

Energy flow accounts

Workshop on Environment Statistics for East and
North-East Asian countries

13-15 March 2017



Outline

- **Scope of energy flow accounts**
- **Principles governing energy flow accounts**
- **The supply-use chain**



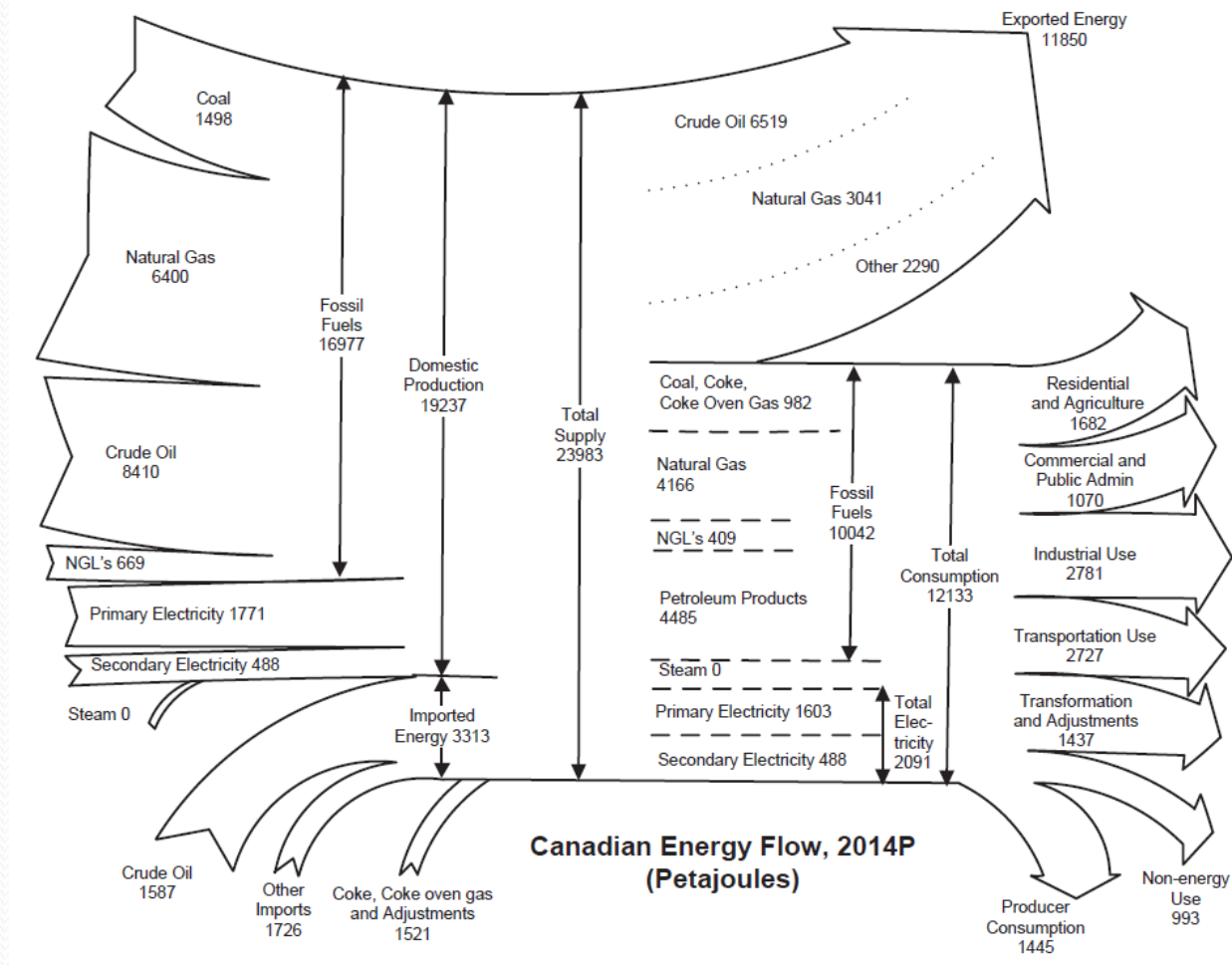
Energy in accounting

<p>SEEA-CF (Central Framework)</p>	<ul style="list-style-type: none"> • Assets • Physical flows • Monetary flows 	<ul style="list-style-type: none"> • Minerals & Energy, Land, Timber, Soil, Water, Aquatic, Other Biological • Materials, Energy, Water, Emissions, Effluents, Wastes • Protection expenditures, taxes & subsidies
<p>SEEA Water; SEEA Energy; SEEA Agriculture, Forestry and Fisheries</p>	<p>Add sector detail</p>	<p>As above for</p> <ul style="list-style-type: none"> • Water • Energy • Agricultural, Forestry and Fisheries
<p>SEEA-EEA (Experimental Ecosystem Accounting)</p>	<p>Adds spatial detail and ecosystem perspective</p>	<p>Extent, Condition, Ecosystem Services, Carbon, Water, Biodiversity</p>
<p>FDES (Framework for the Development of Environment Statistics)</p>	<p>Basic statistics for above plus...</p>	<ul style="list-style-type: none"> • Extreme events and disasters • Human settlements and health • Protection, management & engagement

Scope of energy flow accounts

- SEEA-CF 3.140...*record flows of energy, in physical units,*
 - *from the initial **extraction or capture** of energy resources from the environment into the economy;*
 - *the flows of energy **within the economy** in the form of the supply and use of energy by industries and households; and, finally,*
 - *the flows of energy **back to the environment.***

Energy flows



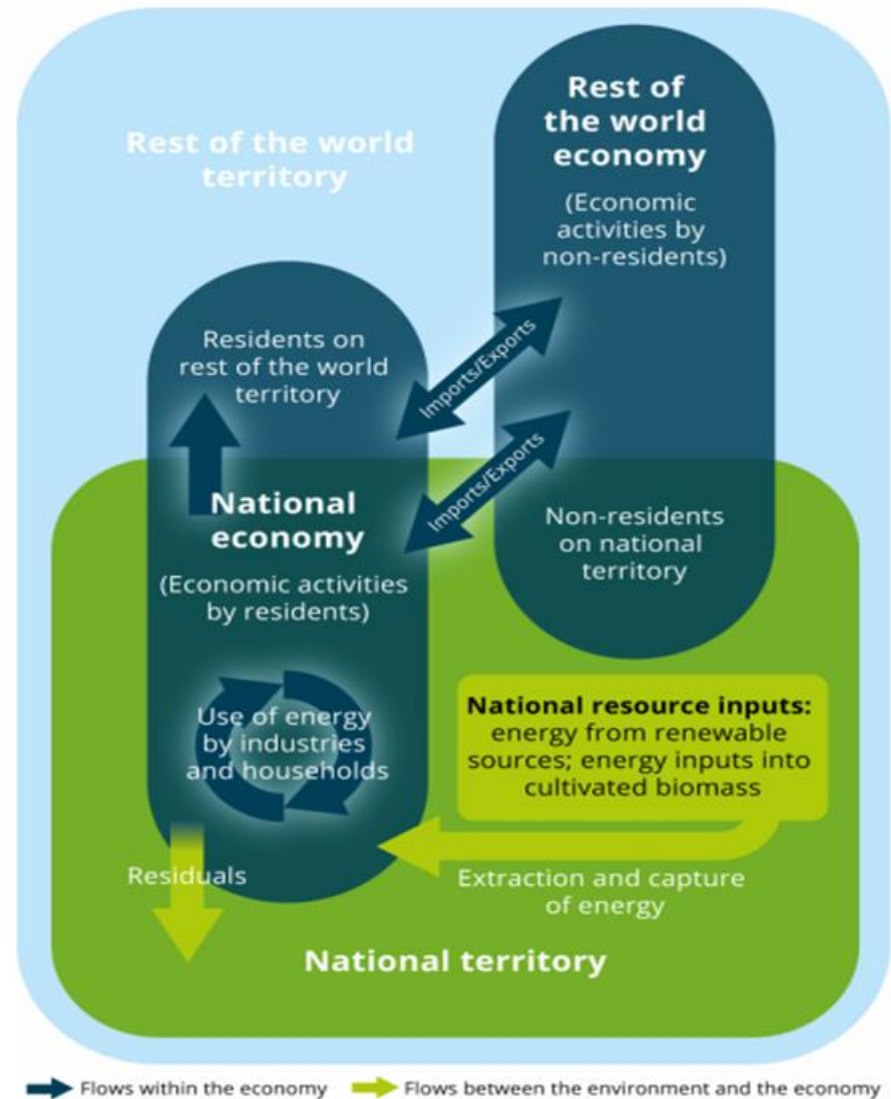
Statistics Canada. (2016). **Report on Energy Supply and Demand in Canada 2014 Preliminary**. Catalogue no. 57-003-X.

Which are energy flows?

- Carbon emissions from fossil fuel combustion
- Cutting trees for fuel wood
- Heating/cooling a home
- Installing solar panels
- Driving a car
- Buying mercury-free batteries
- Generating electricity from wind turbine
- Oil and gas reserves
- Fuel tax

Some principles

- Physical units (Joules)
- Residence principle (to align with SNA)
 - Residents of country regardless of location (e.g., energy products sold to residents)
- Energy balances:
 - Territorial principle
 - Different concept of “intermediary” and “final” consumption



The supply-use chain

Supply Table						
	Industries	Households	Accumulation	Rest of the world	Environment	Totals
Energy from natural inputs					Energy inputs from the environment	Supply of energy from natural inputs
Energy products	Output			Imports		Supply of energy products
Energy residuals	Generated by industry	Generated by households	From Accumulation	Received from rest of the world	Recovered from the environment	Supply of energy residuals
Use Table						
	Industries	Households	Accumulation	Rest of the world	Environment	Totals
Energy from natural inputs	Extraction, harvesting, capture					Use of energy from natural inputs
Energy products	Intermediate consumption	Household consumption	Change in inventories	Exports		Use of energy products
Energy residuals	Collection and treatment		Accumulation of energy residuals	Exports of energy residuals	Releases to the environment	Use of energy residuals

Some definitions

Energy inputs from the environment

Supply Table						
	Industries	Households	Accumulation	Rest of the world	Environment	Totals
Energy from natural inputs					Energy inputs from the environment	Supply of energy from natural inputs
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Energy residuals	Collection and treatment		Accumulation of energy residuals	Exports of energy residuals	Releases to the environment	Use of energy residuals

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

Conventional solid and liquid resources **extracted** and **harvested**

Renewable resources **captured**

Embedded in cultivated biomass **harvested**

Some definitions

Energy products

- Standard International Energy Product Classification (SIEC)
 - Countries may use others (CPC, HS)
- Useful to distinguish
 - Primary/secondary
 - Energy/non-energy uses

Standard International Energy Product Classification (SIEC)

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

Supply Table						
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Energy residuals	Collection and treatment		Accumulation of energy residuals	Exports of energy residuals	Releases to the environment	Use of energy residuals

Section/ Division/ Group	Class	Title	CPC link	HS Link
0		Coal		
01		Hard coal		
011	0110	Anthracite	11010*	2701.11
012		Bituminous coal		
	0121	Coking coal	11010*	2701.19
	0129	Other bituminous coal	11010*	2701.12
02		Brown coal		
021	0210	Sub-bituminous coal	11030*	2702.10*
022	0220	Lignite	11030*	2702.10*
03		Coal products		
031		Coal coke		
	0311	Coke oven coke	33100*	2704*
	0312	Gas coke	33100*	2704*
	0313	Coke breeze	33100*	2704*

Some definitions

Energy Residuals

- Losses during
 - Extraction
 - Distribution
 - Storage
 - Transformation
- Other energy residuals
 - Releases to the environment (lost heat) from energy consumption
- Note: Some non-energy residuals (emissions to air, CO₂, solid waste) can be calculated from energy accounts.

Supply Table						
	Industries	Households	Accumulation	Rest of the world	Environment	Totals
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Table 3.4

Typical components for groups of residuals

Group	Typical components
Solid waste (includes recovered materials) ^a	Chemical and health-care waste, radioactive waste, metallic waste, other recyclables, discarded equipment and vehicles, animal and vegetal wastes, mixed residential and commercial waste, mineral wastes and soil, combustion wastes, other wastes
Wastewater ^a	Water for treatment and disposal, return flows, reused water
Emissions to air	Carbon dioxide, methane, dinitrogen oxide, nitrous oxides, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide, ammonia, heavy metals, persistent organic pollutants, particulates (e.g., PM10 dust)
Emissions to water	Nitrogen compounds, phosphorus compounds, heavy metals, other substances and (organic) compounds
Emissions to soil	Leaks from pipelines, chemical spills
Residuals from dissipative use of products	Unabsorbed nutrients from fertilizers, salt spread on roads
Dissipative losses	Abrasion (tyres/brakes), erosion/corruption of infrastructure (roads, etc.)
Natural resource residuals	Mining overburden, felling residues, discarded catch

^a This list of typical components for groups of residuals can also be applied to certain flows defined as products.

Classifications

Industries

SEEA based on International Standard Industrial Classification (ISIC)

- Countries may use others

Significant energy industries

- Section A: Agriculture, forestry and fishing
- Section B: **Mining** and quarrying
- Section C: Manufacturing
- Section D: **Electricity**, gas, steam and air conditioning supply
- Section H: **Transportation** and storage
- Other industries
- Households

Supply Table						
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Group exercise

- Situation:
 - Have information on energy supply and use
 - Compile basic supply and use tables
- Groups of 3-5 (not alone!)
 - Put data into correct cells in handouts
 - Check totals
- Report on
 - Total supply of energy from natural inputs
 - Total energy supply
 - Total use of energy residuals
 - Total energy use

Physical supply table for energy						
	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows from the environment	Total
Energy from natural inputs						
Coal						
Solar						
Energy products						
Coal						
Electricity						
Heat						
Energy residuals						
Extraction						
Transformation						
Other						
Total						
Physical use table for energy						
	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows to the environment	Total
Energy from natural inputs						
Coal						
Solar						
Energy products						
Coal (Transformation)						
Electricity (End use)						
Heat (End use)						
Energy residuals						
Extraction						
Transformation						
Other						
Total						

Group exercise

A simplified physical supply and use table for energy:

1. The mining industry extracts **150 PJ** of coal.
2. In total, **60 PJ** of electricity are generated from solar panels,
 - **50 PJ** of which are produced by solar power industry and the rest by households.
3. All the coal is sent for processing to the coal power plant.
 - However, due to losses during extraction, the coal power plant received **140PJ** of coal.
4. The remaining supply of coal is converted to electricity and heat.
 - The coal power plant produces **75 PJ** of electricity and **35 PJ** of heat.
 - Losses during transformation account for the rest of the coal supply.
5. The resulting electricity from solar and coal is used as follows:
 - Mining **15 PJ**, manufacturing **20PJ**, Electricity **32 PJ** and with households consuming the rest of the electricity.
6. Households use **26PJ** of heat, electricity sector uses **2 PJ** and the rest is used by mining.

Group exercise – the answers

- Total supply of energy from natural inputs (**210 PJ**)
- Total energy supply (**730 PJ**)
- Total use of energy residuals (**210 PJ**)
- Total energy use (**730 PJ**)

Physical supply table for energy						
	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows from the environment	Total
Energy from natural inputs						
Coal					150	150
Solar					60	60
Energy products						
Coal	140					140
Electricity			135			135
Heat			35			35
Energy residuals						
Extraction	10					10
Transformation			30			30
Other	22	20	34	94		170
Total	172	20	234	94	210	730
Physical use table for energy						
	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows to the environment	Total
Energy from natural inputs						
Coal	150					150
Solar			60			60
Energy products						
Coal (Transformation)			140			140
Electricity (End use)	15	20	32	68		135
Heat (End use)	7		2	26		35
Energy residuals						
Extraction					10	10
Transformation					30	30
Other					170	170
Total	172	20	234	94	210	730

Group exercise – the answers

1. The mining industry extracts **150 PJ** of coal.
2. In total, 60 PJ of electricity are generated from solar panels,
 - 50 PJ of which are produced by solar power industry and the rest by households.

Household solar generation is in electricity industry

3. All the coal is sent for processing to the coal power plant.
 - However, due to losses during extraction, the coal power plant received 140PJ of coal.

Physical supply table for energy

	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows from the environment	Total
Energy from natural inputs						
Coal					150	150
Solar					60	60
Energy products						
Coal	140					140
Electricity			135			135
Heat			35			35
Energy residuals						
Extraction	10					10
Transformation			30			30
Other	22	20	34	94		170
Total	172	20	234	94	210	730

Physical use table for energy

	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows to the environment	Total
Energy from natural inputs						
Coal	150					150
Solar			60			60
Energy products						
Coal (Transformation)			140			140
Electricity (End use)	15	20	32	68		135
Heat (End use)	7		2	26		35
Energy residuals						
Extraction					10	10
Transformation					30	30
Other					170	170
Total	172	20	234	94	210	730

Group exercise – the answers

4. The remaining supply of coal is converted to electricity and heat.

- The coal power plant produces 75 PJ of electricity and 35 PJ of heat.
- Losses during transformation account for the **rest** of the coal supply. $(140 - 35 - 75 = 30)$

Total electricity supply (135 PJ)
= 75 PJ from coal + 60 PJ from solar

5. The resulting electricity from solar and coal is used as follows:

- Mining 15 PJ
- Manufacturing 20PJ
- Electricity 32 PJ and with
- Households consuming the **rest** of the electricity. $(68 PJ)$

Physical supply table for energy

	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Households	Flows from the environment	Total
Energy from natural inputs						
Coal					150	150
Solar					60	60
Energy products						
Coal	140		75+			140
Electricity			63			135
Heat			35			35
Energy residuals						
Extraction	10					10
Transformation			30			30
Other	22	20	34	94		170
Total	172	20	234	94	210	730

Physical use table for energy

	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Households	Flows to the environment	Total
Energy from natural inputs						
Coal	150					150
Solar			60			60
Energy products						
Coal (Transformation)			140			140
Electricity (End use)	15	20	32	68		135
Heat (End use)	7		2	26		35
Energy residuals						
Extraction					10	10
Transformation					30	30
Other					170	170
Total	172	20	234	94	210	730

Group exercise – the answers

6. Households use 26PJ of heat, electricity sector uses 2 PJ and the **rest (7PJ)** is used by mining.
7. “Other” residual is total end use

Check:

- Total supply of natural inputs = total use of natural inputs
- Total supply of energy products = total use of energy products
- Total supply of energy residuals = total use of energy residuals

Bonus question: What energy product is double-counted and why?

Physical supply table for energy

	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows from the environment	Total
Energy from natural inputs						
Coal					150	150
Solar					60	60
Energy products						
Coal	140					140
Electricity			135			135
Heat			35			35
Energy residuals						
Extraction	10					10
Transformation			30			30
Other	22	20	34	94		170
Total	172	20	234	94	210	730

Physical use table for energy

	Mining (ISIC B)	Manufacturing (ISIC C)	Electricity (ICIC D)	Housholds	Flows to the environment	Total
Energy from natural inputs						
Coal	150					150
Solar			60			60
Energy products						
Coal (Transformation)			140			140
Electricity (End use)	15	20	32	68		135
Heat (End use)	7		2	26		35
Energy residuals						
Extraction					10	10
Transformation					30	30
Other					170	170
Total	172	20	234	94	210	730

Energy supply in the SEEA

Physical supply table for energy

	Production (including household production on own account); generation of residuals							Flows from the rest of the world		Total supply
	Agriculture, forestry and fishing ISIC A	Mining and quarrying ISIC B	Manufacturing ISIC C	Electricity, gas, steam and air conditioning supply ISIC D	Transportation and storage ISIC H	Other industries	Households	Imports	Flows from the environment	
Energy from natural inputs										
Natural resource inputs										
Mineral and energy resources									1 161.0	1 161.0
Timber resources									5.0	5.0
Inputs of energy from renewable sources										
Solar									20.0	20.0
Hydro									100.0	100.0
Wind									4.0	4.0
Wave and tidal										
Geothermal										
Other heat and electrical										
Other natural inputs										
Energy inputs to cultivated biomass									2.0	2.0
Total energy from natural inputs									1 292.0	1 292.0
Energy products										
Production of energy products by SIEC class										
Coal									225.0	225.0
Peat and peat products										
Oil shale/oil sands										
Natural gas (extracted)		395.0								395.0
Natural gas (distributed)				369.1						369.1
Oil (e.g., conventional crude oil)		721.0								721.0
Oil (oil products)			347.0					930.0		1 277.0
Biofuels	5.3		0.2	1.5						7.0
Waste	39.0		54.5					16.9		110.4
Electricity				212.0				22.0		234.0
Heat				78.5						78.5
Nuclear fuels and other fuels n.e.c.										
Total energy products	44.3	1 116.0	401.7	661.1				1 193.9		3 417.0
Energy residuals										
Losses during extraction		45.0								45.0
Losses during distribution				12.0						12.0
Losses during storage			6.0							6.0
Losses during transformation			7.0	204.4						211.4
Other energy residuals	50.3	3.2	418.7	90.6	632.0	96.0	240.0			1 530.8
Total energy residuals	50.3	48.2	431.7	307.0	632.0	96.0	240.0			1 805.2
Other residual flows										
Residuals from end use for non-energy purposes			51.0							51.0
Energy from solid waste							93.5			93.5
Total supply	94.6	1 164.2	884.4	968.1	632.0	96.0	240.0	93.5	1 193.9	1 292.0

Energy from natural inputs

Energy products

Residuals & other flows

Energy use in the SEEA

Physical use table for energy

	Intermediate consumption; use of energy resources; receipt of energy losses						Final consumption		Flows to the rest of the world		Total use
	Agriculture, forestry and fishing ISIC A	Mining and quarrying ISIC B	Manufacturing ISIC C	Electricity, gas, steam and air conditioning supply ISIC D	Transportation and storage ISIC H	Other industries	Households	Accumulation	Exports	Flows to the environment	
Energy from natural inputs											
Natural resource inputs	5.0	1 161.0									1 166.0
Inputs of energy from renewable sources				124.0							124.0
Other natural inputs	0.3		0.2	1.5							2.0
Total energy from natural inputs	5.3	1 161.0	0.2	225.5							1 292.0
Energy products											
Transformation of energy products by SIEC class											
Coal				223.0							223.0
Peat and peat products											
Oil shale/oil sands											
Natural gas (extracted)				395.0							395.0
Natural gas (distributed)				87.0							87.0
Oil (e.g., conventional crude oil)			360.0								360.0
Oil (oil products)				16.0							16.0
Biofuels											
Waste				31.0							31.0
Electricity											
Heat											
Nuclear fuels and other fuels n.e.c.											
Total transformation of energy products			360.0	752.0							1 112.0
End-use of energy products by SIEC class											
Coal	2.0	0.1	17.0				1.0	-21.0	1.9		1.0
Peat and peat products											
Oil shale/oil sands											
Natural gas (extracted)											
Natural gas (distributed)	2.0		39.0	0.1		12.0	26.0	2.0	201.0		282.1
Oil (e.g. conventional crude oil)									361.0		361.0
Oil (oil products)	34.0	2.0	326.0		621.0	49.0	102.0	-3.0	80.0		1 211.0
Biofuels	0.3		0.2	1.5			5.0				7.0
Waste	3.0	0.1	4.0	37.0		1.0	33.0	0.3	1.0		79.4
Electricity	7.0	1.0	22.0	50.0	10.0	15.0	29.0		100.0		234.0
Heat	2.0		10.5	2.0	1.0	19.0	44.0				78.5
Nuclear fuels and other fuels n.e.c.											0.0
Total end-use for energy purposes	50.3	3.2	418.7	90.6	632.0	96.0	240.0	-21.7	744.9		2 254.0
End-use of energy products for non-energy purposes			51.0								51.0
Energy residuals											
Losses during extraction										45.0	45.0
Losses during distribution										12.0	12.0
Losses during storage										6.0	6.0
Losses during transformation										211.4	211.4
Other energy residuals										1 530.8	1 530.8
Total energy residuals										1 805.2	1 805.2
Other residual flows											
Residuals from end use for non-energy purposes									51.0		51.0
Energy from solid waste	39.0		54.5								93.5
Total use	94.0	1 164.2	884.4	908.1	632.0	96.0	240.0	-21.7	744.9	1 805.2	6 038.7

Energy from natural inputs

Energy products Transformation & End-Use

Residuals & other flows

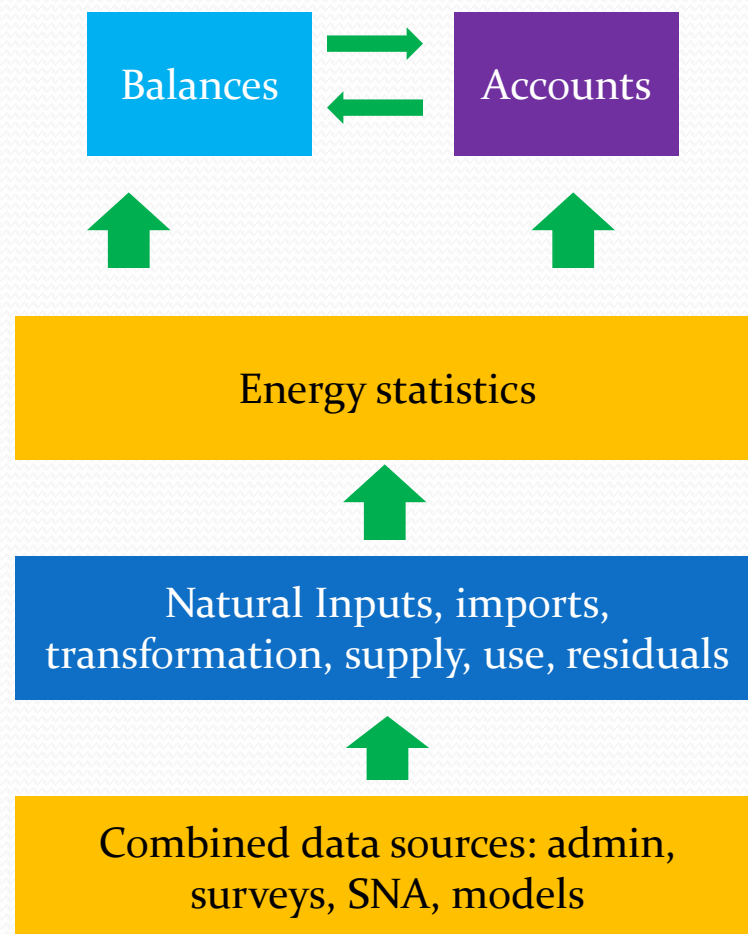
A note on energy balances

Use the same data

- Different approaches and classifications

Suggestion

- NSO, Energy & Environment departments collaborate
- Build common core disaggregated database



Simplifications & Extensions

- Simplifications
 - Supply & use of electricity, renewables or fossil fuels
- Extensions
 - Monetary supply and use for energy (currency units)
 - Calculating air emissions from fossil fuel consumption
 - Apply “factors” to consumption → CO₂, SO_x, solids, ...
 - Allocation to “types” of households
 - Energy for all? Could disaggregate with survey.