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Physical input-output tables (PIOT) -approach

Study visit of Israeli Central Bureau of Statistics
25 – 27 August 2014

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- Physical input-output (PIOT) and supply-use in the SEEA
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UN mission on environmental accounting

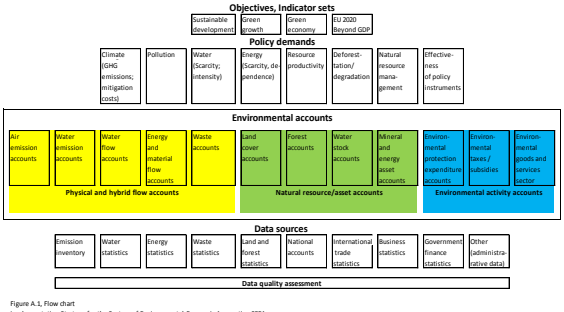

Figure A.1, Flow chart
Implementation Strategy for the System of Environmental-Economic Accounting SEEA
Prepared by the Committee of Experts on Environmental-Economic Accounting

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Minimum required, recommended and desired SEEA datasets (draft)

	1 (minimum	2 (recomm	3 (desired)	Key aggregates
Physical flow accounts				
Full set of supply and use tables for materials			x	
E-W material flow accounts (materials use)		x		Domestic material consumption
PSUTs for water (water use)	x			Total water consumption
PSUTs for energy (energy use)	x			Total net energy consumption
Air emissions accounts	x			Net emissions to air
Water emissions accounts		x		Net emissions to water
Waste accounts		x		Net emissions
Monetary flow acocunts				
Environmental Protection expenditure Accounts	x			Total environmental protection expenditure
Resorce Use and Management Expenditure Accounts		x		Total resource management expenditure
Environmental goods and Services Sector		x		EGSS: total value added and employment
Environmentally related payments to government	x			Total environmental taxes
Environmentally related payments by government		x		Total environmentally motivated subsidies
Emission permits	x			
Permits and licences to use environmental assets			x	
Costs related to termination of fixed assets			x	
Asset accounts				Depletion (in physical and monetary terms)
Mineral and energy resources	x			
Land (forest)	x			
Soil resources			x	
Timber resources		x		
Fish resources		x		
Other biological resources			x	
Water resources			x	

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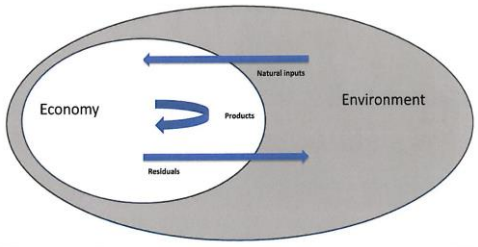
Flows between the economy and the environment

Figure 2.2.1 Physical flows of natural inputs, products and residuals



System of Environmental-Economic Accounting Central Framework 5

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Flows between the economy and the environment

- Natural inputs:
  material, air, water, space, light, heat, wind, other flows
- Products in the economy:
  raw materials, intermediate products, final products (e.g. by CPC)
- Residuals:
  waste, emissions into air, emissions into water,
  residuals from dissipative use of products, dissipative losses,
  natural resource residuals

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Stocks and flows in environmental accounting

Stocks 1.1. and 31.12.
Changes in stocks

- Mineral and energy resources: metals, other minerals, oil, gas, coal, peat
- Land (space)
- Soil
- Timber: cultivated, natural
- Aquatic resources: cultivated, natural
- Other biological resources
- Water: surface, ground, soil water

- Growth, discoveries
- Extraction, natural losses, catasrophes
- Reappraisals, revaluations

Flows, supply and use 1.1.– 31.12.
By industry and by material

- Natural inputs: material, air, water, space, light, heat, wind, other flows
- Products in the economy: raw materials, intermediate products, final products
- Residuals: waste, emissions into air, emissions into water, dissipative residuals and losses, natural resource residuals

- Environmental expenditures,
- Environmental goods and services
- Environmental taxes and transfers
- Env. licences, emission trade

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SEEA CF: Supply and Use Table

Table 2.3.2 Basic form of a Physical Supply and Use Table*

SUPPLY TABLE						
	Industries	**Households**	**Accumulation**	**Rest of the World**	**Environment**	**Totals**
Natural inputs					Flows from the environment	Total supply of natural inputs
Products	Output			Imports		Total supply of products
Residuals	Residuals generated by industry	Residuals generated by household final consumption	Residuals from scrapping and demolition of produced assets			Total supply of residuals
USE TABLE						
	Industries	**Households**	**Accumulation**	**Rest of the World**	**Environment**	**Totals**
Natural inputs	Extraction of natural inputs					Total use of natural inputs
Products	Intermediate consumption	Household final consumption	Gross Capital Formation	Exports		Total use of products
Residuals	Collection & treatment of waste and other residuals		Accumulation of waste in controlled landfill sites		Residual flows direct to environment	Total use of residuals

* Note: Grey cells are null by definition. Blank cells may contain relevant flows. These flows are explained in detail in Chapter 3.

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Economy-wide material flow accounts

Inputs (origin)	Economic activities by NACE	Outputs (destination)
Domestic extraction Plants, game, fish Wood Energyminerals Metallic minerals Industrial minerals Sand and gravel Other earth materials for construction	Agriculture and fishery Forestry Mining and quarrying Food and beverage industry Wood and paper industry Oil refinery and chemical industry Metal industry Other industries Energy supply Water supply and waste management Construction Trade Land transport Water transport Air transport Serveces related to transport Other services and goverment Households	**Exports** Raw materials Other commodities **Emissions to air** CO_2, N_2O, NO_x, NH_3, HFC, PFC, CO, NMVOC, SO_2, PM10, ... **Solid waste to landfils** mineral, mixed, chemical, organic, ... **Emissions to water** **Net additions to stocks** **Dissipative use of materials** **Dissipative losses** **Balancing items** H_2O and CO_2 from combustion, respiration
Imports Raw materials Other commodities		
Balancing items O_2 and N for combustion, respiration etc.		

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Main groups of the material flows in physical flow accounts

- From environment to environment
  - unused extraction
- From environment to the economy
  - raw materials
  - air
  - water
- From economy to economy
  - products
  - residuals
  - net accumulation
- From economy to the environment
  - emissions into the air
  - water vapour
  - discharges into water
  - dissipation

  - indirect inputs of imports

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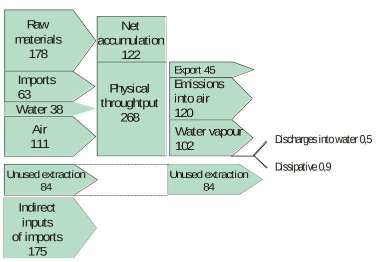
Total material balance, Finland 1999, million tonnes



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PIOT + E-W MFA

Summary of the physical flow accounts by branches of industry, Finland 2002 Million kg (11.1.2006/im)	INPUTS							OUTPUTS									TOTAL		
	From domestic nature				From RoW	Domestic		To use of domestic economy			To RoW	To domestic nature							
Industries	Unused extraction	Raw materials	Water	Air (O, N)	Import	Domestic products	Final waste	Products	Final waste	Net accumulation	Exports	Emissions into air	Water vapour	Dischrges into water	Dissipative use	Unused extraction	INPUT	OUTPUT	I (-) O
1 Agriculture and fishing	0	477	33 316	25 423	1 102	39 460	0	41 655	197	0	652	23 600	33 577	184	0	0	99 777	99 864	88
2 Forestry, logging etc	21 227	50 191	0	348	102	31	0	49 785	0	0	388	335	118	19	15	21 227	71 900	71 887	-13
3 Mining of energy minerals	436	9 448	0	329	4	176	0	9 069	0	0	107	601	2	5	0	436	10 393	10 221	-172
4 Other mining and quarrying	8 437	90 760	0	199	62	28	0	78 269	11 196	0	1 735	188	70	1	0	8 437	99 486	99 895	409
5 Manufacture of food products	0	0	904	479	1 421	8 207	0	7 530	110	0	770	508	2 196	1	0	0	11 010	11 116	106
6 Manuf of textiles etc	0	0	4	108	92	51	0	38	10	0	73	96	48	0	0	0	255	265	10
7 Manuf of wood & wood products	0	0	0	2 522	5 137	24 050	0	15 298	73	0	5 638	2 850	8 163	1	0	0	31 709	32 023	315
8 Manuf of pulp, paper, paper prod	0	0	9	17 612	14 043	53 418	0	21 202	1 289	0	14 269	22 647	25 657	209	0	0	85 083	85 273	191
9 Publishing, printing etc	0	0	37	78	60	593	0	461	58	0	149	78	63	0	0	0	768	810	42
10 Manuf of coke and petroleum ref.	0	0	16	2 995	12 774	595	0	7 553	30	0	4 964	2 800	1 027	1	0	0	16 380	16 376	-4
11 Manufacture of chemicals etc	0	0	1 607	5 420	3 338	4 326	0	7 029	2 354	0	3 327	1 291	767	5	0	0	14 690	14 773	82
12 Manuf of rubber and plastic prod	0	0	0	79	300	306	0	316	23	0	269	73	52	0	0	0	685	734	48
13 Manuf of non-met mineral prod	2 308	5 870	485	986	2 177	6 366	0	12 616	176	0	560	1 979	693	0	0	2 308	18 193	18 331	139
14 Manufacture of basic metals	0	65	56	3 710	8 156	8 189	0	8 026	1 219	0	3 999	5 627	1 302	1	0	0	20 175	20 175	0
15 Manuf of metal products	0	0	4	149	470	502	0	542	54	0	327	150	63	0	0	0	1 125	1 136	11
16 Manuf of machinery and equipm	0	0	1	175	625	346	0	381	105	0	442	192	66	0	0	0	1 147	1 185	38
17 Manuf of electrical equipment	0	0	9	43	252	162	0	161	57	0	247	46	20	0	0	0	466	531	65
18 Manuf of transport equipment	0	0	0	91	139	157	0	30	46	0	250	98	33	0	0	0	387	456	69
19 Manufacturing n.e.c.	0	0	0	40	94	174	0	167	7	0	96	43	47	0	0	0	308	360	52
20 Recycling	0	0	31	8	20	1 434	211	1 456	222	0	16	7	3	0	0	0	1 703	1 703	0
21 Electricity, gas & water supply	0	0	2	27 845	7 122	12 081	0	574	581	0	2	30 778	14 975	1	0	0	47 049	46 911	-138
22 Building	6 000	0	0	934	1 058	21 612	0	19 969	1 932	0	0	1 369	332	0	0	6 000	29 603	29 603	0
23 Civil engineering	18 000	15 760	0	708	618	67 875	0	79 789	3 862	0	0	1 070	241	0	0	18 000	102 961	102 961	0
24 Wholesale and retail trade etc	0	0	0	1 339	191	585	0	0	359	0	0	1 246	509	0	0	0	2 114	2 114	0
25 Hotels and restaurants	0	0	0	114	129	583	0	565	104	0	0	109	48	0	0	0	826	826	0
26 Transport and coomunication	0	0	0	11 614	1 378	2 775	0	0	52	0	0	10 962	4 076	0	677	0	15 767	15 767	0
27 Dwellings	0	0	0	683	192	21	0	0	2	0	0	633	261	0	0	0	896	896	0
28 Public administration and services	0	0	0	688	247	395	0	0	202	0	0	820	279	0	30	0	1 330	1 330	0
29 Sewage, refuse disposal; sanitation	0	0	0	113	4	36	6 025	4 951	755	0	135	250	34	53	0	0	6 178	6 178	0
30 Other service activities	0	0	0	350	175	195	0	0	208	0	0	349	134	0	30	0	721	721	0
Production activities, total	**56 408**	**172 571**	**36 480**	**105 182**	**61 480**	**254 727**	**6 236**	**367 432**	**25 283**	**0**	**38 415**	**110 794**	**94 857**	**480**	**752**	**56 408**	**693 084**	**694 422**	**1 338**
1 Household consumption	0	0	1 658	12 711	2 209	8 975	0	0	1 974	101	0	13 783	9 538	13	143	0	25 552	25 552	0
2 Fixed capital formation	0	0	0	0	348	99 309	0	0	20 519	79 138	0	0	0	0	0	0	99 657	99 657	0
3 Changes in inventories	0	0	0	0	-131	608	0	0	0	478	0	0	0	0	0	0	478	478	0
4 Landfills	0	0	0	0	0	0	41 540	0	0	41 168	0	372	0	0	0	0	41 540	41 540	0
5 Domestic final use, total	**0**	**0**	**1 658**	**12 711**	**2 427**	**108 892**	**41 540**	**0**	**22 493**	**120 885**	**0**	**14 155**	**9 538**	**13**	**143**	**0**	**167 227**	**167 227**	**0**
6 Exports of imports	**0**	**0**	**0**	**0**	**1 743**	**0**	**0**	**0**	**0**	**0**	**1 743**	**0**	**0**	**0**	**0**	**0**	**1 743**	**1 743**	**0**
7 International transfers, net	**0**	**0**	**0**	**-1 483**	**1 247**	**0**	**0**	**0**	**0**	**0**	**1 434**	**-1 213**	**-457**	**0**	**0**	**0**	**-236**	**-236**	**0**
8 Total	**56 408**	**172 571**	**38 138**	**116 410**	**66 897**	**363 619**	**47 776**	**367 432**	**47 776**	**120 885**	**41 593**	**123 736**	**103 938**	**492**	**895**	**56 408**	**861 818**	**863 156**	**1 338**

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Difference between PIOT and E-W MFA

E-W MFA: ORIGIN		PIOT: INPUT		PIOT: OUTPUT		E-W MFA: DESTINATION	
Domestic extraction	**327 119**	**Domestic extraction**	**327 119**				
Raw materials	172 571	Raw materials	172 571				
Water	38 138	Water	38 138				
Air (O,N)	116 410	Air (O,N)	116 410				
Imports	**66 897**	**Imports**	**66 897**				
		Domestic products	**363 619**	**Products for domestic use**	**367 432**		
		Commodities	315 207	Commodities	**319 306**		
		Recovered waste	48 412	Recovered waste	48 126		
		Final waste	**47 776**	**Final waste**	**47 776**		
				Exports	**41 593**	**Exports**	**41 593**
				Net accumulation	**120 885**	**Net addition to stock (NAS)**	**79 717**
				Household consumption	101	Household consumption	101
				Fixed capital formation	79 138	Fixed capital formation	79 138
				Changes in inventories	478	Changes in inventories	478
				Landfills	41 168		
						Domestic processed output	
				To domestic nature	**229 061**	**to nature**	**270 229**
				Emissions into air	123 736	Emissions into air	123 736
				Water vapour	103 938	Water vapour	103 938
				Discharges into water	492	Discharges into water	492
				Dissipative use	895	Dissipative use	895
						Landfills	41 168
Unused extraction	**56 408**	**Unused extraction**	**56 408**	**Unused extraction**	**56 408**	**Unused extraction**	**56 408**
TOTAL	**450 424**	**TOTAL**	**861 819**	**TOTAL**	**863 155**	**TOTAL**	**447 947**

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PIOT or E-W MFA or combination of them?

PIOT

- Full PIOT by branches of industry very resource deriving
- Detailed picture of 'physical' economy
- Needs further use in modeling etc.
- Can be done for selected branches of industry or selected flows, e.g. energy

E-W MFA framework

- Based on existing statistics
- I - Agriculture, mining, construction, import
- O - Waste, emissions into air and water, export, NAS
- Partially by branches of industry
- Key indicators for material efficiency in the EU

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Assessment of the environmental impacts of material flows caused by the Finnish economy with the ENVIMAT model

(Thule-institute of University of Oulu, MoE, FEI, Agrifood Research centre etc.)

- ENVIMAT model can be used to analyze the relationship between material flows, environmental impacts and economic impacts.
- The model is based on monetary and physical input-output tables and on environmental life cycle impact assessment. it represents so-called environmentally extended input-output analysis (EEIO) tools.
- The assessment takes into account both the environmental impacts caused by domestic activities and imports.
- The assessment of imports was conducted in an exceptionally detailed manner. The contribution of exports to all Finnish industries was also assessed. Finnish consumption was analyzed from the perspective of individual and collective consumption.

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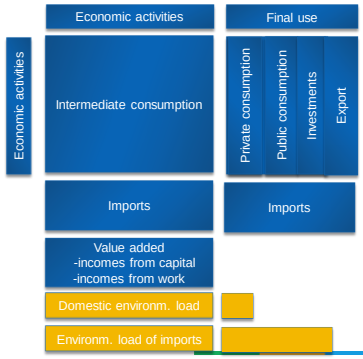
ENVIMAT: Environmentally extended input-output model



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ENVIMAT^{scen} basic scenario

		Level		Growth	Change %
		2008	2030	%/v	2030/2008
Human	Population, 1000 persons	5 313	5 850	0,4	10
	Employees, 1000 persons	2 704	2 736	0,1	1
Economy	GDP Mrd € 2008 prices	186	251	1,4	35
	GDP per capita 1000 €	35	43	0,9	23
	NDP per capita 1000 €	30	35	0,8	19
	Household consumpt. per cap. 1000 €	17	22	1,1	29
	Private consump. Per capita 1000 €	23	30	1,2	30
Employment	Employees 1000 mly	2 531	2550	0,0	1
	Employment rate %	6,4	6,8	0,3	7
	Productivity of work k€/mly	73	98	1,3	34
Nat. resources	Domestic extraction (DE) Mt	183	314	2,5	72
	Raw material consumption (RMC) Mt	212	235	0,5	11
	RMC per capita, tons	40	40	0,0	1
	RMC/GDP, g/€	1 139	936	-0,9	-18
Energy	Total energy consumption, TWh	393	472	0,8	20
	End use of energy, TWh	303	319	0,2	5
	Energy/GDP, kWh/€	1,6	1,3	-1,1	-22
	Share of renewable energy, %	30,7	41,6	1,4	36
Emissions	GHG Mt CO2 ekv	70,4	52,9	-1,3	-25
	GHG/GDP, g/€	379	211	-2,6	-44

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Development of material flow indicators

	2008	2030	%-change
Population, 1000 persons	5 313	5 850	10
GDP Mrd € 2008 prices	186	251	35
Direct material input (DMI), Mt	208	331	59
Raw material consumption (RMC), Mt	209	239	14
DMI per capita, t/person	39	57	45
RMC per capita, t/person	39	41	4
Material productivity (GDP/DMC), t/€	894	758	-15
Raw material productivity (GDP/RMC), t/€	889	1 051	18

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ENVIMAT results

- One of the most important findings is that half of the Finnish economy's environmental impacts are due to the manufacturing of imported products. Greenhouse gas emissions generated outside of Finland are equivalent to about 70-80 % of domestic emissions.
- In the context of other environmental impact categories besides climate change, the contribution of external impacts is even greater. In addition, the Finnish economy consumes as much natural resources abroad as it consumes domestic resources.
- Domestic consumption and investments (referred to collectively as final demand) cause a little more than half of the Finnish economy's environmental impacts. Less than half of the environmental impacts are due to exports. The impacts of domestic final demand are somewhat greater than those of the Finnish export industry.

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ENVIMAT results

- Most of the environmental impacts of domestic final demand are caused by housing, food and private transportation. The contribution from letting and owning of dwellings, public transport and other services is about 40 % of the environmental impacts of domestic final demand.
- The ENVIMAT model is advantageous in constructing a rough life cycle based environmental impact assessment for different products and product groups. A particularly important application area is calculating the carbon footprinting of products. Furthermore, the model can be used for analyzing the consequences of different activities regarding product chains and the economy. In the future, the model will be used for assessing temporal changes in the economy, for monitoring sustainable development, for planning the measurement of climate change and for identifying important factors in the economy including an assessment of their impacts.

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Development of energy accounts in Finland

Study visit of ICBS
25.8.2014
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Energy accounts in the EU

- Physical Energy Flow Accounts are one module of environmental accounting regulation of the EU
- The module came into force in 2014, and accounts on years 2014 and 2015 have to be reported to Eurostat in 2017

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Physical Energy Flow Accounts (PEFA) 1(2)

- Supply-use tables including all energy forms and fuels
- Basic structure adopted from the System of Environmental-Economic Accounting (SEEA)
  - Natural inputs, products, residuals; more than 100 items
  - All branches of industry (NACE A*64), households, accumulation, import and export, environment
- Unit: Terajoule

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Physical Energy Flow Accounts (PEFA) 2(2)

- Supply and use of energy are balanced
- The main differences with respect to energy statistics:
  - Branches of industry highly disaggregated, especially in manufacturing industries and services
  - Private transport is included in the household sector
  - Residence principle as in National Accounts
  - Environmental aspect

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Energy flows

- **NATURAL INPUTS (RESOURCE FLOWS, energy statistics classification)**
  - **Non Renewables**
    - Uranium and thorium ores
    - Hard coal
    - Lignite/Brown coal
    - Peat
    - Crude oil
    - Natural gas liquids
    - Other hydrocarbons
    - Natural gas
  - **Renewables**
    - Hydro power
    - Wind power
    - Solar thermal (resource: solar radiation)
    - Solar PV (resource: solar radiation)
    - Tide, Wave and Ocean
    - Geothermal energy
    - Biomass for energy use

- **PRODUCTS (PRODUCT FLOWS, CPA classification)**
  - Wood, wood waste and other solid biomass
  - Hard coal
  - Lignite, peat and derivatives
  - Crude oil
  - …
  - Coke
  - Motor spirit
  - Kerosenes and jet fuels
  - Gas/Diesel oil
  - Liquid biofuels
  - …
  - Electrical energy
  - Derived gases
  - Biogas
  - Derived heat
  - …
  - Municipal wastes (renewables, non-renewables)
  - Industrial wastes
- **RESIDUALS (RESIDUAL FLOWS)**
  - Waste
  - Losses during distribution/transport
  - Losses during transformation
  - Dissipative heat or end use losses
  - …

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Branches of industry (NACE rev.2)

NACE code	Branch of industry
A01	Crop and animal production, hunting and related service activities
A02	Forestry and logging
A03	Fishing and aquaculture
B05	Mining of coal and lignite
B06	Extraction of crude petroleum and natural gas
B07	Mining of metal ores
B08	Other mining and quarrying
B09	Mining support service activities
C10_C12	Manufacture of food products, beverages and tobacco products
C13-C15	Manufacture of textiles, wearing apparel and leather products
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24_FER	Manufacture of basic iron and steel and of ferro-alloys; of tubes, pipes, hollow profiles, related fittings and other products of first processing of steel; casting of iron and steel
C24_NFER	Manufacture of basic precious and other non-ferrous metals; casting of light metals and other non-ferrous metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C31_C32	Manufacture of furniture; other manufacturing
C33	Repair and installation of machinery and equipment
D	Electricity, gas, steam and air conditioning supply
E36	Water collection, treatment and supply
E37-E39	Sewerage, waste management, remediation activities
F	Construction
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade, except of motor vehicles and motorcycles
G47	Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H501_H502	Sea and coastal water transport

NACE code	Branch of industry
H503_H504	Inland water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I	Accommodation and food service activities
J58	Publishing activities
J59_J60	Motion picture, video, television programme production; programming and broadcasting activities
J61	Telecommunications
J62_J63	Computer programming, consultancy, and information service activities
K64	Financial service activities, except insurance and pension funding
K65	Insurance, reinsurance and pension funding, except compulsory social security
K66	Activities auxiliary to financial services and insurance activities
L	Real estate activities
M69_M70	Legal and accounting activities; activities of head offices; management consultancy
M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74_M75	Other professional, scientific and technical activities; veterinary activities
N77	Rental and leasing activities
N78	Employment activities
N79	Travel agency, tour operator reservation service and related activities
N80-N82	Security and investigation, service and landscape, office administrative and support
O	Public administration and defence; compulsory social security
P	Education
Q86	Human health activities
Q87_Q88	Residential care activities and social work activities without accommodation
R90-R92	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities
R93	Sports activities and amusement and recreation activities
S94	Activities of membership organisations
S95	Repair of computers and personal and household goods
S96	Other personal service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organisations and bodies

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Energy accounts in Finland

- Energy accounts were the first application of Natural resource accounting compiled at Statistics Finland in late 1980s, on 1985 data
- The application was updated in 1995, on 1990 data
- Project on energy accounts in Finland started in spring 2012

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Project organisation

- Project group consists of experts on
  - environmental accounts
  - energy statistics
  - air emission statistics and accounts
  - monetary supply-use tables
- Units represented in the steering group
  - Environment and Energy Statistics
  - Greenhouse Gas Inventory
  - National Accounts

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Objectives

- Develop a methodology to compile energy accounts regularly
- Compatibility with other modules of physical and monetary environmental accounts (e.g. air emission accounts) and energy statistics (note: conceptual differences)
- Compilation system of physical supply and use tables for energy flows in Finland 2008-2011
- Identification of elements of energy accounting calculation system that could be integrated into planned production system of energy statistics

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Challenges

- Different approach than in energy statistics
  - residence principle, private transport, environment
- The availability and quality of the data at the detailed classification levels required for product flows and branches of industry (NACE A*64)
- Especially the energy use of the service sector is problematic to disaggregate into such detailed level

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The main steps 1(2)

- ***Identification of data sources***
  - *Energy statistics: e.g. statistics on energy use in manufacturing and production of electricity and heat*
  - *Monetary supply-use tables of National Accounts: intermediate consumption of energy products*
  - *Finnish Customs: imports and exports of energy*
  - *Air emission accounts: e.g. bridging items*
  - *Waste statistics: industrial waste generation by branches of industry, used for energy production*
  - *Other data sources*

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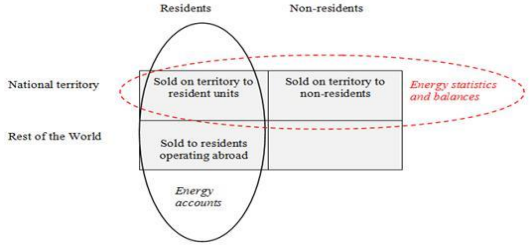
Resident -principle



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Data sources for monetary supply-use tables

- The most important data sources are national accounts, structural statistics on manufacturing and products, structural statistics on service industries, statistics on foreign trade, the Register of Enterprises and Establishments, corporate taxation records, source data for statistics on central and local government and agriculture and forestry, and the Household Budget Survey. Various other data sources are also utilised.
- The inquiry on manufacturing commodities collects value and volume data on the production of enterprises and the materials and supplies used for production by commodity heading. The statistical period used is the calendar year. The annual data are collected in February. The inquiry covers all enterprises with at least ten employees and in certain cases smaller enterprises than this engaged in manufacturing activities.

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The main steps 2(2)

- ***Development of methodology and calculation system***
  - *Identification of links to air emission accounts, energy balance and new production system of energy statistics*
  - *Data modifying and aggregation, linking different classifications*
  - *Supply and use of energy by branches of industry and energy sources*
  - *Balancing the supply and use*
  - *Testing the system with 2011 data*
  - *Improvements to calculation system*
- ***Supply-use tables 2008-2011***

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Example of compiling methods: Energy use of the service sector

- Calculation model for space heating (Statistics Finland)
- Electricity consumption by sector (Finnish Energy Industries)

-> Allocated to branches of industry by using monetary supply-use tables

- Air emission accounts

-> Shares of road transport by branches of industry

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Examples of compiling methods 2(2) Water transport

- MEERI - calculation system for waterborne traffic emissions and energy consumption (Technical Research Centre of Finland – VTT)

-> Allocated to sea/coastal and inland water transport using the Merchant Fleet statistics (Finnish Transport Safety Agency)

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Data sources and compiling methods

(Source: Energy Accounts, Final Technical Implementation Report)

Energy statistics

- Energy statistics and their data sources are the starting point for the calculations of energy accounts. The most important data sources are statistics on energy use in manufacturing and statistics on production of electricity and heat, which cover a large part of the supply and use tables of energy accounts.
- The use of energy products is well covered in energy statistics and can be linked to NACE branches. However, energy use of the services sector and transport fuels are not directly available by individual economic activities.
- Energy use in the services sector is allocated to individual economic activities by using the distribution of intermediate consumption of supply and use tables of national accounts. Before calculating the distribution of intermediate consumption, the transport fuels are subtracted from the data since the use of transport fuels is calculated separately.

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Data sources and compiling methods 2

- The use of road transport fuels is allocated to economic activities and households by using calculations of air emission accounts. The calculations use the shares of intermediate consumption of monetary supply and use tables in disaggregating the data of the greenhouse gas inventory by economic activities.
- Air emission accounts have also allocated emissions of working machines to economic activities. Energy accounts utilise the same distribution in calculating the energy use of working machines to economic activities.
- The Register of Ships maintained by Trafi and the Business Register maintained by Statistics Finland are the basic data sources for disaggregating fuel use of working boats. Working boats are filtered from the Register of Ships and joined with the Business Register by business IDs. Distribution to working boats is calculated by using the Business Register's data of economic activities.

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Data sources and compiling methods 3

- Coke, coke oven gas, blast furnace gas and oil data are complemented with data from IEA/Eurostat Annual Energy Statistics Questionnaires. Since the Questionnaires also use energy statistics' data sources, some overlapping or inadequacy may occur.
- Statistics on production of electricity and heat, and import data on energy constitute the basis of energy supply. The data are complemented with backward calculations from energy use data.

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Data sources and compiling methods 4

Energy use of Finnish residents abroad - land transport

- Bridging items of road traffic are Finnish residents' energy use abroad, and non-residents' energy use in Finland. Energy use of Finnish residents consists of fuels used in international lorry traffic and bus traffic, and of fuels used in cars of Finnish residents (households) travelling in foreign countries.
- Data on vehicle kilometres of Finnish trucks abroad are available from Statistics Finland's statistics on goods transport by road. Vehicle kilometres of Finnish buses abroad are recorded by the Finnish Bus Association. Total vehicle kilometres of lorries and busses in Finland and diesel oil use of lorries and busses are provided by the road traffic calculation model LIISA from the Technical Research Centre of Finland (VTT).

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Data sources and compiling methods 5

Energy use of Finnish residents abroad - land transport

- Statistics on vehicle kilometres or fuel use of Finnish tourists abroad are not directly available.
- Statistics Finland's tourism statistics include data on the number of Finnish tourists travelling abroad by car. Trips include at least one night abroad. The number of shorter trips is estimated. In addition to that, Automobile and Touring Club of Finland (Autoliitto) surveys provide information on the average vehicle kilometres of Finnish travellers abroad.
- By combining this information with information on vehicle kilometres of private cars in Finland provided by the VTT's LIISA model, it can be calculated that the fuel used by Finnish car travellers abroad is approximately two per cent of the fuel used by private cars in Finland.

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Data sources and compiling methods 6

Energy use of Finnish residents abroad - air and water transport

- In the greenhouse gas inventory system, only fuels used in traffic between Finnish airports and harbours are taken into account. Direct information on residence/non-residence of units operating between Finnish ports and Finnish airports is not available. In addition to this, the inventory includes bunker fuels, which are sold to foreign traffic.
- Purchases of bunker fuels by foreign non-residents are taken from national accounts, in which they are recorded as exports of fuel. Respectively, purchases of bunker fuels by Finnish residents abroad are recorded into national accounts and supply-use tables as imports of fuel. When the total intermediate value of residents' domestic water and air traffic is known, fuels used in Finnish international water and air traffic can also be calculated (bridge table rows 2.3 and 2.4). Value information from supply and use tables is converted into energy content.

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Data sources and compiling methods 7

- The aggregated sectoral data are combined into one set of data. For certain energy products (e.g. hard coal, natural gas, industrial wood fuel) total energy consumption is known. The combined data are adjusted so the energy use of these energy products is equal to total energy consumption.
- After the energy use is balanced, backward calculations are made from use data to complement the supply data (e.g. production of biogas, wood fuel, waste). Bridging items are added to the complemented data and losses to environment and non-energy use to accumulation are calculated.

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Data sources and compiling methods 8

- Losses and non-energy use are balanced by calculating the energy use from energy supply data. Oil products are balanced by recording the difference to NACE branch 19. This is done to improve the quality of oil data. The backward calculations that were done to complement supply data also balance supply and use automatically.
- The remaining differences between supply and use by PEFA classes and NACE branches are recorded in the use table in row and column titled 'Statistical Differences'. The differences are left visible to be more transparent and to spot the bigger differences. Balancing the supply and use is one point for development after the project.

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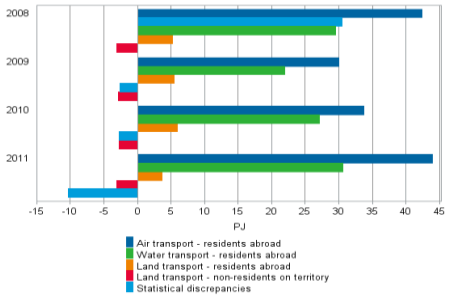
Items of the bridge table in 2008 to 2011



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Supply table 2011 in terajoules (preliminary data)

Supply table	A Agri-culture, forestry, fishing	B Mining and quarrying	C Manu-facturing	D Energy mana-gement	E Water supply, waste mana-gement	F Cons-truction	H Trans-portation, storage	G, I-S Trade, other service activities, administ-ration	House-holds	Rest of the world	Accumu-lation	Environ-ment	Total supply
Natural energy inputs												473 694	**473 694**
Energy products	106 120	321 335	837 152	432 173						1 217 878			**2 914 658**
Energy residuals	38 271	5 758	543 379	301 992	2 553	37 488	166 760	134 995	274 788		229 484		**1 735 469**
Total supply	**144 392**	**327 093**	**1 380 532**	**734 165**	**2 553**	**37 488**	**166 760**	**134 995**	**274 788**	**1 217 878**	**229 484**	**473 694**	**5 123 821**

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Use table 2011 in terajoules (preliminary data)

Use table	A Agri-culture, forestry, fishing	B Mining and quarrying	C Manu-facturing	D Energy mana-gement	E Water supply, waste mana-gement	F Cons-truction	H Trans-portation, storage	G, I-S Trade, other service activities, administ-ration	House-holds	Rest of the world	Accumu-lation	Environ-ment	Statistical diffe-rences	Total use
Natural energy inputs	106 120	321 335		46 238										**473 694**
Energy products	38 271	5 758	1 207 328	657 140	2 428	37 488	166 760	134 995	274 788	330 355	14 165		45 182	**2 914 658**
Energy residuals			218 447	10 912	125						45 511	1 460 474		**1 735 469**
Statistical diffe-rences			-45 243	19 875									25 368	**0**
Total use	**144 392**	**327 093**	**1 380 532**	**734 165**	**2 553**	**37 488**	**166 760**	**134 995**	**274 788**	**330 355**	**59 676**	**1 460 474**	**70 550**	**5 123 821**

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Hybrid table 2011 (total energy use is preliminary)

	Total energy use	CO2 emissions	Energy taxes	Output	Gross value added	Employment
	TJ	tonnes	EUR million	EUR million	EUR million	1000 persons
Households	274 788	5 364 252	1214			
Total industries	**2 927 978**	**55 411 002**	**2 662**	**380 370**	**170 454**	**2 516**
A Agriculture, forestry and fishing	144 392	1 733 998	121	9 266	4 649	115
B Mining and quarrying	327 093	302 810	13	2 179	810	7
C Manufacturing	1 380 532	16 539 413	563	119 260	32 164	369
D Energy management	734 165	21 074 156	215	8 034	3 812	13
E Water supply and waste management	2 553	334 109	35	3 167	1 554	12
F Construction	37 488	1 834 897	178	30 130	10 905	194
H Transportation and storage	166 760	11 300 959	728	22 918	8 715	155
G, I-S Trade, other service activities, administration	134 995	2 290 662	809	185 241	107 670	1 641
T Household service activities				175	175	9

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