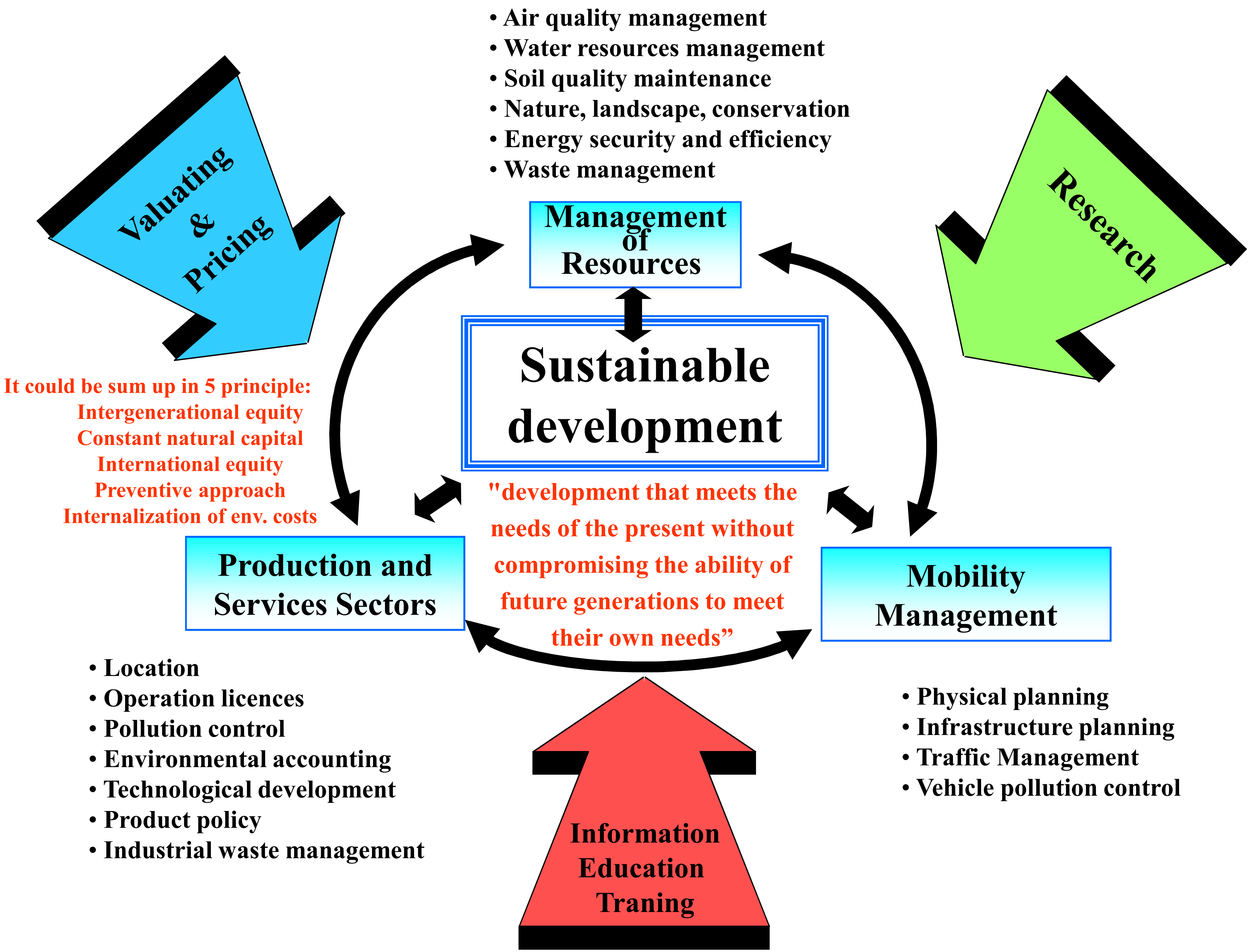
INDUSTRIAL ECOLOGY TOOLS (LCA, ECODESGN, INDUSTRIAL SYMBIOSIS FOR DEVELOPMANT OF MATERIALS, SECOND LIFE PRODUCTS AND INNOVATION

Luciano Morselli

University of Bologna – CIRI Energia e Ambiente

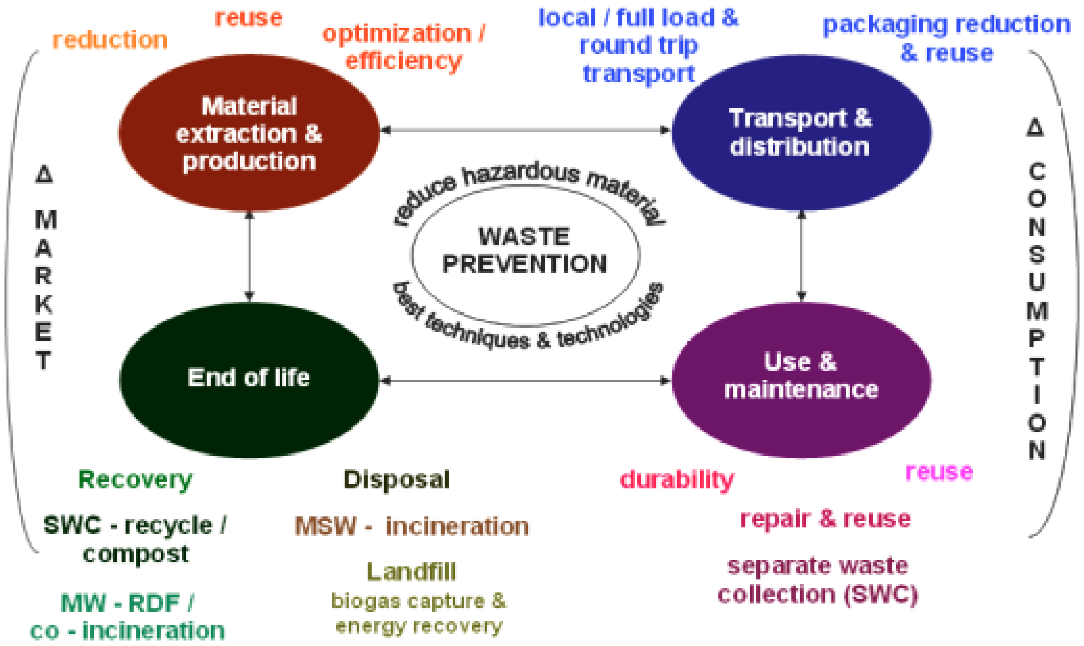
LoWaste – Local Waste Market
For Secon Life Products
Bruxelles 6 March 2014



• Air quality management
• Water resources management
• Soil quality maintenance
• Nature, landscape, conservation
• Energy security and efficiency
• Waste management
Valuating & Pricing
Management of Resources
Research
It could be sum up in 5 principle:
Intergenerational equity
Constant natural capital
International equity
Preventive approach
Internalization of env. costs
Sustainable development
"development that meets the needs of the present without compromising the ability of future generations to meet their own needs”
Production and Services Sectors
Mobility Management
• Location
• Operation licences
• Pollution control
• Environmental accounting
• Technological development
• Product policy
• Industrial waste management
Information Education Traning
• Physical planning
• Infrastructure planning
• Traffic Management
• Vehicle pollution control

Waste Management and Industrial Ecology

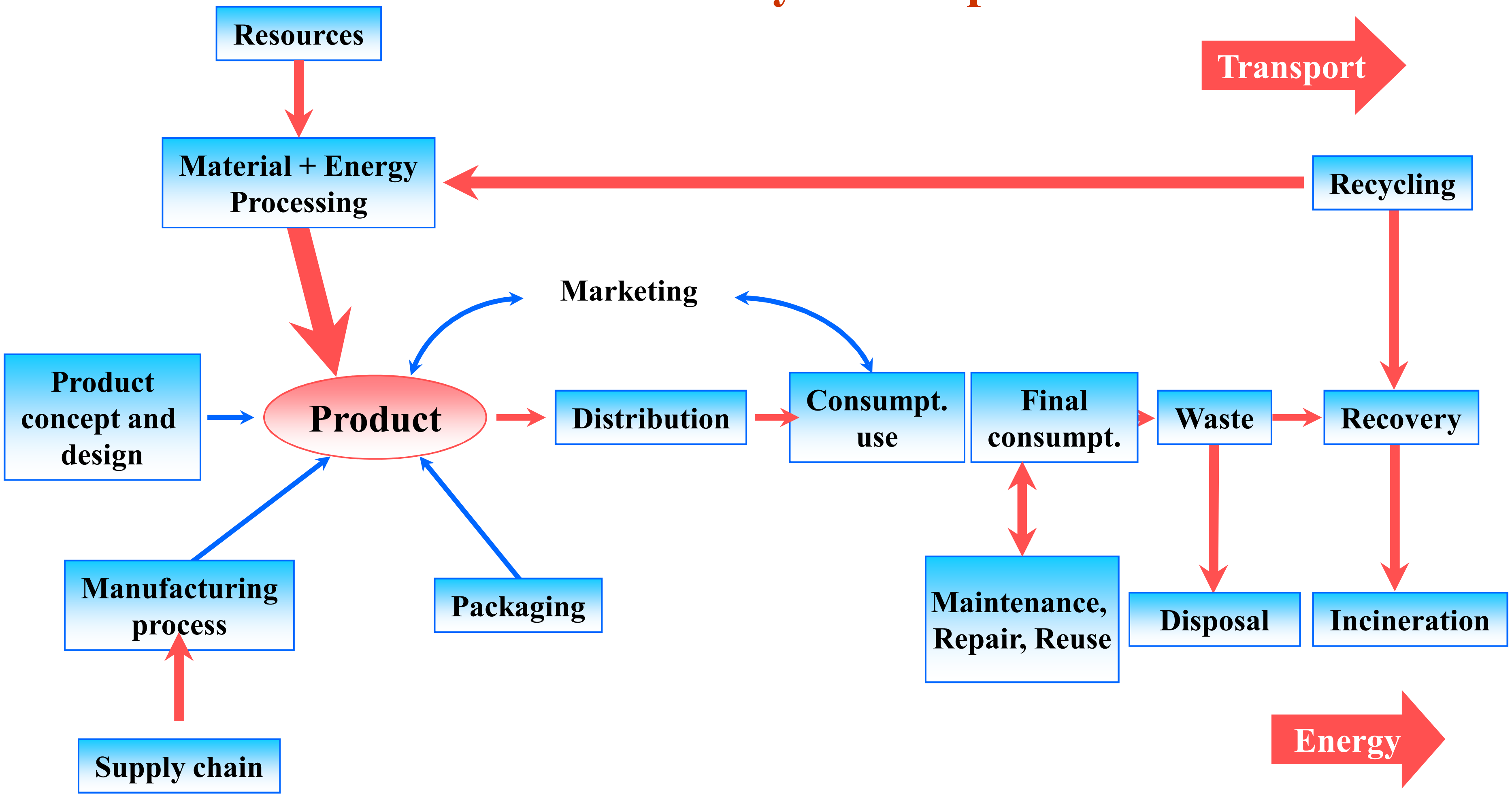
IE is system-based, multidisciplinary discourse that seeks to understand emergent behavior of complex integrated human/natural systems". IE approaches issues of sustainability by examining problems from environmental, economic and social perspectives



The awareness of environmental emergencies, technical and scientific progress together with the sense of responsibility towards the next generations do not allow to ignore or postpone over the need to answer the claim for more sustainability. IE tools allow an overall systemic approach for supporting theoretically and practically the concept of waste as resource.

INTEGRATED PRODUCT POLICY

Schematic life cycle of a product



The whole life cycle of products covering all stages from the mining of raw materials to the production, distribution, use, recycling and/or recovery and final disposal as well as to a broad approach integrating various instruments to achieve the goal of greening of products on the basis of co-operation with stakeholders.

EU environmental policy guidelines for years 2002 - 2012

SIXTH ENVIRONMENTAL ACTION PROGRAMME OF THE EUROPEAN COMMUNITY 'Environment 2010: Our future, Our choice' COM (2001) 31

UE WASTE DIRECTIVE (2008/98/CE)

Mandatory targets for waste prevention, reuse and recycling

Incineration and Lanfills

A crucial point is the reduction of waste sent to incinerators and landfills

Hierarchy

Prevention

Preparing for re-use

Recycling

Other Recovery (en.)

Env. safe disposal

SUSTAINABLE DEVELOPMENT

Environmental Sustainability; **Economic Sustainability** **Social Acceptability**

Recycling Culture; Education; Information,

Diffusion of Information and Communication

WASTE MANAGEMENT **Recycling-oriented**	**Reference tools**
Environmental Policy and Strategies – Sustainable Development ***European and national sector rules***	***Documents*** *(VI Action Program 2000-2010);* ***Communications (COM-667)2005. European Direct.***
Flow Analysis (in Europe-in Italy) **Integrated Waste Management System**	***National Reports*** ***European Reports*** ***CONAI-Consortia Reports***
Waste Collection Systems – Treatment and Recovery Technologies. BAT (Best Available Techniques) Mixed waste □ Preselection □ Product sorting □ suitable treatments and technologies □ materials to be recovered in different product cycles □ Re-Products or thermal process for energy recovery Separate collection of different waste materials □ specific treatments and technologies □ materials to be recovered in the same production cycle of the initial product □ Re-Products	***Planning (National, regional e provincial)*** ***Information*** ***Education*** ***Fiscal benefits (rate system)*** ***BAT*** ***IPPC and guidelines*** ***LCA***
Composition and physico-chemical analysis of the different flows of collected and separate waste related to recovery potential and to the presence of pollutants or precursors of contaminants	***Methodologies: ASTM , ISO-UNI, etc.***
Adoption of material or energy recovery technologies based on the performed characterisations and on BAT	***Legislation, Case Studies, Environmental Controls, Risk Analysis***
RE-PRODUCTS It is the final step of recycling, which can be considered achieved even considering the marketing of obtained products and the features and functions compared to the goods produced from raw materials	***Certifications, Eco-design , Eco-Label, EPD, GPP, (e.g. MATREC ECOFATTO)***

“WASTE AS RESOURCE”
A CONTRIBUTE FROM INDUSTRIAL ECOLOGY PRACTICES

A delay in adopting an integrated waste management system by most of the Member States still occurs. Among others, reasons of such a delay must be sought in obstacles when creating markets for secondary products, adopting criteria for minimum rates of recycled materials in production, extending lifetimes of products and producers’ responsibility, or standardizing measures in the waste management.

Moreover, the EU claims countries to adopt tools and indicators to quantify and assess environmental performances of systems and strategies.

In this sense, Industrial Ecology (IE) supports the seek for a development consistently based on circular flows of material and energy as much as on environment and human health protection.

Specifically, a systemic approach to environmental issues is guarantee by applying methodologies as IE.

Policy approache (e.g. Integrate Product Policy).
Integrated Environmental Monitoring System,
Life Cycle Assessment,
Material Flow Analysis,
Ecodesign,
Industrial Symbiosis ,
Risk Assessment

Indeed, these methodologies answer the necessity to face emergencies related with waste management reflecting criticalities from recovering materials embedded in waste flows and agglomerates, and they inspired part of the contemporary research to consider human conglomerates as "mines of the future" (e.g. urban mining).
The awareness of environmental emergencies, technical and scientific progress together with the sense of responsibility towards the next generations do not allow to ignore or postpone over the need to answer the claim for more sustainability.
IE tools allow an overall systemic approach for supporting theoretically and practically the achievement for a society based on the pillar of "waste as resource" in a Green Economy contests.

Industrial Ecology practices and tools

Industrial Ecology

Material Flow Analysis (MFA) aims at identifying and quantifying flows and stocks of materials and substances within a system at space and time defined.

Considering waste as resource, MFA helps to define strategies for considering human societies as mines of the future (e.g. urban mining)

Life Cycle Assessment (LCA) estimates potential impacts to the environment associated with a product or a process along the whole life cycle.

It is indicated by EU as appropriate approach to validate the European Waste Hierarchy in decision-making.

Industrial Symbiosis (IS) aims to create a network of industry that exchange material and energy flows, in analogy with natural ecosystems where nothing is discarded.

Design for Environment (DfE)

Reduction of toxixity and de-materialization

Increase in recyclability of products

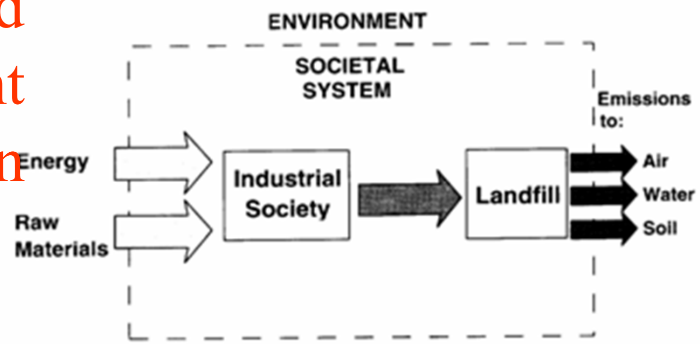
Ecodesign

Increase in renewable energy sources

Policy Approaches

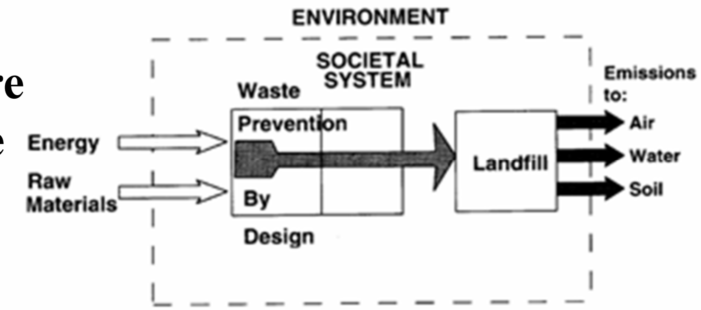
- **Extended/Individual Producers Responsability**
- **Environmental declaration and profile**
- **Green Public Procurement**

The role of IWMS is to reduce energy and row materials taken from the environment and on the same way to reduce emission from system to the environment



The Creation of Waste

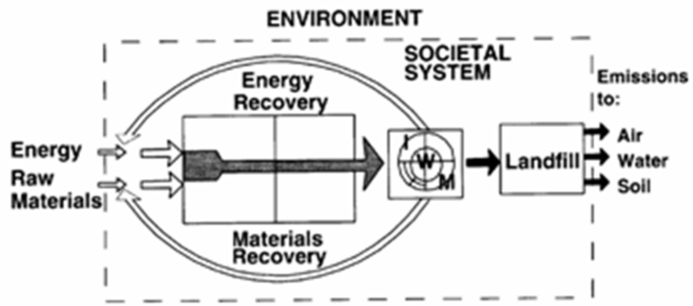
The respective roles of waste prevention and integrated waste management in life cycle studies is defined (indicated by broken line).
Energy and row materials from the environment are used in the system. Emission, including solid waste leave the system and enter into the environment.



Role of Waste Prevention

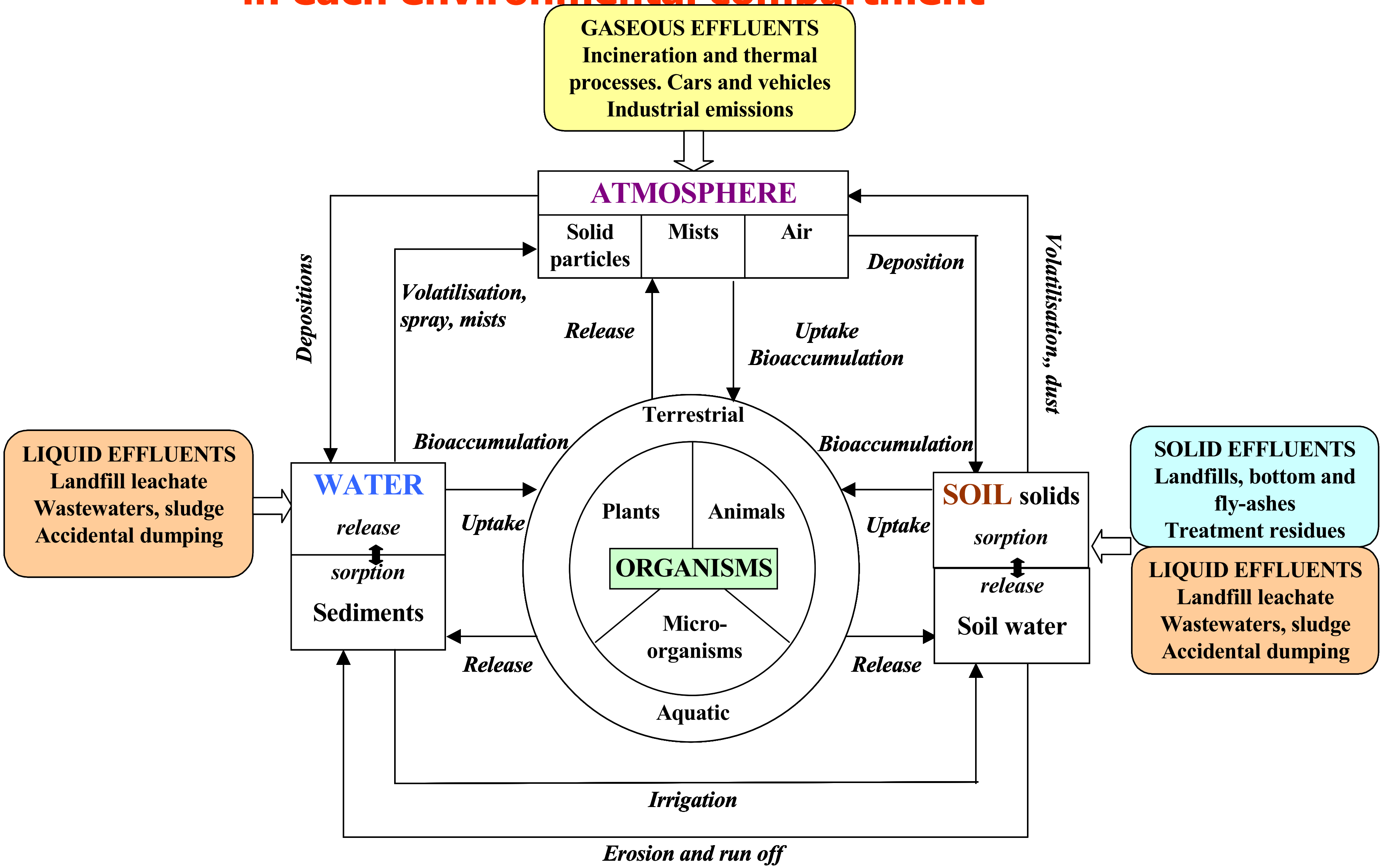
An IWMS must be:

integrated
market oriented
flexible
socially acceptable



Role of Integrated Waste Management

Environmental control by waste management in each environmental compartment

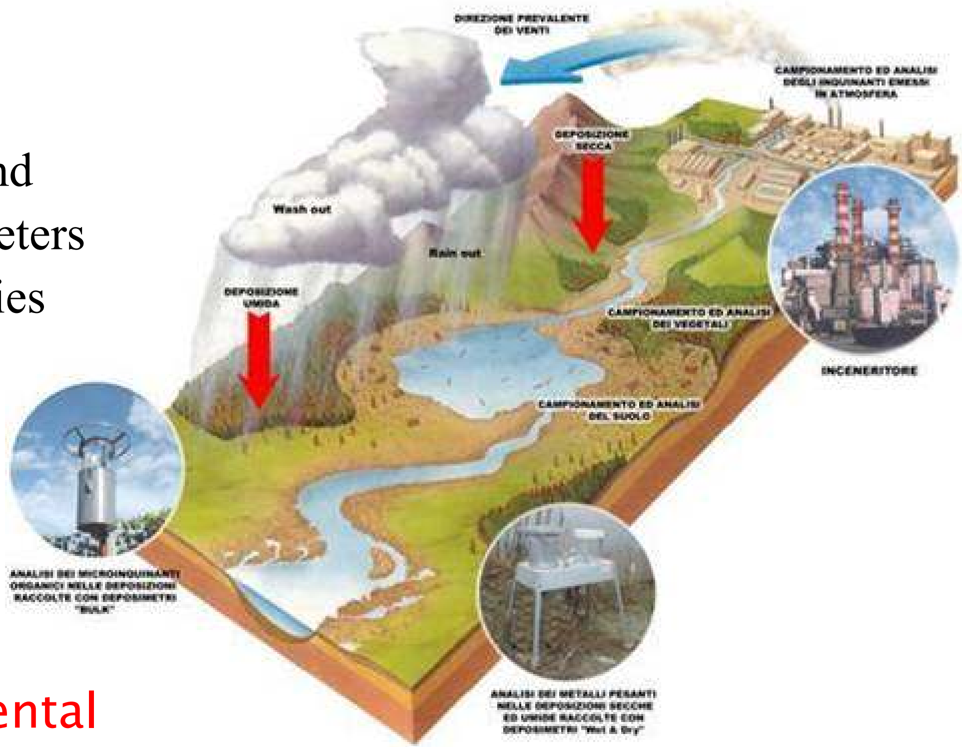


Environmental chemistry is the use of chemistry to understand macroscale systems in air, soil, and water, and their interactions with one another and the living things that inhabit them.

Integrated Environmental Monitoring System

Environmental Monitoring System – Periodically or on-going measurement and characterization of environmental parameters to determine pollutants by human activities in order to prevent negative effects in ecosystems and biosphere.

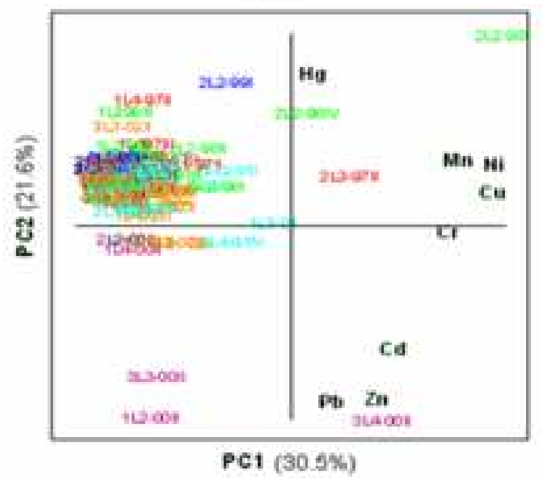
Source: European Environment Agency (EEA)



Characterization of the Environmental Compartments

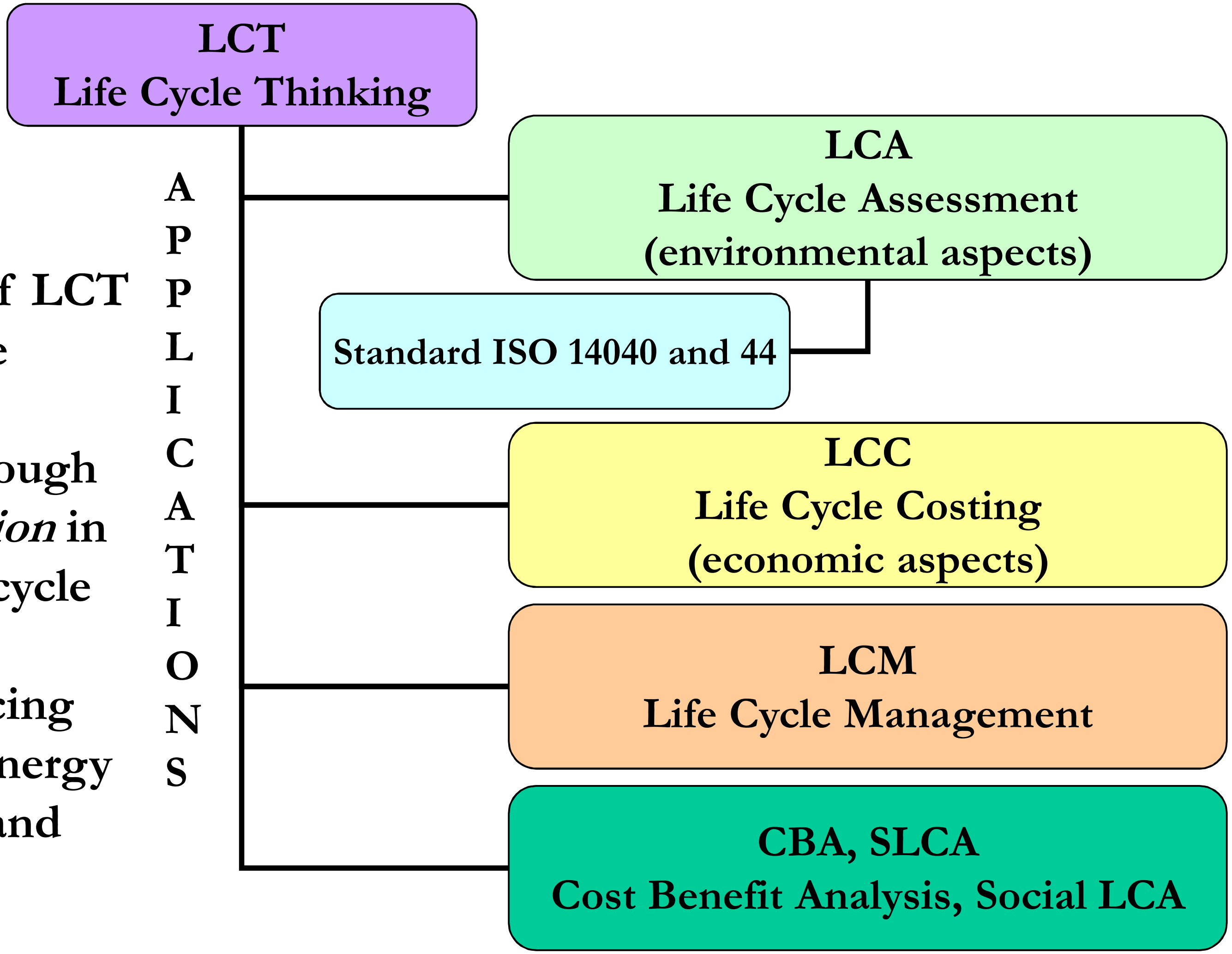
Characterization of the Contamination Source

Data Elaboration and Study of Correlations



Life Cycle Thinking

The concept of LCT is based on the principles of prevention through *impact reduction* in the whole life cycle of products or services, reducing material and energy consumption and limiting waste production.



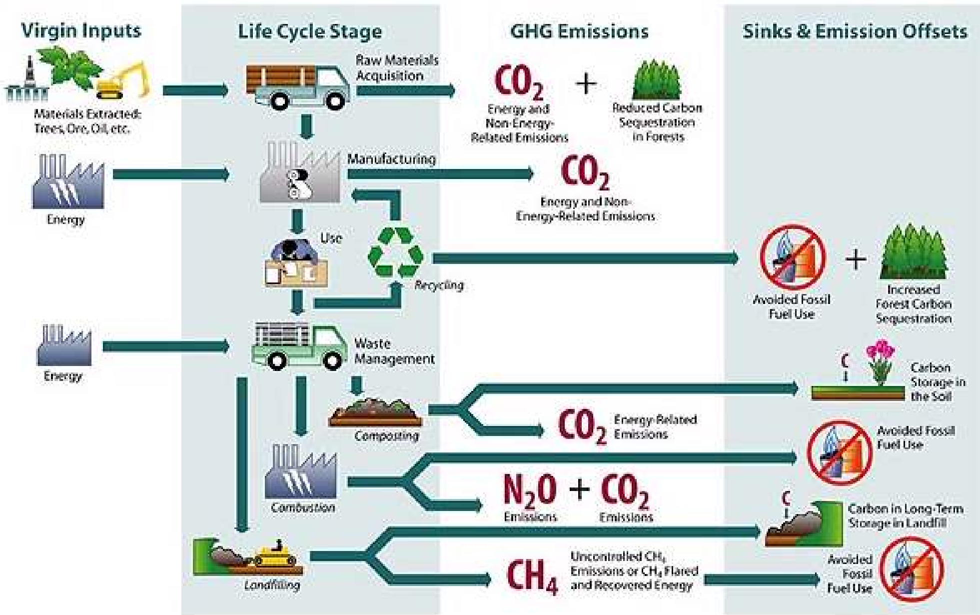
LCA Methodology

Definition: LCA studies environmental topics and potential impacts throughout the product or service life cycle, from raw material extraction, through fabrication and utilisation, till disposal (recovery/landfill).

References: ISO series 14040 and 14044: 2006 / Green Paper on Integrated Product Policy - IPP

Application:
Product environmental profile;
Recognition of system critical points;
Design of new products;

Environmental comparison between products technologies, processes…;
Environmental Product Declarations (EPD)

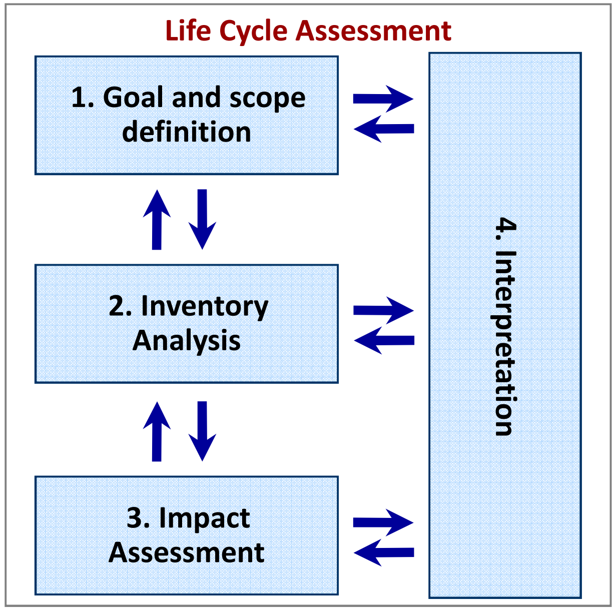


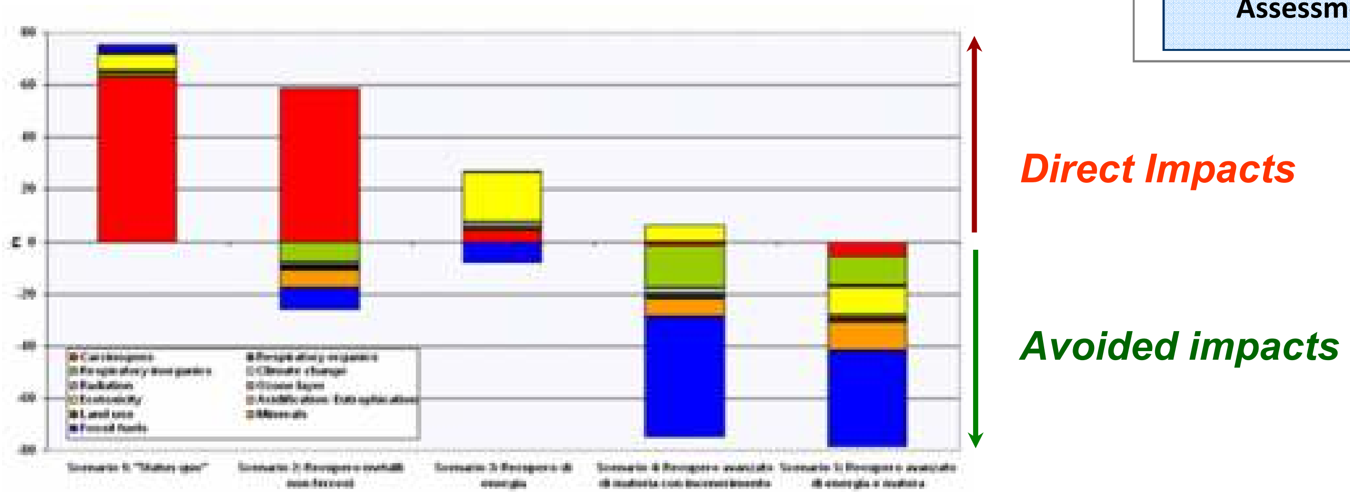
The main categories to be considered concern resource consumption, human health, and ecological consequences.

LCA method

Main steps:

- ***Goal and Scope Definition***
- ***Inventory Analysis*** (LCI): definition of input and output flows
- ***Impact Assessment*** (LCIA): characterization and valuation of environmental effects
- ***Interpretation*** of results and improvements





Some steps producing avoided impacts

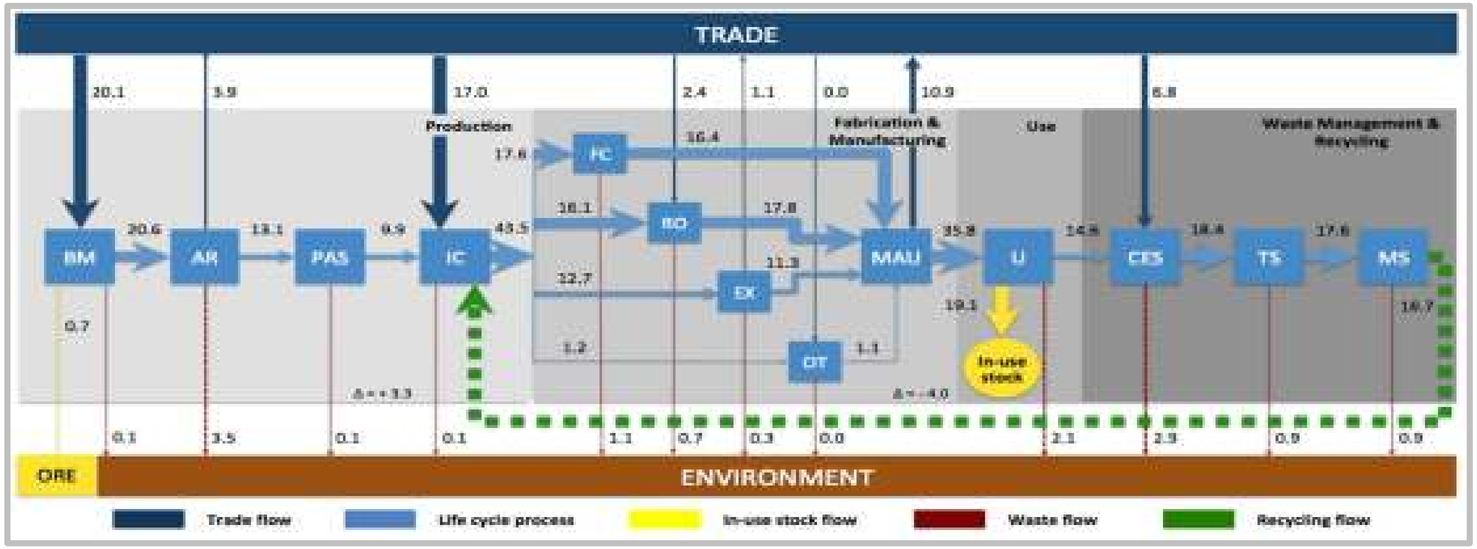
MFA – Material Flow Analysis

The Material Flow Analysis is a tool that exerts the Industrial Ecology concepts, aiming at the creation of circular economies consistently based on the exploitation of secondary material and energy flows.
It is Industrial as focuses on product design and manufacturing processes; and Ecology in sense of looking at natural ecosystem as model for industrial systems and assessing the source of resources used in society and the material sinks.
MFA is defined as a systematic assessment of the flows and stocks of materials with defined space and time.

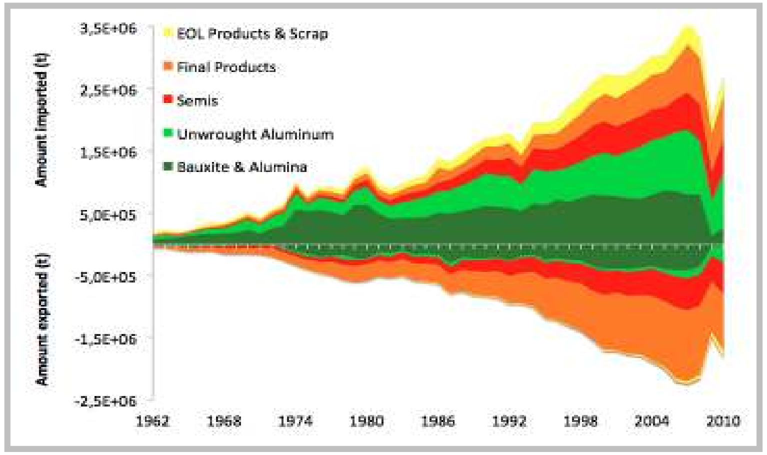
An intensive exploitation of natural reservoirs determines many resources are transformed in technological products. Since usually material inputs entering wide scale economies are larger than outputs, most human societies accumulate materials stocks within their boundaries. Based on the principle of mass conservation, the MFA is a useful tool to show the accumulation of material stocks in natural and anthropogenic environments.
The main application fields cover resource and waste management practices and initiatives oriented towards pollution control and environmental protection.
The former mainly includes metals at different scale level, while the latter shows interesting implications for industrial symbiosis case study.

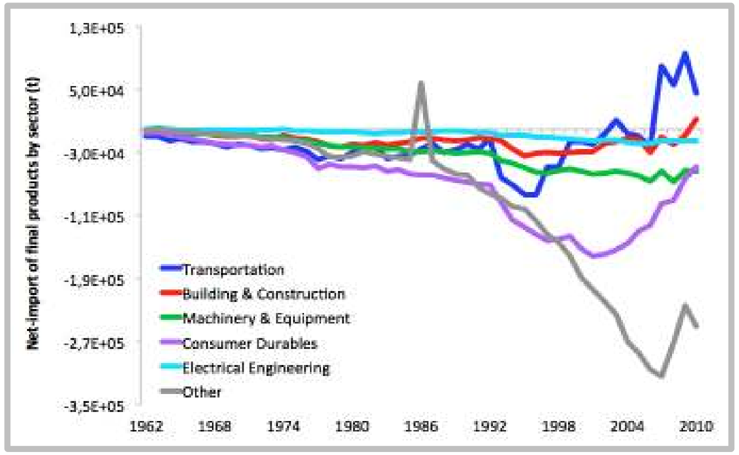
MFA applied to an industrial system

The anthropogenic aluminium cycle in Italy, years 1947-2009



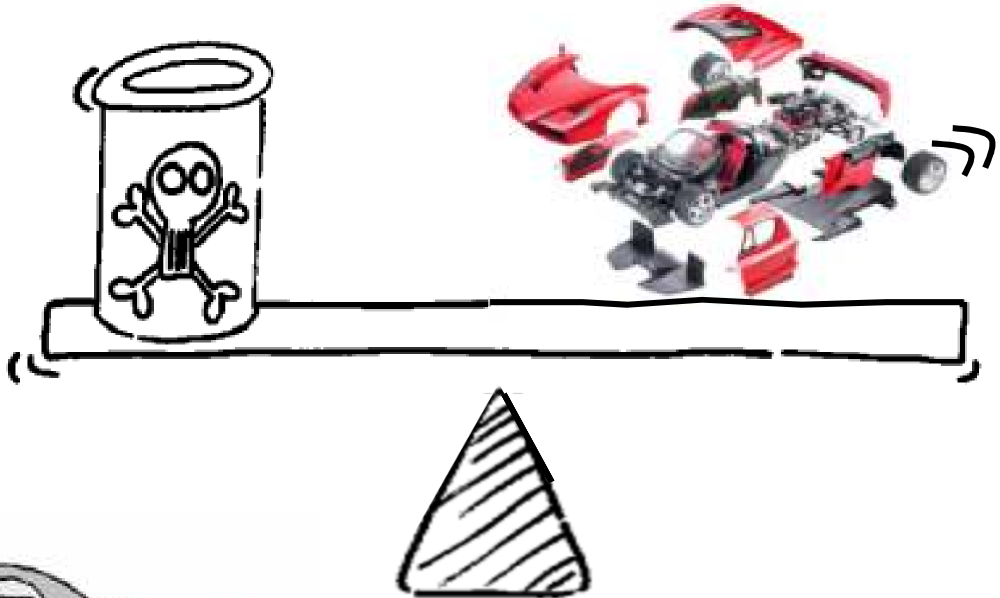
L. Ciacci, W. Chen, F. Passarini, M. Eckelman, I. Vassura, L. Morselli: *Historical evolution of anthropogenic aluminum stocks and flows in Italy*, Resources, Conservation and Recycling 73 (2013) 1-8.

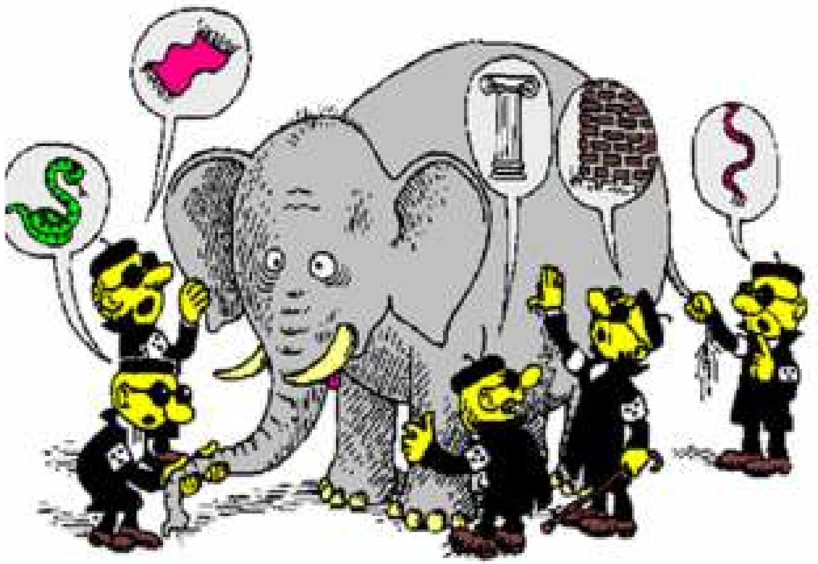




Eco-Design

Eco(nomy) / Eco(logy) + Design = EcoDesign



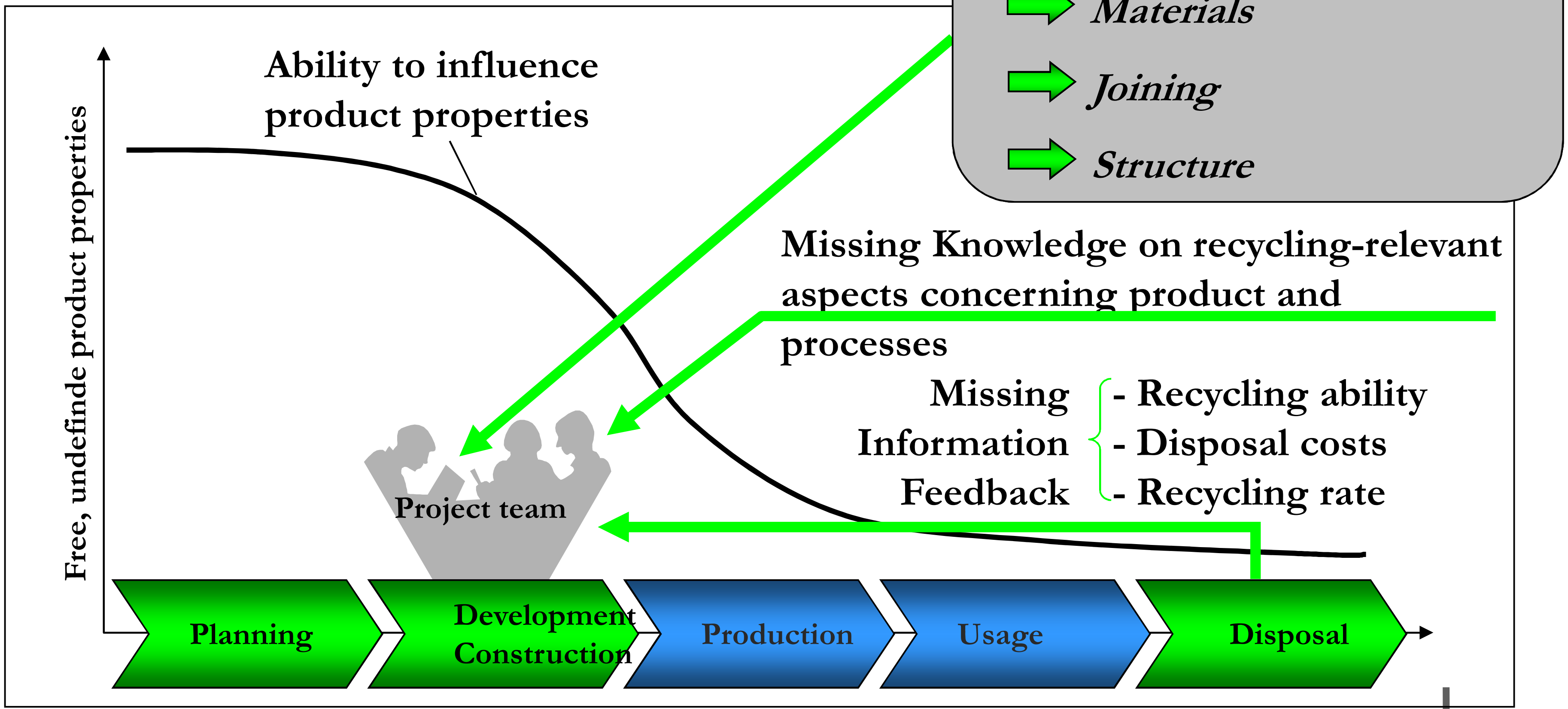


ECO-DESIGN:
"the integration of environmental aspects into the product development process, by <u>balancing</u> ecological and economic requirements".

ECODESIGN

A. Santini, C. Herrmann, F. Passarini, I. Vassura, T. Luger, L. Morselli: *Assessment of Ecodesign potential in reaching new recycling targets for ELVs*, Resources, Conservation and Recycling 54 (2010) 1128-1134.

Systematic integration of environmental issues in the design of the product, in order to improve environmental performance during the whole life cycle



[source: Hesselbach, Kühn, 1998]

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Economics in Waste Management (ex. ELVs)

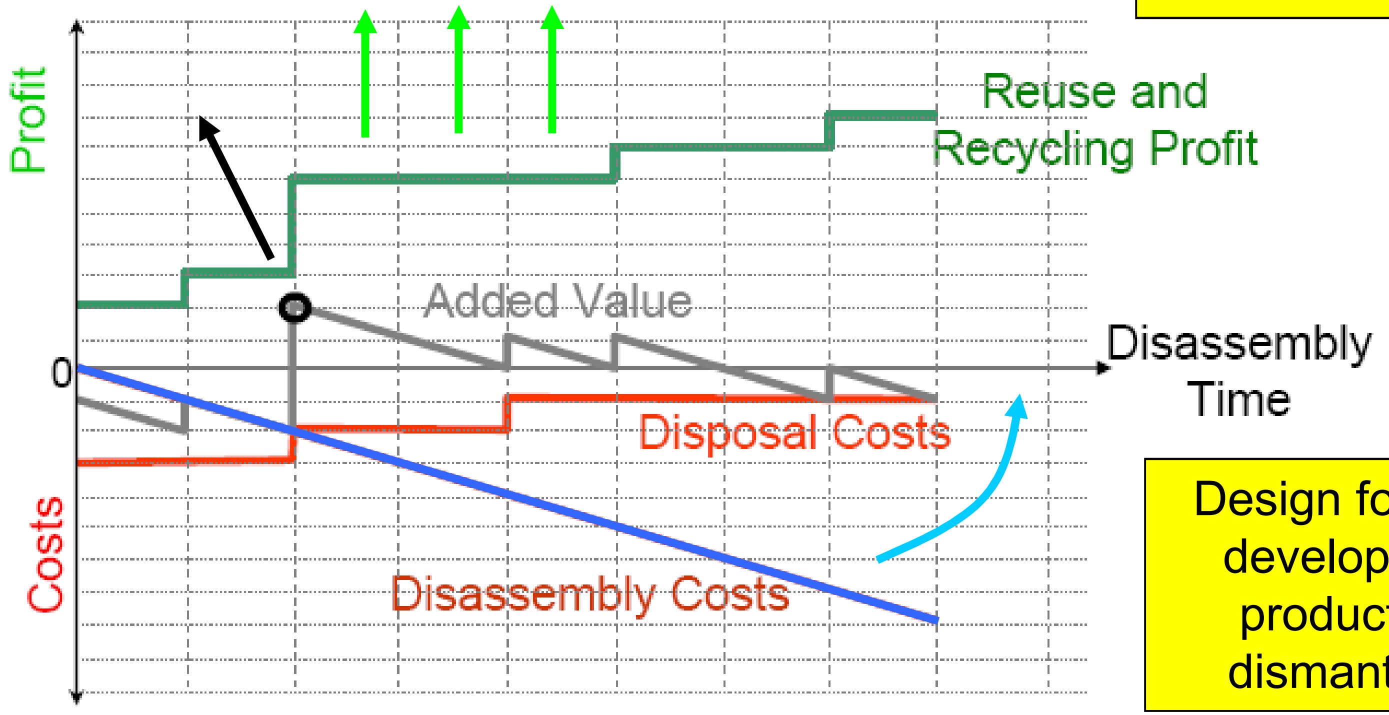
End-of-Life Cost $= C_{Disassembly} + C_{Disposal} - P_{Recycle}$

$C_{Disassembly}$ Labor cost for disassembling the component

$C_{Disposal}$ Cost for possible normal or hazardous wastes of the component

$P_{Recycle}$ Profit of reusing or recycling the component

Design for Recycling aim at develope products by using renewable and mono-materilal components, increasing so far economic value and recyclability of each part.

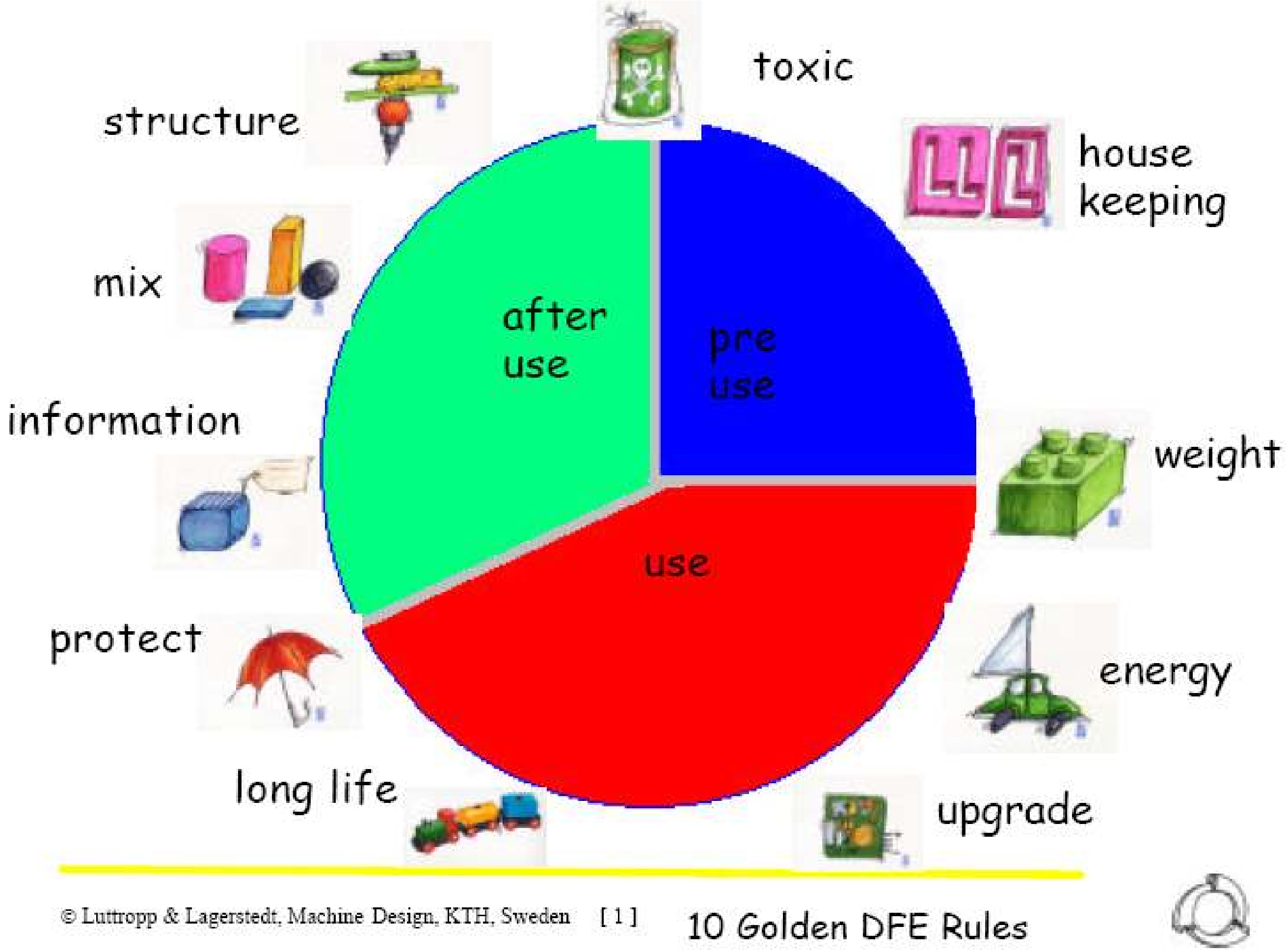


[source: Meißner et al., 1999, mod.]

Design for Disassembly aim at develop easier-to-dismantle product, reducing this way dismantling time and costs.

ECODESIGN

Some “golden rules” of Ecodesign



Luttropp , C., Lagerstedt, J., Ecodesign and The Ten Golden Rules: generic advice for merging environmental aspects into product development, Journal of Cleaner Production 14 (2006) 1396-1408.

ECODESIGN

1

Don't use TOXIC substances and arrange closed loops for necessary but toxic ones.

© Luttropp & Lagerstedt, Machine Design, KTH, Sweden [2] 10 Golden DFE Rules

PREARRANGE upgrading, repair and recycling trough access ability, labelling, modules, breaking points, manuals.

8

© Luttropp & Lagerstedt, Machine Design, KTH, Sweden [16] 10 Golden DFE Rules

ECODESIGN

9

Promote upgrading, repair and recycling by using few, SIMPLE, recycled, not blended materials and no alloys.

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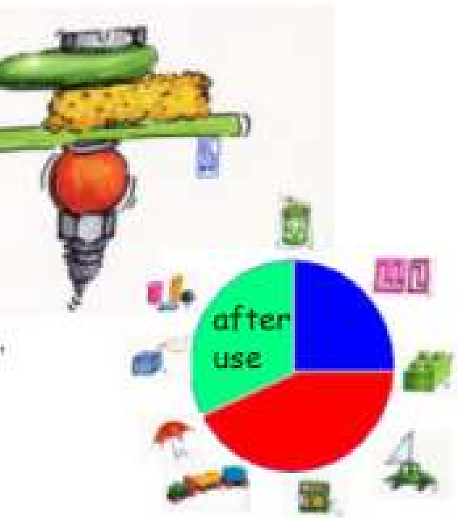
10

Use as FEW joining elements as possible and use screws, adhesives, welding, snap fits, geometric locking etc. according to the life cycle scenario.



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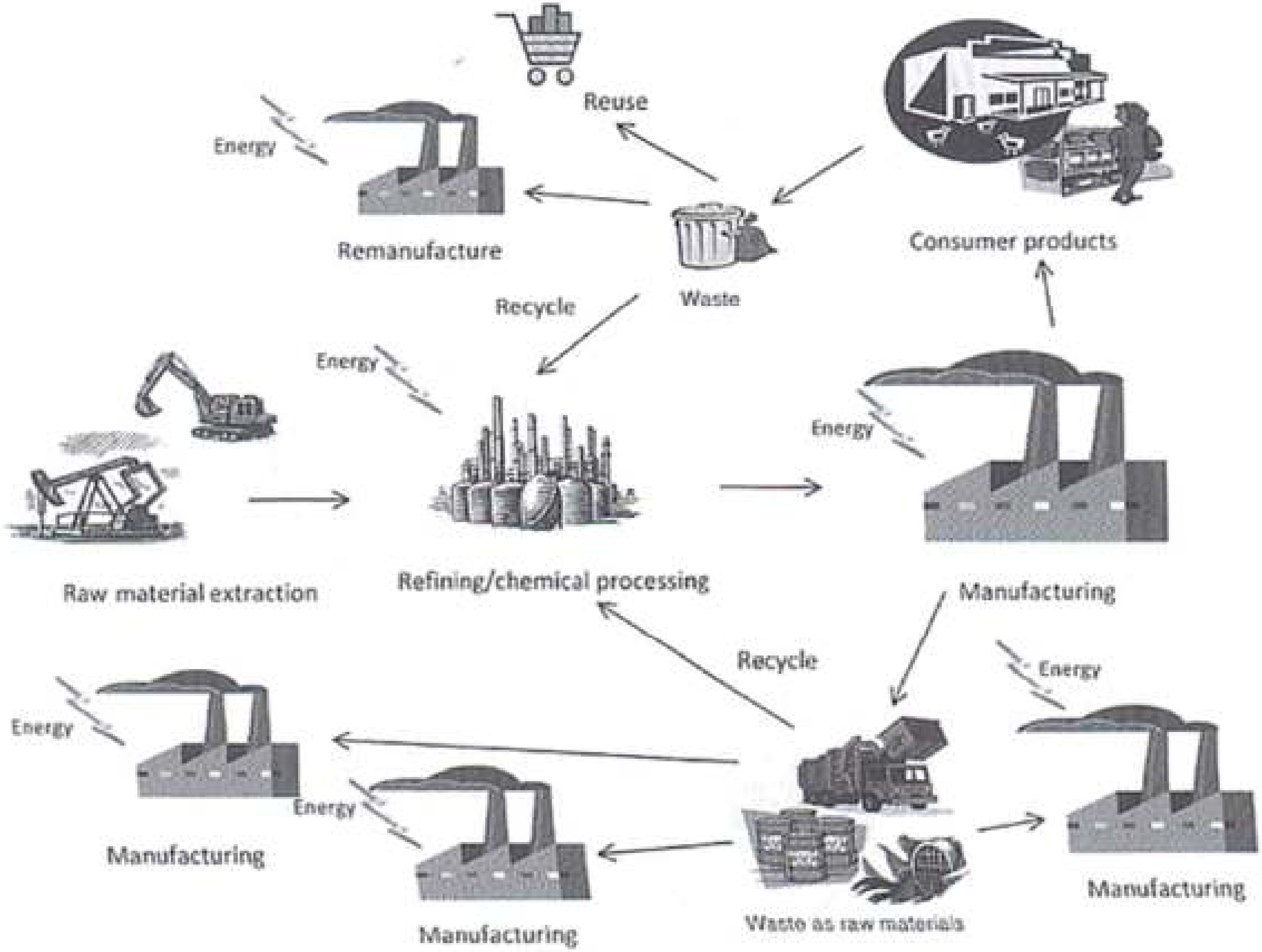
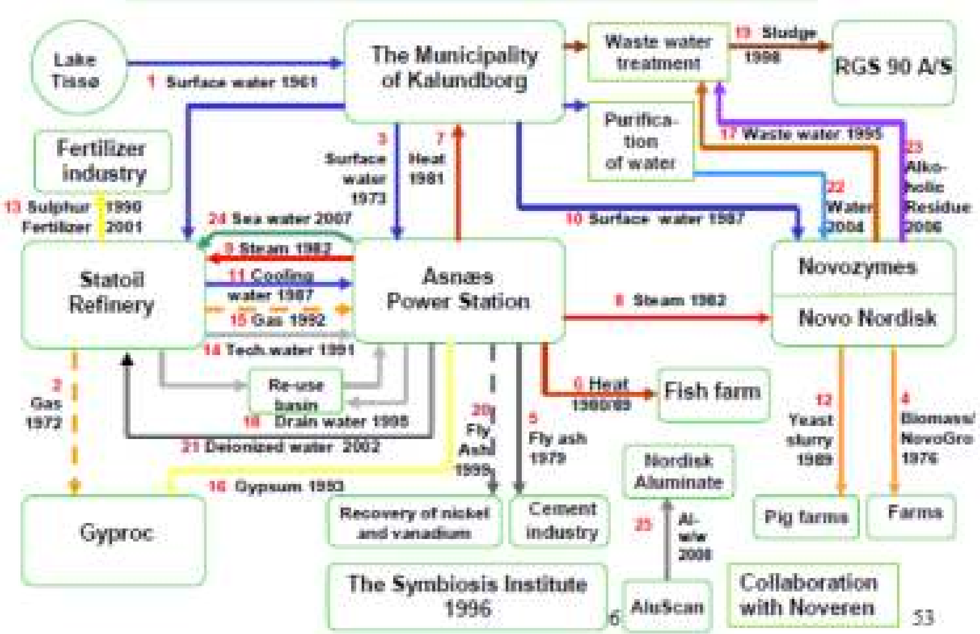
Industrial Symbiosis Model



Industrial Symbiosis

Industrial Symbiosis

- **Industrial symbiosis has been defined as engaging "traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity" (Chertow 2000).**



- The example of Kalundborg (Denmark):

From 5 initial partners (Asnaes – power plant, Statoil Refinery – oil refinery, Gyproc – industry of paper and gypsum panels, Novo Nordisk – pharmaceutical industry, Biotechnical Soil Cleaning – society of contaminated soil and material remediation, Municipal Administration of Kalundborg – provider of water and energy) to 8 partners (year 2009). (Source: Industrial Symbiosis Institute – Kalundborg, 2009)

Human Health Risk Assessment

Definition:

"*the characterization of the potential adverse health effects of human exposures to environmental hazards*" [NAS, 1983].

Reference:

US EPA, 2005, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.
DEFRA, 2004, Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes.
APAT, 2006, Criteri metodologici per l'applicazione dell'analisi assoluta di rischio ai siti contaminati, Rev. 1.

Methodology:

1	HAZARD IDENTIFICATION

- ✓ Source characterization
- ✓ Pollutants Identification
- ✓ Territorial analysis

2	EXPOSURE ASSESSMENT

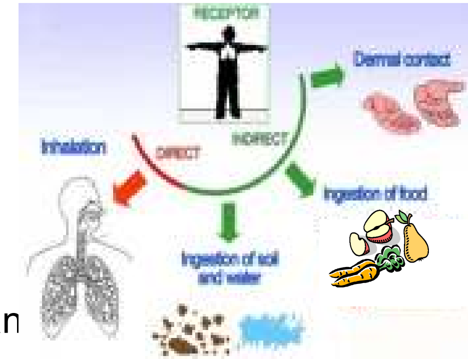
- ✓ Exposure scene definition
- ✓ Dispersion and deposit of pollutan in the environmental compartments
- ✓ Average of dose assumed in time unit

3	DOSE-RESPONSE ASSESSMENT

4	RISK CHARACTERIZATION

- ✓ Risk quantification
- ✓ Acceptability
- ✓ Results communication

Exposure scene definition



Luciano Morselli **with Working Group and Participants of SAMWARE Erasmus Intensive Programme visiting ECOMONDO Fair**

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