Roadmap on using available international datasets on energy to compile the energy accounts as laid out in SEEA Technical Note on Energy Accounts

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Abbreviations

BOP – Balance of Payments

CHP - Combined heat and power plants

EU – European Union

GWh – Gigawatt-hour

IEA – International Energy Agency

IRES – International Recommendations for Energy Statistics

ISIC – International Standard Industrial Classification

LPG – Liquified Petroleum Gases

NACE – Statistical classification of economic activities in the European Community

PEFA – Physical Energy Flow Accounts

PJ – Petajoules

PSUT – Physical supply and use tables

SBS – Structural Business Statistics

SEEA – System of Environmental-Economic Accounting

SEEA-CF – System of Environmental-Economic Accounting – Central Framework

SIEC – Standard International Energy Product Classification

SNA – System of National Accounts

TJ – Terajoule

UN – United Nations

UNCEEA – United Nations Committee of Experts on Environmental-Economic Accounting

UNECE – United Nations Economic Commission for Europe

UNSC – United Nations Statistical Commission

UNSD – United Nations Statistics Division

1 Introduction

Energy is essential to wellbeing, being part of the daily life in modern societies. It is vital for the production of goods, as well as for transportation, heating or cooling.

In the recent decades, energy has become a central policy issue. Discussions on the contribution of human activities to climate change has increased this interest. The contribution of renewable sources to the energy mix, the effect of the supply and use of energy on the environment or the resulting release of emissions, all became important points for policy discussions. Consequently, it became important to have complete and coherent statistical data on energy that could support the policy needs.

In 2012, at its 43rd session, the United Nations Statistical Commission (UNSC) adopted the System of Environmental-Economic Accounting - Central Framework (SEEA-CF), which became the international statistical standard for environmental-economic accounting. From this framework, SEEA Energy emerged as a subsystem that elaborates in more detail the links between energy accounts, energy statistics and balances. The United Nations Committee of Experts on Environmental Economic Accounting (UNCEEA), mandated by the UNSC at its 47th meeting in 2016, endorsed it as the internationally agreed methodological document for energy accounts. Additionally, the UNCEEA was requested to determine the feasibility of using already existing international databases to compile energy accounts following SEEA principles, which lead to the development of the current report.

The main objective of this report is to provide a detailed roadmap on how data from energy statistics can be used as starting point to compile energy accounts as laid out in the SEEA Technical Note on Energy. An emphasis is given to the energy balances made available by the International Energy Agency (IEA). These balances follow the principles and recommendations of the International Recommendations on Energy Statistics (IRES). Furthermore, existing data gaps are identified and possible alternatives for filling them are provided.

Additionally, this document also compares the Physical Supply and Use Tables (PSUT) compiled in this exercise for a group of test countries, with existing data for energy accounts. Finally, the last chapter provides some ideas for further automation of the compilation process.

2 Compilation of energy accounts based on energy balances

2.1 Physical Supply and Use Tables (PSUT)

2.1.1 Structure

The main objective of this document is to provide guidelines for the compilation of the PSUT as laid out in the SEEA Technical Note on Energy. The PSUT, as laid out in this document (with an additional distinction between energy residuals from losses and from end-use), are visible in Figure 1 and Figure 2.

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals								Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Industries (by ISIC)							Households				
	Agriculture, Forestry and Fishery	Mining and Quarrying	Manufacturing	Electricity, gas, steam and air conditioning supply	Transportation and storage	Other industries	Total Industry					
ISIC	A	B	C	D	H							
1 Energy from natural inputs:												
Natural resource inputs												0
Inputs of energy from renewable sources												0
Other natural inputs												0
2 Energy products:												
Production of energy products by SIEC class:												
Coal							0					0
Peat and peat products							0					0
Oil shale / oil sands							0					0
Natural gas							0					0
Oil							0					0
Biofuels							0					0
Waste							0					0
Electricity							0					0
Heat							0					0
Nuclear fuels and other fuels							0					0
3 Energy residuals:												
Energy residuals from end-use							0					0
Energy residuals from losses							0					0
4 Other residual flows:												
Residuals from end-use for non-energy purposes							0					0
Energy from solid waste												0
5 TOTAL SUPPLY	0	0	0	0	0	0	0	0	0	0	0	0

Figure 1 - Physical supply table for energy accounts, as presented on the SEEA Technical Note on Energy Accounts (difference between "energy residuals from end-use" and "energy residuals from losses" was added)

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Industries (by ISIC)							Households				
	Agriculture, Forestry and Fishery	Mining and Quarrying	Manufacturing	Electricity, gas, steam and air conditioning supply	Transportation and storage	Other industries	Total Industry					
ISIC	A	B	C	D	H							
1 Energy from natural inputs:												
Natural resource inputs							0					0
Inputs of energy from renewable sources							0					0
Other natural inputs							0					0
2 Energy products:												
Transformation of energy products by SIEC class:												
Coal							0					0
Peat and peat products							0					0
Oil shale / oil sands							0					0
Natural gas							0					0
Oil							0					0
Biofuels							0					0
Waste							0					0
Electricity							0					0
Heat							0					0
Nuclear fuels and other fuels							0					0
End-use of energy products by SIEC class:												
Coal							0					0
Peat and peat products							0					0
Oil shale / oil sands							0					0
Natural gas							0					0
Oil							0					0
Biofuels							0					0
Waste							0					0
Electricity							0					0
Heat							0					0
Nuclear fuels and other fuels							0					0
End-use of energy products for non-energy purposes							0					0
3 Energy residuals:												
Energy residuals from end-use												0
Energy residuals from losses												0
4 Other residual flows:												
Residuals from end-use for non-energy purposes												0
Energy from solid waste							0					0
5 TOTAL USE	0	0	0	0	0	0	0	0	0	0	0	0

Figure 2 - Physical use table for energy accounts, as presented in the SEEA Technical Note on Energy Accounts (difference between "energy residuals from end-use" and "energy residuals from losses" was added)

2.1.2 Row classification

The rows in the PSUT are divided in three types of energy flows:

- Natural energy inputs;
- Energy products;
- Energy residuals.

Natural energy inputs are defined in energy accounts as physical flows from the environment into the economy, either due to production processes or to direct use in production. They are divided in the PSUT in three categories:

- Natural resource inputs (e.g. oil, natural gas, timber resources);
- Inputs of energy from renewable sources (e.g. solar, hydro, geothermal);
- Other natural inputs (e.g. energy inputs to cultivated biomass).

Energy products are defined consistently with the definition in the System of National Accounts (SNA), referring to services and goods that result from a production process in the economy. By SNA convention, households cannot produce energy products, meaning that they can only originate from domestic industries or be imported.

The classification in the PSUT corresponds to the one-digit level codification of the Standard International Energy Product Classification (SIEC) classification. The correspondence between the product classification in the PSUT and SIEC classification is visible in Table 1.

Table 1 - Product classification in the PSUT

Product in the PSUT	SIEC code
Coal	0
Peat and peat products	1
Oil shale / oil sands	2
Natural gas	3
Oil	4
Biofuels	5
Waste	6
Electricity	7
Heat	8
Nuclear fuels and other fuels	9

In table use, energy products are divided in the two sections:

- "Transformation of energy products by SIEC class", which concerns the transformation of energy products into other energy products;
- "End-use of energy products by SIEC class", which records the use of energy products to produce goods and services other than energy products.

This same table also includes a single row to record the use of energy products for non-energy purposes. It includes, apart from the direct use of products for non-energy purposes, the use of energy products to manufacture non-energy products (e.g. naphtha used to produce plastics).

Energy residuals concern flows from the economy to the environment. In the PSUT, they are presented with the following detail:

- Energy residuals from end-use;
- Energy residuals from losses;
- Residuals from end-use for non-energy purposes;
- Energy from solid waste.

2.1.3 Column classification

The column classification in the PSUT is divided in the following groups:

- Industries (production activities);
- Households (consumption activities);
- Accumulation (changes in stocks of produced assets and product inventories);
- Rest of the World (source/destination of imported/exported energy products);
- Environment (source of natural energy inputs and destination of energy residuals).

The industry classification is directly related with the 4th revision of the International Standard Industrial Classification (ISIC). This correspondence is visible in Table 2.

Table 2 - Industry (and households) classification in the PSUT

Sector in the PSUT	ISIC Rev. 4 code
Total Industry	A to U
Agriculture, Forestry and Fishery	A
Mining and Quarrying	B
Manufacturing	C
Electricity, gas, steam and air conditioning supply	D
Transportation and storage	H
Other industries	E to G ; I to U

2.1.4 Accounting identities

When compiling energy accounts, it is important to keep in mind the existence of certain accounting principles. This is the case with the following balancing identities:

- The supply-use identity implies an equality between total supply and total use, which is valid for natural energy inputs, energy products and energy residuals;
- The input-output identity concerns an identity in flows between the environment and the economy, requiring that, over an accounting period, the flows entering the economy necessarily equal the flows exiting the economy, plus net changes to the inventories ("accumulation"). It applies to households and individual industries.

2.2 From energy balances to PSUT

2.2.1 Introduction

The previous document, "Assessment report on the various international energy and macroeconomic datasets", provided an analysis of the energy datasets maintained by the IEA and UN. It was concluded that the IEA detailed energy balances present a more detailed breakdown, mainly product-wise, but also concerning certain energy flows (as non-energy use or own-use by the energy sector).

Therefore, the following chapters provide a description of the compilation steps to complete as far as possible the PSUT, using the **IEA detailed energy balances** as starting point.

The **UN detailed energy balances** might also be used for the compilation, but its use implies an additional use of auxiliary data, due to the lower level of breakdown both in the product and flow classifications. More detailed figures are available online in the UNSD energy statistics database[1] and can be searched for individual energy products. Since data are only available in original units, an additional step of conversion is required.

This document presents suggestions for the compilation of energy accounts, independently of the country concerned. However, it might well occur that, for specific product/flow combinations, these suggestions do not fit into the reality of a given country. This is especially true in the case of the suggested allocation of flows to industries. Therefore, it is generally advised to verify the country specificities and the respective compilation practices in National Accounts before adopting the proposals of this document.

The chapters of this document generally follow the structure of the energy balances, according to the following blocks:

- Supply, including production, imports, exports, international marine bunkers, international aviation bunkers and stock changes, plus transfers and statistical differences;
- Transformation processes;
- Energy industry own-use;
- Losses;
- Final consumption.

Electricity and heat production, as well as transport, due to their specificity, are addressed in separate chapters.

2.2.2 Product classification

The classification of energy products in the **IEA detailed energy balances** is generally consistent with the International Recommendations for Energy Statistics (IRES), being in accordance with the SIEC classification of energy products (commodities/carriers). The IEA balances provide a detailed list of energy products, providing a good input for the product classification available in the PSUT.

The **PSUT** provide a classification of 10 different energy product categories, including for waste, plus one flow concerning the non-energy use of energy products. The mapping between the product

[1] http://data.un.org/Explorer.aspx?

classification in the PSUT and in the IEA detailed energy balances is straightforward, since both can be directly linked to the SIEC classification (see Table 3).

Table 3 – Relation between the product classification in the PSUT and in the IEA detailed energy balances

Product in PSUT	Product in IEA detailed energy balances	SIEC code
Coal	Anthracite, coking coal, other bituminous coal, sub-bituminous coal, lignite, coke oven coke, gas coke, patent fuel, BKB, coal tar, coke oven gas, gas works gas, blast furnace gas, other recovered gases	0110, 0121, 0129, 0210, 0220, 0311, 0312, 0313, 0314, 0320, 0330, 0340, 0350, 0360, 0371, 0372, 0379
Peat and peat products	Peat and peat products	11, 12
Oil shale / oil sands	Oil shale and oil sands	2000
Natural gas	Natural gas	3000
Oil	Crude oil, natural gas liquids, refinery feedstocks, additives/blending components, other hydrocarbons, refinery gas, ethane, liquefied petroleum gases (LPG), naphtha, motor gasoline excl. biofuels, aviation gasoline, gasoline type jet fuel, kerosene type jet fuel excl. biofuels, other kerosene, gas/diesel oil excl. biofuels, fuel oil, white spirit & SBP, lubricants, bitumen, paraffin waxes, petroleum coke, other oil products	4100, 4200, 4300, 4400, 4500, 4610, 4620, 4630, 4640, 4651, 4652, 4653, 4661, 4669, 467, 4680, 4691, 4692, 4693, 4694, 4695, 4699
Biofuels	Primary solid biofuels, charcoal, biogasoline, biodiesels, other liquid biofuels, biogases	511, 5111, 5120, 5130, 5140, 5150, 5160, 5210, 5220, 5290, 53
Waste	Industrial waste, municipal waste (renewable), municipal waste (non-renewable)	6100, 6200
Electricity	Electricity	7000
Heat	Heat	8000
Nuclear fuels and other fuels	Nuclear[2]	9

Products “non-specified primary biofuels and waste”, “electricity/heat output from non-specified manufactured gases” and “heat output from non-specified combustible fuels” are normally not used. Nevertheless, in case they are reported, they should be attributed to “biofuels” and/or “waste”, “electricity” and/or “heat”, and “heat”, respectively. Similarly, figures for “hard coal” and “brown coal” (only available in case no detailed data exists), should be attributed to “coal”.

2.2.3 Flow “production”

2.2.3.1 Using “production” to approximate natural energy inputs

In the **IEA detailed energy balances**, <u>production</u> concerns products that are extracted from the environment, after removal of impurities (e.g. sulphur from natural gas). This means that it concerns only primary energy products, as hard coal, lignite, peat, crude oil, NGL, natural gas, biofuels and waste, nuclear, hydro, geothermal, solar and the heat from heat pumps. The recorded figure can concern the extraction figure for the product itself (e.g. hard coal) or, in the cases of primary heat and electricity (from renewable sources), the primary energy equivalent calculated based on the respective production of heat or electricity[3].

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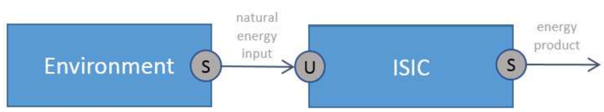
[2] Important to notice that energy statistics refers to nuclear electricity/heat and not to nuclear fuels.

[3] In the absence of country-specific information, the IEA estimates the primary energy equivalent using the following efficiencies: 100% for electricity from hydro, wind, tide, wave, ocean and solar photovoltaic; 33% for electricity from nuclear heat and solar thermal; 100% for solar thermal heat; 50% for heat produced from geothermal heat; 10% for electricity from geothermal heat.

In **energy accounts**, natural energy inputs are defined as physical flows from the environment into the economy, either due to production processes or to direct use in production. Since energy statistics only deals with energy products, the concept of natural energy input does not exist in this framework. However, an energy product has a counterpart in the form of a natural input, which corresponds to the corresponding input obtained from nature. Therefore, the "production" figure from the energy balances can be used to approximate the extraction of natural energy inputs from the environment, as well as the corresponding energy product entering the economy. Therefore, in the **PSUT**, the figure obtained from the energy balances can be used to estimate:

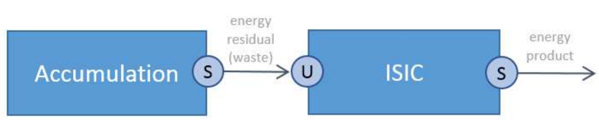
- The natural energy inputs supplied by the environment (recorded in table supply);
- The natural energy inputs used by the extracting industry (table use);
- The energy product supplied by the same extracting industry (table supply).

This means that the same figure is recorded three times. This is represented in the following flow chart:



In the case of waste the **IEA energy balances** record the inputs of indigenous waste under the flow "production". Waste that is imported or obtained from stock is recorded in the respective flows ("imports" and "stock changes") and is dealt in the respective chapters (see 2.2.4 and 2.2.5, respectively). Waste is presented column-wise with three product categories: "industrial waste", "municipal waste (renewable)" and "municipal waste (non-renewable)".

In the case of **energy accounts**, as referred in the SEEA Technical Note on Energy Accounts, by convention the energy embodied in waste enters the system as a residual flow, before becoming an energy product. This residual flow can be approximated by the figure "production" from the energy balances, similar to the approximation for natural energy inputs, done for the other energy products. In the PSUT, the residual flow originates from "accumulation" (table supply), while in the use table it is allocated to the incinerating industry. This is the same industry that supplies the product (which can be later used for electricity and/or heat production):



Each energy product is further transformed or end-used by the same or other industries (or households). It can also be exported or held in stock ("accumulation"). In either case, this will be recorded in other flows of the energy balances ("exports" and "stock changes").

The natural energy input category in the PSUT can be approximated from the classification of energy products. Table 4 shows the proposed derivation for the three categories of natural energy inputs in the PSUT, based on the product classification of the IEA energy balances.

Table 4 – Derivation of natural inputs in the PSUT from the products in the IEA detailed energy balances

Natural inputs in PSUT		Product to approximate the natural input flow		
Category	Flow	Product in IEA detailed energy balance	SIEC code	SIEC label
Natural resource inputs	Oil resources	Conventional crude oil	4100	Conventional crude oil
		Natural gas liquids (NGL)	4200	Natural gas liquids (NGL)
		Other hydrocarbons	4500	Other hydrocarbons

	Natural gas resources	Natural gas	3000	Natural gas
	Coal and peat resources	Anthracite	0110	Anthracite
		Coking coal	0121	Coking coal
		Other bituminous coal	0129	Other bituminous coal
		Sub-bituminous coal	0210	Sub-bituminous coal
		Lignite	0220	Lignite
		Peat	11	Peat
		Oil shale / oil sands	2000	Oil shale / oil sands
	Uranium and other nuclear	Nuclear	9	Nuclear fuels and other fuels n.e.c.
	Timber resources (natural)	Primary solid biofuels	511	Fuelwood, wood residues and by-products
			5120	Bagasse*
			5130	Animal waste
			5140	Black liquor*
			5150	Other vegetal material and residues
		Biogasoline	5210	Biogasoline
		Biodiesels	5220	Biodiesel
		Other liquid biofuels	5290	Other liquid biofuels
		Biogases	53	Biogases
Inputs of energy from renewable sources	Solar	Solar photovoltaics		
		Solar thermal		
	Hydro	Hydro		
	Wind	Wind		
	Wave and tidal	Tide, Wave and Ocean		
	Geothermal	Geothermal		
	Other electricity and heat	Other Sources		
Other natural inputs	Energy inputs to cultivated biomass			

Concerning the ISIC code to assign the production figure, in case no other information exists, one alternative is to approximate the industry through an analysis of the classification of the primary products (Table 5).

Table 5 – Assignment of "production" to PSUT columns, based on the product classification of the IEA detailed energy balances

Product in IEA detailed energy balance	SIEC		Target ISIC for « production »
	Code	Label	
Anthracite	0110	Anthracite	B (ISIC 05)
Coking coal	0121	Coking coal	B (ISIC 05)
Other bituminous coal	0129	Other bituminous coal	B (ISIC 05)
Sub-bituminous coal	0210	Sub-bituminous coal	B (ISIC 05)
Lignite	0220	Lignite	B (ISIC 05)
Peat	11	Peat	B (ISIC 08)
Oil shale and oil sands	2000	Oil shale / oil sands	B (ISIC 06)
Natural gas	3000	Natural gas	B (ISIC 06)
Crude oil	4100	Conventional crude oil	B (ISIC 06)
Natural gas liquids	4200	Natural gas liquids (NGL)	B (ISIC 06)
Additives/blending components	4400	Additives and oxygenates	C (ISIC 20)
Other hydrocarbons	4500	Other hydrocarbons	C (ISIC 19)
Primary solid biofuels	511	Fuelwood, wood residues and by-products	A (ISIC 02)
	5120	Bagasse	A (ISIC 01)
	5130	Animal waste	C (ISIC 10)
	5140	Black liquor	C (ISIC 17)
	5150	Other vegetal material and residues	A (ISIC 01)
Biogasoline	5210	Biogasoline	C (ISIC 20)
Biodiesels	5220	Biodiesels	C (ISIC 20)
Other liquid biofuels	5290	Other liquid biofuels	C (ISIC 20)

Biogases	53	Biogases	D (ISIC 35)
Industrial waste	6100	Industrial waste	Other industries (ISIC 38)
Municipal waste (renewable)	6200	Municipal waste	Other industries (ISIC 38)
Municipal waste (non-renewable)			Other industries (ISIC 38)
Heat	8000	Heat	D (ISIC 35)
Nuclear	9	Nuclear fuels and other fuels n.e.c.	B (ISIC 07)
Hydro			D (ISIC 35)
Geothermal			D (ISIC 35)
Solar photovoltaics			D (ISIC 35)
Solar thermal			D (ISIC 35)
Tide, Wave and Ocean			D (ISIC 35)
Wind			D (ISIC 35)
Other Sources			D (ISIC 35)

In practice, for certain countries, industries might differ from the list proposed. Therefore, it is anyway primarily advised to search for country-specific information concerning the producing industries. In case more than one industry is responsible for the production of one product, the figure from the energy balance might be split accordingly based on existing auxiliary data.

The figure for production can also be complemented with additional information, which might give a closer picture of the real situation and, more important, align it with the way of recording in National Accounts. The following chapters refer to some of those cases.

2.2.3.2 Primary solid biofuels

As visible in the previous table, with the IEA product breakdown, one may assign the industries based on the product classification (assuming a 1-to-1 relation), with the exception of primary solid biofuels, where the aggregation is too high for a detailed distinction.

Primary solid biofuels consist of:

- Fuelwood, wood residues and by-products (SIEC 511);
- Bagasse (SIEC 5120);
- Animal waste (SIEC 5130);
- Black liquor (SIEC 5140);
- Other vegetal material and residues (SIEC 5150).

In case the bulk of "primary solid biofuels" is not extracted by a single industry (considering the industry classification in PSUT), an alternative is to split the figure from the energy balance using the breakdown of the products mentioned above. The 5 Joint IEA/Eurostat/UNECE Energy Questionnaires are a possible source, since they provide data on the indigenous production of the mentioned products. The UNSD energy statistics database[4] also provides data for these products (in original units).

If this more detailed breakdown can be achieved and if no other detailed information exists for the industry allocation, the assignment per ISIC as proposed in Table 5 might then be followed.

[4] http://data.un.org/Explorer.aspx?d=EDATA&f=cmID%3aVW%3btrID%3a01

2.2.3.3 Losses during extraction

One possible adjustment to the "production" figures from the energy balances concerns energy losses during the extraction. Theoretically the natural input flow into the mining industry may be superior to the product output. In practice, due to lack of data, one may assume that the two are equal.

An exception might be venting and flaring of gases during extraction, for which figures are often available from different data sources:

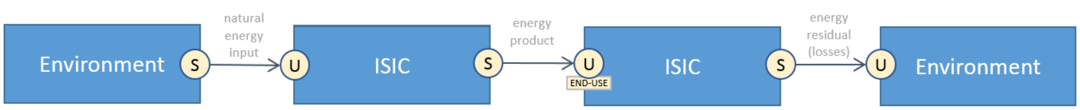
- Flaring and venting of natural gas are recorded as memo items in the 5 Joint IEA/Eurostat/UNECE Energy Questionnaires;
- The UNSD energy statistics database includes data on flaring and venting of natural gas;
- The online international database on energy statistics[5] managed by the United States Energy Information Administration also stores information concerning these flows;
- Additionally, other national sources might provide similar data.

Whenever using these or other data sources, it is important to assure that the figures are comparable (e.g. units, measurement conditions, etc.).

The quantities of gas flared and vented are not included under "production" in the energy balances. Therefore, in case data is available, these quantities should be recorded. The recording is done as follows:

- The natural energy inputs are supplied by the environment;
- The natural energy inputs are used by the extracting industry;
- The energy product is supplied by the same extracting industry;
- The energy product is end-used by the same extracting industry;
- The same industry supplies energy residuals (losses);
- The energy residual is taken (used) by the environment.

which means a total of six recordings:



Important to notice that, as for the case of natural energy inputs, the concept of energy residuals also does not exist in energy statistics, since this framework deals exclusively with energy products. However, energy residuals can often be derived from the data available in energy statistics. The case of flaring and venting is straightforward, since the same quantity is supplied to the environment in the form of energy residual (losses).

2.2.3.4 Nuclear energy

Nuclear energy is defined in energy statistics as the heat produced from nuclear fission or nuclear fusion by a nuclear reactor. Nuclear fuels are outside the scope of the **IEA energy balances**, so nuclear

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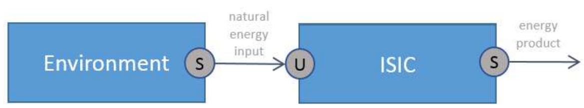
[5] http://www.eia.gov/beta/international/data/browser

heat is chosen as the primary form of energy. If no country-specific information exists, the heat input (presented under "production") is estimated assuming an average efficiency of 33 per cent in the electricity production.

In the **PSUT**, "nuclear fuels and other fuels" are presented as a separate energy product. Following the same assumptions as in energy statistics concerning the heat input, one can directly use the "production" figure from the energy balances to approximate the energy content of the respective natural energy input.

According to the convention followed in energy statistics, the primary nuclear heat appears as an indigenous resource. If one follows the same assumption in the PSUT, this means that it is considered that the domestic mining industry (ISIC B) both extracts the natural energy input and produces the nuclear fuel. Both figures can be derived directly from the "production" figure of the energy balances. This means there is a supply of a natural energy input by the environment, which is transformed into an energy product ("nuclear fuels and other fuels") and further supplied by the extraction industry. This is recorded as follows:



However, it is important to notice that the majority of countries using nuclear power actually import their nuclear fuel. The importation of nuclear fuel involves a single flow concerning the supply of nuclear fuel by the "rest of the world" (table supply):

Additionally, nuclear fuel may be stored for several years. The recording of previously stocked nuclear fuel requires a single flow concerning the supply of nuclear fuel. Since inventories are recorded net in table use (column "accumulation"), the sign needs to be reversed:

Therefore, an adjustment might be done to split the "production" figure reported in the energy balances, using auxiliary data (if available) to calculate the shares of extracted, imported and stocked nuclear fuel.

The production of electricity and heat from nuclear sources appears under "transformation" and is dealt in chapter 2.2.9.

2.2.4 Flows "imports" and "exports"

The **IEA energy balances** refer to imports as the quantities of energy commodities entering a given country as a result of purchases made by persons living in that country, while exports concern quantities leaving the national territorial boundaries of the country. As already discussed, the figures obtained from the energy balances are based on the fuel deliveries on the territory, meaning that they are not reported according to the residence principle.

In **energy accounts** the residence principle is followed, meaning that imports and exports need to strictly relate to transactions between non-resident and resident units (independently of the location). Therefore, the figures from the energy balances need to be adjusted. As these adjustments mainly concern transport, this is discussed in the respective chapter (see 2.2.7). In this chapter, we will then only focus on the way to record the figures in the PSUT.

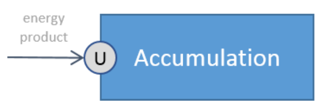
The flow concerning imports is recorded in the **PSUT** as the supply of a product by the "Rest of the World" (table supply):

While the flow for exports is recorded in column "rest of the world" of table use:

2.2.5 Flow "stocks"

The **IEA detailed energy balances** include an energy flow concerning stocks of energy products. A stock increase is shown as a negative number, while a stock drawn is presented with a positive number.

In SEEA **energy accounts**, physical accumulations of energy products are called inventories and are recorded net in column "accumulation" of table use. Therefore, in the **PSUT**, a stock build is recorded with a positive number and a stock reduction has a negative number (i.e. opposite signs of the energy balances).



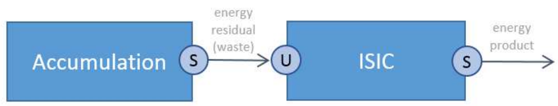
2.2.6 Flow "transfers"

In the **IEA detailed energy balances**, the flow "transfers" includes interproduct transfers, products transferred and recycled products.

Interproduct transfers concerns reclassification of oil products, occurring at the refinery level. The net balance of interproduct transfers is always zero (in original units). Since this flow concerns oil products and these are lumped into a single product category in the PSUT, the resulting figure is always a zero (at least approximately, not taking into account differences due to the conversion of units).

Product transfers relates to oil products imported for further processing in refineries. In the energy balance, these products are transferred to the feedstocks category, i.e. they appear with negative sign for all products and positive sign for refinery feedstocks. This means that the sum for all oil products in the energy balance is again zero (in original units).

Therefore, for the allocation in the **PSUT** and since these three flows are presented together, the figures for "transfers" can be assumed by approximation to correspond to the figures for recycled products (important to notice that this only occurs with the current product breakdown of the PSUT, where all oil products are lumped together, so this approximation does not hold if the product classification is more detailed). These are finished products which are put in the market for a second time (e.g. reprocessed lubricants). This means that they originate from “accumulation”, which supplies them to an industry (ISIC 19) through a residual flow (waste), before the same industry puts them back to the market as energy products:



2.2.7 Flow “statistical differences”

“Statistical differences” are a particular flow of the **IEA detailed energy balances**. The physical meaning of the figures included under this flow relates to discrepancies in the independent measurement of the various flows. The figures included in this flow might relate to any unexplained differences for individual fuels originating from basic energy statistics, to discrepancies from the different conversion factors being applied, or even other reasons which might not be easily traceable.

In the current version of the **PSUT**, such flow is not represented, since it is considered to be an issue of compilation practice. For compilation purposes, the inclusion of this flow separately in the PSUT would be the best option, since its allocation to other flow(s) might not be correct, while not including the figures does not seem an option, since it would have direct implications on the accounting identities (see 2.1.4).

Therefore, considering the current version of the PSUT, a decision needs to be taken concerning the allocation (i.e. which column in the PSUT). This analysis has to be done case-by-case. The 5 Joint IEA/Eurostat/UNECE Energy Questionnaires might include country notes explaining the reported differences, which might give important hints for the allocation. These notes might also be available in the documentation of the energy balances. Otherwise, no other particular method exists for the allocation.

In theory, “statistical differences” can be allocated to any industry, as well as households, “accumulation” or “rest of the world”. Therefore, they should be added to table use, changing the sign of the figure obtained from the energy balances.

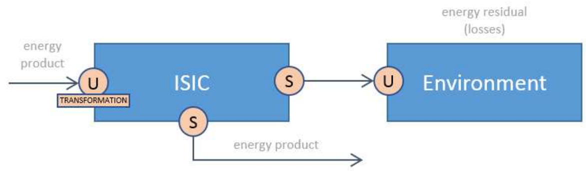
2.2.8 Transformation

Transformation refers to the conversion of primary forms of energy to secondary forms and further transformation. In the **IEA detailed energy balances**, transformation processes are detailed by 15 different energy flows, classified by type of transformation, plus 6 flows concerning electricity and heat production. The inputs to transformation processes appear as negative numbers, while the output from the process is presented with a positive number. In the column total, transformation losses appear with negative numbers.

In the **PSUT**, the transformation of secondary energy products requires an input of energy (which can be a primary or secondary product), while the energy lost in the transformation process (transformation loss) is recorded as an energy residual flow from the economy to the environment. Therefore, transformation is generally recorded as follows:

- Use of an energy product (primary or secondary) by an industry;
- Supply of another product (secondary) by the industry;
- Supply of energy residuals (losses) by the industry;

- Use of residuals by the environment.



The inputs and outputs are distinguished through the sign in the energy balances (negative for input and positive for output), while the energy residuals can be simply calculated through their difference.

In principle, the level of detail provided by the IEA detailed energy balance is sufficient to make the industry allocation in the PSUT, considering that the energy transformations take place in specific industries.

The only flow where the assignment cannot be attributed on a 1-to-1 basis is "non-specified (transformation)". The allocation of these figures is not trivial and needs to be analysed case-by-case. In the case of the 5 Joint Annual Eurostat/IEA/UNECE Energy Questionnaires, the reporting instructions mention that figures reported for these flows should be further explained in the same questionnaire (worksheet "remarks"). This information might give important information concerning the industries concerned. Similar information might accompany the energy balances. Otherwise, in case no additional information exists, a distribution might be attempted based on the detailed figures reported for each sector (i.e. transformation, energy and other).

Table 6 shows the available breakdown for transformation flows (except electricity and heat production, which are dealt separately in the following chapter) and the suggested default industry allocation in the PSUT.

Table 6 – Correspondence between the energy flows in the IEA detailed energy balances and the target column in the PSUT (transformation)

Energy flow in IEA detailed energy balance	Target column in PSUT tables
Transformation processes	
Heat pumps	D (ISIC 35)
Electric boilers	D (ISIC 35)
Chemical heat for electricity production	D (ISIC 35)
Blast furnaces	C (ISIC 24)
Gas works	D (ISIC 35)
Coke ovens	C (ISIC 19)
Patent fuel plants	C (ISIC 19)
BKB/peat briquette plants	C (ISIC 19)
Oil refineries	C (ISIC 19)
Coal liquefaction plants	C (ISIC 19)
Gas-to-liquids (GTL) plants	C (ISIC 19)
For blended natural gas	D (ISIC 35)
Petrochemical plants	C (ISIC 20)
Charcoal production plants	C (ISIC 20)
Non-specified (transformation)	C D

2.2.9 Electricity and heat production

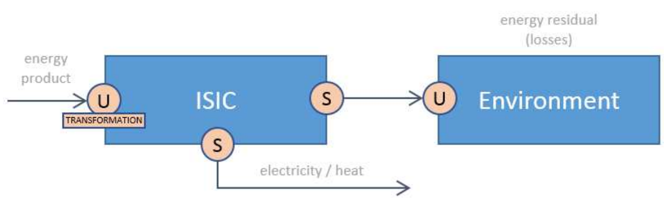
The **IEA detailed energy balances** provide, inside the transformation block, separate flows for main activity producers and autoproducers of electricity and heat. Main activity producers have as primary activity the generation of electricity and/or heat for sale to third parties, while autoproducers generate electricity and/or heat as well, but for support of their primary activity. For each, a further distinction is done between electricity plants, heat plants and CHP (combined heat and power) plants.

In the energy balances, as in all the other transformation flows, inputs to electricity and heat production appear with negative sign, while the output products (electricity and/or heat) are recorded with a positive number. The energy residuals can be calculated through the difference between inputs and outputs.

Additionally, the energy balances include separate flows concerning electricity (in GWh) and heat production (in TJ), with the same breakdown as in the transformation block. Converting electricity production (1 Gwh = 0.0036 PJ), it is also possible to use these more detailed data (in such case, heat and electricity output from the transformation block should not be accounted, to avoid double counting).

In the **PSUT**, the flows concerning the production of electricity and/or heat are recorded as follows:

- Use of an energy product (for transformation) by an industry;
- Supply of heat and/or electricity by the industry;
- Supply of energy residuals (losses) by the industry;
- Use of energy residuals (losses) by the environment.



Industry ISIC 35 is the typical electricity and heat producer. Therefore, the production by main activity producers is normally allocated to this industry.

On the other hand, autoproducers of electricity and heat can theoretically refer to any industry. Therefore, in order to obtain the desired industry breakdown, auxiliary data is necessary to distribute the figures from the energy balances. In the 5 Joint IEA/Eurostat/UNECE Annual Questionnaires, a separate table (table 5) in the electricity questionnaire requests data on the net electricity and heat production by autoproducers. The data is available with the same breakdown as requested in the remaining tables, meaning that it does not provide the necessary breakdown for a direct allocation in the PSUT. Nevertheless, it provides a possible starting point for the allocation.

Table 7 shows the breakdown available in the IEA detailed energy balances and the proposed industry allocation.

Table 7 – Correspondence between the energy flows in the IEA detailed energy balances and the target column in the PSUT (electricity and heat production)

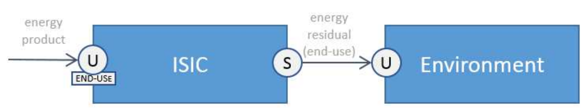
Energy flow in IEA detailed energy balance	Target column in PSUT tables
Transformation processes	
Main activitiy producer electricity plants	D (ISIC 35)
Autoproducer electricity plants	A
	B
	C
	D

	H
	Other
Main activity producer CHP plants	D (ISIC 35)
Autoproducer CHP plants	A
	B
	C
	D
	H
	Other
Main activity producer heat plants	D (ISIC 35)
Autoproducer heat plants	A
	B
	C
	D
	H
	Other

2.2.10 Energy sector

The **IEA detailed energy balances** include separately the own use of energy by the energy sector, which concerns energy used in support of the extraction and transformation activities. Although this is part of the final consumption of the industry sector, it is presented separately. The energy consumed might be either purchased or obtained from the energy products that the same industry extracts or produces.

In **energy accounts**, the energy sector does not exist explicitly and industries are classified independently of being suppliers of energy products or only users. The own-use of energy products (e.g. for lighting or heating) from the energy balances is, in energy accounts, considered an end use of energy products, meaning that it is necessary to allocate the use of those products to the respective industry, as well as the respective energy residuals. Therefore, in the **PSUT**, the figures need to be recorded accordingly, referring to the end-use of an energy product and the consequent supply of residuals:



For the allocation to industries, the detail provided by the IEA detailed energy balances can be considered sufficient. The exception is "non-specified (energy)". As for other "non-specified" figures, the allocation needs to be decided case-by-case. As previously mentioned, country notes accompanying the 5 Joint Annual Eurostat/IEA Energy Questionnaires and/or the IEA energy balances might give an input for the distribution. Table 8 presents the proposed assignment of energy flows to the corresponding ISIC code.

Table 8 – Correspondence between the energy flows in the IEA and UN detailed energy balances and the target columns in the PSUT (energy sector)

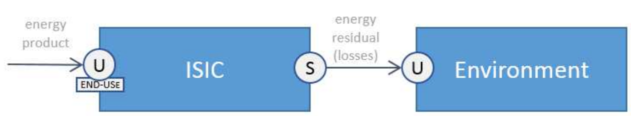
Energy flow in IEA detailed energy balance	Target column in PSUT
Energy industry own use	
Coal mines	B (ISIC 05)
Oil and gas extraction	B (ISIC 06)
Blast furnaces	C (ISIC 24)
Gas works	D (ISIC 35)
Gasification plants for biogases	D (ISIC 35)
Coke ovens	C (ISIC 19)

Patent fuel plants	C (ISIC 19)
BKB/peat briquette plants	C (ISIC 19)
Oil refineries	C (ISIC 19)
Coal liquefaction plants	C (ISIC 19)
Liquefaction (LNG) / regasification plants	B (ISIC 09)
Gas-to-liquids (GTL) plants	C (ISIC 19)
Own use in electricity, CHP and heat plants	D (ISIC 35)
Pumped storage plants	D (ISIC 35)
Nuclear industry	D (ISIC 35)
Charcoal production plants	C (ISIC 20)
Non-specified (energy)	B
	C
	D

2.2.11 Flow "losses"

In the **IEA detailed energy balances**, losses for distribution, transmission and transport are provided in a separate flow named "losses". As mentioned, transformation losses are included under transformation and appear with negative value in the column total. These were dealt in the chapter concerning transformation (see 2.2.8) and electricity and heat production (see 2.2.9).

In **energy accounts**, losses need to be allocated to a specific industry and result in a residual flow from the economy to the environment. In the **PSUT**, this results in the recording of a residual flow, which originates in the industry and is then used by the environment:



Finding auxiliary data to allocate losses to the correct industry is likely difficult. In case no additional information is available for the allocation, one possibility is to assume that the losses are occurring in the same industry that produced the corresponding product. With the IEA product breakdown it is possible to fairly assign an industry for each product, with the exception of primary solid biofuels, where the aggregation is too high for a detailed distinction. For this case, a similar method as followed for "production" might be used (i.e. increasing the product detailing, through the use of auxiliary data).

Table 9 provides a possible default assignment of the flow "losses" to ISIC Rev. 4 codes, based on the product classification available in the IEA detailed energy balances.

Table 9 – Assignment of "losses" to PSUT columns, based on the product classification of the IEA detailed energy balances

Product in IEA detailed energy balance	SIEC code	SIEC label	Flow "losses"
Hard coal	01	Hard Coal	B (ISIC 05)
Anthracite	0110	Anthracite	B (ISIC 05)
Coking coal	0121	Coking coal	B (ISIC 05)
Other bituminous coal	0129	Other bituminous coal	B (ISIC 05)
Brown coal	02	Brown coal	B (ISIC 05)
Sub-bituminous coal	0210	Sub-bituminous coal	B (ISIC 05)
Lignite	0220	Lignite	B (ISIC 05)
Coke oven coke	0311, 0313, 0314	Coke oven coke	C (ISIC 19)
Gas coke	0312	Gas coke	D (ISIC 35)
Patent fuel	0320	Patent fuel	C (ISIC 19)
BKB	0330	Brown coal briquettes (BKB)	C (ISIC 19)
Coal tar	0340	Coal tar	C (ISIC 19)

Coke oven gas	0350	Coke oven gas	C (ISIC 19)
Gas works gas	0360	Gas works gas (and other manufactured gases for distribution)	D (ISIC 35)
Blast furnace gas	0371	Blast furnace gas	C (ISIC 24)
	0372	Basic oxygen steel furnace gas	C (ISIC 24)
Other recovered gases	0379	Other recovered gases	C (ISIC 24)
Peat	11	Peat	B (ISIC 08)
Peat products	12	Peat products	C (ISIC 19)
Oil shale and oil sands	2000	Oil shale / oil sands	B (ISIC 06)
Natural gas	3000	Natural gas	D (ISIC 35)
Crude oil	4100	Conventional crude oil	B (ISIC 06)
Natural gas liquids	4200	Natural gas liquids (NGL)	B (ISIC 06)
Refinery feedstocks	4300	Refinery feedstocks	C (ISIC 19)
Additives/blending components	4400	Additives and oxygenates	C (ISIC 20)
Other hydrocarbons	4500	Other hydrocarbons	C (ISIC 19)
Refinery gas	4610	Refinery gas	C (ISIC 19)
Ethane	4620	Ethane	C (ISIC 19)
Liquefied petroleum gases (LPG)	4630	Liquefied petroleum gases (LPG)	C (ISIC 19)
Naphtha	4640	Naphtha	C (ISIC 19)
Motor gasoline excl. biofuels	4652	Motor gasoline	C (ISIC 19)
Aviation gasoline	4651	Aviation gasoline	C (ISIC 19)
Gasoline type jet fuel	4653	Gasoline-type jet fuel	C (ISIC 19)
Kerosene type jet fuel excl. biofuels	4661	Kerosene-type jet fuel	C (ISIC 19)
Other kerosene	4669	Other kerosene	C (ISIC 19)
Gas/diesel oil excl. biofuels	467	Gas oil / diesel oil and Heavy gas oil	C (ISIC 19)
Fuel oil	4680	Fuel oil	C (ISIC 19)
White spirit & SBP	4691	White spirit and special boiling point industrial spirits	C (ISIC 19)
Lubricants	4692	Lubricants	C (ISIC 19)
Bitumen	4695	Bitumen	C (ISIC 19)
Paraffin waxes	4693	Paraffin waxes	C (ISIC 19)
Petroleum coke	4694	Petroleum coke	C (ISIC 19)
Other oil products	4699	Other oil products n.e.c.	C (ISIC 19)
Primary solid biofuels	511	Fuelwood, wood residues and by-products	A (ISIC 02)
	5111	Wood pellets	A (ISIC 02)
	5120	Bagasse	A (ISIC 01)
	5130	Animal waste	C (ISIC 10)
	5140	Black liquor	C (ISIC 17)
	5150	Other vegetal material and residues	A (ISIC 01)
Charcoal	5160	Charcoal	C (ISIC 20)
Biogasoline	5210	Biogasoline	C (ISIC 20)
Biodiesels	5220	Biodiesels	C (ISIC 20)
Other liquid biofuels	5290	Other liquid biofuels	C (ISIC 20)
Biogases	53	Biogases	D (ISIC 35)
Industrial waste	6100	Industrial waste	Other industries (ISIC 38)
Municipal waste (renewable)	6200	Municipal waste	Other industries (ISIC 38)
Municipal waste (non-renewable)			Other industries (ISIC 38)
Electricity	7000	Electricity	D (ISIC 35)
Heat	8000	Heat	D (ISIC 35)
Nuclear[6]	9	Nuclear fuels and other fuels n.e.c.	B (ISIC 07)
Hydro			D (ISIC 35)

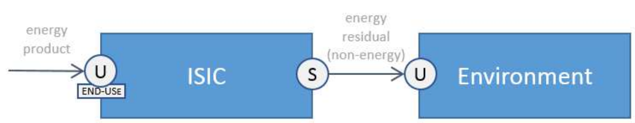
[6] Important to notice that energy statistics refers to nuclear electricity/heat and not to nuclear fuels.

Geothermal			D (ISIC 35)
Solar photovoltaics			D (ISIC 35)
Solar thermal			D (ISIC 35)
Tide, Wave and Ocean			D (ISIC 35)
Wind			D (ISIC 35)
Other Sources			D (ISIC 35)

2.2.12 Non-energy use

The concept of non-energy use refers to energy products which are used as raw materials, but are not consumed as a fuel, nor transformed into another fuel. It is important to notice that, in the case of the **IEA detailed energy balance**, the non-energy use of biomass is not considered. In these energy balances, non-energy use is shown separately in final consumption, under the heading with the same name.

In the **PSUT**, the non-energetic use is not detailed by product. Instead, a single row "end-use of energy products for non-energy purposes" is available. The flow is recorded as the end-use of a product by a given industry, which supplies the same quantity of residuals ("residuals from end-use for non-energy purposes") to the environment:



Data for non-energy use is presented in an aggregated form in the IEA detailed energy balances. This results in a level of detail that is not sufficient for the allocation to industries in the PSUT.

The memo item "non-energy use chemical/petrochemical" refers to cracking and reforming processes occurring the chemical/petrochemical industry (ISIC Rev. 4 201). It is part of "non-energy use in industry/transformation/energy" and the allocation to the respective industry is straightforward (ISIC C).

In the case of "non-energy use in industry/transformation/energy", it requires a distribution across the following columns: "mining and quarrying" (ISIC B), "manufacturing" (ISIC C), "electricity, gas, steam and electricity supply" (ISIC D) and "other industries". However, it is possible to use the memo item referred in the previous paragraph to deduct from this figure, in order to exclude the part that is used by the chemical/petrochemical industry. After this calculation, in case the resulting figure is not zero, a distribution across the mentioned industries is then necessary.

"Non-energy use in other industries" includes non-energetic use of products in other sectors such as residential (households), commercial/public services (ISIC C, H and "other industries"), agriculture/forestry and fishing (ISIC A).

Regarding "non-energy use in transport", following the principles of energy accounts, in theory it needs to be distributed across all ISIC (similar to what occurs for the energy use in road transport).

Table 10 – Correspondence between the energy flows in the IEA detailed energy balances and the target columns in the PSUT (non-energy use)

Energy flow in IEA detailed energy balance	Target column in PSUT
Non-energy use	
Non-energy use industry/transformation/energy	B
	C

	D
	Other
Memo: non-energy use chemical/petrochemical	C (ISIC 20)
Non-energy use in transport	A
	B
	C
	D
	H
	Other
	Households
Non-energy use in other	A
	C
	H
	Other
	Households

2.2.13 Transport

2.2.13.1 Recording transport in the PSUT

Consumption in transport, as available in the **IEA detailed energy balances,** covers all transport activity in mobile engines. It refers to the fuel deliveries on the territory, regardless of the nationality of the operator of the transport activity. Transport activities appear in the block for final consumption and are divided according to the following categories:

- Domestic navigation;
- Domestic aviation;
- Road transport;
- Rail;
- Pipeline transport;
- Non-specified (transport).

Also in the block for “final consumption”, but under the category “other”, appears another relevant flow:

- Fishing.

Finally, in the “supply” block, two additional flows are provided:

- International marine bunkers;
- International aviation bunkers.

In the ISIC Rev. 4 classification, industries responsible for transport services as their principal activity are divided as follows:

- Land transport and transport via pipelines (ISIC 49);
- Water transport (ISIC 50);

- Air transport (ISIC 51).

In the **PSUT**, these sectors are lumped together under sector H, which concerns transportation and storage. For the allocation of the flows water transport, air transport, rail and pipeline transport, one might assume by approximation that this same industry (ISIC H) covers all the fuel consumption.

However, this approximation is not valid for road transport, where the allocation to industries is particular and is dealt in a separate chapter (see 2.2.13.4).

Another particular flow concerns "non-specified (transport)". Theoretically, it might concern any industry and the allocation needs to be decided case-by-case. As previously mentioned, country notes accompanying the 5 Joint Annual Eurostat/IEA Energy Questionnaires and/or the IEA energy balances might give an input for the distribution.

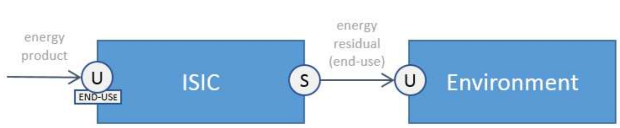
In the case of fishing, the industry concerned is ISIC 03, meaning that the figures should be allocated to column ISIC A in the PSUT.

Table 11 presents the suggested allocation of industries for each flow related to transport.

Table 11 – Correspondence between the energy flows in the IEA detailed energy balances and the target columns in the PSUT (transport)

Energy flow in IEA detailed energy balance	Target column in PSUT
Supply	
International marine bunkers	H (ISIC H50)
International aviation bunkers	H (ISIC 51)
Transport	
Domestic aviation	H (ISIC 51)
Road	A
	B
	C
	D
	H
	Other
	Households
Rail	H (ISIC 49)
Pipeline transport	H (ISIC 49)
Domestic navigation	H (ISIC H50)
Non-specified (transport)	A
	B
	C
	D
	H
	Other
	Households
Other	
Fishing	A (ISIC 03)

The recording in the PSUT of fuel consumption for transport activities corresponds to an end-use of energy products by a given industry, with the corresponding supply of residuals to the environment. This means the following recording:



However, before being recorded in the PSUT, the figures for transport from the energy balances require some adjustments, which are described more in detail in the following chapters.

2.2.13.2 Adjustment to the residence principle

Energy accounts records the energy flows (natural inputs, products, residuals) related to economic activities of resident units. This differs from the principle adopted in the energy balances, where figures are based on a "fuel-sold-on-the-territory" principle, regardless of being sold to resident or non-resident units.

This difference is especially relevant for transport activities. Consequently, the transport figures obtained from the energy balances need to be adjusted, being strictly assigned to the activities of resident units. For all transport modes, the adjustment is done in two steps:

- Fuel purchased on the territory by non-resident units needs to be deducted;
- Resident units' transport fuel purchased abroad needs to be added.

In theory, fuel purchased outside of the territory of a country for diplomatic, military or scientific purposes also needs to be included in the adjustment. However, in practice, this might be not significant and/or difficult to account.

For the majority of the countries, the need for resident adjustment for rail and pipeline transport is considered unlikely. However, these might be important in specific cases. Since no standard approach exists, this should be analysed case-by-case and using available data for that country, if available.

In the case of road transport, methodologies vary across countries and depend on data availability. Possible data sources for the adjustment include:

- Traffic statistics;
- Vehicle-fleet models;
- Foreign trade statistics;
- Balance of Payments (BOP).

A similar adjustment needs to be done for air transport. In this case, two flows are available in the energy balances: "international aviation bunkers" and "domestic aviation". Both flows include deliveries to residents and non-residents, since the split is only based on the airport of departure and landing. This means that, in energy accounts, both flows require an adjustment. Once again, methodologies vary across countries. Possible data sources for the resident adjustment include:

- Air traffic statistics;
- Data for resident airlines;
- Foreign trade statistics;
- National accounts;
- Balance of Payments.

In the case of water transport, the energy balances provide data concerning two flows, plus a separate flow concerning fishing, meaning that an adjustment is necessary for: "international marine bunkers", "domestic navigation" and "fishing".

Once again, the international/domestic split is not depending on the nationality nor the flag of the ship, but only on the basis of the port of departure and arrival. This means that, once again, in energy accounts is necessary to adjust all flows, first deducting the amounts delivered to ships operated by non-resident units and, second, adding quantities of fuels bunkered abroad by vessels operated by resident units.

Examples of data sources that can be used to make the adjustment are:

- Water transport statistics;
- Foreign trade statistics;
- National accounts;
- Balance of Payments.

2.2.13.3 Adjustment for imports and exports

As already mentioned, the figures obtained from the **energy balances** are based on the fuel deliveries on the territory while, in **energy accounts**, imports and exports strictly relate to transactions between non-resident and resident units.

This means that the figures from the energy balances need to be adjusted accordingly. Once again, these adjustments mainly concern transport activities. In theory, this also includes the fuel purchased by tourists outside of their territory. The adjustments are done as follows:

- The fuel sold abroad to resident units should be added to imports (table supply);
- The fuel sold on the territory to non-resident units should be added to exports (table use).

2.2.13.4 Allocation of road transport to PSUT columns

Road transport is a particular case in **energy accounts**, differing from the remaining transport modes in the industry allocation. While for marine and air transport it can be assumed that, as approximation, the respective industries (ISIC 50 and 51) cover all the transport activities, the use of fuels for road transport theoretically concerns all economic activities. The use of fuels for road transport often occurs in the form of ancilliary activities as, for example, the use of ambulances in health service industries, lorries and bulldozers in construction or tractors in agriculture. This means that it is necessary to identify the industries performing these ancillary activities in order to correctly assign the fuel use and the associated residuals.

Approaches vary from country to country. Examples of possible data sources to be used to calculate a distribution key for the allocation per industry are:

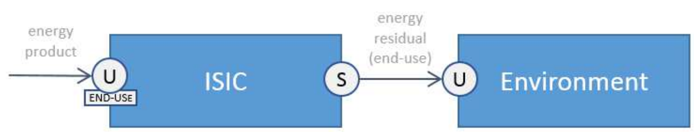
- Transport statistics;
- National vehicle registers;
- Detailed monetary use tables providing information on use of fuels per industry;
- Taxes.

2.2.14 Final consumption

2.2.14.1 Recording final energy consumption in the PSUT

Final energy consumption is defined as the consumption in the end use sectors. In the **IEA detailed energy balances**, the block for final energy consumption excludes uses for transformation processes, as well as own-use in the energy sector (these are shown in their respective blocks). Backflows from the petrochemical industry are also excluded, as well as international aviation bunkers and international marine bunkers, which are included as separate flows.

Final energy consumption, as reported in energy statistics, is considered equivalent to the concept of end use in energy accounts, meaning that the energy content of the product becomes unavailable for further production, consumption and accumulation within the economy and is released to the environment in the form of a residual flow. This is recorded in the **PSUT** as follows:



The allocation to the corresponding column in the PSUT is relatively straightforward for "non-specified (industry)" (industry C in the PSUT), since this flow corresponds to ISIC Rev. 4 divisions 22, 31 and 32.

"Non-specified (other)" includes all fuel use not elsewhere specified and consumption for which separate figures have not been provided. It includes military fuel use, both for the military of that country or for the military of another country which, in theory, should be adjusted to the residence principle. However, in practice this might difficult, since data might not be available. The allocation to the columns in the PSUT is not trivial, but the country notes accompanying the 5 Joint Annual Eurostat/IEA Energy Questionnaires and/or the IEA energy balances might give additional information for the distribution.

In the case of "commercial and public services", the allocation is discussed in the next chapter.

Table 12 presents the suggested allocation of industries for the energy flows under "final energy consumption" in the IEA detailed energy balances. It is important to notice that the flow "fishing", as well as all flows under "transport" are not included, as they are dealt in a separate chapter (see 2.2.13).

Table 12 - Correspondence between the energy flows in the IEA detailed energy balances and the target columns in the PSUT (final energy consumption)

Energy flow in IEA detailed energy balance	Target column in PSUT
Industry	
Iron and steel	C (ISIC 24)
Chemical and Petrochemical	C (ISIC 20 and 21)
Non-ferrous metals	C (ISIC 24)
Non-metallic minerals	C (ISIC 23)
Transport equipment	C (ISIC 29 and 30)
Machinery	C (ISIC 25 to 28)
Mining and quarrying	B (ISIC 07, 08 and 099)
Food and tobacco	C (ISIC 10 to 12)
Pulp, paper and print	C (ISIC 17 and 18)
Wood and wood products	C (ISIC 16)
Construction	Other industries (ISIC 41 to 43)
Textile and leather	C (ISIC 13 to 15)
Non-specified (industry)	C (ISIC 22, 31 and 32)

Other	
Residential	Households
Commercial and public services	C
	H
	Other
Agriculture/Forestry	A (ISIC 01 and 02)
Non-specified (Other)	A
	B
	C
	D
	H
	Other
	HH

2.2.14.2 Commercial and public services

The allocation of final energy consumption in the commercial and public services sector is often difficult to do due high number of industries it includes and the difficulty to find fitting data for the distribution.

In the case of the **PSUT**, ”commercial and public services” mainly fall under the column “Other industries”, with the exception of “Repair and installation of machinery and equipment” (ISIC 33), “Warehousing and support activities for transportation” (ISIC 52) and “Postal and courier activities” (ISIC 53) – see Table 13 below.

Table 13 - Allocation of "commercial and public services” to PSUT columns

Industry classification in energy balances	ISIC Rev. 4	Column in PSUT
Commercial and public services	33	Manufacturing (C)
	52, 53	Transportation and storage (H)
	36, 37, 38, 39, 45, 46, 47, 55, 56, 58, 59, 60, 61, 62, 63, 64, 65, 66, 68, 69, 70, 71, 72, 73, 74, 75, 77, 78, 79, 80, 81, 81, 81, 84 (exc. 8422), 85, 86, 87, 88, 90, 91, 92, 93, 94, 95, 96, 99	Other industries

Therefore, it is necessary to find auxiliary data to distribute the figures from the energy balances across the industries: C, H and “other”. Possible sources include:

- Monetary use tables;
- Structural Business Statistics (SBS).

The latter often provides a very detailed breakdown for the services sector.

In case no auxiliary data exists with sufficient product detailing for this split, it might be verified product-by-product if a full allocation to one of the **PSUT** columns is plausible.

3 Comparison with existing data on energy accounts

Eurostat launches its own data collection of **Physical Energy Flow Accounts** (PEFA), for which there is a separate online section[7], with data for 2008-2013, covering the following countries: Belgium, Bulgaria, Czech Republic, Germany, Greece, Croatia, Latvia, Lithuania, Romania and Slovenia.

PEFA is currently available online in Eurostat's online database with the following tables:

- Energy supply by NACE Rev. 2[8];
- Energy use by NACE Rev. 2;
- Energy use (emission-relevant) by NACE Rev. 2;
- Key indicators by NACE Rev. 2;
- Physical energy flow accounts totals bridging to energy balances totals.

Eurostat also developed a compilation tool for PEFA ("PEFA Builder"), which provides a reporting alternative (not mandatory) for countries that do not have established methodologies to compile energy accounts. The input data for this tool are obtained from the 5 IEA/Eurostat/UNECE Joint Annual Energy Questionnaires.

PEFA tables supply and use were extracted from Eurostat's online database for a series of 5 countries. In parallel, PSUT for these same countries were compiled in the current exercise, in order to compare the two sets of tables. For the year 2013, data was extracted for: Belgium, Czech Republic, Germany, Latvia, and Romania. This sample covers countries using the PEFA Builder (e.g. Belgium), as well as countries having their own methodologies (e.g. Germany).

The supply and use tables used in this exercise (PSUT) and the ones presented in PEFA present some considerable structural differences, namely concerning the row and column detail. Overall, PEFA is more detailed, both product and column-wise.

PEFA presents 64 industry categories (NACE Rev. 2 classification) at the most detailed level, plus 3 categories for households, while the PSUT present 6 product categories (ISIC Rev. 4 classification) and one category for households. In any case, a correspondence between NACE Rev. 2 and ISIC Rev. 4 is possible, since ISIC and NACE have exactly the same items at the highest levels (NACE is more detailed at lower levels). Both include columns for "rest of the world", "accumulation" and "environment".

Concerning the rows, PEFA includes 7 distinct natural energy inputs while, in the PSUT, these appear under 3 categories. The energy products are divided in 10 categories in the PSUT, while in PEFA they are further disaggregated, with a list of 20 different product categories. The PSUT also includes, in the use table, a distinction between "transformation of energy products" and "end-use of energy products". In PEFA, this distinction is available in two separate tables, but only from the 2016 data collection onwards. Finally, both present 4 categories for energy residuals, but concerning different flows.

[7] http://ec.europa.eu/eurostat/web/environment/physical-energy-flow-accounts/database

[8] A correspondence between NACE Rev. 2 and ISIC Rev. 4 is possible, since ISIC and NACE have exactly the same items at the highest levels (NACE is more detailed at lower levels).

However, there are other differences that difficult the comparison between the two sets of tables. These include:

- Peat and peat products are presented in a single product category in the PSUT ("peat and peat products"), but are split between two categories ("brow coal and peat" and "secondary coal products") in PEFA;
- Oil shale/oil sands are presented in a separate product category in the PSUT ("oil shale/oil sands"), while in PEFA they appear together with other products under category "brown coal and peat";
- Statistical discrepancies are presented separately in PEFA, while in the PSUT they need to be assigned to other columns;
- Waste is presented as an energy product in the PSUT, which does not occur in PEFA;
- Non-energy use of products is presented in the PSUT in a single separate category, without detail per product. In PEFA, they are assigned to the respective product category, together with energy use;
- The PSUT presents a distinction between "energy residuals from end-use" and "energy residuals from losses", while in PEFA these two appear in one single row category, named "energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use)".

The comparison for the main row and column totals are presented in Figure 3. For this exercise, the transport figures for the residence adjustment in PEFA were used for the PSUT, while "statistical differences" were not considered for the PEFA figures.

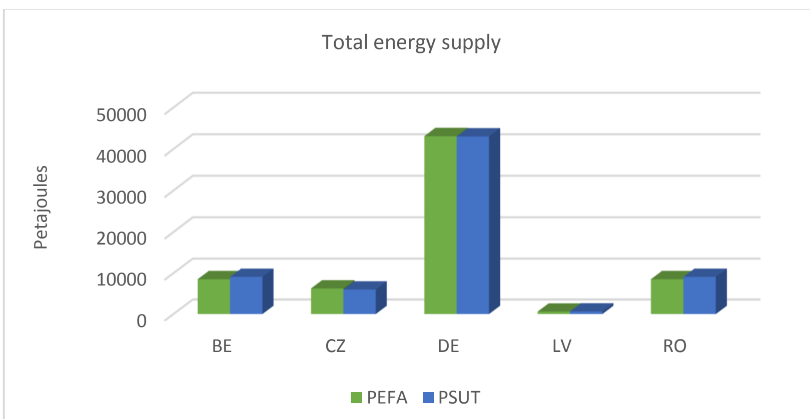


Figure 3 - Comparison between 'total energy supply' in PEFA and in PSUT, for Belgium (BE), Czech Republic (CZ), Germany (DE), Latvia (LV) and Romania (RO)

Overall, it is possible to verify that the figures for "total energy supply" obtained in this exercise in the PSUT are in line with the ones available from PEFA. Figure 4 presents a more detailed comparison for the same group of countries, concerning the totals for the 3 main flow categories.

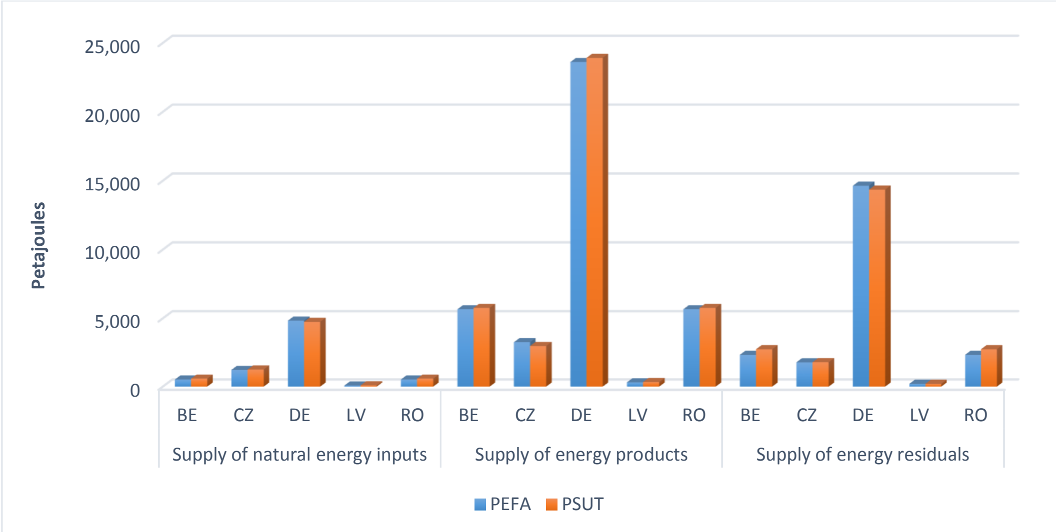


Figure 4 - Comparison between PEFA and PSUT, for Belgium (BE), Czech Republic (CZ), Germany (DE), Latvia (LV) and Romania (RO)

Figure 5 to Figure 9 present a more detailed view of the main values obtained in the PSUT and the equivalent values extracted for PEFA. Tables are presented separately per country.

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					521.8	521.8
Energy products:	2,334.7			3,338.6		5,673.3
Energy residuals:	1,735.9	534.7	61.6			2,332.3
TOTAL SUPPLY	4,070.6	534.7	61.6	3,338.6	521.8	8,527.4

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	521.8					521.8
Energy products:	3,479.2	504.0	-228.6	1,914.9	0.0	5,669.5
Energy residuals:	69.7		76.8		2,185.8	2,332.3
TOTAL USE	4,070.6	504.0	-151.8	1,914.9	2,185.8	8,523.5

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					583.5	583.5
Energy products:	2,438.4			3,331.1		5,769.5
Energy residuals:	2,313.4	375.8	50.0			2,739.1
TOTAL SUPPLY	4,751.8	375.8	50.0	3,331.1	583.5	9,092.1

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	583.5					583.5
Energy products:	4,118.4	375.8	12.5	1,262.9	0.0	5,769.5
Energy residuals:	50.0		329.7		2,359.4	2,739.1
TOTAL USE	4,751.8	375.8	342.3	1,262.9	2,359.4	9,092.1

Figure 5 - Comparison between PEFA (in green) and PSUT (in blue) for Belgium (2013)

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					1,227.0	1,227.0
Energy products:	2,411.6			841.1		3,252.7
Energy residuals:	1,361.0	385.6	35.9			1,782.4
TOTAL SUPPLY	3,772.6	385.6	35.9	841.1	1,227.0	6,262.1

PHYSICAL USE TABLE (unit: P	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	1,227.0					1,227.0
Energy products:	2,509.7	329.8	-12.0	346.7	0.0	3,174.2
Energy residuals:	35.9		108.8		1,675.3	1,820.0
TOTAL USE	3,772.5	329.8	96.9	346.7	1,675.3	6,221.1

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					1,250.3	1,250.3
Energy products:	2,128.3			848.8		2,977.1
Energy residuals:	1,508.4	268.1	13.2			1,789.6
TOTAL SUPPLY	3,636.7	268.1	13.2	848.8	1,250.3	6,017.1

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	1,250.3					1,250.3
Energy products:	2,373.1	268.1	-22.8	358.7	0.0	2,977.1
Energy residuals:	13.2		108.5		1,667.9	1,789.6
TOTAL USE	3,636.7	268.1	85.8	358.7	1,667.9	6,017.0

Figure 6 - Comparison between PEFA (in green) and PSUT (in blue) for Czech Republic (2013)

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					4,835.0	4,835.0
Energy products:	12,179.8			11,435.5		23,615.3
Energy residuals:	10,400.9	3,905.2	335.2			14,641.4
TOTAL SUPPLY	22,580.7	3,905.2	335.2	11,435.5	4,835.0	43,091.6

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	4,835.0					4,835.0
Energy products:	17,410.5	3,597.5	-28.0	2,239.9	0.0	23,219.9
Energy residuals:	335.2		971.9		13,334.2	14,641.4
TOTAL USE	22,580.7	3,597.5	943.9	2,239.9	13,334.2	42,696.3

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					4,748.1	4,748.1
Energy products:	12,905.7			11,013.2		23,918.9
Energy residuals:	11,535.5	2,495.9	326.0			14,357.4
TOTAL SUPPLY	24,441.2	2,495.9	326.0	11,013.2	4,748.1	43,024.5

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	4,748.1					4,748.1
Energy products:	19,367.1	2,495.9	-16.8	2,072.8	0.0	23,919.0
Energy residuals:	326.0		910.1		13,121.3	14,357.4
TOTAL USE	24,441.2	2,495.9	893.4	2,072.8	13,121.3	43,024.5

Figure 7 - Comparison between PEFA (in green) and PSUT (in blue) for Germany (2013)

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					80.4	80.4
Energy products:	121.9			190.9		312.7
Energy residuals:	127.6	71.0	9.4			207.9
TOTAL SUPPLY	249.4	71.0	9.4	190.9	80.4	601.0

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	80.4					80.4
Energy products:	157.6	46.4	7.9	56.5	0.0	268.4
Energy residuals:	11.4		4.5		194.1	210.0
TOTAL USE	249.4	46.4	12.4	56.5	194.1	558.8

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					89.6	89.6
Energy products:	138.7			197.7		336.4
Energy residuals:	155.2	53.1	0.2			208.5
TOTAL SUPPLY	293.9	53.1	0.2	197.7	89.6	634.5

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	89.6					89.6
Energy products:	204.1	53.1	2.8	76.5	0.0	336.4
Energy residuals:	0.2		4.3		204.0	208.5
TOTAL USE	293.9	53.1	7.0	76.5	204.0	634.5

Figure 8 - Comparison between PEFA (in green) and PSUT (in blue) for Latvia (2013)

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					1,078.1	1,078.1
Energy products:	1,783.8			428.7		2,212.6
Energy residuals:	1,010.1	359.1	6.1			1,375.3
TOTAL SUPPLY	2,793.9	359.1	6.1	428.7	1,078.1	4,665.9

PHYSICAL USE TABLE (unit: P.	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	1,078.1					1,078.1
Energy products:	1,709.7	226.3	-7.9	183.9	0.0	2,112.0
Energy residuals:	6.1		67.1		1,302.1	1,375.3
TOTAL USE	2,793.9	226.3	59.2	183.9	1,302.1	4,565.4

PHYSICAL SUPPLY TABLE (unit: PJ)	Production (incl. household own account) and generation of residuals		Accumulation	Flows from the rest of the World (Imports)	Flows from the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:					1,083.1	1,083.1
Energy products:	1,840.9			436.9		2,277.8
Energy residuals:	1,032.3	322.9	1.7			1,356.9
TOTAL SUPPLY	2,873.2	322.9	1.7	436.9	1,083.1	4,717.8

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses	Final Consumption	Accumulation	Flows to the rest of the World (Exports)	Flows to the environment	TOTAL
	Total Industry	Households				
Energy from natural inputs:	1,083.1					1,083.1
Energy products:	1,788.4	322.9	-22.6	189.2	0.0	2,277.8
Energy residuals:	1.7		62.9		1,292.3	1,356.9
TOTAL USE	2,873.2	322.9	40.2	189.2	1,292.3	4,717.8

Figure 9 - Comparison between PEFA (in green) and PSUT (in blue) for Romania (2013)

The analysis of the previous tables allows to conclude that PSUT and PEFA present similar results in terms of the main totals of both tables supply and use, which validates the general methodology being followed in the PSUT to convert data from energy balances into energy accounts. It appears that, in general, similar principles and assumptions were used in PEFA and the PSUT to convert data from energy statistics/balances into accounts, providing also similar results.

The differences between the two datasets (PSUT and PEFA) can be mainly attributed to:

- Additional detailing used by PEFA (due to the use of the IEA/Eurostat/UNECE questionnaires, in contrast to the more aggregated IEA energy balances used for the PSUT);
- Differences in the conversion of units (PSUT uses data in terajoules, while PEFA uses data in original units and performs its own conversions);
- Different treatment of "statistical differences".

However, differences might also originate from:

- Different auxiliary data being used for the industry/households breakdown.

The distribution of the figures from the energy balances across ISIC industries is highly dependant on the auxiliary data being used. Therefore, given the different auxiliary data that might be used, it is expected to have here the main difference between the PSUT and PEFA. This will also likely be the case if comparing any of these two datasets with figures calculated by alternative methodologies.

The total list of cases where it was identified in chapter 2.2 that auxiliary data could be necessary is the following:

- Flaring and venting of natural gas;
- Origin of nuclear fuel;
- Detailed data on primary solid biofuels;
- Statistical differences;
- Autoproducers of electricity and heat;
- "Non-specified";
- Losses;
- Non-energy use;
- Transport (residence adjustment);
- Road transport (allocation across ISIC/households)
- Final consumption by 'commercial and public services'.

In any case, the number of cases where auxiliary data will be actually necessary will depend directly on the country data.

It is important to notice that the current exercise, building energy accounts' tables for a set of test countries, focused on the industry classification provided in the SEEA Technical Note. However, a similar exercise might be attempted having as target a more detailed industry classification. For this, the following steps need to be followed:

- To use the most detailed industry code (ISIC 01, 02, 03, etc.), instead of the 1-digit code (A, B, C, etc.) for the allocation of energy flows, such as "production", "losses", etc. (both levels of detail are presented as "target column" in each table of chapter 2.2);
- In cases where, in chapter 2.2, the mentioned "target column" indicates more than one industry, to find auxiliary data to split the figure across the mentioned industries;
- For all cases where auxiliary data is necessary to build the PSUT, to find auxiliary data with the desired additional level of industry detailing.

However, as mentioned, the current analysis will focus on the industry detailing obtained in the PSUT, which follows the industry classification presented in the SEEA Technical Note.

First of all, in the course of the current exercise (i.e. calculation of the PSUT for few test countries), it was necessary to consider how to allocate the figures in case no fitting auxiliary data could be found.

As an example, in case no information on the origin of nuclear fuel was available, it was necessary to decide whether, by default, it was considered that nuclear fuel was originating from the national environment (as a natural input flow), if it was imported (from the rest of the world) or if it originated from accumulation (i.e., in case it was previously stocked). The option take was to approximate the assumption from energy statistics and consider that nuclear fuel appears as an indigenous resource.

In the case of "statistical differences", since this flow is not available separately in the PSUT and given that it can have positive or negative sign, the option was to include it under "accumulation".

In the case of the adjustment to the residence principle, in case no auxiliary data was available, the only remaining option was to assume that both principles (residence and territory) present similar results.

Concerning the other cases, without auxiliary data to serve as distribution key for the allocation, the solution considered was to allocate the figures to a single ISIC industry.

However, it is important to notice that, in future calculations of a PSUT for a given country, all the above mentioned allocations should be avoided, as they ignore specificities that the use of auxiliary data should provide. These were only considered given the need to produce PSUT for a group of countries and the expected difficulty to find international data sources that could provide data for all the necessary cases.

The list of options for the allocation of figures from the energy balances, in case no fitting auxiliary data was available, is visible in Table 14.

Table 14 – Default options for the allocation of figures from the energy balances (in case no auxiliary data is available)

Block	Flow	Default option
Production	Origin of nuclear	Extraction from nature
	Primary solid biofuels	Fuelwood, wood residues and by-products
Supply	Statistical differences	Accumulation
Electricity/heat production	Autoproducers - electricity plants	ISIC D
	Autoproducers - CHP plants	ISIC D
	Autoproducers - Heat plants	ISIC D
Transformation	Non-specified (transformation)	ISIC C
Energy sector	Non-specified (energy)	ISIC D
Losses	Primary solid biofuels	Fuelwood, wood residues and by-products
Non-energy use	Non-energy use in industry/transformation/energy	ISIC C
	Non-energy use in transport	ISIC H
	Non-energy use in other	ISIC Other
Transport	International marine bunkers	No adjustment to residence principle
	Domestic navigation	No adjustment to residence principle
	Fishing	No adjustment to residence principle
	International aviation bunkers	No adjustment to residence principle
	Domestic aviation	No adjustment to residence principle
	Rail	No adjustment to residence principle
	Pipeline transport	No adjustment to residence principle
	Road	ISIC H
	Non-specified (transport)	ISIC H
Final consumption	Commercial and public services	ISIC Other
	Non-specified (other)	ISIC C

A second step in the calculation of the PSUT concerned the search for fitting auxiliary data, following a case-by-case analysis. As no international data sources were found that could fully and simultaneously satisfy the industry and product breakdowns, an option was made between using the available auxiliary data and maintaining the default allocation.

It is important to notice that, in the course of this work, the research focused on international datasets with a wide geographical coverage. However, for future exercises, it is advised that national data sources are also used (in some cases, only available in national language), increasing the possibilities to find more suitable data.

In the cases of Belgium, Czech Republic, Latvia and Romania, UN data[9] was used to extract figures to further detail the production of primary solid biofuels, while data on the purchase of energy products was obtained from the OECD database[10] to allocate the final energy consumption by commercial and public services. Concerning the adjustment to the residence principle for air, road and water transport, bridging items from PEFA were used, since no better fitting data could be found. Concerning the distribution of road transport across industries, due to lack of fitting auxiliary data, the default allocation was followed.

Concerning Germany, apart from the above mentioned sources, figures for flaring and venting of natural gas were obtained from the UN database.

In the following figures is visible a comparison between the PSUT and PEFA for the supply and use of energy products, with a detail per ISIC industry.

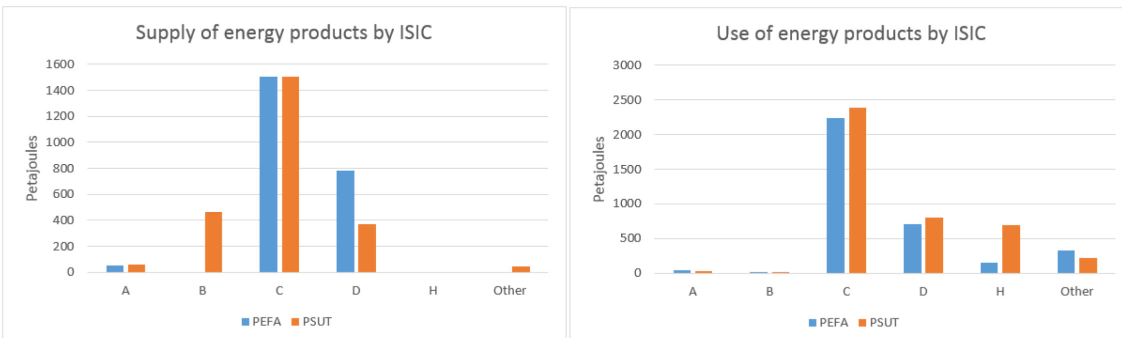


Figure 10 - Comparison between PEFA and PSUT for supply and use of energy products by ISIC – Belgium

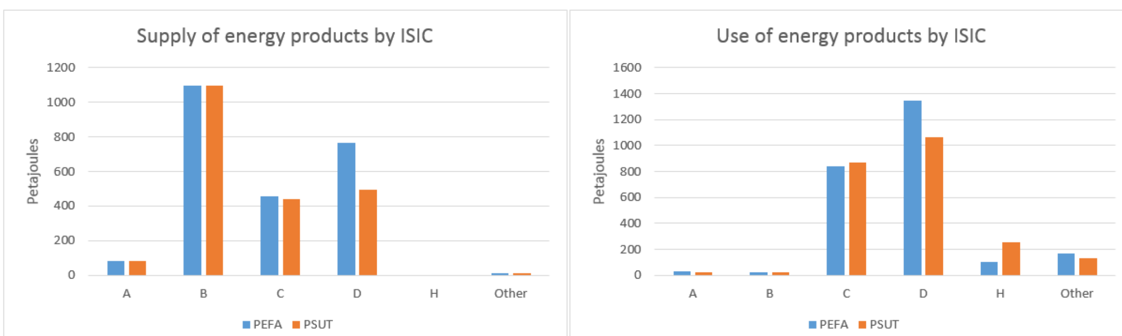


Figure 11 - Comparison between PEFA and PSUT for supply and use of energy products by ISIC – Czech Republic

[9] http://data.un.org/Explorer.aspx?d=EDATA&f=cmID%3aVW%3btrID%3a01
[10] http://stats.oecd.org/Index.aspx?DataSetCode=SSIS_BSC_ISIC4

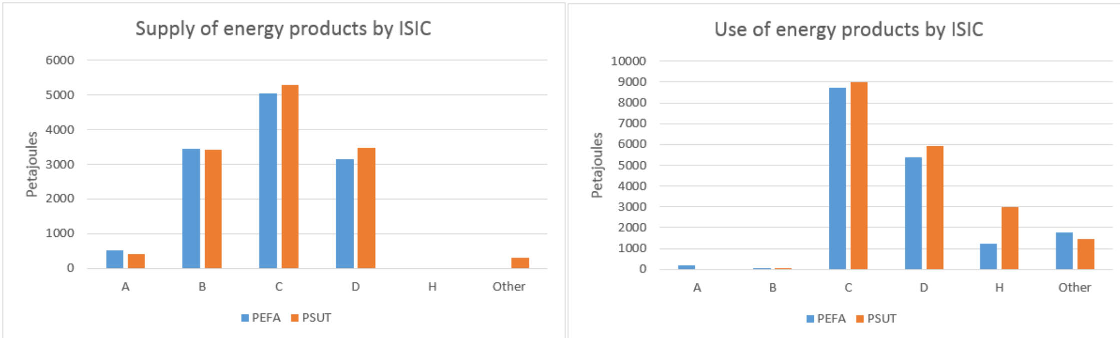


Figure 12 - Comparison between PEFA and PSUT for supply and use of energy products by ISIC – Germany

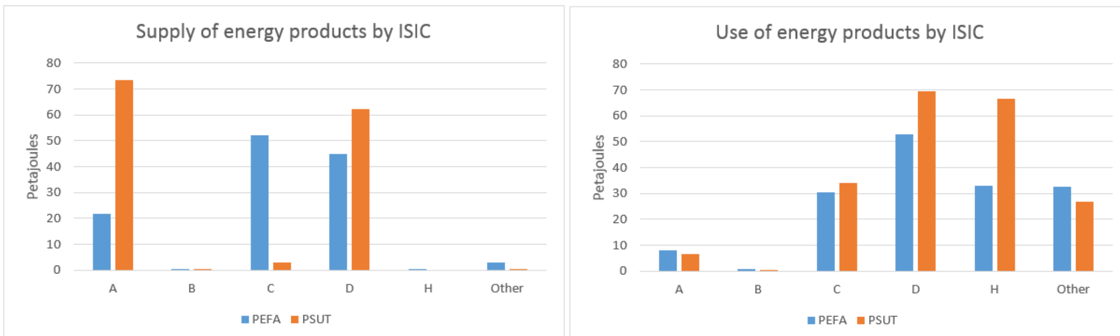


Figure 13 - Comparison between PEFA and PSUT for supply and use of energy products by ISIC – Latvia

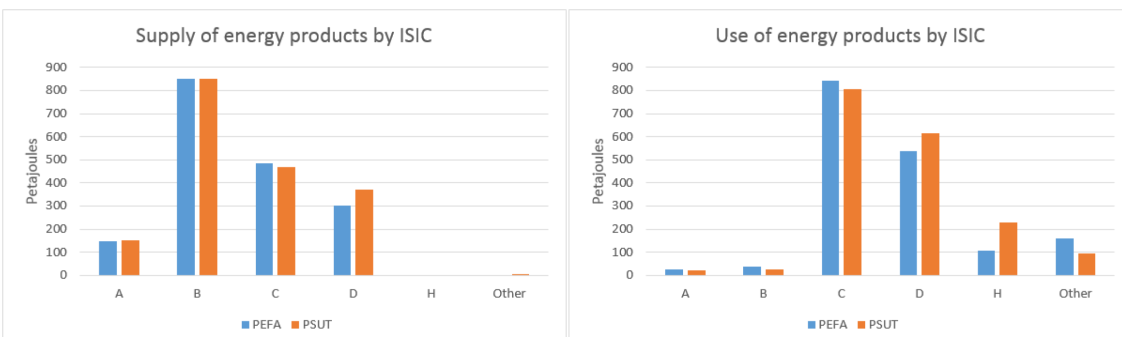
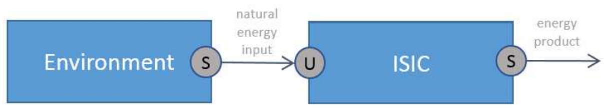


Figure 14 - Comparison between PEFA and PSUT for supply and use of energy products by ISIC – Romania

4 The figures show that, even if differences exist, the results can be considered comparable, even at the industry level of the PSUT. Nevertheless, it is possible to conclude that future work should primarily focus on finding additional auxiliary data (namely for cases where the default allocation was applied), which should lead to better results. Building a model to compile the PSUT

Starting from the compilation practices suggested in this document, it is possible to further automate the compilation of the PSUT. This might be relevant in order to avoid compilation errors due to the considerable amount of data being treated, as well as, for example, in case it is intended to process more than one country or year. The model can be built based on the input format (i.e. energy balances), making it easier to comprehend the way the data are treated.

In energy accounts, each flow is recorded twice, first at its origin and secondly at its destination ("double-entry-bookkeeping”). This means that a single figure from the energy balances often needs to be recorded several times in the supply and use tables. This means that it is possible to attribute to each figure a given flow, which defines the way that figure will be recorded. For example, for the allocation of “production”, we verified that the recording goes as follows:



Therefore, in this case, we could attribute any code for this type flow (e.g. PSUT_flow_x), which can then be attributed to all figures that need to be recorded similarly in the energy balance. However, to complete this information, one also needs to know to which row and column each recording will be assigned. Therefore, the general idea is to build a model that can attribute a specific flow for that figure from the energy balances, as well as provide the respective mapping coordinates (row, column) to allocate it correctly in the PSUT.

An additional parameter that needs to be defined is the multiplication factor to convert the figure from the energy balances into the figure that will appear in the PSUT. In the case of the energy balances, all figures are in terajoules (except electricity production, if used), meaning that the figures need to be multiplied by 0.001 or -0.001, depending on the sign. This multiplication is dependent on the flow, and not on the product, so it needs to be specific for each energy balance row (flow).

The product classification in the energy balances is far more detailed than in the PSUT. Consequently, first of all, a mapping is necessary to assign each product to its column in the PSUT. Second, as discussed, for flows “production” and “losses”, the suggested ISIC allocation for these flows is based on the product classification. For these flows, it is also necessary to define the column where the flow originates from (“accumulation” for waste or “environment” for the remaining products), as well as the respective natural input category or residual.

Concerning the rows (i.e. energy flows), one needs to define the origin or destination of the flow (“rest of the world”, “environment” or “accumulation”), the respective ISIC code (or households), as well as the residuals category. Additionally, as mentioned, a multiplication factor needs to be defined for each row. This results in a model similar to the example in Figure 15.

					Accumulation	Environment	Environment	...	Origin in PSUT
						Renewable	Natural	...	Natural input in PSUT
					Waste	Electricity	Oil	...	Energy product in PSUT
					Residual_waste			...	Residuals in PSUT
					Other	D	D	...	Production — ISIC in PSUT
					Other	D	D	...	Losses — ISIC in PSUT
Multiplication	**Origin/destination in PSUT**	**ISIC in PSUT**	**Residuals in PSUT**		Energy balance product 1	Energy balance product 2	Energy balance product 3	...	
0.001	Environment	C	losses	Energy balance flow 1	PSUT flow x	PSUT flow x	PSUT flow x	...	
0.001	Environment	Other	end-use	Energy balance flow 2	PSUT flow x	PSUT flow x	PSUT flow x		
-0.001	Rest of the world			Energy balance flow 3	PSUT flow y	PSUT flow y	PSUT flow y	...	
0.001	Environment	D	non-energy	Energy balance flow 4	PSUT flow z	PSUT flow z	PSUT flow z	...	
...	...	...	...	...	...	...	...	...	

Figure 15 - Example of a model to generate the mapping instructions between the energy balances and the PSUT

In case a given figure from the energy balances cannot be assigned to a single cell in the PSUT (1-to-N cases), a specific code can be used to make the link to the additional auxiliary data to be used for its distribution.

This type of model can be used to generate a list with all the individual recordings that will be recorded in the PSUT, as well as the respective mapping instructions. Based on these mapping instructions, the PSUT can be easily built (e.g. through a pivot table).