, distinction is also made between renewable and non-renewable for some energy products. For example biofuels would be considered renewable as long as they are produced from crops or wood that is renewably or sustainably managed.

Total production (FDES 2.2.2.a.1)
Production is defined as the capture, extraction or manufacture of fuels or other energy products in forms which are ready for general use.[29] Total energy production originates from non-renewable and renewable sources. Total production corresponds to primary and secondary energy production. Thus it involves double-counting.

Production from non-renewable sources (FDES 2.2.2.a.2)
This refers to the capture, extraction or manufacture of fuels or other energy products from non-renewable sources in forms which are ready for general use.

Production from renewable sources (FDES 2.2.2.a.3)
This refers to the capture, extraction or manufacture of energy from renewable sources in forms which are ready for general use.

Primary energy production (FDES 2.2.2.a.4)
Primary production is 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.[30]

Secondary energy production (FDES 2.2.2.a.7)
Secondary production is the manufacture of energy products through the process of transformation of other fuels or energy, whether primary or secondary. The quantities of secondary fuels reported as production include quantities lost through venting and flaring during and after production. In this manner, the mass, energy and carbon within the primary source(s) from which the fuels are manufactured may be balanced against the secondary fuels produced. Fuels, electricity and heat produced are usually sold but may be partly or entirely consumed by the producer.[31]

Imports of energy (FDES 2.2.2.a.5)

Imports 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, while re-imports (i.e. 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 also excluded from imports. Note that the "country of origin" of energy products should be recorded, where possible, as the country from which goods were imported, but not a transit country.[32]

Imports of fossil and mineral energy resources calculated in term of currency correspond to the mass or volume imported times the price per mass or volume at which the commodities were bought from the rest of the world.

Exports of energy (FDES 2.2.2.a.6)

Exports of energy products comprise all fuel and other energy products leaving the national territory. Goods simply being transported through a country (goods in transit) and goods temporarily withdrawn are excluded, while re-exports (i.e. foreign goods exported in the same state as previously imported) are included. Also excluded are quantities of fuels delivered for use by merchant ships (including passenger ships) and civil aircraft, of all nationalities, during international transport of goods and passengers. Note that the "country of destination" of

[29] United Nations (2016) *International Recommendations for Energy Statistics.* ST/ESA/STAT/SER.M/93, pg.70, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016).
[30] United Nations (2016*) International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.70, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[31] United Nations (2016*) International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.70, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016).
[32] United Nations (2016) *International Recommendations for Energy Statistics.* ST/ESA/STAT/SER.M/93, pg.70, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

energy products (i.e. the country of the last known destination as it is known at the time of exportation) should be recorded as a country to which these products are exported to.[33]

Exports of fossil and mineral energy resources calculated in term of currency correspond to the mass or volume exported times the prices per mass or volume at which the commodities were sold to the rest of the world.

Total energy supply (TES) (FDES 2.2.2.b)

Represents the amount of energy that is available in the national territory during the reference period. [34] It includes also fuels delivered to international aviation and marine bunkers which is not part of the BSES, for further information refer to IRES. [35]

The total energy supply is to be calculated as follow:

Primary energy production
+ Import of primary and secondary energy
- Export of primary and secondary energy
- International (aviation and marine) bunkers
- Stock changes
= Total energy supply (TES)

Final consumption of energy (FDES 2.2.2.c)

The final consumption of energy is the final consumption of all energy products, by all users in the economy, net of intermediate consumption. It 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. As defined by IRES[36] "The final consumption of energy products consists of the (a) final energy consumption, i.e. deliveries of energy products to the users located in the territory of reference for their energy needs such as for heat raising, transportation and electricity, and (b) non-energy use, i.e. deliveries of energy products for use as chemical feedstocks or for use as raw materials". Final consumption of energy products represents the last stage in which the energy products are utilised and disappear from the statistical observation.

[33] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.70, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[34] United Nations (2016*) International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.128, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[35] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.71, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[36] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.72, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

4. International sources and recommendations

4A. Classifications and groupings

Four relevant classifications pertaining to energy resources and products are described below. The first one pertains to fossil energy and mineral reserves and resources while the others classify energy extraction/production activities and energy products.

4A1. The UN Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009).[37]

This classification is useful to understand the different levels of stocks of available resources (or reserves) in different countries, as it is a flexible, universally applicable scheme for classifying-evaluating both fossil energy and mineral reserves and resources. Since countries designate their layers of reserves with different denominations, this classification allows for a common and necessary international understanding of these classifications/evaluations. The classification is designed to allow the incorporation of current existing terms and definitions into the framework and thus to make them comparable and compatible. The specifications set out the basic rules that are considered necessary to ensure an appropriate level of consistency in application. They importantly provide additional instructions on how UNFC-2009 should be applied in specific circumstances.

Figure 4.1 UNFC-2009 Classes and sub-classes[38]

UNFC Classes Defined by Categories and Sub-categories						
Total Commodity Initially in Place	Extracted	Sales Production				
		Non-sales Production				
	Class		Sub-class	Categories		
				E	F	G
	Known Deposit	Commercial Projects	On Production	1	1.1	1, 2, 3
			Approved for Development	1	1.2	1, 2, 3
			Justified for Development	1	1.3	1, 2, 3
		Potentially Commercial Projects	Development Pending	2	2.1	1, 2, 3
			Development On Hold	2	2.2	1, 2, 3
		Non-Commercial Projects	Development Unclarified	3.2	2.2	1, 2, 3
			Development Not Viable	3.3	2.3	1, 2, 3
		Additional Quantities in Place		3.3	4	1, 2, 3
	Potential Deposit	Exploration Projects	[No sub-classes defined]	3.2	3	4
		Additional Quantities in Place		3.3	4	4

[37] UNECE (2010) *United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009.* ECE Energy Series No. 39, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/unfc2009/UNFC2009_ES39_e.pdf (accessed 1 March 2016)

[38] UNECE (2010) *United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009.* ECE Energy Series No. 39, pg. 9, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/unfc2009/UNFC2009_ES39_e.pdf (accessed 1 March 2016)

Fossil energy and mineral reserves and resources can be classified by the UNFC-2009 classes, which divides deposits into two main classes, know deposits and potential deposits. A known deposit is a deposit that has been demonstrated to exist by direct evidence. A potential deposit is a deposit that has not yet been demonstrated to exist by direct evidence (e.g. drilling and/or sampling), but is assessed as potentially existing based primarily on indirect evidence (e.g. surface or airborne geophysical measurements).

In the SEEA Central Framework, classes of known mineral and energy resources are defined according to combinations of criteria from the UNFC-2009.

Both classifications categorise mineral and energy resources by looking at whether, and to what extent, projects for the extraction and exploration of the resources have been confirmed, developed or planned. Based on the maturity of the projects the underlying resources are classified. The UNFC-2009 and the SEEA Central Framework are based on a breakdown of the resources according to three criteria affecting their extraction:

- Economic and social viability (E);
- Field project status and feasibility (F);
- Geological knowledge (G).

Criterion **E** designates the degree of favourability of economic and social conditions in establishing the commercial viability of the project. Criterion **F** designates the maturity of studies and commitments necessary to implement mining plans or development projects, extending from early exploration efforts occurring before it has been confirmed that a deposit or accumulation exists, to projects involving extraction and sale of a product. Criterion **G** designates the level of certainty of geologic knowledge and of potential recoverability of quantities of the resource concerned.[39]

FDES 2013 uses the same classes as the ones of SEEA. The SEEA and FDES classes are defined below.

Class A: Commercially Recoverable Resources. This class includes deposits for projects that fall in categories E1 and F1 and where the level of confidence in the geological knowledge is either high (G1), moderate (G2), or low (G3).

Class B: Potentially Commercially Recoverable Resources. This class includes deposits for those projects that fall in category E2 (or eventually E1) and at the same time in F2.1 or F2.2 and where the level of confidence in the geological knowledge is either high (G1), moderate (G2), or low (G3).

Class C: Non-Commercial and Other Known Deposits are resources for those projects that fall in category E3 and for which the feasibility is categorised as F2.2, F2.3 or F4 and where the level of confidence in the geological knowledge is either high (G1), moderate (G2), or low (G3).

The criteria are reflected in the UNFC-2009 categories. Figure 3 provides a mapping of the UNFC-2009 categories which have been aggregated to the SEEA classes A, B and C.

[39] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 161, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

Figure 4.2 Categories and Sub-categories of Mineral and Energy Resources[40]

SEEA classes		Corresponding UNFC-2009 project categories		
		E	F	G
		Economic and social viability	Field project status and feasibility	Geologic knowledge
Known deposits	A: Commercially recoverable resources[a]	E1. Extraction and sale have been confirmed to be economically viable	F1. Feasibility of extraction by a defined development project or mining operation has been confirmed	Quantities associated with a known deposit that can be estimated with a high (G1), moderate (G2) or low (G3) level of confidence
	B: Potentially commercially recoverable resources[b]	E2. Extraction and sale are expected to become economically viable in the foreseeable future[c]	F2.1 Project activities are ongoing to justify development in the foreseeable future Or F2.2 Project activities are on hold and/or where justification as a commercial development may be subject to significant delay	
	C: Non-commercial and other known deposits[d]	E3. Extraction and sale are not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability	F2.2 Project activities are on hold and/or where justification as a commercial development may be subject to significant delay Or F2.3 There are no current plans to develop or to acquire additional data at the time due to limited potential Or F4. No development project or mining operation has been identified	
Potential deposits (not included in SEEA)	Exploration projects Additional quantities in place	E3. Extraction and sale are not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability	F3. Feasibility of extraction by a defined development project or mining operation cannot be evaluated due to limited technical data Or F4. No development project or mining operation has been identified	Estimated quantities associated with a potential deposit, based primarily on indirect evidence (G4)

Notes

[a] Including on-production projects, projects approved for development and projects justified for development.

[b] Including economic and marginal development projects pending and development projects on hold.

[c] Potential commercial projects may also satisfy the requirements for E1.

[d] Including unclarified development projects, non-viable development projects, and additional quantities in place.

Source: UNFC-2009, figures 2 and 3.

4A2. General product and energy product classifications

Two product classifications are relevant for energy statistics, the Central Product Classification (CPC) and the Standard International Energy Product Classification (SIEC). The CPC is a general purpose product classification, which besides having a primary application in the measurement of production also takes on a central role in linking

[40] SEEA synthesis, based on UNFC-2009, UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 163, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

to other product classifications and providing a common basis for data comparisons. SIEC on the other hand is a classification specifically targeted at the needs of energy statistics, providing additional detail where necessary. While the two classifications can be linked, categories do not fully match. It is expected that future revisions of CPC and SIEC will lead to better harmonization between them.

4A2.1. The Central Product Classification (CPC)

For the purposes of identifying which elements and compounds are considered energy products, it is useful to consider the CPC ver. 2.1[41], which provides a detailed classification of the energy products within its Section 1, Divisions 11, 12, 13, 17, 33, 34 and 35.

Figure 4.3 Central Product Classification ver. 2.1

Group	Class	Subclass	Description	Corresponding HS 2007	Corresponding CPC 2	Corresponding ISIC 4
Section 1			**Ores and minerals; electricity, gas and water**			
Division 11			**Coal and peat**			
110			**Coal and peat**			
	1101	11010	Hard coal	2701.11, .12, .19	11010	0510
	1102	11020	Patent fuel and similar solid fuels manufactured from hard coal	2701.20	11020	1920
	1103	11030	Brown coal	2702.10	11030	0520
	1104	11040	Brown coal briquettes and similar solid fuels manufactured from brown coal	2702.20	11040	1920
	1105	11050	Peat	2703	11050	0892
Division 12			**Crude petroleum and natural gas**			
120			**Crude petroleum and natural gas**			
	1201	12010	Petroleum oils and oils obtained from bituminous minerals, crude	2709	12010	0610
	1202	12020	Natural gas, liquefied or in the gaseous state	2711.11, .21	12020	0620
	1203	12030	Bituminous or oil shale and tar sands	2714.10	12030	0610
Division 13			**Uranium and thorium ores and concentrates**			
130			**Uranium and thorium ores and concentrates**			
	1300	13000	Uranium and thorium ores and concentrates	2612	13000	0721
Division 17			**Electricity, town gas, steam and hot water**			
171			**Electrical energy**			
	1710	17100	Electrical energy	2716	17100	3510
172			Coal gas, water gas, producer gas and similar gases, other than petroleum gases and other gaseous hydrocarbons			
	1720	17200	Coal gas, water gas, producer gas and similar gases, other than petroleum gases and other gaseous hydrocarbons	2705	17200	3520
173			Steam and hot water			
	1730	17300	Steam and hot water	2201.90*	17300	3530
Division 33			**Coke oven products; refined petroleum products; nuclear fuel**			
331			**Coke and semi-coke of coal, of lignite or of peat; retort carbon**			
	3310	33100	Coke and semi-coke of coal, of lignite or of peat; retort carbon	2704	33100	1910
332			**Tar distilled from coal, from lignite or from peat, and other mineral tars**			
	3320	33200	Tar distilled from coal, from lignite or from peat, and other mineral tars	2706	33200	1910

[41] United Nations Statistics Division, (2008) *Central Product Classification (CPC) Ver.2.1*, http://unstats.un.org/unsd/cr/registry/cpc-2.asp

Group	Class	Subclass	Description	Corresponding HS 2007	CPC 2	ISIC 4
333			**Petroleum oils and oils obtained from bituminous materials, other than crude; preparations n.e.c. containing by weight 70% or more of these oils, such oils being the basic constituents of the preparations**			
	3331		Motor gasoline and aviation gasoline			
		33311	Motor gasoline	2710.12*	33310*	1920
		33312	Aviation gasoline	2710.12*	33310*	1920
	3332	33320	Gasolene-type jet fuel	2710.12*	33320	1920
	3333	33330	Naphtha	2710.12*, .19*	33330*, 33350*	1920
	3334		Kerosenes			
		33342	Kerosene-type jet fuel	2710.19*	33342	1920
		33349	Other kerosene	2710.19*	33341	1920
	3335	33350	White spirit and special boiling point industrial spirits	2710.19*	33350*	1920
	3336	33360	Gas oil	2710.19*, 2710.20, 3826.00*	33360	1920
	3337	33370	Fuel oils n.e.c.	2710.19*	33370	1920
	3338	33380	Lubricants	2710.19*	33380*	1920
	3339	33390	Other petroleum oils n.e.c.	2710.12*, .19*	33330*, 33350*, 33380*	1920
334			**Petroleum gases and other gaseous hydrocarbons, except natural gas**			
	3341	33410	Propane and butanes, liquefied	2711.12, .13	33410	1920
	3342		Ethylene, propylene, butylene, butadiene and other petroleum gases or gaseous hydrocarbons, except natural gas			
		33421	Ethylene, propylene, butylene, butadiene	2711.14	33420*	1920
		33429	Other petroleum gases or gaseous hydrocarbons, except natural gas	2711.19, .29	33420*	1920
335			**Petroleum jelly; paraffin wax, micro-crystalline petroleum wax, slack wax, ozokerite, lignite wax, peat wax, other mineral waxes, and similar products; petroleum coke, petroleum bitumen and other residues of petroleum oils or of oils obtained from bituminous materials**			
	3350	33500	Petroleum jelly; paraffin wax, micro- crystalline petroleum wax, slack wax, ozokerite, lignite wax, peat wax, other mineral waxes, and similar products; petroleum coke, petroleum bitumen and other residues of petroleum oils or of oils obtained from bituminous materials	2712, 2713	33500	1920
336			**Radioactive elements and isotopes and compounds; alloys, dispersions, ceramic products and mixtures containing these elements, isotopes or compounds; radioactive residues**			
	3361	33610	Natural uranium and its compounds; alloys, dispersions, ceramic products and mixtures containing natural uranium and its compounds	2844.10	33610	2011
	3362	33620	Uranium enriched in U235 and its compounds; plutonium and its compounds; alloys, dispersions, ceramic products and mixtures containing uranium enriched in U235, plutonium or compounds of these products	2844.20	33620	2011

Group	Class	Subclass	Description	HS 2007	Corresponding CPC 2	ISIC 4
	3363	33630	Uranium depleted in U235 and its compounds; thorium and its compounds; alloys, dispersions, ceramic products and mixtures containing uranium depleted in U235, thorium or compounds of these products	2844.30	33630	2011
	3369	33690	Other radioactive elements and isotopes and compounds; alloys, dispersions, ceramic products and mixtures containing these elements, isotopes or compounds; radioactive residues	2844.40	33690	2011
337			**Fuel elements (cartridges), for or of nuclear reactors**			
	3371	33710	Fuel elements (cartridges), non-irradiated, for nuclear reactors	8401.30	33710	2011
	3372	33720	Spent (irradiated) fuel elements (cartridges) of nuclear reactors	2844.50	33720	3510
Division 34			**Basic chemicals**			
341			**Basic organic chemicals**			
	3411	34110	Hydrocarbons and their halogenated, sulphonated, nitrated or nitrosated derivatives	2901 - 2904	34110	2011
	3412	34120	Industrial monocarboxylic fatty acids; acid oils from refining	3823.11 - .19	34120	2011
	3413		Alcohols, phenols, phenol-alcohols, and their halogenated, sulphonated, nitrated or nitrosated derivatives; industrial fatty alcohols			
		34131	Ethyl alcohol and other spirits, denatured, of any strength	2207.20	34131	2011
		34139	Other alcohols, phenols, phenol-alcohols, and their halogenated, sulphonated, nitrated or nitrosated derivatives; industrial fatty alcohols	2905.11 - .44, 2905.49 - .59, 2906 - 2908, 3823.70	34139	2011
...						
	3417	34170	Ethers, alcohol peroxides, ether peroxides, epoxides, acetals and hemiacetals, and their halogenated, sulphonated, nitrated or nitrosated derivatives; aldehyde-function compounds; ketone-function compounds and quinone-function compounds; enzymes; prepared enzymes n.e.c.; organic compounds n.e.c.	2909 - 2914, 2942, 3507	34170	2011
...						
342			**Basic inorganic chemicals n.e.c.**			
	3421	34210	Hydrogen, nitrogen, oxygen, carbon dioxide and rare gases; inorganic oxygen compounds of non-metals n.e.c.	2804.10 - .40, 2811.21, .29	34210	2011
....						
345			**Miscellaneous basic chemical products**			
	3451	34510	Wood charcoal	4402	34510	0220, 2011
....						
Division 35			**Other chemical products; man-made fibres**			
...						
	3549		Other chemical products			
		35491	Biodiesel	3826.00*	35490*	2029

4A2.2. The Standard International Energy Product Classification (SIEC)

In order to ensure cross-country and temporal comparability of the energy statistics, as well as their comparability with other statistics, it is of paramount importance to have internationally agreed definitions of energy products and their classification. Such definitions and classification should be promoted as a basic tool for energy statistics compilation and dissemination both at national and international levels. SIEC is designed to support the collection of data from data reporters and will: (i) facilitate and standardize the compilation and processing of energy data by providing a uniform, hierarchical coding system; (ii) ensure international comparability of disseminated national data; and (iii) facilitate linking of data on stocks and flows of energy products with data on international trade in energy products and other economic statistics.

A detailed definition for each of the products in the SIEC is presented in the IRES (Chapter 3, Section D). The hierarchy of SIEC consists of four levels, which are referred to as sections (the first level), divisions (the second level), groups (the third level), and classes (the fourth level). The coding system consists of a four-digit numerical code, where the first digit refers to the section, the first two digits to the division, and so on. Thus, all four digits, taken together, designate a particular class of the classification.

Figure 4.4 Standard International Energy Product Classification[42]

Section/Division/Group		Class	
0			**Coal**
	01		**Hard coal**
	011	0110	Anthracite
	012		Bituminous coal
		0121	Coking coal
		0129	Other bituminous coal
	02		**Brown coal**
	021	0210	Sub-bituminous coal
	022	0220	Lignite
	03		**Coal products**
	031		Coal coke
		0311	Coke oven coke
		0312	Gas coke
		0313	Coke breeze
		0314	Semi cokes
	032	0320	Patent fuel
	033	0330	Brown coal briquettes (BKB)
	034	0340	Coal tar
	035	0350	Coke oven gas
	036	0360	Gas works gas (and other manufactured gases for dist.)
	037		Recovered gases
		0371	Blast furnace gas
		0372	Basic oxygen steel furnace gas
		0379	Other recovered gases
	039	0390	Other coal products
1			**Peat and peat products**
	11		**Peat**
	111	1110	Sod peat
	112	1120	Milled peat

[42] United Nations (2016*) International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pgs. 31-34, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

	12			**Peat products**
		121	1210	Peat briquettes
		129	1290	Other peat products
2				**Oil shale / oil sands**
	20			**Oil shale / oil sands**
		200	2000	Oil shale / oil sands
3				**Natural gas**
	30			**Natural gas**
		300	3000	Natural gas
4				**Oil**
	41			**Conventional crude oil**
		410	4100	Conventional crude oil
	42			**Natural gas liquids (NGL)**
		420	4200	Natural gas liquids (NGL)
	43			**Refinery feedstocks**
		430	4300	Refinery feedstocks
	44			**Additives and oxygenates**
		440	4400	Additives and oxygenates
	45			**Other hydrocarbons**
		450	4500	Other hydrocarbons
	46			**Oil products**
		461	4610	Refinery gas
		462	4620	Ethane
		463	4630	Liquefied petroleum gases (LPG)
		464	4640	Naphtha
		465		Gasolines
			4651	Aviation gasoline
			4652	Motor gasoline
			4653	Gasoline-type jet fuel
		466		Kerosenes
			4661	Kerosene-type jet fuel
			4669	Other kerosene
		467		Gas oil / diesel oil and Heavy gas oil
			4671	Gas oil / Diesel oil
			4672	Heavy gas oil
		468	4680	Fuel oil
		469		Other oil products
			4691	White spirit and special boiling point industrial spirits
			4692	Lubricants
			4693	Paraffin waxes
			4694	Petroleum coke
			4695	Bitumen
			4699	Other oil products n.e.c.
5				**Biofuels**
	51			**Solid biofuels**
		511		Fuelwood, wood residues and by-products
			5111	Wood pellets
			5119	Other Fuelwood, wood residues and by-products
		512	5120	Bagasse
		513	5130	Animal waste
		514	5140	Black liquor

		515	5150	Other vegetal material and residues
		516	5160	Charcoal
	52			**Liquid biofuels**
		521	5210	Biogasoline
		522	5220	Biodiesels
		523	5230	Bio jet kerosene
		529	5290	Other liquid biofuels
	53			**Biogases**
		531		Biogases from anaerobic fermentation
			5311	Landfill gas
			5312	Sewage sludge gas
			5319	Other biogases from anaerobic fermentation
		532	5320	Biogases from thermal processes
6				**Waste**
	61			**Industrial waste**
		610	6100	Industrial waste
	62			**Municipal waste**
		620	6200	Municipal waste
7				**Electricity**
	70			**Electricity**
		700	7000	Electricity
8				**Heat**
	80			**Heat**
		800	8000	Heat
9				**Nuclear fuels and other fuels n.e.c.**
	91			**Uranium and plutonium**
		910	9100	Uranium and plutonium
	92			**Other nuclear fuels**
		920	9200	Other nuclear fuels
	99			**Other fuels n.e.c.**
		990	9900	Other fuels n.e.c.

Note: "Coal Products" refer to the products derived from hard coal and brown coal. "Peat products" refer to products derived from peat. "Oil products" refer to products derived from the processing of conventional crude oil, NGLs, other Hydrocarbons, refinery feedstock, etc.

4A3.The International Standard Industrial Classification of All Economic Activities (ISIC), Rev. 4.

In terms of the relevant classification for activities related to mineral extraction, resources extracted, transformed and distributed are classified in activities such as mining and quarrying, and the production and supply of energy. Extraction activities that fall under ISIC Rev. 4, Section B mining and quarrying Division 05, 06, 0721, 0892, 091, 099. Transformation activities fall under Division 19 Manufacture of coke and refined petroleum products; and Section D Electricity, gas, steam and air conditioning supply. Distribution activities fall under Division 35, Group 351 Electric power generation, transmission and distribution, as well as Group 352 Manufacture and distribution of gas.

Figure 4.5 ISIC Rev. 4 Section B Mining and quarrying

Division	Group	Class	Description
Division 05			**Mining of coal and lignite**
	051	0510	Mining of hard coal
	052	0520	Mining of lignite
Division 06			**Extraction of crude petroleum and natural gas**
	061	0610	Extraction of crude petroleum
	062	0620	Extraction of natural gas
Division 07			**Mining of metal ores**
	072		Mining of non-ferrous metal ores
		0721	Mining of uranium and thorium ores
...			
Division 08			**Other mining and quarrying**
	089		Mining and quarrying n.e.c.
		0892	Extraction of peat
...			
Division 09			**Mining support service activities**
	091	0910	Support activities for petroleum and natural gas extraction
	099	0990	Support activities for other mining and quarrying
...			
Division 19			**Manufacture of coke and refined petroleum products**
	191	1910	Manufacture of coke oven products
	192	1920	Manufacture of refined petroleum products
...			
Section D Electricity, gas, steam and air conditioning supply			
Division 35			**Electricity, gas, steam and air conditioning supply**
	351	3510	Electric power generation, transmission and distribution
	352	3520	Manufacture of gas; distribution of gaseous fuels through mains
	353	3530	Steam and air conditioning supply

Energy is used (or consumed) by all economic activities and households. In order to make proper policy interventions to improve the efficiency of energy use, statistics on the final consumers of energy is needed. The breakdown of final consumption of energy by users should also be based on ISIC.

4B. Reference to international statistical recommendations, frameworks and standards

The internationally recommended concepts and methodologies for energy statistics can be found in the *International Recommendations for Energy Statistics (IRES)*.[43] A summary of its main recommendations and encouragements can be found in Chapter 1, Section F.

The main purpose of IRES is to strengthen energy statistics as part of official statistics by providing recommendations on concepts and definitions, classifications, data sources, data compilation methods, institutional arrangements, approaches to data quality, metadata and dissemination policies. Developing energy statistics in compliance with IRES will make these statistics more consistent with other fields of economic statistics.

With respect to the scope of energy statistics in IRES, the recommendations contained in this publication are focused on basic energy statistics and energy balances. The basic energy statistics refer to statistics on energy stocks in the economy and their flows, energy infrastructure, performance of the energy industries, and the availability of energy resources within the national territory of a given country during a reference period. The energy balances are an accounting framework for compilation and reconciliation of data on all energy products entering, exiting and used within that territory. In addition, IRES provides a brief description of some of the uses of basic energy statistics and balances such as the compilation of environmental-economic accounts, indicators and greenhouse gas emissions. UNSD and the Oslo Group are working on the Energy Statistics Compilers Manual that will provide detailed guidance to countries.[44]

Additional conceptual and methodological guidance for energy statistics compilation can be found in the *Energy Statistics Manual* OECD-IEA-Eurostat, 2005.[45]

Energy accounts can also be compiled using the System of Environmental-Economic Accounting (SEEA) Central Framework (CF) methodology. The SEEA Central Framework can be found on the UNSD website http://unstats.un.org/unsd/envaccounting/seearev/. SEEA-Energy is a SEEA 'sub-system', currently under development, and it aims to provide compilers and analysts with agreed concepts, definitions, classifications, tables, and accounts for energy and energy-related air emission accounts. SEEA-Energy expands and elaborates on guidance on accounting included in the IRES. The SEEA Energy draft document is available from http://unstats.un.org/unsd/envaccounting/seeae/chapterList.asp. More detailed information about the links between these energy statistics and SEEA accounts can be found in section 6B.

4C. Sources of global and regional environment statistics and indicators series

UNSD Energy Statistics

UNSD collects energy statistics from more than 190 countries and updates and maintains the Energy Statistics Database, which contains energy statistics for the period 1950-2013. The statistics cover production, trade, transformation and final consumption (end-use) for a range of primary and secondary energy products derived from conventional, non-conventional or renewable energy sources. The Energy Statistics Database can be accessed from http://unstats.un.org/unsd/energy/edbase.htm

[43] United Nations (2016*) International Recommendations for Ene*rgy Statistics. ST/ESA/STAT/SER.M/93, pg.70, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[44] UNSD & Oslo Group (unpublished) *Energy Statistics Compilers Manual*, draft outline and chapters http://oslogroup.org/index.asp?page=escmmainpage.html
[45] OECD, IEA, Eurostat (2005) *Energy Statistics Manual*, http://www.iea.org/publications/freepublications/publication/statistics_manual.pdf

The database is also available in non-aggregated format on-line through UNdata (http://data.un.org/). The Energy Statistics Database provides statistics on production, trade, transformation and consumption (end-use) for solid, liquid, and gaseous fuels, electricity, and heat. The database contains data in their original units (e.g. metric tons, GWh) as well as calorific values to allow interfuel comparison in a common energy unit (terajoules).

The main source of information for the Energy Statistics Database is the UNSD Annual Questionnaire on Energy Statistics which is sent every year to national statistical offices, ministries of energy or other authorities responsible for energy statistics in the countries. Additional sources of information for the database include national, regional and international statistical publications - including, but not limited to publications from: the International Energy Agency (IEA), the Statistical Office of the European Union (Eurostat), the International Atomic Energy Agency (IAEA), the Organization of the Petroleum Exporting Countries (OPEC), and Latin American Energy Organization (OLADE). UNSD prepares estimates where official data are incomplete or inconsistent.

The annual publication Energy Statistics Yearbook is a collection of internationally comparable energy statistics covering the most recent years in the database.[46] The database also contributes to various statistical publications of UNSD, such as the Statistical Yearbook.

In turn, the annual publications Energy Balances and Electricity Profiles present energy data for selected countries in an energy balance format showing the total picture of energy production, transformation and consumption of energy products. It contains basic statistics for more than 200 countries/territories.

The International Energy Agency (IEA)

IEA is an autonomous organisation which works to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA's four main areas of focus are: energy security, economic development, environmental awareness, and engagement worldwide. Founded in response to the 1973/4 oil crisis, the IEA's initial role was to help countries co-ordinate a collective response to major disruptions in oil supply through the release of emergency oil stocks.[47]

IEA collects data though various energy questionnaires[48] and disseminates on its website[49] its statistical databases, including energy balance flows and energy indicators at the national, regional and global level. It also produces the CO_2 Emissions from Fuel Combustion database.[50] IEA also presents yearly publications, such as Key World Energy Statistics, Energy Statistics of OECD countries, Energy Statistics and Balances for non-OECD countries, World Energy Outlook, as well as publications for sale on various energy products such as coal, oil and natural gas information, electricity, renewables, energy balances, etc.

The International Renewable Energy Agency (IRENA)

IRENA is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity".[51] With over 100 states and the European Union as members, and active participation by

[46] United Nations Statistics Division, *Energy Statistics Yearbook*, http://unstats.un.org/unsd/energy/yearbook/default.htm.
[47] International Energy Agency, http://www.iea.org/about/
[48] International Energy Agency, Energy Questionnaires http://www.iea.org/statistics/resources/questionnaires/
[49] International Energy Agency, Statistical Databases http://www.iea.org/statistics/
[50] International Energy Agency, CO_2 Emissions from Fuel Combustion database
http://data.iea.org/payment/products/115-co2-emissions-from-fuel-combustion-2016-edition.aspx
[51] International Renewable Energy Agency, http://www.irena.org/home/index.aspx?PriMenuID=12&mnu=PriPriMenuID=12&mnu=Pri

many more signatories and applicants for membership around the world, IRENA helps countries achieve their clean energy potential and promotes renewable resources and technologies as the key to a sustainable future.[52]

With a mandate from countries around the world, IRENA encourages governments to adopt enabling policies for renewable energy investments, provides practical tools and policy advice to accelerate renewable energy deployment, and facilitates knowledge sharing and technology transfer to provide clean, sustainable energy for the world's growing population.[53]

IRENA provides statistics and spatialized data about renewable energy through:

- The Global Renewable Energy Atlas, hosted on the IRENA website, which maps solar, and wind sources country by country;
- Renewable Energy Country Profiles.[54]

Various publications from IRENA analyse the main global trends in renewable energy production and use around the world.[55] Additionally, IRENA features the Renewable Energy Policies and Measures Database[56], as well as the Studies on Renewable Energy Potential[57] around the world including wind, solar, biomass, hydro, marine and geothermal.

The International Atomic Energy Agency (IAEA)

IAEA was established in 1957 to ensure safe management of the uprising developments on nuclear energy. Today, IAEA is also known as Atoms for Peace within the UN family[58] and its mandate is to facilitate, develop and share technology advances and governance among its over 160 nation members to ensure a safe, responsible and peaceful use of nuclear technologies. On its Medium Term Strategy (2012-2017)[59], the IAEA has strengthened its focus on supporting global socio-economic development by becoming a reliable source of information to policy makers and experts in matters such as human health, cancer treatment, food security, water resource management, industrial applications and environmental monitoring.

IAEA releases the following annual reports:

- IAEA Annual Report, contains statistics on Nuclear Technology, Nuclear Safety and Security and, Technical Cooperation.[60]
- Nuclear Safety Review, covers issues and trends in nuclear, radiation, transport, and radioactive waste safety.[61]
- Nuclear Technology Review, biennial, reports on the global status and trends in fields of nuclear science and technology.[62]

[52] International Renewable Energy Agency, http://www.irena.org/home/index.aspx?PriMenuID=12&mnu=PriPriMenuID=12&mnu=Pri
[53] International Renewable Energy Agency, http://www.irena.org/Menu/index.aspx?PriMenuID=13&mnu=Pri
[54] International Renewable Energy Agency, Reports and papers, http://www.irena.org/Publications/index.aspx?mnu=cat&PriMenuID=36&CatID=141
[55] International Renewable Energy Agency, Reports and papers, http://www.irena.org/Publications/index.aspx?mnu=cat&PriMenuID=36&CatID=141
[56] International Renewable Energy Agency, *Global Renewable Energy Policies and Measures*, http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=35&CatID=109&SubcatID=158&RefID=158&SubID=170&MenuType=Q
[57] International Renewable Energy Agency, Studies, http://www.irena.org/potential_studies/
[58] The International Atomic Energy Agency - IAEA (2015) https://www.iaea.org/about
[59] The International Atomic Energy Agency - IAEA (2015) "Medium Term Strategy 2012–2017", https://www.iaea.org/sites/default/files/mts2012_2017.pdf
[60] International Atomic Energy Agency (2014) *IAEA Annual Report 2014*, https://www.iaea.org/sites/default/files/gc59-7_en.pdf
[61] International Atomic Energy Agency (2014) *Nuclear Safety Review 2014*, https://www.iaea.org/About/Policy/GC/GC58/GC58InfDocuments/English/gc58inf-3_en.pdf
[62] International Atomic Energy Agency (2015) *Nuclear Technology Review 2015,* https://www.iaea.org/sites/default/files/ntr2015.pdf

The Joint Organization Data Initiative (JODI-Oil AND JODI-Gas)

The Joint Organization Data Initiative – JODI-Oil[63], originated in the 1990s in response to the urgent need for a centralized, reliable and transparent database containing global oil market data with the aim to improve oil price volatility. Six international organizations, representing 90% of the oil global supply and demand, committed to submit monthly statistics from their country members via a questionnaire focused on 42 key oil data points. In 2008, JODI expanded to cover natural gas market data (JODI-Gas) which, as of today, includes 80% of the global natural gas market information.[64]

The JODI questionnaire and reports focus on key areas such as internal production, imports and exports, product transfers, direct use, stocks and demand. The information can be consulted by participating country and month of the year.[65]

The Organization of the Petroleum Exporting Countries (OPEC)[66] produces statistics about petroleum and natural gas reserves, production and trade of its member countries every year.

Regional Sources:

The Latin American Energy Organization (OLADE)

OLADE features a system of energy information for the Latin American region (in Spanish: *Sistema de Información Energética Regional*)[67] featuring regional and country level statistics on energy.

[63] Joint Organization Data Initiative – JODI-Oil (2015), https://www.jodidata.org/oil/
[64] Joint Organization Data Initiative – JODI-Gas (2015), https://www.jodidata.org/gas/
[65] Joint Organization Data Initiative – JODI-Oil (2015), https://www.jodidata.org/
[66] Organization of the Petroleum Exporting Countries, http://www.opec.org/opec_web/en/index.htm
[67] Latin American Energy Organization, System of energy information, http://www.olade.org/producto/sie-regional/?lang=en

5. Data collection and sources of data

In general, the production of energy from non-renewable and renewable sources is captured under the economic activities ISIC Rev. 4. Energy products resulting from extraction and transformation activities can be classified according to the Standard International Energy Product Classification (SIEC) contained in the IRES.[68] For further detail see section 4A2 Classifications above.

For the variables relating to energy reserves and production (fossil fuels stocks and extraction), most countries engaged in their production collect and disseminate these basic statistics on a regular basis, and the ones that import them, usually present statistics informing on energy products trade.

Environment statistics about energy resources and their use are commonly collected and disseminated by specialized institutions such as the energy authorities and/or the national statistical offices.

Scope

The scope comprises all energy stocks and flows, including energy resources, energy extracted/produced, energy products traded, and energy consumed for all energy products and types of energy sources.

Statistical unit

For practical purposes of energy statistics, IRES differentiates and defines the following statistical units: enterprise, establishment, kind-of-activity unit, unit of homogeneous production and household. The recommendation of IRES is that the statistical units in energy statistics should ideally be the establishment and households. The establishment is recommended because it is the most detailed unit for which the range of data required is normally available. In order to be analytically useful, data need to be grouped according to such characteristics as kind-of-activity, geographical area and size, and this is facilitated by the use of the establishment unit. The enterprise unit is an economic entity which may be engaged in one or more productive activities in one or more locations; it may consist of several establishments. In practice, in the majority of the cases, the establishment and the enterprise are the same units. Where this is not the case, in general, it is recommended that large enterprises engaged in many economic activities that belong to different industries be broken up into one or more establishments, provided that smaller and more homogeneous units can be identified for which data may be meaningful.[69]

The collection of information about the environment, particularly as it concerns environmental assets, requires consideration of appropriate statistical units for the environment, reflecting the parts of the environment for which statistics may be collected and presented. Examples include inland water bodies (lakes, rivers, etc.), specific deposits of mineral resources, forests and fish stocks. While, in some cases, it will be possible to align the environmental statistical unit and an associated economic unit, this should not be expected.[70]

Measurement unit

This section is synthetized from IRES Chapter 4 Measurement Units and Conversion Factors.[71] Energy products are measured in physical units by their mass, volume, and energy content. The measurement units that are specific to an energy product and are employed at the point of measurement of the energy flow are often referred to as

[68] United Nations (2016) *International Recommendations for Energy* Statistics. ST/ESA/STAT/SER.M/93, pg.70, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[69] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.89, http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)
[70] UN, EC, FAO, IMF, OECD and WB (2014) *System of Environmental-Economic Accounting 2012- Central Framework*, pg. 31, http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf.
[71] United Nations (2016) *International Recommendations for Energy Statistics.* ST/ESA/STAT/SER.M/93, pg.51 onwards. http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

"original" or "natural" units. Coal, for example, is generally measured by its mass and crude oil by its volume. Cross-fuel tabulations such as the energy balances are displayed in a "common unit" to allow comparison across energy products. These "common" units are usually energy units and require the conversion from an original unit through the application of an appropriate conversion factor.[72] When different units are used to measure a product, the compiler is left with the task of converting units which, in the absence of specific information on the products necessary for the conversion between different units (such as density, gravity and calorific value), may lead to discrepancies.

IRES Chapter 4 provides a review of the measurement units used for energy statistics, explains the concepts of "original" and "common" units, and presents default conversion factors to use in the absence of country or region specific calorific values. It also states that the only energy unit in the International System of Units is the *Joule* and it is usually used in energy statistics as a common unit, although other energy units are also applied (e.g., toe, GWh, Btu, calories, etc.). IRES recommends the use of the joule as a common unit. It is further recommended that national and international agencies responsible for energy statistics always clearly define the measurement units as well as the common units used. The conversion factors and the methods used to convert original physical units into the chosen common unit or units should be described in energy statistics metadata and be readily accessible to users. In addition, it should be made clear whether energy units are defined on a gross or net calorific basis.

Sources and institutions

Because different energy statistics have different sources and may be produced by different institutions, it is useful to group them to describe the data collection/compilation processes. Below, a description of the type of sources, the main institutional partners and availability of statistics are provided by grouping the individual statistics about energy resources in five groups.

a) Energy stocks

Fossil energy resources or stocks that are available in countries are usually estimated by the petroleum, mining, energy and/or geological authorities. The statistical source can include a combination of geological surveys and studies as well as expert estimation. Currently, most countries with important fossil energy resources produce estimation of stocks or reserves by fuel regularly, as it is highly relevant for economic production prospects. Levels of estimated fossil energy stocks or oil/gas/coal may vary over time, as determined by the geological, economic and technological information affecting the known reserves. Estimations are presented in physical units for the most important fossil energy resources in each country.

b) Energy stocks reappraisals, reclassifications and catastrophic losses

Petroleum, gas and coal stocks reappraisals, reclassifications and eventual catastrophic losses are usually estimated and reported by the petroleum/mining/energy and/or geological authorities in each country. These estimations are generally based on field observation and expert knowledge and assessment taking into consideration geological, economic and technological factors that affect these variables. Levels of disaggregation and periodicity for variables affecting oil/gas/coal stocks (other than extraction) can vary, but annual data is usually produced. These statistics are usually presented in physical units.

c) Energy production/extraction

The main statistics on fossil energy production/extraction are usually produced by the NSO and/or petroleum/gas/coal and/or geological authorities, and the industrial/economic authorities depending on the institutional set up of the country. Surveys are a common form of data collection, which can include economic surveys or specialized industrial surveys. The main statistics on extraction of energy from non-renewable resources are obtained from economic statistics on mining as well as energy statistics. Currently, most countries with important fossil energy production produce these statistics regularly with dissemination for public use. Levels of disaggregation and periodicity for the energy production/extraction may vary, but quarterly and annual statistics are

[72] The detailed description of units of measure was provided in *Energy statistics: definitions, units of measure and conversion factors,* Studies in Methods, Series F, No. 44, United Nations, New York, 1987 and in IEA/Eurostat *Energy Statistics Manual*, Paris, 2005, Chapter 1, Section 5.

usually produced in most countries, disaggregated by product. Statistics on production/extraction are presented in both physical units and monetary units for the fossil energy products produced in each country.

d) Trade of energy products

Trade of energy products including exports and imports (in quantity and in value incorporating prices) are regularly produced within commodity trade statistics by the NSO and/or the economic and/or trade/authority, habitually based on administrative records produced by the trade and/or the customs authorities in each country. For fossil fuel importing countries that do not produce oil, natural gas and/or coal themselves, these statistics are the only source of their supply of non-renewable energy statistics. Levels of disaggregation and periodicity for the non-renewable energy products traded can vary, but quarterly and annual statistics are usually produced and disseminated in most countries. Statistics are usually presented in both physical units and monetary units.

e) Production, supply and final consumption of energy

Primary and secondary production, and renewable and non-renewable energy production and final consumption statistics are primarily produced by the energy/electricity authorities and possibly by the NSO in the form of energy statistics and energy balances. These institutions usually collect and disseminate these statistics on physical and monetary value, with varied periodicity as informational needs require, but in general, annual production of these statistics is common.

The most important statistics cover the production of energy by the different types of energy from non-renewable and renewable sources, production of primary and secondary energy, total energy supply and the final consumption of energy. Both total production of primary and secondary energy can be disaggregated by energy resource used or fuel, as regularly produced for national energy balances. Total primary energy production is a very important statistic for countries. Final consumption of energy, broken down by economic activity and households is very important to compile indicators about energy intensity and efficiencies, depending on the most energy-intense economic activities in a given country. Further detail is provided in IRES Chapter 8.[73]

Aggregation

Some degree of aggregation and disaggregation of the energy resources, products extracted and produced, as well as final consumption will be necessary, depending on the information objectives of such statistical operations.

Temporal aspects

Energy statistics and energy balances are produced annually in most countries. Some statistics on production and trade of crude oil, natural gas and oil products can be produced per quarter and even monthly, depending on their importance to the national economy. IRES recommends that the Energy Balances are produced with a periodicity of one year. From the environment statistics production perspective, the energy statistics series to be compiled within this sub-component, can also accommodate a periodicity of one year.

Seasonal variation can affect some series, namely production from renewables such as wind and solar, as well as hydroelectric because dry/rainy seasons affect the water in their reservoirs. This should be considered when examining and compiling statistics about these energy production and use processes.

Spatial aspects

Electricity production and use, as well as installed capacity can also be aggregated from primary available statistics. When produced primarily incorporating administrative or geospatial dimensions, energy statistics can be disaggregated by subnational administrative or spatial unit as necessary from the environment statistics perspective.

[73] United Nations (2016) *International Recommendations for Energy Statistics*. ST/ESA/STAT/SER.M/93, pg.130-133 onwards. http://unstats.un.org/unsd/energy/ires/IRES_Whitecover.pdf (accessed 1 March 2016)

Other aspects

It is important to produce statistics by individual energy commodities as this is significant for management of non-renewable resources in a sustainable way. However, to show fuel requirements in terms of a principal product statistics can also be produced by aggregating over energy commodities to show quantities in energy equivalent units, e.g. oil and coal can be aggregated to quantity of oil equivalent.

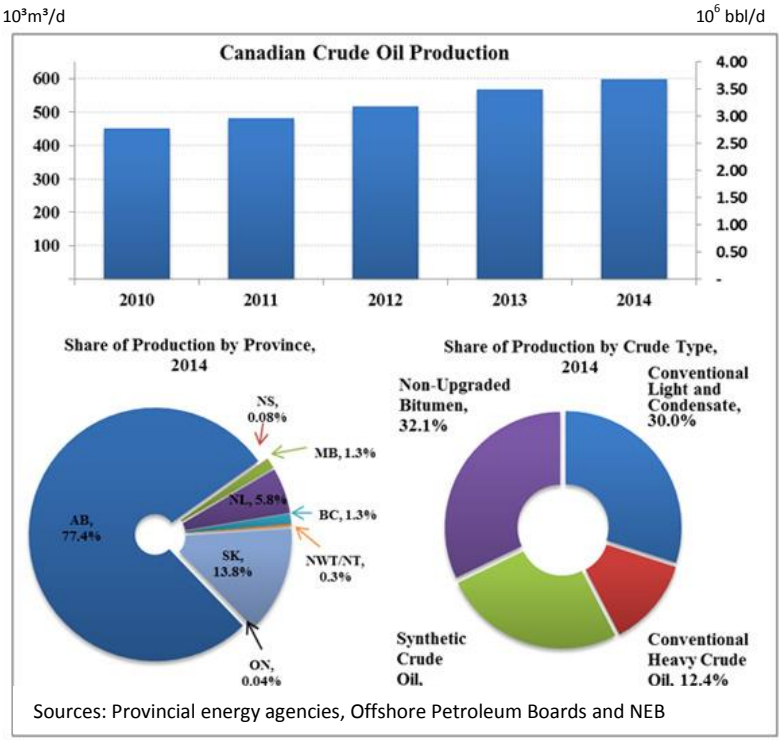
It is also important to link the final consumption of energy to economic activities to ISIC Rev. 4 activities.

6. Uses and dissemination

6A. Potential presentation/dissemination formats

The following images illustrate some of the potential dissemination formats for the supply, consumption and balances at the national levels.

Figure 6.1 Average Annual Crude Oil Production National Energy Board – Canada

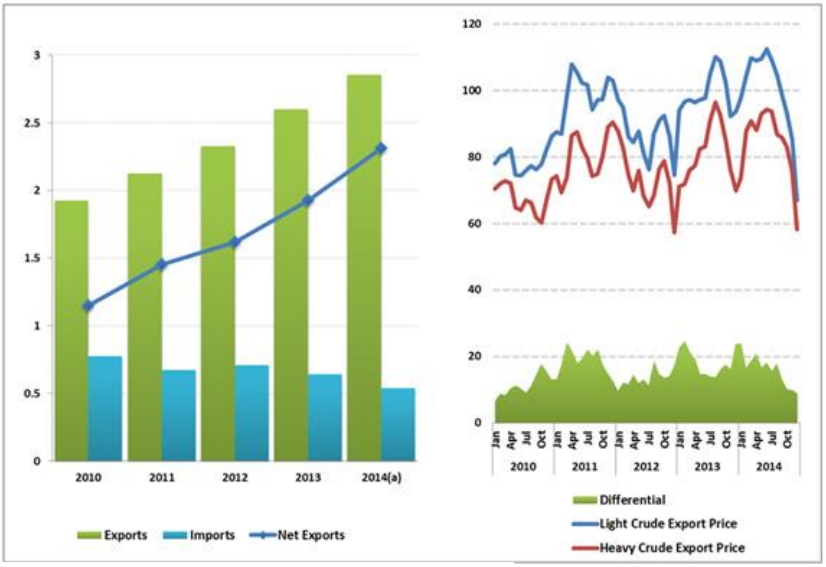


Source: National Energy Board Canada (2015) *Canadian Energy Overview 2014: Energy Briefing Notes*, https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/vrvw/2014/index-eng.html

Shows statistics on production of oil by type of oil product in volume (barrels per day).

Figure 6.2 Average Annual Crude Oil Exports and Imports

A) Light and Heavy Crude Oil Exports (Million bbl/d)



B) Light and Heavy Crude Oil Export Prices ($/bbl)

(b) Estimates Sources: NEB and Statistics Canada

Source: National Energy Board Canada (2015) *Canadian Energy Overview 2014: Energy Briefing Notes*, https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/vrvw/2014/index-eng.html

Shows statistics on oil imports and exports in volume (barrels per day) and price per barrel.

Figure 6.3 Energy Balance, Switzerland 2014 (in TJ)

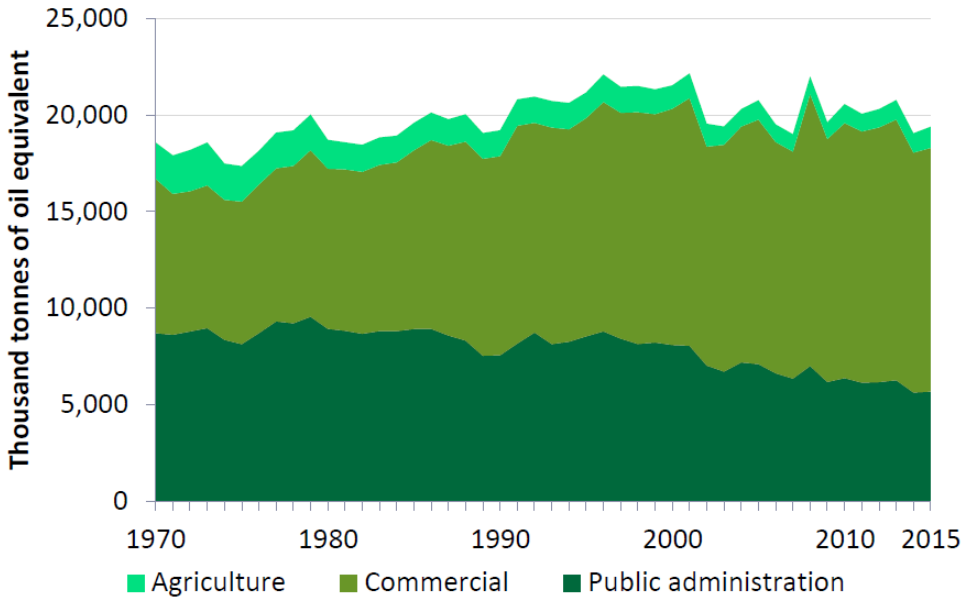
		Energie du bois	Charbon	Ord.mén.et déchets ind.	Pétrole brut	Produits pétroliers	Gaz	Energie hydraulique	Combustibles nucléaires	Autres énergies renou-velables	Electricité	Chaleur à distance	Total
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Production indigène	(a)	37,020		56,880			0	141,510		22,770			258,180
+ Importation	(b)	1,630	4,640		213,010	267,220	111,770		287,670	670	134,780		1,021,390
+ Exportation	(c)	-150	0			-21,810					-154,540		-176,500
+ Variation de stock[1]	(d)		1,270		-480	4,620							5,410
= Consommation brute	(e)	38,500	5,910	56,880	212,530	250,030	111,770	141,510	287,670	23,440	-19,760	0	1,108,480
+ Transformation d'énergie:													
• Centrales hydrauliques	(f)							-141,510			141,510		0
• Centrales nucléaires	(g)								-287,670		94,930	1,190	-191,550
• Centrales thermiques class.,chauffage à distance, centrales chaleur-force	(h)	-2,000	0	-45,050		-780	-4,970				8,810	16,670	-27,320
• Usines à gaz	(i)						0						0
• Raffineries	(j)				-212,530	211,540							-990
• Renouvelables div.	(k)	-2,000					690			-5,990	5,430	0	-1,870
+ Consommation propre du secteur énergétique, pertes de réseau, Pompage d'accumulation	(l)					-14,200	-390				-24,040	-1,570	-40,200
+ Consommation non énergétique	(m)					-20,780							-20,780
= Consommation finale	(n)	34,500	5,910	11,830	0	425,810	107,100	0	0	17,450	206,880	16,290	825,770
Ménages	(o)	16,600	400			75,230	42,520			11,940	65,830	6,480	219,000
Industrie	(p)	10,290	5,510	11,830		16,510	40,210			1,440	64,870	6,210	156,870
Services	(q)	7,040	0			32,920	22,630			2,990	61,630	3,600	130,810
Transport	(r)					298,260	1,500			870	11,050		311,680
Différence statistique, y compris l'agriculture	(s)	570	0			2,890	240			210	3,500	0	7,410

[1] + diminution de stock
- augmentation de stock

Source: Schweizerische Gesamtenergiestatistik 2015 - Tabellen, Swiss Federal Office of Energy SFOE, http://www.bfe.admin.ch/themen/00526/00541/00542/00631/index.html?lang=en&dossier_id=05071

Example of energy balance for various energy products.

Figure 6.4 Energy consumption in the services sector United Kingdom



Source: Department for Business, Energy and Industrial Strategy (2016) *Energy Consumption in the UK, November 2016,* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/573269/ECUK_November_2016.pdf, accessed December 2016.

Statistics on final consumption of energy in the services sector.

Figure 6.5 Production from renewable and non-renewable sources and energy balance

Key figures for energy

Production of energy and district heating

	GWh	Share	Change in % previous period	Year
Electric power production	133 975	100.0	-9.3	2013
Hydroelectric power	128 699	96.1	-9.9	2013
Thermal power	3 395	2.5	1.1	2013
Wind power	1 881	1.4	21.5	2013
Net production of district heating	5 020	.	-5.0	2014

Oil and gas

	Unit	Value	Change in % previous period	Change in % last 3 years	Year
Crude oil production	NOK million	214 310	1.1	45.1	2014

Source: Statistics Norway, https://www.ssb.no/en/energi-og-industri/nokkeltall/energy-and-manufacturing

Statistics on volume of energy produced from renewable and non-renewable sources.

Electricity balance. Annual. GWh.			
	2013	Share	Per cent 2012 - 2013
Production, total	133 975	100.0	-9.3
Hydro power production	128 699	96.1	-9.9
Thermal power production	3 395	2.5	1.1
Wind power production	1 881	1.4	21.5
Imports	10 135		141.9
Exports	15 140		-31.2
Gross consumption	128 970		-0.7
Pump storage use and other own consumption	1 406		-32.9
Loss and statistical difference	8 024		-11.8
Net consumption	119 540	100.0	0.7
Mining and manufacturing etc.	51 928	43.4	0.4
Services etc.	26 647	22.3	0.0
Private households and agriculture	40 965	34.3	1.5

Source: Statistics Norway, https://www.ssb.no/en/energi-og-industri/statistikker/elektrisitetaar/aar

Example of an energy balance for electricity.

Figure 6.6 Stocks and consumption U.S. Energy Information Administration (EIA) – United States of America

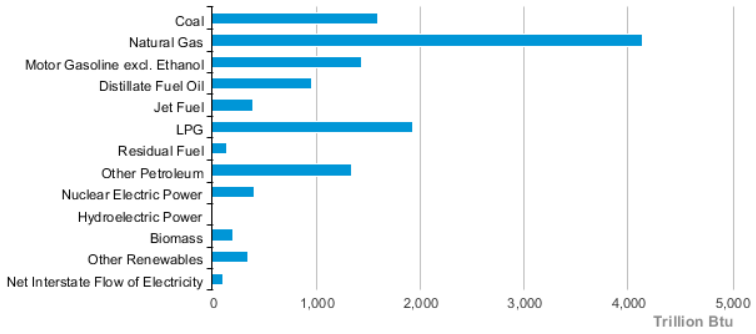
U.S. Total Stocks of crude oil and petroleum products

Show Data By: ◉ Product ○ Stock Type ○ Area	Graph Clear	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	View History
Crude Oil and Petroleum Products		2,032,041	2,047,703	2,046,866	2,062,466	2,062,804	2,047,628	1956-2016
Crude Oil		1,201,394	1,204,084	1,193,068	1,185,109	1,178,710	1,164,153	2005-2016
All Oils (Excluding Crude Oil)		830,647	843,619	853,798	877,357	884,094	883,475	1993-2016
Pentanes Plus		20,248	20,552	20,935	21,950	24,338	24,856	1981-2016
Liquefied Petroleum Gases		149,984	166,533	190,847	208,201	224,246	226,781	1967-2016
Ethane/Ethylene		39,064	44,952	51,566	52,942	49,541	49,602	1967-2016
Propane/Propylene		73,861	76,605	85,179	90,602	98,823	103,828	1971-2016
Normal Butane/Butylene		28,068	36,074	45,214	56,035	67,078	65,041	1981-2016
Isobutane/Butylene		8,991	8,902	8,888	8,622	8,804	8,310	1981-2016
Other Hydrocarbons		23	19	23	14	14	14	2009-2016
Oxygenates (excluding Fuel Ethanol)		1,372	1,388	993	1,239	1,092	1,498	2005-2016
MTBE		1,022	929	893	801	848	1,068	1993-2016
Other Oxygenates		350	459	100	438	244	430	1993-2016
Renewables (including Fuel Ethanol)		25,919	25,525	26,652	26,477	26,276	25,581	2005-2016
Fuel Ethanol		20,992	20,792	21,199	21,167	21,042	20,605	1993-2016
Renewable Diesel Fuel		4,916	4,722	5,417	5,278	5,196	4,926	2009-2016
Other Renewable Fuels		11	11	36	32	38	50	2012-2016
Unfinished Oils		90,034	90,001	86,716	88,057	83,994	83,333	1981-2016
Naphthas and Lighter		20,299	20,647	19,084	19,294	19,803	19,689	2005-2016
Kerosene and Light Gas Oils		15,272	16,297	15,246	15,276	14,470	15,304	2005-2016
Heavy Gas Oils		41,496	40,947	39,378	40,042	37,779	37,113	2005-2016
Residuum		12,967	12,110	13,008	13,445	11,942	11,227	2005-2016

Source: U.S. Energy Information Administration, http://www.eia.gov/dnav/pet/pet_stoc_typ_d_nus_SAE_mbbl_m.htm

Extract from table of statistics on stocks of crude oil and petroleum products (monthly, thousands of barrels).

Texas Energy Consumption Estimates, 2013

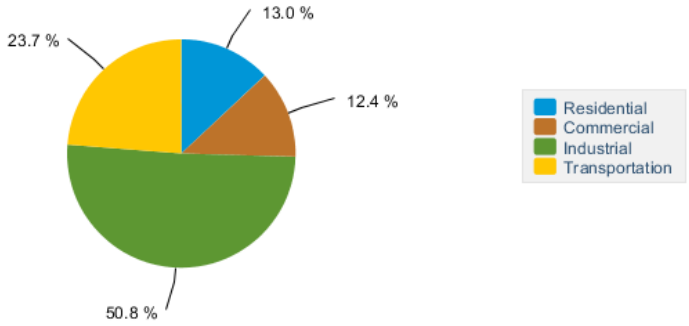


eia Source: Energy Information Administration, State Energy Data System

Source: U.S. Energy Information Administration, http://www.eia.gov/state/?sid=TX

Statistics on final consumption of energy in energy units (btu) by energy product.

Texas Energy Consumption by End-Use Sector, 2013



eia Source: Energy Information Administration, State Energy Data System

Source: U.S. Energy Information Administration, http://www.eia.gov/state/?sid=TX

Statistics on final consumption by sector.

6B. SEEA accounts/tables that use these statistics

The statistics about fossil energy reserves/stocks and flows (extraction, reappraisals, and reclassifications) are key elements of the mineral asset accounts in the SEEA-CF.

Differences between energy balances and energy accounts

While both energy balances and energy accounts show the flow of energy in the economy, they meet different users' needs and have a number of differences which can be grouped into conceptual differences, terminology differences and presentation differences.

A key conceptual difference is that the energy balances are based on the territory principle (as are basic energy statistics), while the energy accounts are based on the residence principle. This leads to differences in the way certain transactions are recorded. Another conceptual difference is that in the energy accounts a physical energy unit is generally regarded as a 'product' when a transaction of positive monetary value occurs between two economic units. Energy produced for own use is included as an energy product by exception. In contrast, the energy balances consider all physical flows of energy.

Differences in terminology primarily relate to terms such as supply, use and final consumption, which are well defined in balances and accounts, but carry different meanings. Supply in the energy balances represents energy entering the national territory for the first time less energy exiting from the national territory and stock changes, thus following a supply for use in the national territory concept. In energy accounts, on the other hand, supply represents output of products (by economic activities) plus imports, following an all energy available for use concept. In turn, this results in a different interpretation of use, which in the energy accounts for example includes exports.

Final consumption in energy balances refers to the use of energy delivered to final consumers (in the form of fuels, electricity or heat), but excludes the use of energy products in the energy industries and by other energy producers as inputs into transformation or energy industry own use. In energy accounts, the term final consumption refers to the use of goods and services by individual households or the community to satisfy their individual or collective needs or wants. When the goods and services are used as inputs to the production process by economic units, this is referred to as intermediate consumption in the energy accounts. (These terminology differences could also be considered as conceptual differences, given their impact.)

The term energy industries own use in energy balances refers to consumption of fuels and energy for the direct support of the production and preparation for use of fuels and energy (excluding use for transformation), while in the energy accounts, own use refers to intra-establishment production and use of energy products. Other smaller terminology differences affect stocks in energy balances, which are referred to as inventories in energy accounts, while their scope is the same.

Due to these differences in terminology, the presentation of energy balances and accounts differs, for example in showing blocks for final consumption or intermediate consumption. Another important difference in presenting data is that energy accounts follow a strict industry breakdown, while energy balances group entries by major type of flow and application in addition to an industry breakdown. As such, information obtained from a single enterprise is not necessarily linked to the unit's ISIC class, but may be presented in different blocks of the balances (such as transformation and energy industries own use), depending on the type of use and ISIC class involved. A particular example is the use of energy for transport purposes, which is presented as a single block in energy balances, while it is allocated across ISIC classes in the energy accounts.

6C. Commonly used indicators that incorporate these statistics

- **Reserves to production ratio** (extraction as a proportion of stocks of resources)
  This ratio represents the remaining period of availability of the resource if its extraction continues at the same path and its resources or reserves are not modified through new discoveries, reappraisals or reclassification. It is commonly used in the oil and gas industry.

  $$Reserves\ to\ production\ ratio = \frac{2.2.2.a.4\ Primary\ energy\ production, by\ resource}{2.2.1.a.1\ Stocks\ of\ commercially\ recoverable\ resources, by\ resource}$$

- **Energy use per capita**
  In developing economies growth in energy use is closely related to growth in the modern sectors - industry, motorized transport, and urban areas - but energy use also reflects climatic, geographic, and economic factors (such as the relative price of energy). Energy use has been growing rapidly in low- and middle-income economies, but high-income economies still use almost five times as much energy on a per capita basis.[74] It is a useful indicator to compare countries with different population.

  $$Energy\ use\ per\ capita = \frac{2.2.2.b\ Total\ energy\ supply}{Population\ of\ the\ country}$$

  The World Bank derives this indicator from data provided by the International Energy Agency: http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE
  UNSD collects and disseminate data on the total energy supply via its Energy Statistics Yearbook: http://unstats.un.org/unsd/energy/yearbook/default.htm

- **Energy consumption per capita**
  In order to compare countries of different population in term of energy consumption, an indicator per capita is required.

  $$Energy\ consumption\ per\ capita = \frac{2.2.2.c\ Final\ consumption\ of\ energy}{Population\ of\ the\ country}$$

  UNSD collects and disseminate data on total consumption of energy via its Energy Statistics Yearbook: http://unstats.un.org/unsd/energy/yearbook/default.htm

- **Energy intensity by sector** (manufacture, agricultural, transportation). Energy intensity by sector is calculated using value added (i.e. GDP by sector). Energy intensity can be used as a proxy to measure the energy efficiency of an economic sector. It is obtained by dividing the energy consumed by a certain sector by the value added of the same sector. An economic sector with a low energy intensity puts less pressure on the environment that an economic sector with high energy intensity.

  $$Energy\ intensity\ by\ sector = \frac{2.2.2.c\ Final\ consumption\ of\ energy, by\ ISIC\ economic\ activity}{Value\ added, by\ ISIC\ economic\ activity}$$

  It is also possible to calculate the total energy intensity (i.e. energy intensity of the whole economy). To do so, the energy consumed by the households should also be included. When calculating the total energy intensity, it is important to keep in mind that the indicator does not take into account the structure of the economy.

[74] The World Bank, *Energy use (kg of oil equivalent per capita) metadata*, http://databank.worldbank.org/data/reports.aspx?source=2&type=metadata&series=EG.USE.PCAP.KG.OE (accessed 28 December 2016)

For the total energy intensity it is also possible to use total energy supply instead of final consumption of energy, as illustrated by the SDG indicator presented in Section 6D or by the former MDG indicator below.

Energy use (kg oil equivalent) per $1,000 GDP was the Millennium Development Goal Indicator 7.2: http://mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=648

$$Energy\ use\ per\ \$1{,}000\ GDP = \frac{2.2.2.b\ Total\ energy\ supply}{[\frac{GDP}{1{,}000}]}$$

- **Energy productivity by sector** (manufacture, agricultural, transportation)
  The indicator is a measure of energy efficiency; it measures the productivity of energy supply of an economy. It is defined as the ratio of output divided by energy consumption, and is thus the inverse of the energy intensity. The indicator is calculated as the value added per unit of energy use. For example constant PPP $ per kg of oil equivalent.

$$Energy\ productivity\ by\ sector = \frac{Value\ added, by\ ISIC\ economic\ activity}{2.2.2.c\ Final\ consumption\ of\ energy, by\ ISIC\ economic\ activity}$$

As for the energy intensity, it is also possible to calculate the total energy productivity (i.e. energy productivity of the whole economy).

- **Energy dependency** (share of imports in energy consumption)
  The indicator is calculated by dividing the imports of energy by the energy supply. It shows the extent to which an economy relies upon imports in order to meet its energy needs, and therefore to what extent the energy resources in the country are sufficient to meet its needs.

$$Energy\ dependency = \frac{2.2.2.a.5\ Imports\ of\ energy}{2.2.2.b\ Total\ energy\ supply}$$

Eurostat has this indicator available for its Member States: http://ec.europa.eu/eurostat/web/products-datasets/-/tsdcc310

- **Share of non-carbon fuels in energy consumption**
  With the growing concerns of global warning that led to the Paris agreement (adopted in 2015), countries have decided to reach global peaking of greenhouse gas emissions as soon as possible. It is therefore important to know how much of the energy consumed in the country does not emit carbon.

$$Share\ of\ non-carbon\ fuels = \frac{2.2.2.c\ Final\ consumption\ of\ energy, non-carbon\ fuels}{2.2.2.c\ Final\ consumption\ of\ energy}$$

- **Share of energy from renewable sources in energy consumption**
  Since the industrial revolution the pressure on the environment has increased to unsustainable levels. Energy from non-renewable resources are not infinite, and some will be increasingly expensive to exploit if we continue to use them at the same pace. Therefore it is important for countries to increase reliance on renewable energy resources. This indicator is thus a good way to follow this evolution.

$$Share\ of\ energy\ from\ renewable\ sources = \frac{2.2.2.c\ Final\ consumption\ of\ energy, renewable\ energy}{2.2.2.c\ Final\ consumption\ of\ energy}$$

- **Share of energy from renewable sources in electricity generation**

$$Share\ of\ electricity\ from\ renewable\ sources = \frac{2.2.2.b\ Total\ energy\ supply, electricity\ from\ renewable\ sources}{2.2.2.b\ Total\ energy\ supply, electricity}$$

The World Bank derives this indicator from data provided by the International Energy Agency: http://data.worldbank.org/indicator/EG.ELC.RNEW.ZS

6D. SDG indicators that incorporate these statistics

- **7.2.1 Renewable energy share in the total final energy consumption**
Since the industrial revolution the pressure on the environment has increased to unsustainable levels. Non-renewable energy resources are not infinite, and some will be increasingly expensive to exploit if we continue to use them at the same pace. Therefore it is important for countries to increase reliance on renewable energy resources. This indicator is thus a good way to follow this evolution.

$$SDG\ 7.2.1\ Renewable\ energy\ share\ in\ the\ total\ final\ energy\ consumption = \frac{2.2.2.c\ Final\ consumption\ of\ energy, renewable\ energy}{2.2.2.c\ Final\ consumption\ of\ energy}$$

- **7.3.1 Energy intensity measured in terms of primary energy and GDP**
Energy intensity is an indication of how much energy is used to produce one unit of economic output. It is a proxy of the efficiency with which an economy is able to use energy to produce economic output. A lower ratio indicates that less energy is used to produce one unit of output.

Energy intensity is calculated by dividing total energy supply over GDP. It can be disaggregated, for example, by sector.

Total energy supply is made up of production plus net imports minus international marine and aviation bunkers plus-stock changes.

$$SDG\ 7.3.1\ Energy\ intensity = \frac{2.2.2.b.Total\ Energy\ Supply}{GDP}$$

F D E S

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