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Issue #17: Recording of losses[1]

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[1] This outcome paper has been prepared by the SEEA Editor. It is based on papers presented to the London Group of Experts on Environmental Accounting and discussions among those experts. Investigation and research for this outcome paper was led by Ole Gravgard of Statistics Denmark and Alessandra Alfieri of the United Nations Statistics Division

A. Introduction

1. Recording losses can provide important information to understand the efficiency of production processes since reducing losses at the various stages of production can significantly improve the overall output from a given process. However, the System of Environmental and Economic Accounts (SEEA) 2003 does not systematically address the recording of losses. Thus, in the revision of SEEA it was recommended that work focus on developing a comprehensive recording of losses in both physical and monetary terms.

2. This paper presents a range of recommendations relating to the recording of losses with particular reference to losses of water and energy as it is the losses of these two materials that are most common and prevalent. Section B proposes a definition and typology of losses in physical terms. Section C describes the treatment of losses in monetary terms in the System of National Accounts (SNA) based on the typology of losses developed in Section B. Section D presents proposals for the treatment of losses in the revised SEEA using the information from examples for water and energy to populate illustrative tables. Recommendations for the revised SEEA are included at various points through the paper. An annex provides an example from some supplementary tables that could be presented in the revised SEEA to provide an alternative view of different types of losses.

B. Definition and typology of losses in physical terms

3. There is a range of potential stages in the production and distribution process during which losses need to be considered. This section proposes a general definition of losses in physical terms and then a typology of losses.

4. The interest in losses stems from an interest in better understanding and recording the physical flows associated with the production process. Consequently, it is important to define the scope of the production process that underpins the definition of losses proposed in this paper. Consistent with the general intent of the SEEA the production boundary to be used in this paper is the production boundary defined by the 2008 SNA. Further, in this paper the SNA production boundary also defines the boundary between the environment and the economy.

5. The proposed general definition of losses is:

> Within the context of the production boundary of the 2008 SNA, losses in physical terms are comprised of (i) flows of natural resources from the environment to the economy that are not available for further use within the economy because they have been returned to the environment; and (ii) materials that do not reach their intended destination or have disappeared from storage.

6. By construction, this definition excludes flows of natural resources that do not enter the production boundary of the 2008 SNA, for example evaporation from lakes, and excludes economic losses due to natural processes such as floods. This is not to say that such flows are not accounted for in the SEEA but simply that they are not considered losses in a production context. The more general issue of the treatment and classification of physical flows in the SEEA has important links to this issue and is to be considered in the SEEA revision process under Issue #2: Classification of physical flows.

7. Within this definition five types of losses are identified by the stage at which they occur through the production process. It is noted that some types of losses may be necessary for maintaining safe operating conditions as is the case of flaring and venting in the extraction of natural gas, while others may be unwanted losses as is the case for water evaporation from distribution channels.

8. The five types of losses are:

i. Losses during extraction/abstraction
ii. Losses during distribution/transport
iii. Losses during storage
iv. Losses during conversion/transformation
v. Losses due to theft

9. *Losses during extraction* are losses that occur at the time of extraction (e.g. flaring and venting of natural gas) of a natural resource before there is any further processing, treatment or transportation of the extracted natural resource. During the extraction process, some of the natural resource may be re-injected into the deposit from which it was extracted. This may be the case for example for natural gas re-injected into the reservoir or water abstracted from groundwater and re-injected into an aquifer. These flows would also be considered as losses during extraction. In effect these are amounts of natural resources which temporarily enter the economy as a result of activity within the production boundary of the SNA but do not remain in the economy for any significant period of time and are not be considered to have entered the inventory of the extractor.

10. *Losses during distribution* are losses that occur between a point of abstraction/extraction and a point of use or between points of use and reuse. These losses may be caused by a number of factors. In the case of water they may be due to evaporation when, for example, water is distributed through open channels; leakages when, for example, water leaks from pipes into the ground. In the case of energy, they may refer to evaporation and leakages of liquid fuels, loss of heat during transport of steam, losses during gas distribution, electricity transmission and pipeline transport.

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

12. *Losses during storage* are losses of energy products and materials held in inventories. They include evaporation, leakages of fuels (measured in mass or volume units), wastage and accidental damage. The fact that losses are defined in the context of the SNA production boundary implies that the scope of storage relates to the storage of products as defined in the SNA. Excluded from this scope are non-produced assets which may be considered as being stored – for example water in artificial reservoirs. Based on this definition, if water in artificial reservoirs was to be considered a produced asset/inventory (an issue to be considered under SEEA Revision Issue #16: Treatment of water in artificial reservoirs), then significant losses during storage of water are likely to be recorded, largely due to evaporation.

13. *Losses during conversion* refer to the energy lost, for example heat, during the conversion of one energy product into another energy product. It is essentially a mass/energy balance concept reflecting the difference in calorific value or mass between the input and output commodities. Losses during conversion do not apply to water.

14. *Losses due to theft* refer to water, electricity, other energy products and other materials that are illegally diverted from distribution networks or from storage. They are discussed separately because unlike the previous types of losses, the materials stolen remain within the economy and are actually used for intermediate or final consumption. In the case of the other losses, the products return in various forms back to the environment. It should be noted that losses due to theft are difficult to measure in practice.

Recommendation 17.1: That, within the context of the production boundary of the 2008 SNA, losses in physical terms are comprised of (i) flows of natural resources from the environment to the economy that are not available for further use within the economy because they have been returned to the environment; and (ii) materials that do not reach their intended destination or have disappeared from storage.

Recommendation 17.2: That, in the revised SEEA, the following five types of losses should be recognized – (i) losses during extraction/abstraction; (ii) losses during distribution/transport; (iii) losses during storage; (iv) losses during conversion/transformation; and (v) losses due to theft.

C. The treatment of losses in the 2008 SNA

15. While the boundary between the environment and the economy can be considered in depth in physical terms by examining the physical processes involved in the extraction, abstraction, use and returns of water, energy and other materials, the same examination is more challenging in monetary terms. In monetary terms the boundary is generally defined by the presence of monetary transactions and where these do not take place a match between monetary and physical flows will not occur.

16. Nonetheless, at the point that the SNA recognizes ownership of the abstracted or extracted material there are accounting treatments outlined in SNA that can be applied to the treatment of losses as have been described in previous section.

17. The general treatment is that where a good has entered the inventory of a producing unit, eg water supplier, electricity producer, then losses are treated as deductions or withdrawals from inventory. It may be that the inventory is of finished goods – i.e. goods that will not be further processed by the producer; or they could be raw materials and supplies – i.e. they are goods that will be subject to further processing. In either case the general treatment is the same.

18. The only exception to this treatment is where the losses are considered abnormally large or extraordinary in which case the loss should be deducted from inventories via the other change in volume of asset account as opposed to being a normal withdrawal of inventories. This distinction will impact on the results presented in a supply and use table since those losses deducted through the other changes in the volume of assets account do not appear in a supply and use table.

19. There are important SNA variables that are impacted by the recording of losses as defined above. Since inventories of finished goods represent goods that are ready for sale, losses of finished goods will impact on the value of output for a producing unit. In general, output is defined in the 2008 SNA as sales less change in inventories (where the change in inventories is equal to additions less withdrawals of inventories). Thus losses that are treated as withdrawals of inventories following the discussion above, will reduce estimated output. The 2008 SNA recognizes that valuing these losses may be difficult but indicates that the losses should be valued in the same way as for other withdrawals from inventories.

20. Changes in the levels of inventories of raw materials and supplies impact on the estimates of intermediate consumption of the producing firm. As for output, estimated values for intermediate consumption must be adjusted for the change in inventories of raw materials and supplies. A loss of raw materials and supplies is reflected as an increase in intermediate consumption – in effect the losses represent a cost of production.

21. Often, there is comment that the SNA measure of output is measured net of losses. While true to some extent in that when losses occur output is lower, in the majority of cases the output is lower due to an actual deduction from inventories that should be accounted for and valued in the same way as for other withdrawals from inventories. Thus it is not generally the case that losses are simply ignored in the SNA. At the same time, it is recognized that there may be significant practical difficulties in estimating losses. For example theft is not collected as part of regular energy statistics data collection.

22. Given this broad introduction to the treatment of losses in the SNA the following comments are made in relation to each of the five types of losses defined in section C.

a. Losses during extraction

It is probable that many of these losses are not recorded in the 2008 SNA framework since there is no monetary transaction and the natural resources that are lost may not be recorded as entering the inventory of the producing firm before being returned to the environment.

Where they are recorded as entering the inventory of the extracting/abstracting unit, for example before being distributed to a processing or treatment unit (possibly within the same business unit), then the general treatment outlined above will apply. However, where the extracted or

abstracted natural resource is not recorded as entering inventories the resulting monetary estimates of output will effectively be recorded net of losses during extraction.

b. Losses during distribution

The general treatment outlined above will apply as in this case the materials will have entered the inventories of the distributing units.

c. Losses during storage

The general treatment outlined above will apply as in this case the materials will have entered the inventories of the storing units.

d. Losses during conversion

The 2008 SNA does not recognize losses during conversion. They are only relevant for physical flows measured in calorific terms (joules). In the 2008 SNA the value of the energy products to be converted reflects an input in the production process and hence is treated as intermediate consumption, while the value of the products derived from the production process is recorded as output.

e. Losses due to theft

The 2008 SNA does not consider theft to be a transaction as there is no mutual agreement between the two parties involved – the producer and the user (2008 SNA paragraph 3.97). Nonetheless, normal levels of theft must be accounted for as a deduction from inventories and hence the general treatment outlined above will apply.

In the case of normal levels of theft, the output of industries is calculated after deducting the cost of theft since the theft will be recorded as withdrawals from inventories and will reduce the value of output by the same amount (2008 SNA para 6.99 and 6.109).

If theft involves significant redistribution or destruction of assets, it is also necessary to take it into account but in such cases the SNA records the theft in the other changes in volume of asset account. If the losses due to theft are extraordinary they are not considered in the calculation of output.

Recommendation 17.3: That in the monetary flow accounts of the revised SEEA the treatment of losses should be consistent with the treatment of losses in the 2008 SNA.

D. Recording losses in physical terms in the revised SEEA

23. As noted in the introduction the SEEA-2003 does not explicitly discuss the recording of losses. Losses only appear in the example of the physical energy accounts for Denmark (SEEA-2003, Table 4.4) where they are shown by product in the use table. This section proposes a way of recording losses within the revised SEEA using examples for water and energy to illustrate the proposal.

Water

24. Figure 1 presents schematically flows of water between the environment and the economy and within the economy. For simplicity, there are only two industries: a water supplier (ISIC 36) and a water user (ISIC 1 - Agriculture). To better follow the description of these flows in the supply and use tables a numerical example is used.

25. The supplier abstracts a total of 148 m^3 of water of which 130 are for further distribution and 18 are for own use (for example, cleaning pipes). Of the 18 m^3 of water abstracted for own use, 16 are discharged into the environment after use and the remaining 2 is assumed to be consumed. Of the 130 m^3 of water abstracted for distribution only 91 are actually delivered to the user, the rest, 39 m^3, is lost. In the example, it is assumed that 20 m^3 are lost because of leakages (hence recorded as a return into

the environment) and the remainder, 19 m^3 are assumed to evaporate or otherwise be removed from the water system, recorded as part of water consumption.

Figure 1: Schematic presentation of recording water flows in the SEEA-Water

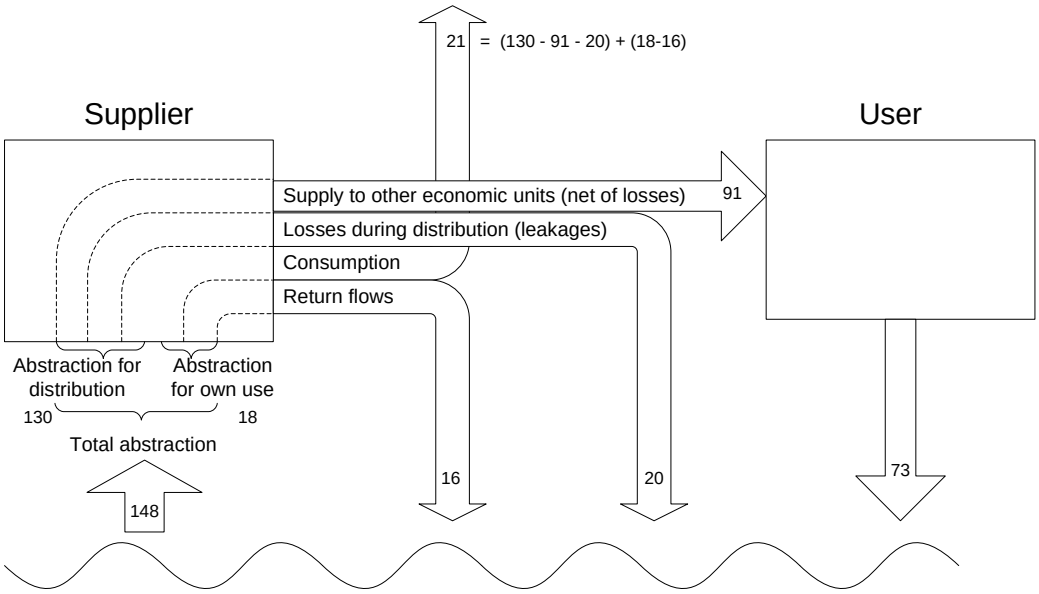

Table 1: Recording losses for water

Use table (Physical units m3)

		ISIC		
		ISIC 1 (user)	ISIC 36 (supplier)	Total
From the environment	U1 - Total Abstraction:		148	148
	Abstraction for own use		18	18
	Abstraction for distribution		130	130
Within the economy	U2 – Use of water received from other economic units	91	0	91
U=U1+U2 - **Total use of water**		91	148	239

Supply table (Physical units m3)

		ISIC		
		ISIC 1 (user)	ISIC 36 (supplier)	Total
Within the economy	S1 - Supply of water to other economic units	0	91	91
From the economy	S2 - Total returns	73	36	109
	L.2 Losses in distribution (leakages)		20	20
	Other returns to the environment		16	16
S=S1+S2 - **Total supply of water**		73	127	200
Waster consumption (= U - S)		18	21	39
Of which: L.2 & L.5 Losses in distribution (evaporation & theft)			19	19

Energy

26. The following example concerns flows of energy. In the example it is assumed for simplicity that the economy consists of an oil well, classified as Division 6 of ISIC Rev.4 *Extraction of crude oil and natural gas*, an electricity plant classified as Division 35 of ISIC Rev. 4 *Electricity, gas, steam and air conditioning supply*, and households, who use the electricity that is produced.

27. As illustrated in Figure 2, the oil well extracts 116 petajoules (PJ) of natural gas from a deposit. 6PJ of the 116PJ extracted is re-injected into the deposit, 7.5PJ is flared and 2.5PJ is vented during the extraction. Of the remaining 100PJ (110=116-6-7.5-2.5), 30PJ is added to the inventory (stock) while 5PJ is lost during storage (including 2PJ that are stolen), 50PJ is distributed to the electricity plant and 20PJ is lost during distribution (of which 10PJ are stolen).

28. The electricity plant receives 50PJ which it uses to produce electricity. During the production process, 12PJ are lost during conversion from natural gas to electricity and 13PJ are lost during distribution from the electricity plant to households of which 8PJ are due to theft.

Figure 2. Schematic presentation of losses of energy

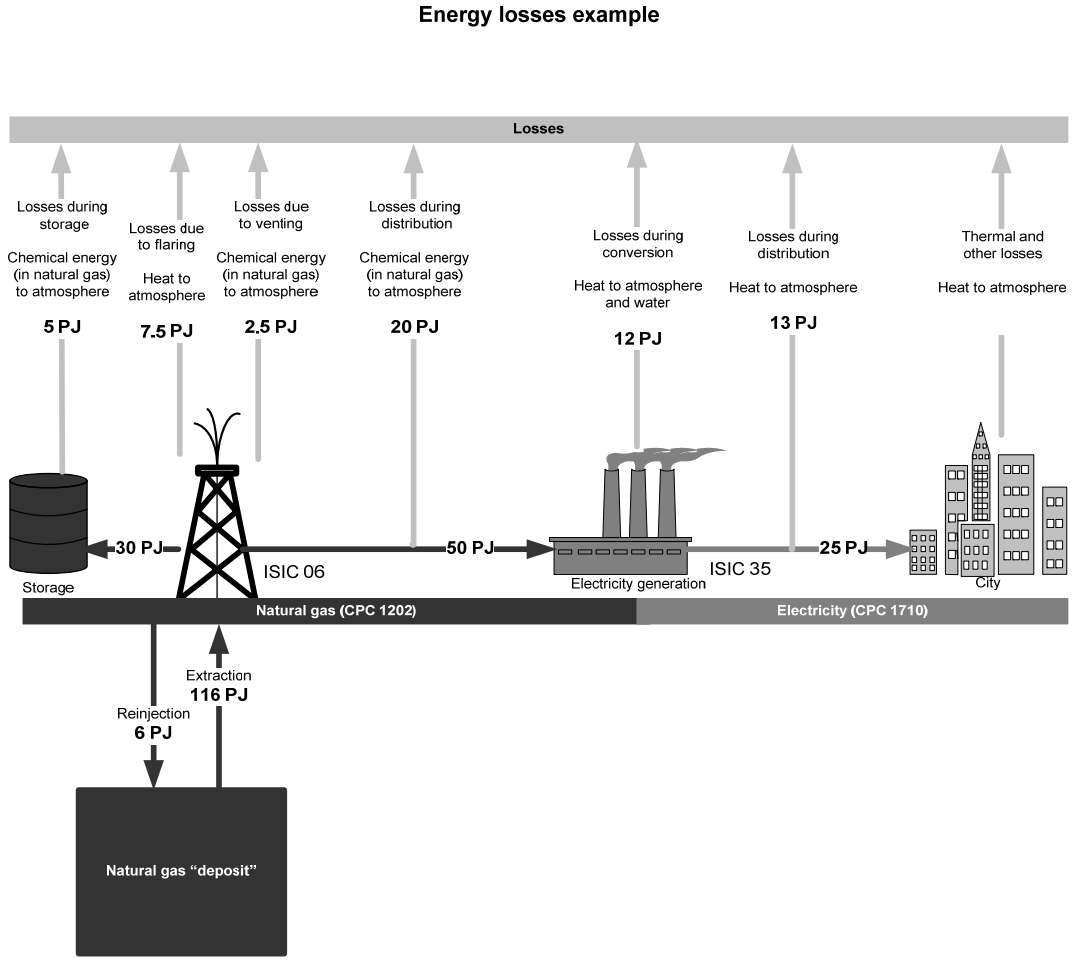

Table 2: Recording losses for energy products

Physical use table

Physical units (Petajoules)

		Industries (by ISIC categories)			Households	Changes in inventories	Total
		6	35	Total			
From the environment	U1 - Total extraction						
	Natural gas	116		116			116
Within the economy	U2 - Use of energy products		50	50	25	25	100
	Natural gas [2]		50	50		25	75
	Electricity				25		25
U=U1+U2 - **Total use**		116	50	166	25	25	216

Physical supply table

Physical units (Petajoules)

		Industries (by ISIC categories)			Households	Changes in inventories	Total
		6	35	Total			
Within the economy	S - Supply	75	25	100			100
	Natural gas	75		75			75
	Electricity		25	25			25
To the environment	L – Losses	29	17	46			46
	L.1- Losses during extraction	16		16			16
	Reinjection	6		6			6
	Flaring	7.5		7.5			7.5
	Venting	2.5		2.5			2.5
	L.2- Losses during distribution (excluding theft)	10	5	15			15
	L.3- Losses during storage[1] (excluding theft)	3		3			3
	L.4- Losses during conversion		12	12			12
S - **Total supply** (= S+L)		104	42	146			146
Balancing item (= U-S)		12	8	20	25	25	20
L.5 Theft							
During distribution		10	8	18			18
During storage		2		2			2

Note: grey cells indicate zero entries by definition.

[1] Losses during storage represent losses of finished goods

[2] Changes in inventories reflects additions to inventories of 30PJ and withdrawals from inventories of 5PJ of which 3PJ is lost to the environment (L.3) and 2PJ is stolen during storage (L.5)

Comments on the proposed tables

29. The following comments on the tables are relevant

- The total amounts abstracted or extracted are recorded gross as flows from the environment before losses are deducted.
- Losses during extraction (L.1) appear only as flows to the environment.
- Losses during distribution (L.2) appear only as flows to the environment.
- Losses during storage (L.3) in this example refer to losses of finished goods. As such they are recorded as a withdrawal from inventories and are subtracted from the output of the industry holding the asset (ISIC 6 in this example) and then again as flows back to the environment.
- Losses during conversion (L.4) also only appear as flows back to the environment.
- Losses due to theft (L.5) are recorded as balancing item between the total use and total supply.

30. The balancing item between the total use and total supply should be conceptualised as including all products that are not returned to the environment. Theft is recorded as part of this balancing item. Accounting for theft in this way has two key advantages: (a) the SNA flows are not affected by this recording, but if available all information on losses due to theft can be presented in the table, and (b) theft is not a flow to the environment but remains within the economy, which is the case in practice.

31. In addition to theft the balancing item also includes the energy that remains within the economy (=25PJ in storage) or which is a final use/end use (=25PJ used by households). It also includes evaporation as this is water that is considered lost because it does not return immediately to the hydrological system and is therefore no longer an available resource.

32. There are alternative ways in which the information on losses can be presented and supplementary tables showing estimates of gross supply of water and energy and supplementary tables concerning theft are presented in Annex 1 for information.

Recommendation 17.4: That in the revised SEEA all types of losses should be separately identified in the portion of the physical supply table showing the flows from the economy to the environment.

Recommendation 17.5: That in the revised SEEA all physical measures of output and related variables should be recorded after accounting for losses so as to maintain consistency with the monetary flows.

Annex 1. Supplementary tables

a. Supplementary tables for gross supply

A supplementary table presenting the gross water supply is included in the SEEA-Water (SEEA-Water table 3.5). Table A1.1 below is a simplification of the table in the SEEA-Water using the numbers from the example above. The use table shows that the losses in distribution (39) by the supplier appear in the use table as intermediate consumption of the supplier.

Table A1.1: Supplementary table of gross supply for water

Supply table			
	ISIC		
	ISIC 1 (user)	ISIC 36 (supplier)	Total
S – (Net) Supply of water to other economic units		91	91
L - Losses in distribution (=L1.+L2.)		39	39
L1. Leakages		20	20
L2. Other (e.g. evaporation, apparent losses, theft, other losses)		19	19
Gross supply within the economy (= S + L)		130	130

Use table			
Gross use of water within the economy	91	39	130
Received from other economic units	91		91
Losses		39	39

A similar table can be constructed for energy (Table A1.2). Gross supply is an important indicator of the efficiency of the production process. In addition, energy statistics and energy balances include losses in the production of secondary energy products. Gross supply is therefore important when constructing bridge tables between energy balances and energy accounts as well as for analytical purposes.

Table A1.2: Supplementary table of gross supply for energy

Supply table			
	ISIC		
	ISIC 6	ISIC 35	Total
S – (Net) Supply of energy to other economic units	75	25	100
L – Losses (including theft)	41	25	66
L.1- Losses during extraction	16		16
Reinjection	6		6
Flaring	7.55		7.5
Venting	2.55		2.5
L.2- Losses during distribution	10	5	15
L.3- Losses during storage	3		3
L.4- Losses during conversion		12	12
L.5- Theft	12	8	20
Gross supply within the economy (= S + L)	116	50	166

b. Supplementary tables for theft

As discussed, theft may occur when, for example, water and electricity are diverted from the distribution networks or when energy products are illegally taken from inventories. Therefore, theft is a special category of losses during distribution and losses during storage. It may be significant in some countries. It not only affects the efficiency of water and electricity distribution networks but at times could cause major problems within the system. Furthermore, it may be analytically useful to allocate theft of water, electricity or energy products to the users – if enough information is available. Some indicators, including the Millenium Development Goals indicators, on access to drinking water and sanitation may provide a biased picture of reality if theft is excluded.

In Tables 1 and 2 theft is shown as a balancing item between total use and total supply. An alternative recording is to present theft in supplementary physical supply and use tables, if sufficient information is available. Table A1.3 below is a simple example of what a supplementary table could look like.

Using the same examples as in the main paper, we assume that households use the water and electricity that have been stolen from the distribution network while natural gas illegally stolen from storage is used by ISIC 1 and that natural gas stolen from the distribution network is used by ISIC 36 (for the sake of simplicity).

Table A1.3: Supplementary physical supply and use tables for theft

Supply table

		Industries (by ISIC categories)				
		1	6	35	36	Total
Within the economy	(Net) Supply					
	Water				91	91
	Theft during distribution				10	10
	Natural gas		75			75
	Theft during distribution		*10*			*10*
	Theft during storage		*2*			*2*
	Electricity			25		25
	Theft during distribution			*8*		*8*
	Gross supply					
	Water				101	101
	Natural gas		87			87
	Electricity			33		33

Use table

		Industries (by ISIC categories)					Households	Total
		1	6	35	36	Total		
Within the economy	Use	9						
	Water	1				91	10	101
	Theft						*10*	*10*
	Natural gas	*2*		50	10	62	25	87
	Theft	*2*			*10*	*12*		*12*
	Electricity						33	33
	Theft						*8*	*8*

As for the monetary tables, the pricing of stolen goods is a complex issue. While the value of the output and consumption would remain the same, one would have to impute a transfer from the users who paid for water to those that used stolen water. We do not recommend this recording as it would not be feasible in practice.

References

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http://unstats.un.org/unsd/sna1993/snarev1.asp