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Recording of losses in the physical supply and use tables

- Should product output be recorded gross or net of the losses?

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- Should product output be recorded gross or net of the losses?

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1. Introduction

The purpose of this paper

The purpose of this paper is to put losses during extraction, storage and distribution into the framework and terminology of the supply and use tables as they are presented in SEEA 2003. It shows how the recording of product output net as well as gross of losses fits into the supply and use framework. It is argued that it is useful to look at the characteristics of the losses and the usual statistical recording of these before it is decided how the losses should be treated.

Read LG/14/3 first

This paper supplements the paper LG/14/3 on the recording of losses in the SEEA[1], and it is suggested to read LG/14/3 before this one, since that paper include a general description of the losses, and a graphical description of the flows. Further, the numerical examples used here are consistent with the examples in LG/14/3.

Conclusions

In Section 4 it is suggested that, in general, it is appropriate to use a gross recording of the product output. This suggestion is to some extent in contrast to the proposal in the LG/14/3 paper, which advocates a net recording as standard, and gross recording as supplementary.

Electricity and natural gas

The examples presented in this paper relate to electricity and natural gas only. However, the recording and arguments can easily be transferred to other physical flows.

The next section gives a short presentation of how the physical flows are presented in the physical supply and use tables in SEEA 2003. Readers who are familiar with these, may prefer to go directly to Section 3.

2. Physical supply and use tables in SEEA 2003

Natural resources, ecosystem inputs, products and residuals

The framework of physical supply and use tables in SEEA 2003 describe the physical flow of natural resources (e.g. natural gas), ecosystems inputs (e.g. oxygen for combustion, etc.), products (e.g. electricity) and residuals (e.g. CO2). The flows are characterized by having an origin and a destination, which at the overall level can be either the economy or the environment. At a more detailed level the economy is divided into industries, households, capital formation (including inventories) and the rest of the world.

Origin described by the supply table…

The supply table shows the origin of the flows of natural resources, ecosystem inputs, products and residuals, i.e. where do the physical quantities of these come from (industries, households, rest of the world (imports) or the environment.

…and the destination by the use table

The use table shows the destination of the same physical quantities, i.e. how much is received by industries, households, rest of the world (exports) and the environment.

Supply = use

It is a general principle of the physical supply and use tables that the supply and use balances, i.e. it is exactly the same quantities we present in the two tables. The difference is that we look at the origin in the supply table and at the destination of the flow in the use table.

If we forget about the ecosystem inputs and the rest of the world, the basic idea of the supply and use table framework of SEEA 2003 can be illustrated by the simplified example in table 1.

[1] Alessandra Alfieri and Ole Gravgård: Recording losses in the SEEA – issue 17. 14th Meeting of the London Group on Environmental Accounting, Canberra 27-30 April 2009.

Table 1. Simplified SEEA 2003 physical supply and use tables

Supply (physical units)

	Industries	Households	Capital formation	Environment	Total supply
Products	15				15
Residuals	5	6			11
Total supply	20	6			26

Use (physical units)

	Industries	Households	Capital formation	Environment	Total supply
Natural resources	12				12
Products	8	6	1		15
Residuals				11	11
Total use	20	6	1	11	38
Net accumulation (balance)			1	11	

Supply of 15 units of products and 6 units of residuals

The supply table shows that the industries produce 15 units (e.g. tonnes) of products and 5 units of residuals (e.g. air emissions, solid waste, etc.), so that in total the physical output of the industries is 20 units. In addition 6 units of residuals come from the households. Overall the total output of the industries and households are 26 units: 15 units of products and 11 units of residuals.

Corresponding use by industries and households

The use table shows that the industries use 12 units of natural resources and 8 units of products. Altogether the industries uses 20 units natural resources and products, which exactly corresponds to its output of products and residuals shown in the supply table. Households use 6 units of products, which corresponds to the output of 6 units of residuals shown in the supply table.

Accumulation

1 unit of products is used for capital formation (e.g. increase in inventories). There is no corresponding flow represented in the supply table, and therefore a net accumulation of 1 unit is shown in the balance line in the bottom of the table.

Residuals flow to the environment

The last entry in the use table is 11 units of residuals flowing to the environment. These 11 units correspond to the quantities of residuals generated by industries and households as shown in supply table. Balancing the flows of residuals to and from the environment gives a net accumulation in the environment of 11 units of residuals.

3. Treatment of losses within the SEEA 2003 supply and use framework.

Types of losses

As explained in the the LG/14/3 paper different types of losses for different kinds of production activities and products exist: losses during extraction, losses in distribution, losses in storage and conversion losses for energy (measured in calorific terms).

What is the nature of the losses?

In order to take these losses explicitly into account in the SEEA 2003 supply and use framework it is necessary to decide about the nature of these losses. Basically it is a question of whether the losses are regarded as flows of products or flows of residuals.

It is instrumental to look at electricity and natural gas. In addition energy conversion losses are discussed separately.

Electricity

Electricity lost in distribution

For electricity, losses in distribution are relevant. The losses can be due to theft from the grid or they can be purely technical losses. To include these losses in the SEEA 2003 framework it has to be decided whether losses of electricity in distribution is a flow of residuals or a flow of products.

Net recording of electricity output

Losses are residuals

A recording of electricity output net of losses means - in terms of the SEEA 2003 supply and use tables - that the electricity which is lost in distribution is regarded as a residual. A consistent recording of the losses as residuals on both the supply and use side is presented in table 2.

25 units of electricity and 3 units of residuals (losses)

The output of electricity is 25 corresponding to the use by the households. In addition there is an output of the residual "losses in distribution" which flows to the environment.

Immediate link to the monetary accounts…

The advantage of this (net) recording is that there is an immediate link to the SNA accounts in the sense that the SNA accounts do not include the distribution losses in the output electricity since there is no economic transaction and no payment associated with this flow.

… but inconsistency with energy statistics…

The disadvantage is that the concept of the physical electricity output is different from what is usually used in energy statistics and balances, which records the total output of electricity (28 units), i.e. including electricity which is lost in distribution.

… and difficulties with theft

The part of the distribution losses which is due to theft is difficult to represent, since it involves either that part of the residual "lost in distribution" has to re-enter into the economy as an input into industries or households in the use table. Alternatively, supplementary tables have to be constructed as suggested in the LG/14/3 paper.

Table 2. Recording net output of electricity and distribution losses as residuals

Supply (physical units)

		Industries	Households	Changes in inventories	Environment	Total supply
Products	Electricity	25				25
Residuals	Distribution losses	3				3
Total supply		28				28

Use (physical units)

		Industries	Households	Changes in inventories	Environment	Total use
Natural resources						0
Products	Electricity		25			25
Residuals	Distribution losses				3	3
Total use			25		3	28
Net accumulation (balance)		-28	25	0	3	

Gross recording of electricity output

Including the losses as part of the product output

An alternative to the net output recording of the electricity is to include the electricity which is lost in distribution as part of the product output instead of regarding it as a residual from the electricity generation, cf. Table 3.

28 units of electricity and no residuals

Output of electricity is thus measured at 28 instead of 25, and no output of residuals is recorded. On the use side 25 units of electricity is allocated to the households as before, and 3 units is recorded as losses to the environment.

Consistency with energy statistics

The advantage of this recording is that the output of electricity is recorded in exactly the same way as in energy statistics and energy balances. It reflects the physical reality of the economy: the electricity is an output of the power plants etc. and it is intended to be used as a product, even though in the end some of it is lost in distribution. This is emphasized by the fact that, in recent years, there has at least in EU been a growing separation of the economic units producing electricity and the units who distributes electricity. In contrast to the net output, the gross output can directly be used for the analysis of the efficiency of the producers of electricity.

Easy to record theft

Another advantage is that it is easy to treat the part of the distribution losses due to theft in an intuitive way by simply recording it in the use table as in input into industries or households. Assume, for instance, that theft by households is 1 unit of electricity out of the distribution loses at 3. Then in the use part of Table 3, households use is 26 instead of 25, and the distribution losses are 2 in stead of 3.

Link to the monetary accounts

The physical output is recorded including the losses while the SNA accounts records the monetary output net of the losses. However, this can be explained by the simple fact that no payments take place for the products lost. It does not mean that the flows are not physical products.

New type of flows compared to SNA 2003

The recording of product flows from the economy to the environment is new compared to what is presented in SEEA 2003, which did not explicitly treat these kinds of flows. However, due to the nature of these losses of products, it seems quite natural to add these flows to the framework.

Table 3 Recording gross output of electricity and distribution losses as products

Supply (physical units)

		Industries	Households	Changes in inventories	Environment	Total supply
Products	Electricity	28				28
Residuals						
Total supply		28				28

Use (physical units)

		Industries	Households	Changes in inventories	Environment (distribution losses)	Total use
Natural resources						
Products	Electricity		25		3	28
Residuals						
Total use			25		3	28
Net accumulation (balance)		-28	25		3	

Alternative: Gross output of electricity and losses as residuals

However, in stead of introducing this new type of flows of products to the environment, it is possible to combine the gross recording of the electricity output with the treatment of the distribution losses as a residual.

28 units of electricity and 3 units of residuals

This can be done by recording the output of electricity at 28 units, cf. Table 4. 3 of these units are then recorded in the use table as input to the electricity industry itself, which then generates 3 units of residuals in the form of distribution losses.

Theft

This recording facilitates also an intuitive treatment of the theft. Electricity used by industries and households would be 2 and 26 units, respectively. And residuals generation would be 2 units if 1 unit of electricity is assumed to be lost by theft.

Table 4 Recording gross output of electricity and distribution losses as residuals

Supply (physical units)

		Industries	Households	Changes in inventories	Environment	Total supply
Products	Electricity	28				28
Residuals	Distribution losses	3				3
Total supply		31				31

Use (physical units)

		Industries	Households	Changes in inventories	Environment (distribution losses)	Total use
Natural resources						
Products	Electricity	3	25			28
Residuals	Distribution losses				3	3
Total use		3	25		3	31
Net accumulation (balance)		-28	25		3	

Natural gas

Net recording of natural gas

75 units product output and 41 units of residuals

Table 5 shows the net recording of natural gas output. Output of natural gas as a product (75 units) is recorded net of any losses in distribution and storage. All losses in distribution and storage are recorded as a supply of residuals. On the use side, 50 and 25 units of the product natural gas is allocated to ISIC 35 and changes in inventories, respectively.

Gross extraction of natural resources

In addition to the recording of natural gas as a product, the use of 116 units of natural resources is recorded in the use table. This corresponds to the gross extraction of natural resources.

Flow of residuals to the environment

41 units of residuals corresponding to the re-injection, and flaring and venting of the natural gas during extraction and the distribution and storage losses are recorded as a flow of residuals to the environment in the use table.

Table 5 Recording net output of natural gas and all losses as residuals

Supply (physical units)

		Industries		House-holds	Changes in inven-tories	Environ-ment	Total supply
		ISIC 6	ISIC 35				
Products	Natural gas	75					75
Residuals	Distrib.losses	20					20
	Storage losses	5					5
	Reinjection	6					6
	Flaring/venting	10					10
Total supply		116					116

Use (physical units)

		Industries		House-holds	Changes in inven-tories	Environment (losses)					Total use
		ISIC 6	ISIC 35			Total	Distribu-tion losses	Storage losses	Re-injection	Flaring/ venting	
Natural resources	Natural gas extracted	116									116
Products	Natural gas		50		25						75
Residuals	losses					41	20	5	6	10	41
Total use		116	50		25	41	20	5	6	10	232
Net accumulation (balance)			50		25	41					116

Gross recording of natural gas

100 units product output

If, instead, the output of the natural gas from ISIC 6 is recorded gross of the losses in storage and distribution, we get a total product output at 100 units as shown in the supply part of Table 6. As before 50 and 25 units of the product natural gas is used as inputs to ISIC 35 and changes in inventories, while 25 units of the product is lost to the environment during storage and distribution.

16 units of losses in extraction as residuals

As before 116 units of natural gas resources is recorded as an input to ISIC 6 in the use table. This is the gross extraction of natural gas. 6 units are re-injected back to the natural resource deposits and 10 units disappear due to flaring and venting of the natural gas during the extraction process. In the use table in Table 6, the re-injection and the flaring/venting is recorded as a flow of residuals to the environment. The reasoning is that neither the re-injected gas nor the flared and vented gas has acquired the characteristics of a product. The re-injected gas is still a natural resource, and the flared and vented gas does never leave the extraction facilities. Further, it is customary in energy statistics and balances *not* to include these parts of the natural gas in the output.

25 units of products flowing into the environment

In addition, 25 units of natural gas, which is lost during distribution and storage, are recorded as a flow of products to the environment.

Table 6. Recording gross output of natural gas, losses in distribution and storage as products, and extraction losses as residuals

Supply (physical units)

		Industries		House-holds	Changes in inven-tories	Environ-ment	Total supply
		ISIC 6	ISIC 35				
Products	Natural gas	100					100
Residuals	Reinjection	6					6
	Flaring/venting	10					10
Total supply		116					116

Use (physical units)

		Industries		House-holds	Changes in inven-tories	Environment (losses)					Total use
		ISIC 6	ISIC 35			Total	Distribu-tion losses	Storage losses	Re-injection	Flaring/ venting	
Natural resources	Natural gas extracted	116									116
Products	Natural gas		50		25	25	20	5			100
Residuals	Extraction losses					16			6	10	16
Total use		116	50		25	41	20	5	6	10	232
Net accumulation (balance)			50		25	41	-96	5	6	10	116

Alternative: gross recording and losses as residuals

Just as in the case of electricity, it is possible to record the output of natural gas gross of the distribution and storage losses, and at the same time record the losses as residuals. It simply requires that 25 units of the output at 100 units is used as inputs in ISIC 6, and correspondingly that the losses in distribution and storage is recorded as flows of residuals to the environment.

Pros and cons

In general, the arguments for recording the natural gas gross in stead of net are the same as for electricity. It brings the recording of the output closer to the energy statistics and energy balances and facilitates the separate analysis of production and distribution efficiencies. The disadvantage is that the immediate link to the net accounting of the monetary accounts disappears, unless we think of physical flows of products with a market price of zero.

Conversion losses

Using calorific values for the energy accounts

Conversion losses are relevant for the supply and use tables for energy products and residuals when calorific values (e.g. joules) are used as the measurement unit. The conversion losses appear when one or more energy products are used to produce one or more energy products.

Losses intimately linked to the production process and not to products

The conversion losses are intimately related to the production process, and since often several products are included both on the input side (e.g. coal, oil, natural gas) and on the output side (electricity and heat) it doesn't make much sense to attribute the conversion losses to any specific products. Instead the conversion losses have to be seen as a residual flowing to the environment.

Recording conversion losses as residuals

Table 7 shows the recording of the conversion losses in the simple case of electricity produced from the use of natural gas.

Table 7. Recording gross output of natural gas and electricity and conversion losses as residuals

Supply (peta joules)

		Industries ISIC 6	Industries ISIC 35	House-holds	Changes in inven-tories	Environ-ment	Total supply
Products	Natural gas	100					100
	Electricity		28				28
Residuals	Conversion losses		22				22
Total supply		100	50				150

Use (peta joules)

		Industries ISIC 6	Industries ISIC 35	House-holds	Changes in inven-tories	Environment (losses) Total	distrbution losses	storage losses	conversion losses	Total use
Products	Natural gas		50		25	25	20	5		100
	Electricity			25		3	3			28
Residuals	Conversion losses					22			22	22
Total use			50	25	25	50	23	5		150

28 units of electricity and 22 units of residuals (conversion losses)

The use table shows that the input of natural gas to ISIC 35 is 50 peta joules which balances with the total output from ISIC 35 presented in the supply table. The output includes 28 peta joules of electricity and 22 peta joules lost during conversion. The conversion loss is included as residuals. The use table shows that the destination of the conversion losses is the environment.

4. Conclusions and suggestions

Losses can be presented consistently within the SEEA 2003 PSUT framework

The physical flow accounts and the physical supply-use tables of SEEA 2003 are capable of presenting the losses during extraction, storage, distribution and conversion in a consistent and logical way. It includes the recording of the losses on both the supply and the use side. However, before recording the losses, it is necessary to decide what it is that is lost. Is it products or residuals?

Losses of products and gross recording

If it is products, which are lost, the simplest solution is to include it as product output in the supply table and as a flow of products to the environment in the use table. (Table 3 and 6). Another solution is first to include it as product output from a specific industry (Table 4). The output is then used as inputs in the same industry (internal delivery), which on the other hand corresponds to an output of residuals equal to the losses.

Losses of residuals and net accounting

If it is residuals, which are lost, the product output is recorded net of the losses (Table 2 and 5). The losses are recorded as output of residuals in the supply table. In the use table the losses are recorded as flows of residuals to the environment.

Theft

Theft is a special type of losses. The gross recording of the product output facilitates that the products, which are lost due to theft, can immediately be recorded as inputs to the industries and households which are behind the theft. If net recording is used, it is necessary to either redirect the losses recorded as residuals back to the economy or to supplement with other tables.

Suggestions

It is suggested here that the decision on whether to include the losses of electricity, heat, and natural gas as products or as residuals - and correspondingly whether the physical product output should be net or gross of the losses - should be based on how the losses are normally perceived, and how these physical outputs are in general recorded in the statistical system.

Gross recording of energy products

In the case of energy products like for instance electricity, heat and natural gas it is customary in energy statistics to record the output gross, and in addition to record the distribution losses as a use of the products. Thus, **it is suggested also for the physical supply and use tables to use gross recording of output of energy products**. (Tables 3/4 and 6). At first sight the recording of gross physical output seems to be in conflict with the recording of the net monetary output in the monetary accounts. However, this is easily solved by regarding the losses as product output with a market price of zero.

Gross recording of natural resource extraction

In the case of energy resource extraction it is customary to *exclude* for instance re-injected, flared and vented gas from the output in the energy statistics, i.e. to use a net output measure. The net output measure does normally also include the own use of energy by the extracting industry. However, **it is suggested here that the inputs of natural resources is measured gross of resources lost during extraction, and that the losses are recorded as flows of residuals in the use table** (Table 6)

Conversion losses are residuals

Further, it is suggested that **conversion losses should be recorded as flows of residuals** (Table 7)**.**