

System of Environmental Economic Accounting



System of
Environmental
Economic
Accounting

Physical supply and use tables for energy

Sjoerd Schenau



United Nations

Content

1. Important concepts and definitions used in the SEEA Energy accounts

- The national economy, resident units and the rest of the world
- Imports and exports
- The residence principle
- Production, consumption and accumulation
- Natural inputs, products and residuals
- Physical and monetary units

2. Physical supply and use tables

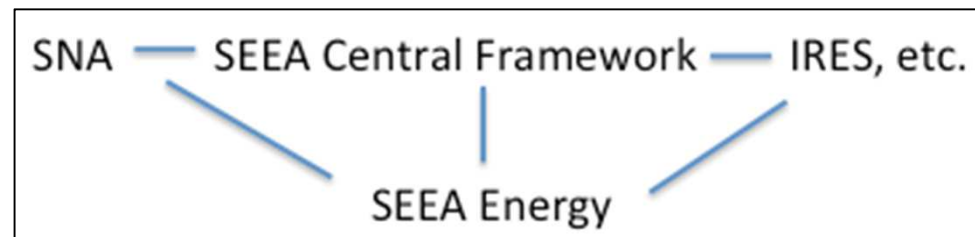
- Accounting identities
- Set up of the tables
- What can you do with these tables ?

Important concepts and definitions used in the SEEA Energy accounts

The SEEA Energy accounts – like any of the SEEA CF accounts – are build around a set of **common definitions and principles**

These definitions and principles have for the main part their origin in the **System of National Accounts**. Others are specific for energy flows and energy resources.

Definitions and concepts specific for energy flows and energy resources are mainly drawn from energy statistics and the International Recommendation of Energy Statistics, IRES



The scope of the energy accounts is energy flows and stocks relevant to *the national economy and resident units*

The *national economy* comprises the set of *institutional units* that are resident in the *economic territory*

Concepts and definitions

The *economic territory* is the area under effective economic control of a single government



An *institutional unit* is an entity that is capable of engaging in economic activities and in transactions with other entities. It may own assets and have liabilities.

A *resident of a country* is an institutional unit with a centre of economic interest in the economic territory of that country

A *non-resident* is an institutional unit with an centre of economic interest outside the economic territory of the country.

The national economy interacts with the *environment* and the *rest of the world*

For the energy accounts *the environment* of primary interest is the area bounded by the country's economic territory. It is from this environment that energy resources are abstracted or captured and from which it enters the *national economy*.

The *rest of the world* is a term used to describe the world outside the national territory.

Imports come from the rest of the world, and *exports* goes to rest of the world.

**Concepts and
definitions**



Residence and territory principle

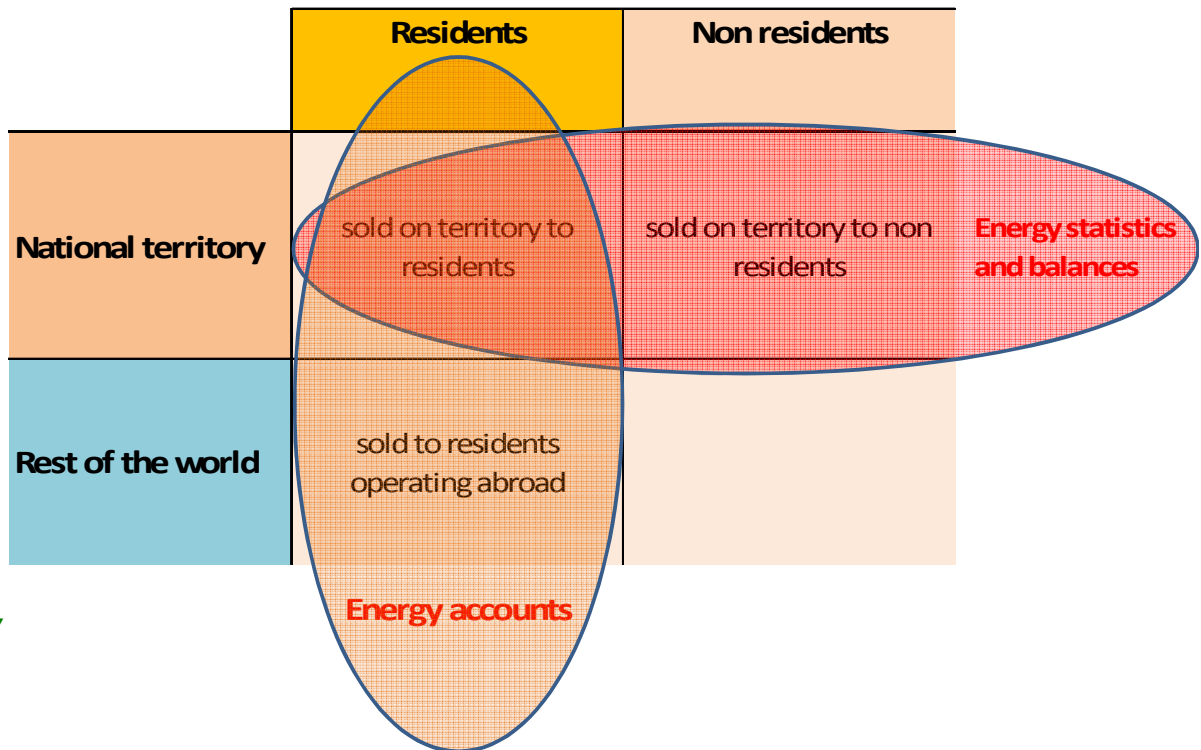
Concepts and definitions



SEEA-Energy uses the **residence principle** i.e. it records the energy production and energy use of residents regardless of the geographic location.

It includes energy products sold to residents, whether operating within the national territory or abroad, including bunkering (i.e. tanking) of fuels in other countries.

Traditional energy statistics and energy balances uses the **territory principle** instead



Industries

Classifications and units



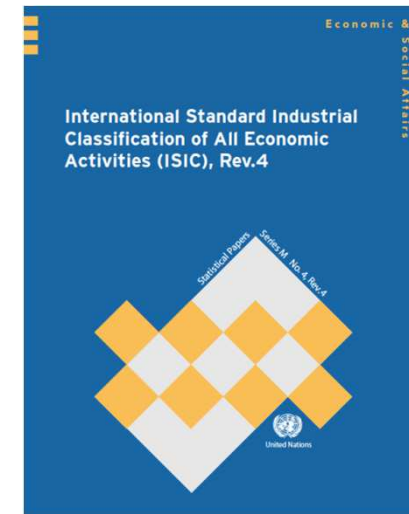
To account for production or intermediate consumption of energy it is often appropriate to classify the economic units involved by *industries*

An *industry* consists of a group of establishments engaged on the same, or similar, kinds of production activity. For classification of industries the UN classification ISIC (International Standard Industry Classification) can be used.

Sometimes national versions of ISIC is used for the national accounts. In such cases they should also be used for the energy accounts.

Link to the ISIC classification

<http://unstats.un.org/unsd/cr/registry/isic-4.asp>



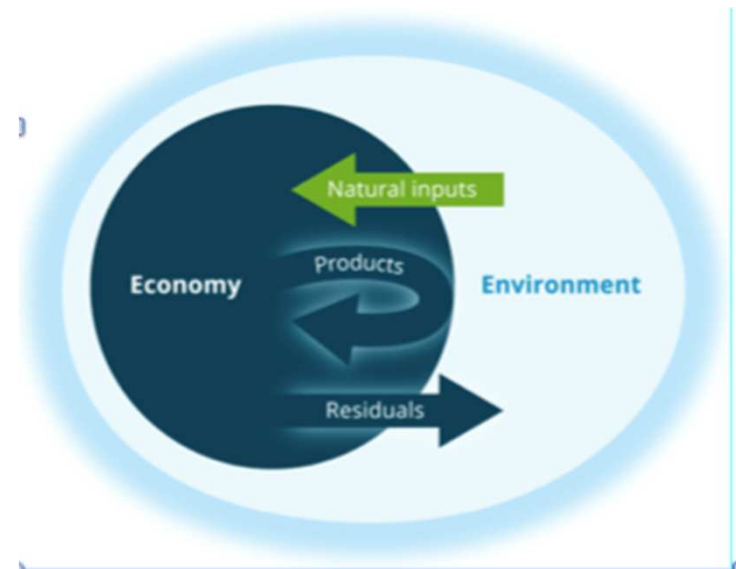
Energy as *natural inputs, products and residuals*

SEEA-Energy – in accordance with SEEA-CF – distinguishes between **three types of "appearances" of energy**:

Natural inputs: This is energy resources i.e. energy as we find it in the environment, and which we may extract or capture.

Energy products: This is energy in the form in which it is bought and sold or stored in inventories owned by companies. Products are always produced or generated by an economic unit belonging to the national or rest of the world economy.

Energy Residuals is a term used to describe energy that are that are discarded, discharged or emitted by industries and households through processes of production, consumption or accumulation.



Classifications and units



Energy as *natural inputs*



Energy as **natural inputs** is in SEEA Energy classified in a way that distinguishes between "conventional" types of solid and liquid natural resources and "circular" renewable forms of energy.

Energy natural resource inputs
Mineral and energy resources
Oil resources
Natural gas resources
Coal and peat resources
Uranium and other nuclear fuels
Natural timber resources
Inputs of energy from renewable sources
Solar
Hydro
Wind
Wave and tidal
Geothermal
Other electricity and heat
Other natural inputs
Energy inputs to cultivated biomass

← "Conventional" solid and liquid natural resources (for extraction)

← "Circular" renewable forms of energy (for capture)

← Energy embedded in cultivated biomass (for harvest)

Energy as products

Energy products includes electricity, heat, coal, petrol, fuel wood, etc. Some energy products, e.g. oil, may be used for non-energy purposes, for instance to produce plastic.



In the national accounts energy as products is often classified according to the Central Product Classification, CPC, or some national version of it.

For the energy accounts, however, it is recommended to use the *Standard International Energy Product Classification (SIEC)*.

Observe that there is no one-to-one relationship between CPC and SIEC.

You can find the complete CPC and IRES classification in the UNSD website

CPC: <http://unstats.un.org/unsd/cr/registry/cpc-2.asp>

Chapter 3 in the IRES: <http://unstats.un.org/unsd/statcom/doc11/BG-IRES.pdf>

SIEC Classification at top level

Classes of energy products

- 0 Coal
- 1 Peat and peat products
- 2 Oil shale / oil sands
- 3 Natural gas
- 4 Oil
- 5 Biofuels
- 6 Waste
- 7 Electricity
- 8 Heat
- 9 Nuclear fuels and other fuels n.e.c

Energy as residuals



Energy losses are grouped into **5 groups**:

- losses during extraction, e.g. when natural gas evaporates during extraction
- losses during distribution, e.g. when an oil tanker spills oil
- losses during storage, e.g. when petrol leaks from a tank
- losses during transformation, e.g. heat losses when coal is used for production of electricity
- Heat losses (other energy residuals)

In addition there are some **other residual flows** related to energy:

- Energy embodied in energy products used for non-energy purposes
- Energy from solid waste



Exercise

Are the following items an energy resource (natural input) or a product (or both)?

	Energy resource (natural input)	Product
1. Timber		
2. Coal		
3. Natural gas		
4. Gasoline		
5. Electricity		
6. Crude oil		

Physical and monetary units

Classifications and units



In SEEA-Energy –as in SEEA Central Framework - two types of units are used to form the accounts: **Physical units and monetary units**

SEEA-Energy uses calorific values measured by **Joules** as a common unit for the physical accounts

In practice one will often have to work with the data at natural energy units (Tonnes, m³, GWh) and one may build the accounts around these units, and finally convert into joules by using conversion factors.

For the monetary accounts the national currency will be the relevant unit for the accounts.

Conversion factors for biofuels – Calorific values GJ per tonnes

Biofuels	
Solid biofuels	
Fuelwood, wood residues and by-products	15.6
Wood pellets	
Other Fuelwood, wood residues and by-products	
Bagasse	
Animal waste	
Black liquor	11.8
Other vegetal material and residues	
Charcoal	29.5
Liquid biofuels	
Biogasoline	26.8 ^b
Biodiesels	36.8 ^b
Bio jet kerosene	
Other liquid biofuels	27.4
Biogases	
Biogases from anaerobic fermentation	
Landfill gas	50.4
Sewage sludge gas	50.4

Supply and use tables for energy



SUPPLY TABLE						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs					Energy inputs from the environment	Total supply of energy from natural inputs
Energy products	Output			Imports		Total supply of energy products
Energy Residuals	Energy residuals generated by industry	Energy residuals generated by household consumption	Energy residuals from accumulation	Energy residuals received from the rest of the world	Energy residuals recovered from the environment	Total supply of energy residuals

USE TABLE						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs	Extraction of energy from natural inputs					Total use of energy from natural inputs
Energy products	Intermediate consumption	Household consumption	Changes in inventories	Exports		Total use of energy products
Energy residuals	Collection & treatment of energy residuals		Accumulation of energy residuals	Energy residuals sent to the rest of the world	Energy residual flows direct to environment	Total use of energy residuals

Main types of SEEA-Energy accounts

In SEEA Energy – like in SEEA Central Framework – there are basically two types of accounts and tables:

Supply and use tables for recording of flows of energy

and

Asset accounts for recording of the stocks of energy and changes in the stocks

All other accounts and tables are variations or combinations of these two types of accounts

SUPPLY TABLE						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs					Energy inputs from the environment	Total supply of energy from natural inputs
Energy products						Total supply of energy products
Energy residuals					residuals from the environment	Total supply of energy residuals
		consumption				
USE TABLE						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs	Extraction of energy from natural inputs					Total use of energy from natural inputs
Energy products	Intermediate	Household	Changes in	Exports		Total use of energy products
Energy residuals					residual direct to environment	Total use of energy residuals

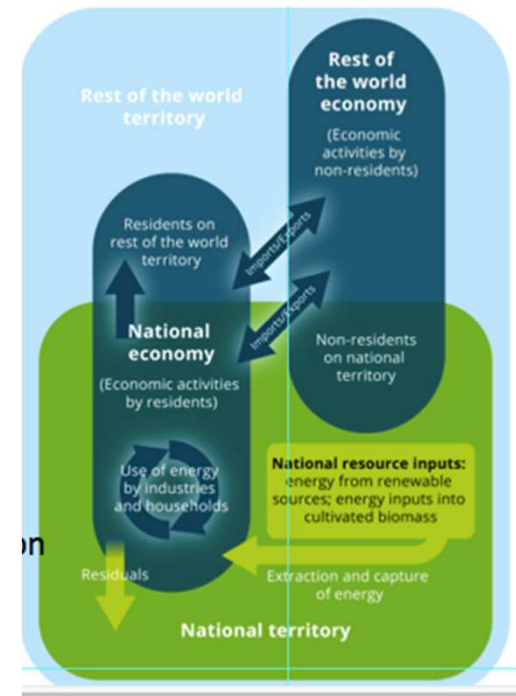
Opening stock of resources		
Additions to stock of resources		
	Growth in stock	
	Discoveries of new stock	
	Upwards reappraisals	
	Reclassifications	
	<i>Total additions to stock</i>	
Reductions in stock of resources		
	Extractions	
	Normal loss of stock	
	Catastrophic loss	
	Downwards reappraisals	
	Reclassifications	
	<i>Total reductions in stock</i>	
Revaluation of the stock of resources *		
Closing stock of resources		

Both types of accounts can be made up in physical or monetary units – the layout and interpretation of the accounts are basically the same with some minor variations

Supply and use tables for energy

With the help of the supply and use tables the energy can be followed

- from the initial extraction or capture from the environment or when it crosses the border from the rest of the world
- through the economy as it is converted by industries, transacted or used by industries, households or the rest of the world
- until it finally flows back to the environment as losses of energy



All flows are identified by its origin (where does it come from) and its destination (where does it go) and its magnitude (number of Joules or dollars, etc.) per time unit

Accounting identities

Supply-Use table is based on **two accounting identities**:

1. Supply-use identity (rows):

TOTAL supply of products = Domestic Output + Import

is identical to

TOTAL use of products = Intermediate Consumption +
Final Consumption + Gross Capital Formation + Export

2. Input-output identity (columns or industries):

TOTAL inputs: product inputs + resource inputs

is identical to

TOTAL outputs = product outputs + residual outputs + net
additions to stock

Check:
For each row the sums
in the supply
and the use table are identical

Check:
For each column the sums
in the supply
and the use table are identical

Exercise

Fill in the missing information based on the known book keeping identities from the accounts

Production of gasoline	100 petajoule
Imports of gasoline	20 petajoule
Exports of gasoline	10 petajoule
Domestic use of gasoline (intermediate consumption plus households)	= ?

Extraction of renewable energy	10 petajoule
Use of crude oil	100 petajoule
Production of gasoline	35 petajoule
Production of petrol	25 petajoule
Production of electricity	15 petajoule
Losses	= ?

Supply and use tables for energy

The supply and use tables are two separate tables which share the same headings and layout

SUPPLY TABLE						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs					Energy inputs from the environment	Total supply of energy from natural inputs
Energy products	Output					Total supply of energy products
Energy Residuals	Energy residuals generated by industry	Energy residuals generated by household consumption	Energy residuals from accumulation	Energy residuals received from the rest of the world	Energy residuals recovered from the environment	Total supply of energy residuals

Supply of energy

USE TABLE						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs	Extraction of energy from natural inputs					Total use of energy from natural inputs
Energy products	Intermediate consumption	Household consumption	Inventories			Total use of energy products
Energy residuals	Collection & treatment of energy residuals		Accumulation of energy residuals	Energy residuals sent to the rest of the world	Energy residual flows direct to environment	Total use of energy residuals

Use of energy

The supply table

The supply table is used for recording of all supplies of energy from natural inputs, energy products and energy residuals.

It shows which entities in the form of industries, households, accumulations (stocks), the rest of the world and the environment that supplies the energy

<u>SUPPLY TABLE</u>						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs		Supply of energy			Energy inputs from the environment	Total supply of energy from natural inputs
Energy products	Output			Imports		Total supply of energy products
Energy Residuals	<u>Energy residuals</u> generated by industry	<u>Energy residuals</u> generated by household consumption	Energy residuals from accumulation	Energy residuals received from the rest of the world	Energy residuals recovered from the environment	Total supply of energy residuals

The use table

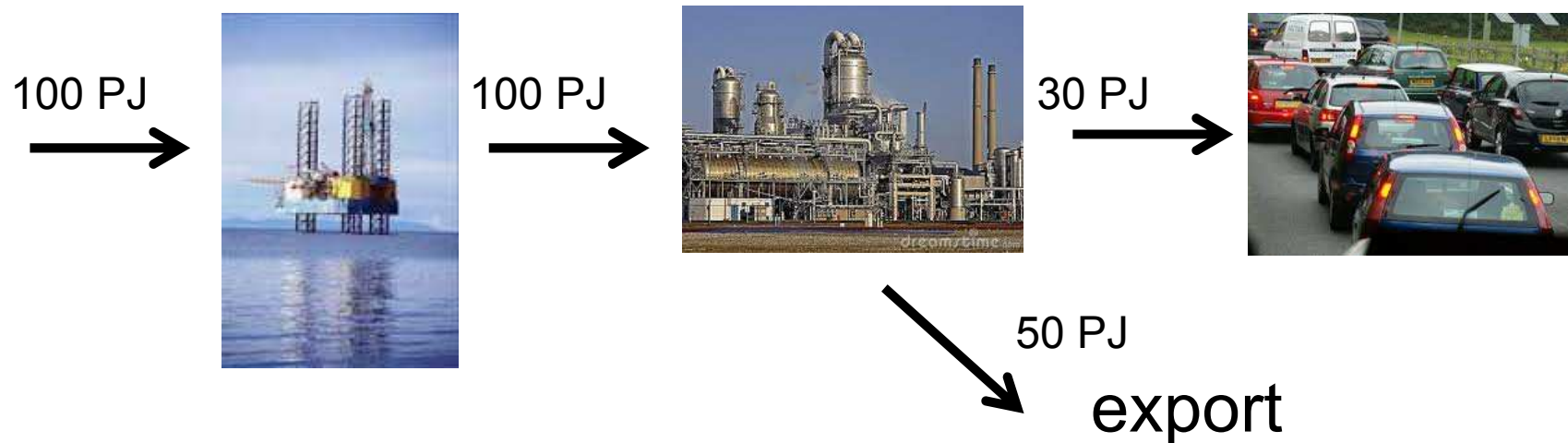
The use table is used for recording of all uses of energy from natural inputs, energy products and energy residuals

It shows which entities in the form of industries, households, accumulations (stocks), the rest of the world and the environment that uses or receives the energy

USE TABLE						
	Industries	Households	Accumulation	Rest of the World	Environment	Totals
Energy from natural inputs	Extraction of energy from natural inputs	Use of energy				Total use of energy from natural inputs
Energy products	Intermediate consumption	Household consumption	Changes in inventories	Exports		Total use of energy products
Energy residuals	Collection & treatment of energy residuals		Accumulation of energy residuals	Energy residuals sent to the rest of the world	Energy residual flows direct to environment	Total use of energy residuals

Example

- Mining of oil resources by mining industry (100 PJ)
- Supply of crude oil to refinery (100 PJ)
- Refining of crude oil → production of petrol (80 PJ)
- Export of petrol (50 PJ)
- Use of petrol by Households (30 PJ)



What can you do with the energy PSUTs ?

Key indicators

- Totals for the economy
- Energy intensities by industry
- Decoupling

Analysis

- Decomposition analysis
- Input for footprint analysis

Modelling and scenario analysis

Together with information on prices, the physical energy flow accounts provide the basis for **monetary energy flow accounts**



Summary of definitions and accounting structures

- Definitions, accounting structures and classifications in **SEEA Energy** are the same as in SEEA CF and the SNA
- A few energy specific concepts and classifications are also added from the **International Recommendation of Energy Statistics, IRES**
- The use of the **residence principle** instead of the territory principle distinguishes SEEA Energy from energy statistics and energy balances
- Three main groups of energy is recorded in SEEA Energy: **natural inputs, products and residuals**
- There are two main types of energy accounts: **Physical supply and use tables** for the recording of energy flows and **asset accounts** for the recording stocks and changes in them
- **Supply should always be equal to use** and the **closing stock should always be equal to the opening stock plus changes**
- If both **physical and monetary accounts** are set up, they can be combined due to their coherence
- For the physical accounts, the use of a common unit, e.g. **Joules**, is recommended by SEEA-Energy

Where do you find more information?

This module is based on **Chapter 2 The SEEA Energy Framework** in the SEEA-Energy publication. The publication can be downloaded from the UNSD website:

<http://unstats.un.org/unsd/envaccounting/seeae/>

Details on **SNA concepts and definitions** (residence principle, production, consumption accumulation, etc. can be found in SNA 2008 and in summary in SEEA CF:

<http://unstats.un.org/unsd/envaccounting/seearev/>

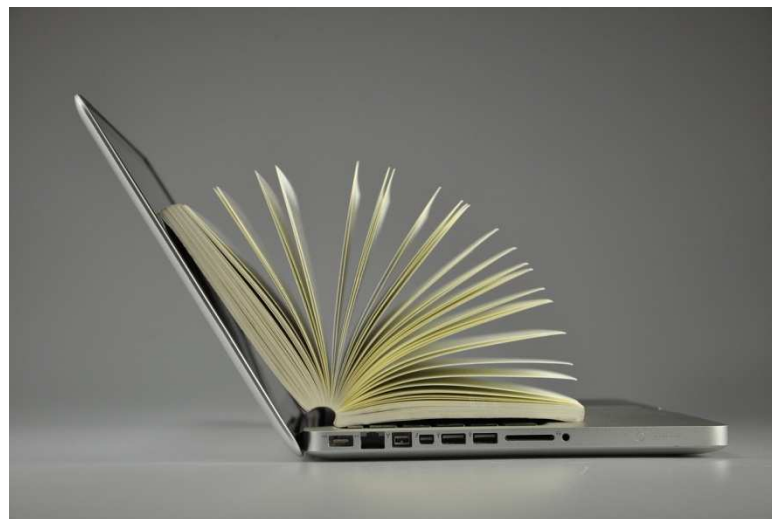
<http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf>

The UNSD website contains a registry of classifications. There you will find the **ISIC and CPC classifications**:

<http://unstats.un.org/unsd/class/default.asp>

The **SIEC classification** of energy products according to the International Recommendation of Energy Statistics, IRES, is found in the the IRES publication:

<http://unstats.un.org/unsd/energy/ires/>



Exercise – Construct a supply and use table for energy

The purpose of this exercise is to populate the simplified supply and use table for energy represented by the template *Physical Flows Energy Exercise Template.xlsx*.

- The National Geological Survey has estimated that that during the year 8 million tonnes of coal has been extracted from domestic deposits. However, after extraction 1 per cent of the coal was lost for various reasons.
- The coal is used domestically only for production of electricity from coal-fired power plants. However, during the year in focus 3 PJ of coal is put on stocks/inventories for use in subsequent years.
- Besides being produced by coal fired power plants electricity is produced by capturing energy from nature through solar panels and windmills. In total 36 PJ of electricity is captured in this way.
- According to the energy statistics the total output of electricity based on coal and renewable energy (solar and wind) is 165 PJ. All production of electricity is distributed to users via the grid owned by the electricity supply industry.
- Unfortunately, during the distribution of the electricity there are some transmission losses and thefts of electricity from the grid. In total these losses amount to 9 PJ.

- Based on the same energy statistics it can be assumed that 4 PJ of electricity is used by *Agriculture and forestry*, 5 PJ by the *Mining industry* and 77 PJ by *Other industries*. 46 PJ of electricity is exported and 24 PJ is used by households.
- A substantial amount, 20 PJ, of fuel wood is used by households. The fuel wood comes from the domestic environment. The felling activities, etc. involved in preparing the fuel wood are regarded as an economic activity carried out by the *Agriculture and forestry* industry.
- Gasoline is used for cars by all industries and households. The use is as follows. Agriculture and forestry: 15 PJ, Mining: 3 PJ, Electricity supply: 1 PJ, Other industries: 14 PJ, Households: 12 PJ. There is no domestic production of gasoline. However, 40 PJ of gasoline is imported from abroad this year. Further, there is some withdrawal of gasoline from inventories, since gasoline was stockpiled in previous years.

