14th Meeting of the London Group on Environmental Accounting
Canberra, 27 – 30 April 2009

Recording losses in the SEEA
-Issue 17-

Alessandra Alfieri, United Nations Statistics Division
Ole Gravgård, Statistics Denmark[1]

[1] The views expressed in this paper are the views of the authors and not those of the United Nations Statistics Division or Statistics Denmark. The paper has benefited from discussions with Ilaria DiMatteo, Ivo Havinga and staff members of the National Accounts and Environmental-Economic Accounts Sections of UNSD.

Recording losses in the SEEA
-Issue 17-

A. Introduction and description of the issue

1. The SEEA-2003 does not systematically address the recording of losses.

2. Issue 17 in the list of issues for the revision of the SEEA recognizes the need to separately identify the different types of losses and develop a common way to record them in the supply and use tables. The proposal presented in this paper is to maintain the physical flows within the economy fully consistent with the monetary transactions of the SNA and explicitly show the various types of losses in the portions of the supply and use tables presenting the flows from the environment to the economy and from the economy back to the environment.

3. In addition, since theft of, for example water and electricity, results in actual usage of the resource, a supplementary presentation showing the supply and use of the stolen water and electricity in physical term is suggested. The valuation of theft of water and energy is a more complex issue and the paper only recommends the allocation of stolen goods in physical terms, if information is available.

4. Section B provides a description of the different types of losses that are common in water and energy. Section C discusses the recording of losses in the SNA2008, Section D discusses how losses, mostly losses during distribution are recorded in the *System of Environmental and Economic Accounting for Water* (SEEAW). Section E discusses the more general cases of losses and suggests a way of recording in the revised SEEA. Section F elaborates an alternative recording in the case of theft and in particular the allocation to the users. A list of questions for the London Group is provided in Section G.

B. Typology of losses

5. There are five types of losses that can occur at different stages of production. They refer to the quantity/value of natural resources that have entered the economy and products that are not available for supply or use within the economy. Some types of losses may be necessary for maintaining safe operating conditions as it is the case of flaring and venting others may be unwanted as it is the case for water evaporation.

6. The most common losses, include:

- Losses during extraction/abstraction
- Losses during distribution/transport
- Losses during storage
- Losses during conversion/transformation
- Losses due to theft

7. *Losses during extraction* are losses that occur either at the time of extraction (e.g. flaring and venting) of the natural resource or before the natural resource reaches the establishment where it is processed (e.g. water evaporated during transportation from

the point of abstraction to the point of treatment). Flaring and venting for example are not unwanted losses but are technical losses that are required to maintain safe operating conditions.

8. 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.

9. *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. Theft is a special case of losses in distribution and is discussed separately.

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

11. *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, accidental damage and theft. Losses during storage do not apply to water. Water is a bulky commodity and therefore is rarely stored. If water in an artificial reservoir were to be considered a produced asset (see issue paper on issue 16), then significant losses during storage may occur, e.g. due to evaporation.

12. *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.

13. *Losses due to theft* refer to water, electricity and other products that are illegally diverted from the distribution networks or taken from storage. They are a special case of losses during in distribution and during storage. They are discussed separately because unlike the previous losses, the goods stolen remain within the economy and are actually used for intermediate and final consumption. In the case of the other losses, the products return in various forms back to the environment.

C. The 2008 SNA and losses

1. Losses during extraction and during distribution

14. In the 2008 SNA, losses during extraction and during distribution that do not involve significant redistribution do not enter the system. The rationale for this is that there is no economic transaction involved. However, the price of the good in general may be affected by these recurrent losses.

15. Depending on the agreement between the producer and the buyer of the product two cases can be thought of. In the first case, the ownership and responsibility of the products is handed over to the buyer before the distribution loss takes place. The loss is then implicitly part of the buyers' intermediate consumption (if an industry) or final use. However, no explicit recording of the losses takes place. In the other case, the ownership and responsibility are handed over to the buyer after the distribution loss takes place. In that case the loss is not recorded explicitly either. The output only includes the value of the goods the user pays for. The result is that the owner's value added is reduced compared to a situation without the losses unless the producer is able to raise the price in order to cover the losses.

16. If the losses in distribution are not recurrent and very significant, they are recorded in the other changes in volume account of the owner.

2. Losses during storage

17. Losses during storage refer to losses of produced goods held in inventories. If the losses are recurrent losses that normally take place and should be expected, they are recorded in the asset accounts as a decrease in inventory while extraordinary losses are recorded as other changes in volumes n.e.c.. (2008 SNA para 6.109 and 12.48).

> 6.109 [Finished] Goods held in inventories are subject to deterioration through the passage of time and are at risk from theft or accidental damage. Recurrent losses due to normal rates of wastage, theft and accidental damage are treated in the same way as withdrawals from inventories and thus reduce the value of output.
>
> 12.48…. Similarly, if the assumption about the rate of shrinkage of inventories is mistaken, this should also be corrected in the other changes in the volume of assets account….

18. In the use table, recurrent losses in storage are recorded as withdrawal from inventories (negative changes in inventory) and are deducted from the output of the industry holding the inventory in the supply table (2008 SNA para 6.99). This recording may yield to negative physical output.

3. Losses during conversion

19. The 2008 SNA does not recognize losses during conversion. They are only relevant for physical flows measured in calorific terms (joule). In the SNA 2008 the value of the energy products used for conversion is an input in the production process and (intermediate consumption), and the value of the products derived from the production process is recorded as output. Measured in calorific units, the difference between the inputs and the outputs is losses during the conversion.

4. Losses due to theft

20. The 2008 SNA does not consider theft a transaction as there is no mutual agreement between the two parties involved – the producer and the user (2008 SNA para 3.97). If theft involves significant redistribution or destruction of assets, it is necessary to take it into account and the SNA records it in the other changes in volume of asset accounts. In both cases, theft is not part of production. (2008 SNA para 3.98 and 6.99)

21. The output of industries is thus calculated net of theft. Regular theft of products that have entered inventories is not included in the value of output. It will be recorded as withdrawals from inventories and a reduction in the value of output of the same amount (2008 SNA para 6.99 and 6.109).

D. Recording of losses in the SEEA-2003 and the SEEAW

22. The SEEA-2003 does not explicitly discuss how to record 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 products in the use table.

23. The SEEAW only considers losses in distribution. Losses in extraction, due for example to evaporation when water is transported to the plant where it is treated and distributed, are usually insignificant for water. They are therefore not explicitly included in the SEEAW. Note that these do not refer to the evaporation of irrigation channel which is considered as a loss during distribution.

24. Losses during storage do not occur as water is usually not stored, being a bulky item and considering that the SEEAW considers water in a reservoir as a non-produced asset.

25. Losses during conversion do not apply to water. However, water incorporated into products is recorded as water consumption.

26. Note that water consumption is a hydrological concept and differs from the concept of consumption in the SNA. It is defined as the part of water use which is not distributed to other economic units and that is not immediately observable as a return to the environment (to water resources, sea and ocean) because during use it has been incorporated into products, consumed by households or livestock. It is calculated as a difference between total use and total supply, thus it may include losses due to evaporation occurring in distribution and apparent losses due to theft and malfunctioning metering. Water consumption is essentially a balancing item.

27. The SEEAW follows the SNA convention and thus records the supply and use of water within the economy NET of losses in distribution. However, losses are shown in the portions of the physical supply and use tables that record flows from the environment to the economy and flows from the economy back to the environment. The rationale for this recording is to maintain the physical flow within the economy fully consistent with the monetary flows of the SNA.

28. Figure 1 presents schematically how the losses are recorded in the SEEAW. For the sake of 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 (Table 1), a numerical example is used.

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

water resources) and the rest, 19 m^3 of water are assumed to evaporate or otherwise be removed from the water system, hence they are recorded as *water consumption*.

30. Table 1 shows how the situation above would be recorded in the supply and use tables in the SEEAW (note that the supplier is identified in the table as ISIC 36).

Figure 1: Schematic presentation of recording water losses in the SEEAW

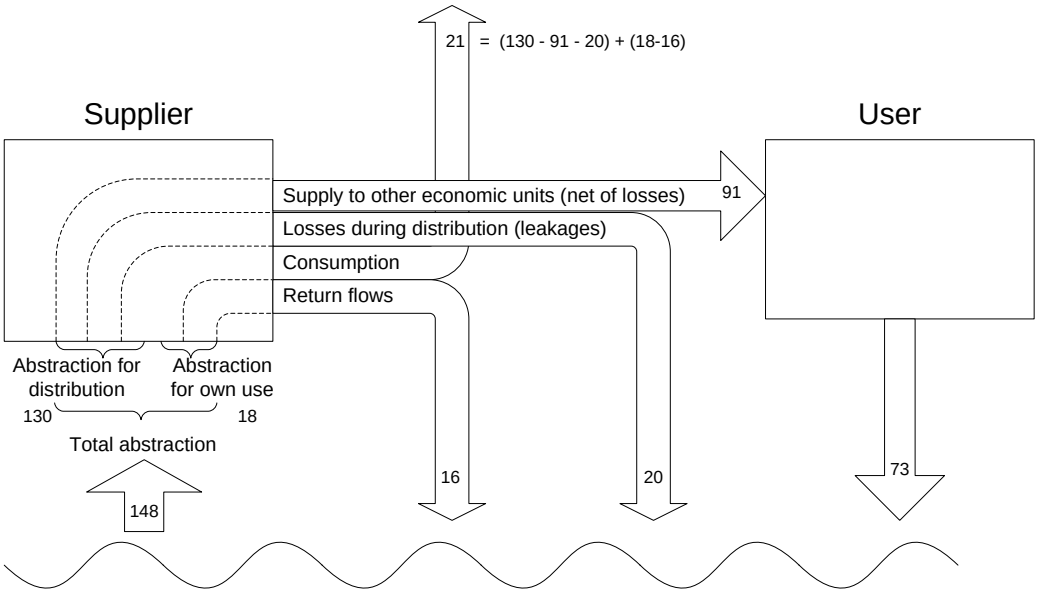


Table1: Physical SUT (net supply)

Use table

		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

		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
	Losses in distribution (leakages)		20	20
	Other returns		16	16
S=S1+S2 - **Total supply of water**		73	127	200
Consumption (= U - S)		18	21	39
Of which: Losses in distribution (evaporation, theft, etc.)			19	19

31. The amount of water abstracted for distribution is equal to the gross water supply. The part of the losses due to leakages is separately identified in the supply table and recorded as a return flow to the environment by the supplier (ISIC 36), while the remaining losses (e.g. due to evaporation, meter errors, theft or other unaccounted losses) are included in water consumption. The rationale of this recording is that leakages are a resource for the hydrological system as they return back to it, while the other types of losses are lost or otherwise removed from the water system.

32. Losses in distribution are allocated to the supplier of water.

2. Losses due to theft

33. The SEEAW follows the recording of the 2008 SNA: theft does not appear as a flow within the economy but only as part of water consumption (see para 26 for the definition of water consumption). This recording has the advantage of maintaining the consistency with the SNA and the direct link between the physical and monetary flows. Furthermore, theft is not recorded as a flow from the economy to the environment which is not the case but as a balancing item. This is in line with the consideration that information on theft is usually not available. However, there are some drawbacks with this recording especially for the computation of indicators such as for example the MDG indicators on access to drinking water and sanitation. Households illegally connected to the water or electricity distribution network, for example, could be considered as having access to water and energy.

34. A supplementary table presenting the gross water supply is included in the SEEAW (SEEAW table 3.5). Table 2 is a simplification of the table in the SEEAW using the same numbers used in the example above.

35. The use table shows a use of the losses (39) by the supplier that is the intermediate consumption of the supplier increases of the same amount of the losses.

Table 2: Supplementary table of losses in distribution

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

E. Proposal for recording of losses in the SEEA

36. Losses are important indicators for the efficiency of the production process – at the various stages of production. We propose the following recording for losses; (a) flows within the economy remain consistent with the monetary flows of the SNA; (b) all types of losses that are analytically important are separately identified in the portion of the physical supply table showing the flows from the economy to the environment; (c) theft is separately identified as a balancing item between use and supply. It is not shown as a flow from the economy back to the environment as it remains within the economy.

37. This proposal is consistent with the recording of losses in the SEEAW. It expands it further to cover losses during extraction, during storage and during conversion which are not relevant in the case of water.

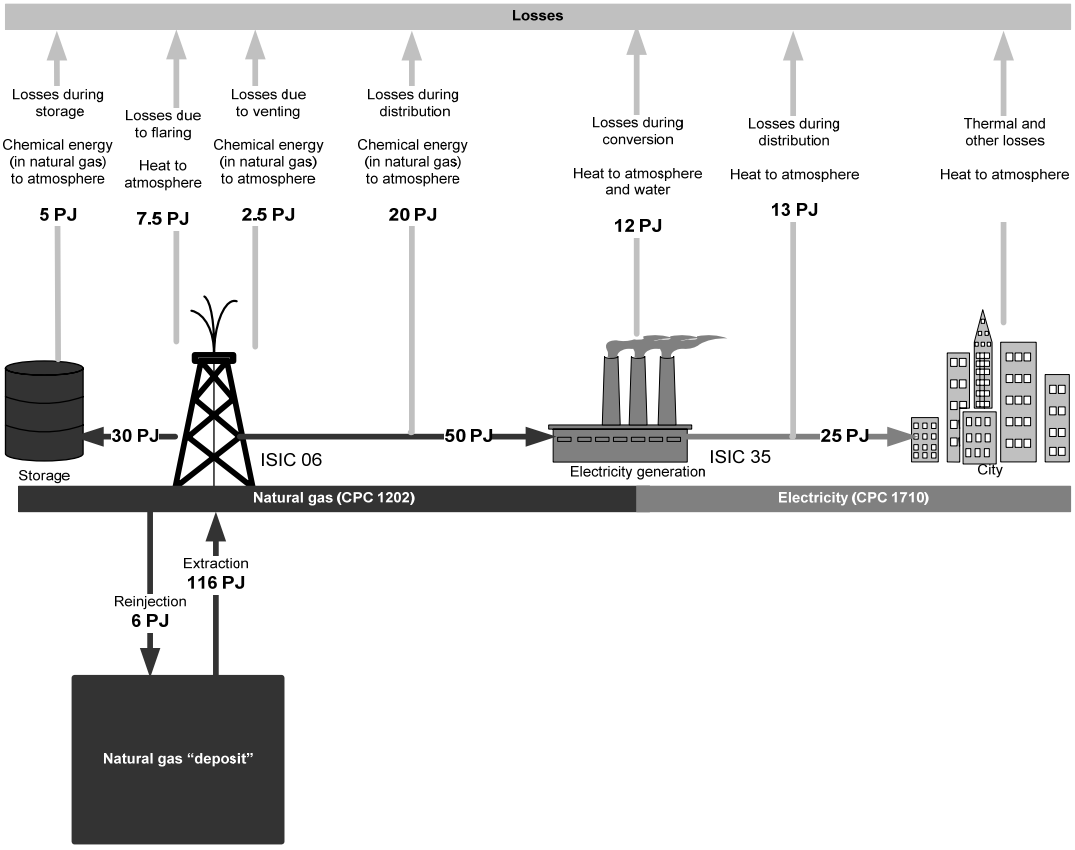
38. The proposal on how to record all the different types of losses is illustrated with an example in the case of energy. We assume for the sake of simplicity that the economy consists of an oil well, classified as Division 6 of ISIC Rev.4 *Extraction of crude oil and natural gas*, an electricity plant classified as Division 35 of ISIC Rev. 4 *Electricity, gas, steam and air conditioning supply*, and households, who use the electricity produced.

39. In the example, 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 (2PJ are stolen), 50PJ is distributed to the electricity plant and 20PJ is lost during distribution (10PJ are stolen). The output of the oil well (ISIC 6) is 75PJ (75=110-20-5) as the output is calculated net of losses during extraction and during distribution and, in addition, the 5PJ lost during storage are deducted from the output. 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. The output of the electricity plant (ISIC 35) is equal to 25PJ (25=50-12-13) which is also what is used by the households for final consumption.

40. Figure 2 illustrates the example in a schematic way and Table 3 shows the suggested recording in the supply and use tables.

41. Theft of natural gas and electricity occurs during storage and during distribution: 2PJ of the 3PJ of losses during storage of natural gas, 10PJ of the 20PJ of losses during distribution of natural gas and 8PJ of 13PJ of losses during distribution of electricity are due to theft.

Figure 2. Schematic presentation of losses of energy



42. All types of losses appear in Table 3. Losses during extraction and during distribution appear only as flows to the environment. Losses during storage are recorded as a withdrawal from inventories and are subtracted from the output of the industry holding the asset (ISIC 6 in our example) and then again as flows back to the environment. Losses during conversion only appear as flows back to the environment. Note that the losses are recorded by product. They are not separately identified in the table because it is self explanatory that losses during distribution and storage of ISIC 6 refer to losses of natural gas and losses during distribution of electricity refer to ISIC 35.

43. Theft is recorded as part of the balancing item between the total use and total supply. Accounting theft in this way has several advantages: (a) the SNA flows are not affected by this recording, but if available all information on losses and theft can be presented in the table; which is actually the case since stolen goods are used; (b) theft is not a flow to the environment but remains within the economy, which is the case in practice; and (c) this recording is fully consistent with the recording in the water case. The balancing item has conceptually a similar meaning than water consumption as it includes all products that are not returned to the environment.

44. The balancing item in addition to theft also includes the energy that remains within the economy (=25PJ in storage) or which is a final use/end use (=25PJ used by households).

Table 3. Recording losses for energy products

Physical use table

Physical units

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

Physical supply table

Physical units

		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 (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
Theft							
During distribution		10	8	18			18
During storage		2		2			2

Note: grey cells indicate zero entries by definition.

45. A similar table to table 2 showing gross supply water can be constructed also for energy. 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 the bridge tables between energy balances and energy statistics as well as for analytical purposes. Although Table 4 can easily be constructed from Table 3, it is shown here for illustrative purposes.

Table 4: Supplementary table of losses gross supply for energy

Supply table			
	ISIC		
	ISIC 6	ISIC 35	Total
S – (Net) Supply of water 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	7.5		7.5
Venting	2.5		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

46. Table 5 below brings together Tables 1 and 3 for water and energy. The table is presented only for illustrative purposes to show that the proposed recording of losses for water and energy is fully consistent. The table uses two different units, cubic meters and petajoules, so the totals are only put for accounting purposes and do not have any analytical meaning. The same table can also be constructed using tons, in the MFA context.

Table 5. Recording losses for water and energy

Physical use table

Physical units

		Industries (by ISIC categories)					Households	Changes in inventories	Total
		1	6	35	36	Total			
From the environment	U1 - Total extraction		116		148	264			264
	Water				148	148			148
	Abstraction for own use				18	18			18
	Abstraction for distribution				130	130			130
	Natural gas		116			116			116
Within the economy	U2 - Use of energy products					0			
	Water	91				91			91
	Natural gas			50		50		25	75
	Electricity						25		25
Total use (=U1+U2)		91	116	50	148	405	25	25	455

Physical supply table

Physical units

		Industries (by ISIC categories)					Households	Changes in inventories	Total
		1	6	35	36	Total			
Within the economy	S1 - Supply		75	25	91	191			191
	Water				91	91			91
	Natural gas		75			75			75
	Electricity			25		25			25
To the environment	S2- Water returns	73			16	89			89
	L - Losses		29	17	20	66			66
	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								
	Water								
	Leakages				20	20			20
	Natural gas		10			10			10
	Electricity			5		5			5
	L.3- Losses during storage		3			3			3
	L.2- Losses during conversion			12		12			12
S= Total supply (= S1+S2+L)		73	104	42	127	346			346
Balancing item/Water consumption (=U-S)		18	12	8	21	59	25	25	109
Of which:									
	Theft		12	8	10	30			30
	During distribution								
	Water				10	10			10
	Natural gas		10			10			10
	Electricity			8		8			8
	During storage								
	Natural gas		2			2			2
	Evaporation, water in the economy, etc.	18			11	29	25	25	109

Note: grey cells indicate zero entries by definition.

F. Proposal for recording theft

47. Theft may occur when for example water and electricity are diverted from the distribution networks or when energy products are illegally taken from inventories. Theft thus 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 network 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 would be available. As indicated earlier some

indicators including the MDGs indicators on access to drinking water and sanitation may provide a biased picture of reality.

48. The SNA treats the theft just as any other distribution or storage losses, i.e. the output and use are net of theft. In reality though there is an exchange of the physical good (water) between a producer and a consumer (legal production and illegal consumption).

49. In Table 5 theft is shown as a balancing item between total use and total supply. An alternative recording would be to present theft in supplementary physical supply and use tables, if sufficient information is available. Table 5 below is a simple example of how the supplementary table would look like.

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

Table 5. 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							
	Water	91				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*

51. As for the monetary tables, the pricing of stolen goods is a complex issues. While the value of the output 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.

E. Questions to the London Group

(1) Does the London Group agree with the typology of losses presented in Section B?

(2) Does the London Group considers useful a table on the presentation of gross supply (Tables 2 and 5)?

(3) Does the London Group agree with the suggested recording of losses during extraction, distribution, storage and conversion as presented in Tables 3 and 5?

(4) Does the London Group agree with the supplementary table for theft?