Energy accounts
Physical flows and assets

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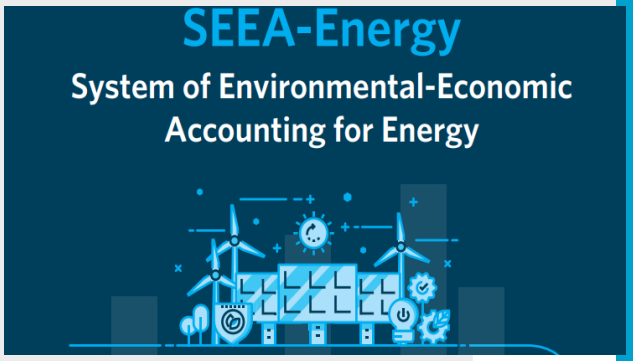
Content

- Introduction : what are the energy accounts
- Key principles of physical flow and energy accounting
- And some key principles for energy asset accounting
- Some examples from the Netherlands

SEEA Central Framework and SEEA energy

The **SEEA Central Framework (SEEA CF)** is the general framework, which deals with all kinds of environmental related flows and stocks

SEEA Energy is a "subsystem" to SEEA CF, which in details decribes how information for energy flows and stocks and changes of energy resources should be organised



Main types of SEEA-Energy accounts

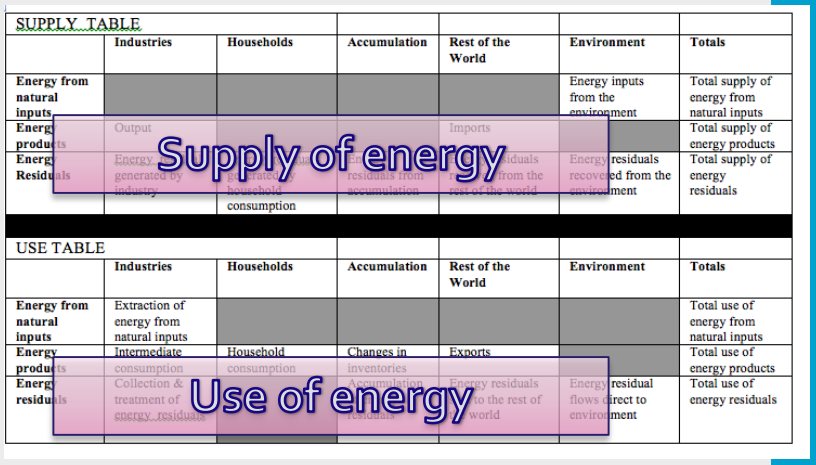
In SEEA Energy – like in SEEA Central Framework – there are basically two types of accounts and tables:

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	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 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	Changes in inventories	Exports		Total use of energy products
Energy residuals	Collection & treatment of energy residuals		Accumulation of residuals	Energy residuals flows to the rest of the world	Energy residual flows direct to environment	Total use of energy residuals

Use of energy

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

Energy asset account

What is physical flow accounting ?

Physical flow accounts describe the physical flows of water, energy, and materials between the economy and the environment and within the economy

→Air emissions, water emissions, solid waste

→Natural resource inputs (energy, water etc.)

→Material flows within the economy

Physical supply and use tables (PSUT) : structure based on monetary supply and use tables from SNA

What can you do with physical flow accounting ?

Monitoring for environmental-economic policies

- Organising framework for physical data
- Important indicators
- Decoupling environmental pressure - GDP

Input for analysis

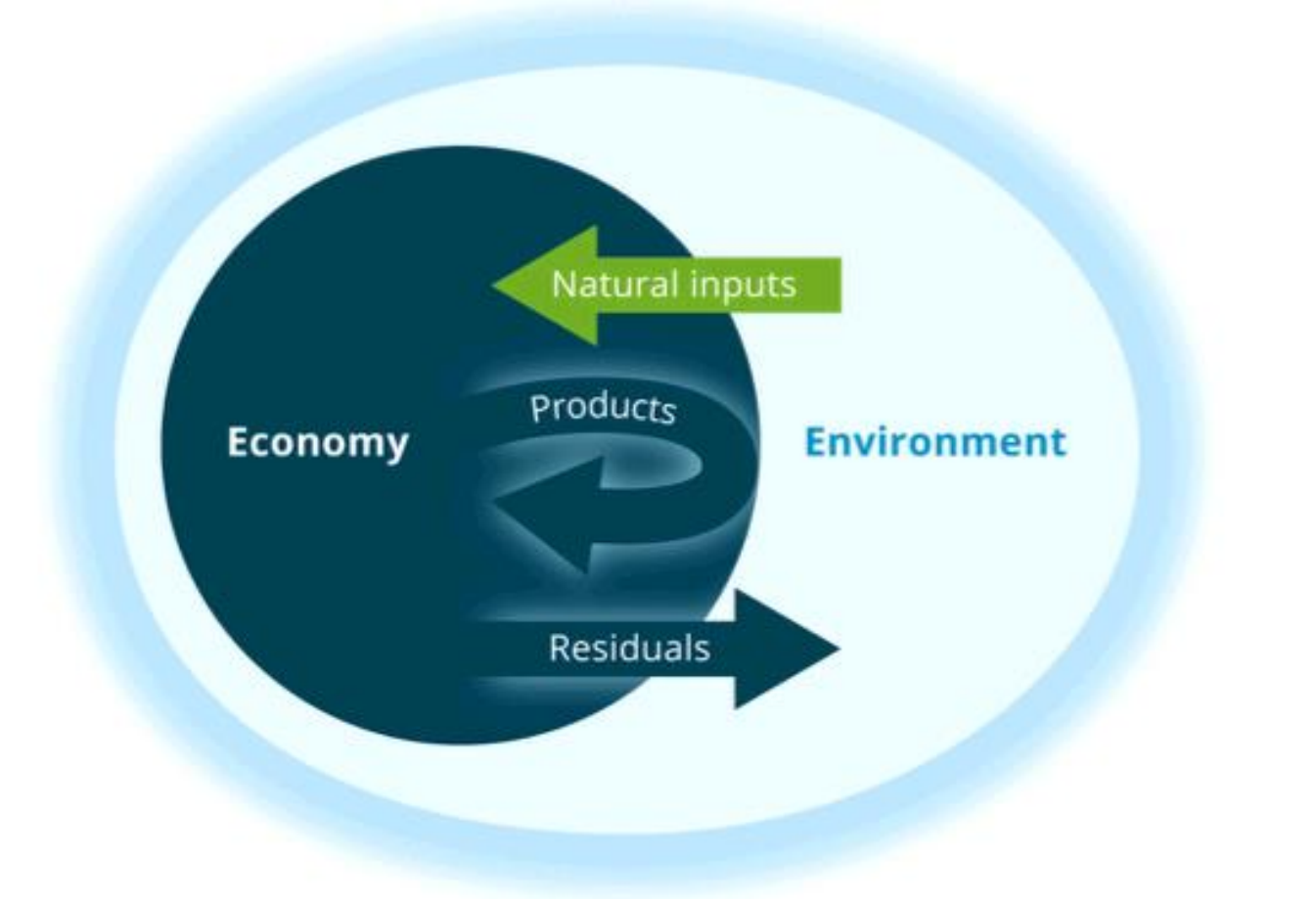
– Decomposition analysis
– Footprint calculations
– Comparison with economic data
– Input for scenario analysis

→ **INPUT FOR POLICY MAKING**

Three subsystems

1. **Energy (joules)**
2. **Water (cubic metres)**
3. **Materials (tonnes)**
   - → emissions to air
   - → emissions to water
   - → waste

Physical flows of natural inputs, products and residuals



Energy as *natural inputs, products and residuals*

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

N*atural 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 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 *t*hat are discarded, discharged or emitted by industries and households through processes of production, consumption or accumulation.

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

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	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

Use of energy

Accounting identities

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

1. Supply and use identity

Within the economy, the amount of a product supplied must also be used with the economy, most likely by a range of different economic units, or exported

Total supply of natural inputs = Total use of natural inputs
Total supply of products = Total use of products
Total supply of residuals = Total use of residuals

2. Input-output identity

Over an accounting period, flows of materials into an economy must equal the flows of materials out of an economy plus any net additions to stock in the economy

Total inputs = Total outputs

Example

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

Mining of oil resources

100 mln kg →

Supply		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Import	Environment	TOTAL
Natural inputs	Oil resources					100	100
	O2						0
Products	Crude oil						0
	Petrol						0
Residuals	CO2						0
TOTAL		0	0	0	0	100	100

Use		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Export	Environment	TOTAL
Natural inputs	Oil resources	100					100
	O2						0
Products	Crude oil						0
	Petrol						0
Residuals	CO2						0
TOTAL		100	0	0	0	0	100

Supply to refineries

100 mln kg →

Supply		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Import	Environment	TOTAL
Natural inputs	Oil resources					100	100
	O2						0
Products	Crude oil	100					100
	Petrol						0
Residuals	CO2						0
TOTAL		100	0	0	0	100	200

Use		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Export	Environment	TOTAL
Natural inputs	Oil resources	100					100
	O2						0
Products	Crude oil		100				100
	Petrol						0
Residuals	CO2						0
TOTAL		100	100	0	0	0	200

Production of petrol

30 mln kg

50 mln kg

export

Supply		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Import	Environment	TOTAL
Natural inputs	Oil resources					100	100
	O2						0
Products	Crude oil	100					100
	Petrol		80				80
Residuals	CO2						0
TOTAL		100	80	0	0	100	280

Use		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Export	Environment	TOTAL
Natural inputs	Oil resources	100					100
	O2						0
Products	Crude oil		100				100
	Petrol			30	50		80
Residuals	CO2						0
TOTAL		100	100	30	50	0	280

CO2 emissions by refineries

Supply		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Import	Environment	TOTAL
Natural inputs	Oil resources					100	100
	O2					60	60
Products	Crude oil	100					100
	Petrol		80				80
Residuals	CO2		80				80
TOTAL		100	160	0	0	160	420

Use		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Export	Environment	TOTAL
Natural inputs	Oil resources	100					100
	O2		60				60
Products	Crude oil		100				100
	Petrol			30	50		80
Residuals	CO2					80	80
TOTAL		100	160	30	50	80	420

$C + O_2 \rightarrow CO_2$

CO2 emissions by households

Supply		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Import	Environment	TOTAL
Natural inputs	Oil resources					100	100
	O2					150	150
Products	Crude oil	100					100
	Petrol		80				80
Residuals	CO2		80	120			200
TOTAL		100	160	120	0	250	630

Use		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Export	Environment	TOTAL
Natural inputs	Oil resources	100					100
	O2		60	90			150
Products	Crude oil		100				100
	Petrol			30	50		80
Residuals	CO2					200	200
TOTAL		100	160	120	50	200	630

$C + O_2 \rightarrow CO_2$

Check the accounting identities!

Supply		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Import	Environment	TOTAL
Natural inputs	Oil resources					100	100
	O2					150	150
Products	Crude oil	100					100
	Petrol		80				80
Residuals	CO2		80	120			200
TOTAL		100	160	120	0	250	630

Use		Mining (ISIC 6)	Refinery (ISIC 19)	Households	Export	Environment	TOTAL
Natural inputs	Oil resources	100					100
	O2		60	90			150
Products	Crude oil		100				100
	Petrol			30	50		80
Residuals	CO2					200	200
TOTAL		100	160	120	50	200	630

Asset accounts: overview

Asset accounts….

→Present stocks and flows of individual environmental assets in physical and monetary terms

→Record changes due to growth, extraction, catastrophic losses, revaluation etc.

→Valuation using market price concepts

What can you do with the asset accounts?

→Physical asset accounts are important tools for **assessment of the economic situation**

→Analysis of **national security, self-sufficiency and commercial conditions**

→Monitoring and management of **natural wealth**

Defining Economic Assets

- **Economic owner:**

  →The institutional unit entitled to claim the benefits associated with the use of an asset in an economic activity

- **Economic benefits**

  → Include operating surplus from sale of extracted resources, rent earned by allowing use of resources, receipts from sale of assets

- **Economic asset**

  → Store of value representing the benefit or series of benefits accruing to the owner by holding or using the asset over time

What are environmental assets ?

"Environmental assets are the **naturally occurring living and non-living components of the Earth**, together constituting the bio-physical environment, which may provide **benefits to humanity**"

Classification of environmental assets

1	**Mineral and energy resources**
1.1	Oil resources
1.2	Natural gas resources
1.3	Coal and peat resources
1.4	Non-metallic mineral resources (excluding coal and peat resources)
1.5	Metallic mineral resources
2	**Land**
3	**Soil resources**
4	**Timber resources**
4.1	Cultivated timber resources
4.2	Natural timber resources
5	**Aquatic resources**
5.1	Cultivated aquatic resources
5.2	Natural aquatic resources
6	**Other biological resources** (excluding timber resources and aquatic resources)
7	**Water resources**
7.1	Surface water
7.2	Groundwater
7.3	Soil water

Accounting structure: physical

Table 5.5.3 Physical asset account for mineral and energy resources (physical units*)

	Type of mineral and energy resource (Class A: Commercially recoverable resources)				
	Oil resources ('000 barrels)	Natural gas resources (m3)	Coal & peat resources ('000 tonnes)	Non-metallic minerals (tonnes)	Metallic minerals ('000 tonnes)
Opening stock of mineral and energy resources	800	1 200	600	150	60
Additions to stock					
Discoveries					20
Upwards reappraisals		200		40	
Reclassifications					
Total additions to stock		200		40	20
Reductions in stock					
Extractions	40	50	60	10	4
Catastrophic losses					
Downwards reappraisals			60		
Reclassifications					
Total reductions in stock	40	50	120	10	4
Closing stock of mineral and energy resources	760	1 350	480	180	76

* Different physical units (e.g. tonnes, cubic metres, barrels) will be used for different types of resources.

→***The basic identity*** (Opening stock + Changes = Closing stock) must always be fulfilled

Causes of change in stocks

Opening stock

\+ **Additions to stock**

- Discoveries
- Upwards reappraisals
- Reclassifications

Three items for additions/increases

\- **Reductions in stock**

- Extractions
- Catastrophic losses
- Downwards reappraisals
- Reclassifications

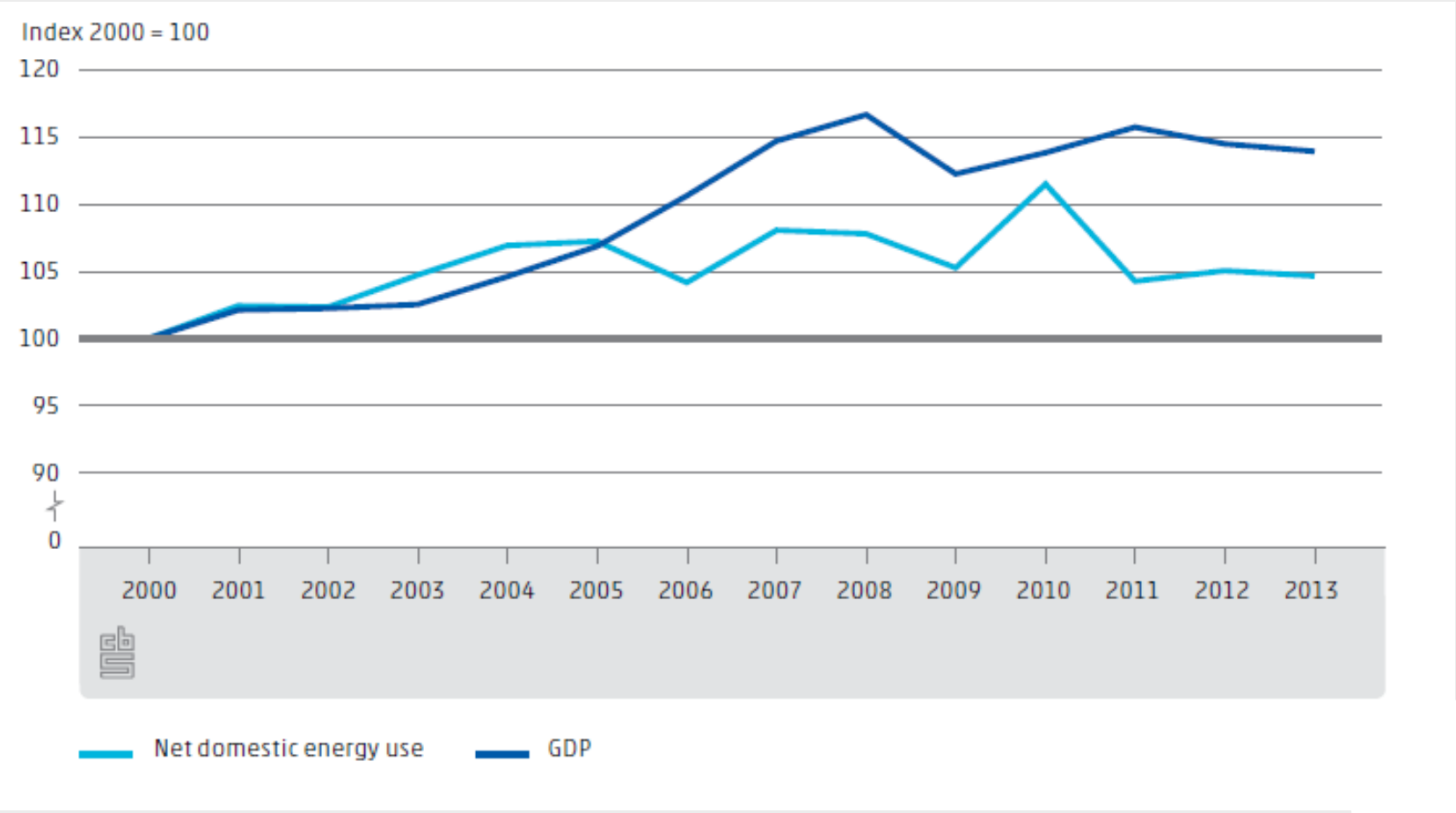
Four items for reductions/decreases

= Closing stock

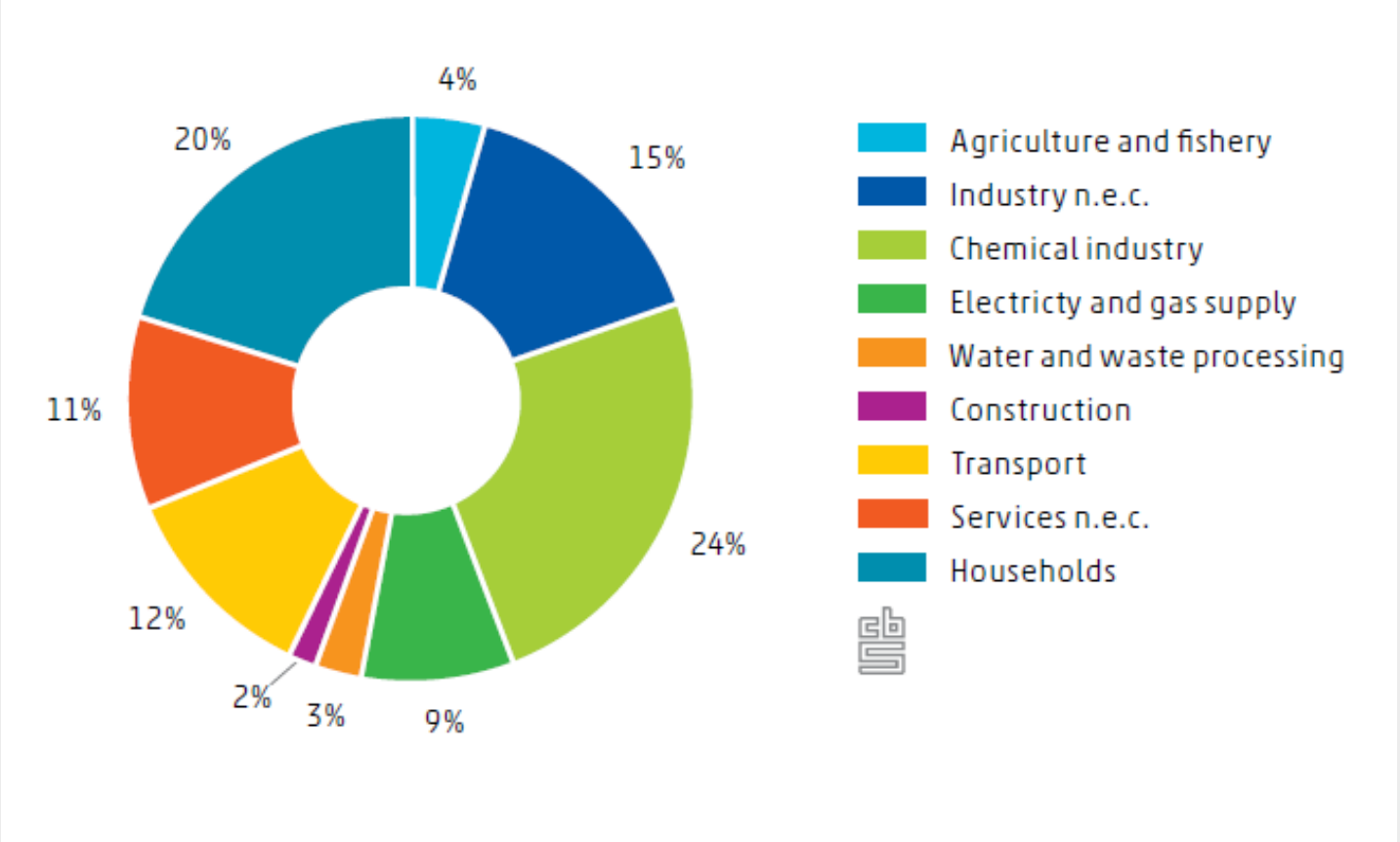
Examples from the Netherlands

- Energy flow accounts
- Energy asset accounts

Net domestic energy use and GDP



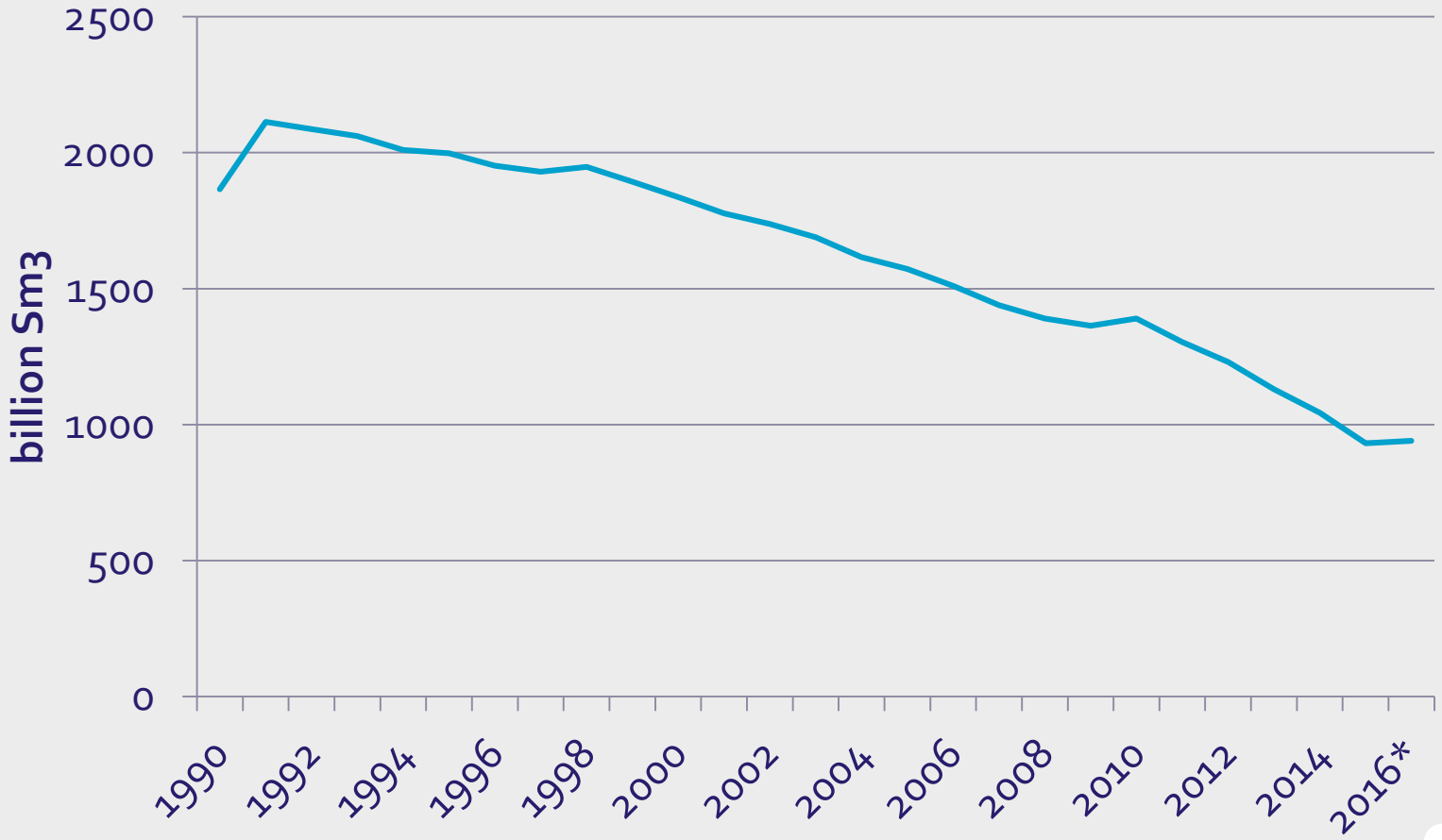
Net energy use in 2013 per sector



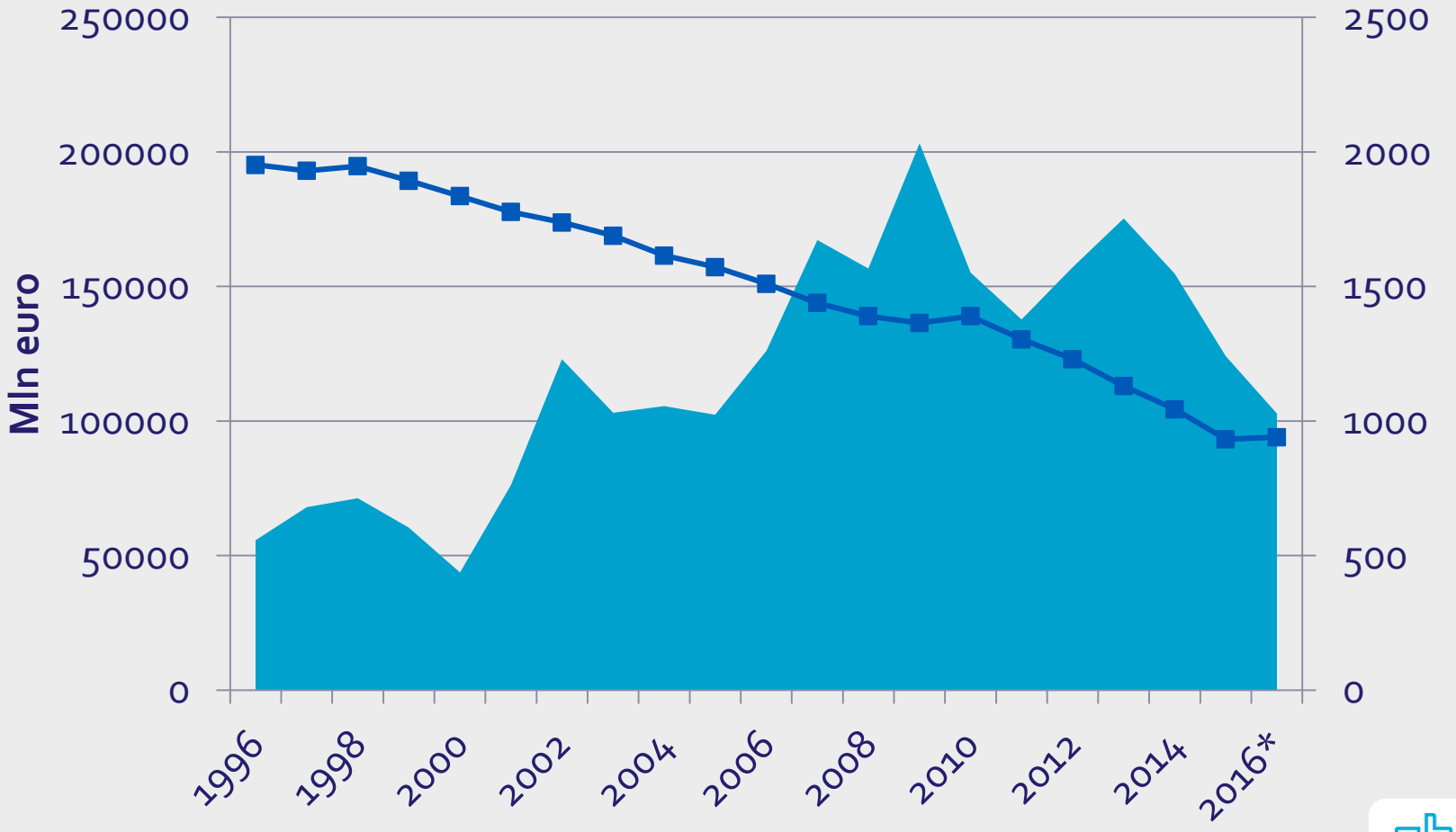
Example from the Netherlands: Natural gas reserves

Mld Sm3	2010	2011	2012	2013	2014	2015	2016
Opening stock	1390	1304	1230	1130	1044	932	940
Net change in stock (+):	-86	-74	-100	-86	-112	8	-95
New discoveries of natural gas (+)	5	6	4	0	2	1	1
Re-evaluation of discovered resources (+)	-5	-2	-25	-2	-46	60	-49
Gross Extraction (-)	-86	-79	-78	-84	-70	-52	-51
Underground storage of natural gas:	2	2	1	0	1	-1	-1
Other adjustments (= remainder)	-2	-2	-1	0	1	1	5
Net closing stock	1304	1230	1130	1044	932	940	846

Stock of natural gas in physical terms



Monetary stock of natural gas



Questions ???