System of Environmental Economic Accounting

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SEEA TECHNICAL NOTE: ENERGY ACCOUNTING

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This note is a part of a series of Technical Notes prepared to support the development of data based on the System of Environmental Economic Accounts (SEEA) Central Framework, the first international standard in environmental economic accounting. Since SEEA is not a single account but a series of modules, the accounts in each of the various modules can be developed separately in accordance with the priorities and the resource availability in each country.

The series of Technical Notes is comprised of a) a note addressing general issues that cut across domains focusing on institutional arrangements and institutional processes that encourage efficient implementation of the standard and associated data compilation exercises (see *Institutional Arrangements and Statistical Production Processes for the Implementation of the SEEA-Central Framework*) and b) a number of notes on specific modules. It is recommended that those wishing to develop data related to any of these specific modules should read the cross cutting note in conjunction with the note on the specific modules to be developed.

The notes on modules summarize the data requirements and other operational considerations in 20-25 pages designed to provide sufficient guidance to initiate the development of the accounts. The notes also provide reference information for additional publications that will support the full development of the accounts and provide information on extensions and linkages that can be exploited once the accounts and tables are in place.

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1. Introduction

1. Energy is essential to wellbeing. It is an important input in the production of goods, including food, and, among others, is used for transportation and heating. Energy is also one of the three components of the water-energy-food security nexus. As such, energy policy has implications on water and food security and vice versa.

2. The effect of energy supply and use on the environment has emerged as a critical policy issue. There is a growing concern about the impact of rising energy use and of related emissions upon global and local environments. Furthermore, the energy product mix, including the level of energy from renewable sources, used to support human activities has also become a focal point of policy discussions in particular with respect to climate change.

3. This technical note provides an overview of energy accounting as set out in the System of Environmental Economic Accounting 2012 Central Framework (SEEA CF) and its subsystem, the System of Environmental Economic Accounting – Energy (SEEA Energy) 1. SEEA CF, which was adopted by the United Nations Statistical Commission in 2012 as the international statistical standard for environmental-economic accounts, is a conceptual framework that has been developed over the past two decades to integrate measurement of environmental and economic phenomena. SEEA Energy is a subsystem of the SEEA CF; it provides further guidance and details on the energy-specific tables and accounts of the SEEA Central Framework and elaborates in more detail the links between energy accounts and energy statistics and balances.

4. At the heart of SEEA-Energy, as in the SEEA CF, is an accounting approach that records, as completely as possible, the stocks and flows of energy in the territory of reference. It supports analyses of the role of energy within the economy and of the relationship between energy-related activities and the environment. The concepts and definitions that comprise SEEA-Energy are designed to be applicable across all countries, irrespective of how their energy is produced and used, their relative state of economic development, the composition and state of their energy resources, and their physical environment.

5. The general purpose of the SEEA Technical Notes is to summarize the key features of accounting for a given topic to support countries in the implementation of the SEEA, and describe what might be a minimum set of information to guide initial efforts in compilation. This technical note will describe the main features of the SEEA accounts for energy, and present a set of core accounts which comprise an adapted version of the SEEA Central Framework accounts to focus and guide initial compilation.

6. The core accounts represent a minimum set of information which countries should aim to compile and report, explicitly identifying the most important data items for the module at hand. While the core accounts represent a minimum set, countries may often wish to extend the level of detail in areas deemed particularly policy relevant. The Technical Notes provide highlights of such

[1] SEEA-Energy is forthcoming.

possible extensions in the explanatory text. The level of detail and industry disaggregation of the core accounts is relatively uniform across the set of module-specific technical notes. For the modules where industry disaggregation is relevant, five broad industry classes are identified.

7. In addition to the core accounts, this technical note presents a combined presentation (see section III). This combined presentation provides countries with a template to present and disseminate an aggregated set of key monetary and physical information from a range of sources (including the SEEA and SNA). The information included in the combined presentations are data items which are of key relevance to policy makers and which, often in combination, are used to calculate particularly important indicators (including the SDG indicators). The level of industry disaggregation mentioned above is maintained, allowing countries to present key information at a sector specific level.

8. Section II briefly describes the SEEA accounting system for energy and presents the core accounts for energy. Section III presents the combined presentation for energy data and provides an overview of the types of indicators which can be derived. Section IV deals with the data sets required to produce the core accounts including the main concepts, data sources and compilation methods. Section V describes how the SEEA accounts and related datasets may be extended to address broader issues and linked to other data sets. Section VI provides references and links to supporting material.

2. SEEA-CF accounts for energy

9. The energy accounts as described in SEEA comprise three types of accounts, namely 1) physical supply and use tables, 2) monetary supply and use tables and 3) asset accounts.

2.1 Physical Supply and Use Tables for Energy

10. The physical supply and use tables (PSUT) provide a structure for compiling and presenting all energy flows that enter, are used within and leave the national economy of a given country for a period of time. It necessarily expresses energy flows in a common unit (joules). The use of the joule as a common measurement unit is recommended by the International Recommendations for Energy Statistics (IRES), and is used in the SEEA Energy when a common unit of measure is required[2]. The physical supply and use tables for energy aim to be comprehensive and record all energy flows within the economy and between the economy and the environment.

[2] Energy statistics are an input to the physical supply and use tables and are compiled by converting physical measures of mass and volume such as tonnes, litres and cubic metres into a common unit representing energy content in net calorific terms. For a discussion on net calorific terms, see IRES, Chapter 4, Section C.

Structure of the physical supply and use tables

11. Core Account 1 shows a PSUT for energy. The PSUT structure is similar to the monetary supply and use tables described in the next section with the PSUT containing extensions to incorporate rows for energy from natural inputs and energy residuals.

Core Account 1: Physical Supply and Use Table for energy

PHYSICAL SUPPLY TABLE (unit:PJ)	Production (incl. household own account) & generation of residuals								Accumula-tion	Flows from the rest of the World (Imports)	Flows from the environ-ment	TOTAL
	Industries (by ISIC)							Households				
	Agriculture Forestry & Fishery (ISIC A)	Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air condition-ing supply (ISIC D)	Transport-ation & Storage (ISIC H)	Other Industries	**Total Industry**					
1. Energy from natural inputs:												
Natural resource inputs											1166	1166
Inputs of energy from renewable sources											124	124
Other natural inputs											2	2
2. Energy Products:												
Production of energy products by SIEC class:												
Coal										225		225
Peat and peat products												
Oil shale / oil sands												
Natural gas		395		369			764					764
Oil		721	347				1068			930		1998
Biofuels	5			2			7					7
Waste	39		55				94			17		111
Electricity				212			212			22		234
Heat				79			79					79
Nuclear fuels and other fuels												
3. Energy Residuals:												
Total energy residuals	50	48	432	307	632	96	1565	240				1805
4. Other Residual Flows:												
Residuals from end-use for non-energy purposes			51									51
Energy from solid waste									94			94
5. TOTAL SUPPLY	94	1164	885	969	632	96	3840	240	94	1194	1292	6660

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses							Final Consumption	Accumula-tion	Flows to the rest of the World (Exports)	Flows to the environ-ment	TOTAL
	Industries (by ISIC)							Households				
	Agriculture Forestry & Fishery (ISIC A)	Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air condition-ing supply (ISIC D)	Transport-ation & Storage (ISIC H)	Other Industries	**Total Industry**					
1. Energy from natural inputs:												
Natural resource inputs	5	1161										1166
Inputs of energy from renewable sources				124								124
Other natural inputs				2								2
2. Energy Products:												
Transformation of energy products by SIEC class:												
Coal				223			223					223
Peat and peat products												
Oil shale / oil sands												
Natural gas				482			482					482
Oil			360	16			376					376
Biofuels												
Waste				31			31					31
Electricity												
Heat												
Nuclear fuels and other fuels												
End-use of energy products by SIEC class:												
Coal	2		17				19	1	-21	2		1
Peat and peat products												
Oil shale / oil sands												
Natural gas	2		39			12	53	26	2	201		282
Oil	34	2	326		621	49	1032	102	-3	441		1572
Biofuels				2			2	5				7
Waste	3		4	37		1	45	33		1		79
Electricity	7	1	22	50	10	15	105	29		100		234
Heat	2		11	2	1	19	35	44				79
Nuclear fuels and other fuels												
End-use of energy products for non-energy purposes			51				51					51
3. Energy Residuals:												
Total energy residuals											1805	1805
4. Other residual flows:												
Residuals from end-use or non-energy purposes									51			51
Energy from solid waste	39		55									94
5. TOTAL USE	94	1164	885	969	632	96	3840	240	29	745	1805	6659

Note: Dark grey cells are null by definition.

12. The PSUT consist of a pair of tables which have the same format/structure. Row-wise, the two tables show the various physical flow types, namely natural inputs, products, and residuals. Column-wise they show the various origins and destinations supplying and using the flow items, namely industries (i.e. production activities), households (i.e. consumption activities), accumulation (changes in stocks of produced assets and product inventories), rest of the world, and environment.

13. The physical supply table shows which flow items are provided by which supplier (industries, households, accumulation (i.e. removal of energy products from inventories), rest of the world and environment); in other words it shows the flows by origin.

14. The physical use table shows who is using or receiving the respective physical flow. In other words, it shows the flows by destination. By design, the physical supply and use table for energy records flows of energy products whenever such products are supplied from one economic unit to another. For example, crude oil can be used by the manufacturing sector to produce oil products which in turn are used by the transportation sector; all three flows would be recorded separately in the PSUT. Hence, caution should be exercised when deriving aggregates and indicators so as to avoid double counting.

15. The accumulation column records changes in the inventories of energy products that can be stored, for example coal, oil, natural gas and waste. By convention the energy embodied in energy products used for non-energy purposes is also recorded in the accumulation column of the use table as being retained within the economy. The imports/exports column captures the flows on energy products into and out of the territory of reference. The imports/exports of energy products need to be adjusted for purchases by residents abroad/purchases by nonresidents on domestic territory

Row entries of the PSUT: three types of energy flows

16. There are three types of energy flows captured in the PSUT: (i) energy from natural inputs, (ii) energy products, and (iii) energy residuals.

17. Energy from natural inputs encompasses flows of energy resulting from the extraction and capture of energy from the environment by resident economic units. These flows include energy from mineral and energy resources (e.g. oil, natural gas, coal & peat, uranium), inputs from renewable energy sources (e.g. solar, wind, hydro, geothermal) and other natural inputs (e.g. energy inputs to cultivated biomass).

18. Energy products are products that are used (or might be used) as a source of energy. They comprise (i) fuels that are produced/generated by an economic unit (including households) and are used (or might be used) as sources of energy; (ii) electricity that is generated by an economic unit (including households); and (iii) heat that is generated and sold to third parties by an economic unit. Energy products include energy from biomass and solid waste that are combusted for the production of electricity and/or heat. It should be noted that some energy products may be used for non-energy purposes.

19. Generally, physical and monetary flows of energy products should be classified using the Standard International Energy product Classification (SIEC) presented in the IRES and SEEA

Energy. SIEC has been developed to obtain a better understanding of energy products. Often, monetary flows are classified using the Central Product Classification (CPC). Since there is not a one-to-one relationship between SIEC and CPC categories[4], a correspondence between these classifications is being developed to aid in doing analysis of combined physical and monetary datasets[5].

20. Section '2: Energy Products' in the use table is split into two main sections.

- The first section, 'Transformation of energy products by SIEC class', records the transformation of energy products into other energy products. For example, the mining and quarrying industry may produce coal as an energy product in the supply table and the use of coal to produce electricity would be shown in the transformation of energy products as the use of coal by the electricity supply industry.

- The second section, 'End-use of energy products by SIEC class', records the use of energy products for other purposes (i.e. not for the transformation of energy products into other energy products). These goods and services may be used for intermediate consumption to produce goods and services that are not energy products, for household final consumption, as a change in inventories of energy products, or for export. Some end use will relate to non-energy uses of energy products, for example the use of oil based products as lubricants or in the production of plastics.

21. Energy residuals in physical terms comprise energy losses and other energy residuals. Particular examples of energy losses include flaring and venting of natural gas and losses during transformation in the production of primary energy products from natural inputs and in the production of secondary energy products. Energy losses during distribution may arise from the evaporation and leakages of liquid fuels, loss of heat during transport of steam, and losses during gas distribution, electricity transmission and pipeline transport. Energy residuals also include other energy residuals particularly heat generated when end users (either households or enterprises) use energy products for energy purposes (e.g. household lighting).

22. In order to fully balance the energy PSUT it is also necessary to record two other flows. The first relates to energy products used for non-energy purposes. Non-energy purposes include: the use of energy products to manufacture non-energy products (for example the energy product naptha is used in the manufacture of plastic, a non-energy product); and, the direct use of energy products for non-energy purposes (for example, as lubricants, etc.). The second additional flow concerns the

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[4] For more on this see: The Standard International Energy Product Classification (SIEC) and its relationship with the Central Product Classification (CPC), http://unstats.un.org/unsd/class/intercop/expertgroup/2011/AC234-14.PDF

[5] For an example of how this has been approached see the Eurostat Physical Energy Flow Accounts (PEFA) Manual http://ec.europa.eu/eurostat/documents/1798247/6191537/PEFA-Manual-2014-v20140515.pdf/12d7dcb3-cc66-46fd-bcb7-45bbbe9ba541

generation of energy from the incineration of solid waste. The energy embodied in solid waste is shown as entering the energy system as a residual flow before becoming an energy product.

23.

Accounting identities in the PSUT for Energy

24. The supply and use identity applies within the PSUT for energy. Thus as shown below, for each product measured in physical terms (for example joules of coal) the sum of domestic production (output) and imports which is equal to the total supply of energy products[6] must equal the consumption (both intermediate and final), changes in inventories and exports (total use of products). The equality between supply and use also applies to the total supply and use of natural inputs and the total supply and use of residuals.

Total Supply of Energy Products = Production + Imports
is equal to
Total Use of Energy Products = Intermediate consumption[7] + Household Consumption + Changes in inventories + Exports

25. In addition to the supply and use identity, the PSUT incorporates an identity concerning flows between the environment and the economy. This second identity, known as the input-output identity, requires that the total flows into the economy (for example in the form of natural gas extracted from natural deposits) are, over an accounting period, either used in production processes, consumed by final users, accumulated as residuals in the economy or returned to the environment. The input-output identity also applies at the level of households and industries. Since natural inputs are transformed and combined in a wide variety of ways and multiple times, recording a full balance is difficult to achieve in practice.

Energy into the economy = Energy inputs from the environment + Imports + Energy residuals received from the rest of the world + Energy residuals recovered from the environment
is equal to
Energy out of the economy = Energy residual flows direct to environment + Exports + Energy residuals sent to the rest of the world
plus
Net additions to stock in the economy = Changes in inventories + Accumulation of energy residuals

[6] Supply as defined in SEEA differs from that in energy balances where Total energy supply = Primary energy production +Imports of primary and secondary energy -Exports of primary and secondary energy -International (aviation and marine) bunkers -Stock (inventory) changes. As supply equals use in both SEEA and energy balances, if energy balance data are to be used as the basis of SEEA accounts both supply and use will have to be adjusted. SEEA-Energy (forthcoming) has a full discussion of the needed adjustments and a brief overview is included in the annex.
[7] Intermediate consumption which is further discussed in SEEA CF Section 2.6, includes some own account production used for intermediate consumption by market producers that might not be included in national accounts estimates.

26. More information on physical flows accounts for energy can be found SEEA-CF and SEEA-Energy.

2.2 Monetary Supply and Use Tables for Energy

27. The basic form of Monetary Supply and Use Tables for Energy is shown in Core Account 2. Monetary supply and use tables in SEEA fully articulate in monetary terms the flows of energy products in an economy between different economic units. Monetary supply and use tables have their origins in economic accounting and the PSUT utilise the organisational principles and characteristics of these tables. Nevertheless, while the PSUT for energy contain three main types of flows i.e. energy from natural inputs, products and residuals, the monetary supply and use tables for energy record only those flows related to energy products.

Core Account 2: Monetary Supply and Use Table for Energy

MONETARY SUPPLY AND USE TABLE (UNIT: CURRENCY)	Industries (by ISIC)							Final consumption and other			Taxes less subsidies on products, trade and transport margins	TOTAL
	Agriculture Forestry & Fishery (ISIC A)	Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air condition-ing supply (ISIC D)	Transport-ation & Storage (ISIC H)	Other Industries	**Total Industry**	Rest of the world	Households	Accumulation		
Supply of energy products (unit: currency):												
Coal								26125			1	26126
Peat and peat products												
Oil shale / oil sands												
Natural gas		4614		4312			8926				3891	12817
Oil		12589	6164				18753	17232			562	36547
Biofuels	2		2	12			16					16
Waste	111		156				267	9				276
Electricity				14414			14414	9			8113	22536
Heat				665			665					665
Nuclear fuels and other fuels												
Use of energy products (unit: currency)												
Intermediate consumption and final use (unit: currency):												
Coal	540		4856	17869			23265	370	556	1935		26126
Peat and peat products												
Oil shale / oil sands												
Natural gas	378		785	3564			4727	7064	865	161		12817
Oil	236	75	1687	95	23580	765	26438	4102	3206	2801		36547
Biofuels				7			7	1	8			16
Waste	12		32	159		15	218	2	56			276
Electricity	1205	806	3089	6854	2304	3569	17827	3206	1503			22536
Heat	15		102	28	15	200	360		305			665
Nuclear fuels and other fuels												

Note: Dark grey cells are null by definition. Data for industries should be presented in basic prices; last column contains information on purchaser prices.

28. Monetary supply and use tables for energy provide information on the energy sector and the level of activity in this sector. They also provide detailed information on the industries within the economy that are using these energy products. Monetary supply and use tables for energy can readily be linked with PSUT for energy to create a powerful analytical tool, for example to do price analyses.

29. The monetary supply table for energy products shows the value of domestic production for various energy products and the value of imports at basic prices. The table also presents, for each type of energy product and the sum of taxes less subsidies, and trade and transport margins. The final column shows the total purchasers price.

30. The bottom part of core account 2 shows the monetary use table for energy in purchasers' prices. It records the amounts paid by users for the various energy products used. As in the physical

use table for energy, the use includes intermediate consumption by industries and other uses including household consumption, exports and accumulation.[8]

2.3 Asset Account for Mineral and Energy Resources

31. The purpose of asset accounts is to record the opening and closing stock of known assets and the various types of stock changes over an accounting period. Accounts for assets in situ, referred to as mineral and energy resource assets, as well as assets held as inventories are presented in the asset accounts.

32. A key motivation for accounting for mineral and energy resources is to assess to what extent current patterns of economic activity are depleting and/or degrading available mineral and energy resources. More broadly, information from asset accounts can be used to assist in the management of energy from natural inputs.

33. Known deposits of mineral and energy resources are categorised into three classes, based on criteria from the UNFC-2009 (see Table 1).

- **Class A: Commercially Recoverable Resources** which includes on-production projects, projects approved for development and projects justified for development.

- **Class B: Potentially Commercially Recoverable Resources** which includes economic and marginal development projects pending and development projects on hold.

- **Class C: Non-Commercial and Other Known Deposits** which includes unclarified development projects, non-viable development projects and additional quantities in place.

34. Known deposits exclude potential deposits where there is no expectation of the deposits becoming economically viable and there is a lack of information to determine feasibility of extraction or to have confidence in the geological knowledge. Table 1 gives an overview of how the classes of energy resources are defined based on the UNFC criteria.

35. The scope of known deposits is broader than the scope of deposits that underpins the measurement of energy resources in the SNA. In the SNA the scope is limited to deposits that are commercially exploitable given current technology and relative prices.9 The broader scope of known deposits is applied in SEEA to ensure that as broad an understanding as possible is obtained on the

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[8] For each energy product, the total use at purchasers' prices is equal to the total supply at purchasers' prices as presented in the last column of the table. This reflects the following accounting identity for the monetary energy flows:
Total supply at purchasers' prices = Domestic production at basic prices + imports, c.i.f. + taxes less subsidies on products + trade and transport margins
=
Total use at purchasers' prices = Intermediate consumption + private consumption + inventory changes + exports

[9] See 2008 SNA, paragraph 10.179.

availability of the stock of energy resources. Issues associated with the scope of the valuation of energy resources are discussed below.

Table 1: Categorization of Mineral and Energy Resources[10]

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

Notes

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

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

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

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

Source: UNFC-2009, figures 2 and 3.

[10] Details on the mapping of the UNFC-2009 classification with other classifications systems (e.g. CRIRSCO, SPE-PRMS) may be found in UNECE (2013).

1: Physical asset account for mineral and energy resources

36. A physical asset account is structured as shown in Core Account 3[11]. In this example, only three resources have been included. Countries should focus on those energy resources most important for their economy. It starts with the opening stock of resources and ends with the closing stock of resources. In physical terms, the changes between the beginning and the end of the accounting period are recorded as either additions to the stock or reductions in the stock and wherever possible the nature of the addition or reduction is recorded.

37. Note that SEEA accounts may cover all types of known resources (i.e. Classes A, B and C), both in physical and monetary units. Even though only Class A is included in the Core Accounts, countries are encouraged to also compile information on Classes B and C. When data is disseminated care should be taken to clearly identify Classes A, B and C because the corresponding resources are not all available for immediate extraction.

Core Account 3: Physical Asset Account for Energy

	Type of Energy Resource (Class A: Comercially recoverable resources)		
	Oil Resources ('000 barrels)	Natural Gas Resources (m3)	Coal & peat resources ('000 tonnes)
Opening stock of mineral and energy resources	800	1200	660
Additions to stock:			
Discoveries			
Upward appraisals		200	
Reclassifications			
TOTAL ADDITIONS TO STOCK		200	
Reductions in Stock:			
Extractions	40	50	60
Catastrophic losses			
Downwards reappraisals			60
Reclassifications			
TOTAL REDUCTIONS IN STOCK	40	50	120
Closing Stock of mineral and energy resources	760	1350	480

38. There are three types of additions to the stock of energy assets:

(a) Discoveries. Discoveries should incorporate estimates of the quantity of new deposits found during an accounting period. To be regarded as a discovery the new deposit must be a known deposit – i.e. in Class A, B or C. In situations in which a quantity of potential deposits becomes known to a higher degree of confidence, this increase should be treated as discoveries. Discoveries should be recorded by type of resource and by category of resource.

(b) Upward reappraisals. Reappraisals should only pertain to known deposits. They will relate to additions in the estimated available stock of a specific deposit, or to changes in the categorization of

[11] See SEEA-CF section 5.5.3.

specific deposits between Class A, B or C based on changes in geological information, technology, resource price or a combination of these factors.

(c) Reclassifications. Reclassifications may occur if certain deposits are opened or closed to mining operations due to a government decision concerning the access rights to a deposit. All other changes in the quantity of known deposits should be treated as reappraisals. Reclassifications may conceivably be recorded if asset accounts for energy resources are being compiled by institutional sector.

39. There are four types of reductions in the stock of energy assets:

(a) Extraction. Estimates of extraction should reflect the quantity of the resource physically removed from the deposit. It should exclude mining overburden, i.e. the quantity of soil and other material moved in order to extract the resource. The quantity should also be estimated before any refinement or processing of the resource is undertaken. Estimates of extraction should include estimates of illegal extraction, either by residents or non-residents, as these amounts reduce the availability of the resource.

(b) Catastrophic losses. Catastrophic losses are rare for most energy resources. Flooding and collapsing of mines does occur but the deposits continue to exist and can, in principle, be recovered. The issue in this example is one of economic viability of extraction rather than actual loss of the resource itself. An exception to this general principle concerns oil wells that can be destroyed by fire or become unstable for other reasons leading to significant losses of oil resources. Losses of oil and related resources in this situation should be treated as catastrophic losses.

(c) Downward reappraisals. Reappraisals should only pertain to known deposits. They will relate to reductions in the estimated available stock of a specific deposit, or to changes in the categorization of specific deposits between Class A, B or C based on changes in geological information, technology, resource price or a combination of these factors.

(d) Reclassifications. Reclassifications may occur if certain deposits are opened or closed to mining operations due to a government decision concerning the access rights to a deposit. All other changes in the quantity of known deposits should be treated as reappraisals. Reclassifications may conceivably be recorded if asset accounts for energy resources are being compiled by institutional sector.

2: Monetary asset accounts for mineral and energy resources

40. Monetary asset accounts for mineral and energy resources provide a market based valuation of physical stocks of mineral and energy resources and the changes in the value of these stocks over time. These estimates can be related to both physical asset accounts for energy and the asset accounts and national balance sheet of the SNA.

41. In practice, many deposits of mineral and energy resources are seldom if ever exchanged on a market and therefore, even if the resources have a market value, these cannot be observed. Thus, under these circumstances a market valuation of the mineral and energy resources must be based on assumptions of what the market prices would have been, if the resources were traded in a market.

42. A full description of the methods of estimating these values is beyond the scope of this technical note. Chapter 6 of SEEA-Energy (forthcoming) describes the methods based on estimating the net present value of these stocks.

43. The Monetary asset account has the same line entries as the physical asset accounts, but an additional term is included to record revaluations to the resource stocks. This entry accounts for changes in the value of assets over an accounting period due to price movements for the resources.

Core Account 4: Monetary Asset Account for Energy

	Type of Energy Resource (Class A: Comercially recoverable resources)		
	Oil Resources (currency)	Natural Gas Resources (currency)	Coal & peat resources (currency)
Opening value of stock resources	48000	30000	36000
Additions to value of stock:			
Discoveries			
Upward appraisals		5000	
Reclassifications			
TOTAL ADDITIONS TO STOCK		5000	
Reductions in value of Stock:			
Extractions	2800	250	3600
Catastrophic losses			
Downwards reappraisals			3600
Reclassifications			
TOTAL REDUCTIONS IN STOCK	2800	250	7200
Revaluations	8000		-5000
Closing value of stock of resources	53200	34750	23800

44. The capacity to account for levels of mineral and energy resources and changes in these levels, and to analyse the state of these reserves, is a fundamental role of SEEA. There are however many conceptual and practical measurement challenges, which are discussed in more detail in Chapter 5 of SEEA-CF.

3. Combined presentation and Indicators for Energy

45. The combined presentation for energy data presents an aggregated set of data which provides enough information to derive relevant indicators. The data in the combined presentation come directly from the energy accounts, but are combined with other relevant data sources such as the national accounts and labour statistics. The combined presentation thus presents an overview of the key data that can be derived from the accounts.

Combined presentation for energy data

		Industries (by ISIC)							Rest of the World	Final Consumption and other		Taxes less subsidies on products, trade and transport margins	TOTAL
		Agriculture Forestry & Fishery (ISIC A)	Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage (ISIC H)	Other Industries	**Total Industry**		Accumulation	Households		
MONETARY FLOWS	**1. Supply of energy and non-energy products (currency):**												
	Total energy products	113	17203	6322	19403			43041	43375			12567	98983
	Total (energy & non-energy products)	59780	72669	38288	39765	304401	6608640	7123543					
	2. Intermediate consumption and final use (currency):												
	Total energy products	2386	881	10551	28576	25899	4549	72842	14745	4897	6499		98983
	Total (energy & non-energy products)	51121	62143	32742	18358	269338	5869950	6303652			491935		
	3. Gross value added (currency)	8659	10526	5546	21407	35063	738690	819891					819891
	4. Employment (thousands)	145	148	78	165	374	9921	10831					10831
PHYSICAL FLOWS	**5. Total energy from natural inputs (from the environment) (PJ)**												1292
	of which: from renewable sources												126
	6. Supply of energy products (PJ):												
	Coal								225				225
	Peat and peat products												
	Oil shale / oil sands												
	Natural gas		395		369			764					764
	Oil		721	347				1068	930				1998
	Biofuels	5			2			7					7
	Waste	39		55				94	17				111
	Electricity				212			212	22				234
	Heat				79			79					79
	Nuclear fuels and other fuels												
	7. End use of energy products (PJ):												
	Coal	2		17				19	2	-21	1		1
	Peat and peat products												
	Oil shale / oil sands												
	Natural gas	2		39			12	53	201	2	26		282
	Oil	34	2	326		621	49	1032	441	-3	102		1572
	Biofuels				2			2			5		7
	Waste	3		4	37		1	45	1		33		79
	Electricity	7	1	22	50	10	15	105	100		29		234
	Heat	2		11	2	1	19	35			44		79
	Nuclear fuels and other fuels												
	8. Net domestic energy use (PJ)												
ENERGY ASSETS	**9. Closing stocks of natural energy resources (currency; Class A)**		111750										
	10. Closing stocks of natural energy resources (PJ; Class A)		244000										
	11. Depletion of natural energy resources (PJ)		1161										
	12. Gross fixed capital formation for energy extraction and supply (currency)		27030		4230								
	of which: from renewable sources		506		125								

46. While countries should strive to populate the combined presentation to the greatest extent possible, they might wish to focus initially on one or more of the accounts that provide the data for the combined presentation. The decision on which accounts to populate first, whether for example it be physical flow accounts or asset accounts should take into account policy demands and data availability.

47. Even if the initial exercise of populating these accounts results in a largely incomplete table, such information is important in and of itself in providing a partial view of the energy situation and in determining data gaps. Furthermore, in the first phase it may be possible to make estimates using existing information and relationships between the variables. Finally it should be noted that for many countries only a small number of cells in the accounts presented here have significant values. For example, in most cases, energy in physical terms is supplied from only a few ISIC divisions for only a few energy products. Countries are encouraged to focus their initial efforts in measuring those flows that are most significant.

48. Each of the energy accounts discussed in the previous section contains sufficient information in and of itself to derive a number of useful aggregates and indicators as is discussed below. Should countries be interested in a more detailed presentation of information, the data can be further

disaggregated; in particular data could be presented at a more detailed level of industries as needed (e.g. 3 digit ISIC level) and/or additional data items could be added to the rows of the tables to provide a finer level of detail. For example, if the generation of electric power is important, data corresponding to Electric power generation, transmission and distribution (ISIC 351) can be presented as an "of which" column within Electricity, gas, steam and air conditioning supply (Section D).

49. The top of the combined presentation (row items 1-4) comes from Core Account 2, the Monetary Supply and Use Tables for Energy and from data items from the national accounts. Note that while the combined presentation only has the aggregates total intermediate consumption and final use, in Core Account 2 data are also presented by energy product. Countries could further disaggregate the data by showing intermediate consumption separately from final use. The top of the combined presentation provides a good starting point for those countries interested in better understanding the relationship between the energy sector and the economy as a whole.

50. The physical supply and use tables for energy (Core Account 1) provide the data for the second part of the combined presentation focusing on physical flows, in particular the supply and end use of energy products (row items 5-8). For each energy product, the top half of combined presentation provides information on what industry is supplying what energy products; the bottom half shows end use of energy products by industry and by households. It should be noted that "End-use of energy products" records the use of energy products to produce goods and services other than energy products and includes energy consumption of energy producers on own account and for purposes other than as an input into transformation.

51. Furthermore the difference between supply of energy and end use of energy as shown in combined presentation is equal to transformation (which includes transformation losses) of energy products from one form to another (e.g. coal into electricity), losses during distribution and storage, and end use of energy products for non-energy purposes (e.g. use of oil as a lubricant) with the later often being not significant[12]. Countries that are interested in their energy mix should consider commencing work by compiling Core Account 1.

52. An important energy aggregate that can be derived from the energy PSUT is *Net Domestic Energy Use*. Net Domestic Energy Use reflects the amount of energy used in an economy through production and consumption activity and can be used to assess trends in energy consumption by resident units. Net Domestic Energy Use is defined as the end-use of energy products (including changes in inventories of energy products) less exports of energy products plus all losses of energy (losses during extraction, losses during transformation, losses during storage and losses during distribution). Separate analysis of the components of Net Domestic Energy Use (e.g. total end-use of energy products less exports, and total energy losses) can also provide important information concerning energy use.

[12] However, can be quite significant in some cases such as when a petrochemical industry is present.

53. *Gross Energy Input* is another aggregate from the PSUT which reflects the total energy captured from the environment, energy products that are imported and energy from residuals within the economy (e.g. from incinerated solid waste). It can therefore provide an indicator of the pressures placed on the environment (or other countries' environments) in the supply of energy to the economy. In terms of entries contained in the energy PSUT, Gross Energy Input is equal to Energy from Natural Inputs plus Imports of energy products plus Energy from waste which is shown as a subitem of item 6 in the combined presentation.

54. Last but not least, the bottom 4 lines of the combined presentation focus on the stocks of natural energy resources and capital used in the supply of energy. This part of the combined presentation is particularly relevant for energy resource rich countries. It not only has information on the stocks of natural energy resources in monetary and physical terms, but also on the value of gross fixed capital formation used for the extraction/capture and delivery of energy products. The information on investments in infrastructure is useful for policy makers working on policies for meeting energy related development goals. It also contains information on the depletion of natural energy resources in physical terms which is closely linked to depletion in monetary terms in Core Account 2.

55. A major objective in designing the combined presentation is to support the preparation of indicators useful for environmental, economic and social policy. The information in the energy accounts information is important in informing at least three of the proposed indicators for the Sustainable Development Goals currently under discussion for the 2030 agenda. The three currently identified as potential indicators are:

- Proposed Indicator for Target 7.2: Renewable energy share in the total final energy consumption (%)
- Proposed Indicator for Target 7.3: Rate of improvement in energy intensity (%) measured in terms of primary energy and GDP
- Proposed Indicator for Target 7.b: Investments in energy efficiency as a percentage of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services

4. Compilation of energy accounts

56. The Generic Statistics Business Process Model (GSBPM) can be used to support the compilation of SEEA accounts as outlined in the first note in this series "Statistical Production Processes for Implementation of the SEEA Central Framework". Figure 2 briefly outlines the steps in this process below.

Figure 2: Steps in the Generic Statistics Business Process Model (GSBMP)

OVERARCHING MANAGEMENT FUNCTIONS	**1. Specify Needs:** Engage users to identify their detailed statistical needs, propose high level solution options and prepare the business case
	2. Design: Design and develop activities and any associated practical research work needed to define the statistical outputs, concepts, methodologies, collection instruments and operational processes. Specify all relevant metadata as well as quality assurance procedures
	3. Build: Build and test the production solution
	4. Collect: Collect and gather all necessary information (data and metadata), using different collection modes and load them for further processing
	5. Process: Clean data and prepare them for analysis
	6. Analyze: Produce statistical outputs, examine them in detail and prepare them for dissemination. Prepare statistical content and ensure outputs are 'fit for purpose' prior to dissemination. Ensure statistical analysts understand the statistics produced
	7. Disseminate: Release the statistical product and support users to access and use the output
	8. Evaluate: Conduct an evaluation of the process and agree an action plan

57. This section outlines some basic steps that are relevant in the compilation of energy accounts. The initial compilation of energy accounts will require several steps that may not need to be undertaken for each data cycle but should be revisited periodically in conjunction with regular budget and planning cycles. It should be noted that the development of energy accounts depends on the availability of quality basic energy statistics and as such could be a medium to longer term project.

4.1 Specify Needs

58. Those looking to begin compilation of the energy accounts must first make the business case, defining the analytical and policy uses of the information being compiled. High level institutional and political buy-in should be obtained through stakeholder discussions to ensure a solid basis for institutionalisation of the accounts' compilation. Securing the necessary resources required to implement a project on compilation is important.

59. Countries may wish to begin compilation on a pilot basis, which can help to obtain the political buy-in for a regular compilation of accounts by providing an initial illustration of the information compiled and its associated uses. Compilation on a pilot basis can be a useful exercise in determining data gaps.

4.2 Design and Build

1: Establish institutional arrangements

60. It is important to build strong institutional arrangements from the outset to establish a common goal and combined strategy for compilation of energy accounts, and to facilitate the exchange of knowledge, expertise and data. Establishing a high level committee of strategic partners will cement political buy-in and can support more cooperative working arrangements and data sharing at the technical level. Technical working groups can then be established under the high level committee. Establishing and maintaining good working relations with the agencies that are the source for basic

data can pay dividends later on in the production process when estimation challenges benefit from expertise in all concerned agencies.

61. For the case of energy, key strategic partners often include the national statistics office, energy ministries and the ministry of planning and/or finance. The roles of these different agencies regarding energy policy and management will depend on the country. These ministries play a key role in defining the country's energy policies and should be included as a key strategic partner from the outset. Other countries may have a more decentralised energy management system, with provincial, state or regional energy authorities. It is therefore essential to understand the legal framework which determines the roles and responsibilities of different agencies in order to identify the key partners.

62. The data required to compile the core accounts will be collected by different members of the National Statistics System. In the case of energy, key government institutions typically include the National Statistics Office as well as Government agencies responsible for Energy, Central Planning, Finance, Geology and Geological Surveys. Furthermore, energy suppliers, energy research organizations and non-governmental organizations such as energy industry associations will hold key sources of data.

2: Define statistical requirements - design outputs

63. The core accounts and their definitions described in this technical note present a simplified and aggregated version of the main SEEA Accounts for energy, and can therefore be used as an initial template to guide compilation. The core accounts identify the most important data items, and provide relatively aggregated industrial classifications.

64. Based on national circumstances and starting from the core accounts, decide the appropriate level of disaggregation. This includes the appropriate level of industry disaggregation, as well as the level of disaggregation of products. This technical note has provided some indication of the potential to further disaggregate, where specific considerations for each account including further disaggregation of industries and products.

65. It will be important to find an appropriate balance between the detail sought by policy makers and analysts and the capacity of the statistical infrastructure to deliver sufficiently robust estimates, especially in the early stages of development. However, it is also important to recognise the demands for detailed estimates so that the development of data sources and systems can anticipate eventual improvements in these dimensions.

3: Define statistical requirements - identify key data items and prioritise

66. Once priority core accounts have been identified, it might be useful to initially focus on the various data items within the core accounts that are most significant either in a policy context and/or magnitude.

67. In some countries energy flow accounts in physical terms might be more policy relevant. Developing countries that face energy shortages for example might wish to initially focus on

identifying the most significant energy products, who is supplying those products and what industries are using those products.

68. In other countries that are resource rich it could be the case that asset accounts would support policy discussions on how to best manage such assets. Again, the focus should initially be on those resources that are most relevant for the economy.

4: Identify important data sources

69. The existence of established energy data programs at the international level[13] generally means that basic data on energy supply and use is available for most countries. Since these sources will likely cover the major energy flows (with possible exception of within enterprise flows and goods for processing) these data in most cases will be sufficient to form the basis for estimating an initial PSUT for energy. For example, if a country has already estimated energy balances, these estimates will generally provide much of the data needed to estimate SEEA energy accounts. Data from energy balances will require adjustments to conform to SEEA accounting rules; the most important adjustments are usually in regards to the residency principle applied in the SEEA (and SNA). These adjustments are presented in SEEA-Energy (forthcoming).

70. In cases where access to national data does not exist or is limited, the use of data from international agencies may provide sufficient information to get started. Agencies that should be considered include International Energy Agency, OECD and World Trade Organisation.

71. Economic data maybe a good source of data on energy use or a basis for estimating missing components of supply and use in physical terms. For example, the monetary supply and use tables from the National accounts may contain information on the use of energy products, which can be used to distribute the physical use of energy to the different users.

72. Methods of distributing or allocating data based on related flows such as from the economic accounts will require careful assessment and the incorporation of data from other sources. Data for use in such methods may be available from one-off studies or from enterprise specific information. If such sources are not available, data from other countries or regions with similar economic activity may prove useful. For example, such data for many European countries may be available from the Eurostat web site.

73. It is important to thoroughly asses the metadata for the available datasets. First, do the dimensions conform or support those set out for the required accounts. If not, is the shortcoming important or can it be overcome with estimates based on alternate sources? Also, key at this stage is to clearly ascertain the classification, conceptual and coverage differences across the various data sets to be used as basic inputs. It is important to assess whether there are readily available concordances between the classification systems and sources that can be used to estimate

[13] UNSD Annual Questionnaire on Energy Statistics, the International Energy Agency (IEA), the Statistical Office of the European Communities (Eurostat), the International Atomic Energy Agency (IAEA), the Organization of the Petroleum Exporting Countries (OPEC), and the Organización Latinoamericana de Energía (OLADE).

adjustments for conceptual and coverage difference. This will be particularly important if proxy data are being used from other countries or international organizations.

5: Build the mapping and correspondence

74. After identifying potential data sources, assess their suitability for estimating the desired variables identified in the accounts. It is important to thoroughly assess the metadata for the available data sets. First, assess whether or not the definitions conform to/and or support those set out in the design phase. Determine the severity of any shortcomings and whether they can be overcome with estimates based on alternate sources.

75. As with all accounting work there are a range of challenges centred on aligning the available data with the conceptual definitions and scope required for coherent accounts. For energy accounting some particular challenges include:

- Reconciling differences between the supply and use of energy in cases where supply and use information do not conform.
- Accounting for losses of energy during distribution.
- The recording of household activity, particularly in countries where energy for own use is prevalent such as the own use of animal dung.
- The need for an appropriate sampling frame which draws a representative picture of energy supply and use from the business register. If samples are drawn on the basis of Value Added there is a risk that the information in terms of energy is not representative.

6: Address data gaps

76. If insufficient basic data is available to produce one or more of the accounts, it may be necessary to initiate a project to generate the missing data. The Annex has a table showing examples of potential data sources for energy accounts. This may well mean that account development splits into two paths, one for the accounts that can be initiated with existing data and one where development will have to await the availability of basic data.

77. In some cases where partial data exists but there are some important data gaps it may be a good idea to construct a preliminary account filling in the missing data with the estimates based on related flows or modelling. While such an exercise may not produce a viable account, it may well reveal more about the extent and importance of data gaps thus providing a better foundation for the development of these missing basic data. In the case where basic data must be developed, it is recommended that a separate project be initiated to develop the necessary data.

78. SEEA compilers will at an early stage need to assure access to these data if it doesn't already exist. A key consideration is the terms of access under current institutional arrangements. These should support cooperative working arrangements and the release of the energy accounts with sufficient detail to address the policy issues important for the country.

79. In cases where institutional arrangements are not yet established, it should be noted that this step can take considerable effort and time as it will be important for all agencies involved to clearly appreciate the mandate of the other agencies and associated constraints.

80. Databases for the basic data and the accounts must be established. Given the SEEA links to the SNA, existing database structures and associated processing systems may be a good source for this development. Some adjustments will be required to add components not in the SNA such as intra-enterprise flows. It is likely that such adjustments will only be significant for a limited set of economic activates, thus efforts should be focused on these areas.

4.3 Collect and Process

81. Import and process the data applying the concordances developed in the 'design and build' phase which may be required between the definitions and classifications used in the imported data and those to be used in the estimates[15]. The heterogeneity of the data for energy flows means that validation of data sources at the micro level may be needed to assure the quality of the datasets being used. Care must be taken in assessing data that may have a high degree of variability.

82. Given that data may be acquired from a number of institutions or agencies, it is important to establish data transfer protocols. Invariably agencies require changes/upgrades to systems and these impact data integration if protocols are not in place. It is also important to collect metadata with each period or at least verify that it has not changed so as to be aware of any changes to classification, definitions, etc.

83. Prepare estimates, including the estimation of data for any data gaps. Given the use of proxies to estimate some data and the varying quality and coverage of these, it is likely that different methods will need to be considered for each industry/sector of the economy.

84. As data is taken from different sources, checks should be undertaken to ensure the numbers make sense when put together in the accounts. Where large disparities exist, expert judgement will be needed to understand the cause of these differences, potentially revisiting metadata and making adjustments to the data where needed. Staff in the source agency should be closely consulted throughout this undertaking.

4.4 Analyse

85. Analyses tables and graphic representations including undertaking an analysis of time series where possible and recognising the likely need for multiple iterations of this and the previous step should be produced in order to help users of the information. Data quality should be assessed and documented at this stage.

86. The above three steps (collect, process and analyse) are the core activities in building the accounts and will be repeated in cycle during each production period. This allows the strength of the

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[15] This is assuming that clean microdata sets are already available.

accounting approach to be used to confront the various data sources and check for consistency and reasonableness in comparison to other datasets such as the related national accounts values.

87. The first time accounts are estimated for a new program, particular attention needs to be made with regard to adjustments required to the source data to ensure the methods used are appropriate and sound. Since these accounts deal with physical flows and stocks, care must be taken to fully understand the challenges in converting estimation methods from other domains where the focus has been economic values.

88. It is also recommended to construct bridge tables to show the conceptual difference between the energy accounts and the basic energy statistics. For example, a bridge table may show the difference between net domestic energy consumption from the energy PSUT and the energy use as derived from the energy balances16.

89. It is recommended that in cases where significant basic data come from other agencies that staff of those agencies be asked to participate in the analysis of the estimates. These experts often have in depth knowledge that can allow the identification and resolution of inconstancies.

4.5 Disseminate

90. The dissemination of data should always be accompanied by sufficient documentation and metadata to allow users to fully understand the information being disseminated (e.g. including indicators, methodological notes and statements of data quality). This is particularly important for the initial dissemination of a new program of data where one might want to identify the initial data as ‘experimental’ or ‘preliminary’ and make it clear that user input is being sought in order to improve future releases. The metadata should be clearly published.

91. Care should be taken to ensure that differences in the SEEA energy accounting figures and other energy statistics previously disseminated are properly clarified, and ensure terms are properly defined and explained. For example, the differences between information in the energy balances and energy accounts should be clarified.

4.5 Evaluate

92. Data and related methodological and other documentation should be archived. A review of estimates, data sources, methods and systems, including actively seeking user feedback should also be undertaken.

93. These last two steps are very important for all statistical programs but when initiating a new program of data, seeking user feedback is crucial. This in turn depends on the existence of good documentation on the methods and systems so as to properly inform users and assess their feedback.

5. Extensions

[16] An example of such a bridge table can be seen in the Annex.

94. Links to other SEEA accounts should be considered. In the case of energy, an obvious linkage is to the air emission accounts, material flow accounts, and waste accounts. In building the energy accounts one should be sure to develop the databases and accounts such that these linkages can be easily made, integrating the data from multiple accounts to further inform policy makers.

95. On the environmental dimension, the energy accounts again play a key role in filling the information gaps required not only for the derivation of the indicators but also by providing necessary background and contextual information. For example, the combined presentation not only contains information that aids in the calculation of emissions by energy product but also by industries using the ISIC classification. Such information allows for a more complete understanding of emissions not only by energy product but also by industry. It supports the formulation of strategies and policies that target emitters and does so in a way that could address the larger emitters.

96. In order to shed light on the factors behind the changes in energy use, structural decomposition analysis based on input-output modelling can be applied. Structural decomposition analysis is a well-established method and reference can be made to a large number of articles and reports describing the method and presenting results.[17]

97. The data in the accounts can be used to properly understand how final demand drives energy use. In particular, input-output analysis gives the allocation of energy use by final use categories or specific products.

98. Extensions to energy accounts can relate to the spatial disaggregation of data contained in other accounts of the SEEA Central Framework and the national accounts, as well as to the SEEA Experimental Ecosystem Accounting.

99. The accounts described in the SEEA Central Framework largely relate to specific materials, substances and resources, and the various stocks and flows recorded for a country as a whole. However, all materials, substances and resources are found in particular locations and, from a policy perspective, knowledge of the location of various stocks and flows may be of particular relevance. Indeed, national averages usually hide important local variations and spatially disaggregating data can help to better identify environmental spatial patterns. For example, some regions may have supplies of electricity based on a renewable source such as hydro whereas other parts of the country may be depended on fossil fuels for electricity.

100. The quality of spatial coding must be assessed carefully as additional datasets are linked and integrated with the energy accounts. The original purpose and sources may not provide precise locational information in all cases. For example, data for many economic data programs are gathered by enterprise, usually though the head office, head offices are often not located where the majority of material flows occur, particularly in large scale manufacturing of energy operations. It may be necessary to pursue more precise locations for some economic activities to fully exploit such data integration.

[17] Potential links to economic models are described further in SEEA Applications and Extensions.

101. There may also be interest in further splitting out energy products into finer categories to allow more detailed analysis of the relative costs and benefits of these various products. Similarly a finer ISIC based industry breakdown could be used in order to provide more details on energy supply and use for industries.

102. The information in the accounts, in particular in the physical and monetary supply and use tables can be linked with information on energy taxes and subsidies to analyse the relationship between taxes and subsides and the energy product mix in a country.

103. Increasingly there is interest in linking many of these data sets with social indicators. Energy access by households and other resources may be of interest. This would include access to energy of households by income status or data on the type of energy use by households for example for transportation. Also, the extent to which household are producers of energy may be a topic of interest in some cases.

6. References and Links

Eurostat (2014). Physical Energy Flow Accounts Manual.

Organisation for Economic Co-operation and Development (2014).

OECD/IEA/Eurostat (2005): Energy Statistics Manual. IEA, Paris.
http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code= NRG-2004

IEA/Eurostat Annual Energy Statistics Questionnaires 2012 & explanatory notes
http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/publications/archives

IEA/Eurostat Annual Energy Statistics Questionnaires 2013 & explanatory notes
http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/questionnaires

OECD/IEA/Eurostat (2005): Energy Statistics Manual. IEA, Paris.
http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=NRG-2004

Schenau, S. (2012): Compilation of physical energy flow accounts (PEFA) for the Netherlands.
https://circabc.europa.eu/w/browse/ad2ff2b8-f9cc-4d3d-b76e-499e09ed01b1 or
http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/Catalogue_of_pilot_study_reports.pdf

Statistics Netherlands (2012). Compilation of physical energy flow accounts (PEFA) for the Netherlands

SEEA Central Framework (2012): http://unstats.un.org/unsd/envaccounting/seearev/

SEEA Energy (2013) draft http://unstats.un.org/unsd/envaccounting/energy.asp and

http://unstats.un.org/unsd/envaccounting/seeae/chapterList.asp

SNA 2008: System of National Accounts https://unstats.un.org/unsd/nationalaccount/sna2008.asp

7. Annex

7.1 Definitions

The following is a list of energy products (at the top level-sections) as defined in IRES.

0 Coal This section includes coal, i.e. solid fossil fuel consisting of carbonized vegetal matter, and coal products derived directly or indirectly from the various classes of coal by carbonization or pyrolysis processes, by the aggregation of finely divided coal or by chemical reactions with oxidizing agents, including water.

Remark: There are two main categories of primary coal, hard coal (comprising medium and high-rank coals) and brown coal (low-rank coals) which can be identified by their Gross Calorific Value - GCV and the Vitrinite mean Random Reflectance per cent - Rr. Peat is not included here.

1 Peat and peat products This section comprises peat, a solid formed from the partial decomposition of dead vegetation under conditions of high humidity and limited air access (initial stage of coalification) and any products derived from it.

2 Oil shale / oil sands A sedimentary rock which contains organic matter in the form of kerogen. Kerogen is a waxy hydrocarbon-rich material regarded as a precursor of petroleum.

Remark: Oil shale may be burned directly or processed by heating to extract shale oil.

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

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

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

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

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

4 Oil Liquid hydrocarbons of fossil origins comprising (i) crude oil;(ii) liquids extracted from natural gas (NGL); (iii) fully or partly processed products from the refining of crude oil, and (iv) functionally similar liquid hydrocarbons and organic chemicals from vegetal or animal origins.

5 Biofuels Fuels derived directly or indirectly from biomass.

Remark: Fuels produced from animal fats, by-products and residues obtain their calorific value indirectly from the plants eaten by the animals.

6 Waste This section includes waste, i.e. materials no longer required by their holders.

Remark: For the purposes of energy statistics, waste refers to the part of these materials that is incinerated with heat recovery at installations designed for mixed wastes or co- fired with other fuels.

The heat may be used for heating or electricity generation. Certain wastes are mixtures of materials of fossil and biomass origin.

7 Electricity This section includes electricity, i.e. the transfer of energy through the physical phenomena involving electric charges and their effects when at rest and in motion.

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

8 Heat This section includes heat, i.e. is the energy obtained from the translational, rotational and vibrational motion of the constituents of matter, as well as changes in its physical state.

Remark: Heat can be produced by different production processes.

9 Nuclear fuels and other fuels n.e.c. This section includes nuclear fuels including uranium, thorium, plutonium and derived products that can be used in nuclear reactors as a source of electricity and/or heat as well as fuels not elsewhere classified.

7.2 Compilation of the PSUTs from the energy balances

Basically, compilation of the physical energy flow accounts takes place in three subsequent steps:

1. Compilation of the physical supply and use tables based on data from the energy balances or directly from basic energy data
2. Correction of the supply and use tables for the concepts of the National accounts
3. Allocation of supply and use to different industries and households

7.2.1 Filling the supply and use tables from energy data sources

The first step consists of the compilation of the physical supply and use tables based on data from the energy balances or directly from basic energy data. Both will be described in more detail below.

The energy balances (EB) are the most important source for the derivation of the physical energy flow accounts. Energy balance sheets describe the supply and the type of consumption of energy commodities, but also the energy consumption by industry. When energy balances are available, they can be directly used as output for the PSUT. The first step thus consists of a reorganizing the data from the energy balance into the supply-use framework.

Figure 3 shows how the data items from the energy balances have to be fitted into the supply use framework. Below we also indicate by the letters in which block of the PSUT they are to be recorded (see also figure 2.1.1).

Figure 3. Data items of the energy balances in the supply use framework

SUPPLY		Industries	Households	Accumulation	ROW	Bunkering	Environment	TOTAL
Natural inputs							Total indigenous production	
Products		Production + indigenous production			Imports			
Residuals	Waste			From accumulation				
	Energy incorporated into products	Final consumption for non-energetic purposes						
	Losses during transformation	Net energy transformation						
	Other losses	Other losses						
	Residual heat losses	Final consumption for energetic purposes						
TOTAL								

USE		Industries	Households	Accumulation	ROW	Bunkering	Environment	TOTAL
Natural inputs		Indigenous production						
Products		Total final energy conmsumption + total transformation input		Stock changes	Exports	Bunkers		
Residuals	Waste	Indigenous production						
	Energy incorporated into products			To accumulation				
	Losses during transformation						Total transformation losses	
	Other losses						Total other losses	
	Residual heat losses						Total residual heat losses	
TOTAL								

A) Natural inputs

Use of natural inputs (B) is equal to total indigenous production by industry/sector, as is directly recorded in the EB. For some energy carriers such as waste, nuclear energy and biofuels, the use is registered in EB as indigenous production, while according to SEEA these are products or residuals. Accordingly, the "extraction" of these energy carriers is not inserted in the natural inputs block (B), but in block N (Use of residuals for energy purposes) or E (intermediate consumption of energy products). By definition all natural inputs are supplied by the environment (A).

B) Energy products

Supply of energy products is equal to production by industries + indigenous production by industries (both C) + imports (D). Use of energy products is equal to total final energy consumption by industries (E) and households (F) + transformation input by industries (E) and households (F) + stock changes (G) + exports (H) + bunkering (in separate column, in the next step to be redistributed.

All these variables can directly be obtained from the EB. Stock changes in the energy statistics are defined as opening stock minus closing stock. Positive values thus indicate that the stock has diminished and negative values that the stock has increased.

According to SEEA 'Energy products include energy from biomass and solid waste that are combusted for the production of electricity and/or heat (SEEA-CF 3.146)'. Accordingly, when waste is used to produce heat or electricity, it has to be recorded both in the use (E) and supply table (C). This thus results is double counting (in fact the production and use of waste as a product is own account production / use).

C) residuals

Waste: The use of waste that has to be recorded in the use table (N) is equal to indigenous production in the EB (as it is recorded that way in the energy balances). In addition, the biomass that has been recorded in the

production block (C) has to be counterbalanced in the residual block and thus has to be added to the row of waste. By definition, all waste is supplied from the accumulation column (K).
Energy incorporated in products: Energy incorporated in products (I) that is recorded in the supply table can be directly obtained from the energy balances by sector as this is equal to final energy consumption for non-energetic purposes. By definition, in the use table these are recorded in the accumulation column (O).
Transformation losses: Transformation losses (I) that are recorded in the supply table can be directly obtained from the energy balances by sector as this is equal to the net energy transformation. By definition, in the use table these losses are recorded in the environment column (Q).
Residual heat losses: Residual heat losses (I) that are recorded in the supply table can be directly obtained from the energy balances by sector as this is equal to energetic final energy use. By definition, in the use table these losses are recorded in the environment column (Q).
Other losses: For two other kind of losses information is available: Losses that occur during flaring and venting from the oil and gas extraction and distribution losses of electricity. Supply of these losses is again recorded in block I. By definition all use is recorded in the environment column (Q) .

When energy balances are not available, the supply and use tables may be filled directly with basic physical energy data. Table 2 provides an overview of several data sources that may be used and also in which table this data may be used.

Table 2. Data sources for supply and use tables

Data source	***Supply***	***Use***	***Asset***
National accounts supply use tables	Monetary data with price data can be used to calculate volumes	Monetary data with price data can be used to calculate volumes	Asset values
Administrative data of regulators (e.g. oil and gas)	Supply of oil and gas	Producer consumption (e.g. venting and flaring), use of natural inputs	Reserves, extraction, depletion
Industry associations data	Value of production	Costs	Extraction, depletion, reserves
Vehicle registries		Kilometres driven an fuel use data can be basis for road fuel estimates	
Annual reports of companies		May contain physical data on energy use (e.g. airlines on total fuel use)	Reserves
International trade statistics	Imports of fuel products	Exports of fuel products	
Tax data		Possible source of data on fuel expenditures or taxation that can be used to derive volumes.	
Energy commodity surveys	Surveys of energy producers can provide production estimates in physical units.	Energy producers (e.g. electric utilities) may provide data on use by class of user, however, re-sellers are not final users	
Electricity production survey	Supply of electricity	Fuel transformation in produce electricity, producer own consumption, estimates of use by customers	
Secondary distributor surveys		Use by wholesalers and estimates of the use by their customers (e.g. households)	
Mining industry survey	Supply of fossil fuels (e.g. coal, uranium), value of production	Use of natural inputs, fuel use in mining industries, cost of production	Extraction, depletion, reserves
Manufacturing survey		Use of fuel products in manufacturing (in monetary or physical terms), non-energy uses for some industries (e.g. fertiliser, chemicals)	
Construction survey		Fuel use in the construction industries	
Transportation surveys		Fuel use, important for airline fuel purchased abroad. Pipeline data may be useful for disposition information.	
Survey of household expenditures		Monetary estimates of fuel consumption (can be used for allocations, e.g. with unit prices)	
Input-output tables		Monetary estimates of fuel consumption (can be used for allocations, e.g. with unit prices)	

The result of step 1 is a supply and use table where both supply equal use, but also the columns for industries and households in de supply and use table are equal (input output identity).

Correction of the supply and use tables for to the concepts of the National accounts

In the compilation of the physical supply and use tables it is important to concur with the conventions of the national accounts. The main conceptual difference between energy balances and accounts is the geographical coverage (IRES 11.11; SEEA-CF 3.178). 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. The energy accounts, on the other hand, use (consistent with the national accounts) the concept of the economic territory with statistics compiled for all the units resident of that economy independently on where they are physically located). A resident of a country is an institutional unit with a centre of economic interest in the economic territory of that country. Units resident outside the territory are considered as part of the rest of the world. This coverage is referred to as the residence principle.

The range of potential data sources that can be used for deriving the residence-adjustmentitems is wide and varying across countries. The adjustments to be made for the residence principle relate to transport activities (road, water, air) undertaken by resident units abroad and undertaken by non-residents on the territory. Hence transport statistics and transport related data sources may serve as auxiliary information. Also, national accounts and balance of payment statistics may serve as a general source. In principle, they should adjust for the residence principle. Also, foreign trade statistics should adjust for the residence principle. E.g. the fuel bunkered in domestic ports and air ports (recorded in total in the IEA/Eurostat Annual Energy Statistics Questionnaires) should only be considered export in trade statistics if sold to non-resident operators of ships and airplanes, i.e. foreign trade statistics may be used to identify the share sold to non-residents.

Subsequently, this information is inserted in table A and B. The use of non-residents is recorded as part of export. The use of residents abroad is recorded as part of import. The columns for rail, road, water and air transport are overwritten with the information on total energy use by residents. Finally, the column for bunkering in the use table is adjusted: this now only records bunkering to non-residents (which is part of exports). Finally, a check is made that supply still equals use and that also the input-output identity still holds for different industries and the economy as a whole. Differences are corrected on the exports.

7.3 Adjustments to energy statistics and energy balances needed to derive 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 re allocated in order to present information on an ISIC-based tabulation such as that used in the SEEA-E.

In order to compile energy accounts, it is important to have information that allows for the adjustments presented in the previous sections. 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.

Bridge table for domestic supply and total supply[19]

	Supply (Energy Balances)	+losses during generation of secondary production	+international marine bunkers	Exports	Accumulations	Purchased by residents abroad	Supply (SEEA-Energy)
Coal	244.1			1.9	- 21.0		225
Peat and peat products							
Oil shale/ oil sands							
Natural gas (extracted)	395						395
Natural gas (distributed)	166.1			201.0	2.0		369.1
Oil (e.g. conventional crude oil)	360			361.0			721
Oil (oil products)	996		44	80.0	- 3.0	160	1277
Biofuels	7						7
Waste	109.1			1.0	0.3		110.4
Electricity	134			100.0			234
Heat	78.5						78.5
Nuclear fuels and other fuels nec							

[19] Exports are removed prior to the calculation of net supply or availability in the energy balances and hence need to be added back.

Bridge table for final consumption and end use of energy

	Final consumption (energy balances)	+international marine bunkers	Exports	Accumulations	Energy sectors use of energy for supporting activities	Purchased by residents abroad	End use (SEEA-Energy)
Coal	21.1		1.9	- 21.0			2
Peat and peat products							
Oil shale/ oil sands							
Natural gas (extracted)							
Natural gas (distributed)	77.1		201.0	2.0	2.0		282.1
Oil (e.g. conventional crude oil)	930		361.0				1291
Oil (oil products)	44	44	80.0	- 3.0	6.0	160	331
Biofuels	7						7
Waste	78.1		1.0	0.3			79.4
Electricity	131		100.0		3.0		234
Heat	76.5				2.0		78.5
Nuclear fuels and other fuels nec							