System of Environmental Economic Accounting

SEEA-Energy

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Contents

- Introduction to SEEA-Energy
- Physical energy flow accounts (PEFA)
- Indicators/applications
- Exercise

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Introduction to SEEA-Energy

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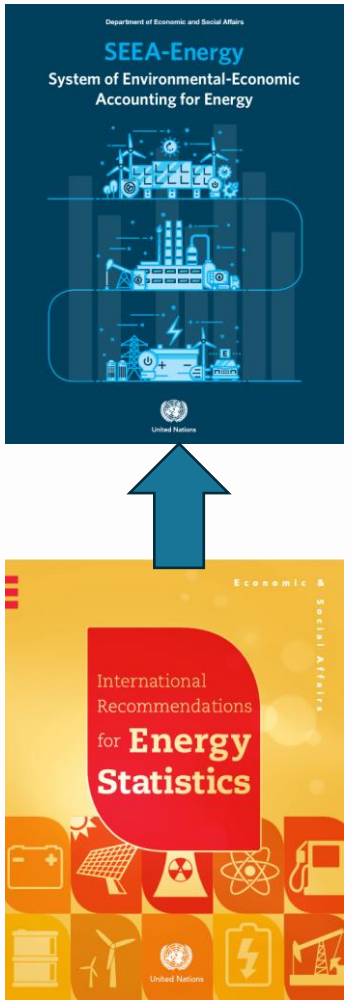
What is SEEA-Energy?

- Multi-purpose conceptual framework for organizing energy-related statistics, consistent with the SEEA Central Framework
- Draws upon and is consistent with the International Recommendations for Energy Statistics (IRES)
- Is NOT meant to replace energy statistics or balances, but rather to integrate an economic perspective to inform policy, e.g.
  - > What economic industries are putting pressures on non-renewable sources of energy, and how is this affecting the stocks of energy resources?
  - > How to best manage and price energy, given the types of energy users and the value added generated by these industries?
  - > Who/what industries could be taxed if we want to aim at reducing environmental pressures associated with energy supply and use?



Types of accounts in SEEA-Energy

- Physical flow accounts for energy
  - > Record flows of energy (a) from the environment to the economy, (b) within the economy and (c) from the economy back to the environment
- Monetary flow accounts for energy-related transactions
  - > Focus on energy products solely within the economy
- Physical asset accounts
  - > Stock (i.e. amount of the asset available) at the beginning and end of accounting period and changes in stocks
  - > Can estimate depletion/extraction of mineral and energy resources
- Monetary asset accounts
  - > Market prices; net present value is used to value resources in-situ
  - > Can help understand the relationship between rates of extraction and current economic activity, as well as the economic costs of extraction, as related to future incomes
- Focus of today is on physical accounts, in particular physical energy flow accounts

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Physical energy flow accounts

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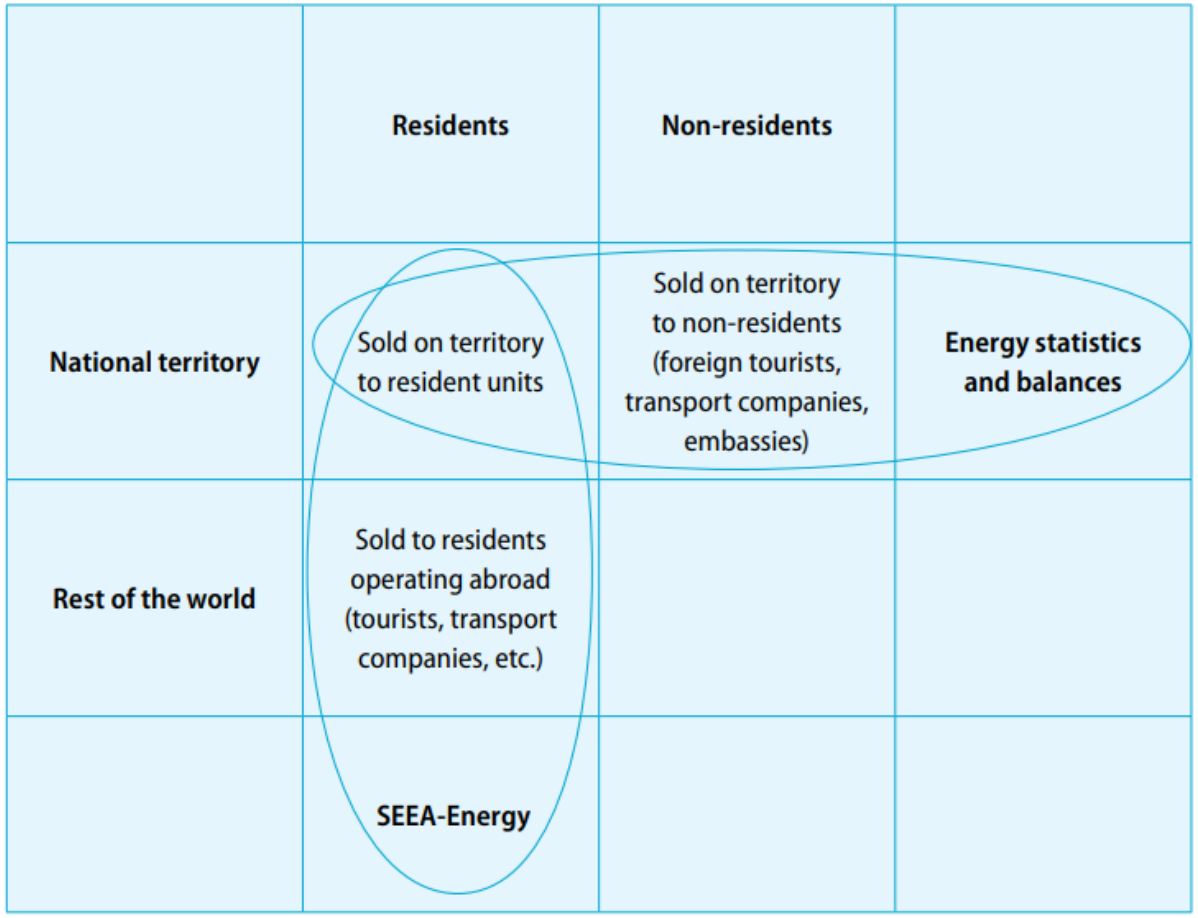
What are physical energy flow accounts?

- Form of supply and use tables
- Illustrates relationship between inputs to and outputs from energy transformation process
  - > Assess how an economy supplies and uses energy products
  - > Changes in production and consumption patterns over time

PEFA in context

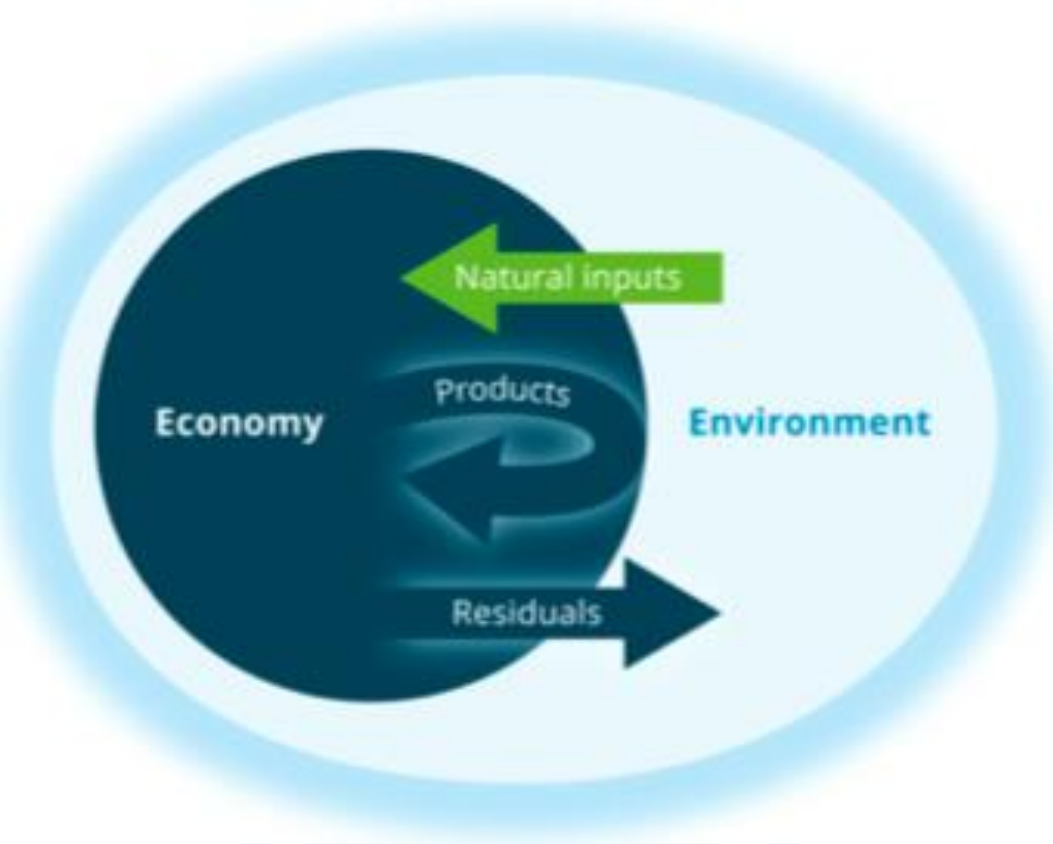
- Many countries have energy statistics and balances, which are then used to create the accounts
- Benefits of PEFA
  - > Coherence with SNA allows for economic analysis and expanded policy applications
  - > Can help improve data sources/quality
- Advantages of balances
  - > Provide information based on industries' energy use according to purpose (e.g. transport, auto-producers, heat, etc)
  - > Emphasis on energy sector, including description of technologies
  - > Territory principle is compatible with UNFCCC inventories

Scope of the economy in SEEA-Energy and PEFA



- The scope of SEEA-Energy covers the economic activity of resident units
- Resident of a country = institutional unit with centre of economic interest in the economic territory of a country
- Resident units can operate inside or outside of the national territory
- Use of residence principle is in contrast to energy statistics and balances

Flows of energy in PEFA



- Natural inputs
  - Energy resources in the environment which can be extracted/captured
- Energy products
  - Products exclusively or mainly used as a source of energy
  - Include fuels produced/generated, electricity and heat
- Energy residuals
  - Flows of energy that are discarded, discharged or emitted by establishments and households
  - Law of conservation of energy!

Structure of PEFA

Basic form of a physical supply and use table for energy (joules)

Supply table

	Industries	Households	Accumulation	Rest of the world	Environment	Total
Energy from natural inputs					A. Energy inputs from the environment	Total supply of energy from natural inputs
Energy products	C. Output			D. Imports		Total supply of energy products
Energy residuals	I. Energy residuals generated by industry	J. Energy residuals generated by household consumption	K. Energy residuals from accumulation	L. Energy residuals received from the rest of the world	M. Energy residuals recovered from the environment	Total supply of energy residuals

Use table

	Industries	Households	Accumulation	Rest of the world	Environment	Total
Energy from natural inputs	B. Extraction of energy from natural inputs					Total use of energy from natural inputs
Energy products	E. Intermediate consumption	F. Household consumption	G. Changes in inventories	H. Exports		Total use of energy products
Energy residuals	N. Collection and treatment of energy residuals		O. Accumulation of energy residuals	P. Energy residuals sent to the rest of the world	Q. Energy residual flows direct to environment	Total use of energy residuals

Note: Dark grey cells are null by definition.

Energy as natural inputs

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

N00	NATURAL ENERGY INPUTS
N01	Fossil non-renewable natural energy inputs
N02	Nuclear non-renewable natural energy inputs
N03	Hydro based renewable natural energy inputs
N04	Wind based renewable natural energy inputs
N05	Solar based renewable natural energy inputs
N06	Biomass based renewable natural energy inputs
N07	Other renewable natural energy inputs

- Classification of energy from natural inputs provides classification by type of resource and is based on the purpose of natural inputs
- Global PEFA questionnaire utilizes simplified classes used by Eurostat

Energy as 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 not elsewhere classified

P08	Hard coal
P09	Brown coal and peat
P10	Derived gases (= manufactured gases excl. biogas)
P11	Secondary coal products (coke, coal tar, patent fuel, BKB and peat products)
P12	Crude oil, NGL, and other hydrocarbons (excl. bio)
P13	Natural gas (without bio)
P14	Motor spirit (without bio)
P15	Kerosenes and jet fuels (without bio)
P16	Naphtha
P17	Transport diesel (without bio)
P18	Heating and other gasoil (without bio)
P19	Residual fuel oil
P20	Refinery gas, ethane and LPG
P21	Other petroleum products incl. additives/oxygenates and refinery feedstocks
P22	Nuclear fuel
P23	Wood, wood waste and other solid biomass, charcoal
P24	Liquid biofuels
P25	Biogas
P26	Electrical energy
P27	Heat

- SEEA-Energy uses IRES definition of energy product, primary energy products and secondary energy products
- Energy statistics usually classify products according to the Standard International Energy Product (SIEC) classification—can also be used for the SEEA
- Global PEFA questionnaire utilizes Eurostat energy product classes (P08-P27)
- If national accounts data is used (or if you want to do a monetary energy SUT), one will need to utilize a cross-walk

Quiz on primary/secondary energy products

- Q: Is a sawdust briquette that undergoes some processing, considered a primary or secondary energy product?

- A: Even though it undergoes some processing, **it is still considered a primary energy product**. It does not undergo transformation.

Primary energy products: energy is produced from the capture or extraction of fuels/energy from natural energy flows, the biosphere or natural reserves of fossil fuels in a form suitable for use.

Energy as residuals

- Energy losses as well as other energy residuals
- Energy residuals are grouped into five groups:
  - > Losses during extraction*
  - > Losses during distribution
  - > Losses during storage
  - > Losses during transformation
- Other energy residuals, primarily dissipative heat generated through the end use of energy products, e.g. fuel combustion for vehicles or electricity for heating
- Other residual flows
  - > Residuals from end use for non-energy purposes
  - > Energy from solid waste

*Compared to energy statistics/balances, they are not included in production

Supply

PHYSICAL SUPPLY TABLE (unit:PJ)	Production (incl. household own account) & generation of residuals								Accumula-tion	Flows from the rest of the World (Imports)	Flows from the environ-ment	TOTAL
	Industries (by ISIC)							Households				
	Agriculture Forestry & Fishery (ISIC A)	Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air condition-ing supply (ISIC D)	Transport-ation & Storage (ISIC H)	Other Industries	**Total Industry**					
1. Energy from natural inputs:												
Natural resource inputs											1166	1166
Inputs of energy from renewable sources											124	124
Other natural inputs											2	2
2. Energy Products:												
Production of energy products by SIEC class:												
Coal										225		225
Peat and peat products												
Oil shale / oil sands												
Natural gas		395		369			764					764
Oil		721	347				1068			930		1998
Biofuels	5			2			7					7
Waste	39		55				94			17		111
Electricity				212			212			22		234
Heat				79			79					79
Nuclear fuels and other fuels												
3. Energy Residuals:												
Total energy residuals	50	48	432	307	632	96	1565	240				1805
4. Other Residual Flows:												
Residuals from end-use for non-energy purposes			51									51
Energy from solid waste									94			94
5. TOTAL SUPPLY	94	1164	885	969	632	96	3840	240	94	1194	1292	6660

Use

PHYSICAL USE TABLE (unit: PJ)	Intermediate consumption, use of energy resources, receipt of energy losses							Final Consumption	Accumula-tion	Flows to the rest of the World (Exports)	Flows to the environ-ment	TOTAL
	Industries (by ISIC)							Households				
	Agriculture Forestry & Fishery (ISIC A)	Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air condition-ing supply (ISIC D)	Transport-ation & Storage (ISIC H)	Other Industries	**Total Industry**					
1. Energy from natural inputs:												
Natural resource inputs	5	1161										1166
Inputs of energy from renewable sources				124								124
Other natural inputs				2								2
2. Energy Products:												
Transformation of energy products by SIEC class:												
Coal				223			223					223
Peat and peat products												
Oil shale / oil sands												
Natural gas				482			482					482
Oil			360	16			376					376
Biofuels												
Waste				31			31					31
Electricity												
Heat												
Nuclear fuels and other fuels												
End-use of energy products by SIEC class:												
Coal	2		17				19	1	-21	2		1
Peat and peat products												
Oil shale / oil sands												
Natural gas	2		39			12	53	26	2	201		282
Oil	34	2	326		621	49	1032	102	-3	441		1572
Biofuels				2			2	5				7
Waste	3		4	37		1	45	33		1		79
Electricity	7	1	22	50	10	15	105	29		100		234
Heat	2		11	2	1	19	35	44				79
Nuclear fuels and other fuels												
End-use of energy products for non-energy purposes			51				51					51
3. Energy Residuals:												
Total energy residuals											1805	1805
4. Other residual flows:												
Residuals from end-use or non-energy purposes									51			51
Energy from solid waste	39		55									94
5. TOTAL USE	94	1164	885	969	632	96	3840	240	29	745	1805	6659

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Transformation and end use

- Use of energy products divided into two categories (two tables/sections that form “use” table in questionnaire)
- Transformation of energy products
  - > Records transformation of energy products into other energy products
- End use of energy products
  - > Use of energy products to produce goods and services that are not energy products
  - > Household consumption of energy

Accounting rules and principles

- Supply and use identity

Total supply of each product = output + imports

is equal to

Total use of each product= Intermediate consumption + final consumption + changes in inventories + exports

- Input-output identity: identity regarding flows between environment and economy

Total inputs into the economy = product inputs + resource inputs + imports

is equal to

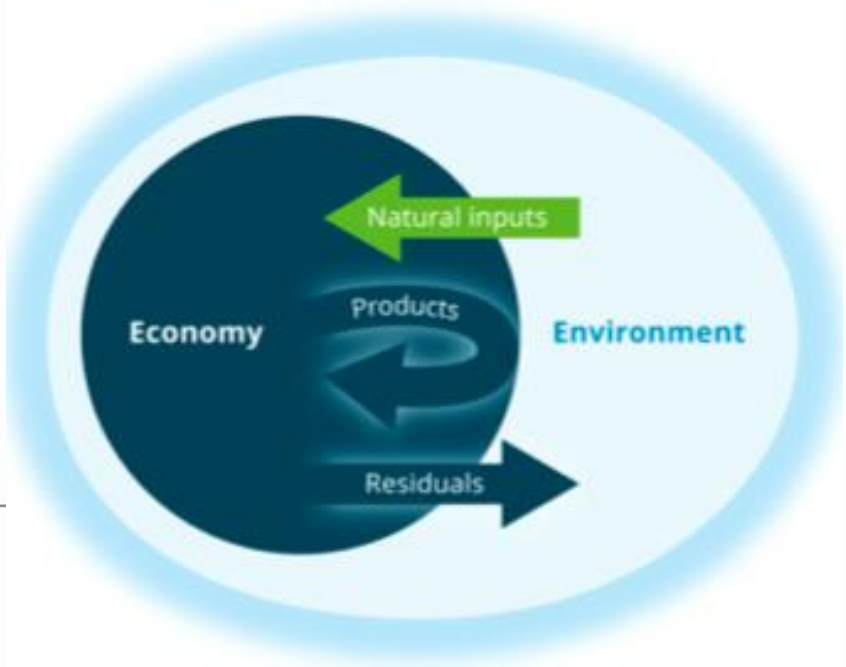
Total outputs from the economy = production outputs + residuals + net additions to stock + exports

Compilation of supply use tables – without balances

- Identify source data, usually from various places (basic energy statistics, trade data, electricity supply company, national accounts data, traffic and transport data, etc)
  - > Often requires close collaboration with Ministry of Energy, colleagues working on energy statistics
  - > Usually more data on supply than use
- Put the data into the accounting format
  - > Allocate supply and use to ISIC
- **Ensure common units (using net calorific value for energy products)– TJ**
- Make corrections for residence principle as necessary
- Ensure accounting identities are met
- Quality assurance

Compilation of supply use tables – a demo

- Extraction of crude oil by mining industry (1500 PJ) // Loss of 100 PJ during extraction
- Supply of crude oil to refinery (1400 PJ)
- Refining of crude oil to diesel (1200 PJ, 200 lost during transformation)
- Use of diesel by transport industry (600 PJ) and households (600 PJ)
- For each flow (environment→economy; economy<->economy; economy→environment), must record twice—once in supply, once in use
- Based on Statistics Netherlands example



Extraction of oil resources

- Extraction of crude oil by mining industry (1500 PJ)
- Environment supplies crude; crude is used/extracted by ISIC B

Supply		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Imports	Flows from Environment	Total
Natural inputs	Oil resources							1500	1500
	Crude								
Energy products	Petrol								
	Losses during extraction								
	Losses during transformation								
Residuals	Other energy residuals								
Total								1500	1500

Use		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Exports	Flows from Environment	Total
Natural inputs	Oil resources	1500							1500
	Crude								
Energy products	Petrol								
	Losses during extraction								
	Losses during transformation								
Residuals	Other energy residuals								
Total		1500							1500

From natural input to product

- 1400 PJ of crude is supplied to the refinery
- 100 is lost during extraction

Supply		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Imports	Flows from Environment	Total
Natural inputs	Oil resources							1500	1500
Energy products	Crude	1400							1400
	Petrol								
	Losses during extraction	100							100
	Losses during transformation								
Residuals	Other energy residuals								
Total		1500						1500	3000

Use		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Exports	Flows from Environment	Total
Natural inputs	Oil resources	1500							1500
Energy products	Crude		1400						1400
	Petrol								
	Losses during extraction							100	100
	Losses during transformation								
Residuals	Other energy residuals								
Total		1500	1400					100	3000

Supply and use of energy products

- Refinery refines all crude (1400PJ) into diesel, but 200 is lost during transformation
- Use of diesel by transport industry (600 PJ) and households (600 PJ)

Supply		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Imports	Flows from Environment	Total
Natural inputs	Oil resources							1500	1500
	Crude	1400							1400
Energy products	Petrol		1200						1200
	Losses during extraction	100							100
	Losses during transformation		200						200
Residuals	Other energy residuals								
Total		1500	1400					1500	4400

Use		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Exports	Flows from Environment	Total
Natural inputs	Oil resources	1500							1500
	Crude		1400						1400
Energy products	Petrol			600	600				1200
	Losses during extraction							100	100
	Losses during transformation							200	200
Residuals	Other energy residuals								
Total		1500	1400	600	600			300	3200

Residuals and balancing

- Need to record dissipative heat – 1200 used by ISIC H and HHs
- Supply now equals use for final total and row/column totals
- Note that we double record the energy content

Supply		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Imports	Flows from Environment	Total
Natural inputs	Oil resources							1500	1500
	Crude	1400							1400
Energy products	Petrol		1200						1200
	Losses during extraction	100							100
	Losses during transformation		200						200
Residuals	Other energy residuals			600	600				1200
Total		1500	1400	600	600			1500	4400

Use		ISIC B Mining	ISIC C Manufacturing	ISIC H Transportation	Households	Accumulation	Exports	Flows from Environment	Total
Natural inputs	Oil resources	1500							1500
	Crude		1400						1400
Energy products	Petrol			600	600				1200
	Losses during extraction							100	100
	Losses during transformation							200	200
Residuals	Other energy residuals							1200	1200
Total		1500	1400	600	600			1500	4400

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Indicators and applications

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Indicators and applications

- Indicators
  - > SDG target 7.3: By 2030, double the global rate of improvement in energy efficiency
    - Indicator 7.3.1: Energy intensity = energy use / value added
  - > Net domestic energy use: Energy no longer available to the economy (supply of energy residuals by production and household consumption activities, and accumulation of energy incorporated in products for non-energy purposes.
  - > The ratio of primary energy production to domestic end use
    - Values greater than 100 per cent = ability to meet domestic demand for energy
    - Values lower than 100 per cent indicate a dependence

Indicators and applications

- Decoupling GDP from energy use
  - > Growth rate of an environmental pressure is less than that of its economic driving force
  - > i.e. growth in energy use is less than that of GDP
- Calculation of air emission accounts