



# Physical Energy Flow Accounts (PEFA)

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## Preface

Energy accounts is one of three modules which has been recently amended to Regulation (EU) No. 691/2011 on European environmental economic accounts. It contributes directly to the Union's policy priorities on green growth and resource productivity by providing important information and indicators on energy in a NACE breakdown.

Physical energy flow accounts (PEFA) as described in this manual comprise a set of five tables. The five tables are included in an electronic questionnaire which Eurostat uses to collect data from ESS<sup>1</sup> countries. In May 2014 a test data collection is launched on a voluntary basis.

This PEFA manual is a draft which has been prepared for the ESTP<sup>2</sup> course on energy accounts (29-30 April 2014 in Vienna) and the launch of the PEFA Questionnaire in May 2014.

The general compilation guidelines (chapter 4 in this manual) are still making references to the 'old' versions<sup>3</sup> of the IEA/Eurostat Annual Energy Statistics Questionnaires. A future revised version of this manual will be adjusted to the 'new' questionnaires.

## Acknowledgement

Eurostat would like to thank the members of the task force on energy accounts who meet five times since 2010 and who developed the PEFA set of tables.

## Important abbreviations

SNA – International System of National Accounts

ESA - European System of National and Regional Accounts

SEEA – System of Environmental Economic Accounting

IEA – International Energy Agency

NACE – Statistical classification of economic activities in the European Community

PSUT – Physical Supply and Use Tables

NCV – Net Calorific Value

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<sup>1</sup> European Statistical System

<sup>2</sup> European Statistical Training Programme

<sup>3</sup> A 'new' version was introduced with the data collection in autumn 2013.

# 1 Introduction

1. This manual presents the theoretical and conceptual foundations of physical energy flow accounts (PEFA) and provides some general compilation guidelines. It primarily addresses compilers of PEFA but also the users of PEFA who are interested in understanding more of the underpinning statistical details.

2. Physical energy flow accounts (PEFA) present data on the physical flows of energy expressed in terajoules in a way that is fully compatible with the concepts, principles, and data reported under the International System of National Accounts (SNA) and European System of National and Regional Accounts (ESA). PEFA record energy flow data in relation to the economic activities of resident units of national economies. They present the supply and use of natural energy inputs, energy products and energy residuals. Economic activities comprise production, consumption, and accumulation.

3. PEFA is a set of five tables which has been developed by a Eurostat task force since 2010. The five tables are included in an electronic questionnaire which Eurostat uses to undertake data collections.

4. PEFA are being developed very close to the System of Environmental-Economic Accounting Central Framework (SEEA-CF). In its chapter 3 (and parts of chapter 2) the SEEA-CF lays out a general physical flow accounting framework and a set of accounting principles and boundaries within which a consistent recording of all types of physical flows relating to economic activities can be made.

5. Most of the data needed to fill the five tables come from energy statistics (IEA/Eurostat Annual Questionnaires). The latter constitute an established source of energy information (based on a statistical regulation) serving European energy policies. PEFA are supposed to complement energy statistics. The idea is to align energy information closer to national accounts enabling the integration of energy concerns into macro-economic monitoring, analyses, modelling, and theory building.

6. In this manual all references to NACE<sup>4</sup> relate to the most recent version NACE Rev.2.

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<sup>4</sup> Statistical classification of economic activities in the European Community

## 2 Conceptual foundations of PEFA

7. Physical energy flow accounts (PEFA) have been developed according to the accounting structures and principles of the [System of Environmental-Economic Accounting – Central Framework](#) (UN et al. 2012). The System of Environmental-Economic Accounting (SEEA-CF) contains the internationally agreed standard concepts, definitions, classifications, accounting rules, and tables for producing internationally comparable statistics on the environment and its relationship with the economy. The SEEA framework follows a similar accounting structure as the [System of National Accounts \(SNA\)](#) and uses concepts, definitions and classifications consistent with the SNA in order to facilitate the integration of environmental and economic statistics.

8. PEFA belong to the SEEA main area of physical flow accounts (see SEEA-CF chapter 3). As such they aim at describing the physical flows of energy within the economy and between the natural environment and the economy. In its chapter 3 (and parts of chapter 2) the SEEA-CF lays out a general physical flow accounting framework and a set of accounting principles and boundaries within which a consistent recording of all types of physical flows relating to economic activities can be made.

### 2.1 The SEEA physical flow accounting framework

9. The accounting framework of physical supply and use tables (PSUT) form the conceptual fundament of SEEA physical flow accounts (SEEA-CF §21, section 2.5, and chapter 3). The PSUT framework has been based on the expansion of monetary supply and use tables used in the SNA by adding columns and rows specifically to accommodate physical flows between the economy and the environment. The same design approach has been used for all specific PSUT, such as those for flows of water and energy (SEEA-CF §21). PEFA Tables A and B constitute the specific PSUT for energy flows.

10. Flows of materials and energy measured in physical units are the subject of measurement in SEEA physical flow accounts. These are termed physical flows. Three generic types of physical flows are distinguished: natural inputs, products, and residuals (see section 2.1.1). The recording of physical flows is arranged in physical supply and use tables (see section 2.1.2).

#### 2.1.1 Definition of natural inputs, products, and residuals

11. Core to the measurement of physical flows in the SEEA-CF are the flows of natural inputs, products and residuals. The production boundary of the SNA (see also section 2.2.3) is used to distinguish between these types of physical flows. The definition of products aligns to the SNA definition being those goods and services created through a production process and having economic value (SEEA-CF §1.39).

12. There are three generic types of physical flows:

- (i) natural inputs,
- (ii) products, and
- (iii) residuals.

Further classifications are needed detailing the three generic flow types (see section 3.3).

13. *Natural inputs* refer to physical flows from the environment into the economy. The SEEA-CF defines natural inputs as all physical inputs that are moved from their location in the environment as a part of economic production processes or are directly used in production. They may be (i) natural resource inputs, such as mineral and energy resources or timber resources, (ii) inputs from renewable energy sources, such as solar energy captured by economic units, or (iii) other natural inputs such as inputs from soil (e.g., soil nutrients) and inputs from air (e.g., oxygen absorbed in combustion processes) (SEEA-CF §2.89). It is important to not confuse natural inputs with products, e.g. in the case of mining activities<sup>5</sup>.

14. *Products* are goods and services that result from a process of production in the economy. They are defined consistently with the definition of products in the SNA. Generally products are evidenced by a transaction of positive monetary value between two economic units (SEEA-CF §2.91). The scope of products flows included in physical flow accounts include also intra-establishment flows which are partly ignored in monetary flow accounts (see also section 2.2.4).

15. *Residuals* refer to flows of solid, liquid and gaseous materials, and energy, that are discarded, discharged or emitted to the environment (e.g., emission to air) by establishments and households through processes of production, consumption or accumulation but may also flow within the economy, as is the case when, for example, solid waste is collected as part of a waste collection scheme. (SEEA-CF §2.92).

### 2.1.2 The framework of physical supply and use tables (PSUT)

16. The PSUT provide an accounting framework enabling the complete and consistent recording of physical flows (materials and energy)

- (i) from the environment into the economy,
- (ii) within the economy, and
- (iii) from the economy to the environment.

Physical flows within the environment, i.e. natural flows of materials and energy, are out of scope.

17. The accounting framework of supply and use tables (SUT) originates from national accounts (SNA, ESA). There, the framework is used for the recording of monetary transaction related to production, consumption, and accumulation activities. For the recording of physical flows the SUT framework has been extended by additional rows and columns in order to accommodate environmental aspects. Whereas the monetary SUTs consider transaction flows only within the economy, the physical SUT comprises also physical flows between economy and environment.

18. The PSUT framework is basically a pair of tables which have the same format/structure.

- Row-wise, the two matrices show the various physical flow types, namely natural

<sup>5</sup> *Natural inputs*, e.g. gross ore, are input flows to the mining industry. *Products*, e.g. processed ore and concentrates, are output by the mining industry.

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.
19. The physical *supply* table (top half of Figure 1) shows which flow items are provided by which supplier (industries, households, accumulation, rest of the world and environment); in other words it shows the flows by origin.
20. The physical *use* table (bottom half of Figure 1) shows who (i.e. production, consumption, accumulation activity etc.) is using or receiving the respective physical flow. In other words, it shows the flows by its destination. Like this, each flow is recorded twice: first at its origin, secondly at its destination. This way of recording is also referred to as "double-entry-bookkeeping".
21. The intersections or segments of the PSUT columns and rows denote sub-matrices. These have been labelled with capital letters from A. to Q in the same way as in the SEEA-CF (chapter 3, Table 3.2.1). Each sub-matrix (cell labelled with capital letters) is explained in the following:
- A. records the supply of natural inputs from the environment.
  - B. records the very same natural inputs, however by the receiving, i.e. extracting, industries.
  - C. shows the supply of products by the producing industries.
  - D. shows the imports of products; i.e. the supply of products by the rest of the world.
22. Sub-matrices E, F, G, and H show how the products supplied (i.e. C and D) are used.
- E. records the intermediate use of products by industries. Industries' intermediate use of products is for the production of other products (e.g. coal to generate electricity).
  - F. records the use of products, usually finished products, by private households.
  - G. records the net change of product inventories and the additions to produced assets (gross capital formation).
  - H. represents the export of products.
23. Sub-matrices I, J, K, L, and M show the generation, i.e. supply, of residuals from different origins (columns).
- I. records the residuals generated by industries.
  - J. records the residuals generated by private households.
  - K. records residuals provided from inventories (e.g. losses) or from produced assets.
  - L. records the inflow of residual provided by rest of the world economies (e.g. non-value waste) – not relevant for energy flows.
  - M. records the supply of residuals from the environment (e.g. collection of oil spills) –



not much relevant.

24. Sub-matrices N, O, P, and Q record how residuals (provided by I, J, K, L, and M) are used.
- N. records the use of residuals by industries, e.g. the non-value waste collected by waste management industries.
  - O. records the accumulation of residuals in the economy (e.g. landfills).
  - P. record the use of residuals by the rest of the world economy – not relevant for energy flows.
  - Q. records the use, i.e. reception, of residuals by the environment.
25. The first column in the supply table presents the production of products (C.) and the generation of residuals (I.) by industries. In the use table it covers the use of natural inputs (B.), the intermediate consumption of products (E.), and the receipt of residuals by industries (N.). The first column is further broken down using NACE classification.
26. The second column covers the consumption of products by households (cell F. in the use table) and the generation of residuals from this consumption (cell J. in the supply table). The activity of households in extracting natural inputs from the environment for their own consumption (e.g. solar thermal or geothermal energy to generate warm water for own use) is considered a productive activity and hence this activity should be recorded in the first column of the use table against the relevant industry class.
27. Unlike the monetary supply and use table, no entries are made for government final consumption. In monetary accounts, government final consumption represents the purchase and consumption by governments of their own output which is services; it does not have an associated physical flow. All of the physical flows related to the intermediate consumption of governments, e.g. paper, electricity etc., are recorded in the first column under the relevant industry class, commonly public administration. In addition, the generation of residuals, e.g. emissions, dissipative heat, by governments in the production of their output is recorded in the first column (i.e. industries).
28. The third column, labelled accumulation, concerns changes in the stock of materials and energy within the economy. From a supply perspective, this column records reductions in the physical stock of produced assets through, for example, demolition, or scrapping (K.). From a use perspective, the accumulation column records additions to the physical stock of produced assets (gross capital formation) and the net changes of inventories of products (G.). It also includes accumulation of residuals stocked within the economy, e.g. in landfills (O.). Note that according to SNA conventions changes in product inventories are recorded net in the use table.
29. The fourth column 'rest of the world' recognises the exchanges between national economies in terms of imports (D.) and exports (H.) of products and flows of residuals. Residuals received from the rest of the world (L.) and sent to the rest of the world (P.) primarily concern the movement of solid waste between different economies.

Figure 1: Basic scheme of a physical supply and use table (PSUT)

Supply table		Production; generation of residuals		Accumulation		Flows from the environment		Total	
Production; generation of residuals by industries (including household production on own account), classified by ISIC		Generation of residuals by households		Industries—classified by ISIC		Flows from the rest of the world		Total supply of natural inputs (TSNI)	
Natural inputs									
Products	C. Output (including sale of recycled and reused products)			D. Imports of products					Total supply of products (TSP)
Residuals	I1. Residuals generated by industry (including natural resource residuals) I2. Residuals generated following treatment	J. Residuals generated by household final consumption		L. Residuals received from rest of the world					Total supply of residuals (TSR)
Total supply									
Use table		Final consumption <sup>a</sup>		Accumulation		Flows to the environment		Total	
Intermediate consumption of products; use of natural inputs; collection of residuals		Households		Industries—classified by ISIC		Flows to the rest of the world		Total use of natural inputs (TUNI)	
Natural inputs									
Products	E. Intermediate consumption (including purchase of recycled and reused products)	F. Household final consumption (including purchase of recycled and reused products)		G. Gross capital formation (including fixed assets and inventories)					Total use of products (TUP)
Residuals	N. Collection and treatment of residuals (excluding accumulation in controlled landfill sites)			O. Accumulation of waste in controlled landfill sites					Total use of residuals (TUR)
Total use									

<sup>a</sup> No entries for government final consumption are recorded in physical terms. All government intermediate consumption, production and generation of residuals is recorded against the relevant industry in the first column of the PSUT.

Source: SEEA-CF, section 3.2.1, table 3.1, p. 41)

30. The fifth column 'environment' is the significant addition to the monetary supply and use

table structure. In this column natural input flows from the environment (A.) and residual flows to the environment (Q.) are recorded. The incorporation of the environmental column allows a full balancing for all physical flows that would otherwise not be possible.

31. The general framework shown in Figure 1 may be articulated only partly. For the case of energy flow accounts, the SEEA recommends the full articulation of the framework. Section 3.2 of this manual presents the PSUT scheme specifically adjusted to energy flows.

### 2.1.3 Accounting and balancing items

32. The general PSUT framework as presented in Figure 1 contains a range of important accounting and balancing identities. One important feature of PSUT is the supply-use-identity (see SEEA-CF §2.44), i.e. the row sums in both tables have to be balanced: the total supply of a given flow type needs equalling the total use of the very same flow type.

33. For products the supply-use-identity implies that within the economy the amount of products supplied must be used within the economy or exported. Thus (using references to the cell-letters in Figure 1)

- Total Supply of Products (TSP) = Domestic production (C) + Imports (D)

is identical to

- Total Use of Products (TUP) = Intermediate consumption (E) + Household Final Consumption (F) + Net inventory changes of products and additions to produced assets (gross capital formation) (G) + Exports (H)

34. This supply-use identity for products also applies in the monetary supply and use table. In the PSUT the supply-use identity is extended to the other types of physical flows, namely natural inputs and residuals. Total supply of natural inputs must equal the total use of natural inputs (TSNI = TUNI):

- Total Supply of Natural Inputs (TSNI) = Flows from environment (A)

is identical to

- Total Use of Natural Inputs (TUNI) = Extraction of natural inputs (B)

35. Thirdly, the supply-use-identity is valid for residuals. The total supply of residuals must equal the total use of residuals (TSR = TUR):

- Total Supply of Residuals (TSR) = Residuals generated by industry (I) + Residuals generated by households (J) + Residuals from inventories and produced assets (K) + Residuals from rest of the world (L) + Residuals recovered from environment (M)

is identical to

- Total Use of Residuals (TUR) = Residuals received by industries (N) + Accumulation of residuals within economy (O) + Residuals to the rest of the world (P) + Residual flows to the environment

36. When applied to all three types of physical flows these equalities also relate to the fundamental physical identities underpinning the PSUT concerning the conservation of mass and the conservation of energy. These physical identities imply the existence of material and energy balances for all individual physical flows within the system.

37. Another balancing principle is the input-output-identity. Over an accounting period, flows of materials into an economy must equal the flows of materials out of an economy plus any net additions to stock in the economy. Thus the input-output-identity describing the physical flows between an economy and the environment is as follows (using references to the cell-letters in Figure 1):

- Physical flows into the economy = Natural inputs (A) + Imports of products (D) + Residuals from the rest of the world (L) + Residuals recovered from the environment (M)

is identical to

- Physical flows out of the economy = Residuals flows to the environment (Q) + Exports of products (H) + Residuals to the rest of the world (P)

plus

- Net additions to stock in the economy = Net inventory changes and gross capital formation (G) + Accumulation of residuals within economy (O) – Residuals from inventories and produced assets (K)

38. This input-output-identity is applied both at the level of the entire economy (as described) and also for the industry column. For industries the input-output identity is:

- Physical input into industries = Extraction of natural inputs (B) + Intermediate consumption of products (E) + Residuals received (e.g. waste) (N)

is identical to

- Physical output out of industries = Domestic production of products (C) + Residuals generated by industry (I)

39. Particular note is made regarding the flows of residuals. For these flows a number of stages need to be recognised. In the first stage residuals are generated or enter the economy as reflected in cells (I), (J), (K), (L), and (M) in Figure 1. These residuals are received by other units in the economy (N and O), sent to other countries (P), or returned to the environment (Q). The residuals received by other units (N) may be treated or processed and then either sold as recycled or reused products (for example reused water) or returned to the environment. If sold as recycled or reused products the production is recorded in (C) and the purchase in (E), (F), or (H).

## 2.2 SEEA principles of physical flow accounting

40. The following sections present various important principles and accounting rules/conventions as derived from SEEA-CF (and often implicitly from SNA) which are also valid

for PEFA.

### 2.2.1 Definition of the economy – residence principle

41. In short, PEFA record all energy flows associated with activities of resident units – regardless where these activities actually take place geographically.

42. In National Accounts the economy of a country is the outcome of the activity of a very large number of units carrying out economic activities such comprising a variety of transactions of various kinds for purposes of production, consumption, accumulation, redistribution, finance etc. (ESA 2010 paragraph 2.01).

43. The units constitute the economy of a country. The units have to be resident; i.e. their centre of economic interest has to be on the economic territory of that country. These units are termed resident units (ESA 2010, paragraph 2.04). Thus, the national economy is defined as the total of all resident units' activities. The national accounts system records all flows and stocks related to the resident units of a national economy.

44. Resident units engage in transactions with non-resident units (i.e. units which are resident in other economies). These transactions are referred to as transactions between national economy and the economy of the rest of the world.

45. It is important to note that PEFA – as in general national and environmental accounts – follow the resident principle. Energy statistics and the underpinning basic energy data follow rather a territory principle. Where energy statistics are used to build up PEFA, adjustments are needed to account for differences between territory and resident principle<sup>6</sup>. These resident-adjustments are presented in the so-called bridge table (PEFA Table E).

46. Energy flows accounted for in PEFA have to be associated with resident unit's activities and not with activities of units acting on the territory. This implies that energy flows associated with resident unit's activities abroad have to be taken into account (e.g. resident unit's fuel bunkering). Conversely, energy flows associated with non-resident's activities on the territory (e.g. foreign trucks, bunkering of foreign vessels) have to be excluded.

47. Also, since PEFA encompass only energy flows associated to economic units' activities, energy flows within the environment are not recorded.

48. Natural inputs denote flows from the environment to the economy, i.e. to resident units. The natural resources from which the natural inputs derive are considered to be owned by residents of the country in which the resources are located. By convention, natural resources that are legally owned by non-residents are considered to be owned by a notional resident unit and the non-resident legal owner is shown as the financial owner of the notional resident unit. Consequently, in general, the extraction of natural resource inputs must take place within a country's economic territory by economic units that are resident in the country.

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<sup>6</sup> Most notably, the use of energy for transport is recorded differently in energy statistics/balances. The production of energy products is recorded widely in the same way in both systems

### 2.2.2 Economic units

49. The relevant economic units are those that interact with each other and that are able to make decisions about the production, consumption, and accumulation of goods and services. They are classified in different ways depending on the type of analysis being undertaken (ESA 2010 paragraphs 2.01 – 2.03).

50. *Industries* are the most homogenous grouping of economic unit's activities. Ideally, an industry is composed of elementary units that undertake the same activity and only that activity. Industries cover, in broad categories, agriculture, mining, manufacturing, construction, and services.

51. The elementary units – which are further grouped to industries – are termed *establishments* (2008 SNA paragraphs 5.11ff.) or *local kind-of-activity units* (ESA 2001 paragraphs 2.144ff.). They are situated in a single location and in which ideally only a single production activity is carried out. These elementary units (establishments, local KAU) are hence most homogenous with regards to their activity. I.e. industries should consist of a group of establishments (SNA) or local KAUs (ESA) engaged in the same, or similar, kind-of-activity.

52. In Europe, the classification used for grouping elementary units to industries is the Statistical Classification of Economic Activities in the European Community (NACE).

### 2.2.3 Production boundary – principal, secondary, and ancillary production activities

53. The national account's definition of the production boundary is important to delineate products from natural inputs and residuals. The SNA defines production as processes or activities carried out under the control and responsibility of institutional units that use inputs of labour, capital, goods and services to produce outputs of goods and services (2008 SNA §§5.5ff., see also ESA 2010 paragraphs 3.10ff.) whereby three types are distinguished: (i) principal activity, (ii) secondary activity, and (iii) ancillary activities.

54. The *principal activity* of a producer unit is the activity whose value added exceeds that of any other activity carried out within the same unit. (The producer unit may be an enterprise or an establishment as defined below.)

55. *Secondary activity* is an activity carried out within a single producer unit in addition to the principal activity and whose output, like that of the principal activity, must be suitable for delivery outside the producer unit. The value added of a secondary activity must be less than that of the principal activity, by definition of the latter. The output of the secondary activity is a secondary product.

56. An *ancillary activity* is incidental to the main activity of a producing unit. It facilitates the efficient running of the producing unit but does not normally result in goods and services that can be marketed. For producing units that are relatively small and have only a single location (i.e. enterprises), ancillary activities are not separately identified. For larger producing units it may be useful to treat ancillary activities in the same way as a secondary or even a principal product.

57. As discussed in the previous section 2.2.2 the producing units as recorded in PEFA are industries which should be as homogenous as possible as regards their production activity. This

implies that production output from secondary activities should be rather small.

58. In addition to the three aforementioned types the production process and its output is decomposed along another criterion: Market production, non-market production, and production for own final use (SNA2008 § 1.42 (§ 2.40; § 5.47), see also ESA 2010 paragraphs 3.24ff.).

#### 2.2.4 *Production of goods for own account and intra-establishment production*

59. The SEEA-CF applies one important variation in the recording of physical product flows compared to the SNA recording or monetary product flows (SEEA-CF §1.41-1.44). In SEEA physical flow accounts all intra-enterprise flows are recorded, i.e. the production and use of goods and services on own-account within enterprises. In the SNA the recording of these is limited to the production of goods for own final use (i.e. excluding intermediate use) and intra-enterprise flows related to ancillary activities. Thus for example the recording of the production of energy (e.g. through the incineration of waste) for own intermediate consumption is recommended.

60. The SEEA-CF also encourages the recording of own-account production and final consumption by households. For such own-account production, the production boundary used is the same as that described in SNA.

#### 2.2.5 *Goods sent for processing and repair*

61. There is a second case where the recording of physical product flows deviates from the SNA recording of monetary flows (SEEA-CF §1.45). Goods sent to other countries for processing and repair, or in cases of merchanting, the SEEA-CF recommends recording the actual physical flows of goods in those cases where the ownership of those goods does not change but remains with a resident of the originating country. This variation is e.g. applied when recording physical flows associated with processing of raw materials (e.g. oil refining) where the physical flow may be largely invariant to the nature of the contractual relationships which are the focus of the recording of monetary flows in the SNA and the Balance of Payments.

#### 2.2.6 *Units of measurement*

62. Physical flows are recorded in physical measurement units. The energy flows recorded in PEFA are measured by their energy content (calorific value in joule) and not their mass or volume. This is to ensure the possibility of aggregation and reconciliation across all accounting entries.

63. For energy content the international physical measurement unit is Joule. The conventions of energy statistics (see e.g. [Energy Statistics Manual](#)) are applied with regards to the use of gross calorific value (GCV) versus net calorific value (NCV).



### 2.2.7 *International transport*

64. International transport refers to the movement of people, animals, and goods from one location to another thereby crossing country borders. The appropriate recording of international transport activity is important particularly for information concerning the use of fuels and the associated release of emissions; the appropriate and consistent attribution of physical flows relating to cross-border transports to individual countries is an important component.

65. The treatment is centred on the residence of the operator of the transport equipment. Usually this will be the location of the headquarters of the transport operator. Therefore, the output from producing these transport services, together with the associated intermediate consumption – including costs for fuels wherever purchased, are attributed to the country of residence of the operator.

66. Once the residence of the operator of international transport equipment has been determined, the appropriate accounting is illustrated in the following examples:

- A ship, whose operator is a resident unit in Country A, transports goods from Country B to Country C, and refuels in Country C before returning home. In this case purchases of fuels are attributed to Country A (being exports of fuel from Country C and imports of fuel of Country A). Payments for transport services by Country C are exports of services by Country A
- A passenger aircraft, whose operator is a resident unit in Country X, transports people from Country X to Country Y and returns to Country X. The passengers are from various countries, X, Y and Z. In this case any purchases of fuels are attributed to Country X and are recorded as imports if purchased in Country Y. Payments by the passengers are recorded as exports of services by Country X if the passengers are resident in Country Y or Z.

67. Special note is required in relation to the bunkering of fuel, primarily for vessels and aircraft. Special arrangements may be entered into such that a unit resident in a country stores fuel in another country while still retaining ownership of the fuel itself. Following the principles of the National Accounts, the location of the fuel is not the primary consideration. Rather focus must be on the ownership of the fuel. Thus if a unit resident in Country A established a storage in Country B and transports fuel to the storage located in Country B in order to refuel a ship that this unit operates then the fuel is considered to have remained in the ownership of country A and no export of fuel to Country B is recorded. Thus the fuel stored in Country B is not necessarily all attributable to Country B. This treatment is likely to differ from the recording in international trade statistics and adjustments may be needed to source data to align to this treatment.

### 2.2.8 *Tourist activity*

68. The recording of tourist activity is consistent with the recording of international transport activity in that the concept of residence is central. Tourist activities include travelling outside their country of residence including the stay of short term students (i.e. less than 12 months), people travelling for medical reasons and those travelling for business or pleasure. The consumption activity of a tourist travelling abroad is attributed to the tourist's country of residence and not to the



location the tourist visited. Thus purchases by the tourist in other countries are recorded as an export of the country visited and as an import of the country of residence of the tourist.

69. Fuel use by public transport used by tourists in a foreign country is attributed to the local transport company.

70. Fuel used for cars are attributed to the country of residence of the operator (in this case the driver of the car); independent of the car is owned by the driver or is being leased from a rental car company. So, if a tourist rents a car in a foreign country the refilling has to be attributed to the country the tourist comes from. Fuel use by taxis, local minibuses and the like are also attributed to the driver or company which is the operator of the means of transport.

## 3 PEFA-questionnaire

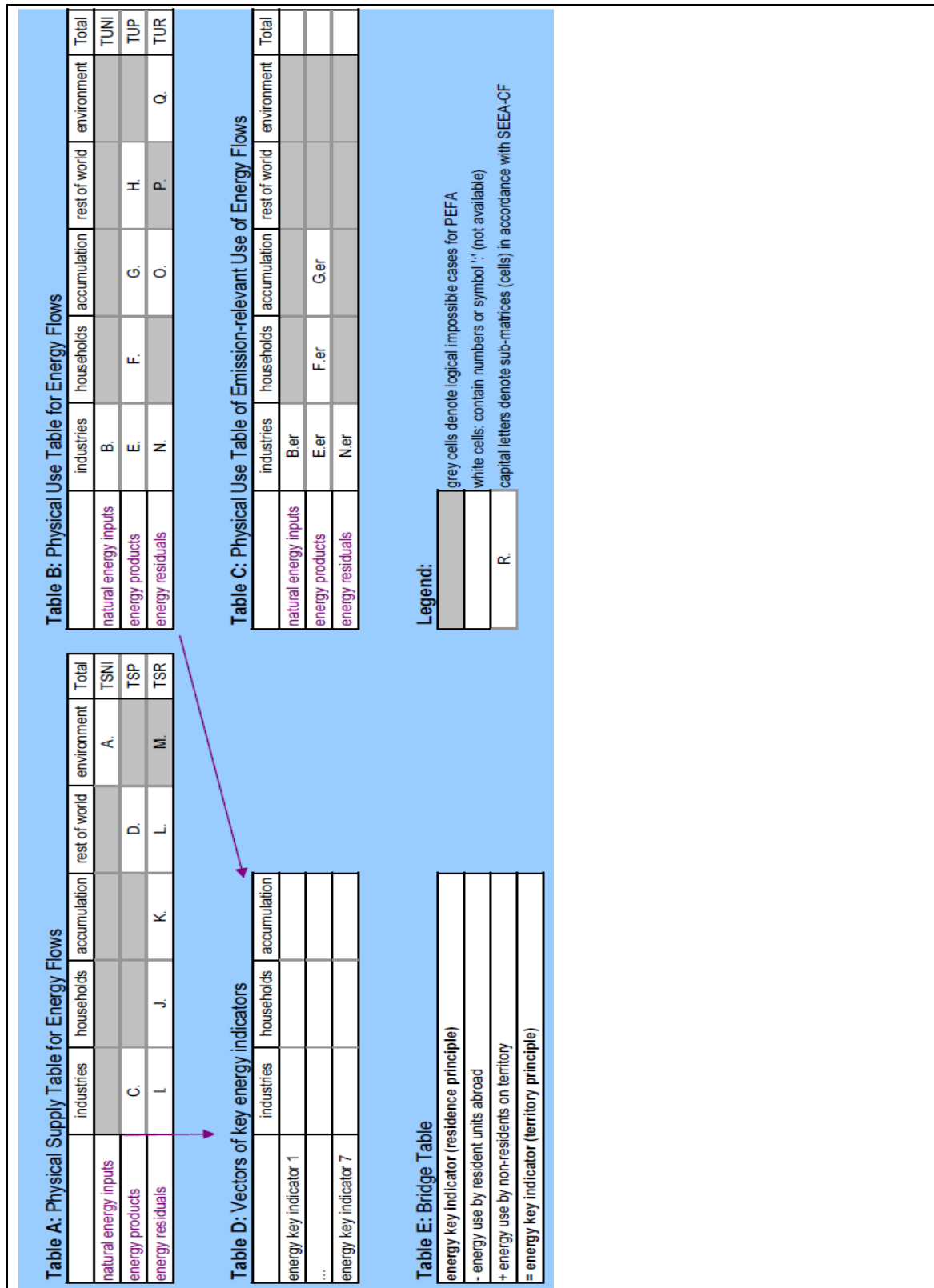
### 3.1 Overview – set of five PEFA Tables

71. Eurostat's electronic questionnaire for Physical Energy Flow Accounts (PEFA-questionnaire) is a MS EXCEL workbook and designed in a way that it accommodates data only for one reporting year. This implies that a series of EXCEL workbook files is required to transmit PEFA for time series.

72. The PEFA questionnaire EXCEL workbook has five reporting tables where actually data are filled in. Figure 2 provides an overview. This chapter explains briefly the five tables.

- Table A – Physical supply table for energy flows
- Table B – Physical use table for energy flows
- Table C – Table of emission-relevant use of energy flows
- Table D – Derived indicators
- Table E – Bridge table

Figure 2: Scheme providing an overview on the set of tables in the PEFA electronic questionnaire



## 3.2 Tables A, B and C – physical supply and use tables of energy flows

### *Explanation of Tables A and B (see SEEA-CF section 3.2)*

73. Tables A and B constitute full-fledged physical supply and use tables (PSUT) for energy flows as introduced in SEEA-CF chapter 3.2 (see also Figure 1 in this manual). Table C is also a physical use table (see further below this section). The concept of physical supply and use tables is briefly explained in section 2.1 above.

74. Tables A, B and C in principle have the same column and row structures/formats. Row-wise they distinguish three broad types of flows, namely natural energy inputs, energy products, and energy residuals. Column-wise they show the origin and the destination respectively of the various flows. The classifications used for the three physical flow types are described and further explained in section 3.3. Section 3.4 describes the columns and their classification.

75. As shown in Figure 2 the two basic physical supply and use tables (Tables A and B) can be decomposed into various sub-matrices in order to explain better their content. Capital letters in the scheme provided in Figure 2 denote these sub-matrices (or cells). These capital letters are the same as used in SEEA-CF (chapter 3, Table 3.1).

76. Table A is a physical supply table. It records the supply of natural energy inputs, energy products, and energy residuals (row-wise) by origin, i.e. ‘supplier’ (column-wise):

- Cell A in Table A shows natural energy inputs as provided (supplied) by the environment.
- Further Table A shows the supply of energy products. There are two principal origins for energy products: Firstly, domestic industries produce energy products as output (cell C). Secondly, energy products are provided by the rest of the world economy, i.e. imported energy products (cell D).
- Finally Table A presents the supply of energy residuals. Energy residuals originate from various sources: Industries (cell I) and households (cell J) produce energy residuals mainly through transformation and end use of energy, i.e. energy losses in form of dissipative heat released to the environment. Accumulation – i.e. the stock of produced assets and product inventories – supplies energy residuals in form of waste for energy recovery or losses from storage (cell K). Theoretically waste can also be imported, i.e. provided from the rest of the world economy (cell L).

77. Table B is a physical use table and records the use of natural energy inputs, energy products, and energy residuals (row-wise) by destination, i.e. ‘user’ (column-wise).

- Cell B in Table B shows how natural energy inputs are used, e.g. harvested, extracted, etc. by industries (cell B) in order to produce energy products. If households should extract natural energy inputs for own use and/or for sale, these flows have to be recorded under the respective industry column typically extracting this type of natural

energy input [the case of 'household's production for own use' needs to be checked and confirmed again].

- Further Table B presents how energy products are used by industries (see Figure 2: cell E in Table B) and households (cell F). Energy products may go on and off product inventories (e.g. petroleum products produced in one period and sold in the following period). These inventory changes in energy products are recorded net in the accumulation column of the physical use table (cell G of Table B) whereby negative signs imply a net supply from inventories. The rest of the world column records the export of energy products (cell H).
- Table B records the use of energy residuals. Some residuals may be used by industries (cell N in Table B) – in particular the waste management industry may take up energy residuals in the form of waste (supplied from stocks of produced assets see cell K. in Table A) in order to recover their energy content through e.g. incineration. Some amounts of energy incorporated in products for non-energy purposes (e.g. plastics, lubricants) are recorded as use under the accumulation column (cell O in Table B). They go quasi on stock and their energy content may be recovered in later periods.

### *Explanation of Table C*

78. Table C is a 'sub-layer' of Table B. It is a physical use table too. Table C records the emission-relevant use of natural energy inputs and energy products (row-wise) by the using and hence emitting unit (column-wise). Table C in general has the same layout/format as Tables A and B (see Figure 2).

79. Emission-relevant use of natural energy inputs and energy products is defined as the use of energy carriers in/during economic production and consumption activities – mainly combustion processes – resulting in physical flows of the following list of gaseous or particulate materials to the atmosphere:

- carbon dioxide CO<sub>2</sub>
- nitrous oxide N<sub>2</sub>O
- methane CH<sub>4</sub>
- hydrofluorocarbons HFC
- perfluorocarbons PFC
- sulphur hexafluoride SF<sub>6</sub>
- nitrogen oxides NO<sub>x</sub>
- sulphur dioxide SO<sub>2</sub>
- ammonia NH<sub>3</sub>
- non-methane volatile organic compounds NMVOC

- carbon monoxide CO
- particulate matter PM10

80. The majority of emission-relevant energy use relates to the combustion (i.e. oxidation) of energy carriers (i.e. hydrocarbons) resulting in emissions of CO<sub>2</sub>, N<sub>2</sub>O, NO<sub>x</sub>, SO<sub>x</sub>, NMVOC, and CO. Emission relevant energy use may also relate to venting, e.g. of methane in the mining industry.

81. Emission relevant use of natural energy inputs and energy products is also related to certain industrial production processes for instance in the refinery and chemical industry such as, e.g. (see also Eurostat 2009, Manual for Air Emissions Accounts):

- Refinery industry: feed stock handling and storage; separation processes; petroleum conversion processes; petroleum treating processes; product storage and handling; auxiliary facilities.
- Iron and steel industry: coke ovens; blast furnace charging; pig iron tapping, oxygen furnace; electric furnace; rolling; sinter and pelletizing, etc.
- Inorganic chemical industries: production of acid, ammonia, chlorine, fertilizers etc.
- Organic chemical industries: production of ethylene, propylene, PVCs, formaldehyde, ethylbenzene etc.
- Production of halocarbons and sulphur hexafluoride using feedstocks.

82. Emission-relevant use of natural energy inputs and energy products occurs in industries (cell E.er in Table C in Figure 2) and in private households (cell F.er). Inventories of energy products (cell G.er) may also constitute a source of emissions (evaporation, leaching). There are a few cases where the use of natural energy inputs may be emission-relevant (cell B.er), namely the loss of gaseous energy carriers during extraction (B.er), e.g. flaring and venting of natural gas by extracting industries.

83. The use of energy residuals is emission-relevant in the case of waste which may be used by industry for energetic recovery (N.er).

### 3.3 Classification of rows (natural energy inputs, energy products, energy residuals)

84. PEFA Tables A, B, and C present row-wise the flows of natural energy inputs, energy products, and energy residuals. The three generic types of physical flows are explained in section 2.1.

85. For the purpose of the PEFA questionnaire Eurostat developed in close consultation with national statistical institutes (NSIs) a classification. The classification of natural energy inputs, energy products and energy residuals is presented in Table 1. It comprises in total 31 items: 7 natural energy input classes, 20 energy product classes, and 4 energy residual classes.

Table 1: PEFA questionnaire – classification of natural energy inputs, energy products,

and energy residuals (PEFA rows)

level	code	label
1	<b>N00</b>	<b>NATURAL ENERGY INPUTS</b>
2	N01	Fossil non-renewable natural energy inputs
2	N02	Nuclear non-renewable natural energy inputs
2	N03	Hydro based renewable natural energy inputs
2	N04	Wind based renewable natural energy inputs
2	N05	Solar based renewable natural energy inputs
2	N06	Biomass based renewable natural energy inputs
2	N07	Other renewable natural energy inputs
1	<b>P00</b>	<b>ENERGY PRODUCTS</b>
2	P08	Hard coal
2	P09	Lignite & Peat
2	P10	Derived gases (= manufactured gases excl. biogas)
2	P11	Secondary coal products (coke, coal tar, patent fuel, BKB and peat products)
2	P12	Crude oil, NGL, and other hydrocarbons incl. Oil shale/sands(excl. bio)
2	P13	Natural gas
2	P14	Motor spirit (without bio)
2	P15	Kerosenes & jet fuels (without bio)
2	P16	Naphtha
2	P17	Transport diesel (without bio)
2	P18	Heating and other gasoil (without bio)
2	P19	Residual Fuel Oil
2	P20	Refinery gas, ethane & LPG
2	P21	Other petroleum products incl. additives/oxygenates and refinery feedstocks
2	P22	Nuclear fuel
2	P23	Wood, wood waste & other solid biomass, charcoal
2	P24	Liquid biofuels
2	P25	Biogas
2	P26	Electrical energy
2	P27	Heat
1	<b>R00</b>	<b>ENERGY RESIDUALS</b>
2	R28	Renewable waste

2	R29	Non-renewable waste
2	R30	Energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use)
2	R31	Energy incorporated in products for non-energy use

86. Annex 1 presents exact definitions of each PEFA row class. The classes are based on international definitions of energy commodities, namely:

- International Recommendations for Energy Statistics (IRES)
- Standard International Energy Product Classification (SIEC)
- IEA/Eurostat Annual Energy Statistics Questionnaires

87. Annex 1 presents the exact correspondences between the PEFA row classes shown in Table 1 and the various international classifications.

### 3.4 Classification of columns (industries, households, etc.)

88. The columns of the physical supply and use tables (i.e. PEFA Tables A, B, and C) show the various activities underlying the respective energy flows. They constitute either the origins (supply Table A) or the destinations (use Table B and C) of the respective energy flows (see also section 2.1). Annex 2 presents the full hierarchical classification of columns employed in the PEFA questionnaire.

89. In accordance with SEEA-CF the columns are broken down by five generic types of activities:

- Production activities (i.e. industries),
- Consumption activities (i.e. households),
- Accumulation (changes in stocks of produced assets and product inventories),
- Rest of the world (imports and exports), and
- Environment (supply of natural energy inputs and absorption of energy residuals).

90. The first generic column type relates to production activities by industries. Industries are homogenous groupings of resident units producing the same output (see also section 2.2). A production activity is defined as the process of transforming certain inputs (products, labour, capital) into outputs (products, i.e. goods and services).

91. NACE is the European classification for production activities. In PEFA Tables A, B, C, and D the industries are broken down using the NACE classification. The basic breakdown level chosen in the PEFA questionnaire is A\*64. In addition some groupings on one-letter-level (A\*21) are inserted so that the column classification is a nested hierarchical one. This is consistent with



monetary supply and use tables as well as with air emissions accounts.

92. The second generic column type relates to the consumption activities of households. Households are resident units consuming products and generating residuals from this consumption. Note that in monetary national accounts households' consumption activity is the final use of products, i.e. the recording ends at this stage. Physical accounts also record the corresponding output from consumption activities in form of residual flows.

93. The household column in PEFA Tables A, B, C, and D relates solely to the consumption activity of households (see SEEA-CF §2.41, §§3.27ff.) broken down by three purposes:

- heating / cooling;
- transport
- other.

Should households engage in the extraction of natural energy inputs and transform those to energy products (e.g. production of electricity using photovoltaic panels) then this is to be considered as a production activity. The production is recorded in the first generic column (e.g. under the column hosting the electricity supply industry). In second step the produced electricity is consumed by households; further on this is then recorded in the household column. By SNA convention, households do not produce energy products.

94. Government consumption activities are not considered in the classification of columns. In monetary accounts government final consumption records the acquisition and consumption of their own output because the final user cannot be specified as it is the entire society (see SEEA-CF §§3.27ff). This convention of booking has no equivalent in physical flow accounts. The energy flows related to production activities of government are entirely recorded in the first generic column.

95. The fourth generic column is entitled accumulation. Broadly it relates to the stock of energy in the economy. E.g. energy incorporated in products for non-energy purposes (e.g. plastics) are additions to this stock. Waste (i.e. end-of-life products) used for the recovery of energy constitute outflows from this stock. The PEFA questionnaire does not further detail the accumulation column, i.e. it remains one single column.

96. Note that the PEFA questionnaire Tables set a column entitled 'statistical discrepancies' aside the accumulation column. The 'statistical discrepancies' column hosts possible discrepancies in the primary data. E.g. the statistic on the supply of a given energy product may originate from production statistics whereas the statistic on the use of the same product may be another source (e.g. consumer surveys). The various sources may lead to a mismatch of the total supply and the total use of a product which is then booked in the column 'statistical differences'.

97. The fifth generic column is the environment. It hosts the supply of natural energy inputs and the absorption of energy residuals. It is a single column in the PEFA questionnaire, i.e. not further broken down.

98. Annex 2 presents the full and detailed classification of PEFA columns.

### 3.5 Table D – Key PEFA indicators

99. Table D presents vectors of certain key indicators derivable from Tables A and B.

100. This table does not have the matrix format as the previous tables. This table shows row-wise vectors of key energy indicators. Column-wise it shows a breakdown by the three generic activity types production (i.e. industries), household consumption, and accumulation i.e. in principle a similar column-structure as presented in Tables A, B and C.

101. Seven key indicators have been identified from a pilot study undertaken by Statistics Netherlands (Schenau 2012):

- Key indicator 1: 'Total extraction of natural energy inputs by economic activities' (=column totals of sub-matrix B from Table B)
- Key indicator 2: 'Domestic production of energy products' (=column totals of sub-matrix C from Table A)
- Key indicator 3: 'Total intermediate consumption of energy products' (=column totals of sub-matrix E from Table B)
- Key indicator 4: 'Total household consumption of energy products' (=total of sub-matrix F from Table B)
- Key indicator 5: 'Total use of waste for energetic purposes' (=column totals of sub-matrix N (waste) from Table B)
- Key indicator 6: 'Net domestic energy use' (= column sums of sub-matrices I and J from Table A, and column sum of cell O in Table B) Note that this indicator vector (slightly deviating from the proposal in the Dutch study) does include energy incorporated in products (sub-matrix O), i.e. non-energy use under the column 'accumulation'!
- Key indicator 7: 'Total energy input/output' (=column totals of sub-matrices C, I and J from Table A which is identical with column totals of sub-matrices B, E, F, and N of Table B)

102. The above key indicators are widely self-explaining as they derive from Tables A and B which are explained in section 3.2. They are defined by making reference to the cells as illustrated in Figure 2.

103. Key indicator 6 'Net domestic energy use' requires some more explanation. It comprises two components: the supply of energy residuals by production (i.e. industries) and household consumption activities, and secondly the accumulation of energy incorporated in products for non-energy purposes.

104. The release of energy residuals (losses) by industries and households (cells I and J in Table A) are equivalent to the amount of energy which is eventually used net for energetic purposes by economic activities of resident units in the reporting period. Key indicator 6 draws on the supply of residuals (Table A cells I and J) instead of the use of natural energy inputs (Table B cell B), energy products (Table B cells E and F), and energy residuals (Table B cell N) because the latter include double counting.

105. The second component of key indicator 6 is the accumulation of energy incorporated in products for non-energy use (cell O in Table B). These relate to e.g. petroleum products which are used to produce plastics.

106. Key indicator 6 could be regarded as the most relevant PEFA indicator which is comparable to the most prominent energy statistics indicator 'Gross inland energy consumption' (GIEC). Note that the latter includes energy use for non-energy purposes. This is the reason why key indicator 6 also takes into account the second component described above.

107. The key indicator 6 'net domestic energy use' is based on the residence principle. The indicator 'Gross inland energy consumption' (GIEC) is based on the territory principle. The 'bridge' from the former to the latter, i.e. the resident adjustment items, are presented in the following section 3.6.

108. The electronic PEFA questionnaire populates Table D automatically from Tables A and B.

### 3.6 Table E – PEFA bridge table

109. Table E – the so-called Bridge Table – shows the various elements making up the difference between the domestic energy use derived from energy accounts (resident principle) and the gross inland energy consumption derived from energy balances (territory principle). The difference between both key indicators is mainly due to differences in treatment of international transport.

110. Table E has a rather simple format. Row-wise it presents at the top the energy accounts indicator and at the bottom the energy statistics indicator. In-between rows accommodate the resident adjustment items which 'bridge' from the top to the bottom indicator. The resident adjustment items (bridging items) have changing signs depending whether they are added or deducted. Table E has a single column as it reports the key indicators and resident adjustment items (bridging items) for the entire national economy (no column-wise breakdown by industries etc.).

111. The following broad positions constitute the 'bridge' from the resident principle indicator to the territory based indicator:

- domestic energy use by resident units (row-total key indicator 6 in Table D)
- – activities by national residents abroad – energy use
- + activities by non-residents on the territory – energy use
- ± Other adjustments and statistical discrepancies
- ≡ gross inland energy consumption (territory based)

112. The resident adjustment items are either deducted or added so as to balance the 'bridge' between the two key indicators.

#### *Energy use related to activities by national resident units abroad*

113. The first resident adjustment item *activities by national residents abroad* relates to activities of resident units outside their territory of residence. In the case of PEFA it refers to purchases of energy products abroad by resident economic units. These are mainly resident units operating and fuelling vehicles outside the territory, e.g. airplanes, trucks, and ships of international transport service industries which are resident units of the country reporting PEFA. Although quantitatively

less important, tourists may also purchase energy products abroad (i.e. a resident households' consumption activity abroad).

114. The item *activities by national residents abroad* needs to be subtracted in above 'bridging equation'. It is part of the residence principle based indicator 'domestic energy use by resident units' but excluded in the territory-based indicator 'gross inland energy consumption'.

115. The classification used in the PEFA questionnaire (PEFA Table E) distinguishes the following sub-items of *activities by national residents abroad*:

- TOT\_NRA Total activities by national residents abroad
  - NRA\_FISH National fishing vessels operating abroad
  - NRA\_I60 Land transport operated by national residents abroad
  - NRA\_I61 Water transport operated by national residents abroad
  - NRA\_I62 Air transport operated by national residents abroad

#### *Energy use by non-resident units on the territory*

116. The second resident adjustment item *activities by non-residents on the territory* relates to the purchase of energy products on the territory by non-resident economic units. Activities of non-residents on the territory involving purchases of energy products are mainly related to transport services operated by non-residents (e.g. foreign aircraft bunkering on domestic airports, foreign trucks on transit, foreign ships bunkering in domestic ports etc.). Consumption activities of non-resident households on the territory (e.g. foreign tourists) are quantitatively less important and mainly related to operating motor-vehicles.

117. The item *activities by non-residents on the territory* needs to be added in above 'bridging equation'. It is excluded from the residence principle based indicator 'domestic energy use by resident units' whilst the territory-based indicator 'gross inland energy consumption' includes sales to non-residents on the territory.

118. The classification used in the PEFA questionnaire (PEFA Table E) distinguishes the following sub-items of *activities by non-residents in the territory*:

- TOT\_NRES Total activities by non-residents on the territory
  - NRES\_I60 Land transport operated by non-residents on the territory
  - NRES\_I61 Water transport operated by non-residents on the territory (note that marine bunkers as recorded in IEA/Eurostat Annual Energy Questionnaires are excluded)<sup>7</sup>
  - NRES\_I62 Air transport operated by non-residents on the territory

119. Note that the amount of fuel reported under the item 'marine bunkers' in IEA/Eurostat Annual Energy Questionnaires is excluded from the territory based key indicator. Hence, they must not be added in the 'bridge'! I.e. they do not count as energy purchases by non-residents on the

<sup>7</sup> Including fuels delivered to fishing vessels operated by non-residents

territory in the context of the bridge table.

*Other adjustments and statistical discrepancies*

120. The bridging item other adjustments and statistical discrepancies in Table E hosts amounts of energy which are not assignable to the bridging items explained above.

## 4 General compilation guidelines

121. Like in the case of classical monetary national accounts the compilation of PEFA is based on a wide range of information and potential data sources. As common to all accounts PEFA is not depending on surveys but exploiting existing data sources.

### 4.1 Data sources

#### *National energy statistics*

122. It is assumed that national energy statistics constitute the primary data source for compilers of PEFA. Depending on the scope and level of detail provided in national energy data bases the compiler will need additional auxiliary data sources such as e.g. national accounts, balance of payments, employment statistics, transport statistics and vehicle registers, foreign trade statistics etc.

123. On national level the basic data underpinning national energy statistics may be organised in various ways. Internationally the collection of energy statistics has been standardised though. In Europe the IEA/Eurostat Annual Energy Statistics Questionnaires are used. This manual can only make reference to the data format of the IEA/Eurostat Annual Energy Statistics Questionnaires because the format and structures of national energy statistics are unknown.

124. The data contained in the IEA/Eurostat Annual Energy Statistics Questionnaires cover a majority of what is needed to compile PEFA. By default the IEA/Eurostat Annual Energy Statistics Questionnaires cover energy products – i.e. products in an SNA sense. Data on natural energy inputs and energy residuals is not included for conceptual reasons. However, the latter can be easily approximated from the energy product data. E.g. the supply of crude oil as a product can be used to approximate the corresponding natural input flow assuming that it is exactly the same amount of energy. Similarly the amount of energy residuals can be derived from the end use of an energy product, assuming that the amount of energy end used is equal to the amount of dissipative heat released through the product consumption.

#### *Data related to resident adjustments*

125. However some important information elements are missing in the IEA/Eurostat Annual Energy Statistics Questionnaires, most notably the information to make adjustments for the residence principle. Note that the IEA/Eurostat Annual Energy Statistics Questionnaires cover energy products sold on the territory to resident units and non-resident units. And they exclude purchases abroad by resident units.

126. The range of potential data sources that can be used for deriving the residence-adjustment-items is wide and varying across countries. **Unfortunately there is no common approach for the residence-adjustment based on internationally harmonised statistics.**

127. 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.

128. 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.

129. For road transport many countries employ national vehicle-fleet-models which could be exploited to distinguish between fuel sold to residents and fuel sold to non-residents. For water and air transport one may exploit annual reports from major resident companies in order to approximate how much fuel was purchased abroad.

#### *Data sources related to industry detailing*

130. The detail of industries in PEFA (classification of columns in PEFA Tables A, B, C and D) is NACE aggregation level A\*64 (see section 3.4). In many national energy statistics this level of detail may not be available. The IEA/Eurostat Annual Energy Statistics Questionnaires provides clearly defined correspondences to the NACE classification (see Table ). E.g. under the industry sector the IEA/Eurostat Annual Energy Statistics Questionnaire distinguishes 13 manufacturing industries. In the so-called energy sector it distinguishes five NACE industries on division level (mining, refineries, electricity, gas and steam supply). For service industries the IEA/Eurostat Annual Energy Statistics Questionnaire only has one class.

131. There are various sources which can be used as auxiliary data to estimate/derive distribution keys. The general idea is to derive shares allowing to distribute a given energy use figure over a number of NACE divisions. The most challenging is probably finding good distribution keys for the service industries. The NACE aggregation level A\*64 distinguishes more than 30 service industries.

132. **Monetary supply and use tables**<sup>8</sup> form one possible auxiliary data source. The monetary use structures may be used to derive a distribution key in particular in the service industry. The annual use table presents the use of three groupings of energy products by 64 NACE industries in purchaser prices (distinguished by domestic produced versus imported) :

- Products from mining and quarrying, including coal products, natural gas, crude oil and other hydrocarbons (CPA B)
- Coke and refined petroleum products (CPA 19)
- Electricity, gas, steam and air-conditioning (CPA D35)

133. **Structural business statistics (SBS)**<sup>9</sup> cover may constitute another auxiliary data source. SBS includes e.g. purchases of energy products (in monetary value) by a very detailed NACE class level for manufacturing industries and construction.

<sup>8</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95\\_supply\\_use\\_input\\_tables/introduction](http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/introduction)

<sup>9</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/european\\_business/introduction](http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/introduction)

## 4.2 Important conventions in compiling PEFA

### 4.2.1 Adjustments for residence principle

134. PEFA record all energy flows associated with activities of resident units – regardless whether these activities take place on the territory of the economy concerned or abroad (see also section 2.2). In contrast energy statistics record the supply and use of energy commodities on the territory regardless of whether the users are resident units or non-residents. If energy statistics (IEA/Eurostat Annual Energy Statistics Questionnaires) are used the compiler of PEFA needs to adjust for the differences between territory principle and residence-principle.

135. Commonly the energy statistics (IEA/Eurostat Annual Questionnaires) from the point of departure for compiling PEFA which record the transport fuel sold on the territory. Hence two resident-adjustments are required: fuels sold to non-residents on the territory need to be deducted and fuels purchased by resident units abroad need to be added.

136. Beside the position '*Marine Bunkers*' the IEA/Eurostat Annual Energy Statistics Questionnaires include energy use by the transport sector which is composed as following:

- International Aviation;
- Domestic Aviation;
- Domestic Navigation;
- Rail;
- Road;
- Pipeline transport.

137. All 7 positions in the IEA/Eurostat Annual Questionnaire include fuel sales to both resident units and non-resident units; the latter needs to be identified and deducted for PEFA. Vice versa, the IEA/Eurostat Annual Questionnaires do not contain any information on fuel purchases by resident units abroad which is needed for PEFA. Unfortunately no internationally harmonised approaches and data sources can be recommended for these kinds of adjustments. Compilers of PEFA need to explore the national information and data sources. They simply have to seek for appropriate information. In the following some general hints are given.

#### *Air transport related resident-adjustments*

138. International and domestic aviation<sup>10</sup> relates to sales of kerosene and jet fuel on domestic airports. Auxiliary information beyond the IEA/Eurostat Annual Questionnaires is required to identify the component purchased by non-residents. Operators of domestic airports could be one possible information source. If not too many – i.e. in smaller countries – they could be approached and asked to provide information on the share or amount of fuel sold to non-resident units.

139. NACE division H51 'Air transport' hosts the activities of resident units engaged in the

<sup>10</sup> Domestic aviation refers to flights between two domestic airports. International aviation refers to flights between domestic airports and airports in the rest of the world.



operation of aircrafts.

140. Balance of payments (BOP) statistics should in theory include the information too. The fuel sales to non-resident airplane operators should be declared export. The BOP statistics reported to Eurostat are not detailed enough. But on national level more detailed BOP statistics may be available. Foreign trade statistics should also contain the fuel sold to non-resident airplane operators (for further details see section 4.5.3).

#### *Water transport related resident-adjustments*

141. Two items in the IEA/Eurostat Annual Questionnaires relate to water transport: '*International Marine Bunkers*' and '*Domestic Navigation*'.

142. *International Marine Bunkers* report the quantities of energy products delivered to ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation<sup>11</sup> (see Domestic navigation) is excluded. It is important to note that *International Marine Bunkers* are treated as kind of export in energy statistics/balances, i.e. it is excluded from derived key energy indicators such as e.g. gross inland energy consumption.

143. *Domestic Navigation* report fuels delivered to vessels of all flags not engaged in international navigation. This item is included in key energy indicators derived from energy statistics/balances.

144. Both items include fuel deliveries to vessels operated by resident units as well as non-residents. The fuel delivered to vessels operated by non-residents needs to be deducted. Fuel purchased abroad for ships operated by resident units needs to be added.

145. Note that the operator of a vessel must not coincide with the flag or the owner of a ship.

146. NACE division H50 'Water transport' hosts the activities of resident units engaged in the operation of ships.

147. Compilers of PEFA have to search for national information and statistical sources which enable the estimation of above resident-adjustments. Potential sources are national accounts, balance of payments, transport and foreign trade statistics (for further details see section 4.5.3).

#### *Road transport fuel use needs to be assigned to all industries*

148. PEFA Tables B and C record the fuel use by NACE industries and households. It is important to note that fuel uses for road transport purposes occur beside in private households in potentially all industries and not only in the road transport service industries.

149. Potentially all industries operate road motor vehicles as an ancillary activity – e.g. ambulance cars in the public health service industry, lorries and bulldozers in the construction industry, tractors in agriculture etc.

150. The compilers of PEFA have to identify these ancillary road transport activities and

<sup>11</sup> The domestic/international split should be determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. Domestic relates to journeys between two domestic ports whereas international refers to journeys between domestic ports and ports in the rest of the world.

distribute accordingly the associated fuel uses over the whole range of NACE industries (for further details see section 4.5.3).

#### 4.2.2 Stock changes are recorded net – statistical differences

151. The IEA/Eurostat Annual Energy Statistics Questionnaires include an item entitled '*Stock Changes*'. Stock changes should reflect the difference between opening stock level and closing stock level for stocks or inventories of fuels held on national territory. In IEA/Eurostat Annual Questionnaires a stock build is shown as a negative number, and a stock draw as a positive number.

152. By SNA convention changes in stocks are recorded net in the use table, i.e. PEFA Table B. This implies that the signs – as reported in IEA/Eurostat Annual Questionnaires – need to be reversed. A stock build is recorded as a positive number and a stock drawn as a negative number.

153. IEA/Eurostat energy statistics/balances include an item entitled 'Statistical Difference'. It derives from possible differences in primary data. It may be that two different information sources are used for the supply and the use respectively of a given energy product. If the two information source do not match the difference is recorded under this item.

154. In PEFA the statistical differences is recorded in the use table, i.e. in PEFA Table B. A specific column has been created to host statistical differences (see Annex 2). The statistical difference recorded in PEFA Table B (use table) has a positive number if the supply of given energy product is greater than the use.

#### 4.2.3 Definition of primary and secondary energy products

155. Energy products – products in the SNA sense (see chapter 2.1.1) – can be distinguished into so-called *primary* and *secondary* energy products. This terminological distinction stems from energy statistics (see [Energy Statistics Manual](#) section 1.3). Primary energy products are extracted or captured directly from natural resources such as crude oil, hard coal, natural gas etc. Secondary energy products are those products which are not primary. Secondary energy products derive from the transformation of primary products. Examples include petroleum products (secondary) from crude oil (primary), coke oven coke (secondary) from coking coal (primary), charcoal (secondary) from fuel wood (primary) etc. Secondary products may further derive from other secondary products.

156. Both, electricity and heat may be produced in a primary or secondary form. *Primary electricity* is obtained from natural sources such as hydro, wind, solar tide and wave power. *Secondary electricity* is produced from the heat of nuclear fission of nuclear fuels, from the geothermal heat and solar thermal heat, and by burning combustible fuels; whereby combustible fuels can be primary (such as coal, natural gas, renewables and waste) and/or secondary (e.g. coke, heating oil, etc.).

157. *Primary heat* is defined as the capture of heat from natural sources (solar thermal panels, geothermal reservoirs) and represents in energy statistics the first 'arrival' of energy commodities into national supplies. *Secondary heat* is derived from the use energy commodities already captured

or produced and recorded as part of the national supplies (heat from combined heat and power plants). Heat is also produced by transforming electricity to heat in electric boilers or heat pumps.

#### 4.2.4 Three compilation steps suggested - overview

158. In the following a general compilation approach is presented. It refers closely to energy statistics as recorded in IEA/Eurostat Annual Questionnaires. The compilation of PEFA Tables A and B – the physical supply and use of energy – may be decomposed into three broad steps:

- Supply of 'primary' energy products and their corresponding natural inputs (residuals)
- Transformation from 'primary' to 'secondary' products and related residual supply (transformation losses)
- End-use of energy products and related residuals

159. In a first step the supply of so-called primary energy products is recorded from the IEA/Eurostat Annual Energy Statistics Questionnaires. These need to be counterbalanced with corresponding natural energy inputs; these can be approximated based on certain assumptions.

160. The second compilation step relates to the transformation from primary into secondary energy products. These transformations are recorded at various places in the IEA/Eurostat Annual Questionnaires. Energy losses during transformation need to be recorded as energy residuals.

161. As a third step it is recommended to compile the end use of energy products. Again, the corresponding energy residual flows need to be derived which, by and large, are the identical energy amounts that have been end used.

### 4.3 Supply of 'primary' energy products and their corresponding natural inputs and possible residuals (losses during extraction)

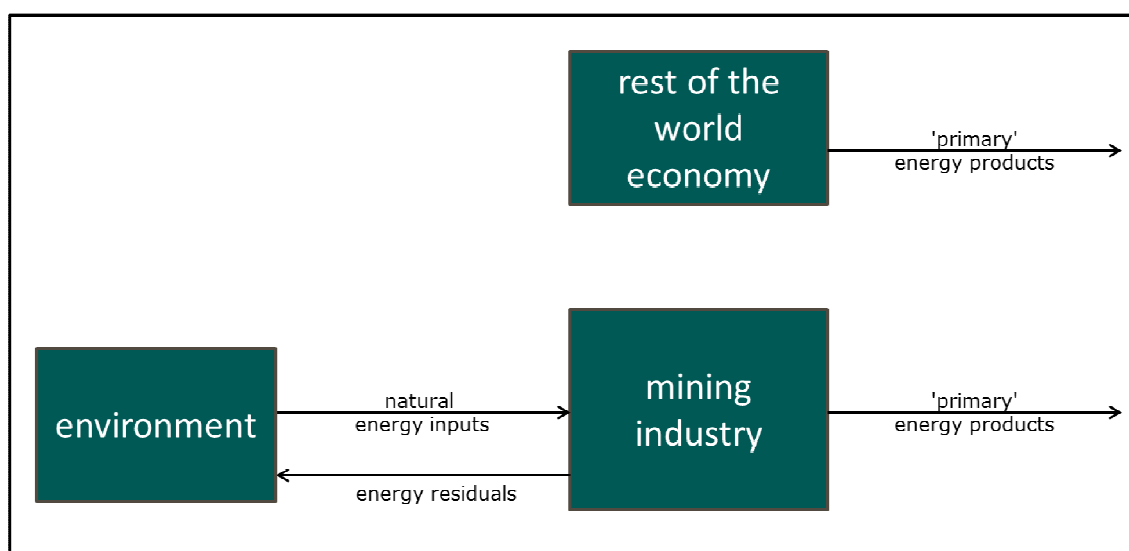
162. Section 4.2.3 introduced the concept of 'primary' and 'secondary' energy products. Primary energy products are extracted or captured directly from natural resources. A look at the 20 energy product groups included in the PEFA row classification of energy flows (see Annex 1) reveals that not all product groups are immediately and clearly identifiable as 'primary'. For the typical fossil based 'primary' products (i.e. various crude coals, natural gas, crude oil) it is obvious. For energy products deriving from renewable sources it is more difficult. E.g. heat and electricity derived from solar, geothermal, hydro, wind do not have their 'own' product group. Moreover they are lumped together in the big product group of electrical energy (P26) and derived heat (P27).

163. In the PEFA framework 'primary' energy products are either produced by domestic production activities (e.g. mining industry) or imported from the rest of the world economy. As far as the domestic production of 'primary' energy products is concerned PEFA requires the recording of corresponding natural energy inputs from the environment which is needed by the extracting industry to enable the 'primary' product output (see Figure 3).

164. In some cases the natural energy input may exceed the 'primary' product output. The differences are losses during extraction and need to be recorded as energy residuals which flow back to the natural environment.

165. This section explains which NACE industries are typical domestic producers – i.e. supplier – of 'primary' energy products and briefly how the product supply can be derived from IEA/Eurostat Annual Energy Statistics Questionnaires. It also shows how to identify, approximate, and record the associated natural energy inputs.

Figure 3: Supply of 'primary' energy products and corresponding natural energy inputs and possible energy residuals



166. A generic distinction is made between 'primary' energy products originating from non-renewable natural resources and those originating from renewable sources.

#### 4.3.1 Non-renewable 'primary' energy products

167. The PEFA row classification (see Annex 1) knows a number of 'primary' energy products which can be considered to originate from non-renewable sources. Beside the classical fossil 'primary' energy products (hard coal (P08), brown coal & peat (P09), crude oil etc. (P12), and natural gas (P13)) also nuclear energy ultimately originates from a non-renewable natural resource (nuclear fuel (P22)).

168. Three of the IEA/Eurostat Annual Questionnaire report the production of 'primary' energy products originating from non-renewable fossil sources:

- Annual Coal Questionnaire – Table 1 (COAL-T1) => P08, P09
- Annual Gas Questionnaire – Table 1 (GAS-T1) => P13
- Annual Oil Questionnaire – Table 1 (OIL-T1) => P12

169. Nuclear energy forms another non-renewable primary source. The recording in PEFA is somewhat special. It is derived employing the IEA/Eurostat Annual Electricity & Heat Questionnaire (ELE-T1).

170. The general compilation approach for PEFA is as following: in a SNA sense the primary products are a production output of the extracting/mining industries. They require corresponding natural inputs which need to be estimated. Theoretically the natural input flow into the mining industry may be somewhat greater than the product output. The difference would equal losses during extraction. In practise, i.e. if the IEA/Eurostat Annual Energy Statistics Questionnaires are used, one may simply assume that the amount of the production output of the mining industry equals the amount of natural energy inputs extracted and hence supplied by the environment. Natural gas is an exceptional case as the Annual Gas Questionnaire explicitly records losses during extraction as a memo item (venting and flaring of natural gas, see GAS-T1).

### *Annual Coal Questionnaire*

171. The Annual Coal Questionnaire Table 1 (COAL-T1) records under the item '*Indigenous production*' the supply of six (seven, in the new IEA/Eurostat Annual Questionnaires) solid coal products which are considered primary products. These are presented below together with the producing NACE industries in brackets:

- Anthracite (NACE B05)
- Coking coal (NACE B05)
- Other bituminous coal (NACE B05)
- Sub-bituminous coal (NACE B05)
- Lignite (NACE B05)
- Peat (NACE B08)
- Oil shale and sands (NACE B06)

172. The supply of these six (seven) primary products is recorded as energy product supply in PEFA Table A under the respective NACE column. The PEFA questionnaire has one joint industry column for the aggregated mining industry, i.e. NACE section B (see Annex 2).

173. The mentioned mining industries cannot produce these solid primary products out of nothing. Moreover they require adequate energy inputs from the natural environment. These inputs from nature are termed *natural energy inputs* (see section 2.1.1). In other words the mining industries extract natural energy inputs and transform these into energy products (see also Figure 3). The adequate natural input class used in PEFA questionnaire is termed *Fossil non-renewable natural energy inputs* (see Annex 1). The corresponding natural input flow is recorded in PEFA Table B as a use under the column heading of the extracting industry (i.e. the mining industry which is on single aggregated column with the heading NACE B).

174. The energy content of natural energy inputs entering the coal mining industry must be at least equal to the energy content of the produced primary energy products. The natural inputs may be somewhat greater if losses of energy occur during the extraction. In PEFA these losses during

extraction are recorded as energy residuals. The respective residual class is entitled *Energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use)* (R30).

175. The IEA/Eurostat Annual Coal Questionnaire does not provide any information on losses during extraction in the coal mining industries. Hence one may assume that the amount of natural energy inputs (PEFA residual code R30 *Fossil non-renewable natural energy inputs*) is equal to the energy content of the produced output which is reported in COAL-T1 under *Indigenous production*.

176. In addition to the domestic production (i.e. *Indigenous production*) the Annual Coal Questionnaire reports the imports of the six (seven) primary coal products (COAL-T1, row 5). These imports are recorded in PEFA Supply Table A under the column 'rest of the world'.

### *Annual Gas Questionnaire*

177. The IEA/Eurostat Annual Gas Questionnaire Table 1 (GAS-T1) records under the item '*Indigenous production*' the supply of natural gas which is considered a primary energy product (note that natural gas vented and flared is not included under indigenous production – see below). The producing industry is NACE B06. Further GAS-T1 reports the amount of natural gas imported in row 7. Both amounts are to be recorded in PEFA Supply Table A as a supply of an energy product under the columns headings of 'NACE B' and the 'rest of the world' respectively.

178. The domestic production of natural gas requires the estimation of a corresponding natural energy input. The respective natural input code is N01 *Fossil non-renewable natural energy inputs* (see Annex 1). The natural energy input flow corresponding to the domestic production of natural gas as a product can be estimated from IEA/Eurostat Annual Gas Questionnaire Table 1: GAS-T1 row 1 *indigenous production*.

179. In addition GAS-T1 (row 17 and 18) reports as a memo item gas vented and flared. According to SEEA-CF conventions these amounts of natural gas vented and flared transform immediately from natural inputs into residuals without becoming product. The SEEA-CF termed these cases '*natural resource residuals*'. Nevertheless, the gas vented and flared needs to be recorded as a natural input. T

180. In summary, the total amount of natural energy input (N01) corresponding to the production of natural gas (P12) includes: indigenous production (GAS-T1 row 1), gas vented (GAS-T1 row 17), and gas flared (GAS-T1 row 18). It is recorded in PEFA Use Table B under the industry column NACE B.

181. The amount of natural gas vented and flared needs to be recorded as a supply of energy residuals (code R30 *Energy losses all kinds of...*) in PEFA Supply Table A under the column-heading of the extracting mining industry.

### *Annual Oil Questionnaire*

182. The Annual Oil Questionnaire Table 1 (OIL-T1) records under the item '*Indigenous production*' the domestic production of three classical fossil primary products (which are grouped together in PEFA row code P12, see Annex 1):

- Crude oil,

- NGL, and
- Other hydrocarbons.

183. The producing NACE industry is B06. Accordingly PEFA Supply Table A records these product outputs (P12) under the column heading of the mining industry (NACE B) as a supply.

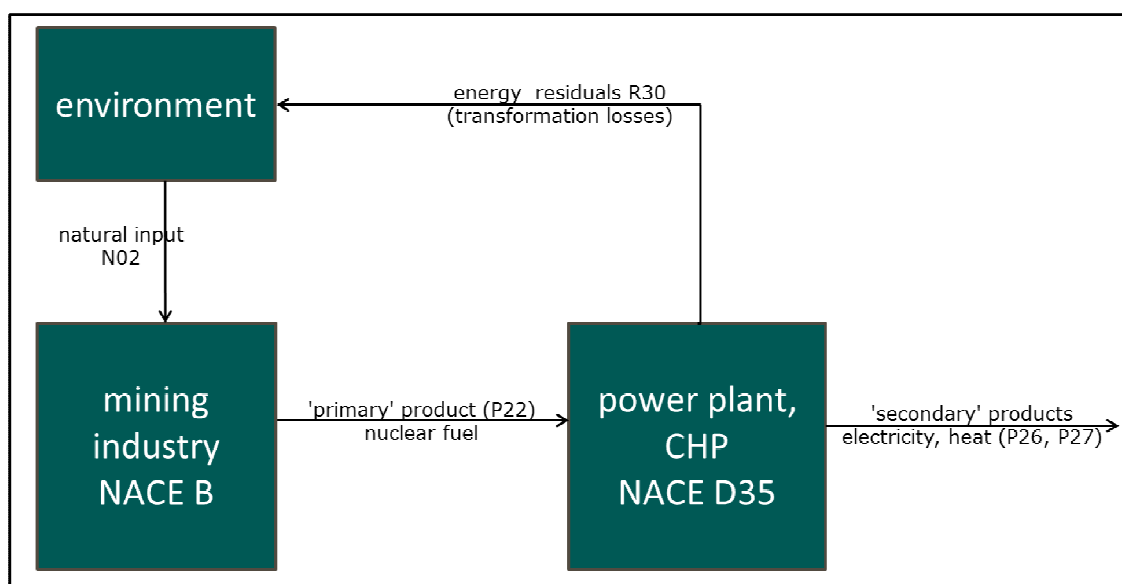
184. The corresponding natural inputs can be assumed equal to the product output. Their extraction is recorded in PEFA Use Table B with the natural input flow code N01 *Fossil non-renewable natural energy inputs* as a use by NACE B. The Annual Oil Questionnaire does not report losses during extraction for these products. PEFA Table A record the supply of the respective amount of natural inputs under the environment-column.

185. OIL-T1 reports the indigenous production of a fourth product: Additives /oxygenates which are actually secondary products used for blending in refineries. Their corresponding natural inputs are ultimately biomass and discussed further below in section 4.3.2.

### Nuclear energy

186. Nuclear fuel (PEFA row code P22) is another non-renewable primary product. Its way of recording is somewhat special. In the Electricity & Heat Questionnaires the recording of nuclear energy appears for the first time in form of electricity and heat. ELE-T1 reports the gross amounts of electricity and heat produced from nuclear power plants and CHP. This amount is actually used to approximate the corresponding primary product (i.e. P22 nuclear fuel) and the natural input (N02).

Figure 4: The flow of nuclear energy as recorded in PEFA



187. For the purpose for energy statistics nuclear energy is the heat obtained from the steam (or other working fluid) produced by the nuclear reactor/fission. The respective energy amount of the input of nuclear fuel can be approximated assuming specific transformation efficiency. By convention energy statistics assume an input-output efficiency of 33.3% for nuclear power and CHP



plants (see IRES). It is recommended to use this convention also for the compilation of PEFA as long as it is not revised by energy statistics conventions.

188. In PEFA compilation it is recommended to multiply the amount of electricity and heat produced from nuclear by a factor of 3 to approximate the corresponding nuclear fuel input. The implicit transformation loss needs to be recorded as energy residual accordingly (see Figure 4).

189. Nuclear fuel is a product in the SNA sense implying that it may originate from domestic production and/or imports (i.e. rest of the world). However, little information is known about the origin of nuclear fuel. In addition nuclear fuel may be stored over long time periods in inventories.

190. Hence in PEFA it is recommended to 'pretend' that nuclear fuel is produced domestically. It is recommended to counter-record a natural input flow (from domestic environment) for the approximated nuclear fuel output (see Figure 4). This kind of artificial recording assumes that the nuclear fuel is produced by the domestic mining industry after the extraction of an identical amount of natural energy input. This implies that possible actual imports/exports of nuclear fuels are ignored.

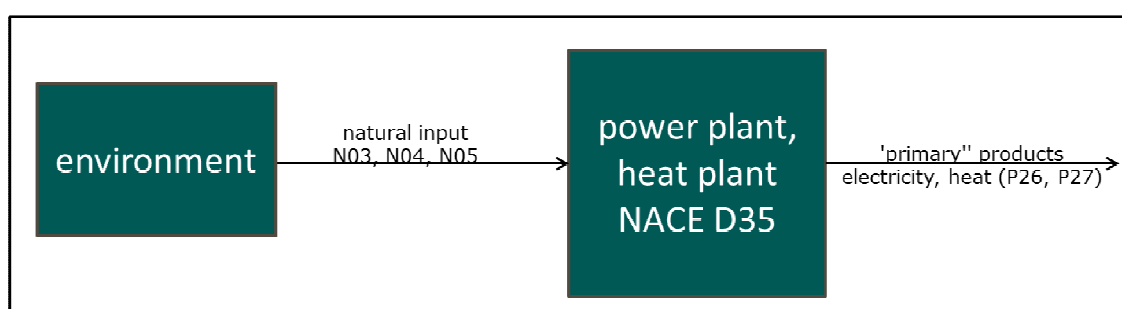
#### 4.3.2 Renewable 'primary' energy products

191. This section describes how the supply of 'primary' energy products from renewable sources can be derived from the IEA/Eurostat Annual Questionnaires.

192. Amongst the 20 energy products of the PEFA row classification (see Annex 1) are only two product groups which can immediately be identified as 'primary' products from renewable sources, namely 'Liquid biofuels' (P24) and 'Biogas' (P25). A further product group entitled 'Wood, wood waste & other solid biomass, charcoal' (P23) obviously seems to contain at least partly what can be considered a 'primary' product from renewable sources. But what about the prominent renewables such as hydro, wind, solar etc.? These renewable energy forms are actually captured in two products: 'Electrical energy' (i.e. electricity, P26) and 'Derived heat' (P27).

193. Electricity and heat are considered 'primary' energy products when produced from hydro, wind, solar, tide and geothermal. The typical producer is NACE division D35. The corresponding natural input flows from the environment into D35 (see Figure 5).

Figure 5: The flow of hydro, wind, solar, tide, and geothermal energy as recorded in PEFA





### Hydro

194. Hydro power, i.e. the kinetic energy of flowing and falling water, is used to produce electricity. The producing industry is NACE division D35. The way electricity (P27) is delineated/defined in the PEFA row classification (see Annex 1) does not allow to specify the origin or type of power generation process employed. In this list electricity is considered a homogenous product as it arrives at the end user – independent of whether it originates from nuclear, fossil combustible fuels or any renewable source.

195. In PEFA, the share of electricity derived from hydro is identifiable only indirectly through the amount of corresponding natural energy inputs. The latter specifies more in detail the character of energy source. The PEFA row classification (see Annex 1) does explicitly include a specific natural input code for hydro power: '*Hydro based renewable natural energy inputs*' (N03). This is booked as a use under the column heading of NACE division D35 in the PEFA Use Table B.

196. Notwithstanding the IEA/Eurostat Annual Energy Statistics Questionnaires explicitly records the production output (gross) of electricity derived from hydro at various places<sup>12</sup>. It addition it records the amount of hydroelectricity obtained from pumped storage plants as an 'of which'-item.

197. These two pieces of information are used to approximate the hydro related natural input: it is the obtained by deducting the pumped storage hydroelectricity from the total hydroelectricity as reported in ELE-T1. This approximation assumes an efficiency of 100%.

### Wind

198. The Annual Electricity & Heat Questionnaire records the gross electricity production from wind. This amount is used one-to-one to approximate the respective natural input flow. The producer of wind-electricity is NACE division D35 which is also assumed to be the 'extractor' of the corresponding natural inputs.

### Solar thermal

199. In the Annual Renewables & Waste Questionnaire (REN) solar thermal energy relates to two things. First it relates to the energy product electricity (P26, see Annex 1) generated from solar heat. In Europe, only one solar thermal power plant exists in South Spain producing electricity from solar heat. Secondly, solar thermal relates to the energy product heat (P27) exploited from solar radiation through e.g. solar thermal panels. This heat is directly used, i.e. the Annual Renewables & Waste Questionnaire does not record it as produced in main or autoproducer heat plants.

200. REN-T2, row 1 'indigenous production', records all primary solar heat exploited for both purposes, i.e. electricity production and heat directly used. Indigenous production (TJ) refers to the amount of heat available to the heat transfer medium, i.e. the incident solar energy less the optical and collector losses. This implies that no transformation losses are assumed in energy statistics (REN-T2), and accordingly in PEFA.

201. NACE division D35 is the typical producer of heat from solar thermal sources. I.e. the product output of P27 which arises from solar thermal sources is recorded under the respective

<sup>12</sup> Annual Electricity & Heat Questionnaire – Table 1 (ELE-T1); Annual Renewables & Waste Questionnaire, Table 1 (REN-T1).

column heading in PEFA Supply Table A. Even if private households operate solar thermal panels this is a production activity in the SNA sense which is recorded first under the column heading of the industry typically producing heat (PEFA Supply Table A). Most– if not all – of this solar heat may be consumed by the producing households though. This is accordingly recorded as a consumption activity in the household column in PEFA Use Table B.

202. In PEFA Use Table B one needs to record the natural input into NACE D35 corresponding to the production. The PEFA row code is N05 'Solar based renewable natural energy input'. The latter is approximated simply by assuming 100% efficiency. I.e. the natural input it is simply assumed to be of the same amount as the solar thermal heat reported in REN-T2, row 1 'indigenous production'.

### *Solar photovoltaic*

203. In the Annual Renewable and Waste Questionnaires (REN) solar photovoltaic (PV) refers to electricity converted from sunlight by the use of solar cells usually made of semi-conducting material which exposed to light will generate electricity.

204. REN-T1 row 8 reports the electricity produced by main producers and autoproducers with the help of PV cells. In PEFA Supply Table A this production is assigned to NACE division D35 who is the typical producer of electricity. It is recorded under the column heading of D35 even if the PV cells are actually operated by private households. The production of electricity is a production activity in SNA sense. If the household should consume their own produced electricity this is recorded in PEFA Use Table as a consumption activity.

205. Based on the assumption of zero transformation losses the very same amount of solar PV electricity produced is used to approximate the corresponding natural input flow into D35. The PEFA row code is N05 'Solar based renewable natural energy input'.

### *Tide, Wave and Ocean*

206. In the Annual Energy Questionnaires tide, wave and ocean refers to electricity generated from mechanical energy derived from tidal movement, wave motion, or ocean current.

207. The electricity produced by main and autoproducers with the help tide, wave, and ocean is reported twice: ELE-T1 (row 7) and REN-T1 (row 10) reports the gross electricity production from tide, wave and ocean. ELE-T2 (row 7) reports the net electricity production.

208. Based on the assumption of zero transformation losses the gross amount is used to approximate the corresponding natural input flow.

### *Geothermal energy*

209. In the Annual Energy Questionnaires geothermal energy refers to energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam. It is exploited at suitable sites:

- for electricity generation using dry steam or high enthalpy brine after flashing;
- directly as heat for district heating, agriculture, etc.

210. REN-T2, row 1 'indigenous production', reports all geothermal heat exploited for electricity generation or as direct energy use. In PEFA Supply Table A this amount is recorded as energy product output (product code P27) by NACE D35 who is the typical producer of heat.

211. The very same amount can be used to approximate the natural input flow associated.

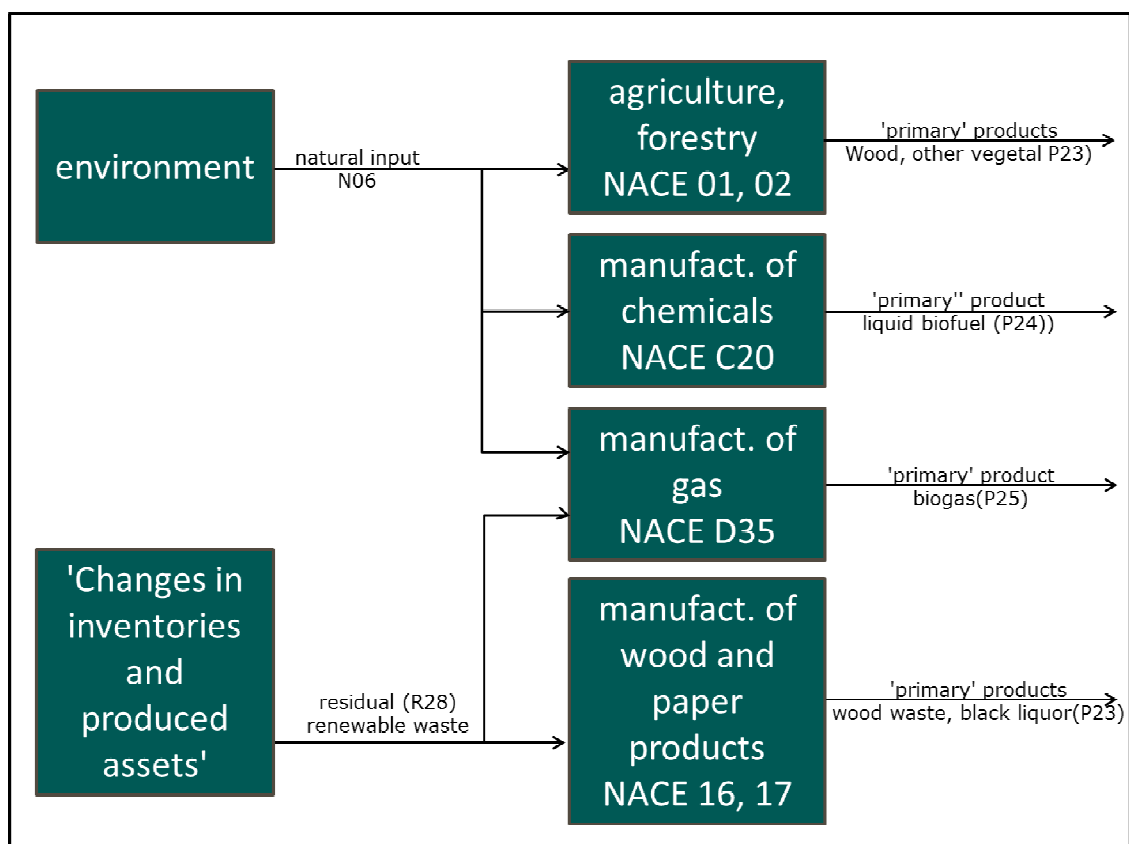
### *Biomass based 'primary' products*

212. Amongst the 20 energy products of the PEFA row classification (see Annex 1) are only two product groups which can immediately be identified as 'primary' products from renewable sources, namely 'Liquid biofuels' (P24) and 'Biogas' (P25). A further product group entitled 'Wood, wood waste & other solid biomass, charcoal' (P23) contains partly wood which can be considered a 'primary' product from renewable sources.

### *Liquid biofuels*

213. 'Liquid biofuels' (P24) is a 'primary' energy product produced by NACE division C20 'Manufacture of chemicals and chemical products'. The output from domestic production is recorded in PEFA Supply Table A under the column heading of NACE C20.

Figure 6: 'Primary' products based on biomass as recorded in PEFA



214. By convention the corresponding natural energy input is recorded as a flow from the

environment into NACE division C20 in PEFA. Figure 6 provides an overview.

215. For some of these 'primary' products based on biomass one needs to identify and approximate adequate natural input flows (code N06 'Biomass based renewable natural energy input'). Others are actually recycled and the corresponding input into their production is a residual flow originating from stocks within the economy. The respective PEFA residual code is R28 'renewable waste'.

### *Biogas*

216. 'Biogas' (P25) is a 'primary' energy product group. The IEA/Eurostat Annual Renewables & Waste Questionnaire (REN) groups actually three individual products under biogas:

- Landfill Gas: formed by the digestion of landfilled waste. The quantity of fuel used should be reported on a net calorific value basis.
- Sewage Sludge Gas: produced from the anaerobic fermentation of sewage sludge. The quantity of fuel used should be reported on a net calorific value basis.
- Other Biogas: such as biogas produced from the anaerobic fermentation of animal slurries and of waste in abattoirs, breweries and other agro-food industries. The quantity of fuel used should be reported on a net calorific value basis.

217. As a principal activity, all three biogases are produced by NACE class 35.21 'Manufacture of gas'. The production of landfill gas may be recorded as secondary activity by NACE class 38.21 'Treatment and disposal of non-hazardous waste'. In individual cases this can be clarified and aligned with compilers of National Accounts. The PEFA-builder assigns by default landfill gas production to NACE division D35.

218. The first two originate from waste in a wider sense. The input into their production is an energy residual flow (PEFA row code R28 'Renewable waste'). The energy content of biodegradable (organic) waste accumulated in landfills constitutes the energy input to the production of landfill gas. In the PEFA logic, this input flow is an energy residual flow. Similar applies for sewage sludge gas. It is produced from sewage sludge which is the result from waste water management. In both cases the energy residual flow originate from the stock within the economy (PEFA column code CHINV\_PA 'Changes in inventories and produced assets', see Annex 2).

219. The energy input to the production of other biogas is assumed to originate from the natural environment (e.g. energy crops). The respective natural input flow has the code N06 (see Annex 1).

### *Wood etc.*

220. 'Wood, wood waste & other solid biomass, charcoal' (P23) is a grouping of individual energy products most of which can be considered 'primary' (charcoal is a secondary product). For the 'primary' products among P23 one needs to approximate either natural input flows or residual flows as input to the 'primary' production. Table 2 shows the various individual products included in P23, their NACE producer and the required inputs to their production.

Table 2: Individual products included in P23 'Wood, wood waste &amp; other solid biomass, charcoal'

Product (type)	type	Eurostat code	Producer	Input
Wood	primary	55411	NACE 02	N06
Other vegetal material and waste	primary	55412	NACE 01	N06
Wood waste	primary	55413	NACE 16	R28
Black liquor	primary	55414	NACE 17	R28
Other solid biomass	primary	55415	NACE 01	N06
Charcoal	secondary	5540	NACE 20	P23

### 4.3.3 'Primary' energy from waste

221. Waste incorporates organic material which is combustible. Waste hence carries energy which potentially can be exploited. The heat arising from the combustion of waste can be used directly or to generate electricity. Waste may be also simply used as a fuel to obtain process heat, e.g. for cement and iron & steel manufacturing.

222. The IEA/Eurostat Annual Electricity & Heat Questionnaire (ELE-T6d) reports the gross production of electricity (P26) and heat (P27) from industrial waste, renewable municipal waste and non-renewable municipal waste as well as the energy content of respective waste inputs. The very same inputs (waste) as well as outputs (electricity and heat) are reported in the IEA/Eurostat Annual Renewables & Heat Questionnaires REN-T2 and REN-T1.

223. In addition REN-T2 reports the energy content of waste which is used directly by certain industries for fuelling industrial processes (e.g. cement, iron & steel). REN-T2 also reports the total energy content of waste provided to the domestic market, i.e. indigenous production, imports, exports, and stock changes.

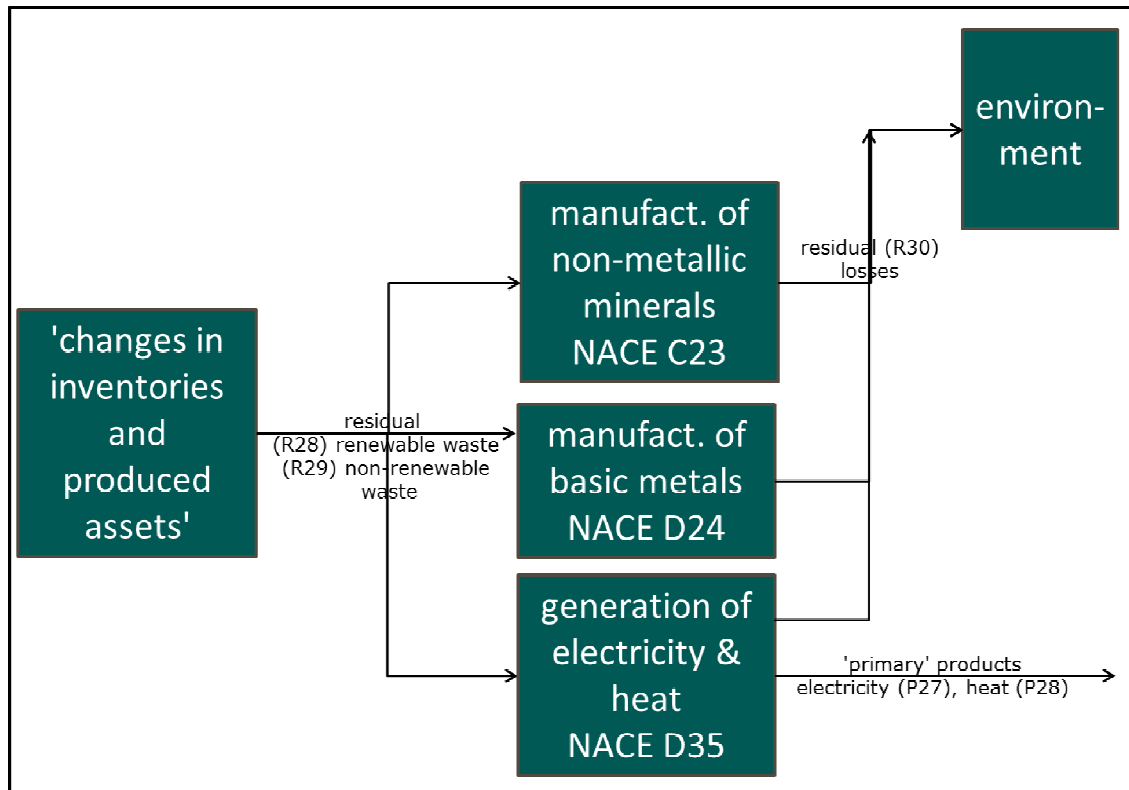
224. The SEEA-CF remains somewhat imprecise in how to record waste flows in energy accounts. One question particularly affects the way of recording. Does waste constitute a residual flow or a product flow or even both? In general the distinction between product and residual is made upon the criteria of monetary value. In most cases waste is a residual. But increasingly waste may become a product. The latter may happen actually e.g. when operators of waste incineration plants buy waste as a fuel product in order to fully exploit the capacity of their plants.

225. In statistical practice it may be difficult to determine whether a waste flow has a monetary value (i.e. constitutes a product) or whether it is a non-product, i.e. a residual. In the former case – i.e. waste as a product – one would need to identify the producer as well (the principal producer is NACE division E38 'Waste collection, treatment and disposal activities; materials recovery').

226. As a matter of fact the IEA/Eurostat Annual Energy Questionnaires do not allow making this distinction between waste as energy product and waste as energy residual. Hence it is recommended in PEFA to record the energy flows related to energetic recovery of wastes in a simplified way. This is also the reason why waste appears only as energy residual (R28 and R29) in

the PEFA classification of energy flows (see Annex 1), i.e. no product code for waste.

Figure 7: PEFA – recommended recording of waste related energy flows



227. Figure 7 shows the simplified way of recording waste related energy flows in PEFA. All wastes originate as residuals from the stock of produced assets within the economy. A distinction is made between renewable waste residual (R28) and non-renewable waste residuals (R29). The majority of waste residuals is used by power plants, CHP and heat plants (NACE division D35) in order to produce 'primary' electricity and heat. The energetic difference between inputs (waste residuals) and outputs (electricity, heat) are transformation losses – an energy residual flow to the environment.

228. A minor part of wastes may be used as combustible fuels by manufacturing industries (e.g. cement, iron & steel). Here, the losses are kind of end use losses. I.e. the total energy amount entering in form of waste is assumed to be released again as energy loss – to be recorded in PEFA as a residual flow to the environment.

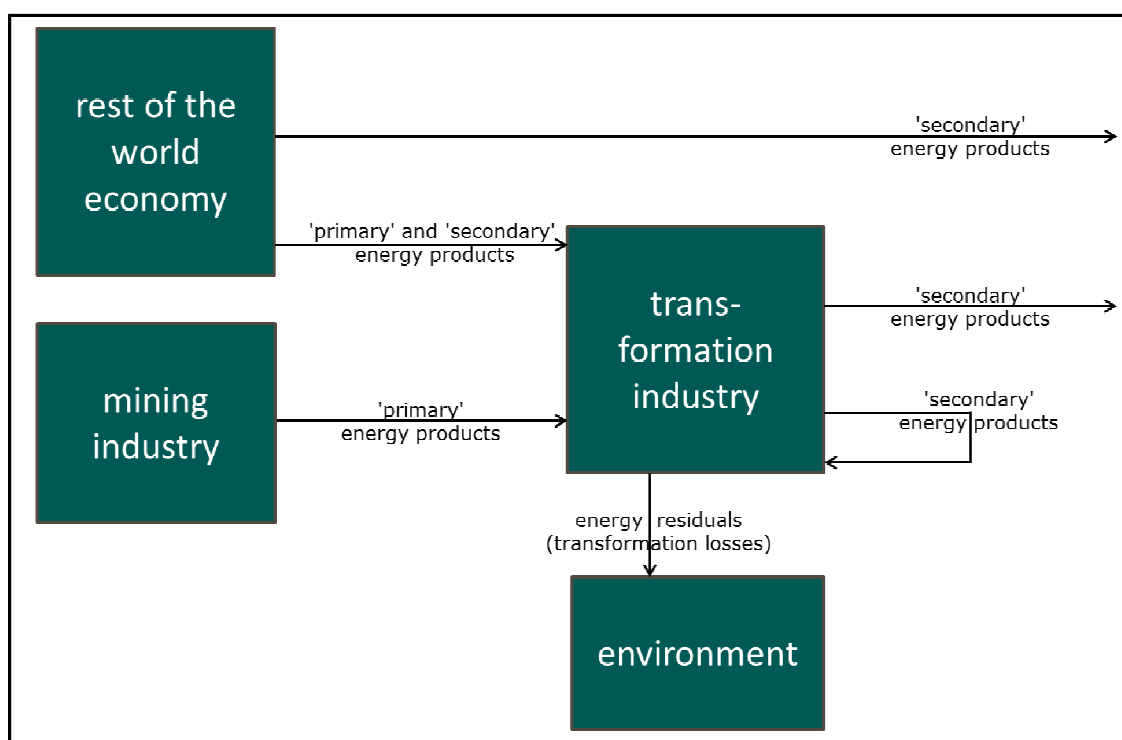
#### 4.4 Transformation into 'secondary' products and related transformation losses

229. The production of 'secondary' energy products requires some form of energy inputs. By

definition these must be energy products ('primary' and/or 'secondary') and must not be natural energy inputs or energy residuals. During the production of 'secondary' energy products some energy may be lost (e.g. when electricity is produced from coal more than half of the input energy is lost in form of dissipative heat). In PEFA this transformation loss is recorded as an energy residual flow from the economy to the environment (see Figure 8).

230. The total amount of 'secondary' products available in a country for further use is supplied either from domestic production or from the rest of the world economy in form of imported 'primary' and/or 'secondary' energy products (see Figure 8).

Figure 8: Production of 'secondary' energy products and related transformation losses



231. The domestic production of 'secondary' energy products as well as their import from the rest of world can be derived from various parts of the IEA/Eurostat Annual Energy Statistics Questionnaires under the items 'indigenous production' ('refinery gross output' in the case of oil products) and 'total imports' respectively:

232. The Annual Coal Questionnaire (COAL-T1) reports the production and imports of:

- P10 Derived gases (= manufactured gases excl. biogas)
- P11 Secondary coal products (coke, coal tar, patent fuel, BKB and peat products)

233. The Annual Oil Questionnaire (OIL-T2a) reports the production and imports of:

- P14 Motor spirit (without bio)
- P15 Kerosenes & jet fuels (without bio)

- P16 Naphtha
  - P17 Transport diesel (without bio)
  - P18 Heating and other gasoil (without bio)
  - P19 Residual Fuel Oil
  - P20 Refinery gas, ethane & LPG
  - P21 Other petroleum products incl. additives/oxygenates and refinery feedstocks
234. The Annual Renewables & Waste Questionnaire (REN-T2) reports the production of:
- P23 Wood, wood waste & other solid biomass, charcoal
235. The Annual Electricity & Heat Questionnaires (ELE-T1, ELE\_T6a-d) report the production and ELE-T8 the imports of:
- P26 Electrical energy
  - P27 Derived Heat
236. Note that some electricity and heat production is considered 'primary' when it originates from certain renewable sources (see section 4.3.2). Further note that natural gas is a 'primary' product the production of which can be derived from the Annual Gas Questionnaire (GAS-T1) which was discussed already in section 4.3.1.
237. In general one needs to calculate the transformation losses occurring during the production of secondary products. The general approach is to determine the difference between the energy input and the energy output of the respective production process. This information can be derived from the IEA/Eurostat Annual Energy Questionnaires, though the calculation approach varies across the five Annual Energy Questionnaires and is explained in the following sections.

#### 4.4.1 Secondary coal products

238. Secondary coal products comprise manufactured gases (P10) and solid secondary coal products (P11). Their domestic production is recorded in COAL-T1 row 1 'indigenous production'. The inputs into their production are also widely recorded in COAL-T1 (see next paragraph). However potentially also non-coal products recorded in the other Annual Questionnaires can constitute inputs to the production of secondary coal products (e.g. waste as a binding agent for the production of coal briquettes).
239. The Annual Coal Questionnaire (COAL-T1 rows 14-28) presents a number of transformation processes for which it records the inputs. The transformation processes relevant for the production of secondary coal products are shown in Table 3.
240. Transformation losses occur in all production processes shown in Table 3. They are not explicitly recorded in the IEA/Eurostat Annual Questionnaires and need to be calculated. For each transformation process one needs to deduct the output from the input. Note that the input of non-coal products needs to be taken into account as well.



Table 3: Transformation processes related to the production of secondary coal products

Transformation process	NACE code	Typical output of secondary coal product (PEFA code, see Annex 1)	IEA/Eurostat Annual Coal Questionnaire
Patent Fuel Plants (Transformation)	C19	Patent Fuel (P11)	row 21
Coke Ovens (Transformation)	C19	Coke Oven Coke (P11) Coke Oven Gas (P11)	row 22
BKB Plants (Transformation)	C19	BKB/PB (P11)	row 23
Gas Works (Transformation)	D	Gas Works Gas (P10) Gas Coke (P11)	row 24
Blast furnaces (Transformation)	C24	Blast Furnace Gas (P10) Oxygen Steel Furnace Gas (P10)	row 25
Coal Liquefaction Plants (Transformation)	C19	Coal Tar (P11)	row 26

241. In PEFA transformation losses belong to the residual flow category R30 'Energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use)' (see Annex 2). They are attributed to the NACE industry undertaking the transformation, i.e. production of respective production of secondary products (see second column in Table 3).

#### 4.4.2 Secondary oil products

242. Secondary oil products are commonly termed petroleum products. They are produced in two industries: refineries (NACE C19) and in the petrochemical industry (NACE C20). Both industries are closely interwoven through a mutual exchange of secondary petroleum products (see Figure 9).

243. Primary oil products (e.g. crude oil, NGL, and other hydrocarbons) constitute quantitatively the major input into refineries (NACE C19). Secondary products delivered from refineries are the main input into petrochemical industry (NACE C20). Also some primary products may be fed into the petrochemical industry. A good portion of petrochemical industries' output is send back to refineries (so-called backflows of refinery feedstock). Both industries deliver secondary products to end users.

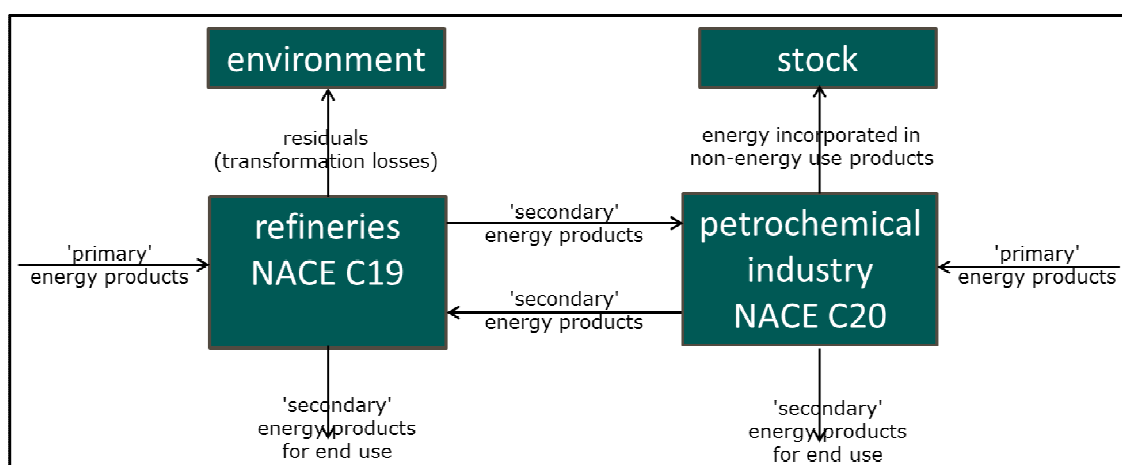
244. The Annual Oil Questionnaire Table 1 (OIL-T1) records refineries' intake (crude oil, NGL, other hydrocarbons). Table 2a (OIL-T2a) records the output of refineries. Under the item 'refinery gross output' (row 2) it shows the domestic production output of some 20 secondary oil products produced by refineries (NACE C19).

245. Table 2b (OIL-T2b) reports the inputs and outputs of the petrochemical industry (NACE C20). Row 2 'gross deliveries to petrochemical sector' reports the inputs. Row 5 'backflows to refineries' reports the output of petroleum products.

246. Residuals in form of transformation losses occur in refineries (NACE C19). They constitute a residual flow from refineries to the environment. The transformation losses in refineries are explicitly recorded in OIL-T1 row 12.

247. The petrochemical industry produces products for non-energy use (e.g. plastics). These amounts of energy are booked as a kind of residual flow (code R31 'Energy incorporated in products for non-energy use', see Annex 1) from the petrochemical industries to the stock of produced assets within the economy.

Figure 9: Energy flows related to the production of secondary oil products



#### 4.4.3 Charcoal – a secondary renewable product

248. Charcoal is defined as the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material production. As such it is the transformation from a 'primary' to a 'secondary' renewable product.

249. The principal producer of charcoal is NACE division C20. The domestic production is recorded in the Annual Renewable & Waste Questionnaire under the item 'indigenous production' (REN-T2 cell G1).

250. The charcoal production process is explicitly included as a transformation sector item in the Annual Renewable & Waste Questionnaire (REN-T2, row 19). There the input into the charcoal production is recorded. The REN questionnaire actually allows entries in product column of wood.

251. Note that both products charcoal and wood belong to the same product group P23 'Wood, wood waste & other solid biomass, charcoal' in the PEFA row classification (see Annex 1).

252. The transformation losses (residual flow to the environment) are simply calculated as the difference between output (charcoal) and input (wood).

## 4.5 End use of energy products and related residuals

### 4.5.1 Overview and energy use versus non-energy use

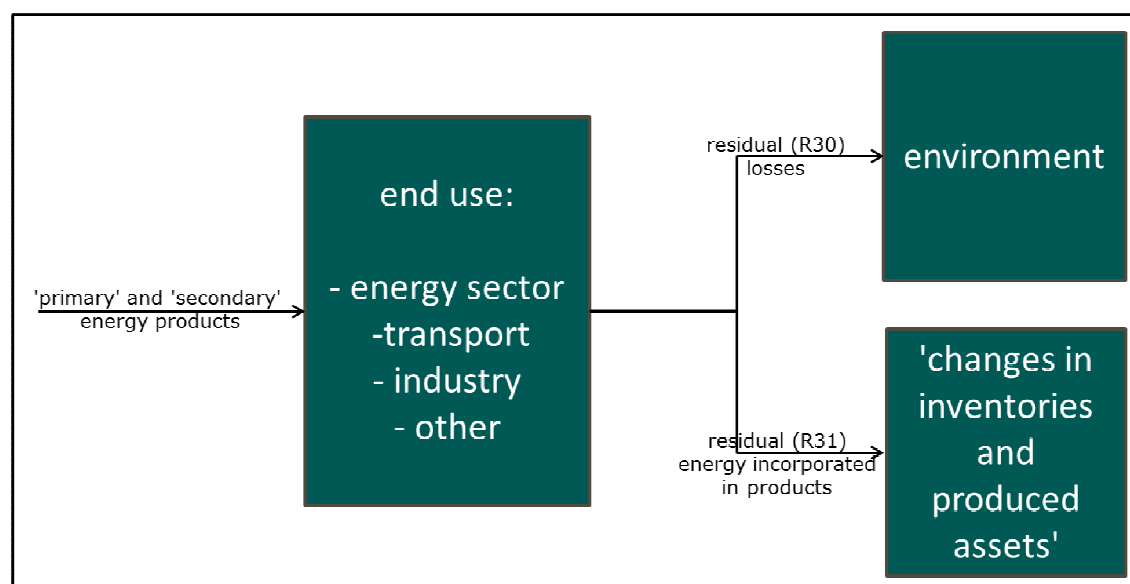
253. In PEFA the end use of an energy product relates to the fact that the energy content of a energy product becomes unavailable for further production, consumption, and accumulation activities in the respective national economy in that accounting period. In most cases the end use relates to the transformation of energy products into energy residuals (see Figure 10) which are either released to the environment or send on the stock of produced assets within the economy (non-energy use products). End use also includes the export of energy products as the energy content becomes unavailable to the reporting economy.

254. End use by and large relates to the SNA concepts of consumption (intermediate consumption, final consumption), gross capital formation, and exports. In energy statistics the concepts of 'final energy consumption' and 'energy sectors' (own) by and large coincide with the PEFA concept of end use.

255. The end use of energy products can be further distinguished into

- energetic purposes: basically implying a combustion and transformation into energy losses (dissipative heat), and
- non-energy purposes: basically the going on stock of energy products (e.g. plastics); and one may add the export of energy products here.

Figure 10: End use of energy products and resulting energy residuals



256. This distinction is important for the recording of energy residuals resulting from the end use of energy products (see Figure 10). In the first case the resulting energy residual has the code R30 'Energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use)' which is taken up by the environment. In the second case the

resulting energy residual has the code R31 'Energy incorporated in products for non-energy use' which is going on stock.

257. In general any energy product may be used for both purposes. But there are some product such as e.g. electricity and heat where a non-energy use is quasi impossible. On the other hand lubricants are most likely only used for non-energy purposes.

258. The IEA/Eurostat Annual Coal Questionnaire records the non-energy use for each product by broad final consumption groups (COAL-T1 rows 42ff.).

259. The Annual Oil Questionnaire records the non-energy use of all products by broad final consumption groups as a memo item (OIL-T3 rows 54ff.). In addition it presents the non-energy use of two products (petroleum coke, other petroleum products) by detailed final consumption items (OIL-T3 columns AA - AB). The 'new' Annual Oil Questionnaire shows the detailed non-energy use for all products (OIL-T3b).

260. The Annual Gas Questionnaire shows the non-energy use of natural gas by detailed final consumption items in transport, industry and other sectors (GAS-T2b).

261. The Annual Electricity & Heat and Renewable & Waste Questionnaires do not record any non-energy uses of their products.

#### 4.5.2 *Energy sector's own use of energy products*

262. In energy statistics the concept of 'energy sectors' own use' refers to units undertaking energy transformation (e.g. power plants, refineries, gas works etc.).

263. Beside their use of energy products for transformation into other energy products the 'energy sector' may use energy products for 'own' purposes (e.g. lightning, heating). The 'energy sectors' own use' is not limited to those energy products which have been produced by the using sector. E.g. a gas works plant may use electricity or heating oil for their facilities.

264. In PEFA the energy sector – as delineated in energy statistics (i.e. IEA/Eurostat Annual Energy Statistics Questionnaires) – does not explicitly exist. In the PEFA logic the 'energy sector' relates to NACE industries producing 'primary' products (mining) and/or 'secondary' products (e.g. refineries). However, in PEFA all NACE industries are treated in the same way independent of whether they produce energy product or only use them. The PEFA tables A and B (supply and use tables) simply record the energy inputs and outputs (natural inputs, products, residuals) of all NACE industries.

265. In PEFA the 'energy sectors' own use' is an end use of energy products. I.e. it is a transformation from energy products into energy residuals, here energy losses due to end use (residual code R30 'Energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use)').

266. The range of NACE division included in the 'energy sector' varies across the five IES/Eurostat Annual Energy Statistics Questionnaires. Table 4 shows how the energy sectors (as delineated in IEA/Eurostat Annual Energy Statistics Questionnaires) relate to NACE industries.

Table 4: NACE divisions covered by the 'energy sector'

Energy sector label	included in Annual Questionnaire	NACE code	NACE label
Coal Mines	COAL, GAS, OIL, ELE, REN	B05	Mining of coal and lignite
Oil and Gas Extraction	GAS, OIL, ELE	B06	Extraction of crude petroleum and natural gas
Patent Fuel Plants	COAL, ELE, REN	C19	Manufacture of coke and refined petroleum products
Coke Ovens	COAL, GAS, OIL, ELE, REN	C19	Manufacture of coke and refined petroleum products
BKB Plants	COAL, ELE, REN	C19	Manufacture of coke and refined petroleum products
Petroleum Refineries	COAL, GAS, ELE, REN	C19	Manufacture of coke and refined petroleum products
Coal Liquefaction Plants	COAL, ELE	C19	Manufacture of coke and refined petroleum products
Liquefaction (LNG) / Regasification Plants	GAS, ELE	C19	Manufacture of coke and refined petroleum products
Gas-to-Liquids (GTL) Plants	GAS, ELE	C19	Manufacture of coke and refined petroleum products
Charcoal Production Plants	ELE, REN	C20	Manufacture of chemicals and chemical products
Blast Furnaces	COAL, GAS, OIL, ELE, REN	C24	Manufacture of basic metals
Own Use in Electricity, CHP, and Heat Plants	COAL, GAS, OIL, REN	D35	Electricity, gas, steam and air conditioning supply
Gas Works	COAL, GAS, OIL, ELE, REN	D35	Electricity, gas, steam and air conditioning supply
Nuclear Industry	ELE	D35	Electricity, gas, steam and air conditioning supply
Gasification Plants for Biogas	ELE, REN	D35	Electricity, gas, steam and air conditioning supply
Non-specified	COAL, GAS, OIL, ELE, REN	1 to N	All industries belonging potentially to the energy sector

#### 4.5.3 Transport's end use requires important adjustments

267. PEFA records the energy flows (natural inputs, products, residuals) related to economic

activities (production, consumption, accumulation) of resident units. The use of energy products and the resulting supply of energy residuals in conjunction with transport have to be related to resident units' activities (see sections 2.2.1 and 2.2.7).

268. In PEFA resident units' production activities are broken down by NACE divisions. Only three NACE divisions use transport fuels in conjunction with their principal production activity – i.e. the production of transport services. Those NACE divisions producing transport services are:

- H49 Land transport and transport via pipelines,
- H50 Water transport, and
- H51 Air transport.

269. Most often the use of transport fuels (and associated supply of residuals) has to be assigned to other NACE industries who undertake transport activities in form of ancillary production activities (see also section 2.2.3). This is particularly the case for the operation of road transport vehicles (e.g. ambulance cars in health service industries, lorries in construction etc.). In these cases the transport fuel use (and associated releases of residuals) has to be assigned to the NACE division hosting the principal activity.

270. With regards to the practical compilation of PEFA based on the IEA/Eurostat Annual Energy Statistics Questionnaires two important compilation challenges evolve:

- First, the transport related use of energy products (and resulting supply of residuals) needs to be adjusted to the **residence principle**. Non-residents' fuel use on the territory needs to be deducted and resident units' transport fuel use abroad needs to be added (see also section 3.6 on PEFA bridging table).
- Secondly, the transport fuel use needs to be assigned to production activities in a NACE breakdown (**industry detailing**).

271. The IEA/Eurostat Annual Energy Statistics Questionnaires do not fully provide the necessary information pieces to make these adjustments. Additional 'auxiliary' information pieces are required.

272. The IEA/Eurostat Annual Questionnaires record transport related energy use at two places:

- All five Annual Questionnaires report the end use of energy products in the so-called transport sector which is broken down by transport modes: rail, road, domestic navigation, international aviation, domestic aviation, and pipeline transport.
- The Annual Oil, Coal and Gas Questionnaires report in addition energy use for an item entitled 'International Marine Bunkers' which relates to fuels sold in domestic ports to vessels operated by residents and non-residents.

273. The explanatory notes accompanying the IEA/Eurostat Annual Questionnaires provide detailed definitions of the above transport modes and items.

274. In general energy use reported in the IEA/Eurostat Annual Questionnaires relate to fuel sales on the territory (territory principle). I.e. they do not relate strictly to the residence principle. In the following the required resident adjustments as well as the assignments to NACE industries

(industry detailing) are discussed mode by mode.

### *Pipeline transport*

275. The Annual Oil, Gas, and Electricity & Heat Questionnaires report the energy use for pipeline transport under the heading of transport sector's final energy consumption. It refers to the use of energy products in the support and operation of pipelines transporting gases and liquids. It includes the use of energy products for pump stations and maintenance of pipelines. The operation of mains for distributing gas, water, steam etc. is explicitly excluded (NACE divisions 35 and 36). For further details see the explanatory notes accompanying the three questionnaires.

276. NACE division H49 'Land transport and transport via pipelines' is the respective service industry operating pipelines. Accordingly the use of energy products for pipeline transport can be assigned to this industry.

277. The need to adjust for the residence principle is also unlikely.

### *Rail transport*

278. The Annual Coal, Oil, Electricity & Heat, and the Renewables & Waste Questionnaires report the energy use for rail traffic under the heading of transport sector's final energy consumption.

279. NACE division H49 'Land transport and transport via pipelines' is the respective service industry operating rail traffic. Accordingly the use of energy products for pipeline transport can be assigned to this industry.

280. The need to adjust for the residence principle is unlikely.

### *Air transport*

281. NACE division G51 hosts air transport services.

282. The IEA/Eurostat Annual Questionnaires report the energy use for two categories of air transport:

- International aviation refers to quantities of aviation fuels delivered to aircrafts on domestic air ports for connections where either destination or departure is located abroad.
- Domestic aviation refers to quantities of aviation fuels delivered to aircrafts on domestic air ports for connections where both, departure and destination is within the national territory.

283. The international/domestic split is on the basis of departure and landing locations. The nationality of the airline is not relevant. This implies that both include deliveries to non-residents as well as residents operating aircrafts.

284. For PEFA on needs to adjust both items (domestic and international aviation) for the residence principle. In a first step the aviation fuel sold to non-resident units on the territory needs to be deducted from the amount reported in the IEA/Eurostat Annual Questionnaires. In a second step aviation fuel purchased in the rest of the world by resident airlines needs to be added.

285. Quantitatively the adjustments can be huge. E.g. in Ireland a big airline is resident which operates aircrafts in whole Europe and beyond. As this airline is an Irish resident unit contributing to Irish GDP also the respective use of energy products and corresponding release of energy residuals have to be assigned to the Irish PEFA.

286. Unfortunately there is no common approach for the residence-adjustment in air transport based on internationally harmonised statistics. As mentioned in section 4.1 there are various potential national information sources which may be approached to estimate the required adjustments. Detailed national account and balance of payment statistics may be a potential source. Annual reports of the resident airlines might serve as auxiliary information. A detailed analysis of the foreign trade statistics compared to the energy statistics might be helpful because the former may consider deliveries of aviation fuel to non-residents as exports. If highly detailed national transport statistics are available for air transport this might help out as well.

### *Water transport*

287. NACE division H50 is the respective service industry hosting water transport operated by resident units.

288. The IEA/Eurostat Annual Questionnaires report energy use for water transport similarly to air transport. There is one category for international and another for domestic navigation, whereby the former has a specific label and is excluded from important indicators derived from energy statistics such as e.g. gross inland energy consumption and final energy consumption:

- International Marine Bunkers: includes all fuel delivered in domestic ports to vessels of all flag engaged in international navigation. The latter includes trips where the port of departure locates in another country than the port of arrival. Note that this item excludes fuels delivered to fishing vessels which is reported separately under final energy consumption in 'Other sector – Fishing'. It also excludes fuel delivered to military forces which is included in final energy consumption of 'Other sector – Not elsewhere specified'.
- Domestic Navigation: includes all fuel delivered to vessels of all flags not engaged in international navigation (i.e. international marine bunkers) bunkering in domestic ports.

289. The domestic/international split is purely determined on the basis of port of departure and port of arrival and not by the flag or nationality of the ship/vessel. It further does not take into account whether the operator of the respective ship is resident or non-resident.

290. For PEFA one needs to adjust both items (domestic and international navigation) for the residence principle. In a first step the fuel delivered to vessels operated by non-resident units needs to be deducted from the amount reported in the IEA/Eurostat Annual Questionnaires. In a second step fuel bunkered in the rest of the world by vessels operated by residents needs to be added.

291. The auxiliary information needed for these adjustments may be found in similar sources as for the case of air transport (see paragraph 286).

### *Road transport*

292. Under the final energy consumption item 'Transport sector – Road' the IEA/Eurostat Annual



Questionnaires report the amounts of fuel sold on the territory for the operation of road vehicles. This includes sales to resident units and non-residents on the territory. A first adjustment is to be made for the residence principle. The sales to non-residents need to be deducted. The purchases of resident unit abroad are to be added.

293. The compiler of PEFA needs to search for appropriate auxiliary information pieces in his country. Here we can give only general advice for possible sources. First the national transport statistics may provide some elements to make the above resident adjustments. There might be some economic statistics as well which give some idea on the amount sold to non-residents on the territory (e.g. balance of payments).

294. A Eurostat task force on transport issues in environmental accounts developed a technical paper<sup>13</sup> where it presents various country approaches for the resident adjustments in road transport.

295. The second step concerns the distribution of road fuel use over NACE industries (industry detailing, see also section 269). The compiler of PEFA needs to develop a distribution key for the main products (diesel, gasoline) based on suitable auxiliary information pieces. The latter will most likely vary from country to country.

296. There might be a road-vehicle-model (e.g. based on national vehicle registers) available which is used e.g. by the environmental authorities to estimate road transport emissions. Often the vehicle register would provide broad NACE sections to which the vehicle holder or operator belongs. Detailed monetary use tables (i.e. with a detailed breakdown of products) may provide the information how much diesel and gasoline is used by NACE divisions. Information on taxes may also serve as a source.

#### 4.5.4 Industry's end use of energy products

297. The IEA/Eurostat Annual Questionnaires report the final energy consumption by industries in a breakdown by 13 industry groups. The 13 industry groups correspond with the NACE classification (see Table 5). Basically NACE sections B 'Mining and Quarrying', C 'Manufacturing', and F 'Construction' are concerned.

298. Obviously the 13 industry groups are broader than the classification of production activities in the PEFA questionnaire (see Annex 2) which is basically NACE division level (2-digit). Hence the compiler of PEFA need to further distribute the energy product use reported for the 13 industry group to more detailed NACE divisions.

299. The compiler of PEFA has to develop respective distribution keys based on auxiliary information pieces which may vary from country to country. **Monetary supply and use tables**<sup>14</sup> form one possible auxiliary data source. The monetary use structures may be used to derive a distribution key in particular in the service industry. The annual use table presents the use of three groupings of energy products by 64 NACE industries in purchaser prices (distinguished by domestic produced versus imported) :

<sup>13</sup> Eurostat task force on transport related issues in environmental accounts: Technical Paper on Road Transport – Resident Adjustments (version, 04 February 2013) <https://circabc.europa.eu/w/browse/53bdb17e-73d8-4751-b26b-1e674b0ab5f7>

<sup>14</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95\\_supply\\_use\\_input\\_tables/introduction](http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/introduction)

- Products from mining and quarrying, including coal products, natural gas, crude oil and other hydrocarbons (CPA B)
- Coke and refined petroleum products (CPA 19)
- Electricity, gas, steam and air-conditioning (CPA D35)

300. **Structural business statistics (SBS)**<sup>15</sup> cover may constitute another auxiliary data source. SBS includes e.g. purchases of energy products (in monetary value) by a very detailed NACE class level for manufacturing industries and construction.

Table 5: Correspondence between NACE and the 13 industry groups employed in IEA/Eurostat Annual Questionnaires

Industry group in IEA/Eurostat Annual Questionnaires	NACE Rev.2 based code for PEFA questionnaire (see Annex 2)
Iron and Steel	C24
Chemical (including Petrochemical)	C20, C21
Non-Ferrous Metals	C24
Non-Metallic Minerals	C23
Transport Equipment	C29, C30
Machinery	C25, C26, C27, C28
Mining and Quarrying	B07, B08, B09
Food, Beverages and Tobacco	C10_C12
Paper, Pulp and Printing	C17, C18
Wood and Wood Products	C16
Construction	F
Textiles and Leather	C13-C15
Non-specified (Industry)	C22, C31_C32

#### 4.5.5 End use by others (households, services etc.)

301. The IEA/Eurostat Annual Questionnaires report the final energy consumption by other sectors in a breakdown by 5 other sector groups. Four of the 5 other sector groups correspond with production activities as classified in NACE (see Table 6). A fifth corresponds with consumption activities by private households (note that transport-related consumption activities are excluded because already covered by transport sectors' final energy consumption, see section 4.5.3).

302. Obviously the 5 groups are broader than the classification of production activities and consumption activities in the PEFA questionnaire (see Annex 2). Hence the compiler of PEFA needs

<sup>15</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/european\\_business/introduction](http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/introduction)

to further distribute the energy product use reported for the 5 groups to more detailed NACE divisions and two private household consumption activities.

303. The compiler of PEFA has to develop respective distribution keys based on auxiliary information pieces which may vary from country to country. **Monetary supply and use tables**<sup>16</sup> form one possible auxiliary data source. The monetary use structures may be used to derive a distribution key in particular for the service industries. The use table presents the use of three groupings of energy products by 64 NACE industries in purchaser prices (domestically produced and imported):

- Products from mining and quarrying, including coal products, natural gas, crude oil and other hydrocarbons (CPA B)
- Coke and refined petroleum products (CPA 19)
- Electricity, gas, steam and air-conditioning (CPA D35)

304. The use of energy products by private households reported in the IEA/Eurostat Annual Energy Questionnaires needs to be broken down into two components:

- use for heating/cooling purposes
- use for other purposes (excluding transport purposes)

305. *Commission Regulation (EU) No XXX/2014 amending Regulation (EC) No 1099/2008 on energy statistics, as regards the implementation of annual statistics on energy consumption in households* will provide detailed data about energy consumption in households (excluding transport). This statistic can be used to make the above split into heating/cooling purposes and other purposes (excluding transport).

306. This statistic will provide households' energy consumption by the following six categories:

- Space heating;
- Space cooling;
- Water heating;
- Cooking;
- Lighting and electrical appliances;
- Other use.

307. The former three items can be related to the PEFA column category HH\_HEAT (Heating/cooling activities by households) and the latter three items can be related to the PEFA column category HH\_OTH (Other activities by households).

<sup>16</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95\\_supply\\_use\\_input\\_tables/introduction](http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/introduction)

Table 6: Correspondence between NACE based PEFA classification and the 5 other sector groups employed in IEA/Eurostat Annual Questionnaires

Industry group in IEA/Eurostat Questionnaires	NACE Rev.2 based code for PEFA questionnaire (see Annex 2)
Commercial and Public Services	C33, E36, E37-E39, G45, G46, G47, H49, H50, H51 H52, H53, I, J58, J59_J60, J61, J62_J63, K64, K65, K66, L, L68A, M69_M70, M71, M72, M73, M74_M75, N77, N78, N79, N80-N82, O, P, Q86, Q87_Q88, R90-R92, R93, S94, S95, S96, T, U
Residential	HH_HEAT, HH_OTH
Agriculture/Forestry	A01, A02
Fishing	A03
Non-specified (Other)	potentially all: A01, A02, A03, C33, E36, E37-E39, G45, G46, G47, H49, H50, H51 H52, H53, I, J58, J59_J60, J61, J62_J63, K64, K65, K66, L, L68A, M69_M70, M71, M72, M73, M74_M75, N77, N78, N79, N80-N82, O, P, Q86, Q87_Q88, R90-R92, R93, S94, S95, S96, T, U

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## Annex 1: Classification and definitions of natural energy inputs, energy products and energy residuals in PEFA questionnaire

This classification of natural energy inputs, energy products, and energy residuals (short: PEFA classification of rows) has been developed for the PEFA questionnaire. It is built upon and hence fully consistent with more detailed international definitions of energy commodities (SIEC, IEA/Eurostat Annual Energy Statistics Questionnaires).

The international classifications (SIEC, IEA/Eurostat) are intended for products only – products in the strict sense of national accounts and SEEA-CF. These international classifications do not consider natural inputs and residuals.

This Annex 1 hence starts with the definitions of the energy products. The classification of the natural energy inputs can be related closely to the international product classifications because each energy product was a natural energy input before it became a product. For the classification of energy residuals the international classifications were less useful. Only waste (as a residual) can be related to the international classifications.

### Energy Products

The PEFA classification of rows includes 20 energy products which are shown in the following table. Each class can be clearly linked to international classifications.

PEFA code	PEFA label (closely aligned to SIEC labels)	Eurostat code	SIEC code
P08	Hard coal	2115, 2116, 2117 + 2118	0110, 0121, 0129
P09	Brown coal & Peat	2118, 2210, 2310	0210, 0220, 11
P10	Derived gases (= manufactured gases excl. biogas)	4200 = 4210 + 4220 + 4240 + 4230	0360, 0350, 0371, 0372
P11	Secondary coal products (coke, coal tar, patent fuel, BKB and peat products)	2120 = 2121 + 2122, 2130, 2112, 2230, 2330	0311, 0312, 0340, 0320, 0330, 12
P12	Crude oil, NGL, and other hydrocarbons incl. oil shale/sands (excl. bio)	2410, 3105, 3106, 3193	2000, 4100, 4200, 4500
P13	Natural gas	4100	3000
P14	Motor spirit (without bio)	3230 = 3234 + 3235	4652, 4651
P15	Kerosenes & jet fuels (without bio)	3240 = 3244 + 3246 + 3247	4669, 4653, 4661
P16	Naphtha	3250	4640
P17	Transport diesel (without bio)	3265	467
P18	Heating and other gasoil (without bio)	3266	467

P19	Residual Fuel Oil	3270A = 3271 + 3272	4680
P20	Refinery gas, ethane & LPG	3210 = 3214 + 3215, 3220	4610, 4620, 4630
P21	Other petroleum products incl. additives/oxygenates and refinery feedstocks	3280 = 3281 + 3282 + 3283 + 3285 + 3286 + 3295, 3192, 3191	4691, 4692, 4695, 4694, 4693, 4699, 4400, 4300
P22	Nuclear fuel	5100	9
P23	Wood, wood waste & other solid biomass, charcoal	5541 = 55411 + 55412 + 55413 + 55414 + 55415, 5544	511, 5150, 5140, 5150, 5160
P24	Liquid biofuels	5545 = 5546 + 5547 + 5548 + 5549	5210, 5220, 5290, 5230
P25	Biogas	5542 = 55421 + 55422 + 55423	5311, 5312, 5319
P26	Electrical energy	6000	7000
P27	Derived Heat	5200, 5550, 5532	8000

The following tables show for each PEFA row class which SIEC position (label and code) and which Eurostat (code) are included. Moreover it presents for each PEFA row class and its sub-items the textual definitions as included in the explanatory notes accompanying the IEA/Eurostat Annual Energy Statistics Questionnaires and the International Recommendations for Energy Statistics (IRES).

### P08 *Hard coal*

The PEFA row class of *hard coal* is a grouping of coals with gross calorific greater than 24 MJ/kg. It includes three sub-items: anthracite, bituminous coal, and coking coal.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Hard coal	2115, 2116, 2117	0110, 0121, 0129	Hard coal refers to coal of gross calorific value equal to or greater than 24 000 kJ/kg on an ash-free but moist basis and with a mean random reflectance of vitrinite of at least 0.6 percent. Hard coal comprises:	Coals with a gross calorific value (moist, ash-free basis) which is not less than 24 MJ/kg or which is less than 24 MJ/kg provided that the coal has a vitrinite mean random reflectance greater than or equal to 0.6 per cent. Hard coal comprises anthracite and bituminous coals.
Anthracite	2115	0110	High rank coal used for industrial and residential applications. It has generally less than 10% volatile matter and a high carbon content (about 90% fixed carbon). Its gross calorific value is equal to or greater than 24 000 kJ/kg on an	A high-rank, hard coal with a gross calorific value (moist, ash-free basis) greater than or equal to 24 MJ/kg and a vitrinite mean random reflectance greater than or equal to 2.0 per cent. Remark: It usually has less than 10%

			<i>ash-free but moist basis.</i>	<i>volatile matter, a high carbon content (about 86-98% carbon) and is non-agglomerating. Anthracite is mainly used for industrial and household heat raising.</i>
<i>Coking coal</i>	2116	0121	<i>Bituminous coal with a quality that allows the production of a coke suitable to support a blast furnace charge. Its gross calorific value is equal to or greater than 24 000 kJ/kg on an ash-free but moist basis.</i>	<i>Bituminous coal that can be used in the production of a coke capable of supporting a blast furnace charge.</i>
<i>Bituminous coal</i>	2117	0129	<i>Coal mainly used for steam raising purposes and includes all bituminous coal that is not included under coking coal nor anthracite. It is characterized by higher volatile matter than anthracite (more than 10%) and lower carbon content (less than 90% fixed carbon). Its gross calorific value is equal to or greater than 24 000 kJ/kg on an ash-free but moist basis. If bituminous coal is used in coke ovens it should be reported as coking coal.</i>	<i>This class includes bituminous coal not included under coking coal. Remark: This is sometimes referred to as "steam coal".</i>

### P09 *Brown coal & Peat*

The PEFA row class of *brown coal & Peat* is a grouping of coals with gross calorific less than 24 MJ/kg and peat. It includes three sub-items: sub-bituminous coal, lignite, and peat.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
<b>Brown coal</b>	<b>2118, 2210</b>	<b>0210, 0220</b>		<b>Brown coal: Coals with a gross calorific value (moist, ash- free basis) less than 24 MJ/ kg and a Vitrinite mean Random Reflectance less than 0.6 per cent. Remark: Brown coal comprises sub-bituminous coal and lignite.</b>
<i>Sub-bituminous coal</i>	2118	0210	<i>Non-agglomerating coal with a gross calorific value equal to or greater than 20 000 kJ/kg and less than 24 000 kJ/kg containing more than 31% volatile matter on a dry mineral matter free basis.</i>	<i>Brown coal with a gross calorific value (moist, ash- free basis) equal to or greater than 20 MJ/kg but less than 24 MJ/kg.</i>
<i>Lignite</i>	2210	0220	<i>Non-agglomerating coal with a gross</i>	<i>Brown coal with a gross calorific value</i>



			calorific value less than 20 000 kJ/kg and greater than 31% volatile matter on a dry mineral matter free basis.	(moist, ash- free basis) less than 20 MJ/kg.
Peat	2310	11	A combustible soft, porous or compressed, fossil sedimentary deposit of plant origin with high water content (up to 90 percent in the raw state), easily cut, and of light to dark brown colour. Peat used for non-energy purposes should not be included here. Milled peat is included here.	A solid formed from the partial decomposition of dead vegetation under conditions of high humidity and limited air access (initial stage of coalification). It is available in two forms for use as a fuel, sod peat and milled peat. Remark: Milled peat is also made into briquettes for fuel use. Peat is not considered a renewable resource as its regeneration period is long.

### P10 Derived gases (= manufactured gases excl. biogas)

The PEFA row class of *derived gases (=manufactured gases excl. biogas)* is a grouping of 'non-natural' gases. It includes four sub-items: coke oven gas, gasworks gas, blast furnace gas, and basic oxygen steel furnace gas.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
<b>Derived gases (= manufactured gases excl. biogas)</b>	<b>4200 = 4210 + 4220 + 4240 + 4230</b>	<b>0350, 0360, 0371, 0372</b>		
Coke oven gas	4210	0350	Obtained as a by-product from the manufacture of coke oven coke for the production of iron and steel. The quantity of fuel should be reported on a gross calorific value basis.	A gas produced from coke ovens during the manufacture of coke oven coke.
Gasworks gas (and other manufactured gases for distribution)	4230	0360	Covers all types of gases produced in public utility or private plants, whose main purpose is manufacture, transport and distribution of gas. It includes gas produced by carbonization (including gas produced by coke ovens and transferred to gas works gas), by total gasification with or without enrichment with oil products (LPG, residual fuel oil, etc.), and by reforming and simple mixing of gases and/or air, reported under the	This group includes gases obtained from the carbonisation or gasification of carbonaceous material of fossil or biomass origins in Gas Works. The gases comprise: (a) gases obtained from carbonisation or gasification of coals, cokes, biomass or waste; and (b) substitute natural gas (a methane-rich gas) made from synthesis gas. Remark: Synthesis gas is a mixture of mainly hydrogen and carbon monoxide obtained by

			<p>rows, From other sources. Under the transformation sector identify amounts of gas work gas transferred to blended natural gas which will be distributed and consumed through the natural gas grid. The quantity of fuel should be reported on a gross calorific value basis. The production of other coal gases (i.e. coke oven gas, blast furnace gas and other recovered gases) should be reported in the columns concerning such gases, and not as production of gas works gas. The coal gases transferred to gas works plants should then be reported (in their own column) in the transformation sector in the gas works plants row. The total amount of gas works gas resulting from transfers of other coal gases should appear in the production line for gas works gas.</p>	<p>cracking hydrocarbons with high temperature steam. The hydrocarbons may be taken from fossil fuels, biofuels or wastes.</p>
Blast furnace gas	4220	0371	<p>Produced during the combustion of coke in blast furnaces in the iron and steel industry. It is recovered and used as a fuel partly within the plant and partly in other steel industry processes or in power stations equipped to burn it. The quantity of recuperated fuel should be reported on a gross calorific value basis. In addition, off-gases from all iron-production reduction processes utilising air as the oxygen source (such as Direct reduced iron) should be reported here.</p>	<p>The by-product gas of blast furnace operation consisting mainly of nitrogen, carbon dioxide and carbon monoxide. Remark: The gas is recovered as it leaves the furnace. Its calorific value arises mainly from the carbon monoxide produced by the partial combustion of coke and other carbon bearing products in the blast furnace. It is used to heat blast air and as a fuel in the iron and steel industry. It may also be used by other nearby industrial plants. Note that where carbonised biomass (e.g. charcoal or animal meal) is used in blast furnaces, part of the carbon supply may be considered renewable.</p>
Basic oxygen steel furnace gas	4240	0372	<p>By-product of the production of steel in an oxygen furnace, recovered on leaving the furnace. The gas is also known as converter gas, LD gas or BOS gas.</p>	<p>The by-product gas of the production of steel in a basic oxygen furnace. The gas is recovered as it leaves the furnace. Remark: The concentration of carbon monoxide in this gas is</p>

				higher than that in blast furnace gas. The gas is also known as converter gas, LD gas or BOSF gas.
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### P11 Secondary coal products (coke, coal tar, patent fuel, BKB and peat products)

The PEFA row class of *secondary coal products* (=manufactured gases excl. biogas) is a grouping of so-called 'secondary' products derived from coal and peat. It includes six sub-items: coke oven coke, gas coke, coal tar, patent fuel, brown coal briquettes (BKB), and peat products.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
<b>Secondary coal products (coke, coal tar, patent fuel, BKB and peat products)</b>	<b>2120 = 2121 + 2122, 2130, 2112, 2230, 2330</b>	<b>0311, 0312, 0340, 0320, 0330, 12</b>		<b>This division includes products derived directly or indirectly from the various classes of coal by carbonisation or pyrolysis processes, or by the aggregation of finely divided coal or by chemical reactions with oxidising agents, including water.</b>
Coke oven coke	2121	0311	<i>The solid product obtained from carbonization of coal, principally coking coal, at high temperature, it is low in moisture and volatile matter. Coke oven coke is used mainly in the iron and steel industry acting as energy source and chemical agent. Coke breeze and foundry coke are included in this category. Semi-coke (a solid product obtained from carbonization of coal at low temperature) should be included in this category. Semi-coke is used as a domestic fuel or by the transformation plant itself. This heading also includes coke, coke breeze and semi-coke made from lignite/brown coal.</i>	<i>The solid product obtained from carbonisation of coking coal at high temperature. Remark: Coke oven coke is low in moisture and volatile matter and has the mechanical strength to support a blast furnace charge. It is used mainly in the iron and steel industry acting as heat source and chemical agent.</i>
Gas coke	2122	0312	<i>By-product of hard coal used for production of town gas in gas works. Gas coke is used for heating purposes.</i>	<i>A by-product from the carbonization of bituminous coal for the manufacture of "gas works gas". Remark: Gas coke is used mainly for heating purposes.</i>

Coal tar	2130	0340	A result of the destructive distillation of bituminous coal or of the low-temperature carbonisation of brown coal. Coal tar from bituminous coal is the liquid by-product of the distillation of coal to make coke in the coke oven process. Coal tar can be further distilled into different organic products (e.g. benzene, toluene, naphthalene), which normally would be reported as a feedstock to the petrochemical industry.	The liquid by-product of the carbonization of coal in coke ovens. Remark: Coal tar may be separated by distillation into several liquid products which may be used for pharmaceutical or wood preservative purposes.
Patent fuel	2112	0320	A composition fuel manufactured from hard coal fines with the addition of a binding agent. The amount of patent fuel produced may, therefore, be slightly higher than the actual amount of coal consumed in the transformation process.	A composition fuel made by moulding hard coal fines into briquette shapes with the addition of a binding agent. Remark: Sometimes referred to as "hard coal briquettes".
Brown coal briquettes (BKB)	2230	0330	BKB is a composition fuel manufactured from lignite or sub-bituminous coal, produced by briquetting under high pressure without the addition of a binding agent.	A composition fuel made of brown coal produced by briquetting under high pressure with or without the addition of a binding agent. Remark: Either sub-bituminous coal or lignite may be used, including dried lignite fines and dust.
Peat products	2330	12	Products such as peat briquettes derived directly or indirectly from sod peat and milled peat.	

### P12 Crude oil, NGL, and other hydrocarbons incl. oil shale/sands (excl. bio)

The PEFA row class of *crude oil, NGL, and other hydrocarbons incl. oil shale/sands (excl. bio)* is a grouping of so-called 'primary' liquid hydrocarbons and oil shale/sands. It includes four sub-items: crude oil, NGL, other hydrocarbons, and oil shale/sands.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Crude oil, NGL, and other hydrocarbons incl. oil shale/sands (excl. bio)	2410, 3105, 3106, 3193	2000, 4100, 4200, 4500		Liquid hydrocarbons of fossil origins comprising crude oil, liquids extracted from natural gas (NGL), fully or partly processed products from the refining of crude oil, and functionally similar liquid

				<b>hydrocarbons and organic chemicals from vegetal or animal origins.</b>
<i>Conventional crude oil</i>	3105	4100	<i>Crude oil is a mineral oil of natural origin comprising a mixture of hydrocarbons and associated impurities, such as sulphur. It exists in the liquid phase under normal surface temperature and pressure and its physical characteristics (density, viscosity, etc.) are highly variable. This category includes field or lease condensate recovered from associated and non-associated gas where it is commingled with the commercial crude oil stream.</i>	<i>A mineral oil of fossil origin extracted by conventional means from underground reservoirs, and comprises liquid or near-liquid hydrocarbons and associated impurities such as sulphur and metals. Remark: Conventional crude oil exists in the liquid phase under normal surface temperature and pressure, and usually flows to the surface under the pressure of the reservoir. This is termed "conventional" extraction. Crude oil includes condensate from condensate fields, and "field" or "lease" condensate extracted with the crude oil. The various crude oils may be classified according to their sulphur content ("sweet" or "sour") and API gravity ("heavy" or "light"). There are no rigorous specifications for the classifications but a heavy crude oil may be assumed to have an API gravity of less than 20° and a sweet crude oil may be assumed to have less than 0.5% sulphur content.</i>
<i>Natural gas liquids (NGL)</i>	3106	4200	<i>NGL are liquid or liquefied hydrocarbons recovered from natural gas in separation facilities or gas processing plants. Natural gas liquids include ethane, propane, butane (normal and iso-), (iso) pentane and pentanes plus (sometimes referred to as natural gasoline or plant condensate).</i>	<i>Natural gas liquids are a mixture of ethane, propane, butane (normal and iso), (iso) pentane and a few higher alkanes collectively referred to as pentanes plus. Remark: NGL are produced in association with oil or natural gas. They are removed in field facilities or gas separation plants before sale of the gas. All of the components of NGL except ethane are either liquid at the surface or are liquefied for disposal. The definition given above is the most commonly used. However, there is some use of terms based on the vapour pressure of the components which are liquid at the surface or can be easily liquefied. The three resulting groups are in order of</i>

				<p>increasing vapour pressure: condensates, natural gasoline and liquefied petroleum gas. NGL may be distilled with crude oil in refineries, blended with refined oil products or used directly. NGL differs from LNG (liquefied natural gas) which is obtained by liquefying natural gas from which the NGL has been removed.</p>
Other hydrocarbons (without bio)	3193	4500	<p>This category includes synthetic crude oil from tar sands, shale oil, etc., liquids from coal liquefaction, (see the Annual coal questionnaire), output of liquids from natural gas conversion into gasoline (see the Annual natural gas questionnaire), hydrogen and emulsified oils (e.g. Orimulsion). All imports of emulsified oils (e.g. Orimulsion) should be reported as imports of Other hydrocarbons. As these oils do not need further processing in a refinery, report these quantities as Direct use and Primary product receipts in the Bitumen category of the Supply of oil products report. Any production of emulsified oils should appear as Indigenous production of Other hydrocarbons. Report all quantities in physical weight of the emulsion (i.e. including the water content).</p>	<p>This division includes non-conventional oils and hydrogen. Non-conventional oils refer to oils obtained by non-conventional production techniques, that is oils which are extracted from reservoirs containing extra heavy oils or oil sands which need heating or treatment (e.g., emulsification) in situ before they can be brought to the surface for refining/processing. They also include the oils extracted from oil sands, extra heavy oils, coal and oil shale which are at, or can be brought to, the surface without treatment and require processing after mining (ex situ processing). Non-conventional oils may also be produced from natural gas. Remark: The oils may be divided into two groups: (i) oils for transformation (e.g., synthetic crudes extracted from extra heavy oils, oil sands, coal and oil shale); and (ii) oils for direct use (e.g., emulsified oils such as orimulsion and GTL liquids). Oil sands are also known as tar sands. Extra heavy oils are also known as bitumen. This is not the oil product of the same name which is made from vacuum distillation residue. Although not a hydrocarbon, hydrogen is included here unless it is a component of another gas.</p>
Oil shale/oil sands	2410	2000	<p>Oil shale production and direct use should be reported in the Annual coal questionnaire under Lignite/brown coal. The production</p>	<p>A sedimentary rock which contains organic matter in the form of kerogen. Kerogen is a waxy hydrocarbon-rich material regarded as a precursor of</p>

			of shale oil (secondary product) is to be reported as Receipts from other sources in the Other hydrocarbons category.	petroleum. Remark: Oil shale may be burned directly or processed by heating to extract shale oil.
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### P13 Natural gas

The PEFA row class of *natural gas* is a mixture of gaseous hydrocarbons; no sub-items.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Natural gas	4100	3000	<p>Natural gas comprises gases, occurring in underground deposits, whether liquefied or gaseous, consisting mainly of methane. It includes both "non-associated" gas originating from fields producing hydrocarbons only in gaseous form, and "associated" gas produced in association with crude oil as well as methane recovered from coal mines (colliery gas) or from coal seams (coal seam gas). Biogases produced by anaerobic digestion of biomass (e.g. municipal or sewage gas) should be reported in the Renewables annual questionnaire, while gas works gas production should be reported in the Coal annual questionnaire. Transfers of such production to the natural gas network will be reported as "Receipts from other sources".</p>	<p>Natural gas is 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.</p> <p>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.</p>

#### P14 Motor spirit (without bio)

The PEFA row class of *motorspirit (without bio)* is a grouping of 2 types of gasoline: motor gasoline and aviation gasoline. This PEFA row class does explicitly not include blending components of biomass origin.

**Remark: We may consider adding a third item: gasoline-type jet fuel (see next P15).**

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Motor gasoline (without bio)	3234	4652	Motor gasoline consists of a mixture of light hydrocarbons distilling between 35°C and 215°C. It is used as a fuel for land based spark ignition engines. Motor gasoline may include additives, oxygenates and octane enhancers, including lead compounds such as TEL (tetraethyl lead) and TML (tetramethyl lead). This category includes motor gasoline blending components (excluding Additives/oxygenates), e.g. alkylates, isomerate, reformat, cracked gasoline destined for use as finished motor gasoline.	A mixture of some aromatics (e.g., benzene and toluene) and aliphatic hydrocarbons in the C5 to C12 range. The distillation range is 25°C to 220°C. Remark: Additives are blended to improve octane rating, improve combustion performance, reduce oxidation during storage, maintain cleanliness of the engine and improve capture of pollutants by catalytic converters in the exhaust system. Motor gasoline may also contain biogasoline products.
Aviation gasoline	3235	4651	This is motor spirit prepared especially for aviation piston engines, with an octane number suited to the engine, a freezing point of -60°C and a distillation range usually within the limits of 30°C and 180°C.	Gasoline prepared especially for aviation piston engines with additives which assure performance under flight conditions. Aviation gasolines are predominantly alkylates (obtained by combining C4 and C5 isoparaffins with C3, C4 and C5 olefins) with the possible addition of more aromatic components including toluene. The distillation range is 25°C to 170°C.

Remark: Gasolines are complex mixtures of volatile hydrocarbons distilling between approximately 25°C and 220°C and consisting of compounds in the C4 to C12 range.

#### P15 Kerosenes & jet fuels (without bio)

The PEFA row class of *kerosenes & jet fuels* is a grouping of 2 classes of kerosene and one type of gasoline (i.e. 3 items): kerosene type jet fuel (without bio), other kerosene, and gasoline-type jet fuel. This PEFA row class does explicitly not include blending components of biomass origin.



Remark: We may consider removing gasoline-type jet fuel to the previous class (more consistent with SIEC).

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Kerosenes		466		Mixtures of hydrocarbons in the range C9 to C16 and distilling over the temperature interval 145°C to 300°C, but not usually above 250°C and with a flash point above 38°C. Remark: The chemical compositions of kerosenes depend on the nature of the crude oils from which they are derived and the refinery processes that they have undergone. Kerosenes obtained from crude oil by atmospheric distillation are known as straight-run kerosenes. Such streams may be treated by a variety of processes to produce kerosenes that are acceptable for blending as jet fuels. Kerosenes are primarily used as jet fuels. They are also used as domestic heating and cooking fuels, and as solvents. Kerosenes may include components or additives derived from biomass.
Kerosene type jet fuel (without bio)	3247	4661	This is a distillate used for aviation turbine power units. It has the same distillation characteristics between 150°C and 300°C (generally not above 250°C) and flash point as kerosene. In addition, it has particular specifications (such as freezing point) which are established by the International Air Transport Association (IATA). This category includes kerosene blending components.	A blend of kerosenes suited to flight conditions with particular specifications, such as freezing point. Remark: The specifications are set down by a small number of national standards committees, most notably ASTM (U.S.), MOD (UK), GOST (Russia).
Other kerosene	3244	4669	Kerosene comprises refined petroleum distillate and is used in sectors other than aircraft transport. It distills between 150°C and 300°C.	Kerosene which is used for heating, cooking, lighting, solvents and internal combustion engines. Remark: Other names for this product are burning oil, vaporizing oil, power kerosene and illuminating oil.
Gasoline-type jet fuel	3246	4653	This includes all light hydrocarbon oils for use in aviation turbine power	Light hydrocarbons for use in aviation turbine power units, distilling between

			units, distilling between 100°C and 250°C. They are obtained by blending kerosene and gasoline or naphtha's in such a way that the aromatic content does not exceed 25% in volume, and the vapour pressure is between 13.7kPa and 20.6kPa.	100°C and 250°C. They are obtained by blending kerosene and gasoline or naphtha in such a way that the aromatic content does not exceed 25 per cent in volume, and the vapour pressure is between 13.7 kPa and 20.6 kPa. Remark: Gasoline-type jet fuel is also known as "aviation turbine fuel".
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### P16 Naphtha

The PEFA row class of *naphtha* is a product group with no further sub-items.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Naphtha	3250	4640	Naphtha is a feedstock destined for either the petrochemical industry (e.g. ethylene manufacture or aromatics production) or for gasoline production by reforming or isomerisation within the refinery. Naphtha comprises material in the 30°C and 210°C distillation range or part of this range. Naphtha imported for blending is reported as an import of Naphtha, then shown on the Interproduct transfer row, as a negative entry for Naphtha, and a positive entry for the corresponding finished product.	Light or medium oils distilling between 30°C and 210°C which do not meet the specification for motor gasoline. Remark: Different naphthas are distinguished by their density and the content of paraffins, isoparaffins, olefins, naphthenes and aromatics. The main uses for naphthas are as feedstock for high octane gasolines and the manufacture of olefins in the petrochemical industry.

### P17 Transport diesel (without bio)

### P18 Heating and other gasoil (without bio)

These two PEFA row classes belong to a superior product class called 'gas oil/diesel oil'. Note that the IEA/Eurostat classification (Annual Energy Statistics Questionnaire) further decomposes gas oils/diesel oil according to their purpose: a) transport and b) heating and other. The SIEC classification does not differentiate between these two purposes.

Note that these two PEFA row classes do explicitly not include blending components of biomass origin.

label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
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Gas oils /diesel oils		4671		Gas oils are middle distillates, predominantly of carbon number range C11 to C25 and with a distillation range of 160°C to 420°C. Remark: The principal marketed products are fuels for diesel engines (diesel oil), heating oils and marine fuel. Gas oils are also used as middle distillate feedstock for the petrochemical industry and as solvents.
Transport diesel (without bio)	3265	467	Gas/diesel oil is primarily a medium distillate distilling between 180°C and 380°C. Several grades are available depending on uses. On-road diesel oil for diesel compression ignition (cars, trucks, etc.), usually of low sulphur content.	
Heating and other gasoil (without bio)	3266	467	Gas/diesel oil is primarily a medium distillate distilling between 180°C and 380°C. Several grades are available depending on uses. Light heating oil for industrial and commercial uses; Marine diesel and diesel used in rail traffic; Other gas oil including heavy gas oils which distil between 380°C and 540°C and which are used as petrochemical feedstocks. This category includes blending components.	

### P19 Residual Fuel Oil

The PEFA row class of *residual fuel oil* covers all residual heavy oils. In the IEA/Eurostat classification it is decomposed into two further sub-items: low-sulphur and high sulphur content.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Fuel Oil	3270A = 3271 + 3272	4680	This covers all residual (heavy) fuel oils (including those obtained by blending). Kinematic viscosity is above 10 cSt at 80°C. The flash point is always above 50°C and density is always more than 0.90 kg/l. - Low sulphur content: Heavy	Comprises residual fuel oil and heavy fuel oil. Residual fuel oils have a distillation range of 350°C to 650°C and a kinematic viscosity in the range 6 to 55 cSt at 100°C. Their flash point is always above 60°C and their specific gravity is above 0.95. Heavy fuel oil is a general term describing a blended product based on the residues from various refinery processes. Remark: Other names commonly used to describe

			fuel oil with sulphur content lower than 1%. - High sulphur content: Heavy fuel oil with sulphur content of 1% or higher.	fuel oil include: bunker fuel, bunker C, fuel oil No. 6, industrial fuel oil, marine fuel oil and black oil. Residual and heavy fuel oil are used in medium to large industrial plants, marine applications and power stations in combustion equipment such as boilers, furnaces and diesel engines. Residual fuel oil is also used as fuel within the refinery.
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### P20 Refinery gas, ethane & LPG

The PEFA row class of *refinery gas, ethane & LPG* covers three gaseous hydrocarbon products: refinery gas, ethane, and liquefied petroleum gases (LPG).

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Refinery gas	3214	4610	Refinery gas includes a mixture of non-condensed gases mainly consisting of hydrogen, methane, ethane and olefins obtained during distillation of crude oil or treatment of oil products (e.g. cracking) in refineries. This also includes gases which are returned from the petrochemical industry.	Includes a mixture of non-condensable gases mainly consisting of hydrogen, methane, ethane and olefins obtained during distillation of crude oil or treatment of oil products (e.g., cracking) in refineries or from nearby petrochemical plants. Remark: It is used mainly as a fuel within the refinery.
Ethane	3215	4620	A naturally gaseous straight-chain hydrocarbon, (C <sub>2</sub> H <sub>6</sub> ) extracted from natural gas and refinery gas streams.	A naturally gaseous straight-chain hydrocarbon (C <sub>2</sub> H <sub>6</sub> ). Remark: Ethane is obtained at gas separation plants or from the refining of crude oil. It is a valuable feedstock for petrochemical manufacture.
Liquefied petroleum gases (LPG)	3220	4630	LPG are light paraffinic hydrocarbons derived from the refinery processes, crude oil stabilisation and natural gas processing plants. They consist mainly of propane (C <sub>3</sub> H <sub>8</sub> ) and butane (C <sub>4</sub> H <sub>10</sub> ) or a combination of the two. They could also include propylene, butylene, isobutene and isobutylene. LPG are normally liquefied under pressure for transportation and storage.	LPG refers to liquefied propane (C <sub>3</sub> H <sub>8</sub> ) and butane (C <sub>4</sub> H <sub>10</sub> ) or mixtures of both. Commercial grades are usually mixtures of the gases with small amounts of propylene, butylene, isobutene and isobutylene stored under pressure in containers. Remark: The mixture of propane and butane used varies according to purpose and season of the year. The gases may be extracted from natural gas at gas separation plants or at plants re-gasifying imported liquefied natural gas. They are also obtained during the refining of crude oil. LPG may be used for heating and as a vehicle fuel. See also the definition for natural gas liquids. Certain oil

				field practices also use the term LPG to describe the high vapour pressure components of natural gas liquids.
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### P21 Other petroleum products incl. additives/oxygenates and refinery feedstocks

The PEFA row class of *other petroleum products incl. additives/oxygenates and refinery feedstock* is a grouping of various petroleum products and one non-hydrocarbon product group used for blending. It comprises 8 sub-items: white spirit and special boiling point industrial spirits (SBP), lubricants, paraffin waxes, petroleum coke, bitumen, other oil products, refinery feedstocks, and additives/oxygenates.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
White spirit and special boiling point industrial spirits (SBP)	3281	4691	White spirit and SBP are defined as refined distillate intermediates with a distillation in the naphtha/kerosene range. They are sub-divided as: - Industrial spirit (SBP): Light oils distilling between 30°C and 200°C. There are 7 or 8 grades of industrial spirit, depending on the position of the cut in the distillation range. The grades are defined according to the temperature difference between the 5% volume and 90% volume distillation points (which is not more than 60°C). - White spirit: Industrial spirit with a flash point above 30°C. The distillation range of white spirit is 135°C to 200°C.	White spirit and special boiling point industrial spirits (SBP) are refined distillate intermediates with a distillation in the naphtha/kerosene range. They are mainly used for non- fuel purposes and sub-divided as: (a) white spirit - an industrial spirit with a flash point above 30°C and a distillation range of 135°C to 200°C; and (b) industrial spirit (SBP) – light oils distilling between 30°C and 200°C. Remark: There are 7 or 8 grades of industrial spirits, depending on the position of the cut in the distillation range. The grades are defined according to the temperature difference between the 5 per cent and 90 per cent volume distillation points (which is not more than 60°C). White spirit and Industrial spirits are mostly used as thinners and solvents.
Lubricants	3282	4692	Lubricants are hydrocarbons produced from distillate by product; they are mainly used to reduce friction between bearing surfaces. This category includes all finished grades of lubricating oil, from spindle oil to cylinder oil, and those used in greases, including motor	Oils, produced from crude oil, for which the principal use is to reduce friction between sliding surfaces and during metal cutting operations. Remark: Lubricant base stocks are obtained from vacuum distillates which result from further distillation of the

			oils and all grades of lubricating oil base stocks.	residue from atmospheric distillation of crude oil. The lubricant base stocks are then further processed to produce lubricants with the desired properties.
Paraffin waxes	3286	4693	These are saturated aliphatic hydrocarbons. These waxes are residues extracted when dewaxing lubricant oils. They have a crystalline structure which is more or less fine according to the grade. Their main characteristics are as follows: they are colourless, odourless and translucent, with a melting point above 45°C.	Residues extracted when dewaxing lubricant oils. The waxes have a crystalline structure which varies in fineness according to the grade, and are colourless, odourless and translucent, with a melting point above 45°C. Remark: Paraffin waxes are also known as "petroleum waxes".
Petroleum coke	3285	4694	Petroleum coke is a black solid by-product, obtained mainly by cracking and carbonising petroleum derived feedstock, vacuum bottoms, tar and pitches in processes such as delayed coking or fluid coking. It consists mainly of carbon (90 to 95%) and has low ash content. It is used as a feedstock in coke ovens for the steel industry, for heating purposes, for electrode manufacture and for production of chemicals. The two most important qualities are "green coke" and "calcinated coke". This category also includes "catalyst coke" deposited on the catalyst during refining processes; this coke is not recoverable and is usually burned as refinery fuel.	Petroleum coke is a black solid obtained mainly by cracking and carbonizing heavy hydrocarbon oils, tars and pitches. It consists mainly of carbon (90 to 95 per cent) and has a low ash content. The two most important categories are "green coke" and "calcined coke". Green coke (raw coke) is the primary solid carbonization product from high boiling hydrocarbon fractions obtained at temperatures below 630°C. It contains 4-15 per cent by weight of matter that can be released as volatiles during subsequent heat treatment at temperatures up to approximately 1330°C. Calcined coke is a petroleum coke or coal-derived pitch coke obtained by heat treatment of green coke to about 1330°C. It will normally have a hydrogen content of less than 0.1 per cent by weight. Remark: In many catalytic operations (e.g., catalytic cracking) carbon or catalytic coke is deposited on the catalyst, thus deactivating it. The catalyst is reactivated by burning off the coke which is used as a fuel

				in the refining process. The coke is not recoverable in a concentrated form.
Bitumen	3283	4695	Bitumen is a solid, semi-solid or viscous hydrocarbon with a colloidal structure, being brown to black in colour, obtained as a residue in the distillation of crude oil, by vacuum distillation of oil residues from atmospheric distillation. Bitumen is often referred to as asphalt and is primarily used for construction of roads and for roofing material. This category includes fluidized and cut back bitumen.	A solid, semi- solid or viscous hydrocarbon with a colloidal structure, being brown to black in color. Remark: It is obtained as a residue in the distillation of crude oil and by vacuum distillation of oil residues from atmospheric distillation. It should not be confused with the nonconventional primary extra heavy oils which may also be referred to as bitumen. In addition to its major use for road pavements, bitumen is also used as an adhesive, a waterproofing agent for roof coverings and as a binder in the manufacture of patent fuel. It may also be used for electricity generation in specially designed power plants. Bitumen is also known in some countries as asphalt but in others asphalt describes the mixture of bitumen and stone aggregate used for road pavements.
Other oil products n.e.c.	3295	4699	All products not specifically mentioned above, for example: tar and sulphur. This category also includes aromatics (e.g. BTX or benzene, toluene and xylene) and olefins (e.g. propylene) produced within refineries.	Products (including partly refined products) from the refining of crude oil and feedstocks which are not specified above. Remark: These products will include basic chemicals and organic chemicals destined for use within the refinery or for sale to or processing in the chemical industry such as propylene, benzene, toluene and xylene.
Additives/oxygenates	3192	4400	Additives are non-hydrocarbon compounds added to or blended with a product to modify fuel properties (octane, cetane, cold properties, etc.): Oxygenates, such as alcohols (methanol, ethanol), ethers (such as MTBE (methyl	Compounds added to or blended with oil products to modify their properties (octane, cetane, cold properties, etc.). Remark: Examples are: (a) oxygenates such as alcohols (methanol, ethanol) and ethers [MTBE (methyl

			<p>tertiary butylether), ETBE (ethyl tertiary butyl ether), TAME (tertiary amyl methyl ether)); Esters (e.g. rapeseed or dimethylester, etc.); Chemical compounds such as TML (tetraethyl lead), TEL (tetramethyl lead) and detergents). Note: Quantities of Additives/oxygenates should relate to the quantities destined for blending with fuels or for fuel use.</p>	<p>tertiary butyl ether), ETBE (ethyl tertiary butyl ether), TAME (tertiary amyl methyl ether)); (b) esters (e.g., rapeseed or dimethylester, etc.); and (c) chemical compounds (such as TML, TEL and detergents). Some additives/oxygenates may be derived from biomass while others may be of fossil hydrocarbon origin.</p>
Refinery feedstocks	3191	4300	<p>A refinery feedstock is a processed oil destined for further processing (e.g. straight run fuel oil or vacuum gas oil) excluding blending. With further processing, it will be transformed into one or more components and/or finished products. This definition also covers returns from the petrochemical industry to the refining industry (e.g. pyrolysis gasoline, C4 fractions, gasoil and fuel oil fractions).</p>	<p>This division includes refinery feedstocks, i.e. oils or gases from crude oil refining or the processing of hydrocarbons in the petrochemical industry which are destined for further processing in the refinery excluding blending. Typical feedstocks include naphthas, middle distillates, pyrolysis gasoline and heavy oils from vacuum distillation and petrochemical plants.</p>

## P22 Nuclear fuel

The PEFA row class of *nuclear fuel* relates to the energy released by nuclear fission or nuclear fusion. It represents the fuel which is used as a transformation input to produce electricity (and heat).

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Nuclear fuels and other fuels n.e.c.	5100	9	<p>Energy released by nuclear fission or nuclear fusion.</p>	<p>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.</p> <p>91 Uranium and plutonium: This division includes uranium ores and concentrates; natural uranium, uranium enriched in U 235, plutonium and their compounds; alloys, dispersions (including cermets), ceramic products and mixtures containing natural uranium, uranium enriched in U 235, plutonium or compounds of these products; as well as fuel elements (cartridges) of nuclear reactors (non- irradiated or irradiated).</p> <p>92 Other nuclear fuels: This division includes thorium and its</p>



				<p>compounds; alloys, dispersions (including cermets), ceramic products and mixtures containing thorium or compounds of thereof; other radioactive elements and isotopes and compounds (other than uranium, thorium or plutonium); alloys, dispersions (including cermets), ceramic products and mixtures containing these elements, isotopes or compounds.</p> <p>99 Other fuels n.e.c.: This division includes fuels not elsewhere classified.</p>
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### P23 Wood, wood waste & other solid biomass, charcoal

The PEFA row class of *wood, wood waste & other solid biomass, charcoal* is a grouping of non-fossil material derived from biomass that is used for energy purposes. This class comprises 5 sub-items.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
<b>Wood, wood waste &amp; other solid biomass, charcoal</b>	<b>5541 = 55411 + 55412 + 55413 + 55414 + 55415, 5544</b>	<b>511, 5120, 5140, 5150, 5160</b>	<b>Covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation.</b>	<b>Solid fuels derived from biomass.</b>
Fuelwood, wood residues and by-products	55411 + 55412	511	Fuelwood or firewood (in log, brushwood, pellet or chip form) obtained from natural or managed forests or isolated trees. Also included are wood residues used as fuel and in which the original composition of wood is retained. Charcoal and black liquor are excluded. The quantity of fuel used should be reported on a net calorific value basis. Wood pellets are a cylindrical product which has been agglomerated from wood residues by compression with or without the addition of a small quantity of binder. The pellets have a diameter not exceeding 25 mm and a length not exceeding 45 mm. Note: EU countries should refer to Commission Regulation (EU) No 1006/2011 of 27	Fuelwood or firewood (in log, brushwood, pellet or chip form) obtained from natural or managed forests or isolated trees. Also included are wood residues used as fuel and in which the original composition of wood is retained. Remark: Charcoal and black liquor are excluded. Wood pellets are a cylindrical product which has been agglomerated from wood residues by compression with or without the addition of a small quantity of binder. The pellets have a diameter not exceeding 25 mm and a length not exceeding 45 mm.

			September 2011 amending Annex I to Council Regulation (EEC) NO 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff.	
Bagasse	55413	5120	Fuel obtained from the fibre which remains after juice extraction in sugar cane processing.	Fuel obtained from the fibre which remains after juice extraction in sugar cane processing.
Black liquor	55414	5140	Energy from the alkaline-spent liquor obtained from the digesters during the production of sulphate or soda pulp required for paper manufacture.	The alkaline-spent liquor obtained from the digesters during the production of sulphate or soda pulp required for paper manufacture. Remark: The lignin contained in the liquor burns to release heat when the concentrated liquor is sprayed into a recovery furnace and heated with hot gases at 900°C. Black liquor is used as a fuel in the pulping process.
Other vegetal material and residues	55415	5150	Biofuels not specified elsewhere and including straw, vegetable husks, ground nut shells, pruning brushwood, olive pomace and other wastes arising from the maintenance, cropping and processing of plants.	Solid primary biofuels not specified elsewhere, including straw, vegetable husks, ground nut shells, pruning brushwood, olive pomace and other wastes arising from the maintenance, cropping and processing of plants.
Charcoal	5544	5160	Char coal covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.	The solid residue from the carbonisation of wood or other vegetal matter through slow pyrolysis.

## P24 Liquid biofuels

The PEFA row class of *liquid biofuels* is a grouping of fuels derived from biomass. It includes 4 sub-items.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Liquid biofuels	5545 = 5546 + 5547 + 5548 + 5549	5210, 5220, 5290, 5230		Liquids derived from biomass and used as fuels. Remark: Liquid biofuels comprise biogasoline, biodiesels, bio jet kerosene and other liquid biofuels. They are used for transport, electricity generation and stationary engines.
Biogasoline	5546	5210	This category includes bioethanol	Liquid fuels derived from biomass and

			<p>(ethanol produced from biomass and/or the biodegradable fraction of waste), biomethanol (methanol produced from biomass and/or the biodegradable fraction of waste), bioETBE (ethyl-tertio-butyl-ether produced on the basis of bioethanol: the percentage by volume of bioETBE that is calculated as biofuel is 47%) and bioMTBE (methyl-tertio-butyl-ether produced on the basis of biomethanol: the percentage by volume of bioMTBE that is calculated as biofuel is 36%).</p>	<p>used in spark- ignition internal combustion engines. Remark: Common examples are: bioethanol (including both hydrous and anhydrous ethanol); biomethanol; biobutanol; bio ETBE (ethyl- tertio-butyl-ether); and bio MTBE (methyl- tertio-butyl-ether). Biogasoline may be blended with petroleum gasoline or used directly in engines. The blending may take place in refineries or at or near the point of sale.</p>
Biodiesels	5547	5220	<p>This category includes biodiesel (a methyl-ester produced from vegetable or animal oil, of diesel quality), biodimethylether (dimethylether produced from biomass), Fischer Tropsch (Fischer Tropsch produced from biomass), cold pressed biooil (oil produced from oil seed through mechanical processing only).</p>	<p>Liquid biofuels derived from biomass and used in diesel engines. Remark: Biodiesels obtained by chemical modification are a linear alkyl ester made by transesterification of vegetable oils or animal fats with methanol. The transesterification distinguishes biodiesel from straight vegetable and waste oils. Biodiesel has a flash point of around 150°C and a density of about 0.88 kg/litre. Biological sources of biodiesel include, but are not limited to, vegetable oils made from canola (rapeseed), soybeans, corn, oil palm, peanut or sunflower. Some liquid biofuels (straight vegetable oils) may be used without chemical modification and their use usually requires modification of the engine. A further category of diesel fuels can be produced by a range of thermal processes, including for example gasification followed by Fischer Tropsch synthesis, pyrolysis followed by hydrogenation, or conversion of sugar to hydrocarbons using microorganisms (e.g. yeast). A wide range of biomass feedstocks, including cellulosic materials and algal biomass could be used in such processes. Biodiesels may be blended with petroleum diesel or used directly in diesel engines.</p>

Other liquid biofuels	5548	5290	This category includes liquid biofuels, used directly as fuel, not included in the definitions of biogasoline, biodiesel or bio jet kerosene and liquid biofuels consumption that cannot be reported under the right category because of missing information.	This group includes liquid biofuels not elsewhere specified.
Bio jet kerosene	5549	5230	Liquid biofuels derived from biomass and blended with Jet kerosene.	Liquid biofuels derived from biomass and blended with or replacing jet kerosene. Remark: Bio jet kerosene can be produced by a range of thermal processes (including for example gasification followed by Fischer-Tropsch synthesis, pyrolysis followed by hydrogenation, or conversion of sugar to hydrocarbons using microorganisms (e.g. yeast). A wide range of biomass feedstocks, including cellulosic materials and algal biomass could be used in such processes.

## P25 Biogas

The PEFA row class of *biogas* is a grouping of gaseous fuels derived from biomass. At least in the case of IEA/Eurostat it consists of three sub-items: landfill gas, sewage sludge gas, and other biogases.

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Biogas	5542 = 55421 + 55422 + 55423	5311, 5312, 5319	<p>Gases composed principally of methane and carbon dioxide produced by anaerobic fermentation of biomass.</p> <ul style="list-style-type: none"> <li>- Landfill gas: formed by the anaerobic digestion of landfill waste. The quantity of fuel used should be reported on a net calorific value basis.</li> <li>- Sewage sludge gas: produced from the anaerobic fermentation of sewage sludge. The quantity of fuel used should be reported on a net calorific value basis.</li> <li>- Other biogases from anaerobic</li> </ul>	<p>The biogases from anaerobic fermentation are composed principally of methane and carbon dioxide and comprise landfill gas, sewage sludge gas and other biogases from anaerobic fermentation. Explanation: The biogases from anaerobic fermentation are composed principally of methane and carbon dioxide and include gas produced from a range of wastes and other biomass materials including energy crops in anaerobic digesters (including sewage sludge gas and landfill gas). The gases may be processed to remove the carbon dioxide and other constituents to produce a methane fuel.</p> <ul style="list-style-type: none"> <li>- Landfill gas: Biogas from the anaerobic fermentation of organic matter in landfills.</li> </ul>

			<p>digestion: such as biogases produced from the anaerobic fermentation of animal slurries and of waste in abattoirs, breweries and other agro-food industries. The quantity of fuel used should be reported on a net calorific value basis.</p>	<ul style="list-style-type: none"> <li>- Sewage sludge gas: Biogas from the anaerobic fermentation of waste matter in sewage plants.</li> <li>- Other biogases from anaerobic fermentation: Other biogases from anaerobic fermentation not elsewhere specified. Remark: Two of the largest sources of these biogases are the fermentation of energy crops and the fermentation of manure on farms.</li> </ul>
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### P26 Electrical energy

The PEFA row class of xxx is a grouping of .....

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Electricity	6000	7000	n.a.	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.

### P27 Derived Heat

The PEFA row class of xxx is a grouping of .....

SIEC label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Heat	5200, 5550, 5532	8000	<ul style="list-style-type: none"> <li>- Geothermal energy is available as heat emitted from within the earth's crust, usually in the form of hot water or steam. It is exploited at suitable sites directly as heat for district heating, agriculture, etc.</li> <li>- Solar thermal energy: Solar radiation exploited for heat generation. Solar thermal consist of equipment for the production of heat for sale (hot water or steam).</li> </ul>	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.

## Natural Energy Inputs

The PEFA classification of rows includes 7 natural energy inputs which are shown in the following table. The category or type of natural energy input is unknown to energy statistics which only deal with products (in the sense of national accounts and SEEA-CF).

Nevertheless each natural energy input class can at least indirectly be linked to certain products which are defined in international classifications; these relations are shown in the following table.

This indirect link is as follows: usually an energy product has a counterpart in form of a natural input flow. E.g. the coal mining industry is producing a certain amount of the product anthracite. This requires some input from nature, i.e. natural energy inputs. One may assume that the energy content of the respective natural input is at least equal (or even bigger in the case of energy losses during extraction) than the amount of energy content in the product output, in this case anthracite.

PEFA are compiled on the basis of energy statistics which usually only contain statistics on the supply and use of products (in the sense of national accounts and SEEA). This information is used to approximate the natural energy input flows associated e.g. with the production of coal, crude oil, natural gas etc. In other words the indigenous production of the so-called primary energy products is used to approximate the counter flow of natural energy inputs.

Note that the SIEC classification does not distinguish electricity and heat by various renewable sources, such as hydro, wind, solar, geothermal etc. The IEA/Eurostat classification allows doing so. However one should bear in mind that the IEA/Eurostat codes actually denote the products electricity and heat.

PEFA code	PEFA label (closely aligned to SIEC labels)	Eurostat <i>product</i> code used to approximate the <i>natural input</i> flow	SIEC <i>product</i> code used to approximate the <i>natural input</i> flow
N01	Fossil non-renewable natural energy inputs	2115, 2116, 2117, 2118, 2210, 2310, 2410, 3105, 3106, 3193, 4100	0110, 0121, 0129, 0210, 0220, 11, 2000, 4100, 4200, 4500, 3000
N02	Nuclear non-renewable natural energy inputs	5100 (electricity)	9
N03	Hydro based renewable natural energy inputs	5510 (electricity)	-
N04	Wind based renewable natural energy input	5520 (electricity)	-
N05	Solar based renewable natural energy input	5532, 5534 (electricity, heat)	-
N06	Biomass based renewable natural energy input Renewable natural	55411, 55412, 55415, 55423, 5545 = 5546 + 5547 + 5548 + 5549	511, 5150, 5319, 5210, 5220, 5290

	inputs - biomass	(electricity, heat)	
N07	Other renewable natural energy input	5550, 5535 (electricity, heat)	-

## Energy Residuals

The PEFA classification of rows includes 4 energy residuals which are shown in the following table. In general, the category or type of *energy residual* is unknown to energy statistics which only deal with *products* (in the sense of national accounts and SEEA-CF).

Waste, represented by two out of 4 residual classes, is also contained in international classifications of energy commodities as long as waste is used to recover energy. Hence these two energy residual classes are directly linkable to the international classifications; these relations are shown in the following table.

PEFA code	PEFA label (closely aligned to SIEC labels)	Eurostat <i>product</i> code used to approximate the <i>natural input</i> flow	SIEC <i>product</i> code used to approximate the <i>natural input</i> flow
R28	Renewable waste (without monetary value)	55431	6200
R29	Non-renewable waste (without monetary value)	55432, 7100	6100, 6200
R30	Energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use)		
R31	Balancing item: Energy incorporated in products for non-energy use		

The IEA/Eurostat classification distinguishes between renewable and non-renewable municipal waste on the one and industrial waste on the other. The SIEC distinguishes between municipal and industrial waste and remarks that municipal waste can be further decomposed into renewable and non-renewable. The definitions of the various wastes are presented in the following table.

PEFA label	Eurostat code	SIEC code	IEA/Eurostat definition	IRES definition
Renewable waste	55431	6200	Municipal waste renewable: waste produced by households, industry, hospitals and the tertiary sector which is biological material collected by local authorities and incinerated at specific installations.	Municipal waste renewable: Household waste and waste from companies and public services that resembles household waste and which is collected at installations specifically designed for the disposal of mixed wastes with recovery of combustible liquids, gases or heat.
Non-	55432,	6100,	- Municipal waste non-	- Municipal waste non-renewable: Household

renewable waste	7100	6200	<p>renewable: waste produced by households, industry, hospitals and the tertiary sector which is non-biological material collected by local authorities and incinerated at specific installations.</p> <p>- Waste of industrial non-renewable origin (solids or liquids) combusted directly for the production of electricity and/or heat. Renewable industrial waste should be reported in the Solid biofuels, Biogases and/or Liquid biofuels categories.</p>	<p>waste and waste from companies and public services that resembles household waste and which is collected at installations specifically designed for the disposal of mixed wastes with recovery of combustible liquids, gases or heat.</p> <p>- Industrial waste: non-renewable waste which is combusted with heat recovery in plants other than those used for the incineration of municipal waste. Remark: Examples are used tires, specific residues from the chemical industry and hazardous wastes from health care. Combustion includes co-firing with other fuels. The renewable portions of industrial waste combusted with heat recovery are classified according to the biofuels which best describe them.</p>
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## Annex 2: Classification of columns in PEFA Tables A, B and C (industries, households, accumulation, rest of the word, environment)

PEFA Tables A, B and C are physical supply and use tables. In accordance with SEEA-CF their columns are classified into five broad kind of activity categories: production, consumption, accumulation, rest of the word, and environment (see sections 2.1 and 3.4). PEFA Table D includes a set of 7 row-vectors (key indicators) and has the same column structure.

Production activities are further broken down by NACE sections (one letter) and divisions (2 digits). The PEFA questionnaire employs a 2-level hierarchical nested classification for the production activities. On the lowest level – mainly divisions – 64 groupings of industries are distinguished. This A\*64 aggregation level is also employed in ESA supply, use and input-output tables. The higher level corresponds to the 21 one-letter-sections (A\*21).

The consumption activities consider only private household consumption which is subdivided into three purposes: transport, heating/cooling, and others. Government consumption activities are not considered in the classification of columns. In monetary accounts government final consumption records the acquisition and consumption of their own output because the final user cannot be specified as it is the entire society (see SEEA-CF §§3.27ff). This convention of booking has no equivalent in physical flow accounts. The energy flows related to production activities of government are entirely recorded in the first generic column, i.e. production activities.

Accumulation, rest of the word, and environment constitute three single columns which are not further broken down.

level	code	label
1	A_U 01-99	Total NACE industries
2	A	Agriculture, forestry and fishing
3	A01	Crop and animal production, hunting and related service activities
3	A02	Forestry and logging
3	A03	Fishing and aquaculture
2	B	Mining and quarrying
2	C	Manufacturing
3	C10_C12	Manufacture of food products, beverages and tobacco products
3	C13-C15	Manufacture of textiles, wearing apparel and leather products
3	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
3	C17	Manufacture of paper and paper products
3	C18	Printing and reproduction of recorded media
3	C19	Manufacture of coke and refined petroleum products

3	C20	Manufacture of chemicals and chemical products
3	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
3	C22	Manufacture of rubber and plastic products
3	C23	Manufacture of other non-metallic mineral products
3	C24	Manufacture of basic metals
3	C25	Manufacture of fabricated metal products, except machinery and equipment
3	C26	Manufacture of computer, electronic and optical products
3	C27	Manufacture of electrical equipment
3	C28	Manufacture of machinery and equipment n.e.c.
3	C29	Manufacture of motor vehicles, trailers and semi-trailers
3	C30	Manufacture of other transport equipment
3	C31_C32	Manufacture of furniture; other manufacturing
3	C33	Repair and installation of machinery and equipment
2	D	Electricity, gas, steam and air conditioning supply
2	E	Water supply; sewerage, waste management and remediation activities
3	E36	Water collection, treatment and supply
3	E37-E39	Sewerage, waste management, remediation activities
2	F	Construction
2	G	Wholesale and retail trade; repair of motor vehicles and motorcycles
3	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
3	G46	Wholesale trade, except of motor vehicles and motorcycles
3	G47	Retail trade, except of motor vehicles and motorcycles
2	H	Transportation and storage
3	H49	Land transport and transport via pipelines
3	H50	Water transport
3	H51	Air transport
3	H52	Warehousing and support activities for transportation
3	H53	Postal and courier activities
2	I	Accommodation and food service activities
2	J	Information and communication
3	J58	Publishing activities
3	J59_J60	Motion picture, video, television programme production; programming and broadcasting activities
3	J61	Telecommunications

3	J62_J63	Computer programming, consultancy, and information service activities
2	K	Financial and insurance activities
3	K64	Financial service activities, except insurance and pension funding
3	K65	Insurance, reinsurance and pension funding, except compulsory social security
3	K66	Activities auxiliary to financial services and insurance activities
2	L	Real estate activities
3	L68A	Of which: Imputed rents of owner-occupied dwellings
2	M	Professional, scientific and technical activities
3	M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
3	M71	Architectural and engineering activities; technical testing and analysis
3	M72	Scientific research and development
3	M73	Advertising and market research
3	M74_M75	Other professional, scientific and technical activities; veterinary activities
2	N	Administrative and support service activities
3	N77	Rental and leasing activities
3	N78	Employment activities
3	N79	Travel agency, tour operator reservation service and related activities
3	N80-N82	Security and investigation, service and landscape, office administrative and support activities
2	O	Public administration and defence; compulsory social security
2	P	Education
2	Q	Human health and social work activities
3	Q86	Human health activities
3	Q87_Q88	Residential care activities and social work activities without accommodation
2	R	Arts, entertainment and recreation
3	R90-R92	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities
3	R93	Sports activities and amusement and recreation activities
2	S	Other service activities
3	S94	Activities of membership organisations
3	S95	Repair of computers and personal and household goods
3	S96	Other personal service activities
2	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
2	U	Activities of extraterritorial organisations and bodies

1	HH	Total activities by households
2	HH_HEAT	Heating/cooling activities by households
2	HH_TRA	Transport activities by households
2	HH_OTH	Other activities by households
1	CHINV_PA	Changes in inventories and produced assets
1	STADIF	Statistical Differences
1	ROW_ACT	Rest of the World - economic activities
1	ENV	Environment