

2008 CTCI Foundation Fall Environmental and Energy
International Conference

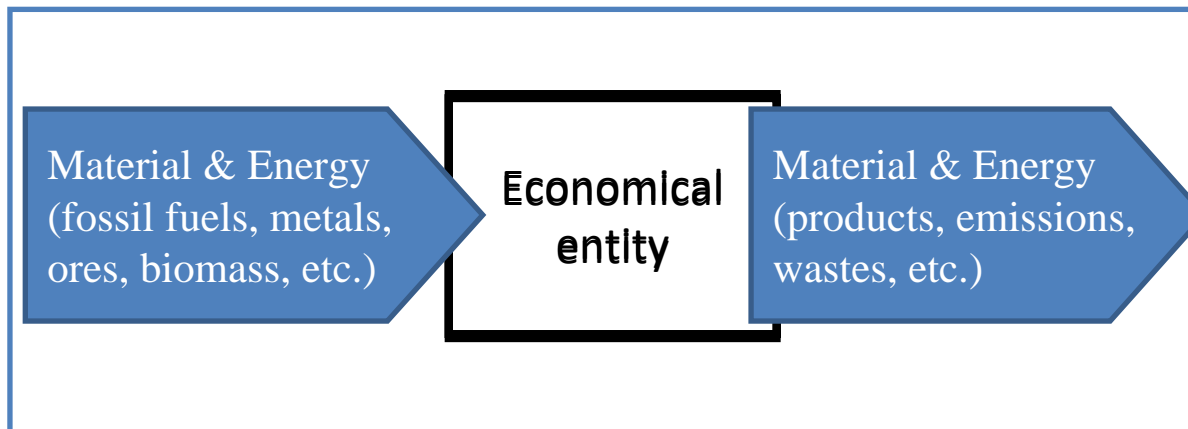
The Analytical Tools and Data for MFA

Hwong-wen Ma

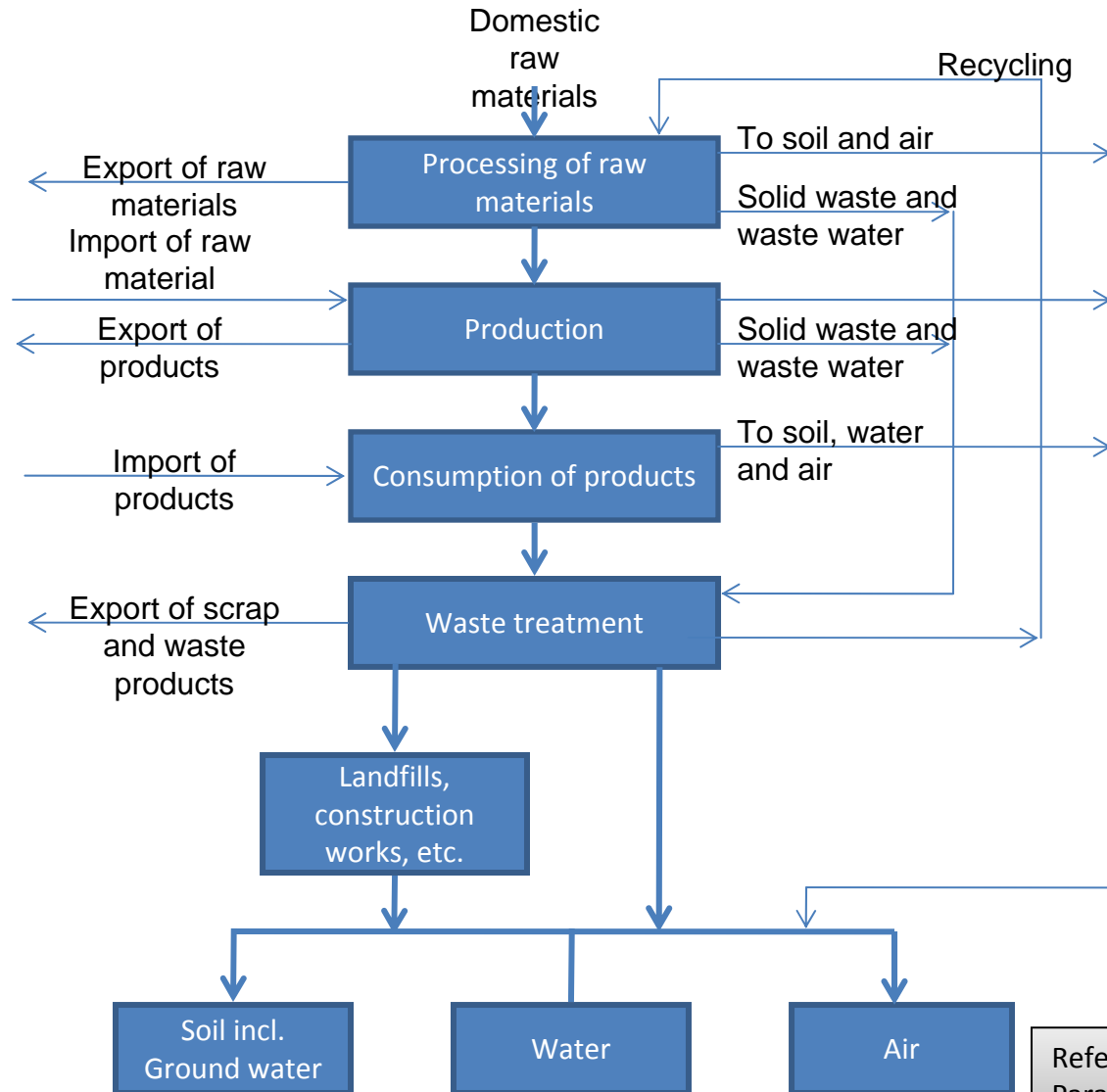
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Introduction

- Use of resources lead to:
 - Decreased resource availability
 - Environmental deterioration due to material and energy perturbation
- Key to sustainability
 - Enhancing efficiency of resource use and environmental protection through management of material and energy (sustainable material management)
- Evaluating the distribution and transformation of material and energy in an economic system (MFA)



The transport and distribution of materials/substances



Reference: Danish EPA
Paradigm for substance flow analysis

Scale of MFA

Scale	Example	Data	Planning	Material
Region	Taiwan	Aggregated information	Regional material planning; industrial structure; sustainable consumption	Sand & gravel, petroleum products, metal, renewable resource, waste
Sector	Iron and steel industries	Information integration	Supply chain management; eco-industrial park; benchmarking	Waste, water, industrial emissions
Process	Chemical factory	Detailed information	Process optimization; clean production; technological and energy efficiency	Raw materials, fuel, power

Application to addressing environmental problems

Environmental problem	Substances or material
Climate change	Fossil carbon, bulk materials (e.g. oil)
Ozone depletion	Various substances (e.g. NOX, CFCs)
Eutrophication	Nitrogen, food production
Acidification	Sulphur, nitrogen
Toxification chemicals	Metals, fuels
Resource depletion	Non-renewable and renewable resources
Land destruction through mining	Fossil fuel and metal
Waste management	Waste
Equity between generations	Total consumption
Equity between regions	Total consumption

source : European Environment Agency (2007)

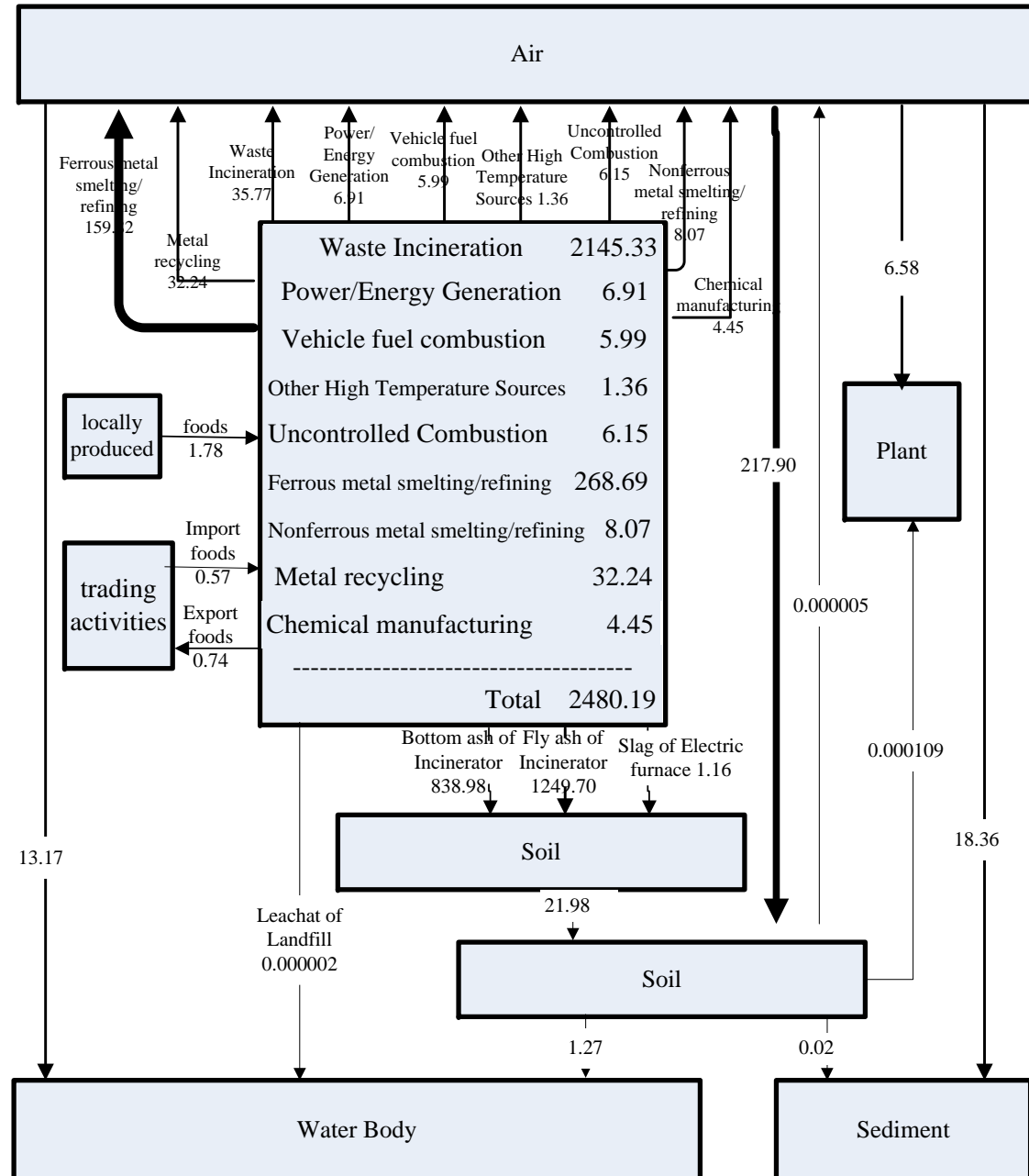
MFA in the World

Country	MFA experience
Austria	Fiber, fertilizer, plastics, PCB, Zn, Ag, Pb, N
Denmark	PBB, PBDE, azocerite, dioxins, CFCs, Al, As, Cd, Cr, Co, Cu, Pb, Hg, Ni, Sn
Germany	Environmental hormones, Pb, Cu, Cd, Al, N, P, Na, Cl, PVC
Netherlands	Heavy metal, nutrients, chlorinated compounds, PVC
Norway	Cr, As, Cu, Pb, Ni, Zn, dioxin, PBB, PBDE, nonylphenol
Sweden	Cd, Cr, Cu, Pb, Hg, Ni, Zn, Sb, PBDE, PAHs, APA, DEHP, PFOS
Switzerland	Cd, dioxins, furan, PBB, PBDE, halogenated solvents, metal & non-metal in the e-waste
Taiwan	Steel, sand & gravel, fossil fuel, water resource, Cr, Cd, dioxin, PET, paper

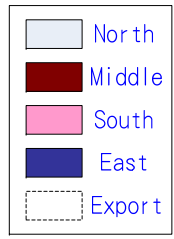
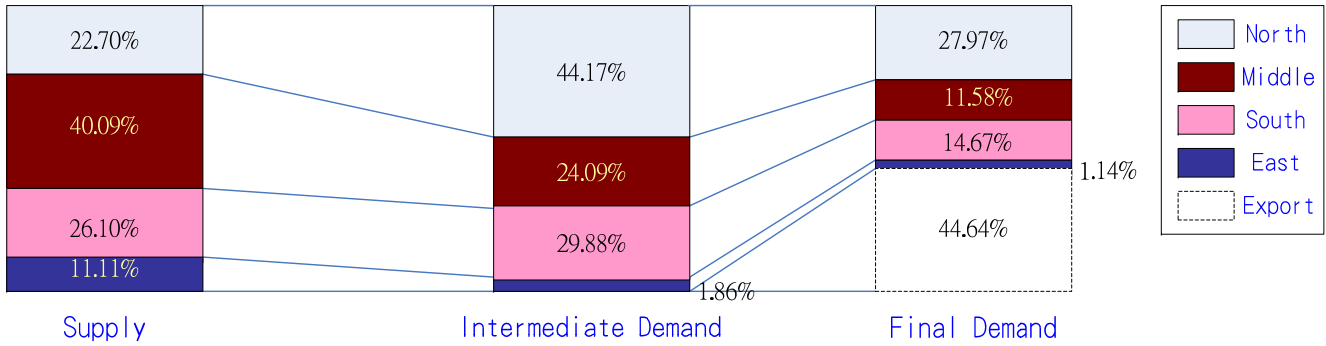
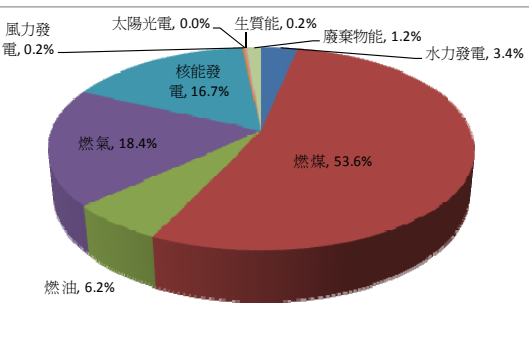
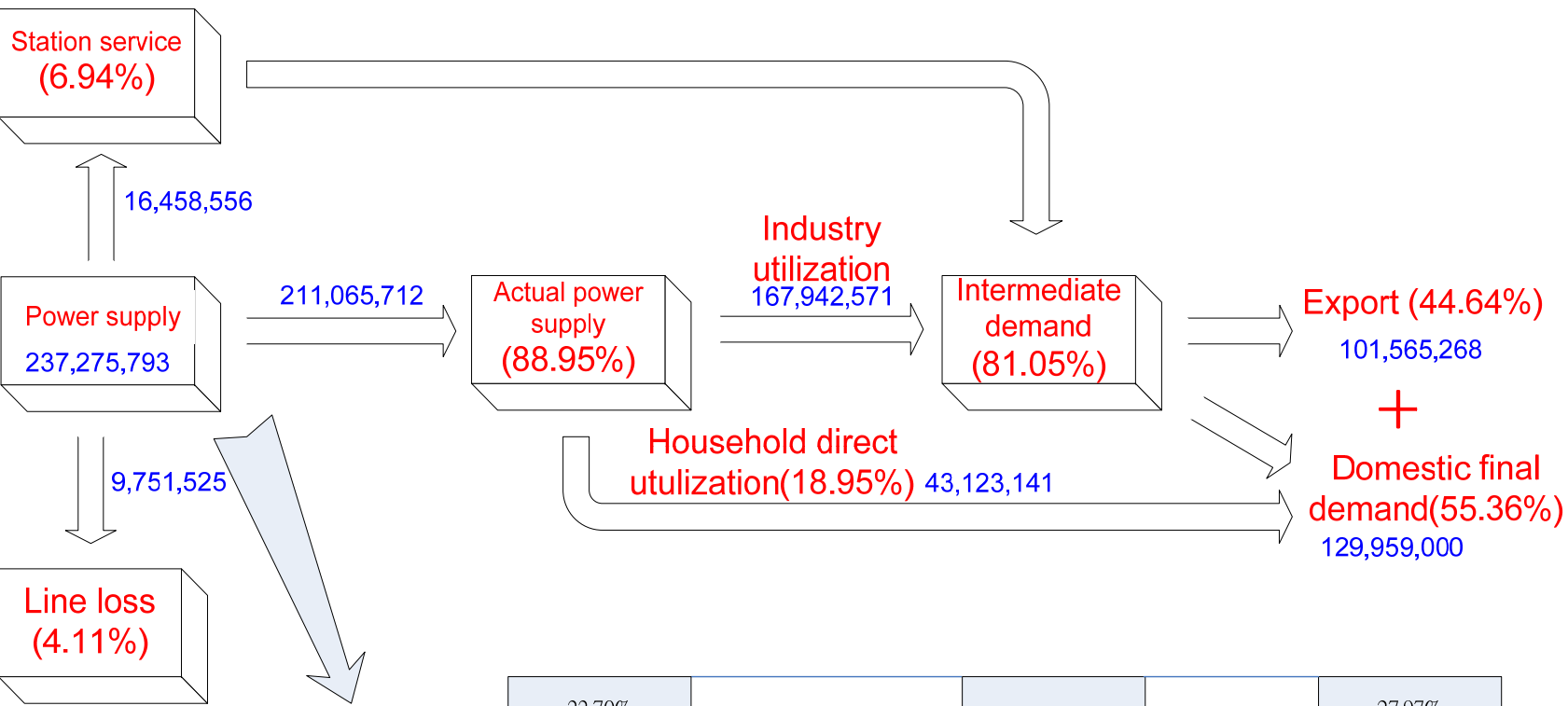
Source : European Environment Agency (2007)

Cases of Application

Dioxins



Electricity Flow



Database

Hot material and substance

Category	Material (substance)
Bulk material resource	Biomass, Fossil fuel, Aggregates, Ferro-material,
Elemental resource	Nutrients of nitrogen and phosphorus, Aluminum, copper, noble metals, carbon
Toxic substance	Heavy metal, PCDDs, PCDFs, BFRs, POPs, VOCs, Endocrine disruptor, pesticide, synthesized chemicals
Aggregated materials	Waste, electrical appliance, particulate matter, plastics, paper



Theme database	Relevant government agency	Query term
Energy flow	Bureau of Energy(能源局)	Import, type, usage
Electrical appliance	Ministry of economic affair(經濟部)	Eco profile, RoHS restricted substance content, composition
Wood and paper	Council of agriculture(農委會)	import ,production,
Biomass	Council of agriculture(農委會)	Water content, heat value, carbon content
Metals	Bureau of mine礦物局	Import, export, domestic, recycle
Construction aggregate	Bureau of mine礦物局	Import, export, domestic, reuse
Hazardous substance	EPA(環保署)	Mass, waste constituent, industry, facilities, treatment, destination, hazard
Emission factor	EPA(環保署)	Emission per unit production, consumption of raw material, fuel burned, pretax income. Control tech.



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Toxics Release Inventory

Maps

Hints for First-time users Assumptions used in the analysis
 This site uses pop-up windows, click here for help on allowing pop-ups from this site [Go To New Report](#)

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- Release Reports
- Waste Transfer Reports
- Waste Quantity Reports

Reports:

- Chemical
- Facility
- Federal Facility
- Trends
- Geography
- Industry

Maps:

- Dynamic

Year of Data

2006

Geographic Location

U.S. by State

Chemical Released

Use selected chemical(s)

Industry

All Industries

Data Set

The default is the current data update (as of June 11 2008)

Select 2006 PDR data set (frozen on October 12, 2007 and released to the public on February 21, 2008)

Map it!

Releases

- Total On-site Disposal or Other Releases
- Total Off-site Disposal or Other Releases
- Total On-and Off-site Disposal or Other Releases

EPA TRI Explorer | US EPA - Mozilla Firefox

http://www.epa.gov/triexplorer/chemist.htm

Select one or more chemicals

Click a chemical to select

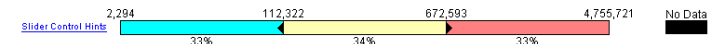
- Mecoprop (listed 1995)
- Melamine (delisted 1988)*
- Mercury
- Mercury Compounds
- Morphos (listed 1995)
- Methacrylonitrile (listed 1994)

Click a chemical to deselect

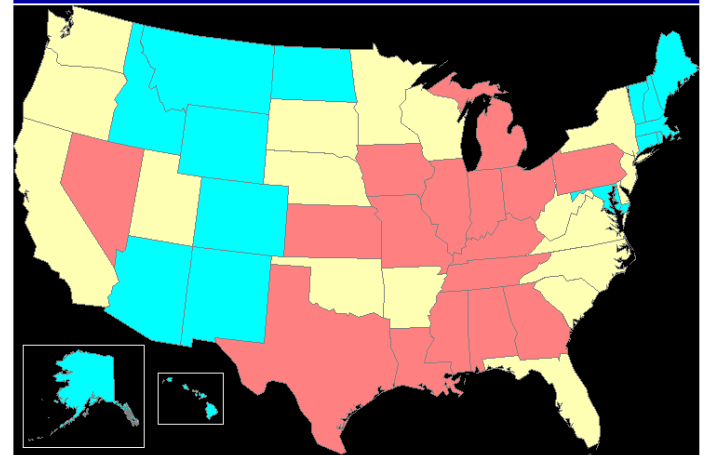
Mercury

Done Cancel

http://www.epa.gov/cgi-bin/tri.getcounties?report=maps&scriptname=maps&state=c_tabrpt=1&c_chk0=false&c_chk1=false&



County Detail State Detail Map Hints

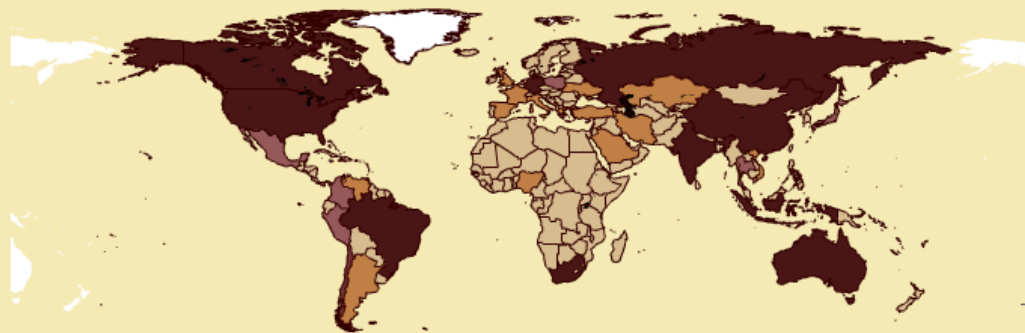


Sustainable Europe Research Institute

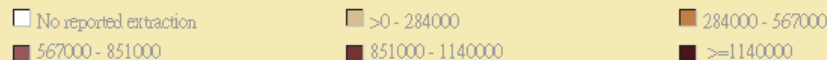
Visualising Global Resource Extraction

Domestic Extraction:
 Reference Parameter:
 Resource Group:
 Resource Sub-Group:
 Year:

Used extraction in 2005 (in kt)



© Sustainable Europe Research Institute 2008



::Download Area::

You have selected used extraction

Last update: 31/07/2008

Additional download specifications:

Year: from until
 Time Period: Country Group:
 Country:

(.xls format)

Eurostat



Important legal notice

v2.2.A.9-20081023_1528-prod

View Table Select Data Demo Tour



Material flow accounts

Interactive extraction size limit: 30000

Current extraction size: 360

Selected Update

GEO MA MFC TIME UNIT

Show all Search

<input type="checkbox"/>	Code	Label
<input checked="" type="checkbox"/>	MA_0	Total
<input type="checkbox"/>	MA_1	Biomass
<input type="checkbox"/>	MA_2	Minerals
<input type="checkbox"/>	MA_3	Fossil fuels

UNIT: 1000T - Thousands of tons

MA: MA_0 - Total

MFC: DE - Domestic Extraction

time	1993A00	1994A00	1995A00	1996A00	1997A00	1998A00	1999A00	2000A0
geo								
EU15	4713803.30	4877486.64	4842995.98	4821997.56	4838575.23	4841399.22	4924358.93	4934518.
BE	115279.54	123940.24	120083.51	119821.55	118546.18	114279.49	118239.00	115075.
DK	94440.68	98244.03	104244.26	108729.23	117288.35	112170.21	130077.50	124121.
DE	1307125.46	1375592.73	1335468.74	1306020.55	1286092.96	1250588.34	1284086.67	1243620.
IE	61043.38	63507.65	69262.53	71593.18	68131.22	68634.38	71727.33	72908.
GR	154916.41	156412.82	154395.86	159950.13	160633.54	173217.82	176823.72	181465.
ES	395604.07	395993.66	406903.86	432284.60	437800.19	468455.16	468839.47	500120.
FR	752993.62	762301.17	758427.68	729139.27	744927.30	751481.60	757620.27	779978.
IT	461462.80	462591.15	458194.39	460333.91	457838.97	461090.31	464092.99	470366.
NL	176316.11	183902.63	173284.59	197359.84	188627.13	184998.30	177110.25	162900.
AT	123217.24	130347.92	124780.10	123631.80	130823.56	121175.02	123480.89	119168.
PT	83017.07	85591.75	86970.54	99694.30	105976.33	106858.93	106527.04	119294.
FI	139409.42	154485.49	153737.63	143682.88	154856.06	154624.84	167767.44	171989.
SE	180249.16	179449.05	193629.33	173136.76	169747.25	179704.89	175754.89	192936.
UK	668728.33	705126.35	703612.94	696619.57	697286.20	694119.93	702211.46	680571.

No footnotes available

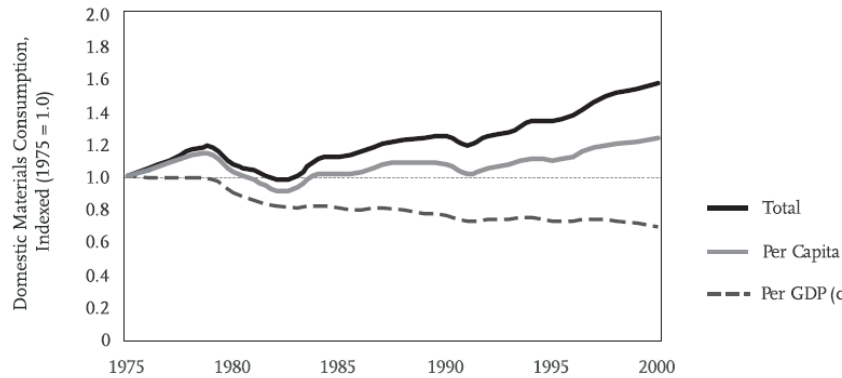
MFA Tools

Physical and economical accounting

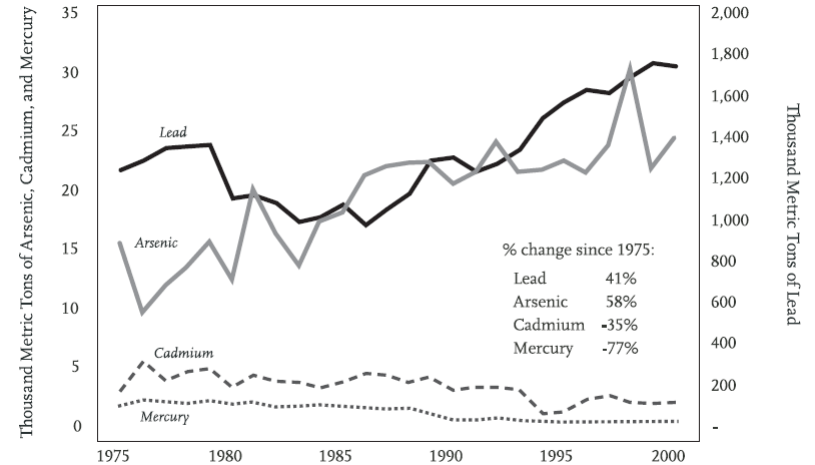
Level of analysis	Substances	Material groups		All material groups and monetary flow
Products/ Firm	SFA	<i>Micro-MFA</i> LCA, MIPS		
Sectors	SFA/EIO	<i>Meso-MFA</i> MFA of selected sectors or activity fields		<i>Integrated economic and environmental accounting</i>
		PIOT	EIO-LCA	NAMEA
Region/Nation	<i>Partial Macro-MFA</i> SFA	<i>Macro-MFA</i> Economy wide MFA		SEEA

Time series analysis

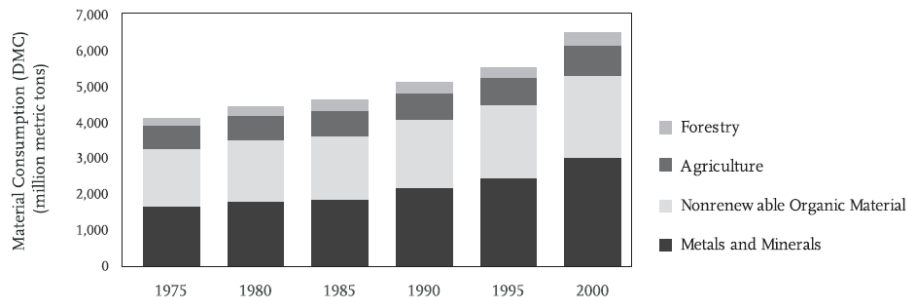
Total flow per capita(GDP)



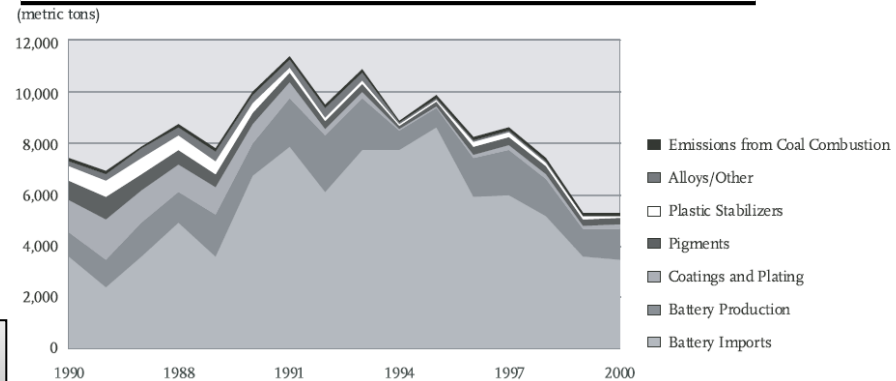
Comparison of over substance



Demand over sectors



Contribution of each use



Source:
World Resource Institute

Indicators

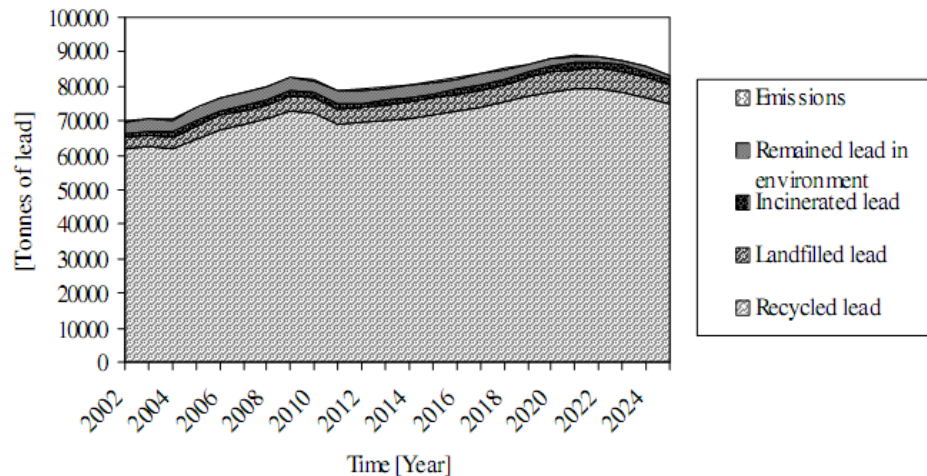
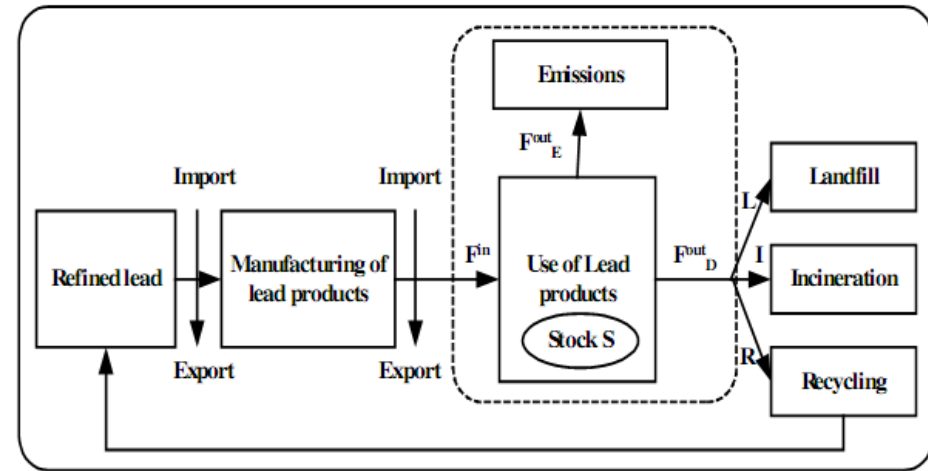
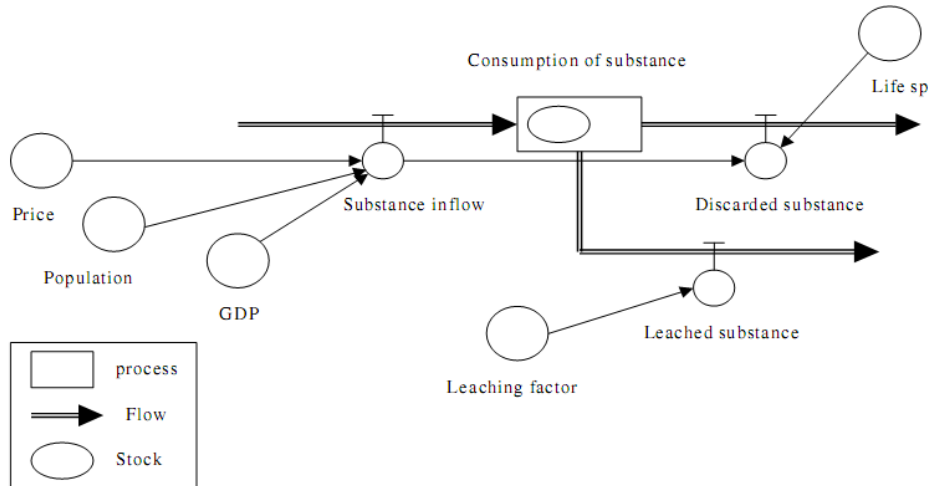
Indicator category	Indicator		Accounting rules
	acronym	Full name	
Import	DMI TMR HF	Direct Material Input Total Material Requirement Hidden flows	DMI=Domestic raw materials+Imports TMR =DMI+HF HF=hidden flows domestic + hidden flows from imports
Export	DPO DMO TDO TMO	Domestic Processed Output Domestic Material Output Total Domestic Output Total Material Output	DPO=Emissions +Waste DMO=DPO +Exports TDO=DPO +hidden flows domestic TMO=TDO +Exports
Consumption	DMC TMC	Domestic Material Consumption Total Material Consumption	DMC=DMI-Exports TMC=TMR-Exports-hidden flows exported
Balance	NAS PTB	Net Addition to Stock Physical Trade Balance	NAS=DMI-DPO-Exports PTB=Imports-Exports

*In addition, balancing items have to be included:

On the input side – oxygen for the combustion of fuels and for the respiration of humans and livestock

On the output side – water vapour from the combustion of fuels and water vapour and CO₂ from the respiration of humans and livestock

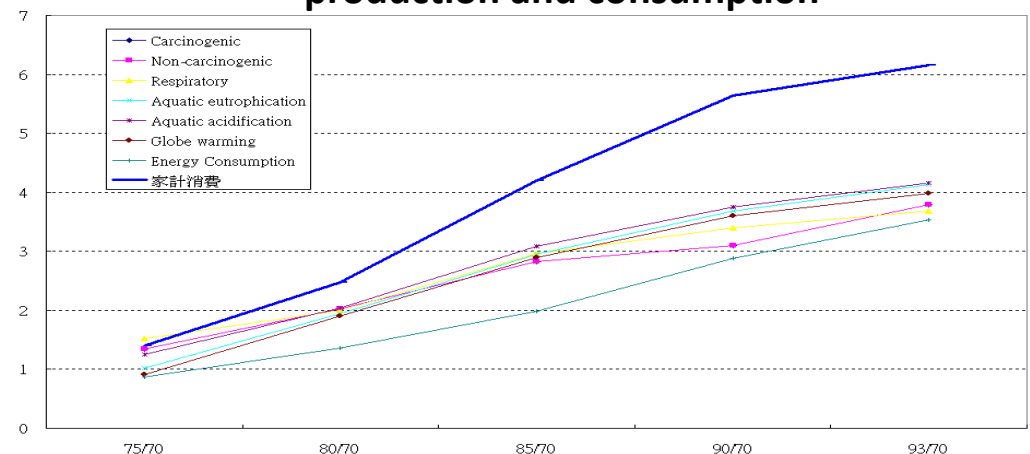
Dynamic material (substance) flow



Monetary Input-output analysis & PIOT

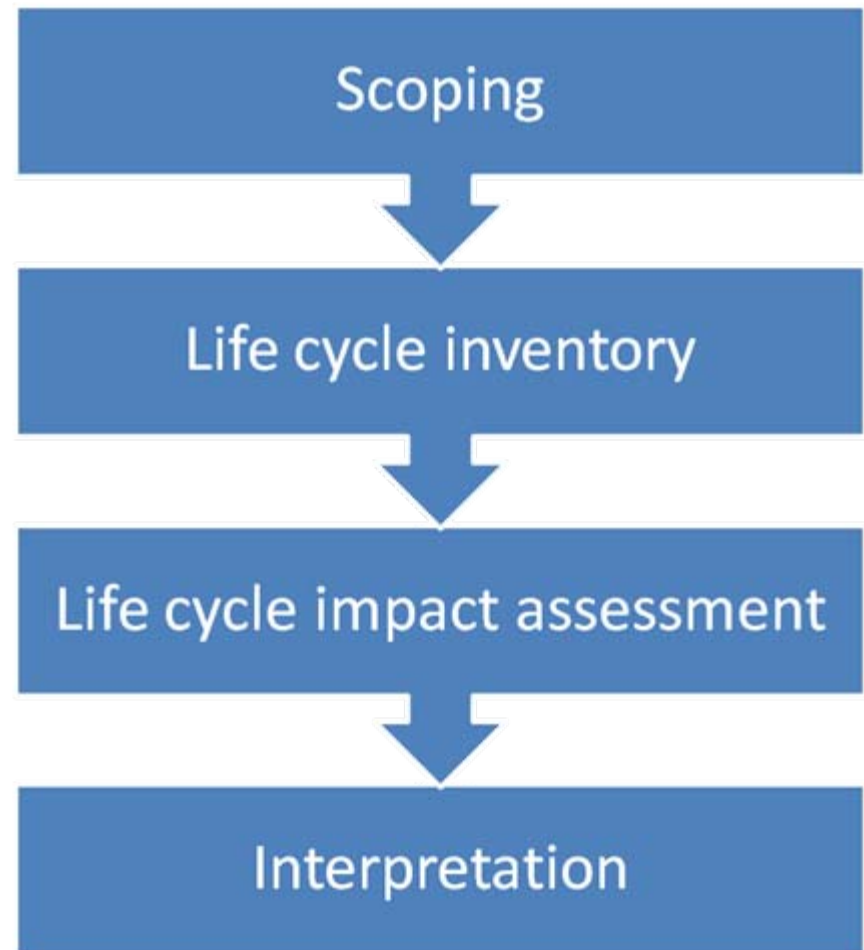
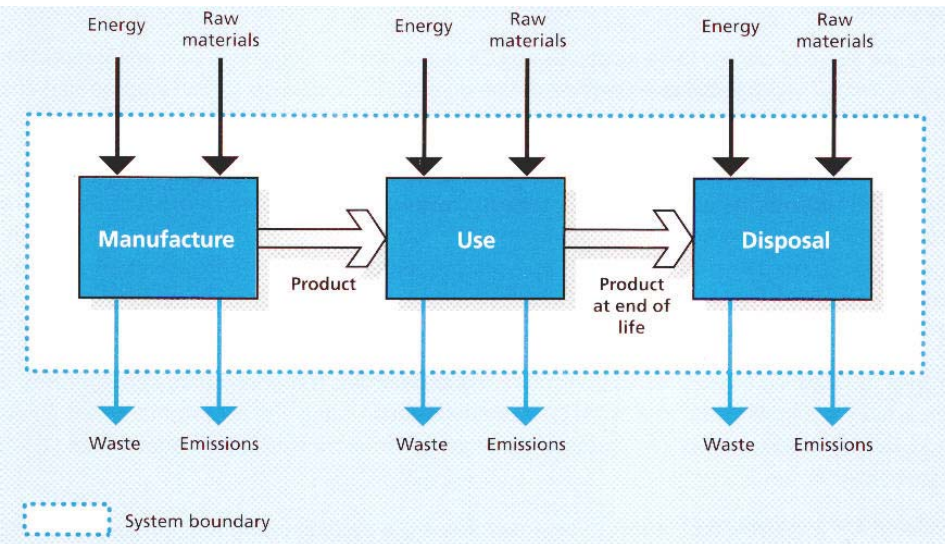
	Agriculture	Manufacturing	Service	...		Intermediate demand	Final demand
Agriculture	Z_{11}	Z_{12}	Z_{13}	Z_{1j}			Y_1
Manufacturing	Z_{21}	Z_{23}	Z_{23}	Z_{2j}			Y_2
Service	Z_{31}	Z_{32}	Z_{33}	Z_{3j}			Y_3
...	Z_{i1}	Z_{i2}	Z_{i3}	Z_{ij}			Y_j
Total input							

Environmental impact due to production and consumption



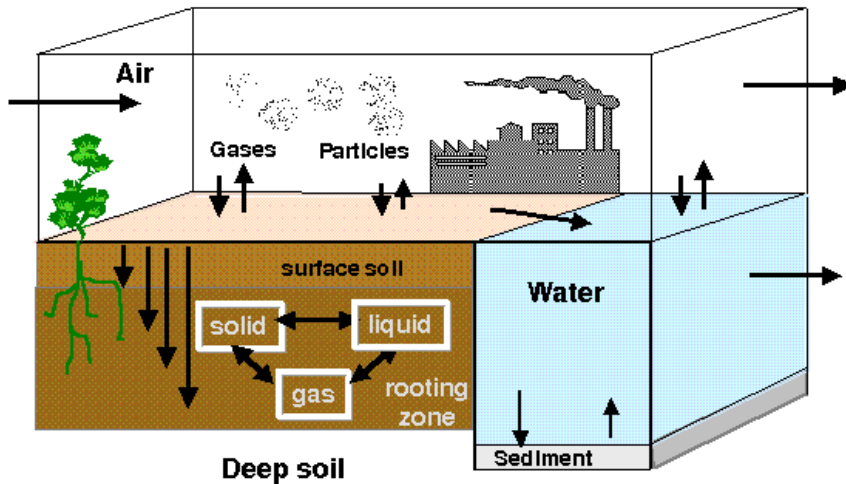
- Derive environmental indicators and impacts
- Predict environment impact driven by the economy
- Analyze interrelationship between sectors

Life cycle assessment

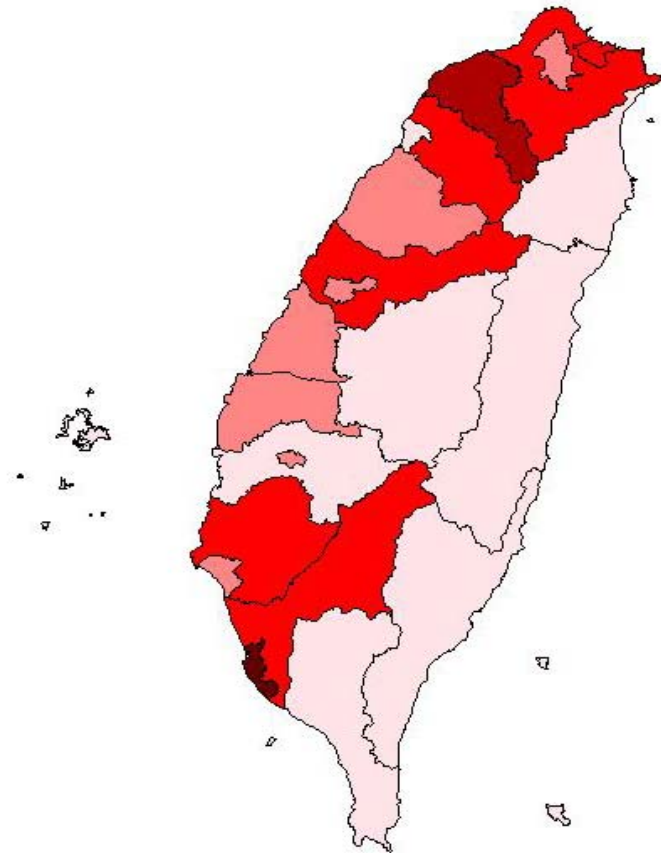


Environmental risk assessment

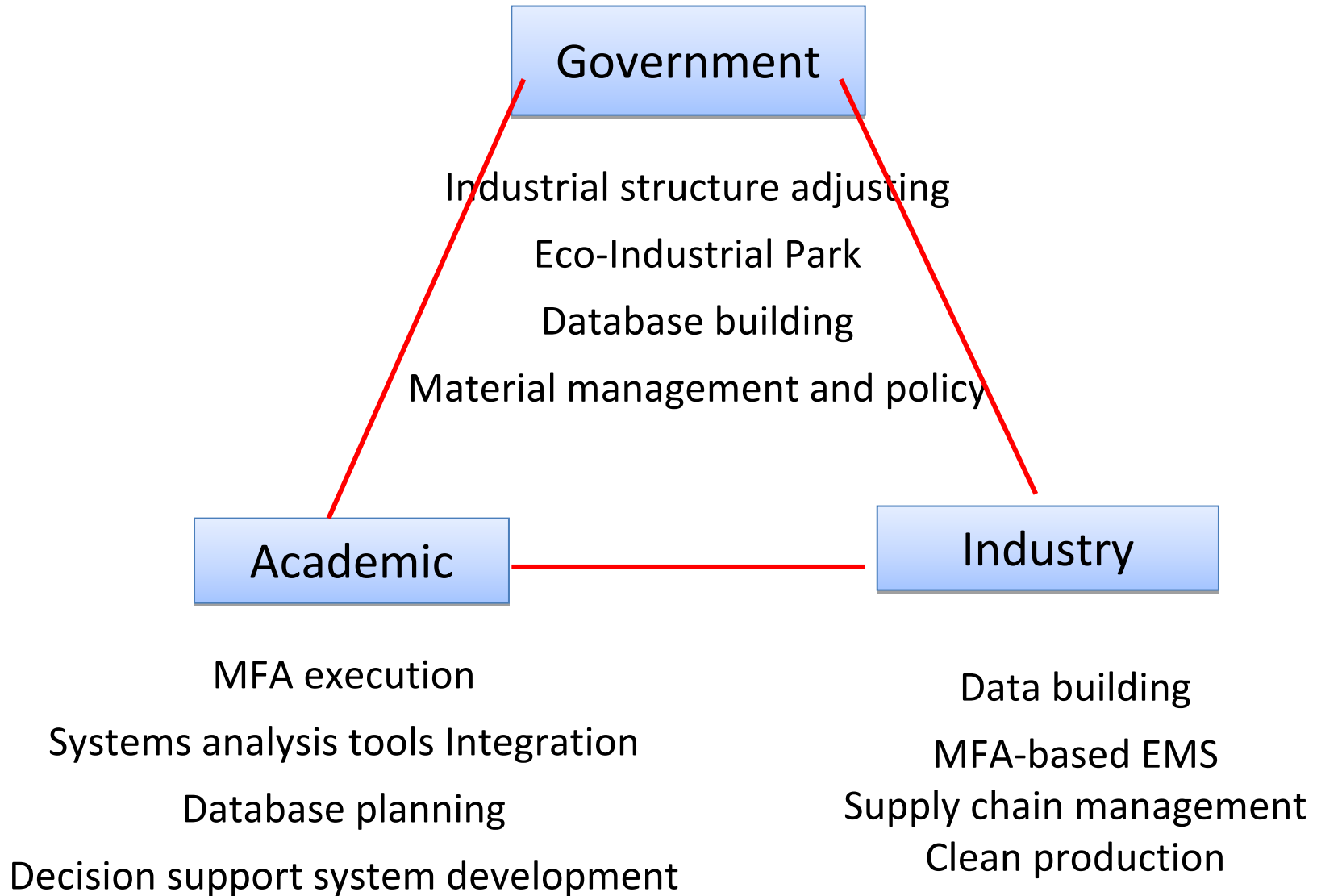
Interflow between environmental compartment



Risk distribution



Outlook



Thanks for Listening