System of Environmental and Economic Accounting for Energy

SEEA-E

Draft Chapter 5 Physical Flow Accounts

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Chapter 5 Physical Flow Accounts

A. Introduction to physical flow accounts for energy

5.1. Physical flow accounts describe energy flows, in physical units, from its initial extraction or capture from the environment into the economy, and within the economy in the form of supply and use, all expressed in quantitative terms.

5.2. The compilation of the physical flow accounts for energy allows for a consistent monitoring of the supply and use of energy by energy type and by the economic agents (industries and households). In combination with monetary information indicators of energy intensity, efficiency and productivity can be calculated from the physical flow accounts.

5.3. The so-called supply table shows the production and imports of energy products. The use table shows the total use of energy by industries and households, the exports, and the changes in inventories. Losses during extraction, distribution and storage are also presented in the tables.

5.4. Physical supply and use tables (PSUT) have the same structure as the monetary supply and use tables compiled as part of the standard national accounts compilation, and generally the two sets of tables share the characteristic that the total use exactly equals the total supply. Organising physical information using the same framework as the monetary accounts is one of the basic features of the SEEA.

5.5. Physical energy flow accounts are a special case and subset of the physical flow accounts of SEEA. Like the general SEEA physical flow accounts, the energy supply and use tables are compiled first by using mass and volume measures such as tonnes, litres and cubic metres or units specific for energy, such as Sm^3 (standard cubic metres). However, because it is useful to measure energy resources and products also by its calorific content of energy, an additional set of accounts, which use joule as the unit, is introduced.

5.6. Throughout SEEA-E the energy products are classified using the Standard International Energy Classification, SIEC, while the industries are classified using the International Standard Industrial Classification of All Economic Activities, ISIC, Rev. 4.

5.7. Section B introduces the general distinction between flows of energy resources from the environment to the economy and flows of products within the economy (i.e. supply and use of energy between two economic units).

5.8. Section C presents the basic supply and use tables for energy flows. Three sets of supply and use tables are presented. First Table 5.1 and Table 5.2 present supply and use tables, respectively, using natural physical units (e.g. tonnes and cubic metres). Then Table 5.3 and 5.4 present the same flows using joules as the measuring unit. These first four tables distinguish between whether the flows are flows of natural resources, flows of products between different economic units, flows of energy for own use within the same establishment or losses of energy. Finally, Table 5.5 and 5.6 shows aggregated flows for each type of energy without making the explicit distinction between whether an energy product is subject of transactions between economic units or for own use, etc.

5.9. Section D treats classifications and specific definitions and accounting rules used for the energy accounts and provides the background for a full understanding of the concepts behind the energy flow accounts.

5.10. Section E and F present additional energy flow tables; First Section E presents a physical use table, Table 5.12, showing the use of energy by purposes. Then, in Section F, Table 5.13 presents the supply of primary energy and imports, Table 5.14 the conversion of energy and Table 5.15 the so-called end-use of energy. The latter presents the energy use without the double counting of energy, which is a general feature of the standard supply and use tables because they include both the primary energy (e.g. coal) and the converted energy (electricity), which is the result of the use of the primary energy by the energy supply industries. The presentation of the energy flows in Section F is close to the way energy flows are presented in so-called energy balances.

5.11. Section G discusses the link between energy statistics, energy balances and energy accounts, while section H presents bridge tables for the link between energy balances and energy accounts.

B. Type of flows

5.12. When constructing a supply and use table for energy, the SEEA-E implicitly takes the perspective of the national economy. It describes flows of energy resources from the environment to the national economy and flows of energy products within the economy. Losses of energy are also included in the SEEA-E accounts where they are described as flows of residuals from the economy to the environment.

5.13. Flows of air emissions and solid waste generated by energy production and use are not described in SEEA-E. On the other hand all types of waste used as inputs for production of energy is included.

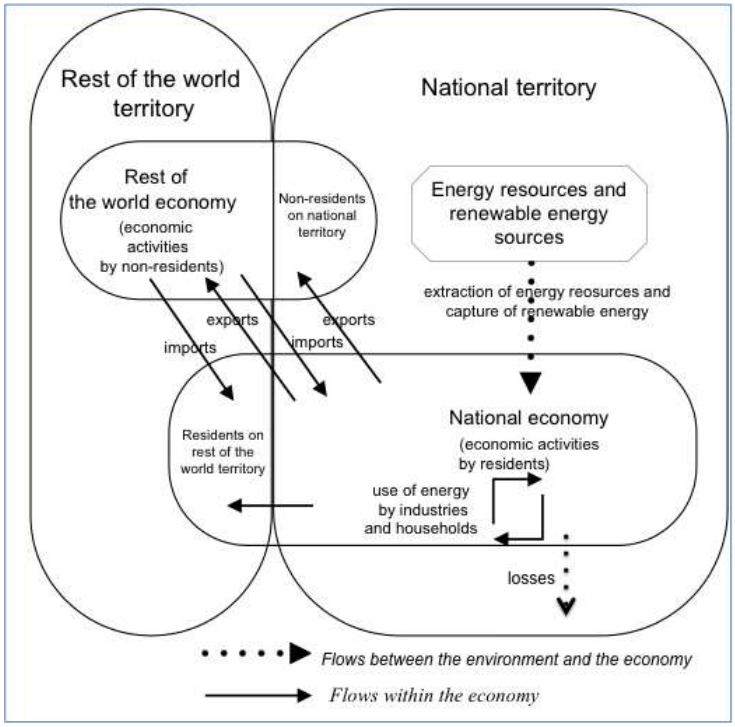
5.14. The physical flow accounts of SEEA-E are presented in a way, which links the physical flows fully consistent with the presentation of the economic flows of SNA 2008. Since the SNA 2008 does not include so-called own use of energy (production and use within the same establishment) and output of energy, which is subsequently lost, for instance, during distribution, such flows are presented separately in SEEA-E.

5.15. Following the terminology of SEEA, energy products include flows of energy, which are associated with a positive price, while residuals include all flows with zero or negative prices. Thus, energy, which is lost, for instance, during distribution is categorised as residuals.

5.16. Own use of energy, i.e. energy produced and used within the same establishment, is not the subject of any monetary transactions and is not recognised by the monetary accounts. However, in the physical flow accounts, energy produced for own use is regarded as energy products and the flows are recorded explicitly in the accounts.

5.17. Flows within the economy include flows between the national economy and other countries' economies (the rest of the world), cf. Figure 5.1. Since the national economy is defined in terms of the activities of residents units (cf. Chapter 2 and section C.5 below), there is not a one-to-one relationship between the national economy and the national territory. Some of the flows to the national economy may take place on foreign territory, and some flows on the national territory may be flows resulting from other economies' activities. Such flows are mainly related to international transport activities. A more detailed figure of some of the flows within the economy is presented in Figure 5.2.

Figure 5.1: Physical flows of energy



1. Flows of energy resources

5.18. Flows from the environment to the economy involve the removal and capture of energy from the environment by economic units in the national territory. Non-renewable energy is removed from the environment through mining and extraction activities. In addition, renewable energy, which originates from sun, wind, waves, biomass and the geothermal system, is captured from the environment.

5.19. In SEEA terms, the supplier of these flows is the environment and the user is the economy, more specifically, the economic agents responsible for the extraction or capture. Extraction of subsoil energy resources can only be undertaken by resident institutional units. An enterprise that undertake extraction is deemed to become resident when the requisite licences or leases are issued, if not before (SNA 2008, 4.15.e)

5.20. Energy is extracted and captured either to be used by the same economic unit, which extracts it (in which case, it is referred to as *extraction for own use*) or to be supplied to other economic units for further processing or direct use. The industry, which extracts non-renewable energy from the environment as a principal activity is classified under section B of ISIC Rev. 4, *Mining and quarrying*. The capture of renewable energy from the environment as a principal activity is classified under ISIC section D – *Electricity, gas steam and air conditioning supply*. The parts of the ISIC industry classification which are of specific interest in relation to the energy accounts, is presented in Section D.

2. Flows of energy products

5.21. Flows within the economy involve energy product exchanges between economic units, cf. Chapter 2. For solid and liquid fuels, these exchanges are carried out in the same way as any other

products, typically via trucks and ships, and for the liquids also via pipelines. Steam and electricity are transported via pipelines and cables, respectively.

5.22. Figure 5.2 presents a detailed description of some of the energy product exchanges. The solid line arrows connecting the economic units represent the physical supply and use of energy within the economy: the origin of the arrow represents the energy supplier, while the destination of the arrow represents the energy user. The dotted line arrows represent flows from the environment to the economy.

5.23. Supplies of energy products are provided by imports and by principal activities in ISIC section B, Mining and quarrying, ISIC Division 19, Manufacture of coke and refined petroleum products, ISIC Class 2011 - Manufacture of basic chemicals (nuclear fuels) and ISIC section D, Electricity, gas, steam and air conditioning supply.

5.24. Energy products are used by these industries themselves or by other industries for intermediate consumption either for direct use or for input into a transformation process in order to produce other energy or non-energy products. In addition, the energy products are used by households as part of their consumption, by the rest of the world (exports), or are stored in inventories.

5.25. Energy supplying industries and other industries hold typically inventories of energy products. Although not shown in the figure, increases in inventories of energy products can be regarded as a particular type of use. Decreases in inventories can similarly be regarded as negative uses. This is the way the changes in inventories of energy products are recorded in the flow accounts.

3. Losses

5.26. Within the context of SEEA, losses of energy in physical terms are comprised of (a) flows of energy resources from the environment to the economy that are not available for further use within the economy because they have been returned to the environment; and (b) energy that do not reach its intended destination or have disappeared from storage.

5.27. Within this definition five types of losses of energy are identified by the stage at which they occur through the production process. It is noted that some types of losses may be necessary for maintaining safe operating conditions. This is the case of flaring and venting in the extraction of natural gas.

4.1. The five types of losses are:

i. Losses during extraction/abstraction

ii. Losses during distribution/transport

iii. Losses during storage

iv. Losses due to theft

v. Losses during transformation/conversion

5.28. Losses during extraction are losses that occur at the time of extraction of an energy resource before there is any further processing, treatment or transportation of the extracted energy resource. This applies, for instance, to flaring and venting of natural gas. Some natural gas may also be re-injected into the ground in order to increase the pressure and facilitate further extraction. These flows are also considered as losses during extraction.

5.29. Losses during distribution are losses that occur between a point of extraction or production and a point of use or between points of use and reuse. These losses may be caused by a number of factors. In the case of energy, they may refer to evaporation and leakages of liquid fuels, loss of heat during transport of steam, losses during gas distribution, electricity transmission and pipeline transport.

5.30. In addition, when losses during distribution are computed as a difference between the amounts supplied and that received, they may also include errors in meter readings, malfunctioning meters, etc. These are commonly referred to as apparent losses.

5.31. Losses during storage are losses of energy products held in inventories. They include evaporation, leakages of fuels (measured in mass or volume units), wastage and accidental damage.

5.32. Losses due to theft refer to electricity and other energy that are illegally diverted from distribution networks or from storage. In this case the energy stolen remain within the economy and are actually used for intermediate or final consumption. For the other types of losses, the products return in various forms back to the environment. It should be noted that losses due to theft are often difficult to separate from e.g. distribution losses in practice.

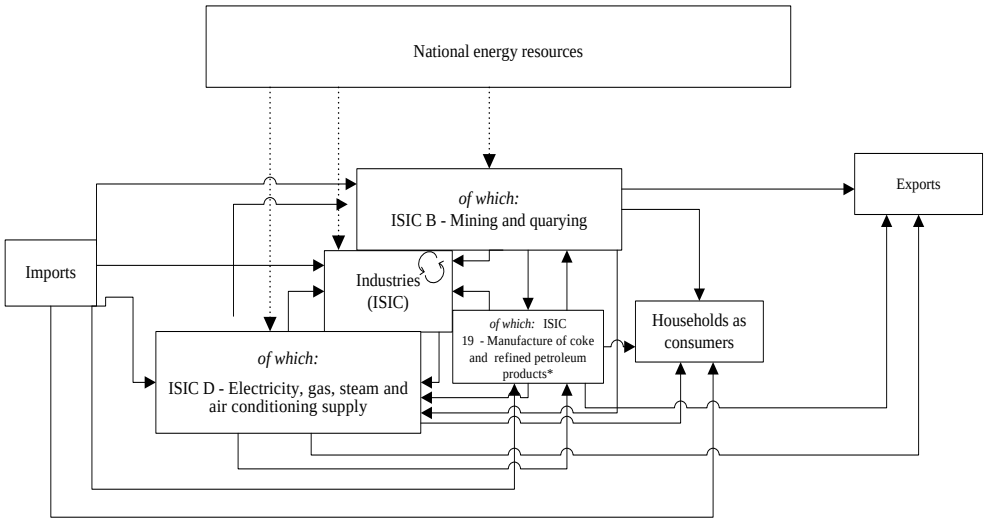
5.33. Losses of energy during transformation from one energy product to another are linked to the difference between inputs and outputs of products, and as such part of the specific industry's intermediate consumption. It appears, for instance, when coal is transformed into electricity. It is a different type of losses compared to the four other types of losses and it is only measured in calorific values. In mass terms it is simply reflected by the fact that intermediate consumption of energy products results in an output of other energy products and residuals in the form of air emissions and solid waste.

5.34. Losses due to evaporation and leaking are often measured in quantity terms (cubic metres, tonnes), while losses of heat to the surroundings are often measured in in energy terms (terajoules, KWh).

5.35. Losses are also dealt with in Section D.11.

5.36. The flows of energy residuals and the transformation losses are not shown in Figure 5.2, but they are shown explicitly in the relevant supply and use tables.

Figure 5.2: Detailed description of physical energy flows within the economy



C. Physical Supply and Use Tables for Energy Resources and Energy Products

5.37. In this section, supply and use tables for energy are presented. In Section D more details on the classifications and definitions lying behind the tables are added.

5.38. First a set of tables showing the flows of all energy resources and energy products are presented. The tables are set up at mass or volume units (tonnes, cubic metres, etc.) as well as at energy units, terajoules.

5.39. The tables include all energy products, also those energy products, which are transformed into other energy products. Therefore, the energy content of some products is counted more than one time. Coal, for example, is used as input into a transformation process to obtain electricity and heat, and the accounts record the coal as well as the resulting electricity and heat. Therefore, in addition, in section F, tables, which record only the energy content once, are also presented. The tables are 1) supply of primary energy and imports, 2) transformation of primary energy and imports into secondary products, and 3) end use of energy. For some analytical purposes, e.g. analysis of a country's overall energy consumption these tables are often better suited than the tables for supply and use of all energy products.

1. Detailed supply and use tables for energy

5.40. Physical supply and use tables for energy record the flows of energy resources and energy products in quantitative terms. They are generally based on the principle that the total supply of each energy resource or energy product is equal to the total uses of the same energy resource or energy product.

5.41. Table 5.1 and 5.2 present the standard supply and use tables for energy resources and products at the mass or volume units (tonnes, cubic metres, etc.) that are characteristic for the various resources and products. Table 5.3 and 5.4 show the same supply and use at the common unit terajoule expressing the calorific value of the products. Section D.11 provides more information on the conversion from mass and volume units into calorific values.

5.42. The supply table presents for each energy resource and energy product how much is supplied by different units. The items in the table heading include two main categories: supply from the industries and imports. The supply from the industries is classified according to ISIC. For the imports, energy products purchased by residents abroad are shown explicitly as an "of which" category.

5.43. The rows of the supply table are divided into three blocks.

5.44. The first block shows the supply of energy products, which ultimately are supplied to other establishments, and for which a monetary transaction is involved. The energy products are classified according to the Standard International Energy Classification, SIEC, cf. Section D. Since the supply of energy products presented in this block represents energy products supplied to other establishments, they are all accompanied by a monetary transaction and there is therefore a full correspondence between this physical supply and the supply presented in the monetary supply table, Table 6.1 in Chapter 6.

5.45. The second block shows the production of energy products, which are used within the same establishment, and for which no payment takes place. In addition, the supply of energy products, which ultimately are used for free by another establishment, is recorded here. It is a prerequisite that the user of the energy product does not make any payment to the supplier. Often it applies, for instance, to the

supply of waste used for energy production. However, if a payment is made from the user to the supplier of the waste, the supply should be recorded in block one, instead.

5.46. Finally, the third block shows the amounts of energy, which ultimately are lost during the extraction, storage and distribution of the energy, cf. Section B.3. All losses are presented by types of energy and the origin (industries and imports) of the energy.

5.47. The division of the energy supply into the three parts according to the type of use is instrumental for obtaining a full consistency between the physical and monetary tables. It should be noted however, that it is not possible to establish such a division of the supply side based on supply side information only. In practice the division requires that information on the use of energy is collected alongside information on imports and the production of energy by the extractors, manufacturers and distributors.

5.48. The use table presents the destination of three blocks of energy: a) the energy resources, which are extracted from the environment, b) the energy products, which are the subject of economic transactions, and c) own use of energy. The latter two blocks corresponds with the two first blocks of the supply table.

5.49. The table heading of the use table shows who is using the energy resources and the energy products. The energy is either used for intermediate consumption by the industries (classified in the same way as in the supply table, i.e. ISIC), for final consumption by households, changes in inventories or exports.

5.50. The 'changes in inventories' items in the use table may be recorded with either positive or negative entries. If energy products are withdrawn from inventories the corresponding changes in inventories are recorded as negative entries.

5.51. Under exports the "of which items" shows how much energy, which has been sold to tourists and other non-residents, e.g. for re-fuelling of their cars and lorries and for bunkering of foreign ships and planes.

5.52. The first block of the use table includes information on how much of each energy resource is being extracted by the industries, normally by the mining and quarrying industry, ISIC B. This information is included in the use table, since the extraction is considered to be a use of the resources from the environment. It does of course not mean that the mining and quarrying industry is using the energy themselves for energy purposes like combustion. Instead, as can be seen from the supply table, the main part becomes a supply of corresponding products from the mining and quarrying industry,.

5.53. In the case of natural gas, the extraction of natural gas is broken down by how it is eventually used. The uses include use by the extraction industry itself, re-injection, flaring and venting, and, in addition, a part, which is distributed to other units in the economy.

5.54. It is only in the use tables that energy resources are represented. There are no entries in the supply tables because energy resources are always supplied from the environment.

5.55. The second block of the use table presents information on the use of energy, which have been supplied from other units, corresponding to the first block in the supply table. Thus, for each of the energy products, the total use for intermediate consumption, final consumption by households, changes in inventories and exports is exactly equal to the total supply of the energy product as presented in block one of the supply table.

5.56. This part of the physical use tables corresponds to the monetary use table presented in Table 6.5 in chapter 6.

5.57. In the third block for own use of energy, etc. many entries corresponds exactly to entries in the second block of the supply table since per definition own use of energy is supplied and used within the same establishment. However, since this block also includes energy products, e.g. waste, delivered without payment from one establishment to another some inter-industry deliveries occurs as well. Also in this case, the total use equals exactly the total supply for each of the energy products.

5.58. The use tables, Tables 5.2 and 5.4, does not include any entries for losses of energy, since all losses, except for thefts, are always "used" by the environment in the sense that energy products ends up in the environment. If information on the use of stolen energy is available this may be presented in separate tables.

5.59. Tables 5.1 and 5.2 at mass or volume units do not include column sums for the total supply or use by categories, for instance a particular industry, since the energy resources and energy products are presented by different physical energy units, i.e. tonnes, cubic metres, etc. In contrast, the supply and use tables, Tables 5.3 and 5.4, at terajoule include both row and column sums. It should be noted, that these supply and use tables record all flows of energy taking place. Coal use, for instance, is recorded both as a resource flow from the environment to the ISIC Section B Mining and quarrying industry and as a flow of coal (as an energy product) from the ISIC Section B Mining and quarrying to the ISIC Section D Electricity, gas, steam and air conditioning supply. In addition, the electricity and steam generated by using the coal is recorded as a flow from the latter industry to other industries, households and the rest of world. This kind of "double counting" characterizes supply and use tables in general whether they are set in physical or monetary terms.

5.60. The physical supply and use tables can be compiled at various levels of detail with regard to both industries and energy products, depending on the intended use and data availability. The standard physical supply and use tables presented here are presented at a relatively high level of aggregation for energy resources and products as well as for industries in order to provide an overview of the concepts and general principles. When it comes to practical implementation, more detailed product classification and industrial classification should normally be used.

Table 5.1 Physical supply table for energy including breakdown by type of flow – Original units (mass and volume)

			Industries by ISIC						Total output	Imports		Total supply
			A	B	C	D	H	E-G, I-U		Total	*of which*	
			Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other industries			*Purchased by residents abroad*	
To the economy	**Supply to other economic units**											
	1. Coal, coke, gas work gas and peat											
	a) Coal, coke and peat	1000 Tonnes								8 946		**8 946**
	b) Gas work gas	1000 m3				28			28			**28**
	2. Oil	1000 Tonnes		16 782	7 848				24 630	22 537	*13 800*	**47 166**
	3. Natural Gas 1)	1000 m3		9 344		9 341			18 685			**18 685**
	4. Electricity	TWh				45			45	6		**51**
	5. Heat	Terajoules				102			102			**102**
	6. Renewable fuels and waste											
	a) Solid biomass and wastes	1000 Tonnes	3 281		1 137				4 418	1 219		**5 637**
	b) Liquid biofuels and biogas	1000 m3										
	Production for own use, etc. 1)											
	1. Coal, coke, gas work gas and peat											
	a) Coal, coke and peat	1000 Tonnes										
	b) Gas work gas	1000 m3										
	2. Oil	1000 Tonnes			347				347			**347**
	3. Natural Gas	1000 m3		709					709			
	4. Electricity	TWh				3			3			**3**
	5. Heat	Terajoules				2			2			**2**
	6. Renewable fuels and waste											
	a) Solid biomass and wastes 1)	1000 Tonnes			3 569				3 569			**3 569**
	b) Liquid biofuels and biogas	1000 m3	13		7	66			86			**86**
To the environment 2)	**Losses and returns to the env. 2)**											
	1. Coal, coke, gas work gas and peat											
	a) Coal, coke and peat	1000 Tonnes								90		**90**
	b) Gas work gas	1000 m3				1			1			**1**
	2. Oil	1000 Tonnes		57	43				99	51		**151**
	3. Natural Gas											
	Reinjection	1000 m3		821					821			**821**
	Flaring and venting	1000 m3		186					186			**186**
	Losses in distribution	1000 m3				3			3			**3**
	4. Electricity	TWh				2			2	1		**2**
	5. Heat	Terajoules				26			26			**26**
	6. Renewable fuels and waste											
	a) Solid biomass and wastes	1000 Tonnes			44				44	13		**57**
	b) Liquid biofuels and biogas	1000 m3				1			1			**1**

1) Includes also waste delivered from one economic unit to another without payment

2) Includes also energy lost due to thefts

Table 5.2 Physical use table for energy resources and transactions of energy products – Original units (mass and volume)

			Use												
			Intermediate Consumption, Industries by ISIC							Final consumtion, inventories and exports					Total use
			A	B	C	D	H	E-G, I-U	**Total**	Con-sump-tion by house-holds	Chan-ges in inven-tories	Exports		**Total final con-sump-tion, inven-tories and exports**	
			Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other industries	Total Indu-stries			Total	*of which sold to non-residents on national territory*		
From the environment	**Energy resources (gross extraction)**														
	E.11 Natural gas	1000 m3		11 060					11 060						11 060
	Extraction for own use	1000 m3		*709*					*709*						*709*
	Reinjection	1000 m3		*821*					*821*						*821*
	Flaring and venting	1000 m3		*186*					*186*						*186*
	Extraction for distribution	1000 m3		*9 344*					*9 344*						*9 344*
	E.12 + E.13 Crude Oil and natural gas liquids, Oil shale	Tonnes		16 839					*16 839*						16 839
	E.14 Natural bitumen, extra heavy oil, shale oil, sand oil and others	Tonnes													
	E.21 Coal	Tonnes													
	E.22 Peat	Tonnes													
	E.23 Uranium and thorium ores	Tonnes													
	Total energy resources			**27 899**					**27 899**						**27 899**
Within the economy	**Use of energy received from other economic units**														
	1. Coal, coke, gas work gas and peat														
	a) Coal, coke and peat	1000 Tonnes	81	5	623	8 943			9 652	21	- 796	70		- 706	8 946
	b) Gas work gas	1000 m3			1			2	3	25				25	28
	2. Oil	1000 Tonnes	799	38	8 489	398	15 222	1 149	26 095	2 346	*- 59*	*18 784*	*723*	21 071	47 166
	3. Natural Gas	1000 m3	51	55	979	11 428	12	306	12 830	711	*53*	*5 091*		5 856	18 685
	4. Electricity	TWh	2	0,1	9	4	2	10	27	11		*14*		24	51
	5. Heat	Terajoules	2	0,0	7		1	29	39	63				63	102
	6. Renewable fuels and waste														
	a) Solid biomass and wastes	1000 Tonnes	178	9	291	2 077		57	2 612	2 942	*18*	*64*		3 024	5 637
	b) Liquid biofuels and biogas	1000 m3													
	Own use of energy. etc. 1)														
	1. Coal, coke, gas work gas and peat														
	a) Coal, coke and peat	1000 Tonnes													
	b) Gas work gas	1000 m3													
	2. Oil	1000 Tonnes			347				347						347
	3. Natural Gas	1000 m3		709											
	4. Electricity	TWh				3			3						3
	5. Heat	Terajoules				2			2						2
	6. Renewable fuels and waste														
	a) Solid biomass and wastes 1)	1000 Tonnes				3 569			3 569						3 569
	b) Liquid biofuels and biogas	1000 m3	13		7	66			86						86

1) Includes also waste delivered from one economic unit to another without payment

Table 5.3 Physical supply table for energy including breakdown by type of flow – Common unit (terajoule)

		Industries by ISIC						Total output	Imports		Total supply
		A	B	C	D	H	E-G, I-U		Total	*of which*	
		Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other industries			*Purchased by residents abroad*	
		TeraJoule									
To the economy	**Supply to other economic units**										
	1. Coal, coke, gas work gas and peat										
	a) Coal, coke and peat								225		**225**
	b) Gas work gas				0.5			0.5			**0.5**
	2. Oil		722	338				1 060	930	*560*	**1 990**
	3. Natural Gas 1)		369		369			739			**739**
	4. Electricity				150			150	22		**173**
	5. Heat				102			102			**102**
	6. Renewable fuels and waste										
	a) Solid biomass and wastes	39		17				56	16.9		**73**
	b) Liquid biofuels and biogas										
	Total transactions	**39**	**1 091**	**355**	**622**			**2 107**	**1 194**	***560***	**3 301**
	Production for own use, etc. 1)										
	1. Coal, coke, gas work gas and peat										
	a) Coal, coke and peat										
	b) Gas work gas							0			**0**
	2. Oil			15				15			**15**
	3. Natural Gas		28		0.1			28.1			**28.1**
	4. Electricity				31			31			**31**
	5. Heat				2			2			**2**
	6. Renewable fuels and waste										
	a) Solid biomass and wastes 1)			37				37			**37**
	b) Liquid biofuels and biogas	0.3		0.2	1.5			2			**2**
	Total own use 1)	**0.3**	**28**	**52**	**34**			**115**			**115**
To the environment 2)	**Losses and returns to the env. 2)**										
	1. Coal, coke, gas work gas and peat										
	a) Coal, coke and peat								2.0		**2**
	b) Gas work gas				0			0			**0**
	2. Oil		2.0	2.0				4	2.0		**6**
	3. Natural Gas				0			0			**0**
	Reinjection		*32*					32			**32**
	Flaring and venting		*7*					7			**7**
	Losses in distribution										
	4. Electricity				6			6	2.0		**8**
	5. Heat				26			26			**26**
	6. Renewable fuels and waste							0			0
	a) Solid biomass and wastes			1				1	0.2		**1**
	b) Liquid biofuels and biogas										
	Total losses and returns		**42**	**3**	**32**			**76**	**6**		**83**

1) Includes also waste delivered from one economic unit to another without payment

2) Includes also energy lost due to thefts

Table 5.4 Physical use table for energy resources and transactions of energy products – Common unit (terajoule)

	Use													
		Intermediate Consumption, Industries by ISIC							Final consumtion, inventories and exports					Total use
		A	B	C	D	H	E-G, I-U	Total	Con-sump-tion by house-holds	Chan-ges in inven-tories	Exports		Total final con-sump-tion, inven-tories and exports	
		Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other industries	Total Indu-stries			Total	*of which sold to non-residents on national territory*		
		TeraJoule												
From the environment	**Energy resources (gross extraction)**													
	E.11 Natural gas		437					437						437
	Extraction for own use		*28*					*28*						*28*
	Reinjection		*32*					*32*						*32*
	Flaring and venting		*7*					*7*						*7*
	Extraction for distribution		*369*					*369*						*369*
	E.12 + E.13 Crude Oil and natural gas liquids, Oil shale		724					*724*						724
	E.14 Natural bitumen, extra heavy oil, shale oil, sand oil and others													
	E.21 Coal													
	E.22 Peat													
	E.23 Uranium and thorium ores													
	Total energy resources		**1 161**					**1 161**						**1 161**
Within the economy	**Use of energy received from other economic units**													
	1. Coal, coke, gas work gas and peat													
	a) Coal, coke and peat	2	0,1	18	223			243	1	- 21	1,9		- 19	225
	b) Gas work gas			0,0			0,0	0,1	0,4				0,4	0,5
	2. Oil	34	2	367	16	621	49	1 089	102	*- 3*	*801*	*31*	900	1 990
	3. Natural Gas	2	2	39	452	0	12	507	28	*2*	*201*		232	739
	4. Electricity	7	0,3	34	2	6	35	84	39		*49*		88	173
	5. Heat	2	0,0	7		1	29	39	63				63	102
	6. Renewable fuels and waste													
	a) Solid biomass and wastes	3	0,1	4	31		1	38	33	*0,3*	*1*		34	73
	b) Liquid biofuels and biogas													
	Total transactions	**50**	**4**	**469**	**724**	**628**	**127**	**2 002**	**267**	**- 22**	***1 055***	***31***	**1 300**	**3 301**
	Own use of energy. etc. 1)													
	1. Coal, coke, gas work gas and peat													
	a) Coal, coke and peat													
	b) Gas work gas													
	2. Oil			15				15						15
	3. Natural Gas		28		0,1			28,1						28,1
	4. Electricity				31			31						31
	5. Heat				2			2						2
	6. Renewable fuels and waste													
	a) Solid biomass and wastes 1)				37			37						37
	b) Liquid biofuels and biogas	0,3		0,2	1,5			1,9						1,9
	Total own use	**0,3**	**28**	**15**	**71**			**115**						**115**

1) Includes also waste delivered from one economic unit to another without payment

2. Supply and use tables for total flows of energy

5.61. The recording in the tables above follows the general SEEA methodology closely with regard to a distinction between a) natural resources, b) physical flows of products, which are the subject of economic transactions between economic units or produced for own use and c) residuals, here represented by losses.

5.62. For some purposes, for instance the estimation of air emissions based on the energy use, however, a presentation of aggregated flows may be useful. Such a presentation does also more clearly underline the general property of supply being equal to use for the different types of energy as a whole.

5.63. Table 5.5 presents the supply table for total flows of energy and table 5.6 presents the corresponding use table.

5.64. The supply table shows for each type of energy how much is produced and imported altogether, irrespectively of whether the energy is for own use or for distribution to users, or perhaps lost on its way to the users. This accounting of the total supply incl. own use and losses corresponds to how information on energy production and import are often obtained from the statistical sources and how it is presented in energy statistics.

5.65. The use table shows for each type of energy how the energy is used for intermediate consumption, incl. own use by industries, for final use by households, for exports and for inventories. In addition the losses of energy are presented as a separate category on the use side.

5.66. These tables do not explicitly show the flows of natural resources from the environment into the extraction industries. However, the amounts of natural resources extracted are implicitly recorded in the supply table since it includes the supply of energy products by the extracting industries, including the own use of energy, and, for instance, the natural gas being re-injected, flared and vented. On the use side, the latter categories are recorded as flows to the environment together with other returns to the environment in the form of losses.

5.67. Tables 5.5 and 5.6 presents explicitly the main accounting identity underlying the flow accounts for energy, including tables 5.1-5.4:

Total supply = Imports + Domestic production (incl. own use and losses)

=

Total use = Exports + Intermediate consumption (incl. own use) + Final consumption by households + Inventory changes + losses in distribution.

Tables 5.5 and 5.6 are useful for further analytical uses and form the basis for subsequent tables in this chapter, as well as for, for instance, the accounts of air emissions related to energy use. Of course, since table 5.5 and 5.6 consist in fact of aggregations and simple rearrangements of tables 5.3 and 5.4, a full correspondence between these and all following tables can also be established.

Table 5.5 Supply table for total flows of energy – Common unit (terajoule)

	Industries by ISIC						Total output	Imports		Total supply
	A	B	C	D	H	E-G, I-U		Total	*of which*	
	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other industries			*Purchased by residents abroad*	
	TeraJoule									
1. Coal, coke, gas work gas and peat										
a) Coal, coke and peat								227		**227**
b) Gas work gas				*0.5*			0.5			**0.5**
2. Oil		724	355				1 079	932	*560*	**2 011**
3. Natural Gas		437		369			806			806
Extraction for own use		*28*					*28*			*28*
Reinjection		*32*					*32*			*32*
Flaring and venting		*7*					*7*			*7*
Distribution		*369*		*369*			*739*			*739*
4. Electricity				187			187	24		**212**
5. Heat				130			130			**130**
6. Renewable fuels and waste										
a) Solid biomass and wastes	39		54				93	17.1		**111**
b) Liquid biofuels and biogas	0.3		0.2	1.5			2			**2**
Total supply of energy	**39**	**1 161**	**410**	**688**			**2 298**	**1 200**	***560***	**3 498**

Table 5.6 Use table for total flows of energy - Common unit (terajoule)

Use															
	Intermediate Consumption, Industries by ISIC							Final consumtion, inventories and exports					Total use by the economy	To the environment: Losses and re-turns	Total use incl. losses and returns
	A	B	C	D	H	E-G, I-U	**Total**	Consumption by households	Changes in inventories	Exports		**Total final consumption, inventories and exports**			
	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other industries	Total Industries			Total	*of which sold to non-residents on national territory*				
	TeraJoule														
1. Coal, coke, gas work gas and peat															
a) Coal, coke and peat	2	0,1	18	223			243	1	- 21	1,9		- 19	225	2	**227**
b) Gas work gas			0,0			0,0	0,1	0,4				0,4	0,5	0	**0,5**
2. Oil	34	2	382	16	621	49	1 104	102	- 3	801	*31*	900	2 004,5	*6*	**2 011**
3. Natural Gas	2	30	39	452	0	12	535	28	2	201		232	767	*40*	**806**
Own use		*28*					*28*						*28*		*28*
Reinjection														*32*	*32*
Flaring and venting														*7*	*7*
Distribution	*2*	*2*	*39*	*452*	*0*	*12*	*507*	*28*	*2*	*201*		*232*	*739*		*739*
4. Electricity	7	0,3	34	33	6	35	115	39		49		88	204	*8*	**212**
5. Heat	2	0	7	2	1	29	41	63				63	104	*26*	**130**
6. Renewable fuels and waste															
a) Solid biomass and wastes	3	0,1	4	68		1	75	33	0,3	1		34	110	*1*	**111**
b) Liquid biofuels and biogas	0,3		0,2	1,5			1,9						1,9		**2**
Total use of energy	**50**	**32**	**484**	**795**	**628**	**127**	**2 116**	**267**	***- 22***	***1 055***	***31***	**1 300**	**3 415**	***83***	**3 498**

D. Classifications and boundaries

5.68. The principles for recording the physical flows of energy are presented in more detail in this section. The difference between the residence principle used by the energy accounts and the territory principle used by energy statistics is also presented.

1. Energy resources

5.69. The classification of energy resources by type is presented in Chapter 3. The classification is used in the supply and use tables as well in order to ensure a full correspondence between the recording of flows and stocks.

5.70. The input of energy resources into the extraction industry is recorded in the use table as the gross input of natural resources, i.e. including any losses, re-injection, flaring and all own use of the energy for the extraction process. The output of the corresponding energy products from the extracting industry is recorded net of the losses and the own use of the resources during the extraction process. In the terminology of SEEA all losses of energy for the extraction process are flows of residuals, i.e. something, which are neither natural resources nor products.

2. Energy products

5.71. The International Recommendation of Energy Statistics, IRES, recommends that energy products refer to products exclusively or mainly used as a source of energy. They include energy in forms suitable for direct use (e.g., electricity and heat) and energy products, which release energy while undergoing some chemical or other process (combustion, etc. By convention, energy products include biomass and waste (i.e., solid or liquid) that are combusted for the production of electricity and/or heat. (IRES, 2011, 2.B).

5.72. This reference to what energy products are emphasizes the use of the product instead of the physical characteristics of the product. The qualifier *mainly* should be noted, since even if a product is normally characterized as an energy product, it can to some extent be used for non-energy purposes. On the other hand many products, which normally are not perceived as energy products are to some extent used as a source of energy.

5.73. A product such as crude oil is normally in its entirety included as an energy product since it is mainly used for energy purposes, although it can also be used for non-energy purposes, e.g. to produce plastic. In some of the SEEA-E accounts a distinction is therefore made between use of energy products for energy purposes and non-energy purposes (cf. Section E).

5.74. Wood can be used as fuel wood or for other purposes, e.g. building materials and pulp and paper. The latter part of the wood is excluded from the energy accounts, while the part used as fuel wood is included as energy products in the accounts.

5.75. Corncobs can be combusted directly to produce heat, they can be used in the production of ethanol as a biofuels, or they can be consumed as food. Although, it can be argued that corncobs used in the production of biofuels can be regarded as used as a source of energy, they are, according to IRES, not included as energy products. Only those corncobs used for combustion are included as energy products (IRES, 2011, 2.11). This distinction is related to the distinction between so-called primary and secondary energy products, which is introduced for analytical purposes.

5.76. In the case of the corncobs, corncobs used for combustion are primary energy products, while the heat or electricity resulting from the combustion are classified as secondary energy products. Ethanol, etc., used as biofuels are on the other hand characterized as primary energy products and therefore all inputs used for the production of biofuels falls outside the scope of energy products.

Primary and secondary energy products

5.77. Primary energy products are the result of the extraction or capture of energy resources from the environment. Once the energy resources have been extracted they become energy products, which are delivered from the extracting industries to other units of the economy. Bio-fuels, heat and power produced by capturing renewable energy (e.g. hydropower) from the environment are included as primary energy products.

5.78. Secondary energy products are the result of transformation of primary or other secondary energy products into other types of energy products. Examples include petroleum produced from crude oil, electricity produced from fuel oil and charcoal produced from fuel wood.

5.79. It should be noted that electricity and heat may be produced either as primary or secondary products. If heat is captured directly from the environment through solar panels or from geothermal reservoirs it is considered to be a primary energy product. If heat is produced from other energy products like coal, oil or electricity it is considered to be a secondary energy product. For electricity the distinction is similar.

Renewable and non-renewable energy

5.80. Energy products can be obtained from both renewable (e.g. solar, biomass, etc.) and non-renewable sources (e.g. coal, crude oil, etc.). It is important for both energy planning and environmental concerns to distinguish between renewable and non-renewable energy products, as well as to distinguish "infinite" renewable sources such as solar from cyclical renewable sources such as biomass. (IRES 2011, 2.10).

5.81. No uniform and formal definition of a renewable energy products exists, and IRES, for instance, makes reference to the sources behind the energy products instead of defining renewable energy products as such. However, whether one talks about sources or products, the notion of renewability involves that the energy is constantly replenished by natural processes. In its various forms, it derives directly or indirectly from the sun, or it is generated within the earth. It includes solar energy, wind energy, geothermal energy, hydropower, biomass and biofuels.

5.82. References to renewable energy may also include the requirement that the energy source should be replenished at a rate comparable or faster than its rate of consumption. Related to this requirement is the question of whether the energy source lying behind and providing the energy product is "infinite" renewable such as wind and solar energy or cyclical renewable such as a forest.

5.83. For the cyclical energy resources time and proper management have a role to play besides the replenishment. For these energy resources the reproduction takes time. If a renewable energy resource is used too extensively, for example by cutting down more trees then the forest can regenerate, the renewable energy resource is being depleted. Hence, proper management of a renewable resource, such as a forest, is necessary to uphold the renewability of the resource.

5.84. In contrast, for the "infinite" energy resources, the possibility for capturing the energy does only depend on the capacity of the available fixed capital like wind mills and solar panels.

5.85. Although, proper management is a prerequisite for upholding the renewability of the cyclical renewable energy resources it seems for statistical and accounting purposes appropriate not to include the management dimension, since it relates to factors, which cannot be observed directly when the information on supply and use of energy products is collected and recorded in the accounts.

3. Standard International Energy Product Classification, SIEC

5.86. To assist countries in the delineation of energy products, IRES (IRES, 2011) presents a list of internationally agreed definitions of energy products and the Standard International Energy Product Classification, SIEC, which arranges the products in a statistical classification.

5.87. The presentation of energy products in the SEEA-E flow accounts is also based on the SIEC. Table 5.7 presents the SIEC in short form. The leading column in the supply and use tables for energy is a further aggregation of the classes of SIEC **(*The tables have to be changed to reflect this*).**

5.88. Reference is made to IRES (IRES 2011, Chapter 3 and Annex A) for more details on SIEC and the definitions of energy products as well as the distinction between primary, secondary, renewable and non-renewable energy. In addition, correspondences between SIEC and other international product classifications, such as the Harmonized Commodity Description and Coding System (HS) and the Central Product Classification (CPC) are provided.

Table 5.7 Standard International Energy Product Classification (SIEC)

Classes of energy products
0 Coal
1 Peat and peat products
2 Oil shale / oil sands
3 Natural gas
4 Oil
5 Biofuels
6 Waste
7 Electricity
8 Heat
9 Nuclear fuels and other fuels n.e.c

Source: IRES, 2011

5.89. The distinctions between primary and secondary energy products, as well as between renewable and non-renewable energy products are not explicit classification criteria in SIEC, although in many cases a complete detailed SIEC category can clearly be assigned to one set. The list of products considered primary or secondary and renewable or non-renewable is given in Annex A in the International Recommendations for Energy Statistics (IRES 2011, 3,16).

5.90. While the distinction between primary and secondary products is used in relation to some of the SEEA-E flow accounts for energy, cf. Section F, the distinction between renewable and non-renewable energy is not included in the SEEA-E accounts. However, such a distinction may easily be introduced in relation to actual implementation of the accounts by appropriate partitioning of the product dimension in the tables.

4. Industries

5.91. Industries are groupings of establishments engaged in the same, or similar, kinds of activities. An establishment is assigned to an industry according to its principal activity, i.e. the activity whose value added exceeds that of any other activity carried out within the same establishment. An establishment may in addition carry out secondary activities for own use or for delivery outside the establishment or ancillary activity entirely for own use. Steam, for instance, may be produced by a steelworks from surplus heat as secondary activity and a manufacturing company may, for instance, produce electricity for own use.

5.92. The classification of industries in the SEEA-E follows the International Standard Industrial Classification of All Economic Activities, ISIC, Revision 4[1]. The classification at the so-called section level is presented in table 5.8.

Table 5.8 Broad structure of ISIC, rev. 4. (ISIC sections)

A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organizations and bodies

5.93. The classification includes all the relevant economic activities for describing the extraction of energy resources, transformation and distribution of energy products. These activities take place within the three sections:

- Section B – Mining and quarrying
- Section C - Manufacturing
- Section D – Electricity, gas steam and air conditioning supply

[1] The following description of the industries is based on the description of ISIC rev. 4,

cf. http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27&Lg=1

Mining and quarrying

5.94. Establishments extracting (non-renewable) energy resources as a *principal activity* are included in Section B, Mining and quarrying. The section is further divided into the following divisions

- ISIC Division 05 - Mining of coal and lignite
- ISIC Division 06 - Extraction of crude petroleum and natural gas
- ISIC Division 07 - Mining of metal ores
- ISIC Division 08 - Other mining and quarrying
- ISIC Division 09 - Mining support service activities

5.95. These industries also carry out certain supplementary activities aimed at preparing the crude materials for marketing, for example, crushing, grinding, cleaning, drying, sorting, concentrating ores, liquefaction of natural gas and agglomeration of solid fuels.

5.96. Divisions 05, 06 are concerned with mining and quarrying of fossil energy (coal, lignite, petroleum, gas); Divisions 07, 08 concern metal ores, various minerals and quarrying products.

5.97. Some of the technical operations of this section, particularly related to the extraction of hydrocarbons, may also be carried out for third parties by specialized units as an industrial service. This is included in Division 09, which represent specialized support services incidental to mining provided on a fee or contract basis. It includes exploration services through traditional prospecting methods as well as drilling. Other typical services cover building oil and gas well foundations, cementing oil and gas well casings, draining and pumping mines, overburden removal services at mines, etc.

5.98. Section B excludes the processing of the extracted materials (included instead in Section C - Manufacturing), separate site preparation activities for mining (see Division 4312) and geophysical, geologic and seismic surveying activities (included in Division 7110).

5.99. The ISIC Rev. 4 divisions are further subdivided into Groups and Classes on the basis of the principal mineral produced. Table 5.9 links the specific energy resources (cf. classification in Chapter 3) to the ISIC industries, which undertake the extraction activities for specific energy resources.

Table 5.9 Energy resources and industries extracting them

Energy resource (SEEA-E classification, cf. Chapter 3)	**ISIC Groups and classes within Section B**
E.11 Natural gas	062 – Extraction of natural gas
E.12 Crude oil and natural gas liquids	061 – Extraction of crude petroleum
E.13 Oil Shale	061 – Extraction of crude petroleum
E.14 Natural bitumen and extra heavy oil	061 – Extraction of crude petroleum
E.21 Coal and lignite	05 - Mining of coal and lignite
E.22 Peat	0892 - Extraction of peat
E.23 Uranium and thorium ores	0721 - Mining of uranium and thorium ores

Industries capturing renewable energy

5.100. Renewable energy is normally not observed or measured as a flow from the environment to the economy, but only as an output flow from the producing industries. Accordingly, the use table does not include renewable energy as a flow from the environment to the economy. This also applies to the use of biomass, e.g. straw and firewood used for combustion.

5.101. The principal activities of capturing heat and electricity from renewable sources, i.e. as primary energy, are included in ISIC Rev. 4, Section D Electricity, gas, steam and air conditioning supply. More specifically Class 3510 Electric power generation, transmission and distribution include the operation of generation facilities that produce electricity including thermal energy, while Class 3530 - Steam and air conditioning supply include production of steam and hot water for heating, power and other purposes.

Manufacturing coke oven products and refined petroleum products

5.102. Within ISIC C, Division 19 Manufacture of coke and refined petroleum products is of specific relevance in relation to the production of energy products. It is further subdivided into the following Groups:

- ISIC Group 191 - Manufacture of coke oven products
- ISIC Group 192 - Manufacture of refined petroleum products

5.103. These industries transform crude petroleum and coal delivered from ISIC section B Mining and quarrying into other energy products. The dominant process is petroleum refining, which involves the separation of crude petroleum into component products through techniques such as cracking and distillation. Included is also the manufacture for own account of products such as coke, butane, propane, petrol, kerosene, fuel oil etc. as well as processing services (e.g. custom refining). The petroleum refineries produce also petroleum based gases such as ethane, propane and butane.

5.104. The enrichment of uranium and thorium ores and production of fuel elements for nuclear reactors processing of uranium takes place in ISIC Class 2011 Manufacture of Basic Chemicals.

Supply of electricity, gas and steam

5.105. ISIC Section D Electricity, gas, steam and air conditioning supply includes the following three Groups:

- ISIC Group 351 - Electric power generation, transmission and distribution
- ISIC Group 352 - Manufacture of gas; distribution of gaseous fuels through mains
- ISIC Group 353 - Steam and air conditioning supply

5.106. These industries provide electricity, natural gas, steam and hot water through a permanent infrastructure (network) of lines, mains and pipes. The dimension of the network is not decisive; also included are the distribution of electricity, gas, steam, hot water in industrial parks or residential buildings. Included is the operation of electric and gas utilities, which generate, control and distribute electricity, gas and steam.

5.107. These industries produce secondary energy by converting other energy products, but in addition they produce, as described above, primary energy by capturing, for instance, energy from sun and wind, and producing electricity and heat from it.

5.108. It should be noted, that the separate ISIC classification of electric power (ISIC Group 351) and steam (ISIC Group 353) is artificial, when it comes to units generating combined heat and power (CHP). The output of electricity and heat can be measured separately, but the inputs of energy products for the CHP process have to be split based on assumptions. As a default option the inputs of energy products for the CHP process may be split based on reference values for separate production of heat and electricity.

Other industries involved in extraction and production of energy

5.109. While the main part of the energy products are generally imported or produced by the above mentioned industries, other industries may in principle be involved in extraction of energy resources. Further, it is not unusual that other industries are involved in the production of energy products like electricity or heat as a secondary activity.

5.110. At the point of departure such activities should be recorded as activities of the industries actually carrying them out. For instance, electricity and heat produced in relation to incineration of waste should be recorded as the result of activities of ISIC Class 3821 - Treatment and disposal of non-hazardous waste.

5.111. While this may be taken as the general rule, it should be observed, that in practice often a reallocation of activities in such industries as agriculture, construction, trade and energy supply take place when the national accounts are set up. This involves that data from basic statistics regarding secondary activities in industries are transferred to the relevant primary industries when the data are entered into the supply and use tables.

5.112. Therefore in order to ensure consistency with the national accounts, it may be necessary to make a similar reallocation of the flows of energy products in order to ensure consistency with the national accounts. If such a reallocation is made the result is that the supply and use tables becomes sparse in the sense that all or most flows are concentrated to the columns of the industries described in the previous sections.

5.113. In addition to the core activities of extracting and producing energy products by the above mentioned industries, supplementary activities are carried out by other industries. Examples include

transport activities such as long-distance transport of gas through pipelines, or transport of energy products by ships, trains and trucks carried out by ISIC Section H Transportation and storage. Since such services are non-physical by nature they are not described by the physical flow accounts.

5. The production boundary

5.114. Production of energy products is a physical process, carried out under the responsibility, control and management of an institutional unit, in which labour and assets are used to transform inputs of energy resources or other energy products into outputs of energy products.

5.115. All energy products supplied from one unit to another are included in the SEEA-E flow accounts no matter if the energy product is sold or exchanged as part of a barter or provided free of charge.

5.116. Following the general principles of the national accounts, energy produced by an establishment and used by the same establishment is excluded from the measure of output of energy products. Thus, if an establishment produces electricity itself and uses this electricity for processing of other goods or services, the output and use of the electricity is neither recorded on the supply nor the use side. However, to the extent that is possible to quantify the *own supply and use of energy products*, these flows should be recorded in the accounts as flows of energy for own use.

5.117. In contrast, still following the general principles from the national accounts, if households extract or produce energy, the energy extraction or production should be recorded as part of the product output of the industry that would otherwise have produced the energy. At the same time a corresponding private consumption of energy products should be recorded for the households. For example, the collection of firewood and dung and the generation of electricity from wind turbines owned by households are within the production boundary of SEEA-E, and the output is seen as part of the total supply of energy products. Depending on the degree of reallocation taking place the energy products generated should be recorded as output of ISIC Section A Agriculture, forestry and fishing, and in the second case as output of ISIC Section D Electricity, gas, steam and air conditioning supply.

5.118. Regular losses during storage and losses from extraction and distribution of energy are not included in output of energy products. However, due to the importance for analysis, these flows are recorded in the accounts as flows of residuals.

6. The residence principle

5.119. In the SEEA-E, the energy use of a country is equal to the sum of the use of all resident institutional units. This is not exactly the same as the sum of use related to all productive activities taking place within the geographical boundaries of the national economy (the territory). Some of the energy use of a resident institutional unit may take place abroad, for example, in relation to international transport activities. Conversely, some of the energy use within a country may be attributable to non-resident institutional units.

5.120. The use of energy in the SEEA-E must be related to the economic activities (production and consumption) of residents units rather than to the units on the national territory. Energy use by resident units abroad, essentially covering tourists driving abroad and companies engaged in international transport activities, should be recorded in the accounts either as the use of industries earning the value added from these activities or as a use of the households (transport). Conversely, all energy use by non-resident entities within the national boundary (foreign ships, planes, trucks and tourists) should be excluded. See also Section G for further description of the residence and the territory principle.

5.121. The use of the resident principle guarantees that aggregates from the SEEA-E such as total energy output and use can be compared consistently with macroeconomic and sector aggregates such as gross domestic product and value added. This is essential for the correct calculation of energy efficiency/intensity indicators defined as energy use by industry over value added.

7. Imports and exports of energy products

5.122. Imports and exports of energy products should be recorded when change of ownership between a resident and a non-resident unit occur. In the absence of sources specifying the date on which ownership changes, there is a strong presumption that the goods will cross the frontiers of the countries concerned either shortly before or soon after the change of ownership takes place. Trade statistics based on customs documents reflecting the physical movement of goods across the national or customs frontier may therefore often be used as an approximation (SNA 2008, 3.166).

5.123. Imports and exports can be recorded according to either the general trade or the special trade system. Under the general trade system, goods are recorded as they enter or leave the national boundary including goods that are imported into and exported from custom-bonded warehouses and free zones. Under the special trade system, goods are recorded as trade only when they cross the customs boundary (i.e. enter free circulation).

5.124. The SEEA-E uses, in accordance with the convention used for the national accounts, the general trade system to determine imports and exports. Thus, the imports of energy products include energy products, which are brought into a free zone. Energy products in transit through the economic territory should generally not be included in imports and exports. However, for electricity and heat it may be difficult to distinguish between transit flows and other flows, and all flows of electricity and heat into a country may therefore in practice be recorded as imports, and all outgoing flows may be recorded as exports.

5.125. According to the SNA 2008 goods sent abroad for processing are not treated as crossing the borders and not as exports or imports since no change of ownership normally takes place. If for example crude oil is sent to another country to be refined, the crude oil is excluded from the exports and the returned refined products are excluded from imports of the country. Instead, an import of a service corresponding to the processing abroad is recorded as imports. Thus the processing corresponds to a similar processing within the country except that it is carried out with the use of an imported processing service.

5.126. However, in relation to SEEA and SEEA-E it is considered appropriate to record the physical flows as they actually take place. Therefore in addition to the import and export flows as they are recognized by the national accounts, also the physical flows related to goods sent abroad for processing are recorded in the physical flow accounts. It should be noted that foreign trade statistics normally records the flows of goods sent abroad for processing and the return flows together with other flows of products crossing the borders.

5.127. Trade statistics records the physical movement of energy products, including electricity, across the boundary of the economic territory. However, when it comes to tourists and companies carrying out international transport activities energy products bought by residents outside the economic territory, and energy products bought by non-residents inside the economic territory are not included as imports and exports of products, respectively. Therefore, the imports and exports figures from the trade statistics have to be supplemented by energy products bought and sold for these purposes. Table 5.10 shows the most important additions and subtractions to the foreign trade statistics needed to arrive at the total import and export concepts used in the SEEA-E.

Table 5.10 Imports and Exports of Energy Products

Imports (general trade system)	Exports (general trade system)
+ Energy products purchased by residents abroad	+ Energy products sold to non-residents on domestic territory
Of which:	*Of which*:
Bunkering of oil abroad for sea transport and fishing vessels	Foreign ships' and fishing vessels' bunkering of oil on territory
Bunkering of jet fuel and kerosene abroad for air transport	Foreign planes bunkering of jet fuel and kerosene on territory
Refuelling abroad of gasoline and diesel for land transport	Foreign vehicles' refuelling of gasoline and diesel on territory
Tourists' and businessmen's purchase of energy abroad including fuel for private cars	Foreign tourists' and businessmen's purchase of energy on territory including fuel for private cars
Energy purchased by military bases on foreign territories	Energy sold to foreign military bases on national territory
Energy purchased by national embassies abroad	Energy sold to foreign embassies on national territory
= total imports of energy products	= total exports of energy products

5.128. Although, the adjustments presented in Table 5.10 cover the most usual differences between imports and exports as they are recorded by the general trade system and SEEA-E it should be underlined that this does not reflect all possible adjustments.

5.129. For instance, it may be necessary to include an additional adjustment if a ship operated by a resident in country A bunkers oil in a harbour in country B, and this oil is delivered directly by road tanker from country A. In this case the bunkering of oil is, according to the national accounts and SEEA-E, simply a flow within country A, but in the foreign trade statistics it may be recorded first as export from country A to B and then as imports to country A from country B.

8. Intermediate consumption

5.130. *Intermediate consumption* include all energy resources and energy products used by the industries as inputs in a production process, regardless of the nature of this production process, i.e. whether it is a process converting an energy product into another energy product for further use in the economy, or whether, for instance, it is a process which ultimately uses the energy content in the product so that no further use of the energy is possible.

5.131. Re-injection of natural gas, as well as flaring and venting of petroleum and natural gas by the extracting industries are not recorded as part of the intermediate consumption of energy products, but instead as flows of residuals, cf. the following sections. The same applies to losses of energy products, when the losses are related to products before a shift of ownership from the producer to the user has taken place. If a product is lost after it has been handed over from the producer to the final user of the product, the loss will be recorded as part of intermediate consumption of the energy product.

9. Final consumption by households, changes in inventories and exports

5.132. Besides intermediate consumption other use of energy products includes three categories: final consumption by households, changes in inventories and exports.

5.133. The final consumption of energy products include energy products produced by the households themselves, i.e. firewood gathered by the households and electricity generated by windmills owned by the households.

5.134. These "other uses" corresponds to what is generally called final use (or final demand) in relation to the national accounts. However, the term "final" is avoided in the SEEA-E because the same term is sometimes used in a somewhat different meaning in energy statistics and balances. In the International Recommendation for Energy Statistics, for instance, final consumption of fuels covers deliveries of energy products to all consumers excluding activities that are not fuel transformation or production of electricity or heat (IRES 2011, 8.33). In the SEEA-E this concept is called "end use" of energy instead, cf. Section F.

5.135. Thus, while energy products used by industries are not categorised as final use by the national accounts and SEEA-E this is the case according to energy statistics and balances, for instance, for fuel used by industries for operating transport equipment.

10. Extractors and producers' own use of energy

5.136. The own use of energy by the establishments, which extract and produce energy products, is in SEEA-E recorded as an output of a separate category of energy called own use of energy, etc. in the supply table. Typically the output will be of ISIC Section B of ISIC Rev. 4, Mining and quarrying or ISIC Section D Electricity, gas, steam and air conditioning supply, but own use may in principle be recorded for any other industry as well.

5.137. Own use of natural gas by the extraction industry is recorded as a production of natural gas for own use in the supply tables (5.1 and 5.3) and a corresponding use in the use tables (5.2 and 5.4).

5.138. Note that an industry's own use of energy is only recorded as a separate category if the own use takes place within the same establishments. If, within the same industry, energy is sold from one establishment to another it is recorded as an output of energy products from the industry and a corresponding use of energy products by the same industry.

11. Losses

5.139. The different types of losses involved in the extraction of energy resources and the production of energy products is described in Section B.3.

5.140. The output of energy produced and subsequently lost during extraction, distribution, and storage is not recognised by the national accounts if the energy is still in the possession of the producer, when the losses take place, since no monetary transactions are involved in this case.

5.141. Since, however, the information about these types of losses are important for analytical purposes they are included separately in the physical energy accounts, cf. table 5.1 and 5.3 distinct from the transactions between economic units and the own use of energy. Thus, for instance, in the case of loss of electricity during distribution, an output of electricity as a residual is recorded in addition to the output of electricity as a product. In the tables for total energy flows, cf. Tables 5.5 and 5.6, the flows are presented in the use table as a flow to environment.

5.142. In cases where theft explains a significant part of the losses in distribution, and where data on this is available, it can be recorded in the tables for total energy flows (Tables 5.5 and 5.6) as flow from the producers to the ultimate users of the energy. Further, the amounts of stolen energy may be presented explicitly in a supplementary use table presenting the input of the stolen (non-transacted) energy to industries or households depending on who is responsible for the theft.

5.143. Energy lost after it has been acquired by a buyer from the producer is, in contrast, recorded as part of the producers' product output and is correspondingly included in the intermediate consumption

or final consumption of energy products by the industry or the households, which have acquired the energy.

5.144. Losses during the transformation of one energy product to another are related to the loss of heat to the environment during the production process and is always measured in energy units, joule. Transformation losses are similar to other intermediate consumption and are therefore recorded explicitly in the accounts in the so-called transformation table, which link the primary supply of energy with the end use of energy, cf. Section F. Thus, transformation losses are not presented in the supply and use tables, Tables 5.1, 5.3 and 5.6.

5.145. Flaring is commonly used during petroleum refining and chemical processing. If the products being flared have been acquired from another units it is recorded as part of the intermediate consumption in the use tables (Table 5.2 and 5.4). Otherwise, if the products being flared have been produced by the establishments carrying out the flaring, it should be included as losses of energy products in the supply tables, Tables 5.1 and 5.3.

12. Measurement units

5.146. The flows of energy resources and energy products are measured as the ratio of a physical measure per time unit. The time unit will typically be a year, and sometimes a quarter of a year or a month. The units used for the physical measures of the energy resources or products reflect the mass, volume or energy content of the resource or product

5.147. The measurement units that are specific to an energy product and are employed at the point of measurement of the energy flow are often referred to as "original" or "natural" units. Typical examples are kilograms or metric tons for solid fuels and barrels, litres or tonnes for oil and cubic metres for gases. The actual units used nationally vary according to country and local condition and reflect historical practice in the country (IRES 2011, 4.9). The original units are often the units used, which are used when the basic statistics is collected. The original units are used for Tables 5.1 to 5.4.

5.148. For statistical and accounting purposes and for many types of analysis it may be useful to convert the original units into a common unit, in order to, for example, compare fuel quantities of different products and to estimate efficiencies. The conversion from different units to a common unit requires some conversion factors for each product. In the *International System of Units*[2] the joule is the only common unit although other common energy units are also applied in practise, for instance, toe, GWh, Btu, calories, etc. The use of the joule as a common unit is recommended by the International Recommendation for Energy Statistics (IRES, 2011, 4.29).

5.149. Reference is made to the International Recommendation for Energy Statistics (IRES, 2011) for further information on measuring units and the conversion between units.

E. Use of energy by purpose

5.150. The tables in the previous part of this chapter have not included any specific information on the purposes of the energy use. However, for some types of analysis it is useful to know whether the energy is used for, for instance, transport, heating, processes or for non-energy purposes. This section presents a physical use table, which include such information.

[2] See International Bureau of Weights and Measures (BIPM) http://www.bipm.org/en/si/

5.151. According to the International Recommendation on Energy Statistics energy products can be used for three purposes: (i) energy purposes; (ii) non-energy purposes; and (iii) transformation. (IRES 2011, 5.78).

5.152. In SEEA-E no distinction is made between purpose (i) and purpose (iii). Instead, an overall distinction between use for energy purposes and non-energy purposes is made.

5.153. An energy product is classified as being used for energy purposes if it is used to raise heat, for transportation or electrical services (IRES 2011, 5.73). In addition, energy products, which are converted into other energy products are classified as used for energy purposes according to SEEA-E.

5.154. Within energy used for energy purposes a further distinction between energy used for transport, energy used for heating, etc, and energy used for processes are made. The category energy used for heating, etc. includes energy used for cooking, lighting, and household appliances. Energy use for processes includes energy used for stationary machines in industries.

5.155. In some cases it is simple to determine the purpose of the use of an energy product. Energy products bought by private households, for instance, are most likely used for energy purposes. In other cases when, for instance, the chemical industry buys oil products it is necessary to obtain specific information from the industries about the purpose.

5.156. Non-Energy uses comprise uses of fuels for chemical feedstocks and non-energy products. Chemical feedstocks are fuels used as raw materials for the manufacture of products, which contain the hydrogen and/or carbon taken from the fuel. Non-energy products are fuel products used mainly for their physical and chemical properties. Examples are lubricants, paraffin waxes, coal tars and oils as timber preservatives, etc. (IRES 2011, 5.21).

5.157. Almost all consumption of electricity is for power and heat use resulting in the disappearance of the electricity as heat. Use of electricity for electrolysis occurs in some industries but statistics distinguishing this use from other uses in the enterprises are not usually available. (IEA, Energy Statistics manual, p. 29).

5.158. Exports, distribution losses and inventory changes of energy products are always classified as non-energy purposes in SEEA-E even though the energy products being exported or put into inventories may of course ultimately be used for energy purposes. However, at the moment they are recorded as exports or inventory change, the ultimate use is usually not known.

Table 5.12 Energy use by purpose

	Intermediate Consumption, Industries by ISIC							Final consumption					Total use by the economy	To the environment: Losses and returns	Total use incl. losses and returns
	A	B	C	D	H	E-G, I-U	Total	Consumption by house-holds	Changes in inventories	Exports		Total final consumption			
	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other industries	Total Industries			Total	of which Sold to non-residents on national territory				
	TeraJoule														
Energy purposes															
Transport	**22**	**1**	**150**	**3**	**601**	**40**	**817**	**65**				**65**	**882**		**882**
2. Oil	22	0.6	150	3	600	40	816	65				65	881		**881**
4. Electricity					1		1						1		**1**
Heating, etc	**23**	**2**	**130**	**6**	**24**	**81**	**267**	**201**				**201**	**468**		**468**
1. Coal, coke, gas work gas and peat															
a) Coal, coke and peat	2						2	0.6				0.6	3		**3**
b) Gas work gas								0.4				0.4	0.4		**0.4**
2. Oil	10	0	110	1	21	9	151	36.9				37	188		**188**
3. Natural Gas	1	2	5	2	0.5	12.1	22.5	28.1				28	51		**51**
4. Electricity	6	0.1	4	1	2	30	43	39				39	82		**82**
5. Heat	2	0.0	7	2	1	29	41	63				63	104		**104**
6. Renewable fuels and waste															
a) Solid biomass and wastes	2	0.1	4			0.8	7	33				33	40		**40.1**
b) Liquid biofuels and biogas	0.2		0.2				0.4						0.4		**0.4**
Others, (energy for processes, etc.)	**5**	**29**	**200**	**786**	**3**	**5**	**1 028**						**1 028**		**1 028**
1. Coal, coke, gas work gas and peat															
a) Coal, coke and peat		0.1	18	223			241						241		**241**
b) Gas work gas			0.0			0.0	0.1						0.1		**0.1**
2. Oil	2	0.8	118	12			133						133		**133**
3. Natural Gas	1	28.2	34	450			513						513		**513**
4. Electricity	1	0.2	30	32	3	5	71						71		**71**
5. Heat															
6. Renewable fuels and waste															
a) Solid biomass and wastes	0.6			68			68						68		**68**
b) Liquid biofuels and biogas	0.1			1			2						2		**2**
Non-energy purposes			**4**				**4**		**- 21.6**	**1 055**	**31**	**1 033**	**1 037**	**83**	**1 120**
1. Coal, coke, gas work gas and peat															
a) Coal, coke and peat									- 21	1.9		- 19.3	- 19.3	2.4	**- 16.9**
b) Gas work gas														0.0	**0.0**
2. Oil			4				4		- 3	801	31	798	802	6	**809**
3. Natural Gas									2	201		203	203	40	**243**
4. Electricity										49		49	49	8	**57**
5. Heat														26	**26**
6. Renewable fuels and waste															
a) Solid biomass and wastes									0.3	0.9		1.2	1.2	0.7	**1.9**
b) Liquid biofuels and biogas															
Total	**50**	**32**	**484**	**795**	**628**	**127**	**2 116**	**267**	**- 22**	**1 055**	**31**	**1 300**	**3 415**	**83**	**3 498**

F. Supply of primary energy and imports, transformation and end use of energy

5.159. In order to both highlight and exclude flows of energy products, which are used for transformation into other energy products and used for non-energy purposes, a specific set of tables are presented. It focuses on 1) the supply of primary energy products and imports; 2) the transformation of primary energy and imports into energy available for end-use; and 3) the end use of the energy. These tables are similar to the energy balances, which are often presented in relation to energy statistics (see, for instance, Energy Statistics Manual, IEA 2005, chapter 7), although the classifications and terminology used are slightly different. The tables have the advantage that they sort out the "double counting" from the supply and use tables presented in Tables 5.5 and 5.6 due to the inclusion of all types of energy products, both primary and secondary at the same time.

5.160. The table for supply of primary energy products and imports focuses on the energy flowing into the economy through the domestic extraction and the imports. The transformation table shows which parts of this energy is transformed into secondary energy products, and how much energy is lost during the transformation processes, and finally how much energy is available for end use.

5.161. End use of energy is defined as use of energy for other purposes than transformation into other energy products. End use of energy corresponds to what is often called final use of energy in energy statistics and balances. The end use table shows how much energy is used by industries and by final use categories for other purposes than transformation.

5.162. All entries in the tables are in the common energy unit terajoule ($=10^{12}$ Joules).

Supply of primary energy products and imports

5.163. Table 5.13 presents the total inflow of energy to the economy from the environment and the rest of the world in a period. It includes the energy made available through domestic extraction of energy resources and through imports of primary and secondary energy products. To avoid double counting with regard to the domestic supply of energy, only the energy produced by the extracting industries are included, not the flows of energy resources from the environment to the extracting industries.

5.164. All types of energy, i.e. energy products, energy for own use and energy, which eventually are lost, are included. The table shows these three types of energy flows aggregated.

5.165. The aggregation level of the energy products shown in the rows of Table 5.13 is somewhat different compared to the level shown in the previous tables because the focus is on presenting the primary energy products and to show the transformation into secondary products. Electricity and heat, for instance, are shown both as primary and secondary energy. Nuclear fuels are not shown in the tables, but electricity and heat produced by the nuclear power plants are included as supply of primary electricity and heat.

Table 5.13 Supply of primary energy and imports of energy

	Industries by ISIC						Total output	Imports		Total supply of primary energy and imports
	A	B	C	D	H	E-G, I-U		Total	*of which*	
	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other Industries			*Purchased by residents abroad*	
	TeraJoule									
1. Coal, coke, gas work gas and peat										
a) Coal, coke and peat								227		**227**
b) Gas work gas										
2. Oil										
Crude oil		724					724	110		**834**
Oil products								822	*560*	**822**
3. Natural Gas		**437**					**437**			**437**
4. Electricity										
Primary (wind, solar, hydro, nuclear, etc.)				22			22			**22**
Secondary electricity								24		**24**
5. Heat										
Primary (solar, geothermal, etc.)										
Secondary heat										
6. Renewable fuels and waste										
a) Solid biomass and wastes	39		54				93	17		**110**
b) Liquid biofuels and biogas	0.3		0.2	1			2			**2**
Total	**39**	**1 161**	**54**	**23**			**1 279**	**1 201**	***560***	**2 480**

5.166. In the table the supply of primary energy from the industries is for the main part carried out by ISIC Section B Mining and quarrying and by ISIC Section D Electricity, gas, steam and air conditioning supply. The former supplies coal etc., crude oil and natural gas and the latter primary electricity and heat. ISIC Section A Agriculture, forestry and fishing delivers biomass for energy purposes, while waste for incineration is delivered by ISIC Section E Water supply; sewerage, waste management and remediation activities. However, other industries may also supply these primary energy products.

5.167. By adding the imports of primary and secondary energy products, the total inflow of the energy to the national economy is obtained (shown in the last column of the table). For the industries, the column sums show how much primary energy they supply. The figure in the intersection of the last row and last column of the table (2 480 terajoule) represents the total of domestic supply of primary energy and imports of primary and secondary energy.

Transformation into secondary products

5.168. The *transformation table*, Table 5.14, shows how energy products entering the economy via domestic supply of primary energy and imports are converted into other types of energy before they are used by industries or households for end use and for non-energy purposes.

5.169. Negative numbers in the transformation table correspond to inputs of primary energy or imports used by an industry for transformation processes while positive numbers correspond to output of secondary energy.

5.170. By following a column in the transformation table, information is obtained about how much of the various types of energy the corresponding industry uses (negative numbers) as intermediate inputs for the transformation, and how much of each secondary energy product is produced (positive numbers) by the same industry as a result of the conversion. A transformation from one type of energy to another is normally associated with some losses of energy. The total amount of energy lost from each of the industries' transformation processes is shown in the last row.

5.171. The rows of the transformation table show how the corresponding types of energy are produced (positive numbers) as a result of the energy transformation processes or used (negative numbers) as inputs for the conversion processes. When all inputs and outputs are subtracted and added, respectively, the total output, net, from the transformation processes is obtained.

Since, the supply of primary energy and imports on the one hand includes energy which is lost during the extraction process, for instance natural gas being re-injected, flared and vented, and the output of natural gas on the other hand is recorded net of these losses they are implicitly presented as transformation losses in the table.

Table 5.14 Transformation of primary energy and imports into energy available for end use

	1. Total supply of primary energy and imports	Inputs to (-) and outputs from (+) energy transformation processes									2. Net output (+) / use (-) of energy from transformation	3. Available for end use (1. + 2)
		A	B	C	D	of which			H	E-G, I-U		
		Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	D. 351 Electric power generation, etc.	D. 352 Manufacture of gas; distribution, etc.	D. 353 Steam and air conditioning supply	Transportation and storage	Other Industries		
	TeraJoule											
1. Coal, coke, gas work gas and peat												
a) Coal, coke and peat	227				*- 223*	*- 168*		*- 55*			- 223	4
b) Gas work gas					0		*0*				0.5	0.5
2. Oil												
Crude oil	834			- 341							- 341	493
Oil products	822			340	*- 16*	*- 13*		*- 4*			324	1 146
3. Natural Gas 1) 2)	**437**		**- 68**		***- 82***	***- 47***	***- 1***	***- 35***			**- 150**	**287**
4. Electricity												
Primary (wind, solar, hydro, nuclear, etc.)	22				*- 22*	*- 22*					- 22	
Secondary electricity	24				*156*	*156*					156	180
5. Heat												
Primary (solar, geothermal, etc.)												
Secondary heat					*130*			*130*			130	130
6. Renewable fuels and waste												
a) Solid biomass and wastes	110				*- 68*	*- 24*		*- 44*			- 68	43
b) Liquid biofuels and biogas	2				*- 1*	*- 1*		*- 0.5*			- 1	0
Transformation losses (inputs-outputs)			**68**	**1**	**127**	**117**	**0**	**9**			**195**	
Total	**2 480**											**2 284**

1) Reinjection, flaring, venting and own use of natural gas by the extraction industry is considered as use for transformation

2) The entry for ISIC D 352 is net input of natural gas representing an input of 370 TJ and an output of 369,5 TJ.

5.172. Primary electricity and heat are not transformed as such before the end use by industries and households, but both types of energy are often delivered into the public grid before they reach the end users. Therefore, usually, it is not possible to determine who is using the primary electricity and heat produced from renewable and nuclear energy and who is using the secondary electricity from e.g. coal fired power plants. In the transformation table the mix of the primary and secondary electricity is represented by a negative number in the intersection between the row for Primary Electricity and the column for D.351 Electric power generation, etc. and a corresponding positive contribution to the entry in the intersection of the same column and the row for secondary electricity. For primary heat delivered to the public grid the recording practice is analogous.

5.173. The amount of energy available for end use (shown in the last column) is subsequently obtained by adding the total net output from the transformation to the domestic supply of primary energy and imports of primary and secondary energy products (shown in the first column).

5.174. The total loss of energy due to the conversions from one energy product to another is obtained by adding up the entries in the row for transformation losses. The numeric example shows a total transformation loss at 156 teraoule. Subtracting this from the total primary supply of energy gives the amount of energy, 2323 terajoule, which remain for end use by industries, households, exports and inventory changes.

5.175. By relating the conversion loss to the total primary supply of energy, a measure of the overall efficiency, i.e. relation between outputs and inputs, of the domestic energy transformation system is obtained.

End use of energy products

5.176. *End use* of energy, shown in Table 5.15, is defined as use of energy for other purposes than transformation into other energy products. For a specific energy product it is what is available after the energy transformation processes have taken place. The term *end use* is preferred over the corresponding term *final use* (or *consumption*), which is sometimes used in energy statistics and balances. The reason is that, according to the terminology of the national accounts and the SEEA, *final use* or *final consumption* generally describes uses, which are not uses by industries. Thus, in SEEA-E end use of energy can be either final use of energy or intermediate consumption by industries except for energy transformation processes.

5.177. The concept of end use is also sometimes called ‘net use’ of energy. However this term is neither used in SEEA-E, since other uses of the term ‘net’ in relation to energy flows are sometimes met.

5.178. For each type of energy, the end use of energy is shown by industries, households and other use categories. The table for end use typically includes few and small items, except for exports, when it comes to primary energy products, since most of them are used for the transformation processes described by the transformation table. In contrast, most industries, if not all, will have entries for secondary energy products, since the use of oil products, electricity and heat is necessary for processes as well as for lighting and heating of buildings and dwellings.

Table 5.15 End use of energy

	Intermediate Consumption, Industries by ISIC														
	A	B	C	D	H	E-G, I-U	**Total**	Final consumption by households	Changes in inventories	Exports		**Total final consumption**	**Total use**	**Losses in distribution etc.**	**Total use incl. losses in distribution, etc**
	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas steam and air conditioning supply	Transportation and storage	Other Industries	Total Industries			Total	*of which Sold to non-residents on national territory*				
	TeraJoule														
1. Coal, coke, gas work gas and peat															
a) Coal, coke and peat	*2*	*0.1*	*18*				20	*1*	*- 21*	*2*		- 19	2	2	4
b) Gas work gas			*0*			*0*	0.1	*0.4*				0.4	0.5	0.0	0.5
2. Oil															
Primary oil (crude oil)									- 2	493		490	490	2	493
Secondary oil products	34	2	26	0.1	621	49	732	102	- 0.5	308	*31*	410	1 142	4	1 146
3. Natural Gas	**2**	**2.2**	**39**		**0**	**12**	**55**	**28**	**2**	**201**		**232**	**287**		**287**
4. Electricity															
Primary (wind, solar, hydro, nuclear, etc.)															
Secondary electricity	7	0.3	34	2	6	35	84	39		49		88	173	8	180
5. Heat															
Primary (solar, geothermal, etc.)															
Secondary heat	2	0.0	7	2	1	29	41	63				63	104	26	130
6. Renewable fuels and waste															
a) Solid biomass and wastes	3	0.1	4			1	7	33	0	1		34	42	1	43
b) Liquid biofuels and biogas	0.3		0				0.5						0.5		0.5
Total end use	**50**	**4**	**128**	**3**	**628**	**127**	**941**	**267**	**- 22**	**1 055**	***31***	**1 300**	**2 240**	**43**	**2 283**
Transformation losses		**68**	**1**	**127**			**195**						**195**		**195**
Total use (= primary supply and imports)	**50**	**72**	**129**	**130**	**628**	**127**	**1 136**	**267**	**- 22**	**1 055**	***31***	**1 300**	**2 436**	**43**	**2 479**

5.179. The table includes a separate column for distribution losses, etc. This row includes all losses which take place between the energy product leaves the supplying unit and is received by the user.

5.180. For each type of energy the end use including distribution losses, etc. as presented in table 5.15 matches the supply of energy available for end use as presented in the transformation table, Table 5.14.

G. Energy statistics, energy balances and energy accounts

5.181. This section addresses the similarities and differences of energy accounts, energy statistics and balances and how they relate to each other. So-called bridge tables, which show the relations between aggregates of supply and use of the different frameworks are also presented.

1. Energy statistics, balances and accounts

5.182. Energy statistics, balances and accounts are three statistical areas, which provide information on energy supply and energy use. *Energy statistics* deal with collecting and compiling information on production, imports, exports and domestic use of energy products on on the basis of specific surveys and by using e.g. business statistics and foreign trade statistics. *Energy balances* re-organise the basic statistics by confronting and consolidating the supply and use side, and by highlighting the transformation of energy within the economy. Similarly, *energy accounts*, can be seen as a re-organization and supplement to the energy statistics and balances, which consistently uses national accounts classifications and definitions. Both energy balances and energy accounts apply the principle that supply equals use, but the supply and use are defined in different ways.

5.183. The main difference between the energy balances and the energy accounts concerns how activities are classified and the scope with respect to which activities are included (boundary). The energy accounts use the resident principle to determine whether a specific energy transaction should be included, for instance, as imports and whether it is included as part of the energy use or not. The boundary of the energy balances follows the national territory just as energy statistics normally do.

5.184. Energy statistics and balances, in contrast to the energy accounts, do normally include only physical data on energy. One of main purposes of energy accounts is to link physical and monetary data in a consistent way.

5.185. In the following sections the main differences between energy balances and the energy accounts are presented. Parts of the text correspond to the text in Chapter 11 of the International Recommendations for Energy Statistics (IRES 2011).

2. Boundaries – residence and territory

5.186. The main conceptual difference between energy balances and accounts is the geographical coverage. The reference territory for the energy balances is the national territory and statistics are compiled for all the units physically located on the territory. Units physically located outside the territory are considered as part of the rest of the world. This coverage is referred to as the territory principle.

5.187. The energy accounts use a geographic coverage based on all institutional units that are resident of a particular national economy – independent of where they are located. Those units that are not resident units are considered to be part of the rest of the world and out of scope. An institutional unit is said to be a resident unit of a country when its centre of predominate economic interest is within the economic territory of the country. Generally, the economic territory will align with the physical

boundary of a country but there is special treatment given to free trade zones, offshore financial centres, embassies and international organizations and the like. This geographical coverage is referred to as the residence principle. See also Section D.8 above.

5.188. The use of the territory or residence principle leads to differences in the way certain statistics are recorded. This is especially the case for imports and exports.

5.189. The use of the territory principle implies that imports and exports cover all transactions between units physically present in the territory and units physically located outside the territory independently of the residence of the units involved (thus trade follows the physical movement of the goods). In addition, transactions between units physically located within the territory are never recorded as imports/exports even if the residence of the units involved differs.

5.190. In the energy accounts, instead, imports/exports cover transactions between resident and non-resident units independently of the location where the transaction occurs (whether it is abroad - in the case, for example, of national tourists abroad - or in the national territory - in the case of foreign companies refueling inland). See also section D.9.

5.191. Similar is the case for recording the uses of products. While in the energy balance the use of energy in the territory covers the use by all units physically located in the territory, in energy accounts, it covers only the use of units resident in the national economy – the use by non-resident units is recorded as an export (provided that the supplying unit is considered resident). In addition, in the energy accounts the use of energy products would also include the use by resident units abroad. This is the case, for example, of resident units who refuel their own vehicles abroad and of ships, operated by residents, which are refueled abroad.

Table 5.16 Comparison of Energy Statistics, Energy Balances and Energy Accounts

Energy Statistics	Energy Balances	Energy Accounts
Based on primary statistics (production, foreign trade, business survey)	Based on energy statistics	Based on energy statistics and balances
	Supply and and use balances	Supply and use balances
Specific energy surveys	Various formats (IEA, Eurostat, UN)	Uses national accounts SUT format
No specific format	Sectors and industries (ISIC)	Industries classified by ISIC
	Rearrangement of industries' energy use according to purpose (transport, auto-producers and heat for sale)	No re-arrangement of industries' energy use
	Detailed description of energy sector including technologies	Energy "sector" described by ISIC No description of technologies
	All transport in one separate sector	Own account transportation included in industries' activities
Territory principle	Territory principle	Resident principle
	Statistical differences	No statistical differences
Physical	Physical	Physical and monetary

3. Industries

5.192. The SEEA-E accounts use the classification scheme and supply-use table format of the national accounts, which follows the principles of classification and the structure of the International Standard Industrial Classification of All Economic Activities (ISIC Rev. 4). Thus, information on any specific enterprise/establishment (be it on the production or on the consumption side) is as a general rule presented under the ISIC division/class of the principal activity of the unit involved. In certain cases, however, a reallocation of activities may take place, cf. Section D.5.

The energy balances, however, do not follow the same principle, as information on a specific enterprise/establishment is not explicitly linked to the relevant ISIC division/class of the unit involved. Rather it is presented in different sections of the balances depending on the type of use and the ISIC division/class of the unit involved.

5.193. Thus, while the ISIC is used for both the energy accounts and the energy balances, they do typically not include the same activities. A predominant example of the difference includes the industries own-account transportation, which is allocated by the ISIC industries in the accounts, while it is allocated to the transport sector in the balances (see section on transport below).

5.194. The same goes for the non-energy industries' generation of electricity and generation of heat for sale. In the accounts this is regarded as secondary activities leading to the output of energy from the specific industries. An example is the production of electricity and heat from the incineration of waste, which is an activity of the ISIC Class 3821 - Treatment and disposal of non-hazardous waste, produces electricity and heat unless the value added from the energy production exceeds that of other activities and to the extent that a reallocation has not taken place to follow national accounts implementation practice. The activities are always allocated to the energy sector in the balances.

4. Industries' own transport, transport industries and the transport sector.

5.195. In the energy balances all energy use related to road, rail, air, sea and pipeline transport are placed under one separate aggregate item: Transport. The only exception is energy used for fishing vessels, which are allocated to "fishing" (IRES 2011, 5.89). Energy use for tractors and other off-road vehicles is not regarded as transport (IRES 2011, 8. 41).

5.196. In the SEEA-E energy accounts the consumption of fuels by transport activities is attributed to the industries that is actually using the fuels. Fuel uses for transport service activities carried out by one unit for another unit for pay are allocated to ISIC Section H. Transport and Storage. An industry's energy use for operating its own lorries and cars, etc. is recorded alongside the same industry's other energy use. The use of fuels for private cars, boat, planes, etc. is allocated to the households' private consumption.

5.197. As a supplement to the SEEA-E standard tables the energy use for transport could be separated from the industries' and households other energy use and shown as a memo-item. This memo-item should not include the fuels used for off-roaders, lawn-movers, etc. See also the use table by purpose, Table 5.12.

5. The energy industries and the energy transformation sector

5.198. The energy balances include a part describing the energy transformation. The energy transformation sector is broken down by various transformation technologies identified by the plants in which they occur: Electricity plants, Combined heat and power plants, Heat plants, Coke ovens, Patent fuel plants, Brown coal briquette plants, Coal liquefaction plants, etc.

5.199. The balances describe inputs and outputs of energy for these technologies.

5.200. The balances do not explicitly describe the extraction of energy resources in the sense that they do not present specifically the flows from the environment to the extraction industries, but they do, of course, show the resulting production of energy products from the extraction activities.

5.201. All production of energy, including industries' own generation of electricity and heat for sale, is allocated to the energy sector. On the use side, the energy industries' own use of energy is included in the energy balances as a separate category.

5.202. The SEEA-E accounts include the following specialised energy producing industries within the ISIC classification :

Mining and quarrying:

ISIC Division 05 - Mining of coal and lignite

ISIC Division 06 - Extraction of crude petroleum and natural gas

Energy production:

ISIC Group 191 - Manufacture of coke oven products

ISIC Group 192 - Manufacture of refined petroleum products

ISIC Group 351 - Electric power generation, transmission and distribution

ISIC Group 352 - Manufacture of gas; distribution of gaseous fuels through mains

ISIC Group 353 - Steam and air conditioning supply

5.203. It should be noted that the ISIC classification of the energy production includes a distinction between the activities of producing electricity and heat. This distinction is artificial with regard to the combined production of heat and electricity. The energy balances include the combined heat and power generation as a separate activity.

6. Supply, use and stock concepts

5.204. In the overall and aggregate energy balances, the term supply represents energy entering the national territory for the first time, less energy exiting from the national territory (through exports or international bunkering) and stock changes. Thus (IRES 2011, 11.14):

Total energy supply =

	Primary energy production
+	Import of primary and secondary energy
-	Export of primary and secondary energy
-	International (aviation and marine) bunkers
-	Stock Changes

5.205. International marine bunkers cover the refuelling of ships (domestic and foreign) at the national territory for international voyages.

5.206. More generally, for individual energy products, the so-called commodity balances defines supply in the following way (IRES 2011, Annex C)

Supply =

	Production
+/-	Transfers between commodities
+	Imports
-	Exports
-	International (aviation and marine) bunkers (as applicable)
-	Stocks changes

5.207. The latter supply concept can be characterised as a supply for use at the national territory.

5.208. Transfers between commodities refer to a reclassification (renaming) of products (IRES 2011, 5.17)

5.209. The energy balances uses the term stock changes for what is called changes in inventories in the SEEA-E. The energy balances includes stock changes (inventory changes) as part of the supply, i.e. an increase of inventories is decreasing the supply, while a decrease in inventory is increasing the supply.

5.210. Since the use is always equal to the supply a consequence of defining the supply in this way is that the use concept of the energy balances excludes exports and fuel for ships undertaking international voyages.

5.211. The SEEA-E defines, in contrast, supply according to the conventions of the national accounts:

Supply (SEEA-E) =

Production (output)
+ imports (according to the residence principle)

5.212. The SEEA-E supply concept is broader than the supply concept of the energy balances, since it includes all energy being available for use, also for exports and international bunkering.

5.213. The use concept of SEEA-E includes all final use as defined in the national accounts, including exports and inventory changes. In addition, international bunkering is recorded in the energy accounts as intermediate consumption if the bunkering is undertaken by a ship operated by a resident unit, or as exports if the ship is operated by a non-resident unit. It should be noted that refueling and bunkering by resident airplanes and ships abroad is also included in the supply and use of the energy accounts.

5.214. Inventory changes is recorded as a use in the SEEA-E, i.e. an increase of inventories is a use, while a decrease in inventory is negative use, which make more of the product available for other uses.

5.215. The term final consumption in energy balances excludes the use of energy products in the energy industries and by other energy producers as input into transformation and energy industry own-use. In the national accounts, the term "final consumption" is used to denote the use of goods and services by individual households or the government to satisfy individual or collective needs or wants. In order to avoid confusion the term final consumption is not used in the SEEA-E. Instead reference is made explicitly to household consumption, changes in inventories and exports. In addition the term end use is introduced in SEEA-E to denote a concept of energy use excluding the use for transformation processes, cf. Section F.

5.216. 11.17 The concepts of stocks and stock changes as defined in the energy balances correspond to inventories and changes in inventories in the SEEA-E (and 2008 SNA).

7. Products

5.217. SEEA-E uses the "positive price" criteria of the national accounts in order to define whether some physical energy unit should be regarded as a product. If no economic transaction (with a positive price) takes place, it is not a product. This ensures coherence between the physical flows of energy products and the monetary flows (cf. Chapter 6). In addition energy produced for own use is included as energy products. Other energy flows, which are not associated with economic transactions are either flows of energy resources or losses, which are categorised as flows of residuals.

5.218. In contrast, the energy balances, does not make this distinction between the different types of flows. Instead all flows of energy are seen as flows of energy products. Therefore in order to compare the energy balances and the energy accounts it is necessary to add the categories for energy products and losses from the energy accounts.

8. Statistical discrepancies

5.219. Energy balances do normally explicitly include an item for statistical discrepancies, which sum up the inconsistencies that inevitable appears when different statistics are confronted and presented within a balance framework.

5.220. Following the tradition form national accounting, the SEEA-E energy accounts do not include an item for statistical discrepancies, and thus it is necessary for the accountant to find ways to "avoid" the statistical discrepancies. If the initial discrepancies are large it is necessary for the compiler to ensure that the discrepancies are not due to errors in the basic data or to see if additional information can be obtained to clarify the reasons for the discrepancies.

5.221. When the discrepancies are of a less magnitude different methods can be applied in order to eliminate them from the accounts. One method, often used in national accounts practice, is to make a proportional distribution. If for example there is a three per cent surplus of supply over use, the surplus of energy can be allocated to users (intermediate consumption, private consumption, inventories) in proportion to the already allocated energy use.

Another method is to only adjust the energy product inventories of energy, i.e. to record the statistical discrepancies as part of the inventory changes. Since information on energy stocks is important with regards to national security and national supply of energy as well as including market sensitive information, using such artificial stock adjustments should be considered carefully, and significant adjustments should always be identified in a note to the accounts.

H. Bridge tables linking energy balances and accounts

5.222. When, in practice, SEEA-E energy accounts are going to be implemented based on energy statistics and energy balances the differences described above needs to be taken into account. In practice this means that adjustments and additions to the data presented by energy statistics and energy balances needs to be made. Box 5.1 sums up some of the adjustments needed.

5.223. Further, in order to show the link between the main concepts and aggregates of the energy balances and the energy accounts countries may compile bridge tables. Tables 5.18 and 5.19 present so-called bridge tables for supply and use, respectively. The bridge tables shows which additions or subtractions are needed in order to go from one concept to the other.

5.224. Table 5.18 starts with the supply of the energy balances. By adding international marine bunkers, exports, inventory changes and purchases by residents abroad the total supply as presented in the SEEA-E accounts is obtained.

5.225. Table 5.19 starts with the final consumption of energy as presented by the energy balances. Again, international marine bunkers, exports, inventory changes and purchases by residents abroad are added in order to reach the end use as recorded in the SEEA-E.

Box 5.1 Adjustments to energy statistics and energy balances needed for the energy accounts

Adjustments on imports/exports. In order to include imports and exports from the energy balances into the energy accounts, adjustments are needed to relate them to transactions between resident and non-resident units independently of the location where the transaction takes place.

Other adjustments for geographical coverage. In order to compile energy accounts, a number of items, in addition to imports/exports, in the energy balances need to be adjusted for the residence of the units involved. This is the case for international marine bunkering and for the items in the bottom block of the balances. In fact, the different uses of energy products of the energy balances need to be disaggregated so that they can be recorded as intermediate/final consumption when the unit is resident or export when the unit is non-resident and need to be complemented with the use by resident units abroad. This is similar to the case of international bunkering.

It should also be noted that, in principle, there might be some additional adjustments necessary to the geographical coverage to exclude and/or include territorial enclaves in the rest of the world. These areas are clearly demarcated land areas (such as embassies, consulates, etc.) located in other territories and used by governments that own or rent them for diplomatic, military or scientific purposes. These areas are excluded from the basic statistics and energy balances, while they are included in the statistics presented by the accounting framework.

Reallocation/regrouping of data to the relevant ISIC division/class. In order to compile the energy accounts, information has to be regrouped according to the different ISIC division/classes. Information on "transport", "non-energy use", "energy industry own use" and "primary production" are example of items that need to be reallocated in order to present information on an ISIC-based tabulation such as that used in the SEEA-E.

Additional data items necessary for the compilation of energy accounts

In order to compile energy accounts, it is important to have information that allows for the adjustments presented. Such information includes, for example, the breakdown of the deliveries for international bunkering of resident and non-resident units; deliveries to resident and non-resident final consumers; and use of energy products by resident units abroad. The additional data items depend to some extent on the methods used to make adjustments to the energy balances.

In view of the above differences countries are encouraged to clearly document and make available the methods used for the reallocation and adjustments of data provided by basic energy statistics and balances to the energy accounts. Details on good country practices in this respect will be provided in the forthcoming Energy Statistics Compilers Manual.

Source: International Recommendations for Energy Statistics (IRES, 2011), Chapter 11.

Table 5.18 Bridge table for domestic supply and total supply

	Supply					
	S.1	+S.2	+S.3	+S.4	+S.5	= S.6
	Supply (energy balances)	+ international marine bunkers	+ Exports	+ Inventory change	+ purchases by residents abroad	**Total supply (SEEA-E)**
	TeraJoule					
1. Coal, coke, gas work gas and peat						
a) Coal, coke and peat	**246**		2	- 21		**227**
b) Gas work gas	**0,5**					**0,5**
2. Oil						
Crude oil	**344**		493	- 3		**834**
Oil products	**265**	44	308		560	**1 177**
3. Natural Gas [1)]	**201**					**806**
4. Electricity						
Primary (wind, solar, hydro, nuclear, etc.)	**22**					**22**
Secondary electricity	**140**		49			**189**
5. Heat						
Primary (solar, geothermal, etc.)						
Secondary heat	**130**					**130**
6. Renewable fuels and waste						
a) Solid biomass and wastes	**109**		1	0,3		**110**
b) Liquid biofuels and biogas	**2**					**2**
Total supply	**1 459**					**3 498**

Note: The energy balances does not include reinjection of natural gas. Total output of the natural gas according to the energy balances is 369+35 = 404 terajoule

Grey cells: not applicable

Table 5.19: Bridge table for final consumption and end use of energy

	U.1	+ U.2	+ U.3	+ U.4	+ U.5	+U.6	= U.7		
	= Final consump-tion (energy balances)	+ inter-national marine bunkers	+ Exports	+ Inventory change	+ Energy sectors' use of energy for supporting activities1)	+ purchases by residents abroad	**End use (SEEA-E) excluding losses in distribution**	Losses in distri-bution	**Total end use incl. losses in distribution and end uses**
	TeraJoule								
1. Coal, coke, gas work gas and peat									
a) Coal, coke and peat	**21**		2	- 21	0		**2**	2	4
b) Gas work gas	**0.5**						**0.5**	0	0.5
2. Oil									
Crude oil	**0.5**		493	- 3			**490**	2	493
Oil products	**224**	44	308		6	560	**1 142**	4	1 146
3. Natural Gas	**81**		201	2	2		**287**		**287**
4. Electricity									
Primary (wind, solar, hydro, nuclear, etc.)									
Secondary electricity	**120**		49		3		**173**	8	180
5. Heat									
Primary (solar, geothermal, etc.)									
Secondary heat	**102**				2		**104**	26	130
6. Renewable fuels and waste									
a) Solid biomass and wastes	**41**		1	0.3	0		**42**	1	43
b) Liquid biofuels and biogas	**0.5**						**0.5**		0.5
Total supply	**590**	44	1 055	- 22	13	560	**2 240**	43	2 283

1) The energy sector include companies extracting energy, refineries and production of electricity, gas and steam.
Energy for supporting activities is energy which does not enter directly into the transformation of energy, but supports the processes, e.g. heating.