CREEA - Compiling and Refining Environmental and Economic Accounts

Report and data Task 4.2: P-SUT

Authors:
Stefano Merciai (2.-0 LCA consultants)
Jannick Schmidt (2.-0 LCA consultants)
Randi Dalgaard (2.-0 LCA consultants)
Stefan Giljum (SERI)
Stephan Lutter (SERI)
Arkaitz Usubiaga (Wuppertal Institute)
Josè Acosta (Wuppertal Institute)
Helmut Schütz (Wuppertal Institute)
Dominic Wittmer (Wuppertal Institute)
Roel Delahaye (Statistics Netherlands)

CREEA is a Collaborative project funded by the EU's
Seventh Framework Program – Theme ENV.2010.4.2.2-1
Grant agreement no: 265134

Deliverable number:	**D4.2**
Revision number:	**-**
Date of current draft:	**13 September 2011**
Due date of deliverable:	**1st February 2013**
Actual submission date:	**5th July 2013**
Dissemination level:	**PU (Public)**

CREEA

Compiling and Refining Environmental and Economic Accounts
Funded by the EU's Seventh Framework Program – Theme ENV.2010.4.2.2-1
Collaborative project
Grant agreement no: 265134
Start date of the project: 1 April 2011, Duration: 36 Months

About CREEA

The main goal of CREEA is to refine and elaborate economic and environmental accounting principles as discussed in the London Group and consolidated in the future SEEA 2012, to test them in practical data gathering, to troubleshoot and refine approaches, and show added value of having such harmonized data available via case studies. This will be done in priority areas mentioned in the call, i.e. waste and resources, water, forest and climate change / Kyoto accounting. In this, the project will include work and experiences from major previous projects focused on developing harmonized data sets for integrated economic and environmental accounting (most notably EXIOPOL, FORWAST and a series of EUROSTAT projects in Environmental Accounting). Most data gathered in CREEA will be consolidated in the form of Environmentally Extended Supply and Use tables (EE SUT) and update and expand the EXIOPOL database. In this way, CREEA will produce a global Multi-Regional EE SUT with a unique detail of 130 sectors and products, 30 emissions, 80 resources, and 43 countries plus a rest of world. A unique contribution of CREEA is that also SUT in physical terms will be created. Partners are:

1. Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek (TNO), Netherlands (co-ordinator)
2. JRC -Joint Research Centre- European Commission (DG JRC IPTS), Belgium /Spain
3. Universiteit Leiden (Unileiden), Netherlands
4. Centraal Bureau voor de Statistiek (CBS), Netherlands
5. Norges Teknisk-Naturvitenskapelige Universitet (NTNU), Norway
6. Statistiska Centralbyran (SCB), Sweden
7. Universiteit Twente (TU Twente), Netherlands
8. Eidgenössische Technische Hochschule Zürich (ETH) Switzerland
9. 2.-0 LCA Consultants Aps (2.-0 LCA), Denmark
10. Wuppertal Institut Fur Klima, Umwelt, Energie Gmbh. (WI), Germany
11. SERI - Nachhaltigkeitsforschungs Und –Kommunikations Gmbh (SERI) Austria
12. European Forest Institute (EFI), Finland / Spain

For more information contact the co-ordinator at: arnold.tukker@tno.nl

Executive Summary

This report describes the mass-flows data collected and how they have been used in order to have fully balanced physical supply and use tables (PSUTs) that are fully consistent with the monetary accounts.
The amount of collected data is enormous and the whole process has taken long time within the CREEA project. Data collection had to meet two requirements:
- the search for reliable data with enough detail to satisfy the requirements of the CREEA data set;
- the choice of data sets that are continuously upgraded, since reproducibility of the database production needs to be ensured.

Thus, working with such guidelines in mind, the data collection was firstly driven towards international agencies databases, such as FAO, IEA, Eurostat and so on, and only when these were not exhaustive, alternative sources were used, i.e. specialized websites or scientific journal papers.

The explanation of the data collection process in the current report has been divided in chapters according to different accounts of PSUTs.

The **first chapter** is dedicated to the introduction and aims to describe the framework adopted for the PSUTs as previously described in deliverable D4.1.

The **second chapter** deals with the accounting of the supply of products. For this accounts many different data sources have been investigated. FAOSTAT has been chosen for the accounting of agricultural and food products, since it provides reliable and very comprehensive data. For the manufacture products, many different data sets have been used. The main sources are the PRODCOM provided by Eurostat, the United States and British Geological surveys for metal products, International Fertilisers Industry Association for fertilisers, and International Energy Agency (IEA) for energy products. For many manufactured products there were not complete data, hence estimations from monetary data divided by prices have been used. Finally, for waste treatment services the main sources are the waste accounts of Eurostat, the United States Environmental Protection Agency, The Canadian Statistics and many other national reports and articles. It is noteworthy to mention that, whenever a physical supply flow is collected, it is also possible to determine domestic prices endogenously.

In the **third chapter** the data collection process of use-side accounts is presented. The only data on the uses of product that have been collected are concerned with energy products. Here the IEA has played a fundamental role, even though a great effort has been put on the reallocation of energy product flows according to the CREEA classification. Furthermore, always remaining on the use-side, technical coefficients

have been collected. The latter have been used for disaggregating and shaping the production functions of the productive actives. For this task, among the others, we have strongly relied on Ecoinvent and FORWAST data sets. Finally a complete mass balance for crops and animals has been produced using the procedure outlined by IPCC.

The **fourth chapter** deals with trade flows and trade prices. These data have been used for the PSUTs generation although the process of collection has taken place in WP7. Export prices have been used as domestic prices when these could not be calculated endogenously because the physical supply figure was not available.

The **fifth chapter** introduces the emission and resource factors used for the generation of accounts concerning the exchanges with the environment. The emission factors are determined mainly based on IPCC guidelines. This is valid for the emissions from crops and animals, and from combustion and non-combustion of energy products. However more detailed information on the procedure applied for the latter is in the deliverable D6.1. Emissions from the treatment of waste flows have been taken from FORWAST. With regard to resource factors, SERI and Wuppertal Institute database have covered most of the data need.

The **sixth chapter** shows some other coefficients that are necessary for the generation of PSUTs. These refer to the dry matter coefficients, which are calculated for each product. They are used for converting the collected flows in dry matter, since the PSUTS are constructed in dry-matter tonnes. The second group of coefficients refer to the transfer coefficients, which indicate how much of a product is embodied in the final production of an activity. These coefficients are taken from the FORWAST data set.

The **seventh chapter** explains the model used for the balancing of all the collected data. The model also generates the supply of waste accounts endogenously. The idea behind the algorithm is that the data of supply-side accounts are kept constant and the uses are allocated in order to satisfy the Mass Conservation Law. At the same time the model uses the MSUTs as constraints so that consistency between the physical and monetary level are assured. The final outcome of the model is PSUTs. In addition, the model produces hybrid mixed-unit SUTs. Figure 1 shows the main relations of the model and how the algorithm works.

The **annex** makes a comparison between supply and use tables compiled by CREEA and Statistics Netherlands. It seems that on an aggregated level the domestic monetary supply and use table compiled by CREEA matches the supply and use table of the Statistics Netherlands quite closely. However, on a disaggregated level the CREEA and CBS tables show differences for some product groups and industrial branches. The discrepancies between the CBS and CREEA data grow larger when physical data is considered. Therefore the usefulness of the physical

CREEA supply and use tables for accounting purposes by individual countries is therefore questionable.

Concluding, the generation of the PSUTs has been a very difficult task because of poor physical data availability. A comprehensive data source exists only for the EU member countries and for the US. However also for these countries some flows, mainly with regard to manufacture products, are still lacking to some extent. The same applies for the waste flows, where the detail of CREEA was never reached by any data sets investigated. Hence, many estimations were needed.

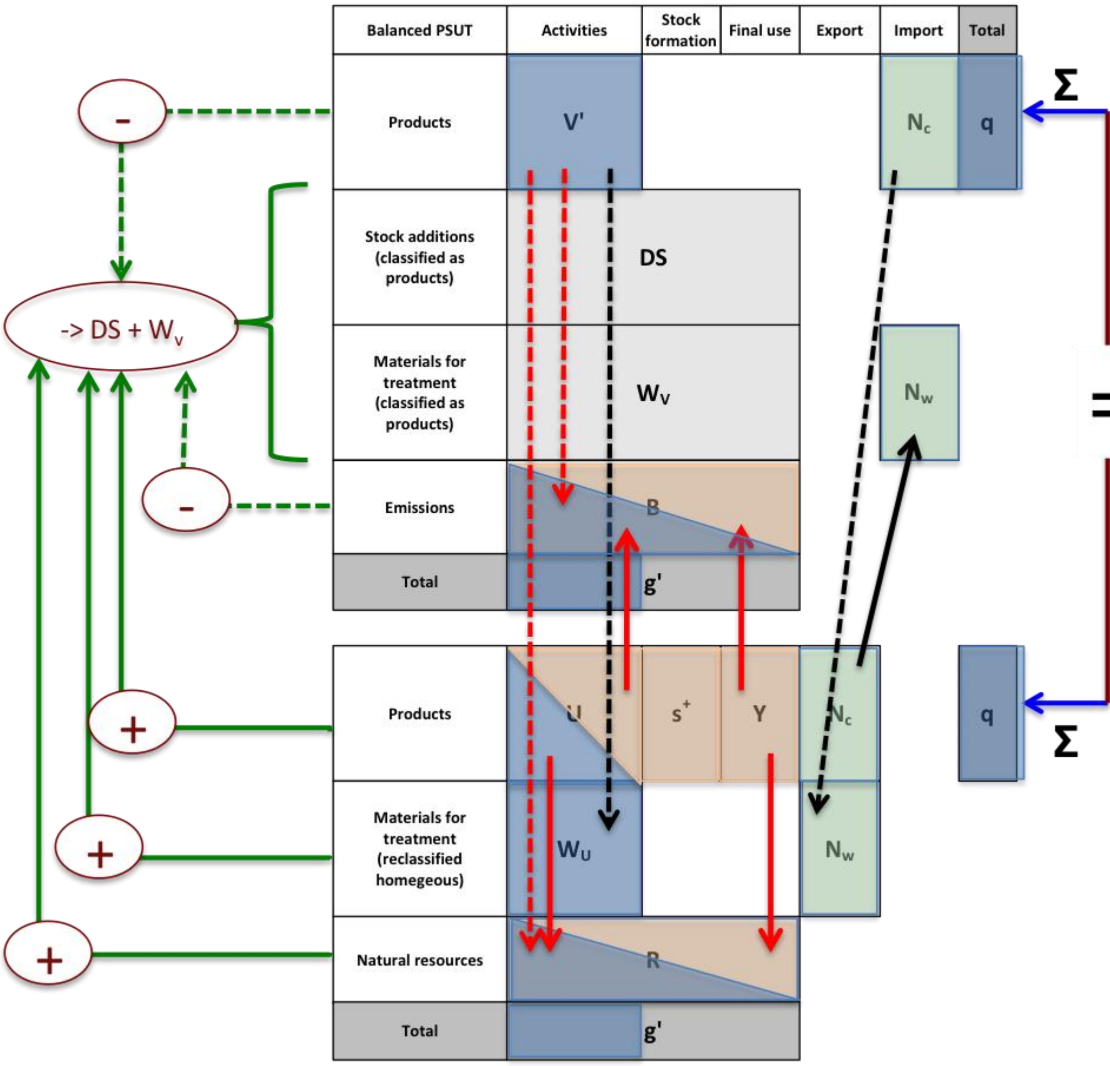


Figure 1 : The model used for generating the PSUTs.

Accounts painted in blue and in green, are derived exogenously, while the others in orange, or in light grey, are determined endogenously. Accounts painted half in blue and half in orange are partially determined endogenously and partially exogenously. The dotted line indicates there is a relation that is triggered by the supply of; instead the continuous line shows a relation generated by the use of. Red lines are meant to indicate where coefficients are used, while the red line where direct relation exists. Finally on the left side there is the equation for determining the supply of waste account, while on the right side the commodity balance.

1 Introduction

In the process of generating Physical Supply and Use tables, the phase of data collection has a very relevant place, even more if the reproducibility of the process is at stake. Data collection needs to follow two requirements. On the one hand it is important to search for reliable data with enough detail to satisfy the requirements of the CREEA data set; on the other hand, it is preferable to use data sources that are continuously upgraded so that in the future the data set can be easily renewed.

Working with such guideline in mind, the data collection was firstly driven towards international agencies databases, such as FAO, IEA, Eurostat and so on, and only when these were not exhaustive, alternative sources were used, i.e. specialized websites or scientific journal papers.

The use of international agencies databases was favoured due to two main reasons: the first one is that data could be directly extracted for many and even sometimes all the countries and regions selected within the CREEA project. The second one is that the use of these databases reduces the risk of inconsistencies resulting from different procedures and assumptions adopted by data set makers.

The amount of data collected within the WP4 is, hence, enormous. In order to facilitate the reading, the documentation of the sources used in the data collection is organized in different chapters that follow the structure of PSUTs, as shown in Figure 1.1 (see deliverable D4.1: Schmidt et al., 2013) for a more exhaustive picture of the adopted framework). Once the data collection phase is finalized, all this information enters into a model (see deliverable D4.1 for the theoretical approach of the model) that assures consistency between the different sources. So the final output of the model is fully balanced PSUTs, which are harmonized with the monetary accounts.

Figure 1.1 helps us to understand how the initial estimated have been constructed. The blue parts indicate accounts where data collection is aimed to group mass flows directly from documented sources. This case refers to the supply of products and, given the proportionality, the use of waste flows (use of waste flows is the physical counterpart of the supply of waste treatment services). The supply of product in physical terms, in combination with the monetary data, also allows us to determine the domestic prices. When it is not possible to have supplied products in physical terms, prices are obtained from alternative sources (see deliverable D7.1). Data collected for the blue parts are considered exogenous and are not touched by the balance-solving model.

The orange parts in Figure 1.1 instead indicate where coefficients are collected or calculated, and used to generate initial estimates of the accounts in combination with monetary values. This refers to emission and resource accounts. Notice that the use of products is painted in blue and orange. This is because the use of products is partially generated by physical flows directly accounted, i.e. the energy products, and partially by technical coefficients in combination with monetary values.

The green parts in Figure 1.1 refer to initial estimates derived from monetary values divided by prices. For these accounts there is no data collection of physical flows. This case refers to the trade data and to final demand accounts. Trade data are also kept constant in the model.

With regard to remaining accounts, which are left in light grey, no data collection takes place too. These accounts are completely determined by the model.

The report is structured as follows: chapter 2 shows the references and the accounting of the supply of goods and services; chapter 3 shows the process of collection of technical coefficients and of energy products; chapter 4 introduces the data sources for the trade data; chapter 5 those for the generation of emission and natural resource coefficients; chapter 6 introduces other coefficients that are important for the generation of PSUTs; chapter 7 is dedicated to the explanation of the balance-solving model used for the construction of the PSUTs. Finally in chapter 8 the Conclusions are outlined.

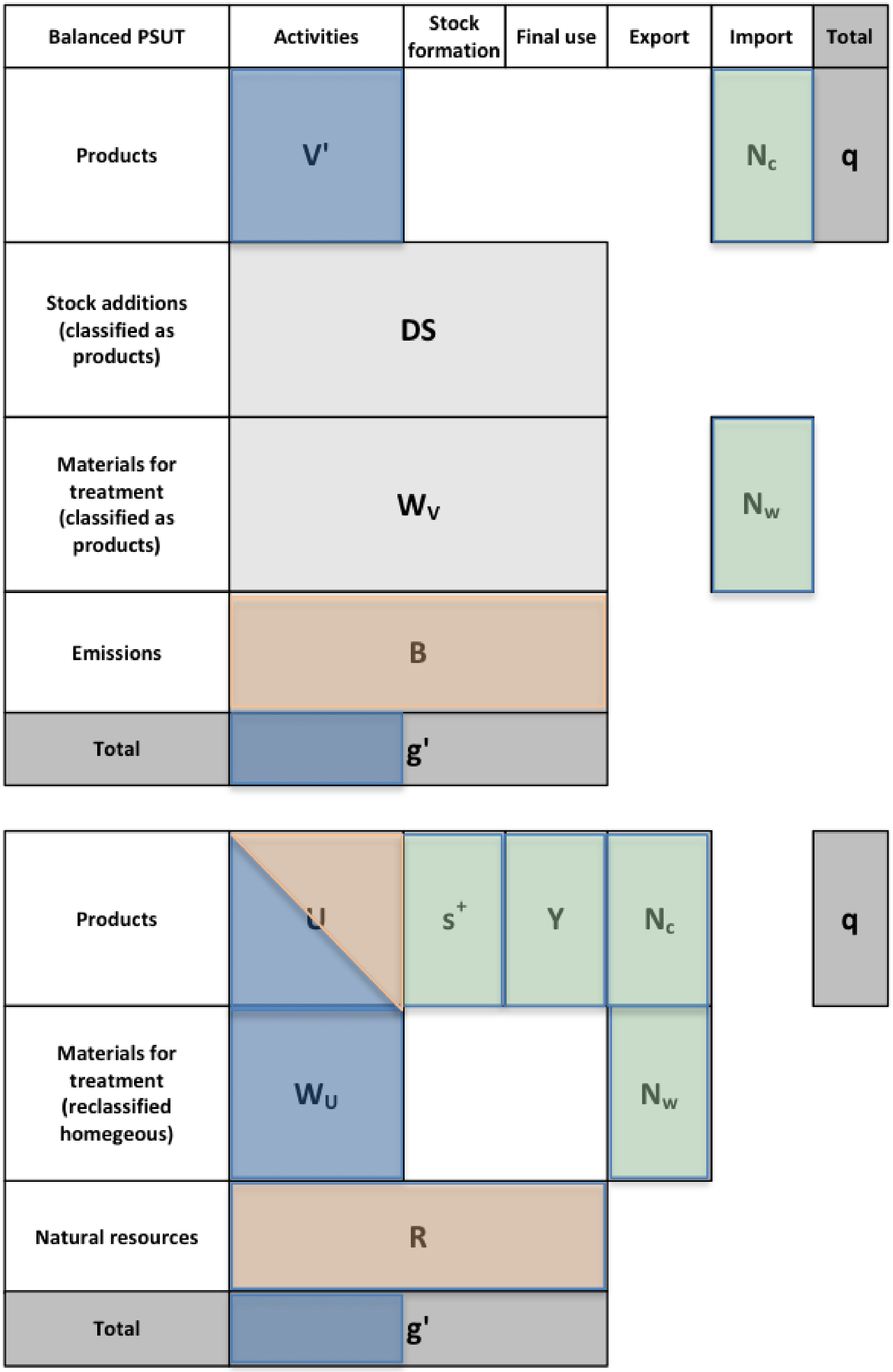
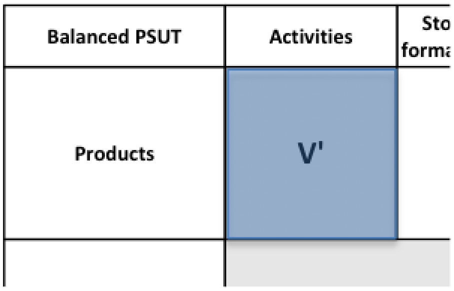


Figure 1.1: The PSUTs framework. Different colours indicate different ways of generating the initial estimates of the accounts. Blue: direct data collection; orange: via proper coefficients; green: monetary data divided by prices; grey: determined endogenously (see deliverable 7.1). Use table is partially derived from direct physical flows and partially from technical coefficients.

2 Supply of products (**V'**)



The first account described in this report is the supply of products, which indicates the total production of commodities by all the domestic activities. For each country a vector of total production of commodities is thus constructed.

Data sets from many national and international organizations have been used for the generation of these accounts. Often more sources have been used in order to determine more accurate estimations. Sometimes when mass data were not available from any reliable source, they have been estimated using the monetary data divided by prices.

The following sections describe the data collected and the further elaborations to meet the demanded requirements. For simplicity the data are regrouped in main categories and presented in separated sections.

2.1 Products of Agriculture, Fishery, Forestry and Food industry

The main source used for agricultural data is FAOSTAT (2013), which has the most reliable and complete data set for such accounts. Yet additional information is sometimes required because the FAO focuses particularly on food production and for some categories it directly provides processed products. This does not perfectly fit with the requirements of an input-output database, where also the raw materials have to be included.

Therefore additional data have been used for converting some of the transformed products, i.e. all the processed meat, which are outputs of food industry, in unprocessed materials produced by agricultural activities, which are accounted as live weight animals. These additional data consist of dressing percentages. Then the processed meat divided by the dressing percentages leads to the weight of live animals produced. Table 2.1 shows the sources used for estimating the supply of products of Agriculture, Forestry, Fishery and Food Industry.

No.	CREEA name product code:	Source:
1	Paddy rice	FAOSTAT (2013)
2	Wheat	FAOSTAT (2013)
3	Cereal grains nec	FAOSTAT (2013)
4	Vegetables, fruit, nuts	FAOSTAT (2013)
5	Oil seeds	FAOSTAT (2013)
6	Sugar cane, sugar beet	FAOSTAT (2013)
7	Plant-based fibers	FAOSTAT (2013)
8	Crops nec	FAOSTAT (2013)
9	Cattle	own elaborations of FAOSTAT (2013)
10	Pigs	own elaborations of FAOSTAT (2013)
11	Poultry	own elaborations of FAOSTAT (2013)
12	Meat animals nec	own elaborations of FAOSTAT (2013)
13	Animal products nec	FAOSTAT (2013)
14	Raw milk	own elaborations of FAOSTAT (2013)
15	Wool, silk-worm cocoons	own elaborations of FAOSTAT (2013)
16	Products of forestry, logging and related services (02)	FAOSTAT (2013)
17	Fish and other fishing products; services incidental of fishing (05)	FAOSTAT (2013)
18	Products of meat cattle	FAOSTAT (2013)
19	Products of meat pigs	FAOSTAT (2013)
20	Products of meat poultry	FAOSTAT (2013)
21	Meat products nec	FAOSTAT (2013)
22	products of Vegetable oils and fats	FAOSTAT (2013)
23	Dairy products	FAOSTAT (2013)
24	Processed rice	derivaded from monetary data
25	Sugar	FAOSTAT (2013)
26	Food products nec	derivaded from monetary data
27	Beverages	derivaded from monetary data
28	Fish products	derivaded from monetary data
29	Tobacco products (16)	derivaded from monetary data

Table 2.1: Data sources of agricultural products

The conversion coefficients used for the estimation of the live weight of animals are shown in Table 2.1. The latter shows the dressing percentages, i.e. the ratio of carcass weight to live animals expressed in percentages points, for the various animal categories taken into account. These values are assumed to be valid for all countries.

Animal:	Dressing percentage:	Source:
Beef	60	FAO (1991)
Pork	70	FAO (1991)
Lamb	50	FAO (1991)
Chicken, broilers	70	Verheijen et al. (1996)
Chicken, capon	68	Verheijen et al. (1996)
Turkey, broiler	77	Verheijen et al. (1996)
Duck, Peking	58	Verheijen et al. (1996)
Pheasant	78	Verheijen et al. (1996)
Horse	62	Badiani et al. (1993); Lacheretz et al. (1990)
Camel	55.8	Yousif and Babiker (1989)
Goat	43	Schoenian (2009)
Rabbit	60	MSU (2010)

Table 2.2: Dressing (carcass/live weight) percentages of various animals and references

Data extracted from FAOSTAT (2013) and their further elaborations have much higher detail than that reported in CREEA, hence an aggregation process is required. Table 2.3 shows what FAOSTAT agricultural products are included in the CREEA categories and where the dressing percentages have been used.

No.	CREEA product names:	FAOSTAT product names:
1	Paddy rice	Rice, paddy
2	Wheat	Wheat
3	Cereal grains nec	Barley; Buckwheat; Canary seed; Cereals, nes; Fonio; Maize; Millet; Mixed grain; Oats; Popcorn; Quinoa; Rye; Sorghum; Triticale.
4	Vegetables, fruit, nuts	Almonds, with shell; Apples; Apricots; Artichokes; Asparagus; Avocados; Bananas; Beans, green; Berries Nes; Blueberries; Cabbages and other brassicas; Carobs; Carrots and turnips; Cashew nuts, with shell; Cashewapple; Cassava leaves; Cauliflowers and broccoli; Cherries; Chestnuts; Chick peas; Chillies and peppers, dry; Chillies and peppers, green; Citrus fruit, nes; Cranberries; Cucumbers and gherkins; Currants; Dates; Eggplants (aubergines); Figs; Fruit Fresh Nes; Fruit, tropical fresh nes; Garlic; Ginger; Gooseberries; Grapefruit (inc. pomelos); Grapes; Hazelnuts, with shell; Kiwi fruit; Leguminous vegetables, nes; Lemons and limes; Lettuce and chicory; Maize, green; Mangoes, mangosteens, guavas; Nuts, nes; Okra; Onions (inc. shallots), green; Onions, dry; Oranges; Other melons (inc.cantaloupes); Papayas; Peaches and nectarines; Pears; Persimmons; Pineapples; Pistachios; Plantains; Plums and sloes; Pome fruit, nes; Pumpkins, squash and gourds; Quinces; Raspberries; Sour cherries; Spinach; Stone fruit, nes; Strawberries; Tangerines, mandarins, clem.; Taro (cocoyam); Tomatoes; Vegetables fresh nes; Walnuts, with shell; Watermelons.
5	Oil seeds	Castor oil seed; Coconuts; Cottonseed; Groundnuts, with shell; Hempseed; Jojoba Seeds; Kapok Fruit; Karite Nuts (Sheanuts); Linseed; Melonseed; Mustard seed; Oil

		palm fruit; Oilseeds, Nes; Olives; Poppy seed; Rapeseed; Safflower seed; Sesame seed; Soybeans; Sunflower seed; Tallowtree Seeds; Tung Nuts.
6	Sugar cane, sugar beet	Sugar beet; Sugar cane; Sugar crops, nes.
7	Plant-based fibers	Cotton lint; Fibre Crops Nes; Flax fibre and tow; Hemp Tow Waste; Jute; Kapok Fibre; Manila Fibre (Abaca); Other Bastfibres; Ramie; Sisal.
8	Crops nec	Agave Fibres Nes; Alfalfa for forage and silage; Anise, badian, fennel, corian.; Arecanuts; Bambara beans; Beans, dry; Beets for Fodder; Brazil nuts, with shell; Broad beans, horse beans, dry; Cabbage for Fodder; Carrots for Fodder; Chicory roots; Cinnamon (canella); Clover for forage and silage; Cloves; Cocoa beans; Coffee, green; Cow peas, dry; forage Products; Grasses Nes for forage;Sil; Green Oilseeds for Silage; Gums Natural; Hops; Kolanuts; Leguminous for Silage; Leeks, other alliaceous veg; Lentils; Lupins; Maize for forage and silage; Maté; Mushrooms and truffles; Natural rubber, in shell; Nutmeg, mace and cardamoms; Peas, dry; Peas, green; Pepper (Piper spp.); Peppermint; Pigeon peas; Potatoes; Pulses, nes; Pumpkins for Fodder; Pyrethrum,Dried; Roots and Tubers, nes; Rye grass for forage & silage; Sorghum for forage and silage; Spices, nes; String beans; Sweet potatoes; Swedes for Fodder; Tea; Tobacco, unmanufactured; Turnips for Fodder; Vanilla; Vegetables Roots Fodder; Vetches; Yams.
9	Cattle	Cattle meat*
10	Pigs	Pig meat*
11	Poultry	Chicken meat*; Duck meat*; Goose and guinea fowl meat*; Turkey meat*; Hen eggs.
12	Meat animals nec	Buffalo meat*; Camel meat;* Game meat*; Goat meat*; Goatskins; Horse meat*; Meat nes*; Meat of Asses*; Meat of Mules;* Meat of Other Rod*; Meat Other Camelids*; Rabbit meat*; Sheep

		meat*.
13	Animal products nec	Honey, natural; Other bird eggs, in shell; Snails, Not Sea
14	Raw milk	Buffalo milk, whole, fresh; Camel milk, whole, fresh; Cow milk, whole, fresh; Goat milk, whole, fresh; Sheep milk, whole, fresh.
* use of dressing percentages for the live weight determination.		

Table 2.3: Correspondence between CREAA agricultural products and FAOSTAT commodities

Moving to the forestry and fisheries, the main source of data is again the FAOSTAT. The latter has a special section dedicated to forestry, which is named ForesSTAT. This includes a wide detail of the production of different types of wood produced by countries. Fishing products have instead been derived from another section of FAOSTAT dedicated to Fisheries and Aquaculture.
The FAOSTAT products taken into account in the CREEA categories are shown in the **Table 2.4.**

CREEA product:	**FAOSTAT product:**
Products of forestry, logging and related services	Other Industrial Roundwood (C); Pulpwood, Round & Split (C); Sawlogs + Veneer Logs (C); Wood Fuel (C); Other Industrial Roundwood (NC); Pulpwood, Round & Split (NC); Sawlogs + Veneer Logs (NC); Wood Fuel (NC).
where (C) indicates conifer and (NC) non conifer wood.	
Fish and other fishing products; services incidental of fishing	Aquatic plants; Crustaceans: Diadromous fishes: Freshwater fishes; Marine fishes; Miscellaneous aquatic animal products; Miscellaneous aquatic animals; Molluscs; Whales, seals and other aquatic mammals.

Table 2.4: Correspondence between CREEA forestry and fisheries products and FAOSTAT commodities

However forestry products as downloaded from FAOSTAT cannot be used as they are because they are accounted in volume units, i.e. cubic meters. Hence they are converted in the mass unit tonne by mean of specific conversion factors derived from UN (2010). These factors in wet weight are 912 kg/m^3 for conifer and 1061 kg/m^3 for non-conifer, while in dry matter they become respectively 420 kg/m^3 and 549 kg/m^3.
Finally data for the food industry products have also be taken from FAOSTAT. As said above, FAO indicates meat production, so these values can be directly used for this CREEA category. In addition to meat production also the hide and skin production is taken into account. For the other food industry products, only sugar and vegetable oils are taken from FAOSTAT, whereas the remaining products are derived from the monetary accounts by means of prices. The reasons for that are, from

one side, because FAOSTAT does not cover perfectly the CREEA categories, from the other side, to assure full consistency between physical and monetary accounts.
Table 2.5 shows the FAOSTAT commodities included in the CREEA food categories.

No.	CREEA product names:	FAOSTAT product names:
1	Products of meat cattle	Cattle Hides; Cattle meat.
2	Products of meat pigs	Pig meat.
3	Products of meat poultry	Chicken meat; Duck meat; Goose and guinea fowl meat; Turkey meat;
4	Meat products nec	Bird meat, nes; Buffalo Hide; Buffalo meat; Camel meat; Game meat; Goat meat; Goatskins; Horse meat; Meat nes; Meat of Asses; Meat of Mules; Meat of Other Rod; Meat Other Camelids; Offals Nes; Rabbit meat; Sheep meat; Sheepskins; Snails, not sea.
5	Products of vegetable oils and fats	Cottonseed oil; Groundnut oil; Linseed oil; Maize oil; Margarine Short; Olive oil, virgin; Palm kernel oil; Palm oil; Rapeseed oil; Safflower oil; Sesame oil; Soybean oil; Sunflower oil.
6	Dairy products	Derived from monetary data divided by prices.
7	Processed rice	Derived from monetary data divided by prices.
8	Sugar	Molasses; Sugar Raw Centrifugal.
9	Food products nec	Derived from monetary data divided by prices.
10	Beverages	Derived from monetary data divided by prices.
11	Fish products	Derived from monetary data divided by prices.
12	Tobacco products	Derived from monetary data divided by prices.

Table 2.5: Correspondence between CREEA forestry and fisheries products and FAOSTAT commodities

2.2 Mining products

The main data source for mining products for the use in the EXIOBASE is the SERI MFA database (SERI, 2013a). The SERI database is the worldwide most comprehensive MFA database currently covering the time period 1980-2009, more than 200 countries and about 320 different material categories. With regard to mining products the database builds mainly on raw data from the British Geological Survey (BGS, 2012) for European and international data and the US Geological Survey (USGS,

2012) for international data. The following mining product categories are covered in the EXIOBASE:

No.	CREEA name product code:	Code product:	Code product:	Source:
32	Uranium and thorium ores (12)	p12	C_ORAN	SERI MFA database version 2013 (BGS/USGS)
33	Iron ores	p13.1	C_IRON	SERI MFA database version 2013 (BGS/USGS)
34	Copper ores and concentrates	p13.20.11	C_COPO	SERI MFA database version 2013 (BGS/USGS)
35	Nickel ores and concentrates	p13.20.12	C_NIKO	SERI MFA database version 2013 (BGS/USGS)
36	Aluminium ores and concentrates	p13.20.13	C_ALUO	SERI MFA database version 2013 (BGS/USGS)
37	Precious metal ores and concentrates	p13.20.14	C_PREO	SERI MFA database version 2013 (BGS/USGS)
38	Lead, zinc and tin ores and concentrates	p13.20.15	C_LZTO	SERI MFA database version 2013 (BGS/USGS)
39	Other non-ferrous metal ores and concentrates	p13.20.16	C_ONFO	SERI MFA database version 2013 (BGS/USGS)
40	Stone	p14.1	C_STON	SERI MFA database version 2013 (BGS/USGS)
41	Sand and clay	p14.2	C_SDCL	SERI MFA database version 2013 (BGS/USGS)
42	Chemical and fertilizer minerals, salt and other mining and quarrying products n.e.c.	p14.3	C_CHMF	SERI MFA database version 2013 (BGS/USGS)

Table 2.6: Coverage and data source for mining products

Regarding the metal data, the majority of the data are reported as "mine production" in metal content values. In order to align the data with MFA standards and make them fit to the CREEA categories, the data are transformed from metal content into metal ore values. For this purpose, we used factors, in order to calculate the corresponding gross extraction (run of mine). Information on concentrations of metals in crude ores was obtained through interviews with experts and a literature survey of more than 300 publications, in particular country and metal reports from the German Federal Geological Institute and the US Geological Survey as well as recent scientific literature. The concentration values were then transformed into factors to upscale the metal content values to metal ore values.
The availability of the following types of factors was checked, and the respective factors were used in the following order of priorities:

National factor ➔ continental average factor ➔ world average factor

These data were integrated into the SERI MFA database where the content values are directly transformed into gross ore values (for more detail see SERI, 2013b). The data imported into the EXIOBASE are in 1000 tons (kt). It has to be noted that only in a few cases the data reported by BGS and USGS, and hence imported into the SERI MFA database explicitly cover "ores" of specific metals. Hence, the values imported into the EXIOBASE might slightly underestimate the real sum values of "ores and concentrates".

In the case of the mineral data (stone, sand and clay, etc) the values reported by BGS and USGS do not need to be converted – except for diamonds, where carat are converted into raw material, and those cases where the unit is not 1000 tons (kt). Table 2.7 shows the three mineral product categories used in CREEA and illustrates which material categories of stone, sand and clay, etc included in the SERI MFA database were aggregated and imported into the EXIOBASE:

CREEA name product code:	SERI MFA database material
Stone	Calcite
	Chalk
	Chert and flint
	Crushed stone
	Dolomite
	Igneous rock (basalt, basaltic lava, diabase, granite, porphyry, sandstone etc.)
	Limestone
	Marble, travertines etc.
	Sandstone
	Slate including fill (incl. roof slate)
	Turfaceous rock
Sand and clay	Ball clay
	Bentonite, sepiolite and attapulgite
	Common clay, clay for bricks etc.
	Construction Minerals NEC
	Fire, refactory and flint clay, Andalusite, kyanite and sillimanite (all Al-containing)
	Fuller's earth
	Industrial sand
	Kaolin
	Lavasand
	Loam
	Potter clay
	Sand and Gravel
	Siliceous earth
	Sillica sand (quartzsand)
	Slate clay
	Special clay
Chemical and fertilizer minerals, salt and other mining and quarrying products n.e.c.	Abrasives, natural (puzzolan, pumice, volcanic cinder etc.)
	Amber
	Asbestos
	Barite
	Boiled salt
	Borate minerals
	Diamonds, gems
	Diamonds, industrials
	Diatomite
	Feldspar
	Fluorspar
	Gluesand
	Graphite, natural
	Graphite, natural
	Gypsum and anhydrite
	Iron ore for pigments
	Magnesite
	Mica
	Ochre and pigment earths
	Peat for agricultural use
	Pegmatite sand
	Perlite
	Phosphate rock (natural phosphates)
	Potash
	Qartz and quartzite
	Rock salt
	Salt from brine
	Salt in brine, sold or used as such
	Siliceous earth
	Siliceous earth
	Solar salt
	Strontium minerals
	Sulphur
	Sulphur as a by-product of natural gas etc.
	Sulphur from pyrites
	Talc (steatite, soapstone, pyrophyllite)
	Talcous slate
	Vermiculite
	Volastonite

Table 2.7: CREEA mineral mining products and SERI MFA database materials

2.3 Manufacture products

For the data on manufactured products the responsibilities regarding data collection and manipulation were split according to expertise of the involved partners. SERI was responsible for the following categories:

- 55; Textiles
- 56; Wearing apparel; furs
- 57; Leather and leather products
- 58; Wood and products of wood and cork (except furniture); articles of straw and plaiting materials
- 86; Plastics, basic
- 90; Chemicals nec
- 96; Rubber and plastic products
- 97; Glass and glass products
- 99; Ceramic goods
- 100; Bricks, tiles and construction products, in baked clay
- 101; Cement, lime and plaster
- 103; Other non-metallic mineral products
- 104; Basic iron and steel and of ferro-alloys and first products thereof
- 106; Precious metals
- 108; Aluminium and aluminium products
- 110; Lead, zinc and tin and products thereof
- 112; Copper products
- 114; Other non-ferrous metal products
- 116; Foundry work services

Extensive research was carried out regarding possible data sources. The main data sources selected and analysed for data quality and coverage were the following:

- Eurostat PRODCOM (EUROSTAT, 2012b)
- UNIDO Indstat (UNIDO, 2012)
- UN Industrial Commodities Statistics (United Nations, 2012)
- USGS Minerals Information (USGS, 2012)
- BGS World Mineral Statistics (BGS, 2012)
- SERI MFA database version 2013 (SERI, 2013a)

In Table 2.8 we show which of the different data sources cover the necessary data for the use in the in the different product categories of the EXIOBASE. Further, our evaluation of the data quality and possible alternative data sources are illustrated.
It can be seen that many of the available data did not receive a good rating – especially due to their low country coverage. In many cases no satisfying data source with very good data quality could be found; in others only for European countries (data from Eurostat PRODCOM). In two cases (Bricks, tiles and construction products, in baked clay; Foundry work services) no data was found at all.

No.	CREEA name product code:	Code product:	Code product:	Source:	Data quality:	Alternative source:
55	Textiles	p17	C_TEXT	Eurostat PRODCOM / UNIDO Indstat	A/B-	UN Industrial Commodities Statistics
56	Wearing apparel; furs	p18	C_GARM	Eurostat PRODCOM / UNIDO Indstat	A/B-	UN Industrial Commodities Statistics
57	Leather and leather products	p19	C_LETH	Eurostat PRODCOM / UNIDO Indstat	A/B-	UN Industrial Commodities Statistics
58	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials	p20	C_WOOD	UN Industrial Commodities Statistics	B	PRODCOM/UN Industrial Commodities Statistics
86	Plastics, basic	p24.1	C_PLAS	UN Industrial Commodities Statistics	C	UN Industrial Commodities Statistics
90	Chemicals nec	p24.4	C_CHEM	UN Industrial Commodities Statistics	C-	UN Industrial Commodities Statistics
96	Rubber and plastic products	p25	C_RUBP	Eurostat PRODCOM / UNIDO Indstat	A/C	UN Industrial Commodities Statistics
97	Glass and glass products	p26.a	C_GLAS	UN Industrial Commodities Statistics	C	UN Industrial Commodities Statistics
99	Ceramic goods	p26.b	C_CRMC	Eurostat PRODCOM / UNIDO Indstat	A/C	UN Industrial Commodities Statistics
100	Bricks, tiles and construction products, in baked clay	p26.c	C_BRIK	NO DATA	NONE	NONE
101	Cement, lime and plaster	p26.d	C_CMNT	USGS Minerals information	A	NONE
103	Other non-metallic mineral products	p26.e	C_ONMM	Eurostat PRODCOM / UNIDO Indstat	A/C	NONE
104	Basic iron and steel and of ferro-alloys and first products thereof	p27.a	C_STEL	BGS World Mineral Statistics	A	NONE
106	Precious metals	p27.41	C_PREM	BGS World Mineral Statistics	B-	UN Industrial Commodities Statistics
108	Aluminium and aluminium products	p27.42	C_ALUM	BGS World Mineral Statistics	A	UN Industrial Commodities Statistics
110	Lead, zinc and tin and products thereof	p27.43	C_LZTP	SERI MFA database version 2011	A	NONE
112	Copper products	p27.44	C_COPP	BGS World Mineral Statistics	A	NONE
114	Other non-ferrous metal products	p27.45	C_ONFM	Eurostat PRODCOM / none	C-	SERI MFA database version 2011/UN Industrial Commodities Statistics
116	Foundry work services	p27.5	C_METC	NO DATA	NONE	NONE

Table 2.8: CREEA manufacture products – data sources and quality (A…very good, B…average, C…not satisfying)

In the team we decided to use only those data with very good rating (“A”) and to use a different approach for those categories (or countries) where no satisfying data was available. Here data on monetary supply (see D7.1) combined with price data (see Section 4) were used to estimate physical amounts of production.

Data for the supply of fertilisers have been taken from the dataset of the International Fertilizer Industry Association (IFA, 2013b) that provides data on the supply of nutrients used as fertilisers. In this way it is possible to know exactly how much nitrogen and other nutrients are produced in each country and in the residual rest of the world (ROW) regions. Once the total mass of nutrients supplied is obtained, these values are multiplied by the nutrient content of fertilizers. It is assumed that a nitrogen fertiliser contains 33.5% of nutrient, which is the case for Ammonium nitrate, one of the most used worldwide. The content of phosphate and potassium is 30.9% and 30%, respectively (IFA, 2013a). These percentages refer to phosphate rock and potassium magnesium sulphate.

2.4 Energy products

The task of generating energy accounts for all the countries covered in EXIOBASE 2.0 is carried out in WP6 and thus, the data on energy products used in WP4 is part of these results. The detailed methodology is given in D6.1.

The main data sources for energy products are the IEA energy balances (IEA 2010b, 2010c). These represent the supply and use of 63 energy products for 85 items (groups of industries and final use categories) in a single table. The figures that show a product use, are signed by the algebraic sign "-" (minus), while those that refer to a "product" supply, with "+" (plus). Thus, the balances have to be split into supply and use by including all the negative values into the use table and the positive values into the supply table.

The energy balances, and by extension these energy supply and use tables, follow the so-called territory principle, i.e. the system boundary refers to the geographical border of the country. In contrast, the SEEA applies the residence principle, i.e. the system boundary is the functional border of a country's economy. In practical terms, this means that the energy uses of the resident units in a foreign country have to be added to the energy tables, while the energy uses of the foreign units in the national territory have to be extracted.

In the supply side, the domestic supply of energy products remains the same as in the residence principle. Nevertheless, the imported quantities might vary as result of international transport and fishing activities.

Hence, the domestic supply of the 63 IEA energy products has to be first converted to mass units by means of conversion factors extracted from the IEA and then allocated to the 200 CREEA products. Most of the IEA energy products can be allocated one-to-one to CREEA products.

2.5 Service of waste treatment

The accounting of waste treatment service supply is the most challenging task. Waste has often no economic value, is composed of different fractions frequently mixed together, reused in industrial processes or illegally dumped. These circumstances among others make the accounting of waste a really difficult task.

For these accounts a wide range of sources has been used. Indeed it has not always possible to extract data from one source, so many different sources have been used simultaneously and many elaborations have been required.

For the European Union countries a very comprehensive source is the Eurostat database on waste accounts. Here quite a detailed account of the different waste fractions divided according to the waste treatment is provided. Nonetheless some other further information needs to be collected since the detail required in CREEA is higher than that reported by Eurostat.

Other good sources for the waste treatment service in particular of metals are represented by the US Geological Surveys, Associations of Producers such as the Worldsteel Association and the European Aggregates

Association, and other international organizations such as the International Copper Study Group. These data can be directly incorporated in the CREEA database.

For non-European countries some good comprehensive data are made available by some National Offices (for example United States and Canada), while in some cases alternative data sources are used. This consists of partial data provided by national studies, international organization reports (OECD, IEA and FAOSTAT), scientific journals and specialized web pages. All this amount of information is structured and further elaborated to match with the CREEA framework.

Table 2.9 shows the main sources that are used for the supply of waste services.

	Waste treatment service:	Source:
1	Manure (conventional treatment)	FAOSTAT(2013); IPCC (2006); own elaborations;
2	Manure (biogas treatment)	FAOSTAT(2013); IPCC (2006); AEBIOM (2009); own elaborations;
3	Secondary paper for treatment, Re-processing of secondary paper into new pulp	EUROSTAT (2012); EPA (2008); WRAP (2011); Hyder consulting (2009); OECD (2010); Perele and Solovyeva (2011); DETEC-FOEN (2008); Ecolamancha (2008) ; own elaborations;
4	Wood material for treatment, Re-processing of secondary wood material into new wood material	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); FAOSTAT(2013); Ecolamancha (2008) ; own elaborations;
5	Secondary plastic for treatment, Re-processing of secondary plastic into new plastic	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); OECD (2010); CEMPRE (2010); Statistics Canada(2008); Perele R. and Solovyeva S. (2011); DETEC-FOEN (2008); Ecolamancha (2008) ; own elaborations;
6	Secondary glass for treatment, Re-processing of secondary glass into new glass	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); CEMPRE (2010); Statistics Canada(2008); DETEC-FOEN (2008); Ecolamancha (2008) ; own elaborations;
7	Ash for treatment, Re-processing of ash into clinker	Smith I. (2005); own elaborations;
8	Secondary construction material for treatment, Re-processing of secondary construction material into aggregates	UEPG (2008); EPA (2003); Statistics Canada(2008); Hyder consulting (2009); BGS (2012); own elaborations;
9	Secondary steel for treatment, Re-processing of secondary steel into new steel	Worldsteel Association (2010); USGS (2012);
10	Secondary preciuos metals for treatment, Re-processing of secondary preciuos metals into new preciuos metals	USGS (2012);
11	Secondary aluminium for treatment, Re-processing of secondary aluminium into new aluminium	USGS (2012);
12	Secondary lead for treatment, Re-processing of secondary lead into new lead	USGS (2012);
13	Secondary copper for treatment, Re-processing of secondary copper into new copper	ICSG (2010); USGS (2012);
14	Secondary other non-ferrous metals for treatment, Re-processing of secondary other non-ferrous metals into new other non-ferrous metals	USGS (2012);
15	Bottles for treatment, Recycling of bottles by direct reuse	JCPRA(2013); Heinisch J. (2009); Brewers of Europe (2010); own elaborations;
16	Incineration of waste: Food	EUROSTAT (2012); EPA (2008);Hyder consulting (2009); Statistics Canada(2008); National Bureau of Statistics China (2008); Chen X. et al. (2010); Perele R. and Solovyeva S. (2011); IEA (2010); Christensen T. H. (1998); own elaborations;
17	Incineration of waste: Paper	EUROSTAT (2012); EPA (2008); DETEC-FOEN (2008); Statistics Canada(2008); National Bureau of Statistics China (2008); Chen X. et al. (2010); Perele R. and Solovyeva S. (2011); IEA (2010); Christensen T. H. (1998); own elaborations;
18	Incineration of waste: Plastic	EUROSTAT (2012); EPA (2008); DETEC-FOEN (2008); Statistics Canada(2008); National Bureau of Statistics China (2008); Chen X. et al. (2010); Perele R. and Solovyeva S. (2011); IEA (2010); Christensen T. H. (1998); own elaborations;
19	Incineration of waste: Metals and Inert materials	EUROSTAT (2012); EPA (2008); DETEC-FOEN (2008); Statistics Canada(2008); National Bureau of Statistics China (2008); Chen X. et al. (2010); Perele R. and Solovyeva S. (2011); IEA (2010); Christensen T. H. (1998); own elaborations;
20	Incineration of waste: Textiles	EUROSTAT (2012); EPA (2008); DETEC-FOEN (2008); Statistics Canada(2008); National Bureau of Statistics China (2008); Chen X. et al. (2010); Perele R. and Solovyeva S. (2011); IEA (2010); Christensen T. H. (1998); own elaborations;
21	Incineration of waste: Wood	EUROSTAT (2012); EPA (2008);DETEC-FOEN (2008); Statistics Canada(2008); National Bureau of Statistics China (2008); Chen X. et al. (2010); Perele R. and Solovyeva S. (2011); IEA (2010); Christensen T. H. (1998); own elaborations;
22	Incineration of waste: Oil/Hazardous waste	EUROSTAT (2012); EPA (2008); DETEC-FOEN (2008); Statistics Canada(2008); National Bureau of Statistics China (2008); Chen X. et al. (2010); Perele R. and Solovyeva S. (2011); IEA (2010); Christensen T. H. (1998); own elaborations;
23	Biogasification of food waste, incl. land application	Levis J.W. et al., (2010); AEBIOM (2009); EUROSTAT (2012); EPA (2010; 2011); own elaborations;
24	Biogasification of paper, incl. land application	Levis J.W. et al., (2010); AEBIOM (2009); EUROSTAT (2012); EPA (2010; 2011); own elaborations;
25	Biogasification of sewage slugde, incl. land application	Levis J.W. et al., (2010); AEBIOM (2009); EUROSTAT (2012); EPA (2010; 2011); own elaborations;

Table 2.9: Sources used for the account of waste service supply (continued)

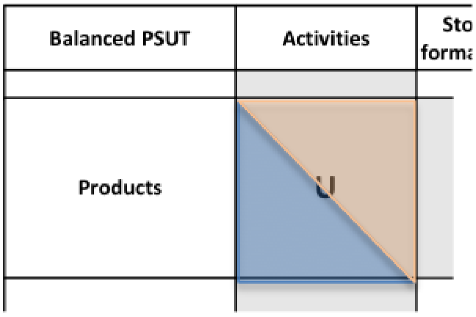
26	Composting of food waste, incl. land application	EUROSTAT (2012); EPA (2008); OECD(2010); IBGE (2002); Statistics Canada(2008); Chen X. et al. (2010); own elaborations;
27	Composting of paper and wood, incl. land application	EUROSTAT (2012); EPA (2008); IBGE (2002); Statistics Canada(2008); Chen X. et al. (2010); own elaborations;
28	Waste water treatment, food	EUROSTAT (2012); EPA (2008); FAOSTAT(2013); DETEC-FOEN (2008); Statistics Canada(2008); own elaborations;
29	Waste water treatment, other	EUROSTAT (2012); EPA (2008); DETEC-FOEN (2008); Statistics Canada(2008); own elaborations;
30	Landfill of waste: Food	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); Statistics Canada(2008); National Bureau of Statistics China (2008); Zhang D. Q et al. (2010); Jelenska E. (2010); CEMPRE (2010); Ecolamancha (2008) ; Christensen T. H. (1998); own elaborations;
31	Landfill of waste: Paper	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); Statistics Canada(2008); National Bureau of Statistics China (2008); Zhang D. Q et al. (2010); Jelenska E. (2010); CEMPRE (2010); Ecolamancha (2008) ; Christensen T. H. (1998); own elaborations;
32	Landfill of waste: Plastic	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); Statistics Canada(2008); National Bureau of Statistics China (2008); Zhang D. Q et al. (2010); Jelenska E. (2010); CEMPRE (2010); Ecolamancha (2008) ; Christensen T. H. (1998); own elaborations;
33	Landfill of waste: Inert/metal/hazardous	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); Statistics Canada(2008); National Bureau of Statistics China (2008);Zhang D. Q et al. (2010); Jelenska E. (2010); CEMPRE (2010); Ecolamancha (2008) ; Christensen T. H. (1998); own elaborations;
34	Landfill of waste: Textiles	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); Statistics Canada(2008); National Bureau of Statistics China (2008); Zhang D. Q et al. (2010); Jelenska E. (2010); CEMPRE (2010); Ecolamancha (2008) ; Christensen T. H. (1998); own elaborations;
35	Landfill of waste: Wood	EUROSTAT (2012); EPA (2008); Hyder consulting (2009); Statistics Canada(2008); National Bureau of Statistics China (2008); Zhang D. Q et al. (2010); Jelenska E. (2010); CEMPRE (2010); Ecolamancha (2008) ; Christensen T. H. (1998); own elaborations;

Table 2.9 (continued); Sources used for the account of waste service supply

Data on waste service supply are expressed in tonnes, however in the matrix of supply **V’** these flows represent a service hence are immaterial flows. Consequently these flows have to be interpreted as tonnes of waste treatment service.

The real amount of treated waste expressed in mass terms is instead included in the extension accounts of the supply of waste. This is because the determination of waste treatment services in the matrix **V’** generates automatically the use matrix of the waste accounts $\mathbf{W_U}$.

3 Use of products (**U**)



In this section we describe the data used for the construction of the use of commodities matrix. Here the effort put in data collection is reduced when compared to that of the supply part. This is because once the total physical supply and the trade are calculated (see section 4), the total demand is just a residual value.
However some substantial effort is put in the collection of some very relevant data that are strategic in the construction of the use table, in both physical and monetary terms.
The first data collected are the technical coefficients needed for defining the productive structure of the economic activities. In particular life cycle inventory coefficients are mostly chosen for such task. These coefficients are used as key values for disaggregating the monetary supply and use tables (MSUTs) preserving a technological coherence.
The second group of data are the energy products. Defining such flows in an accurate way is an essential requirement of a physical database. Energy data are structured in a matrix format product by industry, and are country-specific.

3.1 Technical coefficients

The importance of technical coefficients in an input-output data set is of fundamental importance. The relevance of such coefficients becomes even bigger when conservation laws, such as mass and energy balance, are at stake.
Currently the most reliable data sets providing data in mass and energy units have been developed by the life cycle assessment community. These data sets include very detailed analyses of the structure of industrial processes and are used for the assessment of environmental impact of product systems. Due to their robustness and completeness life cycle datasets are chosen for the provision of technical coefficients to be used for the construction of the economic activities structures.
The main data source used is Ecoinvent v2.2, which has been produced by a group of organizations located in Switzerland (www.ecoinvent.org). This database covers thousand of productive processes and it is considered one of the most comprehensive data sets in the world for life cycle analysis. However not all the activities included in CREEA dataset

are included in such database, consequently technical coefficients are taken from alternative existing literature or from the other databases. The latter include the FORWAST data set (Schmidt, 2010a; Schmidt, 2010b; Schmidt, 2010c; Dalgaard and Schmidt, 2010; Schmidt. et al., 2010.) and the LCAfood data set produced in Denmark (Nielsen et al., 2005).
The coefficients taken into account regard the use of the most crucial inputs in the economic activities. Table 3.1 shows the activities and the inputs for which coefficients have been collected. The column of the inputs also includes the co-productions of multifunctional activities. When this occurs, in order to make a clear distinction, in the cell a text "negative inputs" is added to the product classification.

Activity:	Input:	Source:
Cultivation of paddy rice	Paddy rice	Ecoinvent process: Rice, at farm/US U
	Aggregated fuels	Ecoinvent process: Rice, at farm/US U
	Aggregated electricity	Ecoinvent process: Rice, at farm/US U
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent process: Rice, at farm/US U
Cultivation of wheat	Wheat	Ecoinvent process: wheat grains, at farm/kg/US
	Aggregated fuels	Ecoinvent process: wheat grains, at farm/kg/US
	Aggregated electricity	Ecoinvent process: wheat grains, at farm/kg/US
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent process: wheat grains, at farm/kg/US
Cultivation of cereal grains nec	Cereal grains nec	Ecoinvent processes: barley straw IP, at farm/kg/CH; corn, at farm/kg/US; grain maize IP, at farm/kg/CH; grain maize IP, at farm/kg/CH; rye grains IP, at farm/kg/CH.
	Aggregated fuels	Ecoinvent processes: barley straw IP, at farm/kg/CH; corn, at farm/kg/US; grain maize IP, at farm/kg/CH; grain maize IP, at farm/kg/CH; rye grains IP, at farm/kg/CH.
	Aggregated electricity	Ecoinvent processes: barley straw IP, at farm/kg/CH; corn, at farm/kg/US; grain maize IP, at farm/kg/CH; grain maize IP, at farm/kg/CH; rye grains IP, at farm/kg/CH.
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent processes: barley straw IP, at farm/kg/CH; corn, at farm/kg/US; grain maize IP, at farm/kg/CH; grain maize IP, at farm/kg/CH; rye grains IP, at farm/kg/CH.
Cultivation of vegetables, fruit, nuts	Vegetables, fruit, nuts	Ecoinvent processes: Carrot farming, no straw; Onion, farming, conventional; palm fruit bunches, at farm/kg/MY; Tomato, standard; fava beans IP, at farm/kg/CH; potatoes IP, at farm/kg/CH; protein peas, IP, at farm/kg/CH.
	Aggregated fuels	Ecoinvent processes: Carrot farming, no straw; Onion, farming, conventional; palm fruit bunches, at farm/kg/MY; Tomato, standard; fava beans IP, at farm/kg/CH; potatoes IP, at farm/kg/CH; protein peas, IP, at farm/kg/CH.
	Aggregated electricity	Ecoinvent processes: Carrot farming, no straw; Onion, farming, conventional; palm fruit bunches, at farm/kg/MY; Tomato, standard; fava beans IP, at farm/kg/CH; potatoes IP, at farm/kg/CH; protein peas, IP, at farm/kg/CH.
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent processes: Carrot farming, no straw; Onion, farming, conventional; palm fruit bunches, at farm/kg/MY; Tomato, standard; fava beans IP, at farm/kg/CH; potatoes IP, at farm/kg/CH; protein peas, IP, at farm/kg/CH.
Cultivation of oil seeds	Oil seeds	Ecoinvent processes: rape seed, at farm/kg/US; soybeans, at farm/kg/US; sunflower IP, at farm/kg/CH.
	Aggregated fuels	Ecoinvent processes: rape seed, at farm/kg/US; soybeans, at farm/kg/US; sunflower IP, at farm/kg/CH.
	Aggregated electricity	Ecoinvent processes: rape seed, at farm/kg/US; soybeans, at farm/kg/US; sunflower IP, at farm/kg/CH.
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent processes: rape seed, at farm/kg/US; soybeans, at farm/kg/US; sunflower IP, at farm/kg/CH.
Cultivation of sugar cane, sugar beet	Sugar cane, sugar beet	Ecoinvent processes: sugar beets IP, at farm/kg/CH; sugarcane, at farm/kg/BR
	Aggregated fuels	Ecoinvent processes: sugar beets IP, at farm/kg/CH; sugarcane, at farm/kg/BR
	Aggregated electricity	Ecoinvent processes: sugar beets IP, at farm/kg/CH; sugarcane, at farm/kg/BR
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent processes: sugar beets IP, at farm/kg/CH; sugarcane, at farm/kg/BR

Table 3.1: Sources used for the account of technical coefficients (continued)

Cultivation of plant-based fibers	Plant-based fibers	Ecoinvent processes: cotton fibres, at farm/kg/US; jute fibres, irrigated system, at farm/kg/IN.
	Aggregated fuels	Ecoinvent processes: cotton fibres, at farm/kg/US; jute fibres, irrigated system, at farm/kg/IN.
	Aggregated electricity	Ecoinvent processes: cotton fibres, at farm/kg/US; jute fibres, irrigated system, at farm/kg/IN.
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent processes: cotton fibres, at farm/kg/US; jute fibres, irrigated system, at farm/kg/IN.
Cultivation of crops nec	Crops nec	Ecoinvent processes: fodder beets IP, at farm/kg/CH; silage maize IP, at farm/kg/CH.
	Aggregated fuels	Ecoinvent processes: fodder beets IP, at farm/kg/CH; silage maize IP, at farm/kg/CH.
	Aggregated electricity	Ecoinvent processes: fodder beets IP, at farm/kg/CH; silage maize IP, at farm/kg/CH.
	N-fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	P- and other fertiliser	IFA (2013); FAOSTAT (2013); own elaborations.
	Chemicals nec	Ecoinvent processes: fodder beets IP, at farm/kg/CH; silage maize IP, at farm/kg/CH.
Cattle farming	Feed intake	own assumptions based on IPCC (2006)
	Aggregated fuels	DalgaardR. and Schmidt J. (2012)
	Aggregated electricity	DalgaardR. and Schmidt J. (2012)
Pigs farming	Feed intake	FORWAST (2010)*
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Poultry farming	Feed intake	FORWAST (2010)*
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Meat animals nec	Feed intake	own assumptions based on IPCC (2006)
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Raw milk	Feed intake	own assumptions based on IPCC (2006)
	Aggregated fuels	DalgaardR. and Schmidt J. (2012)
	Aggregated electricity	DalgaardR. and Schmidt J. (2012)
Manure treatment (conventional), storage and land application	N-fertiliser	Nielsen P. H. et al. (2005)
	P- and other fertiliser	Nielsen P. H. et al. (2005)
	Aggregated fuels	Ecoinvent process: Solid manure loading and spreading, by hydraulic loader and spreader/CH U
Manure treatment (biogas), storage and land application	N-fertiliser	Nielsen P. H. et al. (2005)
	P- and other fertiliser	Nielsen P. H. et al. (2005)
	Aggregated fuels	Ecoinvent process: Solid manure loading and spreading, by hydraulic loader and spreader/CH U
Forestry, logging and related service activities (02)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
	N-fertiliser	FORWAST (2010)*
	P- and other fertiliser	FORWAST (2010)*
	Chemicals nec	FORWAST (2010)*
Fishing, operating of fish hatcheries and fish farms; service activities	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Mining of coal and lignite; extraction of peat (10)	Aggregated fuels	Ecoinvent processes: Anthracite coal, at mine/kg/RNA; hard coal, at mine/kg/AU; hard coal, at mine/kg/EEU;hard coal, at mine/kg/RU;hard coal, at mine/kg/ZA; Peat, at mine/NORDEL U.
	Aggregated electricity	Ecoinvent processes: Anthracite coal, at mine/kg/RNA; hard coal, at mine/kg/AU; hard coal, at mine/kg/EEU;hard coal, at mine/kg/RU;hard coal, at mine/kg/ZA; Peat, at mine/NORDEL U.
Extraction of crude petroleum and services related to crude oil extraction, excluding surveying	Aggregated fuels	Ecoinvent processes: crude oil, at production offshore/kg/NL, crude oil, at production offshore/kg/NO, crude oil, at production onshore/kg/NL, crude oil, at production onshore/kg/RU, natural gas, at production offshore/m3/NL, natural gas, at production offshore/m3/NO, natural gas, at production onshore/m3/DE, natural gas, at production onshore/m3/NL, natural gas, at production onshore/m3/RU, natural gas, unprocessed, at extraction/m3/RNA
	Aggregated electricity	Ecoinvent processes: crude oil, at production offshore/kg/NL, crude oil, at production offshore/kg/NO, crude oil, at production onshore/kg/NL, crude oil, at production onshore/kg/RU, natural gas, at production offshore/m3/NL, natural gas, at production offshore/m3/NO, natural gas, at production onshore/m3/DE, natural gas, at production onshore/m3/NL, natural gas, at production onshore/m3/RU, natural gas, unprocessed, at extraction/m3/RNA
Extraction of natural gas and services related to natural gas extraction, excluding surveying	Aggregated fuels	Ecoinvent processes: crude oil, at production offshore/kg/NL, crude oil, at production offshore/kg/NO, crude oil, at production onshore/kg/NL, crude oil, at production onshore/kg/RU, natural gas, at production offshore/m3/NL, natural gas, at production offshore/m3/NO, natural gas, at production onshore/m3/DE, natural gas, at production onshore/m3/NL, natural gas, at production onshore/m3/RU, natural gas, unprocessed, at extraction/m3/RNA
	Aggregated electricity	Ecoinvent processes: crude oil, at production offshore/kg/NL, crude oil, at production offshore/kg/NO, crude oil, at production onshore/kg/NL, crude oil, at production onshore/kg/RU, natural gas, at production offshore/m3/NL, natural gas, at production offshore/m3/NO, natural gas, at production onshore/m3/DE, natural gas, at production onshore/m3/NL, natural gas, at production onshore/m3/RU, natural gas, unprocessed, at extraction/m3/RNA

Table 3.1 (continued): Sources used for the account of technical coefficients

Extraction, liquefaction, and regasification of other petroleum and gaseous materials	Aggregated fuels	Ecoinvent processes: crude oil, at production offshore/kg/NL, crude oil, at production offshore/kg/NO, crude oil, at production onshore/kg/NL, crude oil, at production onshore/kg/RU, natural gas, at production offshore/m3/NL, natural gas, at production offshore/m3/NO, natural gas, at production onshore/m3/DE, natural gas, at production onshore/m3/NL, natural gas, at production onshore/m3/RU, natural gas, unprocessed, at extraction/m3/RNA
	Aggregated electricity	Ecoinvent processes: crude oil, at production offshore/kg/NL, crude oil, at production offshore/kg/NO, crude oil, at production onshore/kg/NL, crude oil, at production onshore/kg/RU, natural gas, at production offshore/m3/NL, natural gas, at production offshore/m3/NO, natural gas, at production onshore/m3/DE, natural gas, at production onshore/m3/NL, natural gas, at production onshore/m3/RU, natural gas, unprocessed, at extraction/m3/RNA
Mining of uranium and thorium ores (12)	Aggregated fuels	Ecoinvent processes: Uranium natural, at open pit mine/RNA U; Uranium natural, at underground mine/RNA U.
	Aggregated electricity	Ecoinvent processes: Uranium natural, at open pit mine/RNA U; Uranium natural, at underground mine/RNA U.
Mining of iron ores	Aggregated fuels	Ecoinvent process: iron ore, 46% Fe, at mine/kg/GLO
	Aggregated electricity	Ecoinvent process: iron ore, 46% Fe, at mine/kg/GLO
Mining of copper ores and concentrates	Aggregated fuels	Ecoinvent process: copper concentrate, at beneficiation/kg/GLO
	Aggregated electricity	Ecoinvent process: copper concentrate, at beneficiation/kg/GLO
Mining of nickel ores and concentrates	Aggregated fuels	Ecoinvent process: nickel, 99.5%, at plant/kg/GLO
	Aggregated electricity	Ecoinvent process: nickel, 99.5%, at plant/kg/GLO
Mining of aluminium ores and concentrates	Aggregated fuels	Ecoinvent process: bauxite, at mine/kg/GLO
	Aggregated electricity	Ecoinvent process: bauxite, at mine/kg/GLO
Mining of precious metal ores and concentrates	Aggregated fuels	Ecoinvent processes: gold, at refinery/kg/AU, gold, at refinery/kg/US, gold, at refinery/kg/ZA, palladium, primary, at refinery/kg/RU, palladium, primary, at refinery/kg/ZA, platinum, primary, at refinery/kg/RU, platinum, primary, at refinery/kg/ZA, rhodium, primary, at refinery/kg/RU, rhodium, primary, at refinery/kg/ZA.
	Aggregated electricity	Ecoinvent processes: gold, at refinery/kg/AU, gold, at refinery/kg/US, gold, at refinery/kg/ZA, palladium, primary, at refinery/kg/RU, palladium, primary, at refinery/kg/ZA, platinum, primary, at refinery/kg/RU, platinum, primary, at refinery/kg/ZA, rhodium, primary, at refinery/kg/RU, rhodium, primary, at refinery/kg/ZA.
Mining of lead, zinc and tin ores and	Aggregated fuels	Ecoinvent process: lead concentrate, at beneficiation/kg/GLO
	Aggregated electricity	Ecoinvent process: lead concentrate, at beneficiation/kg/GLO
Mining of other non-ferrous metal ores and concentrates	Aggregated fuels	Ecoinvent process: manganese concentrate, at beneficiation/kg/GLO
	Aggregated electricity	Ecoinvent process: manganese concentrate, at beneficiation/kg/GLO
Quarrying of stone	Aggregated fuels	Ecoinvent process: limestone, at mine/kg/CH, Limestone, at mine/kg/US.
	Aggregated electricity	Ecoinvent process: limestone, at mine/kg/CH, Limestone, at mine/kg/US.
Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c.	Aggregated fuels	Ecoinvent process: phosphate rock, as P2O5, beneficiated, dry, at plant/kg/MA; sodium chlorate, powder, at plant/kg/RER
	Aggregated electricity	Ecoinvent process: phosphate rock, as P2O5, beneficiated, dry, at plant/kg/MA; sodium chlorate, powder, at plant/kg/RER
Processing of meat cattle	Cattle	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)
Processing of meat pigs	Pigs	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)
Processing of meat poultry	Poultry	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)
Processing vegetable oils and fats	Oil seeds	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)
Processing of dairy products	Raw milk	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)
Processed rice	Paddy rice	Blengini G. A. and Busto M., (2009)
	Aggregated fuels	Blengini G. A. and Busto M., (2009)
	Aggregated electricity	Blengini G. A. and Busto M., (2009)
Sugar refining	Sugar cane, sugar beet	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)

Table 3.1 (continued): Sources used for the account of technical coefficients

Processing of Food products nec	Aggregated grains	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)
Manufacture of beverages	Aggregated grains	FORWAST (2010)*
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of fish products	Fish and other fishing products; services incidental of fishing (05)	Nielsen P. H. et al. (2005)
	Aggregated fuels	Nielsen P. H. et al. (2005)
	Aggregated electricity	Nielsen P. H. et al. (2005)
Manufacture of tobacco products (16)	Crops nec	FORWAST (2010)*
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of textiles (17)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of wearing apparel; dressing and dyeing of fur (18)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and	Products of forestry, logging and related services (02)	UNECE/FAO (2010)
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Re-processing of secondary wood material into new wood material	Wood and products of wood	Ecoinvent process: Particle board, indoor use, at plant/RER U
	Aggregated fuels	Ecoinvent process: Particle board, indoor use, at plant/RER U
	Aggregated electricity	Ecoinvent process: Particle board, indoor use, at plant/RER U
Pulp	Products of forestry, logging and related services (02)	UNECE/FAO (2010)
	Aggregated fuels	Schmidt et al. (2007)
	Aggregated electricity	Schmidt et al. (2007)
Re-processing of secondary paper into new pulp	Pulp - negative input	Schmidt et al. (2007)
	Aggregated fuels	Schmidt et al. (2007)
	Aggregated electricity	Schmidt et al. (2007)
Paper	Pulp	Schmidt et al. (2007)
	Aggregated fuels	Schmidt et al. (2007)
	Aggregated electricity	Schmidt et al. (2007)
Publishing, printing and reproduction of recorded media (22)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of coke oven products	Aggregated fuels	Ecoinvent process: Hard coal coke, at plant/RER U
	Aggregated electricity	Ecoinvent process: Hard coal coke, at plant/RER U
Petroleum Refinery	Crude oil	Ecoinvent processes: Diesel, at refinery/RER U; Heavy fuel oil, at refinery/RER U; Kerosene, at refinery/RER U; Light fuel oil, at refinery/RER U; Naphtha, at refinery/RER U; Petrol, low-sulphur, at refinery/RER U; Petrol, unleaded, at refinery/RER U; Petroleum coke, at refinery/RER U; Propane/ butane, at refinery/RER
	Aggregated fuels	Ecoinvent processes: Diesel, at refinery/RER U; Heavy fuel oil, at refinery/RER U; Kerosene, at refinery/RER U; Light fuel oil, at refinery/RER U; Naphtha, at refinery/RER U; Petrol, low-sulphur, at refinery/RER U; Petrol, unleaded, at refinery/RER U; Petroleum coke, at refinery/RER U; Propane/ butane, at refinery/RER
	Aggregated electricity	Ecoinvent processes: Diesel, at refinery/RER U; Heavy fuel oil, at refinery/RER U; Kerosene, at refinery/RER U; Light fuel oil, at refinery/RER U; Naphtha, at refinery/RER U; Petrol, low-sulphur, at refinery/RER U; Petrol, unleaded, at refinery/RER U; Petroleum coke, at refinery/RER U; Propane/ butane, at refinery/RER
Plastics, basic	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Re-processing of secondary plastic into new plastic	Plastics, basic - negative input	Schmidt et al. (2007)
	Aggregated fuels	Schmidt et al. (2007)
	Aggregated electricity	Schmidt et al. (2007)
N-fertiliser	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*

Table 3.1 (continued): Sources used for the account of technical coefficients

P- and other fertiliser	Chemical and fertilizer minerals, salt and other mining	FORWAST (2010)*
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Chemicals nec	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of rubber and plastic products (25)	Plastics, basic	FORWAST (2010)*
	Chemicals nec	FORWAST (2010)*
	Rubber and plastic products (25)	FORWAST (2010)*
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of glass and glass products	Stone	Schmidt J. (2005)
	Sand and clay	Schmidt J. (2005)
	Chemicals nec	Schmidt J. (2005)
	Aggregated fuels	Schmidt J. (2005)
	Aggregated electricity	Schmidt J. (2005)
Re-processing of secondary glass into new glass	Glass and glass products - negative input	Schmidt J. (2005)
	Aggregated fuels	Schmidt J. (2005)
	Aggregated electricity	Schmidt J. (2005)
Manufacture of ceramic goods	Aggregated fuels	Nicoletti et al., (2002)
	Aggregated electricity	Nicoletti et al., (2002)
Manufacture of bricks, tiles and construction products, in baked clay	Aggregated fuels	Ecoinvent processes: Brick, at plant/RER U
	Aggregated electricity	Ecoinvent processes: Brick, at plant/RER U
Manufacture of cement, lime and plaster	Aggregated fuels	Ecoinvent processes: Portland cement, strength class Z 42.5, at plant/CH U and Clinker, at plant/CH U
	Aggregated electricity	Ecoinvent processes: Portland cement, strength class Z 42.5, at plant/CH U and Clinker, at plant/CH U
Re-processing of ash into clinker	Cement, lime and plaster - negative input	FORWAST (2010)*
	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of other non-metallic mineral products n.e.c.	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of basic iron and steel and of ferro-alloys and first products thereof	Iron ores	Ecoinvent processes: Steel, converter, unalloyed, at plant/RER U and Pig iron, at plant/GLO U
	Aggregated fuels	Ecoinvent processes: Steel, converter, unalloyed, at plant/RER U and Pig iron, at plant/GLO U
	Aggregated electricity	Ecoinvent processes: Steel, converter, unalloyed, at plant/RER U and Pig iron, at plant/GLO U
Re-processing of secondary steel into new steel	Basic iron and steel and of ferro-alloys and first products thereof - negative input	Ecoinvent process: Steel, electric, un- and low-alloyed, at plant/RER U
	Aggregated fuels	Ecoinvent process: Steel, electric, un- and low-alloyed, at plant/RER U
	Aggregated electricity	Ecoinvent process: Steel, electric, un- and low-alloyed, at plant/RER U
Re-processing of secondary preciuos metals into new preciuos metals	Precious metals - negative input	Ecoinvent process: Gold, secondary, at precious metal refinery/SE U; Ayres U et al., 2003.
	Aggregated fuels	Ecoinvent process: Gold, secondary, at precious metal refinery/SE U; Ayres U et al., 2003.
	Aggregated electricity	Ecoinvent process: Gold, secondary, at precious metal refinery/SE U; Ayres U et al., 2003.
Aluminium production	Aluminium ores and concentrates	Ecoinvent processes: Aluminium, primary, at plant/RER U, Aluminium, primary, liquid, at plant/RER U, Aluminium oxide, at plant/RER U and Aluminium hydroxide, at plant/RER U
	Aggregated fuels	Ecoinvent processes: Aluminium, primary, at plant/RER U, Aluminium, primary, liquid, at plant/RER U, Aluminium oxide, at plant/RER U and Aluminium hydroxide, at plant/RER U
	Aggregated electricity	Ecoinvent processes: Aluminium, primary, at plant/RER U, Aluminium, primary, liquid, at plant/RER U, Aluminium oxide, at plant/RER U and Aluminium hydroxide, at plant/RER U
Re-processing of secondary aluminium into new aluminium	Aluminium and aluminium products - negative input	Ecoinvent processes: Aluminium, secondary, from new scrap, at plant/RER U and Aluminium, secondary, from old scrap, at plant/RER U
	Aggregated fuels	Ecoinvent processes: Aluminium, secondary, from new scrap, at plant/RER U and Aluminium, secondary, from old scrap, at plant/RER U
	Aggregated electricity	Ecoinvent processes: Aluminium, secondary, from new scrap, at plant/RER U and Aluminium, secondary, from old scrap, at plant/RER U
Lead, zinc and tin production	Lead, zinc and tin ores and concentrates	Ecoinvent process: Lead, primary, at plant/GLO U
	Aggregated fuels	Ecoinvent process: Lead, primary, at plant/GLO U
	Aggregated electricity	Ecoinvent process: Lead, primary, at plant/GLO U

Table 3.1 (continued): Sources used for the account of technical coefficients

Re-processing of secondary lead into new lead	Lead, zinc and tin and products thereof - negative input	own assumption
	Aggregated fuels	Ecoinvent process: Lead, secondary, at plant/RER U;
	Aggregated electricity	Ecoinvent process: Lead, secondary, at plant/RER U;
Copper production	Copper ores and concentrates	Ecoinvent process: Copper concentrate, at beneficiation/RER U
	Aggregated fuels	Ecoinvent process: Copper, primary, at refinery/RER U
	Aggregated electricity	Ecoinvent process: Copper, primary, at refinery/RER U
Re-processing of secondary copper into new copper	Copper ores and concentrates	own assumption
	Aggregated fuels	Ecoinvent process: Copper, secondary, at refinery/RER U
	Aggregated electricity	Ecoinvent process: Copper, secondary, at refinery/RER U
Other non-ferrous metal production	Nickel ores and concentrates	Ecoinvent process: Nickel, primary, from platinum group metal production/RU U
	Aggregated fuels	Ecoinvent process: Nickel, primary, from platinum group metal production/RU U
	Aggregated electricity	Ecoinvent process: Nickel, primary, from platinum group metal production/RU U
Re-processing of secondary other non-ferrous metals into new other non-ferrous metals	Other non-ferrous metal products	Ecoinvent process: Nickel, secondary, from electronic and electric scrap recycling, at refinery/SE U
	Aggregated fuels	Ecoinvent process: Nickel, secondary, from electronic and electric scrap recycling, at refinery/SE U
	Aggregated electricity	Ecoinvent process: Nickel, secondary, from electronic and electric scrap recycling, at refinery/SE U
Casting of metals	Aggregated fuels	Ecoinvent process: Casting, brass/CH U
	Aggregated electricity	Ecoinvent process: Casting, brass/CH U
Manufacture of fabricated metal products, except machinery and	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of machinery and equipment n.e.c. (29)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of office machinery and computers (30)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of electrical machinery and apparatus n.e.c. (31)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of radio, television and communication equipment and apparatus (32)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of medical, precision and optical instruments, watches and clocks (33)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of motor vehicles, trailers and semi-trailers (34)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of other transport equipment (35)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Manufacture of furniture; manufacturing n.e.c. (36)	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Recycling of bottles by direct reuse	Glass and glass products	Schmidt J. (2005)
	Aggregated fuels	Schmidt J. (2005)
	Aggregated electricity	Schmidt J. (2005)
Production of electricity by coal	Aggregated fuels	Ecoinvent process: Electricity, hard coal, at power plant/UCTE U
Production of electricity by gas	Aggregated fuels	Ecoinvent process: Electricity, natural gas, at power plant/UCTE U
Production of electricity by nuclear	Aggregated fuels	Ecoinvent process: Electricity, nuclear, at power plant/UCTE U
Production of electricity by petroleum and other oil derivatives	Aggregated fuels	Ecoinvent process: Electricity, oil, at power plant/UCTE U

Table 3.1 (continued): Sources used for the account of technical coefficients

Production of electricity by solar photovoltaic	Aggregated fuels	Ecoinvent process: Electricity, production mix photovoltaic, at plant/DE U
Manufacture of gas; distribution of gaseous fuels through mains	Aggregated fuels	Ecoinvent processes: Drying, natural gas/NO U, Sweetening, natural gas/DE U and Natural gas, high pressure, at consumer/RER U
	Aggregated electricity	Ecoinvent processes: Drying, natural gas/NO U, Sweetening, natural gas/DE U and Natural gas, high pressure, at consumer/RER U
Steam and hot water supply	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Re-processing of secondary construction material into aggregates	Aggregated fuels	FORWAST (2010)*
	Aggregated electricity	FORWAST (2010)*
Incineration of waste: Food	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Incineration of waste: Paper	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Incineration of waste: Plastic	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Incineration of waste: Textiles	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Incineration of waste: Wood	negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Incineration of waste: Oil/Hazardous waste	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Biogasification of food waste, incl. land application	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
	N-fertiliser - negative input	FORWAST (2010)*
	P- and other fertiliser - negative input	FORWAST (2010)*
Biogasification of food waste, incl. land application	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
	N-fertiliser - negative input	FORWAST (2010)*
	P- and other fertiliser - negative input	FORWAST (2010)*
Biogasification of food waste, incl. land application	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
	N-fertiliser -negative input	FORWAST (2010)*
	P- and other fertiliser - negative input	FORWAST (2010)*
Composting of food waste, incl. land application	Aggregated electricity	FORWAST (2010)* and Nielsen P. H. et al. (2005)
	N-fertiliser -negative input	FORWAST (2010)* and Nielsen P. H. et al. (2005)
	P- and other fertiliser - negative input	FORWAST (2010)* and Nielsen P. H. et al. (2005)
Composting of food waste, incl. land application	Aggregated electricity	FORWAST (2010)* and Nielsen P. H. et al. (2005)
	N-fertiliser -negative input	FORWAST (2010)* and Nielsen P. H. et al. (2005)
	P- and other fertiliser - negative input	FORWAST (2010)* and Nielsen P. H. et al. (2005)
Waste water treatment, food	Aggregated electricity	FORWAST (2010)*
Waste water treatment, other	Aggregated electricity	FORWAST (2010)*

Table 3.1 (continued): Sources used for the account of technical coefficients

Landfill of waste: Food	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Landfill of waste: Paper	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Landfill of waste: Plastic	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Landfill of waste: Inert/metal/hazardous	Aggregated electricity	FORWAST (2010)*
Landfill of waste: Textiles	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
Landfill of waste: Wood	Aggregated electricity	FORWAST (2010)*
	electricity from waste - negative input	FORWAST (2010)*
	Heat from waste - negative input	FORWAST (2010)*
*it refers to Schmidt, 2010a; Schmidt, 2010b; Schmidt, 2010c; Dalgaard and Schmidt, 2010; Schmidt. et al., 2010		

Table 3.1 (continued): Sources used for the account of technical coefficients

It must be highlighted that some coefficients are obtained from own elaborations, so the remaining part of the section is dedicated to explaining those cases. More precisely, this explanation is concerned with the fertilizer inputs in cultivation and the total feed intake by animals. These coefficients are country-specific.

3.1.1 Input of fertilizers to cultivation – crop balance

The procedure explained here is based on official data and general crop data.
First of all the crop productions (FAOSTAT, access January 2013) are converted into dry matter (see Section 6) and aggregated according to the CREEA categories. Subsequently the yield (dry-matter tonne/ha) is obtained dividing the production by the harvested area (FAOSTAT). Yield for pastures is calculated based on grassing gap, which is calculated as follows (see section 5.1.2):

grassing gap = the total feed intake by animals - the feed sold in the market.

Then the harvested land is compared to the total arable and pasture land; whenever the harvested land exceeds the total arable land it means that a rotation of crops has been applied in the field hence a multiple-cropping activity is estimated. This affects the annual yields.
Concerning the roughage, since FAOSTAT does not contain production and land data for its cultivation, the land used for this crop is calculated as a residual:

land for roughage = total arable land - land for crops (where double cropping is addressed).

Once the picture of land use and crop production is ready it follows the calculation of the total applied fertilizers using the data from IFA (see Section 2.6) and the total production of manure in the country, which is obtained as described in the following section. Finally the total mineral fertilisers and manure is distributed on the different crops based on generic fertiliser recommendations for crops (FAO et al. 2002; FAOSTAT 2006).

3.1.2 Input of aggregated feed to animals – animal balance

The procedure underlying the calculation of the total feed requirement by animals is based on IPCC (2006; Chapter 10), which is also used by national authorities for the assessment of the greenhouse gases (GHG) emissions.
IPCC list three alternative procedures for the estimation of GHG emissions, each of them depends on the detail of available data. The first level, i.e. tier 1, relies on little national information and many default data. Increasing the data detail can allow the use of the tier 2 and , with a really exhaustive data source, the tier 3.
Our case corresponds to a mixed procedure mostly relying on the tier 2 approach, although some assumptions are required to fill all the data required. In particular, our main source, i.e. FAOSTAT, does not provide all the necessary information and therefore other data are taken from literature.
The procedure has been applied to ruminants, which are the main source of GHG emissions. For the other animals, like poultry and pigs, FORWAST data are used.
The first step consists of splitting the total stock of animals into milk and meat systems and then the herd composition is determined.

Cattle
Concerning cattle, the total meat and milk production, the total stock of animals and the slaughtered heads are obtained from FAOSTAT. Next, data on the herd composition (cows, heifers and bulls) of milk and meat systems are taken from Dalgaard and Schmidt (2012). These data are used as default for the disaggregation of the herd. Also a default value for the weight of adult animals and new-born veal is assumed. Finally data on the trade of animals are taken into account (see Section 4).
By combining all these data together it is possible to split the total herd in cows, heifers and bulls. However some manual adjustments are required since some countries like India show a specific situation due to religion beliefs, while for others changes are due to less industrialized production system, for example the rest of Africa and Europe.

Sheep

With regard to sheep, data on total animal stock, production of milk, meat and wool, milk and meat yield, slaughtered animals and on trade are taken from FAOSTAT. In addition to these, data on the weight of adult animals, their lifetime, their fertility rate and herd composition (rams per herd) are taken from the Claeys and Rogers (2003).
First of all the existence of the milk system is determined by comparing the milk yield (milk for internal uses is not considered) with a given reasonable threshold (150 kg/year)[1]. Above this threshold it is assumed that a milk system beyond subsistence exists in the country. Otherwise it is assumed that only the meat system exists. An exception is Australia where it is assumed that there is also a wool production system. This is due to the fact that in this country the most precious wool in the world is produced (Country Leader, 2008), constituting a very profitable commodity, and thus justifying the consideration in the model of a dedicated sector for this material..
Once the number of ewes is obtained in the milk system, the number of lambs is obtained by the fertility rate and by a derived replacement rate that takes into account the slaughtered heads and the lifetime of the animals. The number of rams is obtained by the herd composition default figure.
When the milk system is determined, the meat system is calculated on the remaining animals using the fertility rate, the replacement figure and the herd compositions. In a similar way the wool system herd composition of Australia is determined.
At the end of the procedure the average weight of slaughtered adult lambs is calculated. If these figures are in accordance with those from Claeys and Rogers (2003), the procedure is considered concluded. For each system (milk, meat and wool) the numbers of ewes, lambs and rams is determined. No manual adjustments are required in this case.

IPCC (2006) procedure
When all the information is available for the composition of the cattle and sheep herds, the IPCC (2006) tier 2 procedure is applied for each category of the herd. This means that a tier 2 approach is carried out for cows, bulls and heifers in both the milk and meat system. A similar procedure is carried out for the different sheep systems (ewes, lambs and rams). Some additional information is required which has not been mentioned so far. The latter is collected from existing databases such as the annual temperatures from World Bank (Climate Change Knowledge Portal), or assumed if no data sources are available (like the physical activity of animals).
The output of this procedure is a country-specific feed intake figure for sheep and cattle. The latter are also used for the determination of the total feed intake of other ruminants like buffalos, goats and camels. This can be partially justified by the similarities between animals and by the reduced number of these animals compared to cows and sheep.

[1] Specialized dairy breeds produce from 180 to 490 kg of milk per lactation (http://www.sheep101.info/dairy.html). Assuming that some milk could be used for internal uses and that one lactation occurs per year, 150 kg/year as average yield seamed a reasonable threshold.

Once the total feed intake is derived the next step is obtaining the mass balance for each animal category. In practice this consists of determining the outputs generated as a consequence of such feed intake. These outputs consist of meat (body growth), milk (when produced), wool (for sheep), carbon in the exhaled air, methane from enteric fermentation, water and, finally, manure.

From the IPCC (2006) procedure it is possible to derive also the emission of methane due to enteric fermentation. This is a relevant factor in the assessment of GHG emissions (see Section 5.2). The meat, milk and wool productions are derived from FAOSTAT data. Coefficients related to the carbon exhaled and water, are instead taken from the FORWAST database. Finally the residual value is the manure.

In this way a full mass balance is obtained for each animal category. These values are finally weighted so that a mass balance is fulfilled for the CREEA animal categories.

3.2 Use of energy products

As mentioned in chapter 2.4 the IEA energy balances have to be transformed from the territory to the residence principle to generate energy accounts that are in line with the SEEA accounting rules. Once done, the supply and use tables obtained in IEA format (IEA energy product x IEA item) have to be converted into CREEA energy accounts by splitting the energy flows into three broad groups (energy from natural inputs, energy products and energy residuals). These main groups can be further divided as shown in Table 3.1.

	Intermediate consumption			Final consumption	Accumulation	Flows to RoW	Flows to the environment	Total Use
	I_1	…	I_n	HH		Exports		
Energy from natural inputs								
Natural resource inputs								
Mineral and energy resources								
NI_1								
…								
NI_n								
Timber resources								
Inputs of energy from renewable resources								
NI_{n+1}								
…								
NI_x								
Other natural inputs								
Energy inputs to cultivated biomass								
Total energy from natural inputs								
Energy products								
Transformation								
EP_1								
…								
EP_n								
End use								
EP_1								
…								
EP_n								
Own end use								
EP_1								
…								
EP_n								
End use for non-energy purposes								
Energy residuals								
ER_1								
…								
ER_n								
Other residual flows								
Residuals from end use for non-energy purposes								
Energy from solid waste								
Total Use								

Table 3.1: Example of Energy Use table according to SEEA. The dark areas refer to 0s.

In terms of use of energy products, WP6 has provided WP4 with two 200 x 175 (CREEA product x CREEA industries and final categories) matrices that result from the aggregation of the submatrices of transformation of energy products, end-use of energy products, own end-use of energy products and end-use of energy products for non-energy purposes (in light green). One of the matrices delivered refers to the gross use and the other one to the emission-relevant energy use, i.e. the energy use related to the combustion of energy products.

In order to produce the 200 x 175 gross-use and emission-relevant energy use matrices, a 5-step procedure has been applied:

Task 1 "From IEA - Energy Balances to Raw Gross Energy Tables" refers to the splitting of the IEA energy balances into the supply and the use of energy flows as indicated in chapter 2.4.

Task 2 "Bridging from the territory principle to the residence principle" consists of including the energy consumption by resident units in foreign territory in and deducting the energy consumption of non-resident units in national territory from the appropriate IEA items. The main activities affected refer to international transport and fishing. Thus, four world international transport models[2] have been built in order to:

- Estimate the distribution shares of the use of energy products from international marine bunkers by resident units[3]
- Estimate the distribution shares of the use of energy products from international aviation bunkers by resident units[4]
- Estimate the distribution shares of the use of energy products from road transport by resident units and allocate it to the appropriate industries and final use categories (e.g. households)[5]
- Estimate the distribution shares of the use of energy products from fishing activities by resident units[6]

[2] The details of how each model has been built are given in D6.1.

[3] The IEA item “International marine bunkers” covers the delivery of energy products to ships of all flags that are engaged in international transport (IEA 2011). Thus, this item has been interpreted as exports (to bunkers) while the calculated use of energy products has been interpreted as imports (from the bunkers).

[4] The IEA item “International aviation bunkers” covers the delivery of energy products to aircrafts engaged in international transport (IEA 2011). Thus, this item has been interpreted as exports (to bunkers) while the calculated use of energy products has been interpreted as imports (from the bunkers).

[5] The IEA item “Road” refers to the use of energy products from road transport within the territory (IEA 2011). Hence, the use of energy products has to be estimated according to the residence principle. The differences are interpreted as the net foreign trade.

[6] The IEA item “Fishing” refers to the delivery of energy products to fishing vessels of all flags that have refuelled in the country (including international fishing) as well as energy used in the fishing industry (IEA 2011). Hence, the use of energy products has to be estimated according to the residence principle. The differences are interpreted as the net foreign trade.

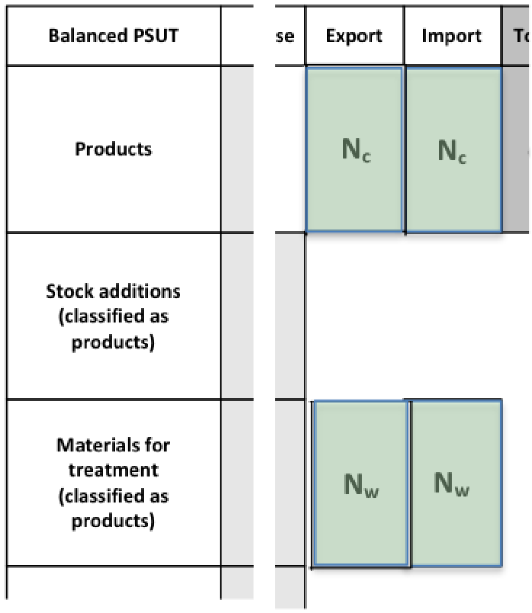
The outputs of this task are energy supply and use tables according to the residence principle in IEA energy product x IEA item format. Further, the gross use table is multiplied cell-by-cell by a matrix of the same size with a dummy variable that indicates whether an energy product is combusted or not in each IEA item. Thus the emission-relevant energy use table is also produced in IEA energy product x IEA item format.

Task 3 "Generation of Correspondence Tables" refers to the production of equivalence tables between IEA energy products and CREEA products on the one hand, and IEA items and CREEA industries and final use categories on the other. These correspondence tables are the basis to carry out the allocation in the next task.

Task 4 "Allocation of Items in the Raw Gross Energy Tables to CREEA industries and Final Use Categories". By means of the correspondence tables generated in the previous task and complex allocation and breakdown procedures that are based in a wide range of auxiliary datasets (see D6.1. for more information), the allocation of the energy uses by IEA item to CREEA industries and final use categories is carried out, which results in three 63 x 175 (IEA energy product x CREEA industries and final use categories) matrices; one for the gross supply, one for the gross use and one for the emission relevant energy use.
However it is noteworthy to mention that the allocation to CREA industries has been done considering that industries have their own principal and secondary productions (EUROSTAT, 2008), which are defined in the MSUTs. This implies full consistency between the physical and the monetary level
The next step consists of transforming the 63 x 175 matrices into 200 x 175 matrices. As in the case of the supply (cf. chapter 2.4), the 63 IEA energy products are allocated to the 200 CREEA products on a one-to-one basis, except in a few cases in which monetary distributions extracted from the MSUTs are used to disaggregate those products.

Task 5 "Generation of the final Use Energy Tables" comprises the preparation of the energy supply and use tables according to the SEEA framework and the data arrangements based on the analytical requirements of CREEA. This is done in a several-step process on the basis of the accounting rules described in chapter 3 of revised SEEA and the recommendation of the manual for energy accounts from Eurostat (UN 2013, Eurostat 2011). The resulting gross energy use and emission relevant energy use tables have the format shown in Table 3.2 although the matrix of the energy products is aggregated into a 200 x 175 matrix to match the needs of WP4.

4 Imports, exports and prices



In modern economies trade plays an important role. Economies are more and more dependent on imports and exports. In quantitative terms this means that a huge flow of goods is traded daily hence it is of fundamental importance to take this aspect into account when dealing with national physical databases. Furthermore, in a multi-regional data set that aims to cover all the areas of the world, overall coherence between imports and exports is required. This means that goods exported from country A to country B should be equal to import of B from A. If this simple property is respected for each couple of countries, the final result is that the whole trade at global level is coherent.

However trade accounting does not take place in WP4 but in WP7. Therefore the interested reader can find more information about this topic in deliverable D7.1.

With regard to prices, they have been determined dividing the monetary domestic production by the physical domestic production. However this was possible only for products where a mass flows could be defined (see Section 3). For the remaining products prices of exported goods were taken into account. Deliverable D7.1 shows how the prices of traded goods are determined.

5 Exchanges with the environment

In this section two important sets of coefficients are introduced. They are used for the construction of the resource and emission accounts. Their role is to build a direct link between the supply and use of specific flows in the technosphere and the environment. In this way the resource and emission accounts are fully harmonized with what it is included in the use and supply of products.

5.1 Natural resources

One important pillar of the work in Task 4.2 was the improvement of data availability and data quality of material flows in key areas of importance. Four areas were selected as focus areas of the work on material flow analysis (MFA) undertaken in CREEA:

1. Improvements of the estimation procedure for the extraction of construction minerals
2. Improvement of estimation procedures for biomass uptake by animals (grazing)
3. Harmonisation and improvement of extraction data of metal ores
4. Review and update of data for unused domestic extraction (UDE)

In the following, a technical description for the work undertaken is provided for each of the four key areas.

5.1.1 Extraction of construction materials

For almost all countries world-wide, reported data on the extraction of construction materials are incomplete and thus underestimate the true levels of extraction. This holds particularly true for emerging and developing countries, where the reporting on the extraction of construction materials, such as sand and gravel, is almost completely missing.
Exceptions to this general situation are the EU countries, for which MFA data is available from official statistical sources or reported by EUROSTAT[7], as well as the US, for which reliable data are available from the US Geological Survey[8].
In order to estimate the amount of the extraction of construction minerals for other countries, estimation methods need to be applied. Two different estimation methods were applied in the CREEA project.
The first method estimates the amount of extraction of limestone, sand and gravel based on physical data on cement production and consumption of countries and on the national production of bitumen (i.e. asphalt). For all countries, for which USGS reported solid time series data on cement and bitumen production, this procedure was applied. By this

[7] See: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_mfa&lang=en
[8] http://minerals.er.usgs.gov/minerals/pubs/commodity/aggregates/

first estimation method, we cover around 50% of all countries world-wide, including all countries, which are individually modelled in CREEA.

Construction minerals are mainly used for two purposes: the construction of buildings and the construction of transport infrastructure, such as roads and runways. Regarding buildings, the major product applied is concrete. A typical composition[9] of concrete consists of around 70% aggregates (sand and gravel), 12% cement, 18% water, and small amounts of burnt lime as binder. Thus, if the numbers for cement are known, the corresponding requirements for aggregates (sand and gravel) to produce concrete can be estimated. Krausmann et al. (2009) introduced a factor of 6.5 to transform cement data into the corresponding requirements of sand and gravel. In addition, also cement itself requires construction mineral, notably limestone, for its production. For each tonne of cement, around 1.4 tonnes of limestone are required (Krausmann et al., 2009).

The calculation procedure thus starts with compiling data on cement production taken from USGS (see minerals.usgs.gov/minerals/pubs/commodity/cement). Mass data on cement production is multiplied with a factor 1.4, in order to estimate the quantities of limestone required to produce the reported amounts of cement. It is assumed that the limestone is always extracted in the same country, where the cement production takes place.

In order to estimate the amount of sand and gravel required for concrete production, we first calculated the amounts of national cement consumption, by adding cement imports and subtracting cement exports from the national cement production values from USGS. Data on cement trade was taken from the UNComtrade database (see comtrade.un.org). Thus, we calculate the Domestic Material Consumption (DMC) of cement in each country. This cement consumption is then multiplied by a factor 6.5 (see above), in order to estimate the corresponding requirements for sand and gravel.

Asphalt (or bitumen) is the main material used for the construction of transport infrastructure, such as roads and runways. Asphalt is the sticky, black and highly viscous liquid or semi-solid present in most crude petroleum and is used as the binder mixed with aggregate particles to create asphalt concrete. Following Krausmann et al. (2009), we estimated that each ton of asphalt is mixed with around 20 tonnes of sand and gravel, in order to produce asphalt. The main data source of bitumen production is the International Energy Agency (IEA, 2012). The bitumen production is then multiplied by a factor 20, in order to estimate the corresponding requirements for sand and gravel.

The total extraction of construction minerals is then calculated for each country by summing up the extraction related to buildings (concrete) with the extraction related to transport (asphalt concrete). In CREEA, this estimation procedure was for the first time applied in a time series from 1980 to 2010.

[9] There are diverse possibilities to replace parts of the recipe by other secondary materials, e.g. granite or even tires, however, these cases are neglected here.

For all other countries, forming the various country groups in the CREEA database, we applied the second estimation method that has been developed in a previous FP project. This method estimates the per capita extraction of construction minerals based on GDP/capita data, assuming that the extraction of construction minerals increases with population growth, and that as countries get richer, growth in construction minerals extraction per capita slows down and comes to an end above 20.000 US$/capita at a level of 10 tonnes per capita per year. For more information on the second estimation method, see SERI (2013).

5.1.2 Biomass uptake by animals (grazing)

Biomass uptake by grazing animals is one of the biggest single material categories within the group of biotic materials. Global agricultural databases contain data on the supply of market feed and fodder crops, but do not include any information on biomass grazed by livestock or mowed for livestock sustenance. Thus, biomass uptake from grazing needs to be estimated.

Eurostat's MFA Guide therefore suggests two different approaches (EUROSTAT, 2012):
(A) The "supply approach", which multiplies areas of permanent pastures with annual yield coefficients. This approach requires global data on land used for grazing and regionally specific information on grass yields.
(B) The "demand approach", which multiplies annual livestock data with estimations of yearly fodder demand by different grazing animals.

Both estimation methods provide rather crude estimations, if no additional data is taken into account. In CREEA, we decided to follow the demand approach, as no consistent database on land used as grazing area is publicly available and the use of land cover data would severely distort the results. However, in addition to estimating the yearly fodder demand, we also estimated to what extent this fodder demand is already being met by other fodder production.
The refined demand approach requires a vast amount of data and detailed information on the livestock system and feed production in each of the analysed countries. The basic logic of this approach is to calculate grazing demand as the difference between (a) overall feed demand and (b) the supply of market and non-market feed (with the latter including fodder crops and crop residues) in each country. The resulting amount of biomass is called the "grazing gap", which is the amount of feed required by the livestock of a country that is not supplied from other sources (see Figure 5.1). Figure 5.1 illustrates the general approach of the "grazing gap".

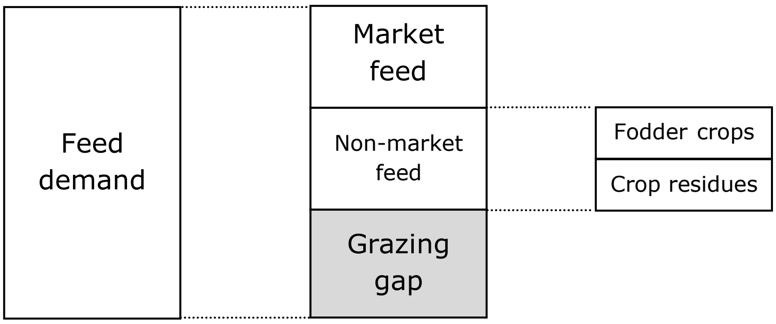


Figure 5.1: General concept of the refined grazing demand approach

For the calculation of feed demand, country-specific data on stock and production for 11 livestock species were taken from the FAO database. We then applied region-specific feed demand coefficients in kilograms dry matter per head and day published by Krausmann et al. (2008b). For cattle and buffaloes we calculated national feed demand based on assumed linear correlations between average daily feed intake per head and average national milk yield and carcass weight provided by Krausmann et al. (2008b).

Feed supply consists of market feed and non-market feed. Market feed was taken from the FAO commodity balances that give detailed information on the supply of feed from primary crops such as soy and wheat. These values were transformed into dry matter, as FAO provides all production volumes including the moisture content at harvest. Non-market feed is composed of fodder crops (leguminous crops, maize for silage, fodder beets, etc.) that are reported in FAO's agricultural production database, and feedstuff from crop residues (e.g. straw, leaves) that are calculated for each country based on crop residue recovery rates published in literature (collected by and listed in Krausmann et al., 2008b).

The grazing gap, i.e. the difference between total feed demand and the supply by market and non-market feed was assumed to equal the volume of biomass harvested on grazing land in each country. This number was finally converted from dry matter into fresh weight assuming 15% moisture content in accordance with the MFA guidelines (EUROSTAT, 2012).

5.1.3 Extraction of metal ores

Different MFA databases reveal high variability in the data for metal ore extraction. According to MFA conventions (EUROSTAT, 2012), metal ores are accounted as crude ores, i.e. gross ores including metal content. In MFA, flows of metal ores are thus accounted with regard to the run-of-mine production, i.e. the total amount of extracted crude ore that enters the first stage of processing (after extraction).

Only a few metal ores are reported as crude ores in metal statistics, for example, iron ore, or bauxite as the raw material for aluminium production. The mining of most metals is reported by net metal contents, i.e. the amount of pure metal that is extracted from the crude ore. For those metals, factors have to be appliedthat refer to the average metal concentration and thus allow to transform the data from net metal content to crude ore. The differences in data found in various MFA databases mainly stem from different assumptions on the average metal concentrations per country.

5.1.3.1 Harmonizing the databases of Wuppertal Institute and SERI

In order to proceed towards a more consistent global database for metal ore extraction, it was decided to align two MFA databases in the CREEA project: the database by the Wuppertal Institute that covers all OECD countries and SERI's Global Material Flow Database (www.materialflows.net) that contains data on metal ore extraction for all countries world-wide.
The process of alignment was undertaken in several steps:

1. Identification of disparities by comparing ore extraction time series for all CREEA countries and all metal categories. This step revealed the biggest disparities between the two databases.
2. Selection of most important metals in terms of absolute disparities (in tonnes). We found that the following five metals caused more than 80% of the disparities between the two databases: iron (here termed: iron ore), copper, gold, lead and zinc.
3. Identification of the reasons for the disparities. We found that
    a. Differences in primary data sources reporting metal production (reported by USGS and BGS) only reason minor variations of the results
    b. Different assumptions for metal contents in crude ores are responsible for more than 80% of variations
4. Alignment of ore grade assumptions using best available factors from both databases. For each of the five metal ores, all available metal concentration factors from the two databases were gathered and compared with regard to their reliability (i.e. the quality of the primary source), transparency (i.e. available documentation) and timeliness (i.e. more recent factors were preferred over older factors). From this evaluation, a first suggestion for the best available factors was derived.

5.1.3.2 Literature review on metal concentrations

In addition to the factors already available at the databases of the Wuppertal Institute and SERI, a literature review was performed, in order to check for recent information on metal concentrations that was not yet available in the databases. On the one hand, we reviewed recently published studies on national material flow accounts, such as those published by Statistics Finland (2013) and the UK Office of National Statistics (ONS, 2011). On the other hand, we made bibliographic searches, using keywords such as "concentrations of metal ores" or "metal content" in large data bases for scientific publications, such as Scopus. In addition to the literature review, a number of key experts were contacted directly, in order to obtain relevant information, including partly unpublished information (supplementary material). Key experts included representatives from USGS, BGS, EUROSTAT and national statistical institutions, and universities.

All contacted experts confirmed that national average data on metal ore concentrations were not available in a harmonised and standardised form. The Experts suggested locating national datasets for every country, through (1) national statistical offices, (2) specialized consultancies or (3) annual reports of mining companies. The difficulties in determining global or even national averages are enormous, due to the inherent geological peculiarities of the mines, and the by-products of the mines. A detailed complete assessment of national statistical sources or annual reports of mining companies was beyond the scope of the CREEA project. The Raw Materials Group situated in Stockholm could possibly provide such type of data based on assessments on the level of individual mines, but the costs for this database exceeds the budget framework of CREEA.

As a result, only very few new factors for metal ore concentrations could be obtained from the literature or directly from experts. In particularly useful were recent publications of the Australian metal mining specialist Mudd, who published a series of articles containing average national concentrations for various metal ores (for example, Mudd, 2007, 2010; Mudd, 2012). Where reliable factors were available from these publications, existing factors in the Wuppertal or SERI data base were replaced.

The result of this work on metal ores is an improved and harmonised data set for metal ore extraction in all countries world-wide that for the first time integrates the best available elements from existing databases from both SERI and the Wuppertal Institute, updated with recent factors from technical literature.

5.1.3.3 Allocation of coupled production

Further, co-production and by-production in the metal sector requires adequate allocation of e.g. crude ore to the individual metals. As the current Eurostat MFA compilation guide applies monetary allocation (EUROSTAT, 2012), the maximum availability of metal prices was investigated for the purposes of monetary allocation.

Data on metal prices from price statistics of Geological Surveys were reviewed and assessed with regard to temporal comprehensiveness and coverage of the multitude of metals. The price data of the USGS Historical Statistics (in 98US$) were considered as most adequate for the given purposes. They are provided in average annual metal prices.

Information on coupled production of two or several metals in one unit crude ore is rare and often ambiguous. The occurrence of coupled production of ores should be identified on a mine by mine basis by referring to annual business reports. Only partly that information is also reported in the country reports of USGS. We therefore decided to confine this approach to lead and zinc which are commonly found in one type of ore, i.e. lead zinc ores. Using the metal concentration data and price data obtained as descibed above, we applied the algorithm proposed by Eurostat (2012) in Excel:

Step 1: is on calculating the total gross ore based on the main metal contained. For deciding on what metal is regarded as the main metal of the ore, the physical quantities of the metal output in tonnes) is converted into value terms using the USGS price data as multipliers. The total amount of gross ore is calculated by dividing the metal output of the main metal by the ore grade of that metal, based on the implicit assumption that metal output and metal content of the ore are practically equal.

Step 2: is on allocation of gross ore to metals from coupled production. The total amount of gross ore has to be attributed to the different metals mined in coupled production. This can be done by using the relationships regarding the values defined in step 1. For example, for metal m_1, the attributed fraction of total gross ore (gm_1) should be calculated as follows:

$$gm_i = \text{total gross ore in [t]} * vm_i / (vm_1 + vm_2 + ... + vmn)$$

With: gm_i is the fraction of the total gross ore attributable to the extraction of metal m_1; and vm_i is the value of the metal $_i$

For numerical examples refer to Eurostat (2012), table 14.

The result of the above procedure are standard coefficients for allocating one unit of gross ore by extracting country to lead and zinc (ores), respectively.

5.1.4 Unused domestic extraction

Unused domestic extraction (UDE) of materials is another category, where data availability and quality is far from satisfactory so far. UDE refers to materials that are extracted from the environment without the intention of using them, including soil and rock excavated during construction or overburden from mining, the unused parts of felling in forestry, the unused fishery by-catch or the unused parts of the straw harvest in agriculture (EUROSTAT, 2012).

As part of the research on metal concentrations, experts were also asked, whether information on overburden and/or overburden/ore ratios from mining activities was available. The result was not rewarding, as even the most important data providers (such as USGS) are missing this information. As Keith Long, a USGS expert put it in an e-mail conversation: "No government statistical agency is collecting this information. The only way to get this data would be to research every mine that reports production data - a very time-consuming and tedious process. Of course, no such data will be available for almost all mines in China, Russia, and a few other countries, and there will be some non-reporting mines even in countries where mining companies listed on stock exchanges are required to report regularly on production." Thus, no additional data on overburden has been collected in CREEA, and the

CREEA database thus builds on UDE factors for metals that were collected in earlier projects (for a description, see SERI, 2013).

The issue of unused domestic extraction is also very relevant with regard to biomass harvest in agriculture and forestry. In CREEA, a new system of calculating UDE from agricultural production was developed, in which our own earlier work was integrated (Jölli and Giljum, 2005) and updated with new information (in particular from Krausmann et al., 2008a). For each crop reported in the FAO database on agricultural production, a so-called harvest factor was compiled from the literature, which reports on the amount of biomass being produced (i.e. harvested) in addition to the main product (e.g. straw, leaves, etc.). This factor ranges from 0.2 (e.g. for fibres) up to 3.5 (e.g. for maize). For each kilogram of fibres produced, additional 0.2 kg of biomass is potentially available for use, whereas per each kilogram of maize, 3.5 kg of additional biomass is being produced. Mainly based on the two publications listed above, a so-called unused factor was then introduced that reports on the share of biomass in the additional harvest, which is not used for other purposes (e.g. for feeding, or other purposes). This share of unused biomass in the additional harvest ranges from around 10% (e.g. in the case of beans or lentils) to 100% (e.g. for many permanent crops such as apples or oranges, where all additional biomass, such as branches and leaves, is not used for any other purposes). The total unused extraction of biomass from agriculture is thus calculated with the following formula:

Unused extraction of biomass from agricultural production =
primary production (from FAO) x harvest factor x unused factor

For the first time, unused extraction of biomass from agricultural production was thus calculated on the full detail for all crops reported in the FAO production statistics.

5.2 Emission factors

CREEA covers all relevant air emissions from both greenhouse gases (impact on global warming) and air pollutants (impacts on health and ecosystems). The list of substances included is given in Table 5.1.

Group	Substances
Greenhouse gases	CO_2, CH_4, N_2O, SF_6, PFCs, HFCs
Main air pollutants	NO_x, SO_x, NMVOC, CO, NH_3
Particulate matter	TSP, PM_{10}, $PM_{2.5}$
Heavy metals	As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn
Polycyclic Aromatic Hydrocarbons (PAH)	Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total PAHs
Other persistent organic pollutants	HCB, PCB, Dioxins and Furans

Table 5-1: Overview of substances for which air emissions have been calculated

The emission factors determine the amount of emissions produced either per unit of used product or per unit of supplied commodity. This means that every time a particular commodity is used or supplied certain substances might be emitted. This assures coherence between what happens within the technosphere and the exchanges with the environment.
As a general rule, the emissions in CREEA are calculated as follows:

$$E_{substance} = \sum_{activities} AR_{activity}\ x\ EF_{activity,substance}$$

$E_{substance}$ *(t)*	The emission of a certain *substance* at time *t*
$AR_{activity}$ *(t)*	The activity rate for a certain *activity* at time *t,* represented by either and input or output measure
$EF_{activity,substance}$	The emission factor, an attribute of the selected activity

There are two types of emissions, the first is related to the use of certain flows, for example the use of fuels generates some emissions. The magnitude of these emissions, which is expressed by emission factors, depends on the industrial process using fuels because the adopted technology may differ and, consequently, the produced emissions too.
The second group of emission factors is connected with the supply of certain outputs. In this case it is not easy to connect the discharged emissions to specific inputs hence they are related to the output for simplicity. This case, for example, refers to emissions from crops and from chemicals production plants. This implies an asymmetry for the mass balance since emissions are not counterweighted by proper inputs. To solve this mismatch a new fictitious category of resources is created, which is named 'dummy resource for compensating the emissions'. By doing so the mass balance is assured. The drawback of this procedure is that it determines an overestimation of the waste produced of an amount equal to the dummy resources. Indeed the input that should become emissions will instead end up in the supply table of waste accounts. However, seen the irrelevance in numerical terms of such flows compared to other mass flows within a modern economy, this procedure does not involve serious problems.
In a few cases (HFC, PFC and SF6) emissions could not be calculated with the approach shown above, since these depend on several variables for which there are limitations in data availability. In these cases, the emissions reported in UNFCCC have been taken when possible, and completed with data from the JRC EDGAR emission model for the remaining countries.
In the following part emission factors are presented. They are divided in five categories:

- Emission coefficients from agricultural activities
- Emission coefficients from combustion uses

- Emission coefficients from non-combustion of energy products
- Emission coefficients from non-energy uses
- Emission coefficients from waste management activities

5.2.1 Emissions from agricultural activities

Crops

With regard to the emission of crops, the coefficients are based on the output.

The generic and crop specific parameters of the IPCC (2006) method are all obtained from this reference. Based on the calculated emissions N-balances of each CREEA crop are established. The N-balances take into account inputs of mineral and organic fertiliser and atmospheric N-deposition, and outputs of crops and emissions of N_2O-N (direct), NO_x-N, NH_3-N, NO_3-N and N_2. Nitrogen in the harvested crop is determined based on protein content of the crops. The protein in different crops is estimated from Moeller et al. (2005). The protein is converted to nitrogen using a protein to nitrogen ratio at 6.25 kg protein/kg N. The N_2 is calculated as N-inputs minus all other outputs; hence N_2 is the balancing item of the N-balance. In some cases, the calculated N_2 turned out to be negative. In these cases the protein content of the crop has been adjusted to ensure a consistent N-balance.

The emissions factors are calculated for N_2O (direct and indirect), NO_x, NH_3, NO_3 and CO_2 from peat oxidation:

- Total emissions per crop and country
- Emissions per kg dry matter crop and country
- Emissions per hectare year crop and country

For the emissions produced by animals, the coefficients are linked to inputs, in practice to the feed intake. Emission coefficients are determined using the procedure developed by the IPCC (2006). More details on the procedure are given in Section 3.1.2.

Manure treatment

Manure is a by-product from the animal production and substitutes mineral fertilizer as it is used for crop fertilization. The handling of manure also gives rise to emission of methane and different kinds of N containing compounds, which impact on the environment. Here we describe how the fate of manure is modelled and how the emissions are quantified.

The amount of dry matter manure excreted from the different animal types is based on the animal balances (see section 3.1.2). The N content in the manure is calculated using data on N content of dry matter in manure from different animal types (e.g. dairy cows, broilers, bulls, pigs) from Poulsen et al. (1997), Wesnæs et al. (2009) and Moore et al. (1998).

It is assumed that 10% of the manure excreted is not used as fertilizer. This manure could for instance be kept in lagoons, excreted in streets or other land where crops are not cultivated. The remaining 90% of the manure is partitioned between arable land and pasture by assuming all manure in stables is collected and applied to the arable land, and the rest is excreted on pasture. It is assumed the dairy cattle and beef cattle are indoor 50% and 10% of the time respectively, whereas pigs and chicken are indoor 100% of the time. All other animal types are assumed to be outdoor all the time. The amount of N in manure excreted per hectare on pasture in each country is calculated by dividing the country-wise amount of manure N with the permanent pasture area from FAOSTAT (2013). The nitrogen excreted per ha of permanent grass became unrealistically high for a few countries (Cyprus, India, Slovenia and South Korea) and therefore the percentages of 'manure not used as fertiliser' and 'time indoor' are moderated for these four countries.

The emissions from manure are to a large extent modelled according to IPCC (2006). However, a methane conversion factor (MCF) of 7% is used for all countries even though it varies with the climate and type of manure. The 7% is calculated as a simple average of the methane conversion factors used for calculations in climatic regions where the average temperature is less than 10 degrees Celsius. In countries with warmer climate the MCF will be higher. It is assumed the manure N loss (ammonia, etc.) is 10% from stable and 20% from pasture and that each kg N in manure substitute 0.48 kg mineral fertilizer.

The modelling of manure emissions is further described by Schmidt et al. (2012) and Dalgaard and Schmidt (2012).

5.2.2 Emission coefficients from Combustion Uses

The final emission factors related to the combustion and non-combustion of energy products, as well as those related to the non-energy uses have been obtained using the TNO Emission Assessment Model (hereafter referred to as "TEAM") as a starting point. This is an emission estimation model that explicitly models the use of certain technologies (Pulles et al., 2007). This is mainly important when longer time series are studied, allowing for the introduction of new, cleaner technologies in later years. By doing so, the use of country specific emission factors (that only contain information on the "average" technology in this country) is avoided.

In the TEAM model, emissions according to the territory principle are calculated to check and validate the emission factors that will be used as a starting point to generate the final emission factors used in WP4. These emissions are calculated by multiplying activity rates by weighted emission factors that take into account the technological specificities of the country:

$$E_{substance} = \sum_{activities} \left(AR_{activity} \times \sum_{technologies} \left(EF_{technology,substance} \times P_{technology} \right) \right)$$

while at the same time ensuring that for all *activities* and all *t*:

$$\sum_{technologies} P_{activity,technology}(t) = 1 ,$$

where:

$E_{substance}(t)$	The emission of a certain *substance* at time *t*
$AR_{activity}(t)$	The activity rate for a certain *activity* at time *t*
$P_{activity,technology}(t)$	The penetration: fraction of the *activity* performed using the specific *technology*, at time *t*
$EF_{technology,substance}$	The emission factor, an attribute of the selected technology, which determines the linear relation between the activity rate and the resulting emission of a certain *substance*, using a specific *technology*

Using this approach, the emission factors are explicitly independent of time and location. The spatial and temporal information is accounted for by the activity as well as implicitly in the penetration, which models the use of technologies varying with time and location. Emission factors are therefore only a property of the technology and not of the activity. This differs from the classical emission inventorying where country specific implied emission factors are the weighted average of all technologies applied for a certain activity.

The emission factors resulting from the TEAM model are determined according to the IPCC source or IEA item classification, which is not compatible with the CREEA product and industry classification. The following sections explain how these emission factors have been further processed in WP6 to generate the final emission factors delivered to WP4.
To calculate the emissions in WP4, emission-relevant energy use data (activity rate) are combined with the final country-specific emission factors for combustion uses (according to the CREEA classification) that have been delivered by WP6.
The procedure to generate the emission factors is as follows:

Generation of a first dataset of emission factors with the TEAM model
The first set of emission factors is generated after applying the TEAM model. The resulting emission factors, which are weighted by technology and therefore are country specific, are given by IEA item as kg of substance emitted per MJ of energy products combusted. Their validity is checked by calculating the emissions according to the territory principle and comparing them to the existing emission inventories. When necessary, corrections or adjustments are made.
These emission factors have been generated according to internationally established methodologies to build emission inventories at national level that are suitable for reporting under the international reporting

obligations (UN Framework Convention on Climate Change, UNECE Convention on Long Range Transboundary Air Pollution)[10].

Generation of a final dataset of emission factors

Since the emission factors are not readily compatible with the CREEA product and industry classification, a second set of emission factors has to be produced. For such a task, the emissions according to the residence principle have to be generated by multiplying the emission relevant energy use by their corresponding emission factors (as calculated in Task 2 in chapter 3.2). This leads to emission tables according to the IEA product and industry classification.

The conversion of these emission tables from the IEA classification to the CREEA classification is carried out by applying the procedure explained in chapter 3.2. Once the emission tables are obtained in the CREEA classification, a simple cell-by-cell division by the emission relevant energy use in the CREEA classification leads to the emission factors that have been used in WP4.

5.2.3 Emission coefficients from the Non-Combustion of Energy Products

As in the previous case, the emission factors related to the non-combustion of energy products are extracted from the UNFCCC reporting guidelines and the EMEP/EEA guidebook (IPCC 2006, EMEP/EEA 2009).

These are combined with the appropriate energy use data, in this case, the non-emission relevant energy use, which is obtained by deducting the emission relevant energy use from the gross energy use, to generate the emission with the TEAM model. Afterwards, thee emissions are compared to official estimates from inventories and the emission factors are adjusted as appropriate.

Once the emissions are calculated according to the IEA classification, an allocation matrix that distributes the IEA items into CREEA industries and final use categories is used to convert the emissions into the CREEA classification. This allocation matrix is generated based on the physical and monetary outputs of the industries. From this, the emission factors according to the CREEA requirements can be produced.

5.2.4 Emission coefficients from Non-Energy Products

The emission factors used to calculate the air emission from non-energy products have been obtained from the UNFCCC reporting guidelines and the EMEP/EEA guidebook in the case of industrial processes and from the GAINS[11] model in the case of solvent and other products uses.

[10] Since road transport is a major source of pollution and a lot of information is available on technologies and emissions, a more detailed model has been elaborated for its emissions, and emission factors are calculated separately for each country, fuel and pollutant based on the detailed data available.

[11] http://www.iiasa.ac.at/

In contrast to the previous cases, these emissions do not depend on the energy use. As a result, appropriate activity data has to be gathered from various sources (see Annex 2 of D6.1).
These data are combined to generate the emissions in the IPCC source classification. These are then converted to the CREEA classification with the aid of an allocation matrix built as in section 5.2.3, and from there, the emission factors in by CREEA product and industry are generated.

5.2.5 Emission coefficients from waste management activities

The waste treatment activities play an important role in the CREEA project. These activities have a great detail, therefore they can be modelled with accuracy in the PSUTs generation procedure.
Emission coefficients for the management of manure are already described in 5.2.1 when dealing with agricultural activities.
For the other activities, which include recycling, incineration, landfilling, composting and biogasification, the emission factors are taken from the FORWAST database (J. H. (2010a); Schmidt J. H. (2010b); Schmidt J. H. (2010c); Dalgaard R. and Schmidt J. H. (2010); Schmidt J. H. et al. (2010)).
In the CREEA project effort has been put on finding alternative sources to FORWAST with the aim of enhancing the already available data set. Yet the outcome of the search has been that of confirming the validity of the FORWAST emission coefficients, therefore the latter have been applied also in the CREEA procedure.
FORWAST data set shows the amount of emissions discharged by waste activities per unit of processed waste. These coefficients are thus connected directly with the use of waste by productive activities.

6 Other coefficients

In the previous sections the coefficients used directly for shaping the production functions of activities and for generating the resource and emissions accounts have been shown.
Here some other coefficients used in the generation of PSUTs are documented, namely the transfer coefficients for the determination of the waste accounts, and the dry matter coefficients to convert all the mass flows in dry weight.

6.1 Transfer coefficients

This set of coefficients show how much of an input is embodied in the supplied products by activities. Consequently, in combination with the emission factors, these coefficients are fundamental for the assessment of the waste accounts. Indeed, for the mass conservation law, what enters into a productive process may either be embodied in the output or becomes emissions or waste.
Transfer coefficients are included in the interval [0;1] and their source is the FORWAST database (Schmidt J. H. (2010a); Schmidt J. H. (2010b); Schmidt J. H. (2010c); Dalgaard R. and Schmidt J. H. (2010); Schmidt J. H. et al. (2010)).
Besides the mean values for these transfer coefficients, upper and lower limits are also provided to describe their variability/uncertainty. These limits are also obtained from the FORWAST database.

6.2 Dry matter coefficients

Dry matter coefficients (DMCs) are of extreme importance because the PSUTs are produced in dry matter units, thus they are used to convert the physical flows that are usually accounted in wet weight in most of databases.
DMCs are determined for all the FAOSTAT products that are then aggregated in the CREEA categories. Accurate estimations were performed for agricultural productions covering roughly 75% of the world production. For 17% of the world's production, DMCs from the previous group were used as they were assumed to be reasonable surrogates. Finally for the remaining 8% of the agricultural world production, average coefficients are used. For the remaining products, some DMCs are taken from existing literature, many of them from the FORWAST database.
Table 6.1 shows all the CREEA product categories accounted in mass units and the sources taken into account for the DMCs.

CREEA Products:	**Source:**
Paddy rice	Møller et al. (2000)
Wheat	Møller et al. (2000)
Cereal grains nec	Møller et al. (2000)
Vegetables, fruit, nuts	Pérez R. (1997), Salman S. R. (2005) and own estimations
Oil seeds	Weng C. K. (1999) and own assumptions
Sugar cane, sugar beet	Preston T. R., (1988)
Plant-based fibers	own estimations

Table 6.1: Sources used for the dry matter coefficients of products accounted in mass units (continued)

Crops nec	Chávez A. L. et al. (2008) and Sestras A. et al. (2006)
Cattle	Aschbacher P.W. et al. (1965)
Pigs	Houseman R.A et al. (1973)
Poultry	Heinz and Hautzinger (2007) and Gebhardt and Thomas (2002)
Meat animals nec	Hanna S. S. (2010)
Animal products nec	Gebhardt and Thomas (2002)
Raw milk	Gebhardt and Thomas (2002)
Wool, silk-worm cocoons	own estimations
Manure (conventional treatment)	Johnson and Eckert (2013)
Manure (biogas treatment)	Johnson and Eckert (2013)
Products of forestry, logging and related services (02)	UNECE/FAO (2010)
Fish and other fishing products; services incidental of fishing (05)	Gebhardt and Thomas (2002)
Anthracite	FORWAST (2010)*
Coking Coal	FORWAST (2010)*
Other Bituminous Coal	FORWAST (2010)*
Sub-Bituminous Coal	FORWAST (2010)*
Patent Fuel	FORWAST (2010)*
Lignite/Brown Coal	FORWAST (2010)*
BKB/Peat Briquettes	FORWAST (2010)*
Peat	FORWAST (2010)*
Crude petroleum and services related to crude oil extraction, excluding surveying	FORWAST (2010)*
Natural gas and services related to natural gas extraction, excluding surveying	FORWAST (2010)*
Natural Gas Liquids	FORWAST (2010)*
Other Hydrocarbons	FORWAST (2010)*
Uranium and thorium ores (12)	FORWAST (2010)*
Iron ores	FORWAST (2010)*
Copper ores and concentrates	FORWAST (2010)*
Nickel ores and concentrates	FORWAST (2010)*
Aluminium ores and concentrates	FORWAST (2010)*
Precious metal ores and concentrates	FORWAST (2010)*
Lead, zinc and tin ores and concentrates	FORWAST (2010)*
Other non-ferrous metal ores and concentrates	FORWAST (2010)*
Stone	FORWAST (2010)*
Sand and clay	FORWAST (2010)*
Chemical and fertilizer minerals, salt and other mining and quarrying products n.e.c.	FORWAST (2010)*
Products of meat cattle	Heinz and Hautzinger (2007) and Buljan et al. (2010)
Products of meat pigs	Heinz and Hautzinger (2007)
Products of meat poultry	Heinz and Hautzinger (2007)
Meat products nec	Gebhardt and Thomas (2002)
products of Vegetable oils and fats	FORWAST (2010)
Dairy products	Gebhardt and Thomas (2002)
Processed rice	Gebhardt and Thomas (2002)
Sugar	Gebhardt and Thomas (2002)
Food products nec	Gebhardt and Thomas (2002)
Beverages	Gebhardt and Thomas (2002)
Fish products	Gebhardt and Thomas (2002)
Tobacco products (16)	FORWAST (2010)*
Pulp	FORWAST (2010)*
Paper and paper products	FORWAST (2010)*
Printed matter and recorded media (22)	FORWAST (2010)*
Coke Oven Coke	FORWAST (2010)*
Gas Coke	FORWAST (2010)*
Coal Tar	FORWAST (2010)*
Motor Gasoline	FORWAST (2010)*
Aviation Gasoline	FORWAST (2010)*
Gasoline Type Jet Fuel	FORWAST (2010)*
Kerosene Type Jet Fuel	FORWAST (2010)*
Kerosene	FORWAST (2010)*
Gas/Diesel Oil	FORWAST (2010)*

Table 6.1 (continued): Sources used for the dry matter coefficients of products accounted in mass units

Heavy Fuel Oil	FORWAST (2010)*
Refinery Gas	FORWAST (2010)*
Liquefied Petroleum Gases (LPG)	FORWAST (2010)*
Refinery Feedstocks	FORWAST (2010)*
Ethane	FORWAST (2010)*
Naphtha	FORWAST (2010)*
White Spirit & SBP	FORWAST (2010)*
Lubricants	FORWAST (2010)*
Bitumen	FORWAST (2010)*
Paraffin Waxes	FORWAST (2010)*
Petroleum Coke	FORWAST (2010)*
Non-specified Petroleum Products	FORWAST (2010)*
Nuclear fuel	FORWAST (2010)*
Plastics, basic	FORWAST (2010)*
N-fertiliser	FORWAST (2010)*
P- and other fertiliser	FORWAST (2010)*
Chemicals nec	FORWAST (2010)*
Charcoal	FORWAST (2010)*
Additives/Blending Components	FORWAST (2010)*
Biogasoline	FORWAST (2010)*
Biodiesels	FORWAST (2010)*
Other Liquid Biofuels	FORWAST (2010)*
Rubber and plastic products (25)	FORWAST (2010)*
Glass and glass products	FORWAST (2010)*
Ceramic goods	FORWAST (2010)*
Bricks, tiles and construction products, in baked clay	FORWAST (2010)*
Cement, lime and plaster	FORWAST (2010)*
Other non-metallic mineral products	FORWAST (2010)*
Basic iron and steel and of ferro-alloys and first products thereof	FORWAST (2010)*
Precious metals	FORWAST (2010)*
Aluminium and aluminium products	FORWAST (2010)*
Lead, zinc and tin and products thereof	FORWAST (2010)*
Copper products	FORWAST (2010)*
Other non-ferrous metal products	FORWAST (2010)*
Foundry work services	FORWAST (2010)*
Fabricated metal products, except machinery and equipment (28)	FORWAST (2010)*
Machinery and equipment n.e.c. (29)	FORWAST (2010)*
Office machinery and computers (30)	FORWAST (2010)*
Electrical machinery and apparatus n.e.c. (31)	FORWAST (2010)*
Radio, television and communication equipment and apparatus (32)	FORWAST (2010)*
Medical, precision and optical instruments, watches and clocks (33)	FORWAST (2010)*
Furniture; other manufactured goods n.e.c. (36)	FORWAST (2010)*
Coke oven gas	FORWAST (2010)*
Blast Furnace Gas	FORWAST (2010)*
Oxygen Steel Furnace Gas	FORWAST (2010)*
Gas Works Gas	FORWAST (2010)*
Biogas	FORWAST (2010)*
*it refers to Schmidt J. H. (2010a); Schmidt J. H. (2010b); Schmidt J. H. (2010c); Dalgaard R. and Schmidt J. H. (2010); Schmidt J. H. et al. (2010);	

Table 6.1 (continued): Sources used for the dry matter coefficients of products accounted in mass units

7 Use of physical flows for PSUTs generation

In this section we explain how the data collected within the WP4 have been used in the process of PSUTs generation.
The procedure is briefly presented since report D4.1 (Schmidt et al. 2013) has already widely described the theoretical framework for the PSUTs generation.
This section is divided in two parts: the first one shows how data have been put together either to directly determine some accounts (**V'** and $\mathbf{W_U}$), which are then kept constant, or to trace initial estimates (**B** and **R**). This phase is quite simple and straightforward. The second part shows how the remaining accounts are derived endogenously from the proposed algorithm. This part also includes a brief description on the initial estimation of these accounts than are then modified by the model.
The aim of this section is to ensure the reader has a complete understanding of how the PSUTs have been constructed. Figure 7.1 shows the adopted procedure. Accounts painted in blue and in green, are derived exogenously, while the others in orange, or in light grey, are determined endogenously. Accounts painted half in blue and half in orange are partially determined endogenously and partially exogenously.
It is noteworthy that the PSUTs generation procedure makes full use of the information embodied in the MSUTs. By doing so a double goal is reached, firstly, the physical accounts make use of monetary data that currently have a better coverage than physical data, and secondly, there is full consistency between physical and monetary levels.

7.1 The supply table V' and the accounts generated exogenously

In the previous sections we have shown what data have been collected. In this section we explain how these data are used for directly generating part of the accounts of PSUTs. In other words here we explain how the collected data generate PSUTs accounts without the need of special elaborations.
The supply table of products **V'** is directly obtained by distributing the total physical supply of commodities (section 2) according to the monetary figure. This implies that the monetary and physical supply tables are proportional by a scale factor equal to the prices hence constant sale prices are assumed (basic prices are used as suggested by international organizations guidelines, European Commission et al. 2008; Eurostat 2008).
Once the supply table is known, the activity rates are defined. Consequently it is possible to start filling in the resource and emission accounts (**B** and **R**). As shown in Figure 7.1 some resources and emissions are directly derived from the output of activities by mean of

resource and emission factors introduced above (see section 5.1 and 5.2).
At the same time it is also possible to shape the use of waste accounts, i.e. the matrix $\mathbf{W_U}$. Indeed the amount of waste treatment services provided by waste management activities is shown in the matrix **V'**. To each waste treatment service corresponds a physical flow, i.e. the managed waste flow. These flows are introduced in the use of waste accounts.

7.2 The use table **U** and the accounts generated endogenously

In this section we explain how the remaining accounts of the PSUTs are constructed (see orange and light grey coloured accounts in Figure 7.1). Starting from the supply of products, by adding the imports and subtracting the exports (Section 4) it is possible to derive what is wholly demanded domestically. Then the total domestic demand has to be distributed to users. The monetary use table, which shows how much an activity, or a final demand category, has paid to purchase its inputs, plays a fundamental role here. Indeed the total domestic demand is distributed according to the figure of the monetary use table **U**. In this way it is possible to obtain initial physical values for the uses.
It is noteworthy to remember that the construction of the monetary use tables takes into account the technical coefficients needed for shaping the productive structure of activities. These coefficients are introduced in Section 3.1. Thus, we are already sure that the monetary tables have incorporated technical information when used in our model. This facilitates the model in reaching a solution.
Once the estimations of the total domestic uses are done, they enter into the model that modifies them with the aim of assuring balance conditions, i.e. the Mass Conservation Law. When the demand side is thus calculated, all the remaining accounts are defined, and the PSUTS are finally determined.
We can move now to explain more in depth how the algorithm works. Figure 7.1 shows the relations between accounts and how they are obtained, endogenously or exogenously.
The main conditions/constraints of the balance-solving algorithm are:

- each physical flow is multiplied by the DMC (Section 6.2) in order to have dry matter values;
- the total physical supply table is kept constant (sale prices are kept constant). Trade flows are also kept constant;
- for each activity, the sum of all the inputs multiplied by the transfer coefficients (Section 6.1) has to be equal to the mass of supplied products;
- physical uses multiplied by prices have to be equal to monetary uses (monetary tables are constraints for physical accounts);
- prices may differ per purchaser but their weighted average has to be equal to the market prices. Market prices are weighted

averages of the domestic and import prices. Prices of exports are constant;

- prices and transfer coefficients may fluctuate within a given interval. In particular, range of the transfer coefficients is: [average value * 0.75; average value * 1.25]. However a transfer coefficient is always positive and lower than 1. Prices have to be positive. Then there is not a upper limit for prices valid for all the products, rather it is defined according to the product;
- resource and emission accounts are finalized determining the extracted resources, and the produced emissions, as a consequence of the use of certain inputs. These remaining values, which are added to those determined exogenously (see Section 7.1), are obtained multiplying the inputs of products by specific emission and resource coefficients (Section 5). For example the use of (combusted) fuel discharges carbon dioxide as emission, and needs oxygen as resource;
- an input or part of it that is not embodied in the supplied product, neither in the emissions, becomes waste. In this approach waste refers to material for treatment (see D4.1, Section 3.3) and stock addition materials that are treated as delayed waste;
- supply of waste is connected to the use of waste treatment services;
- for each commodity supply has to be equal to use. In the case of waste flows, the model may imply differences between (endogenous) use and (exogenous) supply of waste fractions. This difference is defined as residual waste. When a residual waste fraction is positive it means that either there is an accumulation of waste or there are unregistered flows of waste fractions; if the residual is negative it means that either there are waste flows not produced in the accounting period but in the precedent ones that are sent to treatment, or trade data have underestimated the import of waste flows (underestimation of the export of waste treatment services). When the latter is the case, a revision of the initial trade data has to be performed.

Once the algorithm finds a solution the PSUTs in dry weight are generated. Matrices of uses $\mathbf{U}$ and of waste supply $\mathbf{W_V}$ are determined. At the same time matrices of emissions $\mathbf{B}$ and of resources $\mathbf{R}$ are completed. The physical level is thus generated and is fully consistent with the monetary level.

Before concluding it is noteworthy to mention that the procedure just presented may be used also for the generation of hybrid mixed-units SUTs. Indeed the PSUTs can be generated only if all the flows within the economies are taken into account. This means that flows with no mass, e.g. electricity or services, have to be included anyway, hence the final result of the algorithm are hybrid mixed-units SUTs, from which the PSUTs are extracted.

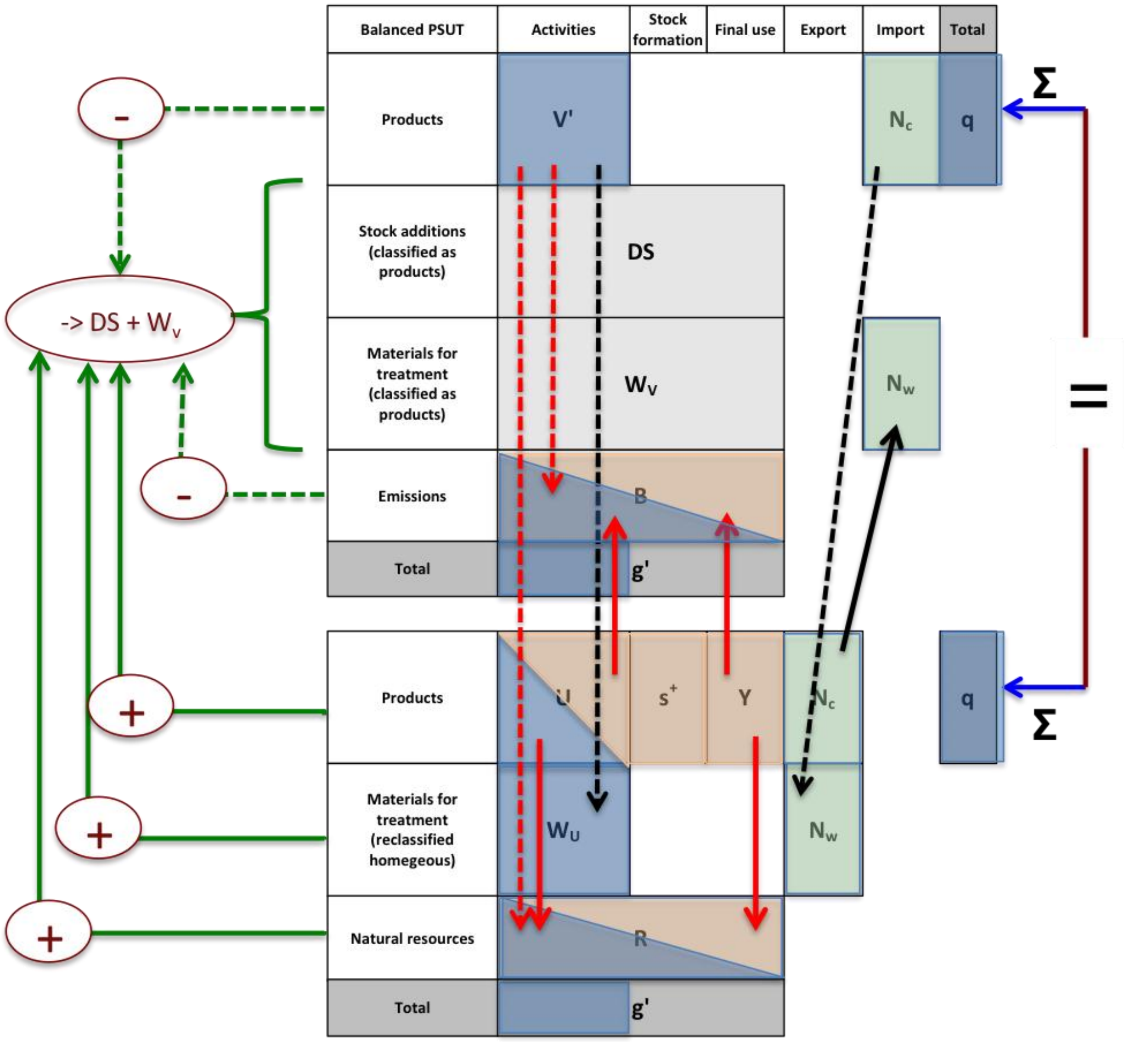


Figure 7.1 : The balance-solving algorithm used for generating the PSUTs.
The dotted line indicates there is a relation that is triggered by the supply of; instead the continuous line shows a relation generated by the use of. Red lines are meant to indicate where coefficients are used, while the red line where direct relation exists. Finally on the left side there is the equation for determining the supply of waste account, while on the right side the commodity balance.

8 Conclusions

In this report the process of data collection and the model used to generate PSUTs have been presented. The amount of data collected is enormous and it has been a long process. For some products, where exhaustive data are available, the task has been quite straightforward. This group includes:

- agro, food, forestry and fishery data, provided by FAOSTAT;
- energy products, provided by IEA;
- some waste account services for EU countries, provided by Eurostat;
- production of minerals and metals, recycling of metals and construction waste provided by US Geological Survey, Wordsteel Association, European Aggregates Association and International Copper Study Group;
- production of fertilizers, provided by International Fertilisers Industry Association;
- technical coefficients, provided by Ecoinvent;
- waste flows provided by Eurostat.

For many important coefficients used in the generation of PSUTs, such as dry matter, emission factors, transfer and technical coefficients, the FORWAST database has played a fundamental role.
For the remaining flows data collection has not been straightforward. Many different sources have been merged and many estimates have been required since the CREEA product detail was hardly reached.
Concluding, the process of data collection has been quite smooth for the EU countries where the availability of data is quite comprehensive. Data on some manufactured products were instead poor for most of the countries, even for the EU members.
For the non-EU countries, apart from the data provided by international organizations, data availability is really poor and for many countries, mainly those not economically advanced, often data do not exist at all. This the case for waste treatment activities, where still informal economies play an important role. Also a huge problem has been the lack for some countries of informative websites in English with accessible information ready to download.
Given these limitations quickly updating the data currently collected is possible only for EU countries and the US, where the data are not as good as the EU countries but, however, are reasonably comprehensive.

9 References

AEBIOM (European Biomass Association) 2009, A biogas Road Map for Europe, Brussel, Belgium;

AEBIOM (European Biomass Association), 2011 Annual Statistical report, Brussel, Belgium;

Aschbacher P. W., Kamal T. H. and Cragle R. G., 1965. Total Body Water Estimations in Dairy Cattle using Tritiated Water. Journal of Animal Science May 1965 vol. 24 no. 2 430-433

Badiani A., Manfredini M. and Nanni N., 1993. Qualità della carcassa e della carne di puledri lattoni. Zoot. Nutr. Anim. 19 (1): 23-31.

BGS, 2012. World Mineral Statistics. BGS - British Geological Survey, London.

Blengini G. A. and Busto M., 2009. The life cycle of rice: LCA of alternative agri-food chain management systems in Vercelli (Italy). Journal of Environmental Management 90 (3), pp1512-1522

Brewers of Europe (The), 2010. Beer Statistics 2010. Brussels, Belgium

Buljan J., Reich G., Ludvik J. 2000. Mass Balance In Leather Processing, UNIDO Vienna

CEMPRE (Compromisso Empresarial para Reciclagem) 2010, Fichas Tecnicas 2010. SÃo Paulo Website: http://www.cempre.org.br (Accessed May 2012)

Chávez A. L., Ceballos H., Rodriguez-Amaya D. B., Pérez. J. C., Sánchez T., Calle F. and Morante N. 2008. Sampling Variation for Carotenoids and Dry Matter Contents in Cassava Roots. Journal of Root Crops, 2008, Vol. 34 No. 1, pp. 43-49

Chen X., Geng Y. and Fujita T., 2010. An overview of municipal solid waste management in China. Waste Management 30 (2010) 716–724

Christensen T. H. 1998. Affaldsteknologi, Teknisk Forlag A/S, Copenhagen, Denmark

Claeys M.C. and Rogers S.B., 2003. Sheep Facts. Department of Animal Science, North Carolina State University – webpage: http://www.cals.ncsu.edu/an_sci /extension/animal/4hyouth/sheep/sheepfacts.htm

Country Leader, 2008. NSW Wool Sells for a Quarter of a Million, edition of 7 July 2008. Tamworth, NSW, Australia

Dalgaard R. and Schmidt J. H., 2010. Input-output modelling of the Danish Agricultural Sector - Update of the FORWAST Danish Input-Output Database. Appendix to the report documenting the project 'Pilotprojekt - effektvurdering af forskningsmæssig indsats' (English: Pilot project - assessment of the effect of research) funded by the Danish Ministry of Food, Agriculture and Fishery. The report is currently under publication.

Dalgaard R. and Schmidt J. H., 2012. National and farm level carbon footprint of milk - Life cycle inventory for Danish and Swedish milk 2005 at farm gate. Arla Foods, Aarhus, Denmark. http://www.lca-net.com/ArlaLCI

DETEC-FOEN (Federal Department of the Environment, Transport, Energy and Communications and Federal Office for the Environment) 2008. Total Quantities Of Waste For 2007, Including Recycled Waste. Berne, Switzerland

Ecolamancha, 2008. http://www.ecolamancha.org/index.php?option=com_content&view=article&id=240:industria-del-recicladoenmexico&catid=30:reciclado&Itemid= 5923. (Accessed May 2012)

EMEP/EEA, 2009. EMEP/EEA Air Pollutant Emission Inventory Guidebook – 2009. Technical Report No 9/2009.

EPA (United States Environmental Protection Agency) 2008. Municipal Solid Waste in The United States. 2007 Facts and Figures. Washington, DC, United States of America

EPA (United States Environmental Protection Agency) 2011. Opportunities for Combined Heat and Power at Wastewater Treatment Facilities: Market Analysis and Lessons from the Field. Combined Heat and Power Partnership, October 2011, Washington, DC, United States of America

EPA (United States Environmental Protection Agency), 2003. Estimating Building-related Construction and Demolition Material Amount 2003. Washington, DC, United States of America.

EPA (United States Environmental Protection Agency), 2010. U.S. Anaerobic digester Status Report. Agstar, October 2010, Washington, DC, United States of America

European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and United Nations, 2009. System of National Accounts 2008. New York, United States of America.

EUROSTAT, 2008. Eurostat Manual of Supply, Use and Input-Output Tables, 2008 edition. Luxembourg.

Eurostat, 2011. "Economy Wide Material Flow Accounts (EW-MFA): Compilation guidelines for Eurostat's 2011 EW-MFA questionnaire" Luxembourg, Luxembourg.

Eurostat, 2011. Preliminary Manual for Physical Energy Flow Accounts (PEFA-Manual). Draft version: 9 January 2011.

Eurostat, 2012. Statistical Database Environment: Waste Statistics, Luxembourg. http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database (Accessed November 2011 – April 2012)

EUROSTAT, 2012a. Economy-wide Material Flow Accounts (EW-MFA). Compilation Guide 2012. Statistical Office of the European Communities, Luxembourg.

EUROSTAT, 2012b. PRODCOM Database. Statistical Office of the European Communities, Luxembourg.

FAO (Food and Agriculture Organization of the United Nations), 1991. Guidelines for slaughtering, meat cutting and further processing, Rome

FAO (Food and Agriculture Organization of the United Nations), 2006. Fertilizer use by crop. Fertilser and Plant Nutrition Bulletin 17. ftp://ftp.fao.org/agl/agll/docs/fpnb17.pdf

FAO (Food and Agriculture Organization of the United Nations), IFA (International Fertilizer Industry Association), IFDC (International Fertilizer Development Center) IPI (International Potash Institute) PPI (Phosphate and Potash Institute), 2002. Fertilizer use by crop. Rome 2002

FAOSTAT, 2013. FAOSTAT, Food and agriculture organization of the United Nations. http://faostat.fao.org/ (Accessed January 2013).

Gebhardt S. E. and Thomas R. G. 2002. Nutritive Value of Foods. U.S. Department of Agriculture, Agricultural Research Service, Home and Garden Bulletin 72. U.S. Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory, Beltsville, Maryland.

Hanna S. S., 2010. Estimation of Carcass Composition of Sheep. PakistanJournal of Nutrition 9 (11), pp 1107-1112

Heinisch J., 2009. Verbrauch von Getränken in Einwegund Mehrweg-Verpackungen Berichtsjahr 2007. Gesellschaft für Verpackungsmarktforschung mbH, Wiesbaden, Geermany

Heinz G. and Hautzinger P., 2007. Meat Processing Technology. For small – to medium scale producers. FAO, Rome, Italy.

Houseman R. A., Mcdonald I. and Pennie K. 1973. The measurement of total body water in living pigs by deuterium oxide dilution and its relation to body composition. British Journal of Nutrition Vol. 30 (01), July 1973, pp 149-156

Hyder consulting, 2009. Waste and Recycling in Australia. Amended report, 2009. Melbourne AU

IBGE (Brazilian Institute of Geography and Statistics, The) 2013. Website: www.ibge.gov.br

IEA (International Energy Association), 2010. Renewables Information 2009, Paris, France.

IEA (International Energy Association), 2010b. Energy Balances of OECD Countries. IEA Statistics.

IEA (International Energy Association), 2010c. Energy Balances of Non-OECD Countries. IEA Statistics.

IEA (International Energy Association), 2011. Energy Balances of OECD Countries. Documentation for Beyond 2020 Files. 2011 Edition.

IEA (International Energy Association), 2012. Energy statistics of non-OECD countries. 1960-2010. Online database. International Energy Agency, Paris.

IFA (International Fertilizer Industry Association), 2013a. Conversion factors – Nutrients as % of product. International Fertilizer Association. http://www.fertilizer.org/ifa/HomePage/STATISTICS/Conversions - factors (Accessed February 2013)

IFA (International Fertilizer Industry Association), 2013b. Statistics. International Fertilizer Association. http://www.fertilizer.org/ifa/HomePage/STATISTICS (Accessed February 2013)

IPCC (Intergovernmental Panel on Climate Change), 2006. 2006 IPCC Guidelines for national greenhouse gas inventories, Prepared by the

National Greenhouse Gas Inventories Programme, Eggleston H S, Buendia L, Miwa K, Ngara T and Tanabe K (eds). IGES, Japan. Accessed 20100923, http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html.

JCPRA (Japan Containers and Packaging Recycling Association, The) 2013, Statistics on web: http://www.jcpra.or.jp/eng/statistics.html

Jelenska E. 2010, Landfills in Russia: Precarious Grounds for Waste Management Opportunities. Webpage: http://www.frost.com/sublib/display-market-insight-top.do?id=216893446

Johnson J. and Eckert D., 2012. Best Management Practices: Land Application of Animal Manure. Ohio State University Extension Department of Horticulture and Crop Science, Columbus, Ohio

Jölli, D., Giljum, S., 2005. Unused biomass extraction in agriculture, forestry and fishery. Sustainable Europe Research Institute, Vienna.

Krausmann, F., Erb, K.-H., Gingrich, S., Lauk, C., Haberl, H., 2008a. Global patterns of socioeconomic biomass flows in the year 2000: A comprehensive assessment of supply, consumption and constraints. Ecological Economics 65, 471-487.

Krausmann, F., Fischer-Kowalski, M., Schandl, H., Eisenmenger, N., 2008b. The global socio-metabolic transition: past and present metabolic profiles and their future trajectories. Journal of Industrial Ecology 12, 637-656.

Krausmann, F., Gingrich, S., Eisenmenger, N., Erb, K.-H., Haberl, H., Fischer-Kowalski, M., 2009. Growth in global materials use, GDP and population during the 20th century. Ecological Economics 68, 2696-2705.

Lacheretz A., Ravaille C., Darre R., Barraud J.Y., 1990. Le laiton et l'avenir des chevaux de trait - Etude pondérale, économique et de promotion. Rev. Méd. Vét. 141(10): 749-757.

Levis, J.W. Barlaz M.A., Themelis N.J. and Ulloa P. 2010. Assessment of the state of food waste treatment in the United States and Canada. Waste Management 2010 30 (8- 9): 1486-1494

Moeller J., Thøgersen R., Helleshøj M. E., Weisbjerg M. R., Søegaard K. and Hvelplund T., 2005. Fodermiddeltabel 2005 (English: Feed property table 2005). Rapport nr. 112. Dansk Kvæg. Dansk Landbrugsrådgivning.

Moore P. A., Daniel T. C., Sharpley A. N. and Wood C. W., 1998. Poultry manure management in Wright et al (editor): Agricultural Uses of Municipal, Animal and industrial Byproducts. U.S. Department of Agriculture, Agricultural research Service, Conservation Research Report No. 44, 135 pp. http://www.ars.usda.gov/is/np/agbyproducts/agbycontents.htm?pf=1

MSU (Mississippi Agricultural and Forestry Experiment Station), 2010. Rabbit production webpage: http://msucares.com/livestock/small_animal/slaughter.html (last accessed: Jan.2012)

Mudd, G.M., 2007. Global trends in gold mining: Towards quantifying environmental and resource sustainability. Resources Policy 32, 42-56.

Mudd, G.M., 2010. The Environmental sustainability of mining in Australia: key mega-trends and looming constraints. Resources Policy 35, 98-115.

Mudd, G.M., 2012. Key trends in the resource sustainability of platinum group elements. Ore Geology Reviews 46, 106-117.

Nicoletti G. M., Notarnicola B. and Tassielli G., 2002. Comparative Life Cycle Assessment of flooring materials: ceramic versus marble tiles. J. of Cleaning production (10) 283-296

Nielsen P. H., Nielsen A. M., Weidema B. P., Dalgaard R. and Halberg N., 2005. LCA food database. www.lcafood.dk. The database is available in the LCA software SimaPro 7.

OECD (Organisation for Economic Co-operation and Development), 2010, Waste management and the 3Rs (Reduce, Reuse, Recycle) - Japan, Paris

OECD, 2008. "Measuring Material Flows and Resource Productivity, Volume II: The Accounting Framework".

ONS (Office of National Statistics), 2011. Material flow account for the United Kingdom 1970 to 2009. Office of National Statistics, London.

Perelet, R. and Solovyeva, S. 2011. Analysis for European Neighbourhood Policy (ENP) Countries and the Russian Federation on social and economic benefits of enhanced environmental protection – Russian Federation Country Report

Pérez R., 1997. Feeding pigs in the tropics, Chapter 5. FAO, Rome. http://www.fao.org/ag/AGA/AGAP/FRG/APH132/chap5.htm

Plastic Waste Management Institute 2009. An Introduction to Plastic Recycling, Japan

Poulsen D. M. and Kristensen V. F., 1997. Normtal for husdyrgødning. English: Norm values for animal manure. No. 736. Ministry for food, agriculture and fishery.

Preston T. R., 1988. Sugarcane as animal feed: An overview. Proceedings of an FAO Expert Consultation held in Santo Domingo, Dominican Republic from 7–11 July 1986. FAO, Rome. http://www.fao.org/docrep/003/s8850e/S8850E05.htm

Salman S. R., Abou-hussein S. D., Abdel-Mawgoud A. M. R. and El-Nemr M. A., 2005. Fruit Yield and Quality of Watermelon as Affected by Hybrids and Humic Acid Application. Journal of Applied Sciences Research 1(1): 51-58, 2005

Schmidt J. H. and Dalgaard R., 2012. National and farm level carbon footprint of milk – Methodology and results for Danish and Swedish milk 2005 at farm gate. Arla Foods, Aarhus, Denmark. (www.lca-net.com/files/Arla-Methodology_report_20120724.pdf)

Schmidt J. H., 2005. LCA af forsøg med indsamling af ikke–pantbelagt drikkevareemballage af plast og metal i eksisterende glasbeholdere. København: R98

Schmidt J. H., 2010a. Documentation of the data consolidation, calibration, and scenario parameterisation. Deliverable 6-1 of the EU FP6-project FORWAST. http://forwast.brgm.fr/

Schmidt J. H., 2010b. Contribution analysis, uncertainty assessment, and policy recommendation. Deliverable 6-3 of the EU FP6-project FORWAST. http://forwast.brgm.fr/

Schmidt J. H., 2010c. Comparative Life Cycle Assessment of Rapeseed Oil and Palm Oil. International Journal of Life Cycle Assessment 15:183–197

Schmidt J. H., Holm P., Merrild A. and Christensen P., 2007. Life cycle assessment of the waste hierarchy – A Danish case study on waste paper. Waste Management 27(2007): 1519-1530

Schmidt J. H., Weidema B. P. and Suh S., 2010. Documentation of the final model used for the scenario analyses. Deliverable 6-4 of the EU FP6-project FORWAST. http://forwast.brgm.fr/

Schmidt J. H., Merciai S., Delahaye R., Vulk J., Heijungs R., de Koning A. and Sahoo A., 2013. Recommendation of terminology, classification, framework of waste accounts and MFA, and data collection guideline. CREEA deliverable D4.1

Schoenian S., 2009. Meat goat carcass evaluation, University of Maryland, United Stats of America http://www.sheepandgoat.com/programs/GoatTest/2009/09carcassevaluation.html

SERI, 2013a. Global Material Flow Database. 2013 Version. Available at www.materialflows.net. Sustainable Europe Research Institute, Vienna.

SERI, 2013b. Technical Report on the compilation of the material flow database for www.materialflows.net. Sustainable Europe Research Institute, Vienna.

Smith I., 2005. Cement and concrete – benefits and barriers in coal ash utilisation. IEA Clean Coal Centre CCC/94, London

Statistics Canada, 2008. Waste management Industry Service: Business and Government Survey 2008, Ottawa, Ontario, Canada

Statistics Finland, 2013. Economy-wide material flow accounts [e-publication]. Statistics Finland, Helsinki.

UEPG (European Aggregates Association) 2008. Estimates of Aggregates Production data 2008, Brussel, Belgium http://www.uepg.eu/statistics/estimates-of-production-data/data-2008 (Accessed: January 2013)

UN (United Nations) 2013. System of Environmental-Economic Accounting for Energy SEEA-Energy. Draft Version for Global Consultation. Prepared under the auspices of the United Nations Committee of Experts Environmental-Economic Accounting.

UN (United Nations), European Commission, International Monetary Fund, OECD (Organisation for Economic Co-operation and Development) and World Bank, 2012. System of Environmental-Economic Accounting, Central framework, New York.

UN (United Nations), European Commission, International Monetary Fund, OECD (Organisation for Economic Co-operation and Development) and World Bank, 2009. System of National Accounts 2008, New York.

UNECE (United Nations Economic Commission for Europe) and FAO (Food and Agriculture Organization of the United Nations), 2010. Forest Product Conversion Factors For The Unece Region. Geneva Timber And Forest Discussion Paper 49. Geneva, Switzerland

UNIDO (United Nations Industrial Development Organization), 2012. Industrial Statistics Database. United Nations Industrial Development Organisation.

UN (United Nations), 2012. Industrial Commodity Statistics. UNO, New York.

USGS, 2012. International Minerals Statistics and Information. US Geological Survey, Washington D.C. http://minerals.usgs.gov/minerals/ (Accessed April 2012).

Verheijen L.A.H.M., Wiersema D., Hulshoff Pol L.W., 1996. Management of Waste from Animal Product Processin. International Agriculture Centre Wageningen, The Netherlands

Weng C.K. 1999. Biomass production in the Oil Palm Industry. In: Singh G, L K Huan, Leng T and D L Kow (1999), Oil Palm and the Environment – A Malaysian Perspective. Malaysian Oil Palm Growers Council, Kuala Lumpur

Wesnæs M., Wenzel H. and Petersen B. M., 2009. Life cycle assessment of slurry management technologies. Environmental project No. 1298. The Danish Environmental Protection Agency. Denmark.

Worldsteel Association 2010, Steel Statistical Yearbook 2009, Brussels, BelgiumNational Bureau of Statistics China (2008). China Statistical yearbook 2008. Beijing, China

WRAP 2011, The Chinese markets for recovered paper and plastics – an update . Market Situation Report – Spring 2011. United Kingdom

Yousif O.K. and Babiker S.A. 1989. The desert camel as a meat animal. Meat Science, Volume 26, Issue 4, 1989, Pages 245–254.

Zhang D. Q., Tan S. K., Gersberg R.M, 2010. Municipal solid waste management in China: Status, problems and challenges, Journal of Environmenta lManagement 91 (2010) pp. 1623-1633

Appendix: comparison with supply and use tables compiled by Statistics Netherlands (CBS)

1. Introduction

1.1 Objective

The objective of this document is to present physical supply and use tables (PSUT) for the Netherlands as compiled by Statistics Netherlands. These tables are used to check the plausibility of the Dutch PSUT created for the EXIOBASE.

1.2 Background

The SEEA2012 handbook provides an internationally agreed conceptual framework to measure the interactions between the economy and the environment and the state of the environment (United nation et al, 2012). Most relevant for this paper is chapter 3 on physical flow accounts. This chapter deals with measuring physical flows using accounting concepts and classifications consistent with the economic accounting structure of the 2008 SNA (System of National accounts; United nations et al, 2009). One important feature of the physical flow accounts is their one-to-one relationship to the monetary accounts, especially the SNA supply-use tables. Bringing both pieces of information together, these so-called hybrid flow accounts are a powerful analytical tool for reporting on the environmental performance of consumption and production activity.

2.Physical supply and use tables in the SEEA2012

The physical flow accounting framework presented in the SEEA 2012 is intended to provide a set of accounting principles and boundaries in which a consistent recording of all types of physical flows relating to economic activity can be made. In material flow accounting, flows can be measured in terms of mass (e.g. tonnes). In this chapter the physical supply and use tables (PSUT) as proposed in SEEA2012 are presented. These tables are based on the structure of the monetary supply and use tables used to measure economic activity as outlined by the production boundary in the 2008 SNA. After the description of the tables, the system boundaries, definitions and classifications that are applied are being discussed. The mayor part of this section is taken from SEEA chapter 3.

2.1 Description of the SEEA PSUT

The rows of table 2.1a and 2.1b distinguish natural inputs, products and residuals. Natural inputs and residuals are extensions to the monetary supply and use table in the SNA. The supply table shows the flows relating to the production and supply of natural inputs, products or residuals by different economic units or the environment. The use table shows the flows relating to the consumption and use of natural inputs, products and residuals by different economic units or the environment.

The columns of the PSUT are structured to indicate the activity underlying the flow, e.g. whether it is related to production, consumption or accumulation, and the economic units involved. The first column covers the use of natural inputs, the production and intermediate consumption of products, and the generation and receipt of residuals by all units in the economy. The second column covers the consumption of products by households and the generation of residuals from this consumption. The activity of households in extracting natural inputs from the environment for their own consumption is considered a productive activity and hence this activity should be recorded in the first column against the relevant industry class. Unlike the monetary supply and use table, no entries are made in relation to government final consumption. Government final consumption represents the purchase and consumption by governments of their own output and does not have an associated physical flow. All of the physical flows related to the intermediate consumption of governments are recorded in the first column under the relevant industry class, commonly public administration. In addition, the generation of residuals, e.g. emissions, solid waste, by governments in the production of their output is recorded in the first column. The third column, labelled accumulation, concerns changes in the stock of materials in the economy. From a supply perspective, this column records reductions in the physical stock of produced assets through, for example, demolition or scrapping. It also shows emissions from controlled landfill sites which are accumulations of residuals from previous accounting periods. Controlled and managed landfills should be considered as operating within the production boundary. From a use perspective, the accumulation column records additions to the physical stock of produced assets (gross capital formation) and the accumulation over an accounting period of materials in controlled landfill sites. Flows to emission capture and storage facilities are also recorded as use by accumulation. These accumulation flows may be classified by industry and, if so, can be combined with industry level information from the first column to provide an overall assessment of flows of residuals by industry. Retaining the distinction between residuals from current production activity (from the first column) and residuals from past production activity (from the third column) may be important for some analyses. Alternatively, the accumulation flows may be classified by product. The fourth column shows the exchanges between national economies in terms of imports and exports of products and flows of residuals. Excluded from these flows are so-called transboundary flows, for example polluted water flowing downstream into a neighbouring country or air emissions transferred into other countries' environments. Transboundary flows are considered flows within the environment and hence out of scope of the PSUT framework. The fifth column is the significant addition to the monetary supply and use table structure in the SNA. In this column flows to and from the environment are recorded. Within the PSUT the environment is a "passive" entity that does not undertake production, consumption or accumulation in the way as units inside the economy. Nonetheless, the incorporation of the environmental column allows a full accounting for flows of natural inputs and residuals that would otherwise not be possible. In order to achieve a supply-use balance, flows to and from the environment in relation to respiration of livestock and combustion processes need to be recorded.

SUPPLY						
	Production and generation of residuals		**Accumulation**	**Flows from the Rest of the World**	**Flows from the Environment**	**Total**
	Production and generation of residuals by industries (incl. household production on own account) - classified by ISIC	**Generation of residuals by households**	Industries - classified by ISIC			
Natural inputs					A. Flows from environment (incl. natural resource residuals)	Total Supply of Natural Inputs (TSNI)
Products	C. Domestic production (incl sale of recycled and reused products)			D. Imports of products		Total Supply of Products (TSP)
Residuals	I1. Residuals generated by industry (incl. natural resource residuals) I2. Residuals generated following	J. Residuals generated by household final consumption	K1. Residuals from scrapping and demolition of produced assets K2. Emissions from	L. Residuals received from rest of the world	M. Residuals recovered from the environment	Total Supply of Residuals (TSR)

Table 2.1a: General physical supply table (SEEA 2012)

USE							
	Intermediate consumption of products, use of natural inputs and collection of residuals		**Final consumption***	**Accumulation**	**Flows to the Rest of the World**	**Flows to the Environment**	**Total**
	Industries - classified by ISIC		**Households**	Industries - classified by ISIC			
Natural inputs	B. Extraction of natural inputs						Total Use of Natural Inputs (TUNI)
	B1. Extraction used in production	B2. Natural resource residuals					
Products	E. Intermediate consumption (incl purchase of recycled and reused products)		F. Household final consumption (incl purchase of recycled and reused products)	G. Gross Capital Formation	H. Exports of products		Total Use of Products (TUP)
Residuals	N. Residuals received by waste mgt and other industries (incl residuals from scrapping and demolition of produced assets; excl accumulation in controlled landfill sites)			O. Accumulation in controlled landfill sites	P. Residuals sent to the rest of the world	Q. Residual flows direct to environment Q1. Direct from industry and households (incl. natural resource residuals & landfill emissions) Q2.Following treatment	Total Use of Residuals (TUR)
TOTAL USE							

*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.

Table 2.1b: General physical use table (SEEA 2012)

2.2 Balancing supply and use

The PSUT contains a range of important accounting and balancing identities. The starting point for the balancing of the PSUT is the supply-use identity, which recognizes that, within the economy, the amount of a product supplied must also be used within the economy, most likely by a range of different economic units, or export. This supply-use identity for products also applies in the monetary supply and use table. In the PSUT the supply-use identity is extended such that the total supply of natural inputs must equal the total use of natural inputs and the total supply of residuals must equal the total use of residuals.

Regarding the flows of residuals a number of stages need to be recognized. In the first stage residuals are generated or come into the economy as reflected in cells (I1 and J to M). These residuals are received by other units in the economy (N & O), sent to other countries (P) or returned to the environment (Q1). The residuals received by other units (N) may be treated or processed and then either sold as recycled or reused products or returned to the environment. If sold as recycled or reused products the production is recorded in (C) and the purchase in (E) or (F). The supply of the treated residual is recorded in (I2) and the use in (Q2). The supply and use of natural resource residuals (e.g. mining overburden) are, subsequently, recorded in (A) and (Q1).

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. This identity may be applied both at the level of an entire economy (as described) and also at the level of an individual industry or household. More information can be found in chapter 3 of the SEEA (UN et al., 2012). In the following chapters the system boundaries, definitions and classifications that are applied in table 2.1 are being discussed.

2.3 System boundaries: treatment of cultivated biomass

The system boundary applied in the EXIOBASE and the Dutch environmental accounts is to a large extent according to the EW-MFA concepts (OECD, 2008; Eurostat 2011). However, the system boundary according to EW-MFA [12] differs from the physical flow accounting as proposed in the SEEA and the SNA. The main difference between system boundaries according to EW-MFA and SEEA lies in the treatment of cultivated biomass. According to the SNA, cultivated biological resources are within the production boundary of a country. As a result, the contribution to the growth of cultivated biological resource, e.g. natural inputs like CO2 and water, should be recorded as flows from the environmental to the economy. In EW-MFA, the harvest of both cultivated and non-cultivated vegetable resources are recorded as flows from the environment to the economy. For practical reasons and a more useful interpretation of the results this approach is also adopted here.

2.4 Definitions

An extended overview of the recommended definitions of natural inputs, products and residuals are presented in SEEA and chapter 2 of the WP 4.1 document. In short: natural inputs are all physical inputs that are moved from their location in the environment as a part of economic production processes or are directly incorporated into economic production processes. Some natural resource inputs do not subsequently become used in production and instead immediately return to the environment. These flows are termed natural resource residuals. Products are goods and services that result from a process of production in the economy. Residuals are physical flows of materials that are discarded,

[12] "Economy-wide material flow accounts are compilations of the material inputs into national economies, the changes of material stock within the economic system and the material outputs to other economies or to the environment. EW-MFA cover all solid, gaseous, and liquid materials, except for bulk water and air; the unit of measurement is tonnes (i.e. metric tonnes) per year."

discharged or emitted by businesses and households through processes of production, consumption or accumulation. In situations where the generator receives money or other benefits in kind in exchange for the discarded good, this is treated as a transaction in a product and not as a residual. According to this rational solid waste can be recorded as a product or as a residual depending on which way the money flows.

2.5 Classifications

An extended overview of the classifications recommended for material flows and industries are presented in SEEA and chapter 2 of the WP 4.1 document. The main recommendation for SUTs was to comply with international standards such as ISIC (United Nations classification for industries) and CPC (United Nations classification for products). For some material categories (e.g. residuals) the CPC classification does not apply. In that case lists of components that belong to a particular class of materials were given. The regulations on how establishments make up a single class of ISIC are taken from the 2008 SNA (System of National accounts; United nations et al, 2009). In chapter 2 of the WP 4.1 document recommendations are made on how to treat waste recycling within an establishment whose primary activity is not waste treatment.

3. Material flow accounts according to Dutch environmental accounts

3.1 Purpose of a Dutch physical supply and use table

The Dutch physical supply and use table is compiled in order to support policy makers in monitoring the Dutch resource strategy. Important issues are dependency of the Dutch economy on resources (in particular scarce materials), the substitution of materials (in particular the transition to a biobased economy), resource efficiency (e.g. the use of secondary materials as a resource) and the environmental impact of the Dutch resource use.

3.2 Methodology

3.2.1 A first estimate

The basis for physical supply and use tables (PSUTs) are the monetary supply and use tables (both in basic prices) of the national accounts. In order to get a first estimate of the physical flows of products, prize information from the international trade statistics is used to convert the monetary tables to physical tables. For a number of commodities, price information from the production statistics is used. Also, price information is available for some of the feedstock used by industries. The latter two statistics provide individual prices per commodity per industry.

For some commodities physical information is available on the supply and use by industry. Wherever physical information is available, it directly employed in the supply and use tables. Physical data on energy carriers is obtained from the energy accounts. Agricultural statistics provide physical data on the amount of harvested biomass and the production of agricultural products. From the environmental accounts data is available on waste flows, recycled products and CO_2 emissions.

3.2.2 Balancing supply and use

The above approach results in a first estimate of a physical supply and use table in which supply and use are not equal. The reasons for these differences are: the uncertainty in the used source material and inhomogeneous commodities. With regard to industries the lack of some balancing items can results in differences between supply and use. The next step is to eliminate big differences between supply and use. Small differences will be eliminated using an automated procedure.

The cause of large differences between the use and supply are investigated by using a variety of methods. First of all, price information is checked on outliers that can not be accounted for. Secondly, physical information from the international trade statistics is used to check the estimated import and export in the PSUT. Another way to eliminated differences is to check if the use of a commodity (for example animals for slaughter) and the supply of the relating commodity (for example the production of meat) are plausible. After the supply and use for each commodity are more or less in balance, the supply and use per industrial branch is checked.

Balancing supply and use for each industrial branch proves to be a more difficult task. First of all, balancing items are introduced to account for, among others, the O_2 uptake and the H_2O emissions related to combustion processes. Some of the balancing items, that are related to use of certain commodities like energy carriers for example, are relatively easy to estimate. It is more difficult to estimate the uptake or loss of water in products. The uptake of water in a product is especially apparent in the industry involved in the manufacturing of beverages. Supply and use of bulk water is not taken into accounts in the Dutch physical supply and use table. Because bulk water is used to produce beverage, the supply of the "manufacturing of beverages" industry is much higher than the use. Another problem in balancing industries occurs for some service industries, for example restaurants. Restaurants use resources like food and drink but only supply (non physical) services. Also, for the construction industry an imbalance in supply and use occurs. The outputs of the construction industry are, for example, buildings and infrastructural works. For this kind of output there is no price information (euro/kg) available and therefore the monetary data of the national accounts can not be converted to physical data. For the latter examples of imbalances it is difficult to estimate balancing items on the basis of source data. Therefore we assumed that the balancing items were equal to the differences between the supply and use of an industrial branch. Subsequently, the plausibility of the balancing items is checked by estimating if there is an uptake of loss of water in products during the production process. This is done by making an estimate of the water balance (in or out during the production process) by making use of the water content of each commodity that is supplied and used by an industrial branch. Balancing items that occur for reasons not related to water content are also checked on plausibility. Finally, a balancing item was introduced to accounts for the accumulation of materials in the economy.

After balancing the industries it turned out that the supply and use of some commodities became imbalanced. In that cast the above process was repeated until only relative small imbalances remained. After this an automatic procedure was used to fully balance the supply and use tables.

3.3 Results

An adaptation of the SEEA supply and use tables for the Netherlands are presented in figure 3.3a and 3.3b.

Physical use table (1000 tonnes)																		
		Intermediate consumption of products; use of natural inputs; collection of residuals												Final consumption	Accumulation	Flow to the rest of the world	Flows to the environment	Total use
		Industries																
		Agriculture	Mining & Quarying	Food, Beverage & Tobacco	Textile, Wood & Paper	Petroleum	Chemical & Rubber	Constructio n material	Metal, Machinery & Transport	Other industries	Water, Electricity & Waste	Construction	Transport, services & Government	Households	Industries			
Natural inputs	Biomass (incl. cultivated product	38.112	-	-	-	-	-	-	-	-	-	-	-					38.112
	Minerals	-	32.194	1.113	-	-	3.763	7.143	-	-	-	-	5.445					49.658
	Fossil fuels	-	67.076	-	-	-	-	-	-	-	-	-	-					67.076
	From air	29.243	3.137	5.986	2.406	14.696	21.368	2.880	7.137	451	67.249	2.990	58.538	59.088				275.169
Products	Agriculture	5.170	-	42.129	791	-	163	-	2	15	6	10	1.167	2.548	433	16.525		68.959
	Mining & quarrying	4.428	2.484	2.206	761	55.935	12.172	19.740	11.312	92	17.986	37.483	6.282	7.894	2.194	83.088		264.057
	Food,Beverage & Tobacco	13.357	-	17.389	142	-	821	11	-	9	95	38	5.395	11.088	1.376	31.865		81.586
	Textile, Wood & Paper	133	18	1.138	5.795	15	560	191	546	542	58	1.441	4.338	2.102	374	7.584		24.835
	Petroleum	638	80	61	25	6.675	9.443	101	3.066	156	694	1.295	16.938	5.953	2.064	81.771		128.960
	Chemical & Rubber	1.467	22	642	655	1.160	27.598	280	1.083	435	270	1.124	1.954	935	541	42.054		80.220
	Construction material	225	9	459	119	-	219	6.137	911	135	174	34.570	4.997	1.720	1.072	7.555		58.302
	Metal, Machinery & Transport	4	41	142	63	9	202	323	9.266	776	164	1.872	974	780	4.034	22.558		41.208
	Solid waste and treated residual	48	-	2.551	991	-	760	885	1.892	-	8.106	9.861	-	-	-	11.522		36.615
	Other products	-	1	-	2	1	1	1	388	67	619	90	148	806	896	496		3.516
Residuals	Solid waste	74.864	-	5.059	2.223	-	474	1.439	197	-	17.957	19.232	-		2.133	5.766	-	129.345
	Natural resource residuals	-	-	-	-	-	-	-	-	-	-	-	-		-		371.441	371.441
Balancing iter	e.g. water uptake, additions to stock	20.122	-	7.429	-	-	-	6.920	-	-	-	-	-	-	105.298			139.769
Total use		187.811	105.062	86.304	13.973	78.491	77.544	46.051	35.800	2.678	113.378	110.006	106.176	92.914	120.415	310.784	371.441	

Figure 3.3a Physical use table (1000 tonnes) on the basis of CBS 2008 data.

		Production and generation of residuals													Accumulation	Flow from the rest of the world	Flows from the environment	Total supply
		Industries																
		Agriculture	Mining & Quarying	Food, Beverage & Tobacco	Textile, Wood & Paper	Petroleum	Chemical & Rubber	Constructio n material	Metal, Machinery & Transport	Other industries	Water, Electricity & Waste	Construction	Transport, services & Government	Generation of residuals by households	Industries			
Natural inputs	Biomass (incl. cultivated production)																38.112	38.112
	Minerals																49.658	49.658
	Fossil fuels																67.076	67.076
	From air																275.169	275.169
Products	Agriculture	41.194	-	-	-	-	-	-	-	40	-	-	3			27.722		68.959
	Mining & quarrying	-	100.966	604	-	168	2.789	628	-	10	113	286	6.466			152.027		264.057
	Food,Beverage & Tobacco	215	-	59.396	1	-	64	-	-	-	-	-	135			21.775		81.586
	Textile, Wood & Paper	-	-	-	9.763	1	224	-	21	138	-	-	736			13.952		24.835
	Petroleum	-	-	-	-	58.152	2.241	-	2.317	-	-	-	4.812			61.438		128.960
	Chemical & Rubber	18	30	258	29	1.090	44.633	35	120	20	165	-	32			33.790		80.220
	Construction material	-	18	-	73	-	48	40.806	100	5	-	-	20			17.232		58.302
	Metal, Machinery & Transport	-	-	2	34	-	17	4	17.531	158	-	-	91			23.371		41.208
	Solid waste and treated residual	638	2	3.889	263	1	235	45	785	40	16.075	704	660			13.277		36.615
	Other products	-	-	-	5	-	2	1	1.041	820	1	1	236			1.409		3.516
Residuals	Solid waste	73.323	107	3.650	803	141	1.346	870	3.026	244	2.542	22.418	4.954	10.054	4.569	1.299	-	129.345
	Natural resource residuals	54.257	3.939	7.466	3.002	18.938	25.803	3.662	9.337	580	86.641	3.793	74.686	78.573	764		-	371.441
Balancing iter	e.g. water loss, dissipative losses	18.166	-	11.039	-	-	142	-	1.522	623	7.841	82.804	13.345	4.287	-			139.769
Total supply		187.811	105.062	86.304	13.973	78.491	77.544	46.051	35.800	2.678	113.378	110.006	106.176	92.914	5.333	367.292	430.015	

Figure 3.3b Physical supply table (1000 tonnes) on the basis of CBS 2008 data.

Similar tables can be compiled using CREEA 2007 data. Starting point are the monetary supply and use tables available from Eurostat. The Eurostat tables are based on the CBS data but are on a more aggregated level of detail. In order to match the classification used in EXIOPOL the Eurostat tables are disaggregated. Disaggregation occurs on the basis data provided by SERI. Next the monetary tables are converted to physical tables by using prize information or direct physical data if available. In CREEA, physical tables are compiled in dry weight. In tables 3.4a and 3.4b the CREEA data is presented after conversion to wet weight and aggregation to the SEEA classification.

		Intermediate consumption of products; use of natural inputs; collection of residuals												Final consumption	Accumulation	Flow to the rest of the world	Flows to the environment	Total use
		Industries																
		Agriculture	Mining & Quarying	Food, Beverage & Tobacco	Textile, Wood & Paper	Petroleum	Chemical & Rubber	Constructio n material	Metal, Machinery & Transport	Other industries	Water, Electricity & Waste	Construction	Transport, services & Government	Households	Industries			
Natural inputs	Biomass (incl. cultivated production)																	
	Minerals																	
	Fossil fuels																	
	From air																	
Products	Agriculture	7.869	25	25.537	594	9	172	9	130	67	280	131	3.626	10.350	399	15.981		65.180
	Mining & quarrying	1.211	6.672	2.693	1.285	61.406	22.727	65.526	5.128	325	45.262	42.532	11.645	7.968	49.839-	92.980		317.520
	Food,Beverage & Tobacco	1.859	-	10.780	54	-	821	5	-	12	77	16	4.409	27.881	13.059-	40.010		72.864
	Textile, Wood & Paper	384	19	6.575	27.328	28	1.332	447	1.654	675	218	3.513	13.249	10.869	30.216-	17.040		53.114
	Petroleum	614	50	96	35	7.639	7.008	45	368	31	3.134	325	9.446	10.769	5.459	94.493		139.512
	Chemical & Rubber	1.181	16	492	711	866	29.389	174	1.192	340	281	1.083	2.473	9.847	19.266-	54.452		83.230
	Construction material	202	13	476	54	17	2.735	9.077	850	71	2.874	5.831	5.365	1.260	27.855	6.019		62.698
	Metal, Machinery & Transport	101	54	363	474	11	1.061	288	14.623	204	382	973	4.654	8.469	5.276	47.601		84.534
	Solid waste and treated residuals																	-
	Other products	0	0	3	4	2	2	1	15	45	1	47	107	344	1.412	627		2.612
Residuals	Solid waste																	
	Natural resource residuals																	
Balancing iten	stock																	

Figure 3.4a Physical use table (1000 tonnes) for the Netherlands on the basis of CREEA 2007 data

		Production and generation of residuals													Accumulation	rest of the world	the environment	Total supply
		Industries												Generation of residuals by households				
		Agriculture	Mining & Quarying	Food, Beverage & Tobacco	Textile, Wood & Paper	Petroleum	Chemical & Rubber	Constructio n material	Metal, Machinery & Transport	Other industries	Water, Electricity & Waste	Construction	Transport, services & Government		Industries			
Natural inputs	Biomass (incl. cultivated production)																	
	Minerals																	
	Fossil fuels																	
	From air																	
Products	Agriculture	34.942	-	-	-	-	-	-	-	602	-	-	131			29.504		65.180
	Mining & quarrying	-	100.844	-	-	3.588	7.807	1.409	-	61	16.462	3.002	7.597			176.750		317.520
	Food,Beverage & Tobacco	439	-	32.656	1	-	141	-	-	-	269	-	173			39.184		72.864
	Textile, Wood & Paper	-	-	-	31.279	2	74	-	30	52	-	2	540			21.302		53.281
	Petroleum	-	-	-	-	59.243	5.796	-	164	-	-	-	3.188			71.120		139.512
	Chemical & Rubber	7	9	51	59	549	37.817	10	219	20	7	-	104			44.408		83.260
	Construction material	-	31	-	31	-	177	50.745	677	15	92	254	493			16.040		68.555
	Metal, Machinery & Transport	-	5	53	315	6	649	18	27.480	107	19	218	2.271			54.557		85.697
	Solid waste and treated residuals																	-
	Other products	-	-	0	6	-	1	1	33	800	0	-	5			1.764		2.612
Residuals	Solid waste																	
	Natural resource residuals																	
Balancing iten	e.g. water loss, dissipative losses																	

Figure 3.4b Physical supply table (1000 tonnes) for the Netherlands on the basis of CREEA 2007 data

Although the CREEA [13] and CBS tables show data for different years and are estimated according to different methods, the total amounts should be in the same ballpark. First the supply of products (excluding solid waste) is considered. The total supply (domestic supply plus imports) of products estimated by CBS is around 750 billion kilo, the total supply estimated in CREEA is around 890 billion kilos. The majority of this difference is due to differences in the total import: the import estimated by CBS is around 350 billion kilo, the import estimated by CREEA is around 450 billion kilo. The domestic supply estimated by CBS and CREEA is respectively around 400 and around 430 billion kilo. The physical tables are based on the monetary supply and use tables. Therefore differences that appear between the physical CBS and CREEA tables may originate from differences in the monetary tables. Therefore, in the following analyses the monetary data are also under scrutiny.

The difference between the total monetary supply estimated by CBS and CREEA is relatively small (not shown). Monetary import in the CBS and CREEA tables amounts to, respectively 405 and 380 billion euro. Monetary domestic supply in the CBS and CREEA tables amount to, respectively 1150 and 1085 billion euro. The lack of a big difference is not surprising as the starting point of the CREEA table are the Eurostat supply and use tables which, in turn, are based on CBS data. Next we will first focus on the import and then have a closer look at the domestic supply.

Import

Hardly any difference in the total amount of physical import estimated by CBS and CREEA is found for agricultural products (both: around 30 billion kilo) and mining and quarrying products (CBS: around 150 billion kilo and CREEA around 175 billion kilo). In order to investigate if there are any differences on a more detailed level, a closer look is taken at both types of products. In table 3.5 the import of agricultural products is presented both in physical and monetary terms. Physical data is retrieved from CREEA in both wet and dry conditions. Monetary data is retrieved from the CREEA table. This data is compared to the monetary and physical supply tables that are compiled by CBS. The classification is taken from CREEA and the CBS classification is adjusted accordingly.

First the monetary data of agricultural products in figure 3.5 is considered. The difference between the total import estimated by CREEA and CBS is relatively small and can easily be explained by the presentation of data from different years. However, looking at individual agricultural products some differences can be observed. Beside the presentation of different years, these differences can occur as a result of a mismatch of the classification of the CREEA and CBS product groups or uncertainties in the disaggregation procedure (of the Eurostat table) applied by CREEA.

Second the physical import data in figure 3.5 is considered. The CBS data of 2008 is compared to the CREEA data for agricultural products in wet and dry matter of 2007. CBS data is collected for the products as they are imported, i.e. in wet matter. The

[13] For some product groups the total supply does not equal the total use. The reason for this is not clear but something that originates in the source data.

CREEA data in dry matter is also presented in order to estimate the difference between the data that is caused by the conversion factors from dry to wet weight. As can be seen from figure 3.5 the conversion from dry to wet weight brings the CREEA and the CBS data close to each other. A big difference between the CBS and CREEA data can only be found for oil seeds products.

	Physical (in mln kilo's)			Monetary (in mln euro's)	
Products	20LCA_dry_2007	20LCA_wet_2007	CBS_2008	CREEA_2007	CBS_2008
Wheat	4.314	5.016	5.571	671	1.100
Cereal grains nec	5.523	6.459	6.045	1.067	1.214
Vegetables, fruit, nuts	1.442	8.013	10.828	4.069	6.329
Oil seeds	6.077	6.641	2.009	1.194	969
Sugar cane, sugar beet	8	30	26	0	1
Plant-based fibers	40	44	-	30	-
Crops nec	370	1.753	1.767	4.713	3.352
Cattle	36	76	104	51	198
Pigs	59	131	86	39	118
Poultry	80	265	224	116	339
Meat animals nec	6	13	11	37	57
Animal products nec	56	75	168	230	196
Raw milk	-	-	138	0	49
Wool, silk-worm cocoons	2	3	-	14	-
Products of forestry, logging etc	391	802	592	391	329
Fish and other fishing products etc	37	183	153	572	511
Total	18.438	29.504	27.722	13.194	14.762

Table 3.5 Comparison between monetary and physical import of agricultural products

In figure 3.6 a comparison between CBS and CREEA data is made for the import of natural resources. In monetary terms the difference in the total amounts of import is larger than for agricultural products. Regarding individual products the largest absolute differences occur for crude petroleum and natural gas. Relative differences in monetary terms are the largest for metal ores. In physical terms the absolute differences increase. The differences might be due to the procedure used to disaggregate the monetary Eurostat table. A check with the monetary and physical international trade data of, for example, metal ores showed that CBS data closely match these data.

	Physical (in mln kilo's)			Monetary (in mln euro's)	
	20LCA_dry_2007	20LCA_wet_2007	CBS_2008	CREEA_2007	CBS_2008
Products					
Coal	26.093	34.193	19.787	2.130	2.649
Peat	-	-	485	-	87
Crude petroleum	48.891	48.891	50.317	18.279	22.890
Natural Gas Liquids	9.789	9.789	9.061	4.377	4.196
Natural gas	16.307	16.307	20.500	5.673	7.508
Iron ores	13.683	13.683	6.698	207	842
Other non-ferrous metal ores	1.941	1.941	926	1.701	1.271
Stone	4.724	4.724	3.787	203	163
Sand, clay and gravel	32.511	42.778	36.721	504	579
Chemical and fertilizer minerals, salt and	4.444	4.444	3.745	371	488
Total	158.383	176.750	152.027	33.446	40.673

Table 3.6 Comparison between monetary and physical import of natural resources

The above examples of agricultural products and natural resources are exemplary for the differences between CBS and CREEA import data for all products. In the next chapter a closer look is taken at the domestic supply.

Domestic supply

In order to investigate the similarity between the domestic supply tables compiled by CBS and CREEA we focus on the supply of agricultural products. Figure 3.7a shows the monetary supply of several agricultural products by four types of agricultural branches as compiled by CBS and CREEA. Notice here that "agricultural services" as distinguished by CBS is not included here because it was not clear to what commodity of the CREEA classification it had to be allocated. Therefore the totals differ somewhat from the original aggregated figure. The total monetary supply of agricultural products by the agricultural branches (including forestry and fishing) does not differ a whole lot between the tables (CBS: around 22 billion kilo, CREEA around 25 billion kilo). Here we investigate if the same is true for the disaggregated components.

A closer look at figure 3.7a reveals that some of the figures match nicely as for others there is quite a big difference. Differences are found for the commodities: vegetables etc, crops nec, poultry and animal products. Also noticeable is that the CBS figures show a more diversity of produced products by both the "cultivation of crops" and the "animal farming" branches. This latter might be a result of the CBS classification. The CBS distinguishes the branch "Other agriculture" which represents mixed (crops and animals) agricultural activity. In table 3.7a this branch is allocated to the "cultivation of crops" branch. On the other hand the "animal farming" branch grows (and sells) also feed. One reason this diversity in production is not found in the CREEA table is because the level of detail shown in table 3.7a is a result of the breakdown of an aggregated Eurostat supply table. Other differences between data might also be a result of the disaggregation procedure. For example, in the CREEA table no value is allocated to "animal products n.e.c.". In the CBS this commodity contains mainly eggs. Another example, not shown in table 3.7a, is a relative large (in respect to the amount of fish) supply by the fishing industry of goods produced mainly by the food industry. A big difference, which might also be due to the disaggregation procedure, is the difference in the supply of poultry.

Industrial branches / Products	CREEA 2007				CBS 2008			
	Cultivation crops	Animal farming	Forestry	Fishing	Cultivation crops	Animal farming	Forestry	Fishing
Wheat	339	-	-	-	199	8	-	-
Cereal grains nec	203	-	-	-	74	4	-	-
Vegetables, fruit, nuts	6.939	-	-	-	3.651	98	-	-
Oil seeds	4	-	-	-	3	-	-	-
Sugar cane, sugar beet	304	-	-	-	183	17	-	-
Plant-based fibers	2	-	-	-	-	-	-	-
Crops nec	3.031	-	-	-	6.373	190	-	-
Cattle	-	2.924	-	-	50	1.670	-	-
Pigs	-	2.788	-	-	117	2.884	-	-
Poultry	-	2.399	-	-	95	593	-	-
Meat animals nec	-	25	-	-	19	118	-	-
Animal products nec	-	-	-	-	74	589	-	-
Raw milk	-	5.704	-	-	71	4.150	-	-
Products of forestry, logging etc	150	-	6	-	158	-	5	-
Fish and other fishing products etc	-	-	-	193	-	-	-	181
Total	10.971	13.841	6	193	11.067	10.321	5	181

Table 3.7a Comparison between monetary domestic supply of agricultural products

The above described discrepancies will, of course, also come to expression in comparisons between the physical data of CBS and CREEA (table 3.7b). One noticeable figure which shows another pattern than the monetary table is the supply of "products of forestry". Although the monetary figures for CBS and CREEA are almost the same, the physical figures deviate to a large extent. This probably due to the use of different prizes to convert the monetary data into physical data. In the data compiled by CREEA a prize of 0,20 euro/kilo is used. The CBS uses two different prizes depending on the branch that is producing the commodity (0,50 euro/kilo for the "cultivation of crops" branch and 0,01 euro/kilo for the forestry branch). The reason CBS uses two different prizes is because in reality two different types of products are being produced: firewood by the "forestry" branch and Christmas trees and other trees by the "cultivation of crops" branch.

Industrial branches / Products	CREEA 2007				CBS 2008			
	Cultivation crops	Animal farming	Forestry	Fishing	Cultivation crops	Animal farming	Forestry	Fishing
Wheat	990	-	-	-	1.384	53	-	-
Cereal grains nec	530	-	-	-	486	24	-	-
Vegetables, fruit, nuts	4.689	-	-	-	11.056	542	-	-
Oil seeds	15	-	-	-	4	-	-	-
Sugar cane, sugar beet	5.511	-	-	-	4.819	447	-	-
Plant-based fibers	15	-	-	-	-	-	-	-
Crops nec	6.735	-	-	-	3.028	2.627	-	-
Cattle	-	442	-	-	29	589	-	-
Pigs	-	1.872	-	-	100	2.231	-	-
Poultry	-	1.623	-	-	129	802	-	-
Meat animals nec	-	8	-	-	2	13	-	-
Animal products nec	-	-	-	-	18	431	-	-
Raw milk	-	11.174	-	-	183	11.172	-	-
Products of forestry, logging etc	765	-	31	-	318	-	660	-
Fish and other fishing products etc	-	-	-	539	-	-	-	47
Total	19.250	15.118	31	539	21.556	18.931	660	47

Table 3.7b Comparison between physical domestic supply of agricultural products

Finally a comparison is made between the supply tables regarding the production of food by the food industry. In figure 3.8a the monetary supply data estimated by CREEA and CBS are presented. The total supply estimated by CREEA and CBS is not very different, respectively 53 and 56 billion euro. However, for individual products some differences can be observed. As noticed before, the off diagonal production is much larger in the CREEA table than in the CBS table. Especially the production by the "food nec" industry in the CREEA table does not seem plausible. Other individual differences that stand out are the production of pig meat and beverages.

CREEA 2007

Products \ **Industrial branches**	Meat	Oils and fats	Dairy	Rice	Sugar	Food nec	Beverages	Fish	Tobacco
Products of meat cattle	1.304	-	-	-	-	1.138	-	-	-
Products of meat pigs	207	-	-	-	-	509	-	-	-
Products of meat poultry	2.689	-	-	-	-	144	-	-	-
Meat products nec	2.537	-	-	-	-	272	-	-	-
products of Vegetable oils and fats	-	1.676	-	-	-	1.190	-	-	-
Dairy products	-	-	4.741	-	-	2.303	-	-	-
Processed rice	-	-	-	201	-	3	-	-	-
Sugar	-	-	-	-	100	450	-	-	-
Food products nec	2.705	1.751	672	244	636	20.375	1.684	-	-
Beverages	-	-	-	-	-	813	697	-	-
Fish products	-	-	-	-	-	-	-	517	-
Tobacco products	-	-	-	-	-	-	-	-	3.502
Total	9.443	3.428	5.413	445	737	27.197	2.381	517	3.502

CBS 2008

Products \ **Industrial branches**	Meat	Oils and fats	Dairy	Rice	Sugar	Food nec	Beverages	Fish	Tobacco
Products of meat cattle	1.726	-	-	-	-	8	-	-	-
Products of meat pigs	2.652	-	-	-	-	24	-	-	-
Products of meat poultry	1.986	-	-	-	-	14	-	-	-
Meat products nec	1.930	-	-	-	-	270	-	-	-
products of Vegetable oils and fats	-	5.036	35	-	-	95	-	-	-
Dairy products	-	-	8.299	-	-	65	36	-	-
Processed rice	-	-	-	152	-	7	-	-	-
Sugar	-	-	-	-	751	-	-	-	-
Food products nec	84	20	489	-	-	23.856	-	-	-
Beverages	-	-	-	-	-	496	4.825	-	-
Fish products	-	-	-	-	-	-	-	520	-
Tobacco products	-	-	-	-	-	-	-	-	2.950
Total	8.378	5.056	8.823	152	751	24.835	4.861	520	2.950

Table 3.8a Comparison between monetary domestic supply of food products

In figure 3.8b the physical supply data estimated by CREEA and CBS are presented. The total supply estimated by CREEA and CBS is quite different, respectively 32 and 59 billion kilo. The differences that are already apparent in the monetary table are magnified in the physical due to the introduction of uncertainties in the conversion from monetary to physical tables.

CREEA 2007

Products \ Industrial branches	Meat	Oils and fats	Dairy	Rice	Sugar	Food nec	Beverages	Fish	Tobacco
Products of meat cattle	282	-	-	-	-	246	-	-	-
Products of meat pigs	393	-	-	-	-	964	-	-	-
Products of meat poultry	713	-	-	-	-	38	-	-	-
Meat products nec	30	-	-	-	-	3	-	-	-
products of Vegetable oils and fats	-	702	-	-	-	498	-	-	-
Dairy products	-	-	2.848	-	-	1.384	-	-	-
Processed rice	-	-	-	554	-	8	-	-	-
Sugar	-	-	-	-	172	773	-	-	-
Food products nec	1.802	1.167	448	163	424	13.575	1.122	-	-
Beverages	-	-	-	-	-	2.036	1.746	-	-
Fish products	-	-	-	-	-	-	-	195	-
Tobacco products	-	-	-	-	-	-	-	-	369
Total	3.220	1.869	3.296	716	596	19.526	2.868	195	369

CBS 2008

Products \ Industrial branches	Meat	Oils and fats	Dairy	Rice	Sugar	Food nec	Beverages	Fish	Tobacco
Products of meat cattle	287	-	-	-	-	2	-	-	-
Products of meat pigs	1.351	-	-	-	-	14	-	-	-
Products of meat poultry	1.188	-	-	-	-	2	-	-	-
Meat products nec	647	-	-	-	-	63	-	-	-
products of Vegetable oils and fats	-	5.642	45	-	-	60	-	-	-
Dairy products	-	-	5.156	-	-	34	34	-	-
Processed rice	-	-	-	132	-	4	-	-	-
Sugar	-	-	-	-	1.885	-	-	-	-
Food products nec	34	16	288	-	-	34.880	-	-	-
Beverages	-	-	-	-	-	626	6.581	-	-
Fish products	-	-	-	-	-	-	-	101	-
Tobacco products	-	-	-	-	-	-	-	-	248
Total	3.507	5.658	5.489	132	1.885	35.685	6.615	101	248

Table 3.8b Comparison between physical domestic supply of food products

The above examples are exemplary for the differences between CBS and CREEA supply data for all products. An analysis of other product groups and industrial branches will very likely give a similar picture.

3.4 Conclusions

It seems that on an aggregated level the domestic monetary supply table compiled by CREEA matches the supply and use table of the CBS quite closely. This is not surprising as CREEA uses datasources, like the Eurostat tables, that are in turn based on CBS data. The reason the aggregated figures are not exactly the same is because CBS presents data for 2008 as the CREEA data is for 2007. However, on a disaggregated level the CREEA and CBS tables show differences for some product groups and industrial branches. This is probably due to uncertainties in the used disaggregation procedure and, to a lesser extent, to a mismatch between the classification used by CBS and CREEA.

The discrepancies between the CBS and CREEA data are larger when physical data is considered. This is due to the introduction of uncertainties in the conversion from monetary to physical data: 1) conversion from dry to wet matter, 2) the use of different prize information to convert monetary data into physical data. In the case physical data is directly used as input in CREEA (like the data from FAOSTAT), it is not exactly clear where the difference stems from.

To sum up, from this investigation, it appears that the disaggregated physical supply and use tables compiled by CREEA do not represent the tables compiled by the Netherlands on the basis of their source data. The usefulness of the physical CREEA supply and use tables for accounting purposes by individual countries is therefore questionable.