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IMEA WP3: EE IO

TNO Kennis voor zaken



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What do I tell

- Introduction: some examples of EE IO as an accounting tool
- The practical situation with regard to EE IO in Europe
 - Eurostat Data Centres and related available data
 - EXIOPOL data sets
- Capability of dealing with imports
- Based on the following projects:
 - EIPRO (with CML, DTU, VITO for IPTS, 2005)
 - FP6 IP EXIOPOL, 2,5 Mio Euro, building a global MR EEIO (with CML, NTNU, SERI, WI, GWS, RU Groningen, IPTS, ZEW, 2011)
 - Environmental Indicators for Resource Use (with CML, CE for EUROSTAT, 2009)
 - Development of Eurostat Data Centres on Resources and Products (with CML and SERI, 2009-2011)

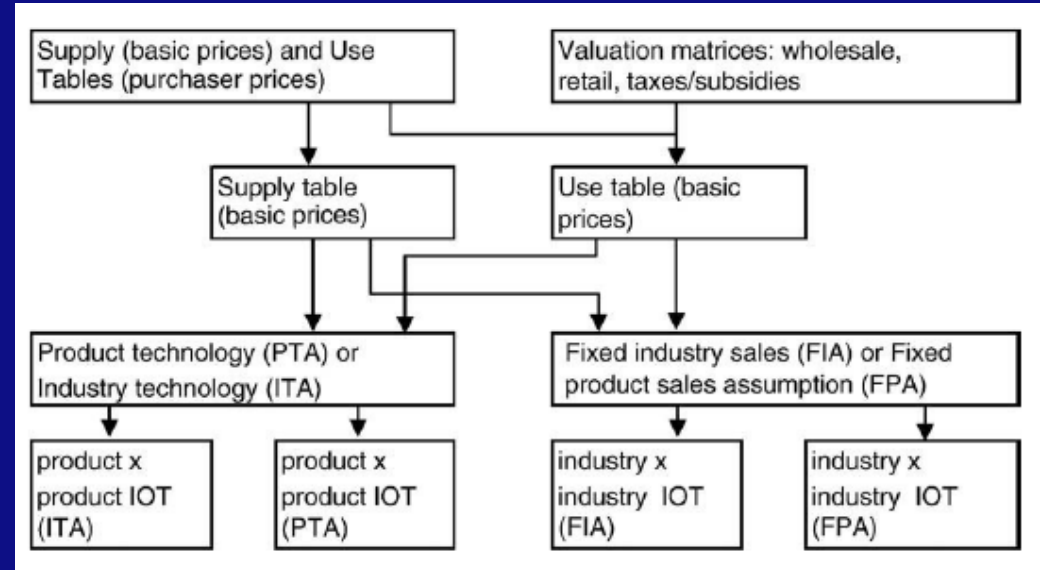
Introduction: EE IO basics

- You map the monetary flows between industry sectors in a country
- You inventory the emissions and primary resource inputs as extensions
- For each final consumption category, you can calculate the added value contributed of each sector
- ...and with emissions per Euro known, you can calculate impacts related to that consumption category too.

	Ind			
Ind	<i>i/o</i> by industry	<i>Final use</i>	<i>Exports</i>	Use ind bp
	Tax/sub prod			
	Value added			
	<i>Imports cif</i>			
	Supply ind bp			
	Extensions..	Ext		

Excursus: building IOT via Supply and Use tables

	Products	Industries			
Products		Use	Final use	Exports	Use of products
Industries	Make / Supply				Output of industries
	Imports cif	Value added			
	Supply of products	Input of industries			
		Extensions: - Primary Natural Resource input - Emissions output - etc.			



An example of what EE IO is capable of: EIPRO

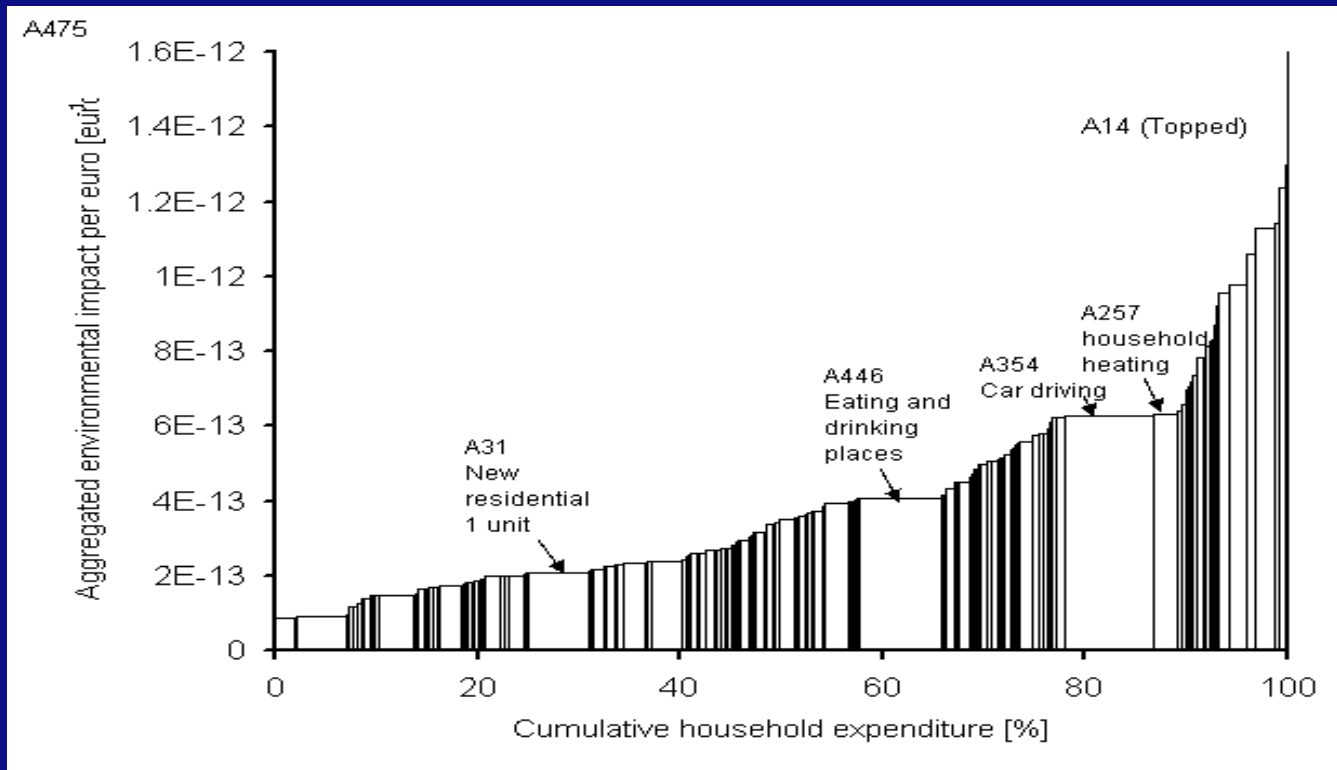
- Study for EU's Integrated Product Policy
 - For DG JRC IPTS and DG ENV
 - Analysing 'Environmental Impacts of Products'
 - With CML, VITO, DTU
- Pillar 1: Review existing priority setting studies for products
- Pillar 2: Economic Input-Output model with Environmental Extensions for the EU25, with 500 sectors (EE I-O)
 - I-O: describes monetary flows between sectors
 - EE: give 'emission per Euro' per sector
 - Via traditional I-O mathematics you can calculate per Euro consumption which sectors contribute, and in this way, also the 'total emission'

EIPRO: Results Pillar 1

- Food, Mobility and Housing dominate (70 % of impacts at 50% expenditure)

COICOP	Study	Dall et al.	Kok et al.	Labouze et al.	Nemry et al.	Nijdam and Wilting	CEDA EU25
	Indicator	Energy	Energy	GWP	GWP	GWP	GWP
	Main approach	Bottom-up	Hybrid	Bottom-up	Bottom-up	IO	IO
CP01-02	Food	26,2%	13,0%	7,0%NA	3,6%NA	22,1%	31,0%
CP03	Clothing	1,3%	2,2%	3,3%	1,3%	6,5%	2,4%
CP04-05	Housing	40,8%	54,3%	58,8%	53,5%	33,4%	23,6%
CP06	Health		1,8%		0,3%	0,3%	1,6%
CP07	Transport	19,5%	18,3%	29,6%	32,9%	17,3%	18,5%
CP08	Communication			0,0%	2,9%	0,0%	2,1%
CP09	Recreation	7,2%	8,1%	0,0%		15,1%	6,0%
CP10	Education		1,8%			0,7%	0,5%
CP11	Restaurants					2,8%	9,1%
CP12	Miscellaneous	5,1%	0,4%	1,3%	5,4%	1,8%	5,2%
	TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

EIPRO: Resultats Pillar 2



- Impact per Euro per product x totale expenditure = impact
- => surface is a measure for priority
- => figure indicates if shift in expenditure makes environmental sense, and if 'rebounds' are possible

EIPRO: Overall conclusions

- Priority products and consumption activities are:
 - Mobility: cars and air transport
 - Food: meat, dairy, followed by others
 - Energy use in and around the house: cooling/heating, and 'Energy using products'
 - Building, renovation and demolition of the house
- The method proved its value, but there are clear problems
 - Basic data
 - I-O data situation in EU is not good (ESA95, 60 sectors/products)
 - To reach 500 sectors we 'Europeanised' US data
 - Method
 - Final expenditure: consumption vs. Government
 - Sector classifications and detail
 - Inclusion of capital goods (allocated to sectors that use them, or more dynamic)
 - Modelling of imports (real versus 'as if made in Europe')
 - Use and waste stage (usually not in I-O)

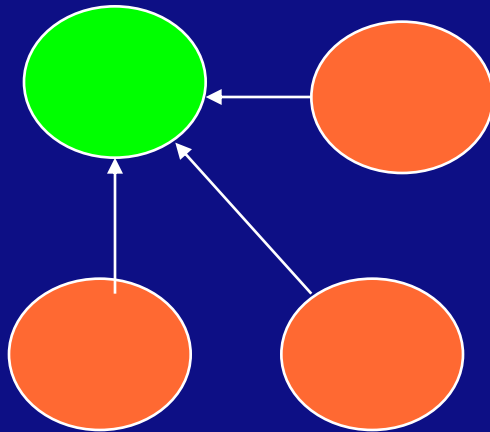
EE IO and imports/exports

- In many cases EE IO tables are build for single countries
- 'Burden shifting' between countries is only partially visible
 - If e.g. manufacturing is outsourced to China, this results in less domestic production, and higher imports in the IO table....
 -but without further specific data, one can only assume that imported products are made with domestic technology and related emissions.....
 -which neglects the fact that production abroad may be dirtier or cleaner as domestically.....
- Example from Peters and Hertwich, 2006:
 - Norway has mainly hydropower, very low SO₂ production emissions.....
 - The embedded SO₂ emissions from clothing imported from China appeared to be a staggering 20-30% of the Norwegian total!

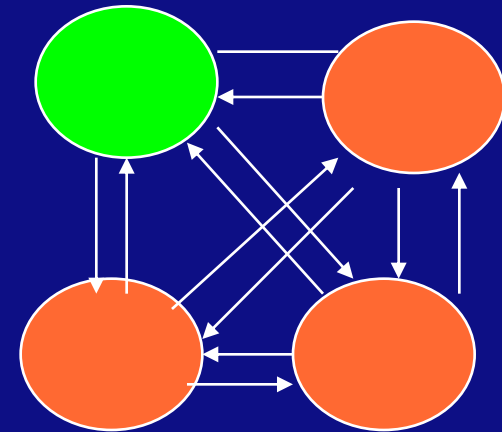
How can EE IO include imports?

- Solution 1: bilateral trade
 - Develop EE IO tables for the central country and its most important trade partners; link via trade
- Solution 2: multi-regional EE IO
 - Develop EE IO tables for the central country and a number of other world regions, and link them ALL via trade

EE IO with bilateral trade links



MR EE IO



Data sets and methods available in the near future (1)

- EUROSTAT
 - Has for most EU27 countries
 - SUT (yearly) and IOT (5 yearly)
 - NAMEA Air (15 emissions/extensions)
 - NAMEA resources (in production)
 - NAMEA energy and waste (in production)
 - ...at 60 sector and product level
 - Problems:
 - EU27 tables NOT structurally integrated to an EU table (IPTS did pilot for one year)
 - No EE IOTs for non EU countries
 - With some capacity enhancement at EUROSTAT availability of a fairly complete EE IOT for EU27 should be available on a structural basis
 - The TNO/CML/SERI project on Data centres for Products and Resources will certainly recommend this

Eurostat data sets and quality for 'IMEA'

- Environmental accounting ability
 - Inherent quality of methodology?
 - Broad set of impacts / indicators / local impacts less well covered
 - Product chain/consumption perspective
 - Geographical burden shifting/imports part covered
 - Homogeneity and proportionality: reasonable sector detail (60)
 - Economic allocation of impacts, exchange rate (PPP or MER), inclusion of capital goods and waste treatment tricky, etc.
 - Data available and audible?
 - IO and NAMEA data for EU27: mostly there, in 2 years
 - Integration to EU27 table not yet done
 - Improvement potential?
 - Depending on EUROSTAT staff capacity and country contributions, extension of ESA95
- Decision making ability
 - Usability/communicative power?
 - Great, in principle indicators like EF, TMR, LCIA etc. supported
 - Analytical potential?
 - Great, various perspectives possible (sector, product, resources)
 - Linkages to accounting frameworks?
 - Inherent part of SEEA; can be linked to LCA via hybrid LCA

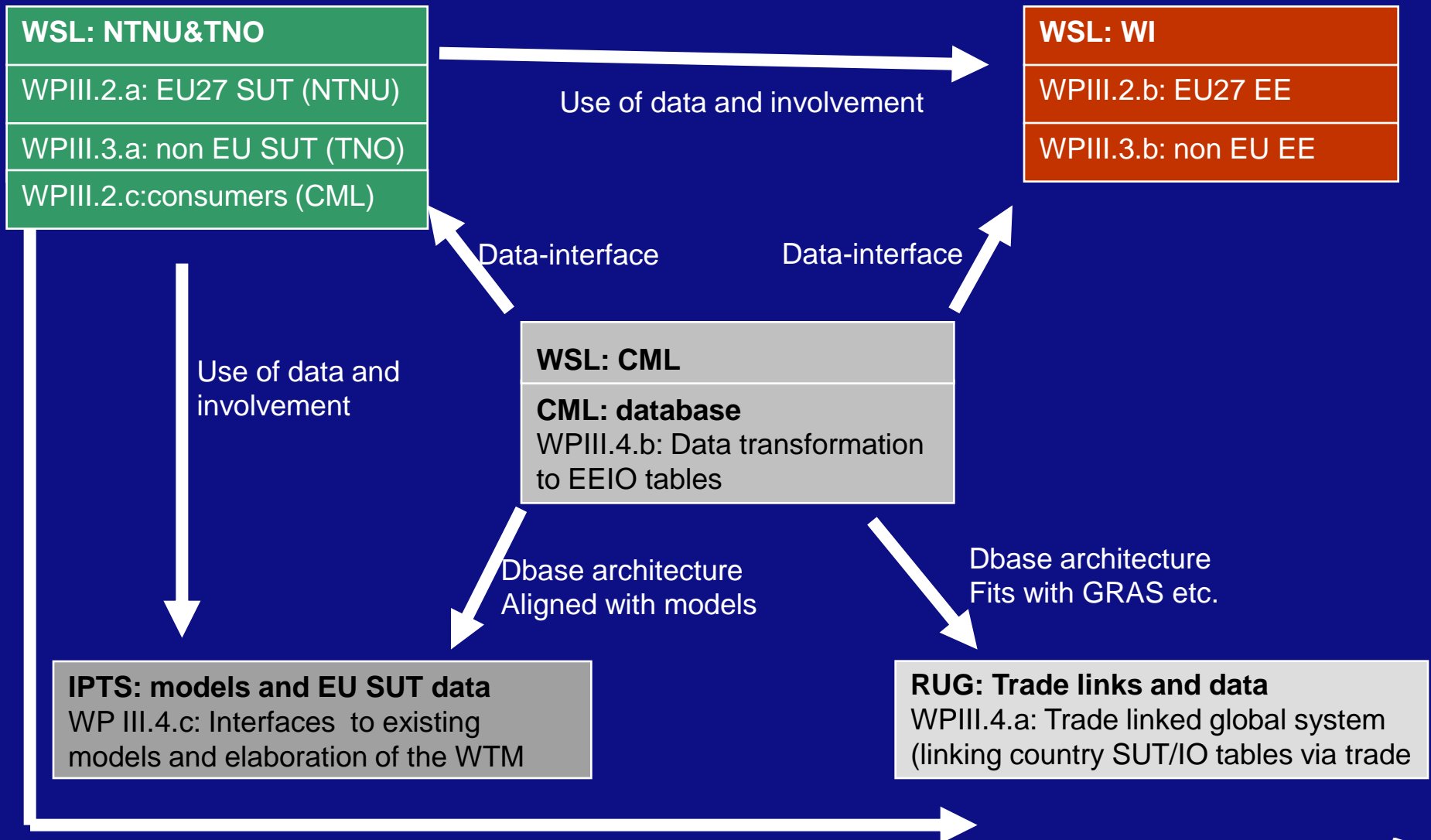
Data sets and methods available in the near future (2)

- EXIOPOL: Integrated Project under FP6 of the EU
 - Topic: 'externalities in an economic/environmental accounting framework'
 - 5 Mio EU FP6
 - 2006-2010
- Lead by
 - FEEM, co-ordinator (Anil Markandya), focus on externalities
 - TNO, scientific director (Arnold Tukker), focus on EE I-O
 - 35 other partners, with CML, NTNU, Wuppertal Institute, SERI, Groningen University, EU DG JRC IPTS, GWS, ZEW in EE I-O
- Main clusters
 1. Management & Strategy (0.3 Mio)
 2. Externalities (2 Mio)
 3. EE I-O (2 Mio)
 4. Illustrative policy applications (0.4 Mio)
 5. Education and dissemination (0.3 Mio)
- Philosophy
 - Protected, open source database
 - To be handed over to IPTS, EEA, Eurostat for formal use
 - Filling an essential gap in the EU toolbox

The EE I-O work in EXIOPOL

- Structure and ambition
 - Building a true global MR EE IO
 - WS 2: SUT / I-O data with 130 sectors
 - EU27
 - 16 other countries and RoW
 - Special WP on consumers and waste
 - WS 3: Environmental extensions: use various sources (NAMEA's, EEA, FAO Stat, WI and SERI databases, etc.)
 - EU27
 - 16 other countries and RoW
 -totalling around 150 extensions including land use and water
 - WS 4: Integrate into a single database
 - Link via trade (PhD trajectory with RU Groningen)
 - Transforming input data to a EE I-O database
 - Link with 1-2 dynamic models in use at IPTS
 - Base year 2000 and 2005

Or, in another perspective:



Expected result

		Industries				$Y_{*,A}$	$Y_{*,B}$	$Y_{*,C}$	$Y_{*,D}$	q
Products		$Z_{A,A}$	$Z_{A,B}$	$Z_{A,C}$	$Z_{A,D}$	$Y_{A,A}$	$Y_{A,B}$	$Y_{A,C}$	$Y_{A,D}$	q_A
		$Z_{B,A}$	$Z_{B,B}$	$Z_{B,C}$	$Z_{B,D}$	$Y_{B,A}$	$Y_{B,B}$	$Y_{B,C}$	$Y_{B,D}$	q_D
		$Z_{C,A}$	$Z_{C,B}$	$Z_{C,C}$	$Z_{C,D}$	$Y_{C,A}$	$Y_{C,B}$	$Y_{C,C}$	$Y_{C,D}$	q_C
		$Z_{D,A}$	$Z_{D,B}$	$Z_{D,C}$	$Z_{D,D}$	$Y_{D,A}$	$Y_{D,B}$	$Y_{D,C}$	$Y_{D,D}$	q_D
W		W_A	W_B	W_C	W_D					
g		g_A	g_B	g_C	g_D					
C & L		Capital _A	C_B	C_C	C_D					
		Labor _A	L_B	L_C	L_D					
Environ Ext		NAMEA _A	NAMEA _B	NAMEA _C	NAMEA _D					
		Agric _A	Agric _B	Agric _C	Agric _D					
		Energy _A	Energy _B	Energy _C	Energy _D					
		Metal _A	Metal _B	Metal _C	Metal _D					
		Mineral _A	Mineral _B	Mineral _C	Mineral _D					
		Land _A	Land _B	Land _C	Land _D					

Figure courtesy of Troy Hawkins, NTNU

EXIOPOL data sets and quality for 'IMEA'

- Environmental accounting ability
 - Inherent quality of methodology?
 - Broad set of impacts / indicators / local impacts less well covered
 - Product chain/consumption perspective
 - Geographical burden shifting/imports covered via non-survey data
 - Homogeneity and proportionality: good sector detail (130)
 - Economic allocation of impacts, exchange rate (PPP or MER), inclusion of capital goods and waste treatment tricky, etc.
 - Data available and audible?
 - For the time being for 2000 and 2005 only; NACE 1.1
 - Data transparent and audible but some rough assumptions
 - Improvement potential?
 - Ideally I'd see a EU/EUROSTAT/OECD/UN platform taking this over and work on structural time series of data
- Decision making ability
 - Usability/communicative power?
 - Great, in principle indicators like EF, TMR, LCIA etc. supported
 - Analytical potential?
 - Great, various perspectives possible (sector, product, resources)
 - Linkages to accounting frameworks?
 - Inherent part of SEEA; can be linked to LCA via hybrid LCA

Basic choices made - general

- Country list:
 - EU27
 - 16 others based on GDP/trade: United States, Japan, China, Canada, South Korea, Brazil, India, Mexico, Russia, Australia, Switzerland, Turkey, Taiwan, Indonesia, Norway, South Africa
 - Resource extracting sectors in the RoW
- Basic structure: based on supply and use tables
 - SUT -> add EE and trade link to a MR EE SUT -> MR EE IOT
 - Reason: most flexible (sectors and product perspectives that allows to link EE and trade; allows transforming to various MR EE IOTs (pxp, ixi, various technology assumptions)
- Base year 2000 with extrapolation to 2005

Basic choices made - SUT

- Harmonizing SUT in basic prices of EU27 and 16 other countries
 - Sector and product classification: NACE 1.1, / CPA 1.1, with the 60 ESA95 sectors and products as default
 - Enhanced detail until 130 sectors in view of difference in impact intensities
 - Agro-food
 - Resource extraction
 - Energy
 - Valuation (retail, transport and tax/subsidies) => Use table in pp
 - Splitting up SUT in matrices giving domestic and import/export part
- Added value elements
 - Compensation of employees (wages and social contributions, specified by high/medium/low skilled workers)
 - Net taxes on production
 - Gross operating profit (consumption of fixed capital, land rents, royalties on selected resources, other net operating profit)

Basic choices made: SUT

- Selected constraints/stocks
 - Labor supply
 - Resource availability of oil, gas, coal, iron ore, bauxite, and copper ore
- Data sources
 - EU27:
 - Eurostat ESA95 as harmonized and expanded for agriculture by IPTS
 - Creating additional detail by using NSI data, or auxiliary sources (many already inventoried as extensions, e.g. IEA energy database, FAO, etc.)
 - Other countries: NSI data
- => More information: NTNU/TNO presentation of van Bree, Hawkins and others

Basic choices made – Environmental extensions

- Environmental extensions + physical flows
 - Some 50 emissions based on IEA database and emission factors,
 - 80 resources, 15 physical product flows based on SERI and WI MFA databases
 - Including land use and water use
- Aim: cover those extensions that allow to calculate
 - Material flow indicators (alike)
 - Ecological footprint (alike)
 - External costs (based on 'external cost per kg emission per country' values provided by EXIOPOL Cluster II)
 - Key Life cycle impact assessment themes, most notably
 - Global warming potentiation
 - Acidification
 - Ozone depletion
 - Eutrophication
- => More information: Wuppertal Institute/SERI presentation of Moll, Giljum, Lutter, Acosta and others

Basic choices made: trade linking

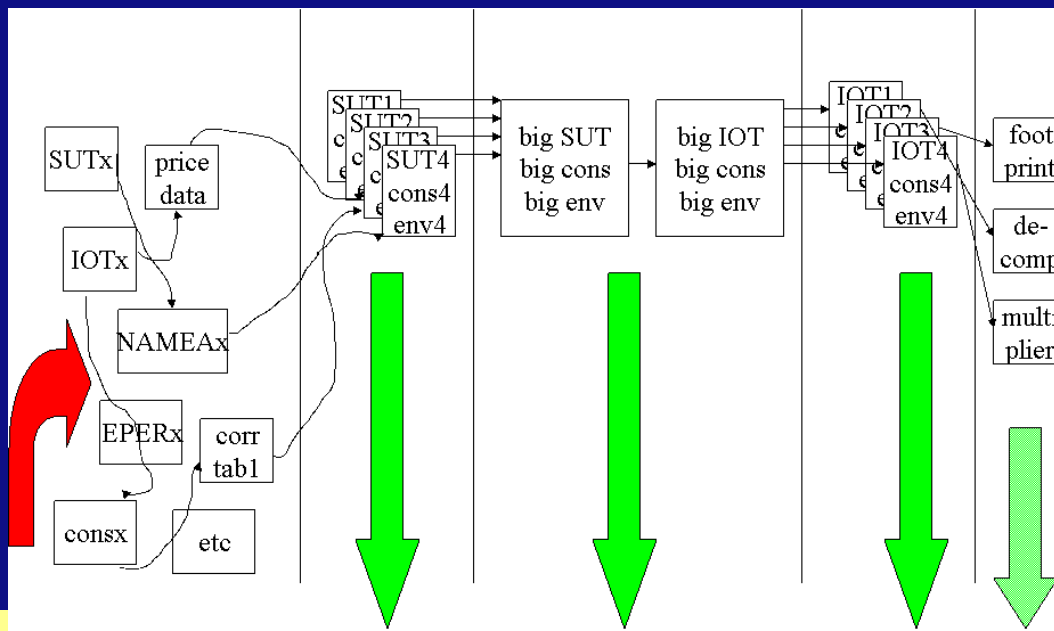
- Trade linking:
 - Import and export matrices from SUT are starting point,
 - Destination of exports and origins of imports estimated by using distribution factors based on UN COMTRADE
 - This inevitably leads to an unbalanced MR SUT; the full table is rebalanced using GRAS
- => More information: RU Groningen presentation of Bouwmeester and Oosterhaven

Basic choices made: consumption and waste

- Waste: 7-9 sectors in the SUT, discussion if additionally physical modelling has added value
- Final use
 - Traditional split of
 - Household consumption
 - NPISH
 - GovernmentImport
 - Fixed capital formation
 - Change in valuables and inventories
 - Further discussion about how to specify household consumption
 - Households emit and also have extensions
 - Options:
 - Directly linking extensions to products for final use that cause emissions
 - Developing a household activity matrix and link extensions there
 - Other attention points: our tables will be in basic prices, where final demand vectors are usually in purchaser prices
- => Some further information: IPTS presentation of Mognelli et al; or Reinout Heijungs, CML, WP Leader

Basic choices made – database system

- Database structure
 - ‘open source’ principle, transparent
 - Front end in excel with transformation steps and documentation (SUT and EE work)
 - Then relational 3 databases (Access or MySQL) with scripts doing linking the blocks shown below
 - Data entry script
 - ‘Trade link’ script
 - Scripts transforming MR EE SUT - > different MR EE IOTs (pxp, ixi, various technology assumptions)
 - Scripts linking final MR EE IOT to selected models



Status

- Project is now at year 1 of 4
- Scoping and various method development parts concluded
- (Partial) data for 4 test countries gathered
 - NL, No, US, China
- Currently imported in the database structure and made ready for a test with GRAS
- After evaluation of procedures data for other countries to be produced, and ready by Year 2.5/3
- Then some illustrative applications in combination with the externality work
- => an illustrative application: NTNU paper of Hawkins et al on comparing emission intensities across countries

Expected result

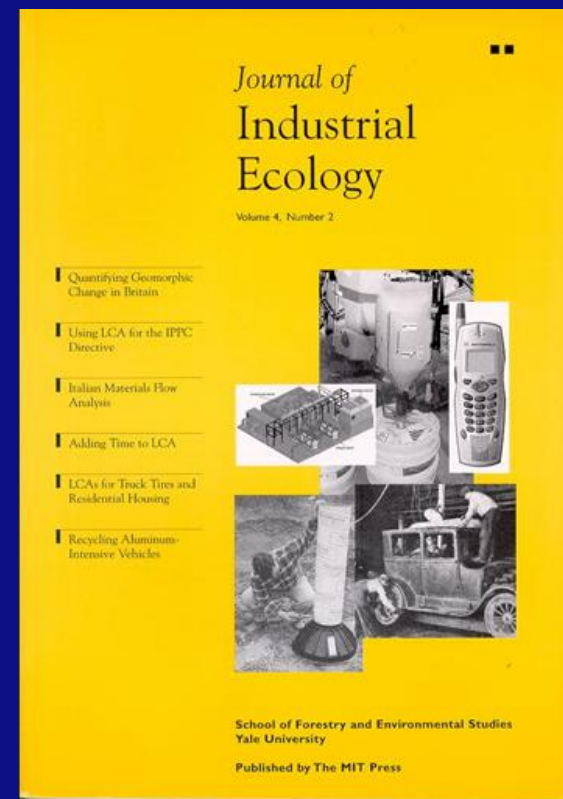
- MR EE SUT database
 - SUT: 27 EU countries + 16 other countries plus Rest of World countries, covering > 90% global GNP and impacts, 120+ sectors
 - Including consumption and waste
 - EE: material input, land use, emissions, allowing for calculating indicators like: *TMR, external costs, environmental LCIA themes and ecological footprint* (resources, land use, emissions etc.)
 - Compatible 1-2 other models
- Filling a fundamental gaps in the toolbox of EEA, Eurostat, DG JRC IPTS

Involvement

- Further involvement of
 - OECD, WB, EU and others in Advisory Board
 - Several statistical bureaux and Eurostat as subcontractor
- Strong connections with the I-O and Industrial Ecology communities via IIOA and ISIE
- Various EXIOPOL workshops
 - These sessions at IOMME
 - Probably a workshop back to back with the June 2009 ISIE conference in Lisbon (EXIOPOL cannot spent budget on travel outside Europe -> we cannot do this in Sao Paulo....)

More information

- EIPRO (EU IPP Site)
- *Journal of Industrial Ecology* 10:3 EIPRO Special Issue (Summer 2006; Yale and MIT Press)



Environmental impacts covered

Pressures ('inventory of interventions' or 'environmental extensions')		Impacts / Impact indicators
<i>Emissions (air, water, soil)</i>	<i>Key Data sources</i>	
<ul style="list-style-type: none"> GWP substances (CO₂, CH₄, etc.) Ozone depleting substances (HCFCs, etc.) 	EU25: Eurostat NAMEA-air project RoW: UNFCCC Annex 1 parties ; EDGAR/TEAM other countries	<u>LCA impact categories</u> With the interventions listed left the following themes from LCA can be calculated (e.g. using the method of Guinée et al., 2002): <ul style="list-style-type: none"> GWP ODP POCP Acidification Eutrophication <u>Ecological footprint (EF)</u> Wackernagel et al. (2005) describe a method that allows calculating the EF on the basis of GWP emissions, land use, and the use of specific biotic resources, which are all inventoried. <u>Total material consumption (TMC/MFA)</u> Wuppertal institute (Eurostat, 2001) developed a method that uses the items listed under 'input of primary resources' to calculate indicators such as the Total Material Consumption <u>External costs</u> The list of emissions left covers all emissions for which past research and EXIOPOL have calculated impacts in terms of external costs. WP III.1.b will transform such data in external costs per kg emission.
<ul style="list-style-type: none"> Acidifying substances (SO₂, NO_x, NH₃) POCP forming substances (NMVOC) 	EU25: Eurostat NAMEA-air project RoW: LRTAP convention for UN-ECE members ; TEAM/ EDGAR for other countries	
<ul style="list-style-type: none"> Eutrophying emissions (NH₃, PO₄, BOD) Toxic pollutants (mainly energy related: (As, Cd, Cr, Pb, Ni, formaldehyde) Toxic pollutants (mainly transport related: BaP, benzene, 1,3 butadiene, diesel particles, PM10) Pesticides 	EU25: LRTAP convention, where incomplete from TEAM RoW: LRTAP convention for UN-ECE members ; TEAM/EDGAR for other countries	
<i>Input of primary resources</i>		
<ul style="list-style-type: none"> Primary energy carriers Other abiotic resources Biotic resources 	EU25: Ongoing Eurostat project and Wuppertal Institute and SERI/MOSUS database RoW: SERI/MOSUS database, IEA, UNSD, FAO, WMC, etc.	
<ul style="list-style-type: none"> Land use 	EU25: FAOSTAT, CORINE landcover, others RoW: FAOSTAT, CORINE landcover, LUCC, NASA	

The EU IP EXIOPOL

- Role of each partner in the EE I-O cluster
 - TNO: manager, expert in emission databases and I-O
 - CML: expert in impact assessment and EE I-O
 - WI: expert in emission and MFA data (Eurostat NAMEA project)
 - SERI: expert in MFA data (MOSUS project)
 - GWS: expert in trade links (MOSUS project)
 - NTNU/RPI: expert in I-O and EE I-O
 - IPTS: EU foresight 'planning bureau' and expert in modelling
 - ZEW: expert in CGE modelling
 - RU Groningen: expert in trade link of I-O (FP6 EU KLEMS)
- Philosophy
 - Protected, open source database (hence foregoing GTAP)
 - To be handed over to IPTS, EEA, Eurostat for formal use
 - Filling an essential gap in the EU toolbox