Imperial College London
Centre for Environmental Policy
Environmental Quality Research Group

Understanding systems and their complex interrelationships: a prerequisite to solving environmental problems

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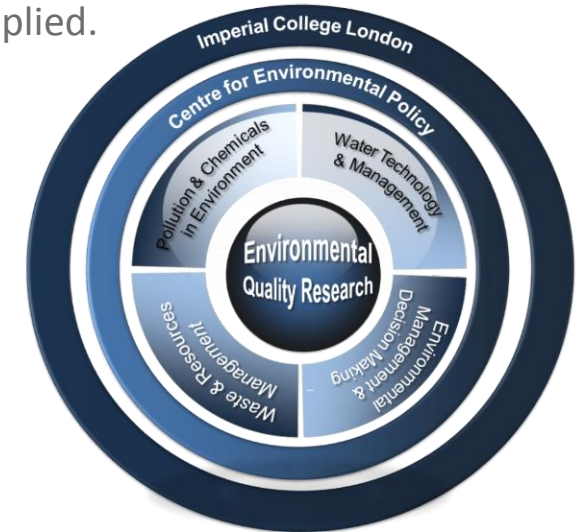
Introduction

- **Imperial College London** embodies and delivers world class scholarship, education and research in science, engineering medicine and business, with particular regard to their application in industry, commerce and healthcare.

- The **Centre for Environmental Policy** at Imperial provides a unique research interface between science and technology and the economic and policy context in which it is developed and applied.



- The **Environmental Quality Research Group** focuses on the integrated scientific study of the environment with emphasis on waste, water and wastewater management. Complemented by the development and application of tools in sustainability analysis, multi-criteria optimisation and lifecycle assessment.

What is an "environmental problem"?

- The perception of what constitutes a problem varies between individuals and societies
- The decision maker asks the question and therefore defines the problem

***Problem** – gap between an actual (a) and desired (d) situation, therefore problem solving: How do we get from (a) to (d)*

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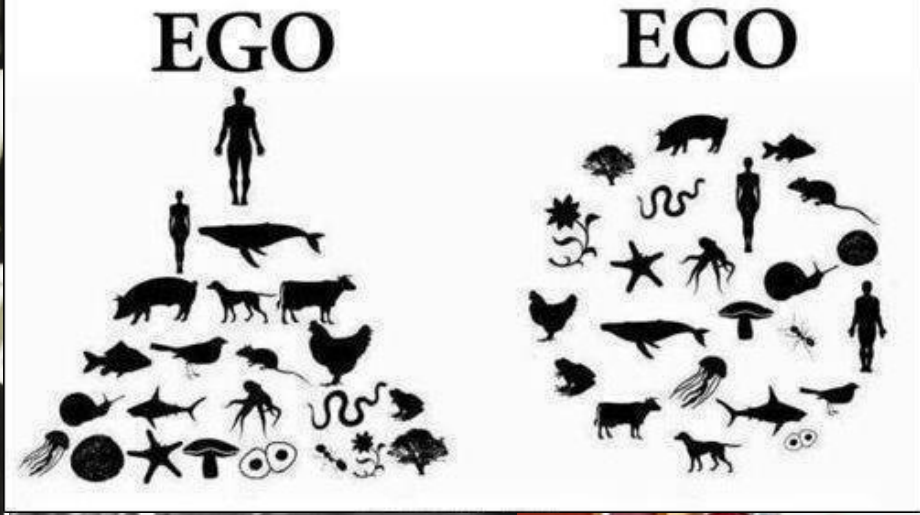
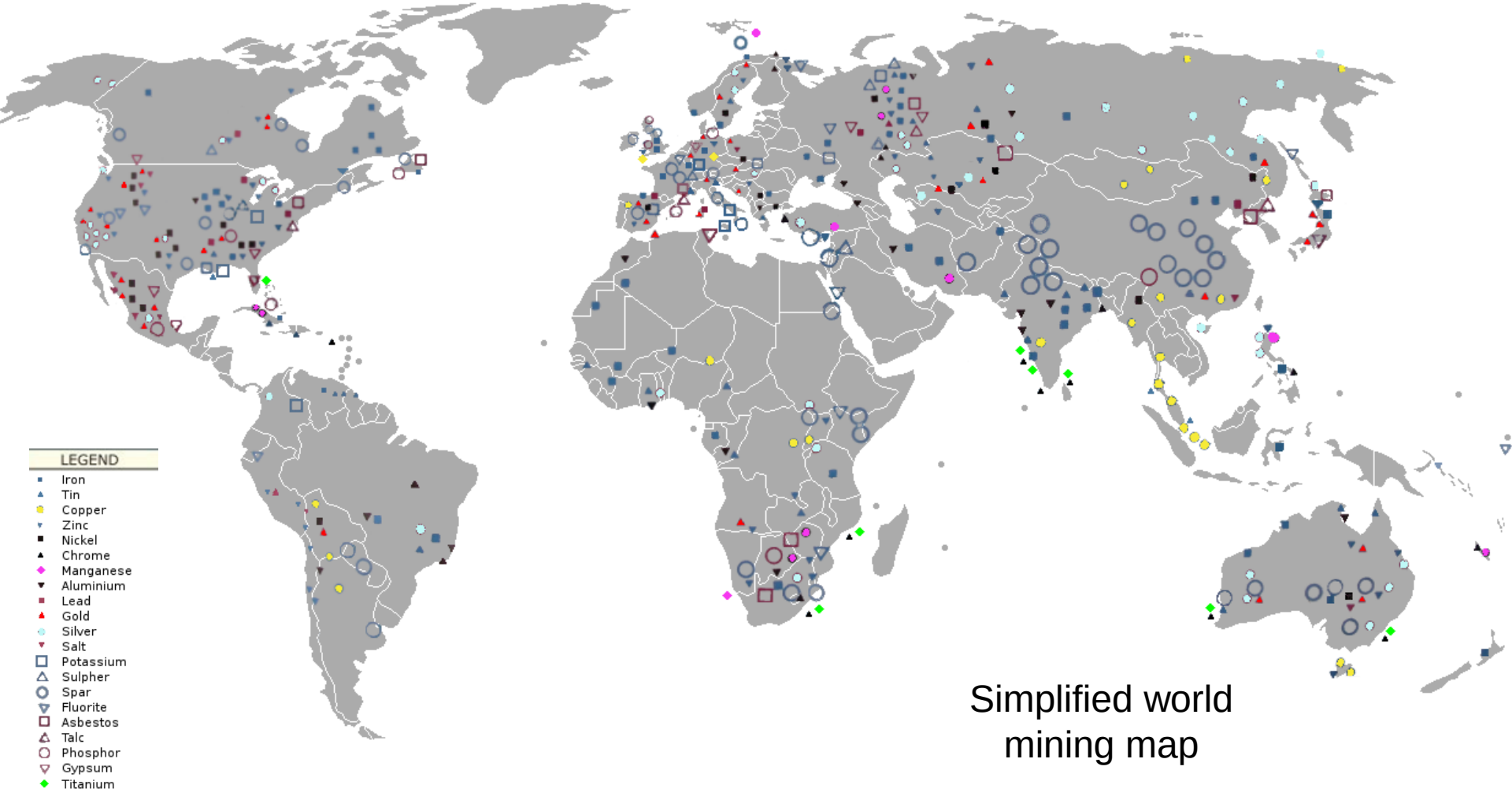
***Decision-making** * is a process of choosing among alternative courses of action in order to attain goals and objectives.*

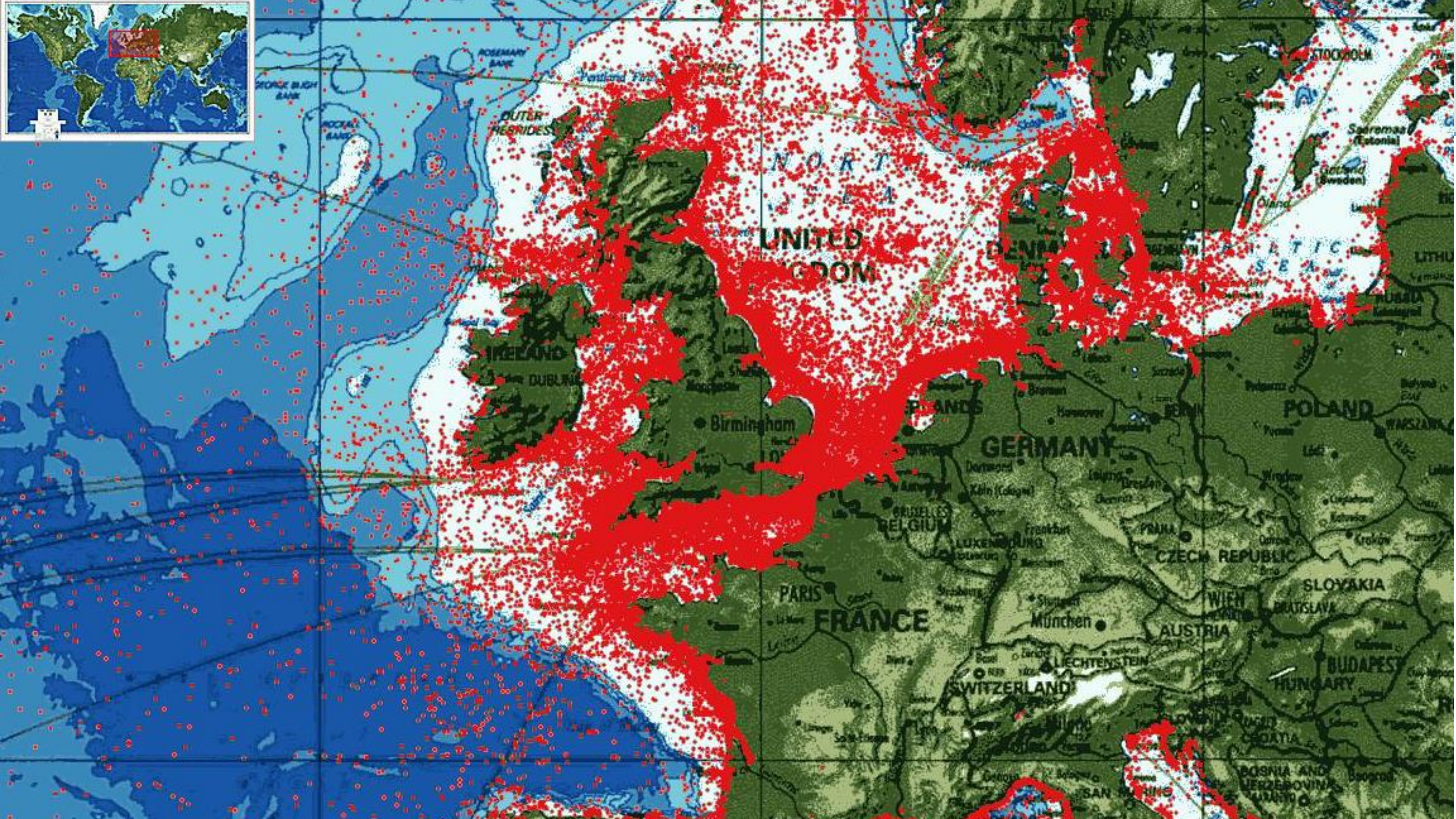


* *The process of decision-making is synonymous with the practice of management*

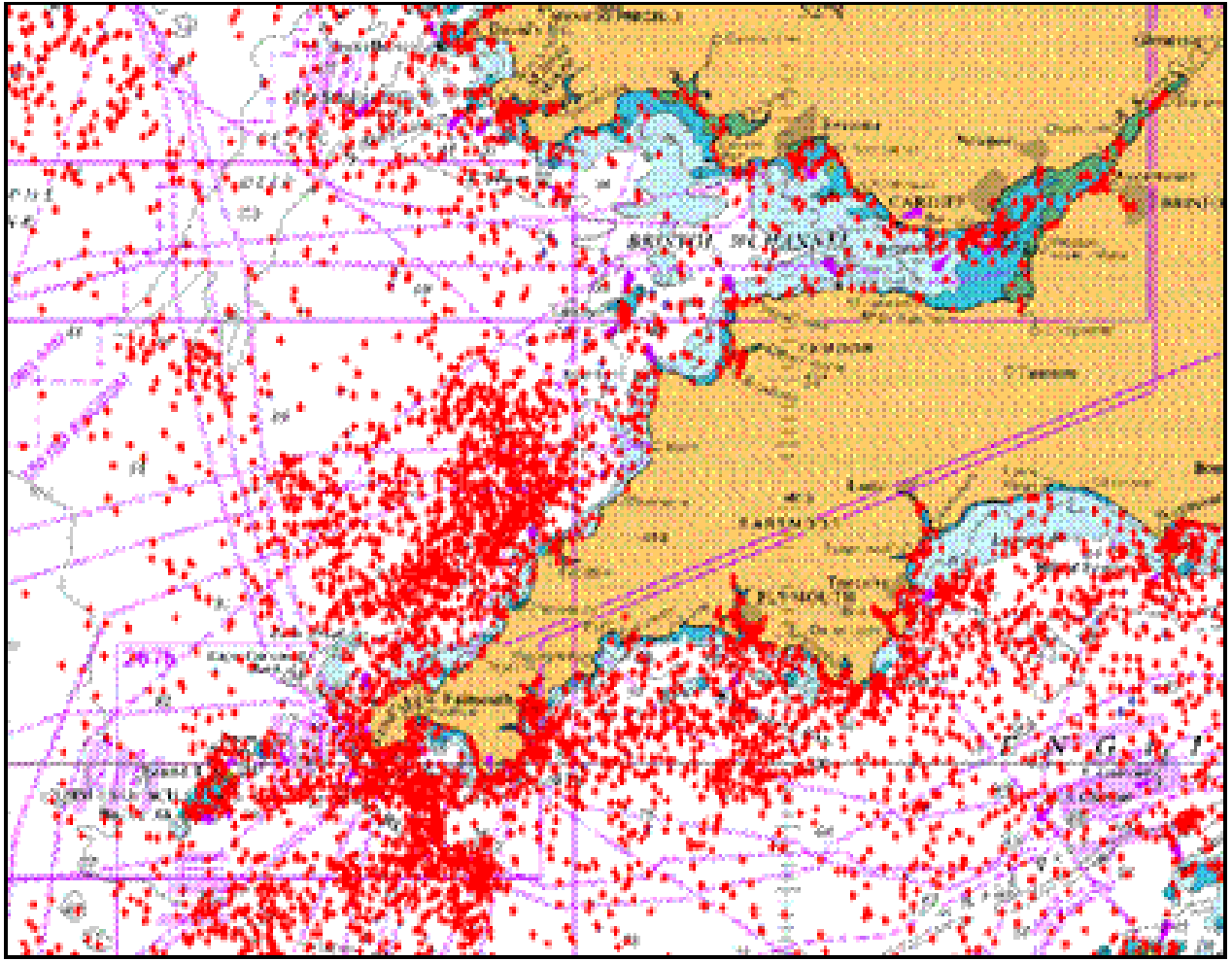


Simplified world mining map

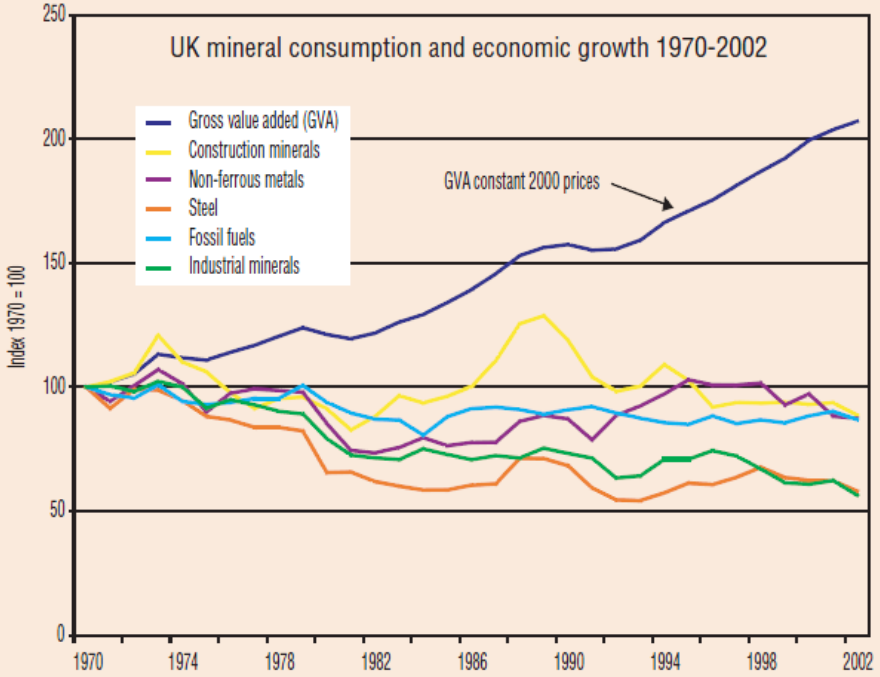

TOO MANY WK
SELECT A SUB
FILTER OR US
AREA
ADVERTISEME
advertise
DO NOT USE
NAV
NORTH
ATLANTIC
OCEAN
PACIFIC
OCEAN
INDIAN
OCEAN
UNITED
STATES
CANADA
RUSSIA
CHINA
INDIA
BRAZIL
ALGERIA
LIBYA
MALAYSIA
HUDSON BAY
LABRADOR
SEA



ROSEMARY BANK
OUTER HEBRIDES
UNITED
IRELAND
DUBLIN
Birmingham
GERMANY
PARIS
FRANCE
SWITZERLAND
LIECHTENSTEIN
München
AUSTRIA
WIEN
BRATISLAVA
CZECH REPUBLIC
SLOVAKIA
POLAND
WARSZAWA
BUDAPEST
HUNGARY
CROATIA
BOSNIA AND
STOCKHOLM
Frankfurt

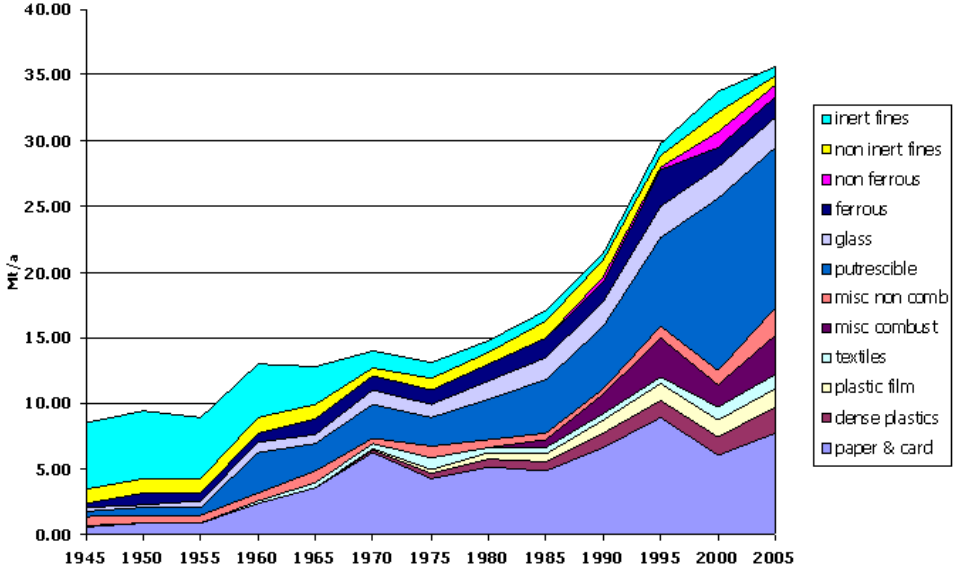


UK Hydrographic Office shipwrecks database

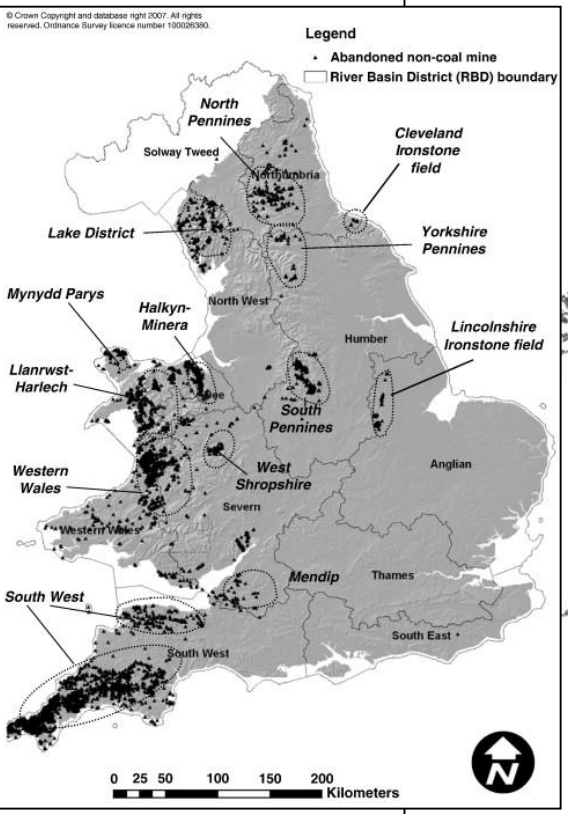


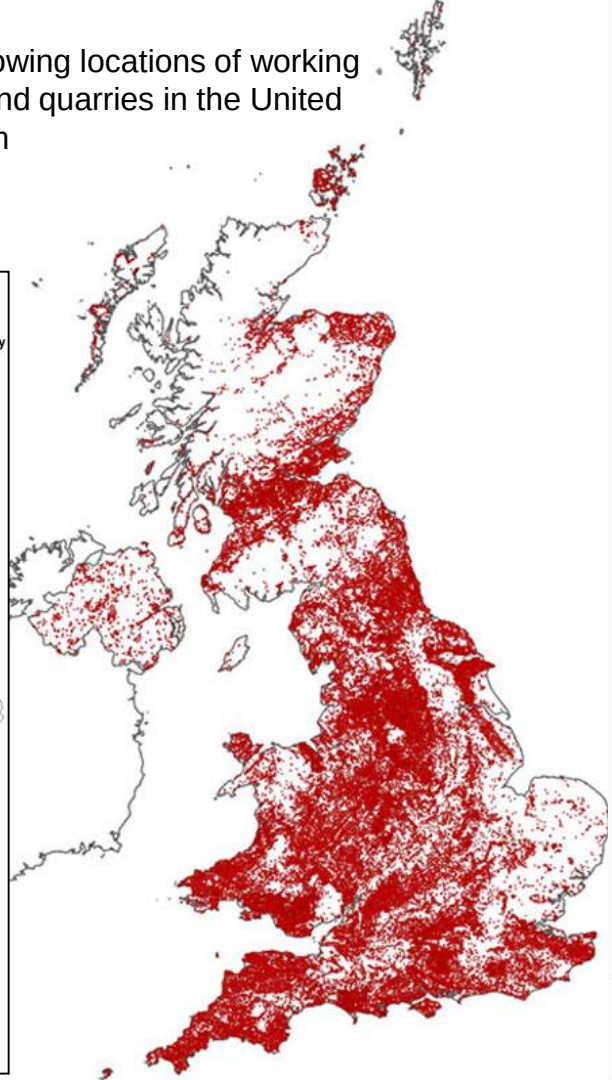
Gross Value Added (GVA) is an important economic indicator that shows the difference between the value of output and the cost of inputs used to produce it. UK GVA has increased by over 100% since 1970 but the consumption of minerals has declined by about 25%, partly as a result of using minerals in a more efficient and sustainable way.

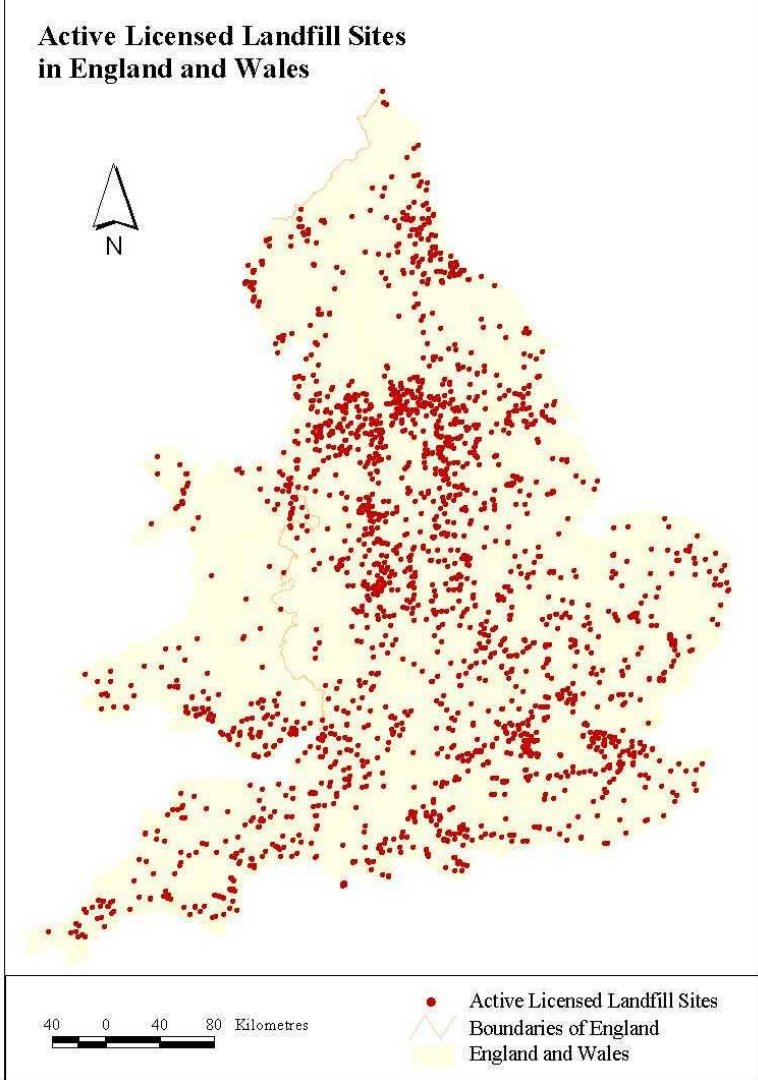
MSW arisings & composition UK 1945-2005



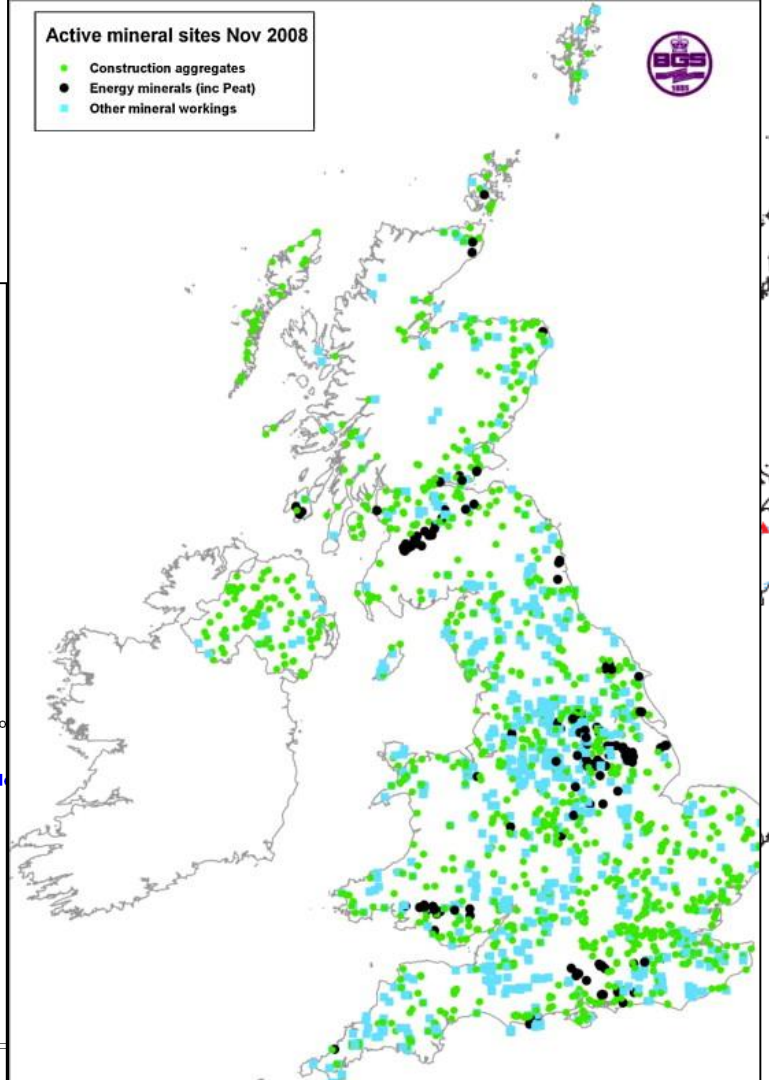
Map showing locations of working mines and quarries in the United Kingdom

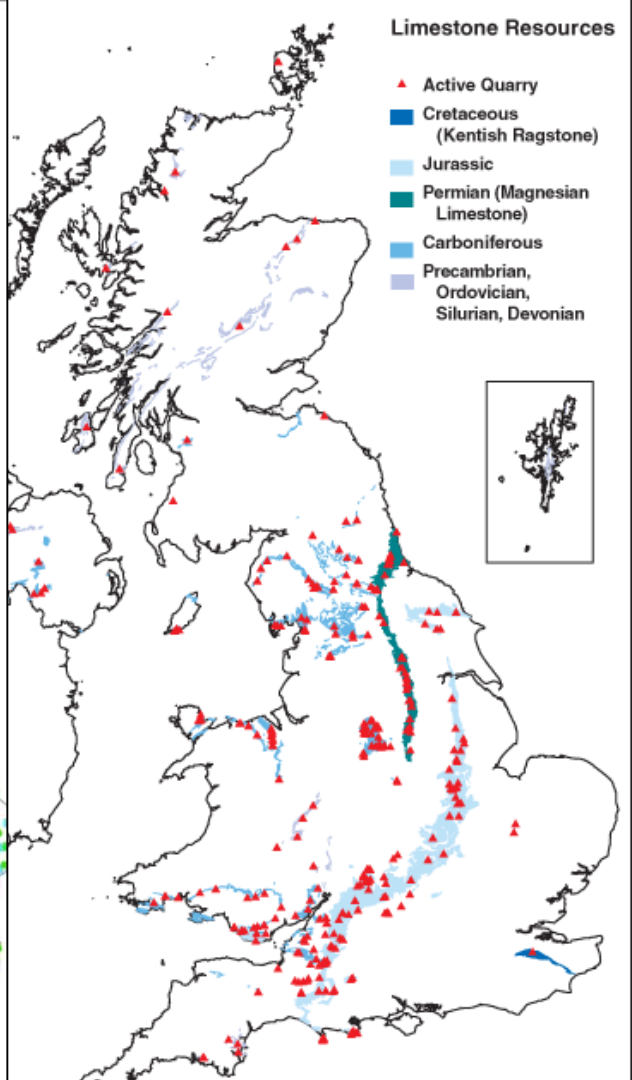






Cement Plants:
Chalk Raw Materials





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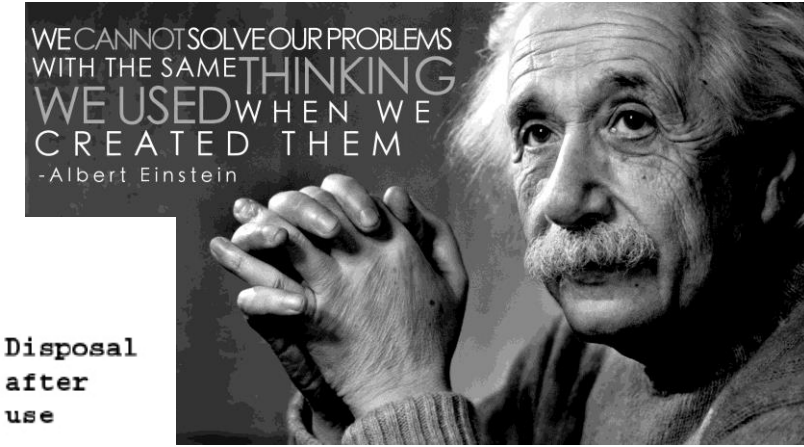
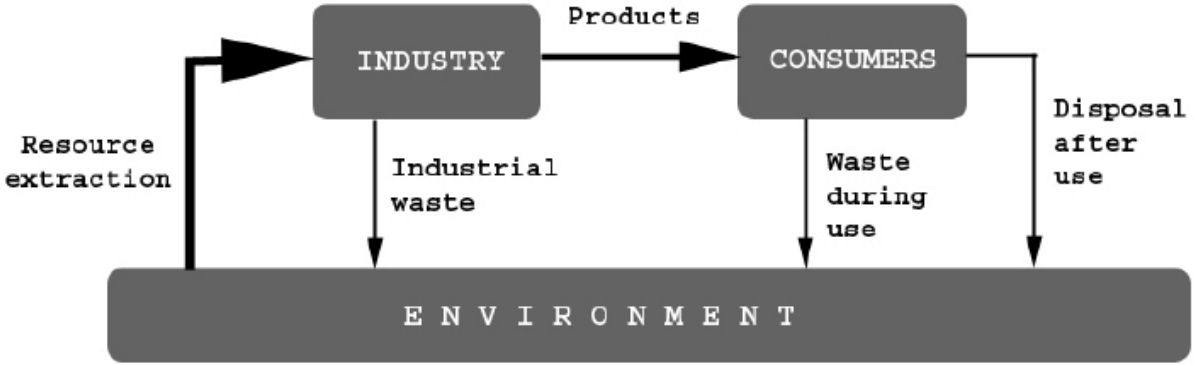
Traditional approaches

One of the most profound failures of our industrialised society is the way in which our production processes are so entirely linear.



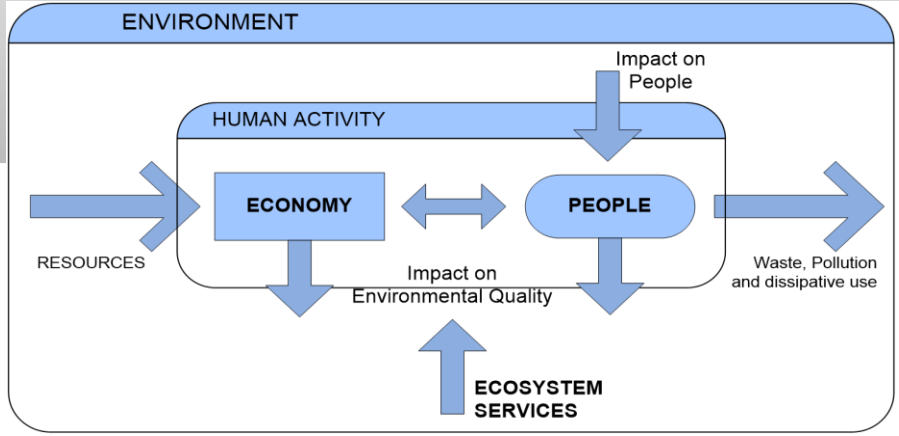


Traditional approaches to economic and environmental management are based on **static**, **compartmentalized** models.

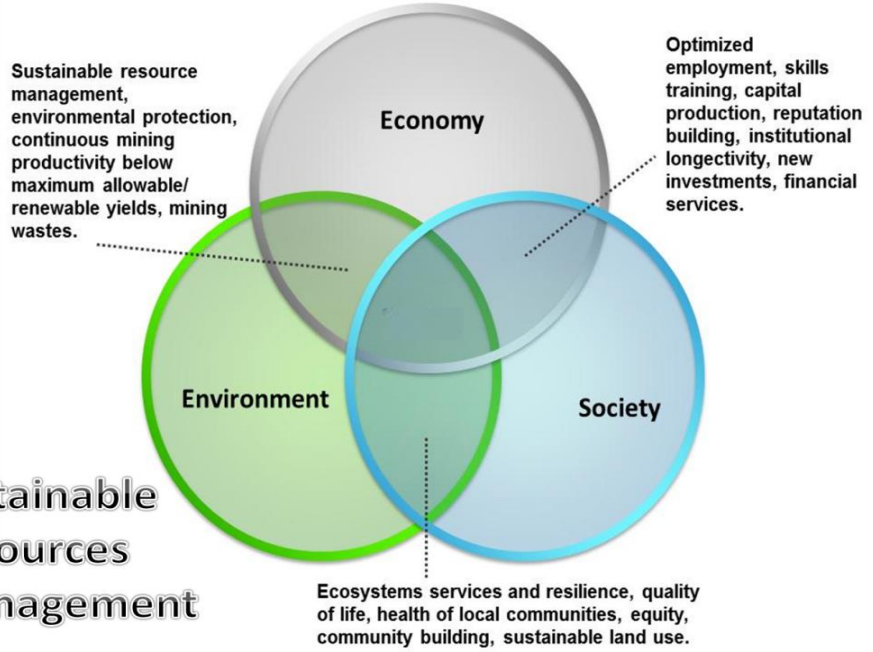
While this approach is perhaps “efficient” in the traditional sense (more product, less time, fewer inputs), when we consider the larger costs of production—those that are most often seen as externalities (e.g., wastewater discharge, air emissions, depleted soils, razed forests)— it is harder to demonstrate overall net benefit.

Economics and sustainable management

Traditional economic approaches have linked economic growth and social welfare with increased production and consumption and have assumed that this has no irreversible impacts to the natural capital.



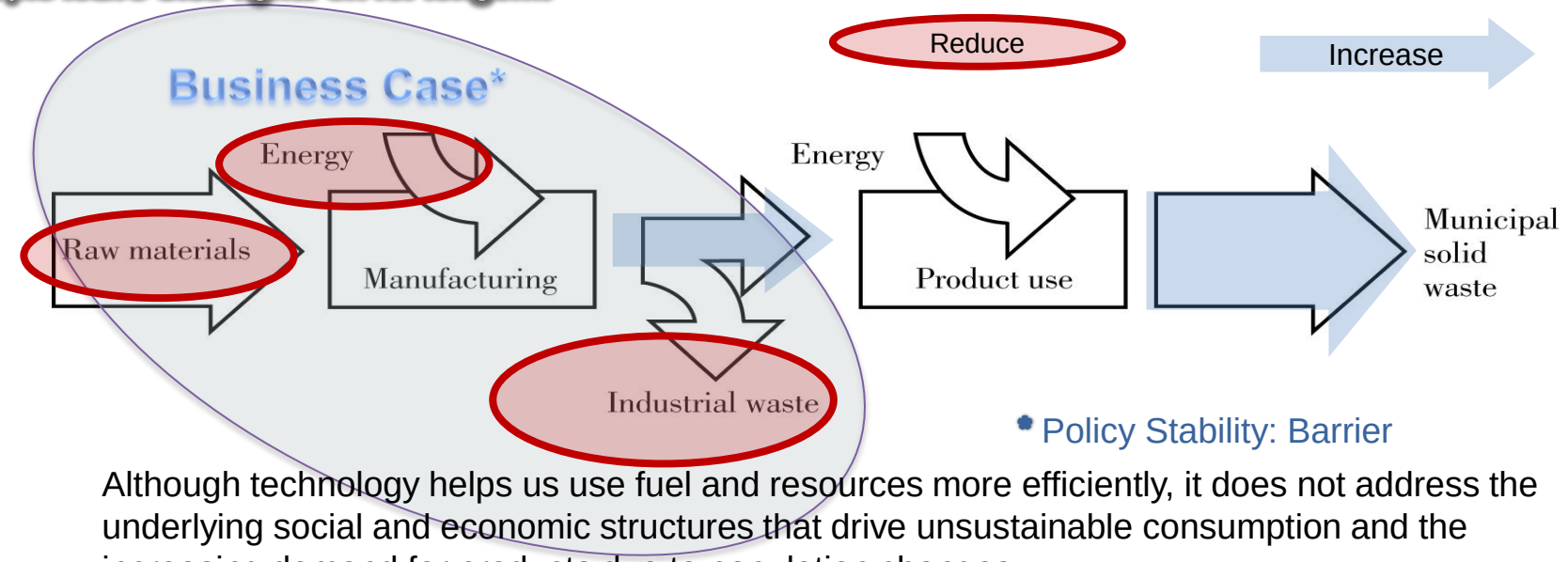
This has now been changed….



New economics have environment and society in their core and accept that ecosystems do not react in a predictable, linear way to external stresses.

Resource Efficiency

As lower-energy bulbs become more common, people leave their lights on for longer...



- Policy Stability: Barrier

Although technology helps us use fuel and resources more efficiently, it does not address the underlying social and economic structures that drive unsustainable consumption and the increasing demand for products due to population changes.

Continued economic growth and demand could eventually cancel out any efficiency savings

A problem for any resource efficiency improvement

- Dramatic **improvements** in efficient lighting technologies over the last 30 years have left energy **intensity of lighting unchanged**, with global **GDP spent on lighting constant** during this period. The higher energy efficiencies have been followed by ever-expanding lighting applications.
- So-called direct rebounds of up to 30% have been observed in automotive transport, heating, cooling and other consumer energy uses (this means energy savings were reduced by up to 30 %).
- Rebound is not limited to end-use energy consumption.
- A recent simulation study of the German economy indicates a 55% rebound following an increase in material efficiency and raises a provocative question:

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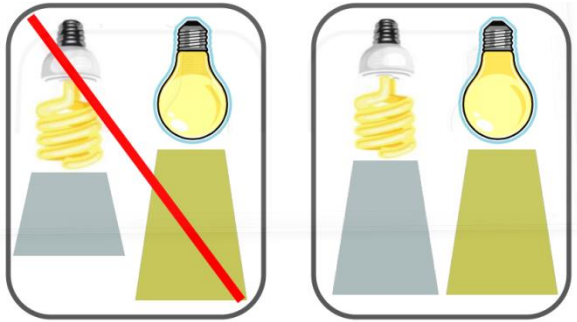
What about overall impact?

- When comparing light bulbs (e.g. compact fluorescent and incandescent) you must compare light bulbs with the same luminescence



  - CFL with an output of 900 lumens, and a 10,000 hour life,
  - An incandescent bulb with an output of 900 lumens and 1,000 hour life

- How many incandescent bulbs are needed to serve a study where the functional unit is 900 lumens delivered for 10,000 hours?
  - 10,000/1,000 = 10 bulbs

- What if we made the study time horizon 11,000 hours?
  - 11 incandescent bulb lifetimes
  - 2 CFL Bulbs (1 bulb, + 10% of the useful life of another)
  - How should we treat the remaining useful life of the CFL?

But…

- CFLs have Hg vapor in their glass tubing. When bulbs are broken, the Hg (in elemental form) is released to the environment. If disposed in a trash bin, breakage is inevitable

 more Hg from electricity **vs.** Hg emissions at disposal 

The electricity grid in the U.S. emits on average 0.0184 mg Hg/kWh

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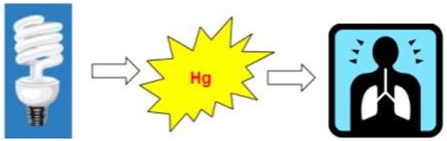
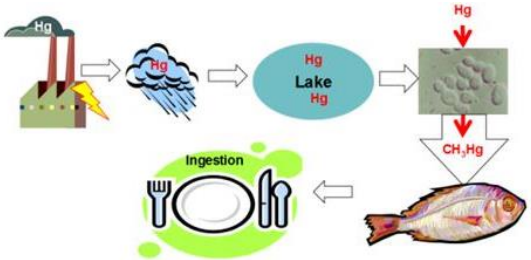
Misleading comparison

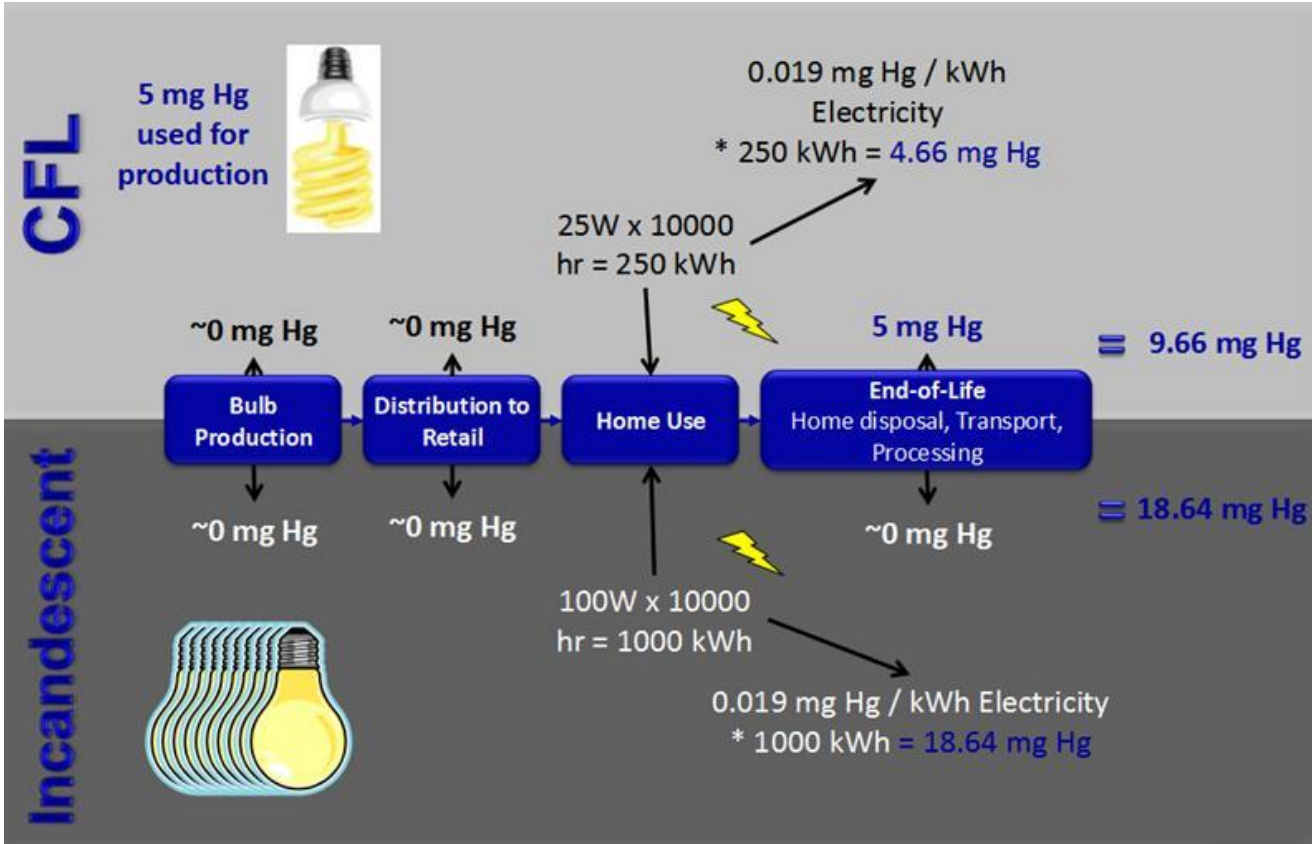
Functional unit: 1700 lumens, 10,000 hours of light. The CFL bulb is a 25 W bulb, the Incandescent is a 100 W bulb.



Impact is dependent on the fate of pollutants and who or what environments are exposed

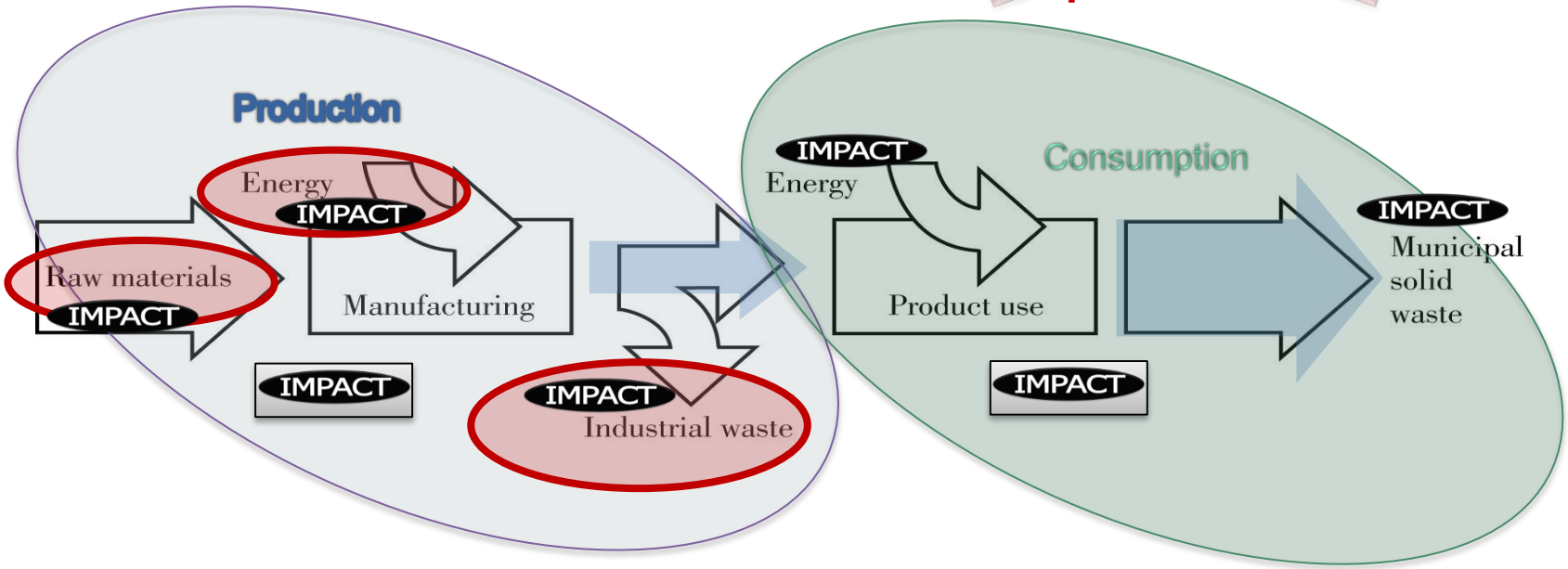
– For our light bulb example, there are big differences in the way Hg is emitted and how people/environments are exposed





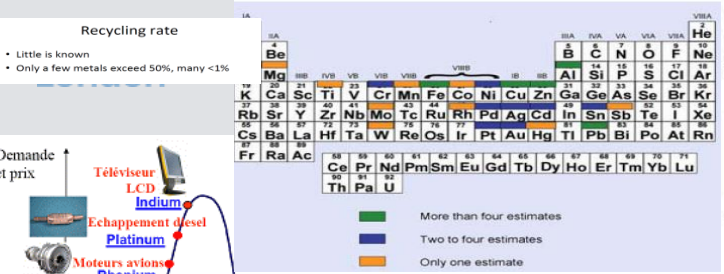
Reduce impact
‘better’ rather than ‘less’…

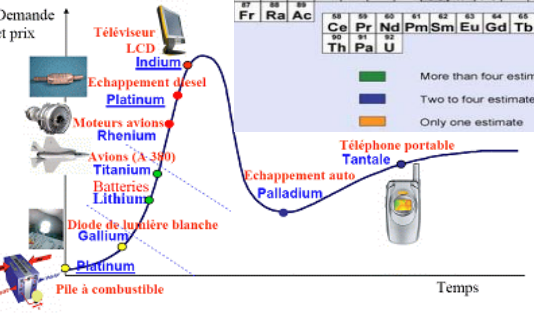
- Greater efficiencies do not always mean ‘less impact’…
- Greater efficiencies do not always mean ‘less consumption’…



Recycling rate

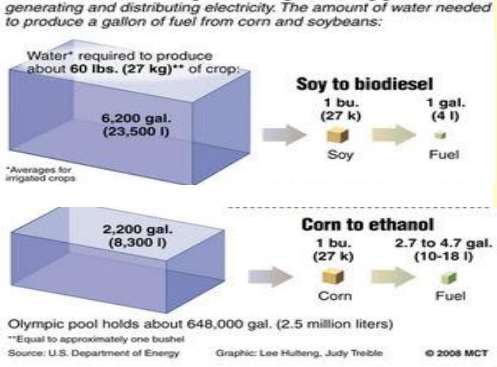
- Little is known
- Only a few metals exceed 50%, many <1%

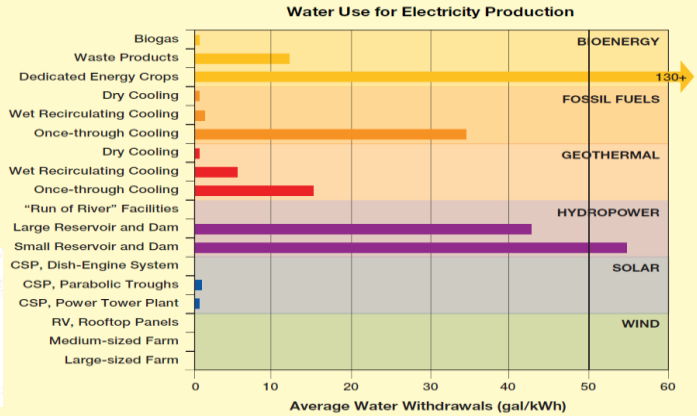




Water essential to make energy

Water is needed for mining coal, drilling oil, refining gasoline and generating and distributing electricity. The amount of water needed to produce a gallon of fuel from corn and soybeans:



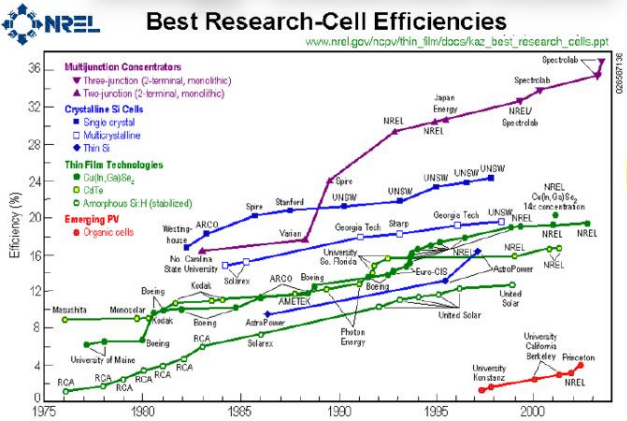


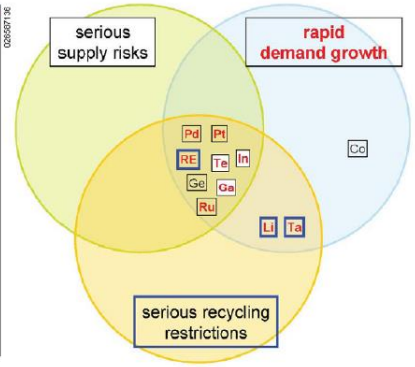
Water requirements are highest for electricity generated from irrigated crop-based biomass, hydroelectric power, and for thermoelectric generation using once-through cooling technology. Note: not all energy crops are irrigated, and regional irrigation differences are great. CSP = concentrating solar power (power towers and parabolic trough plants).

- Energy efficiency v.s. materials efficiency/availability

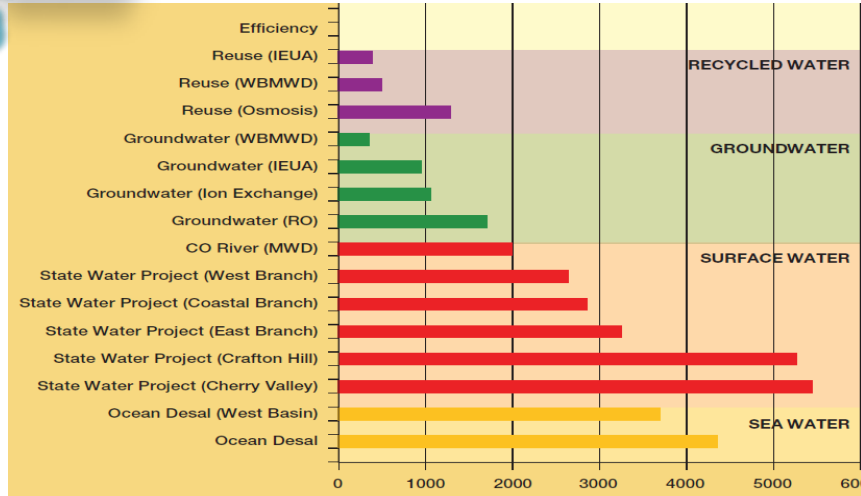
Energy- materials nexus

Energy- water nexus





Öko-Institut (2008): *Critical metals for future sustainable technologies and their recycling potential*, Freiburg, Germany.



1 acre-foot = 1,233.48184 m³

IEUA — Inland Empire Utilities Agency; MWD — Metropolitan Water District; RO — Reverse Osmosis; WBMWD — West Basin Municipal Water District

Energy intensity of selected water supply sources in Southern California.

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A systems' approach

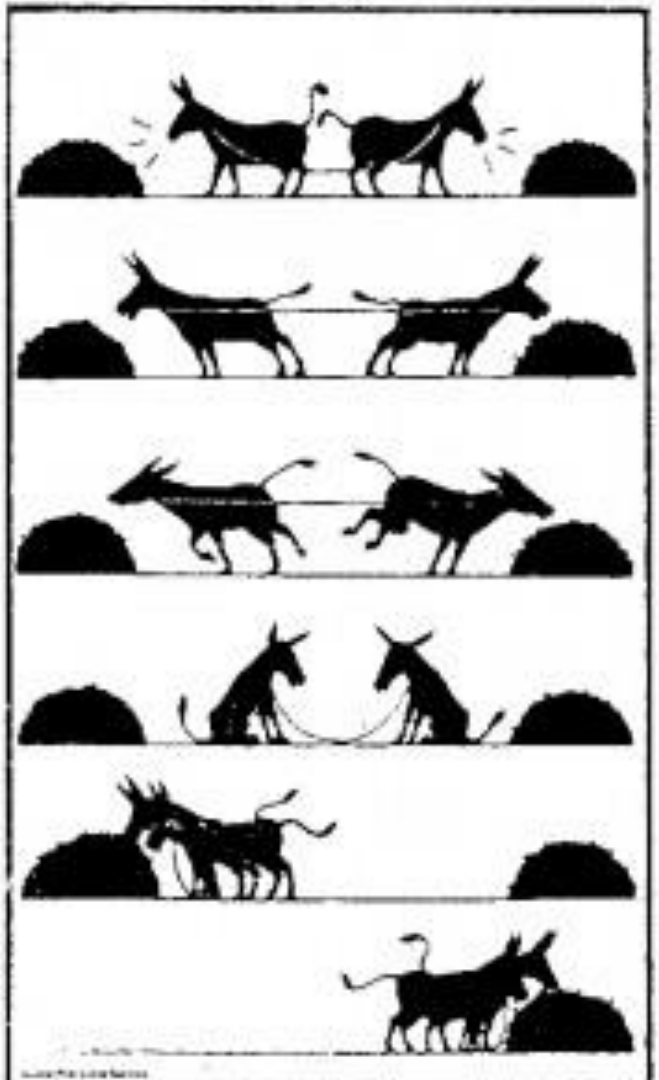
The "linkages" between sectors, disciplines and systems for addressing the interactions of the environment and human health must be addressed based on an interdisciplinary, integrated and holistic approach.

- Techniques and technologies from biotechnology and engineering, and innovation at all levels of management are needed to deal with materials reuse and redesign, while mitigating and adapting to climate change.
- Managing and balancing supply and demand for materials across sectors through a range of environmental and socio-economic policy instruments, and necessary investments are required for broadening the systems approach.
- A mix of behavioural change and communication through participatory approaches that engage the public and all stakeholders in a constructive dialogue is necessary for understanding and dealing with the problem at its source.

collaboration

replaces

competition



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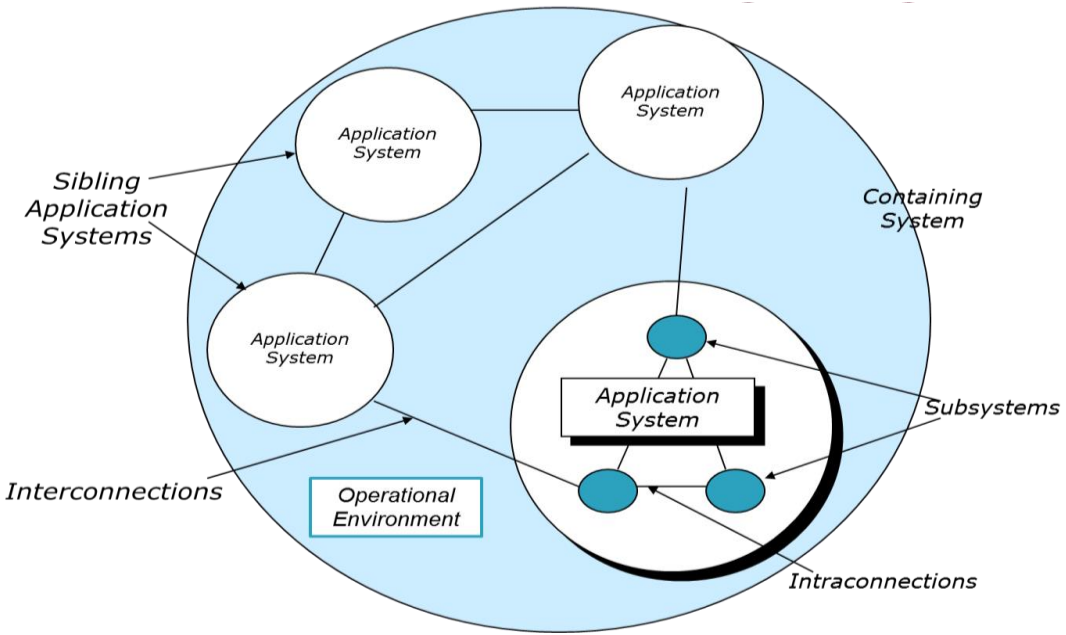
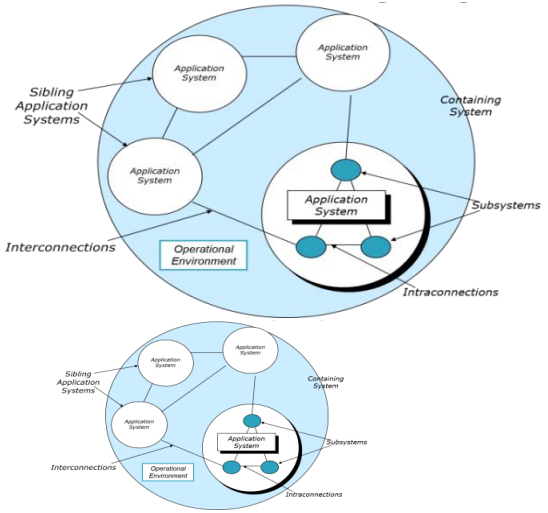
Industrial Symbiosis





A system is sustainable if, over its lifetime, it produces more than it consumes.

SMM … the way forward

but for what? the toast or the toaster…

- The aim of Sustainable Materials Management is to **reduce the negative environmental impacts of materials use** and **preserve natural capital along the whole chain.**
- SMM takes a life-cycle approach as its basic premise and includes sustainable extraction, ecological design, eco-efficient production, sustainable consumption, and sustainable waste management.
- SMM requires a systems approach entailing policy integration. It takes into account ecological, economic and social gains and environmental policies **cannot be developed in isolation from other policy fields.**


rethink
does not mean …

http://www.core77.com/blog/business/sustainability_through_resource_efficiency_focus_on_the_toast_not_the_toaster_21661.asp

‘It is the toast we want, not the toaster’

More toast…

Less toasters…

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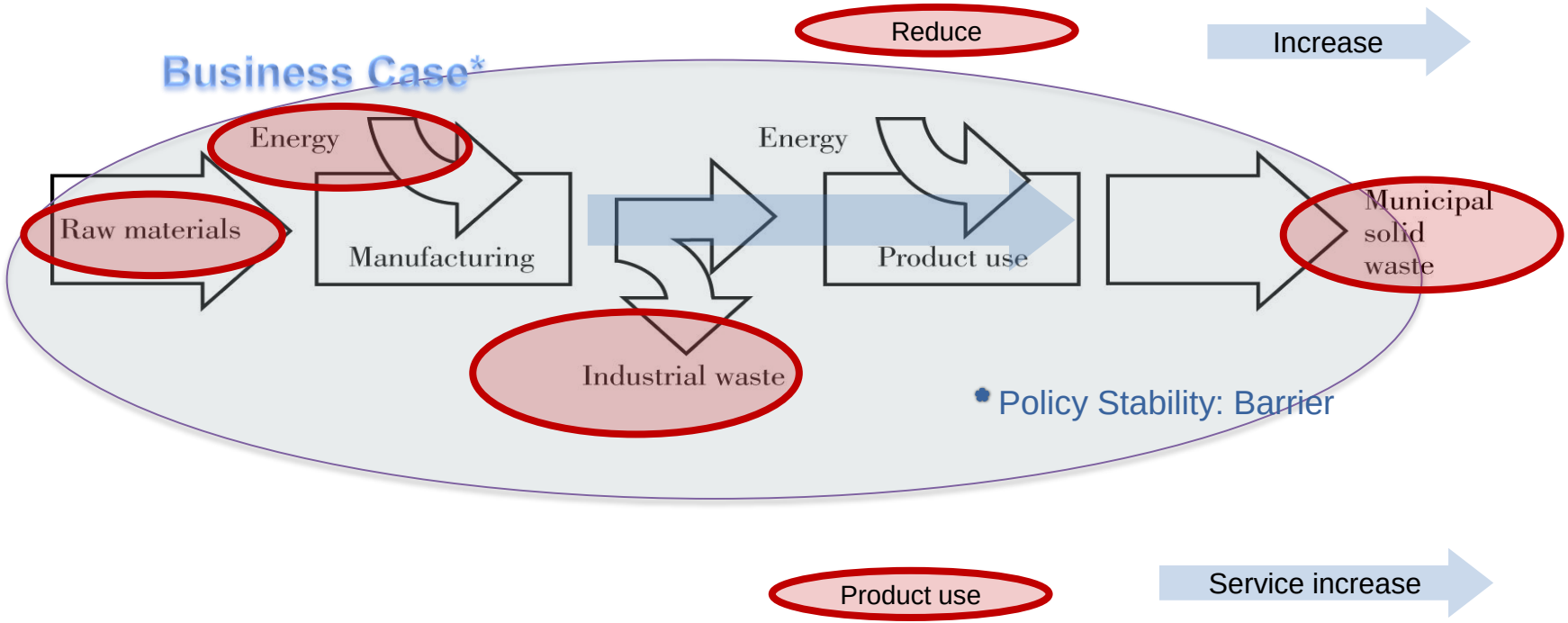
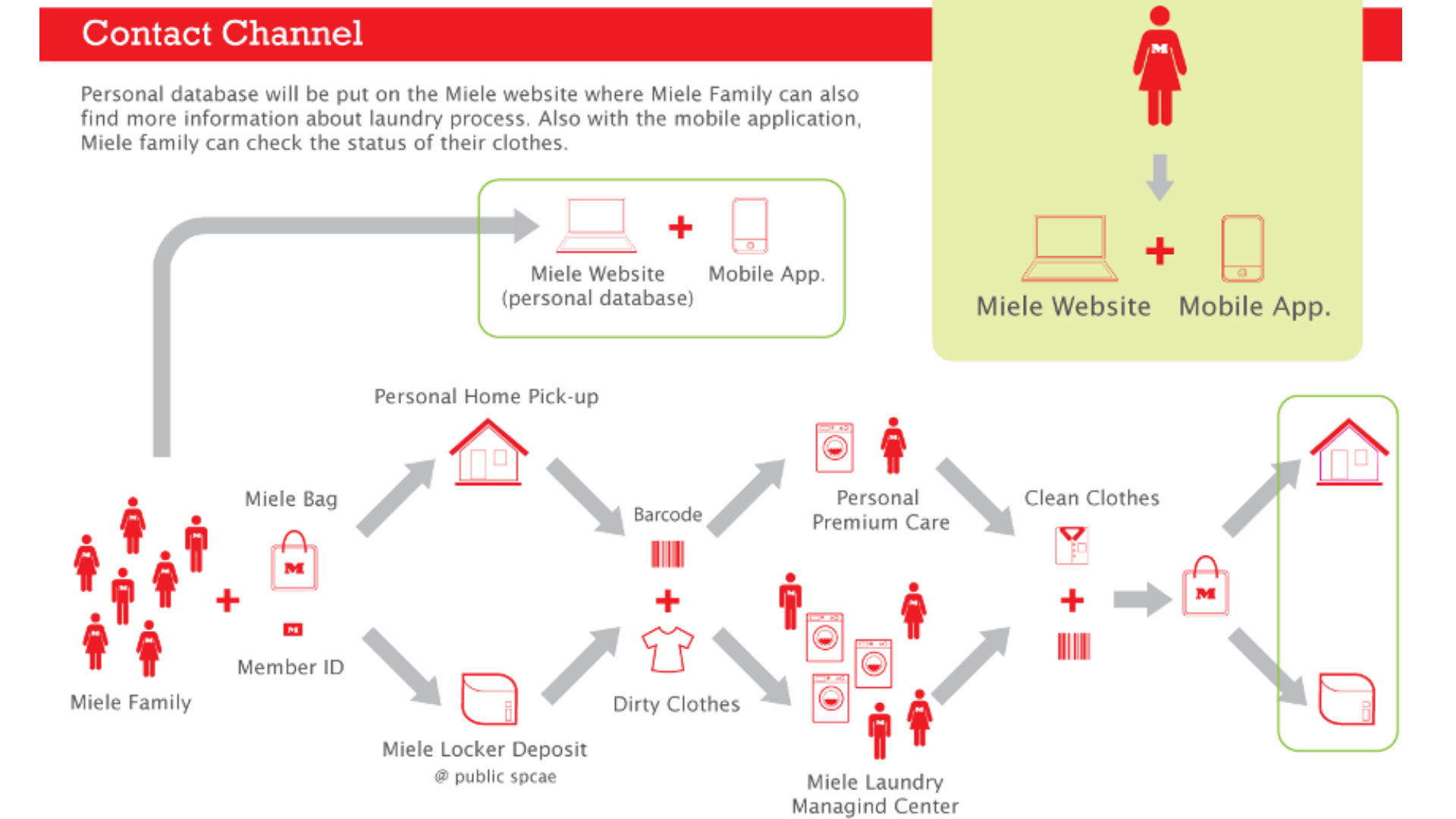
From products to services



Contact Channel

Personal database will be put on the Miele website where Miele Family can also find more information about laundry process. Also with the mobile application, Miele family can check the status of their clothes.



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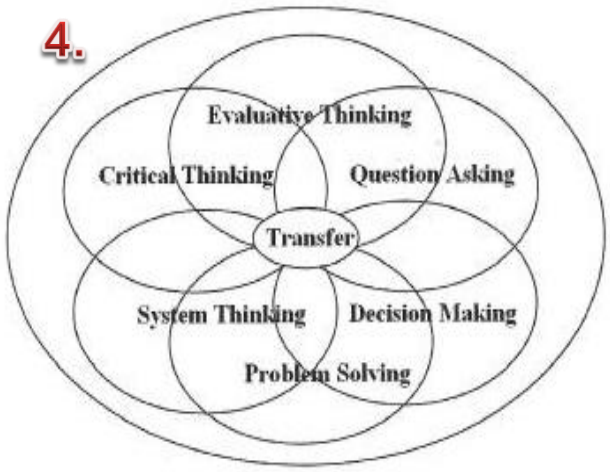
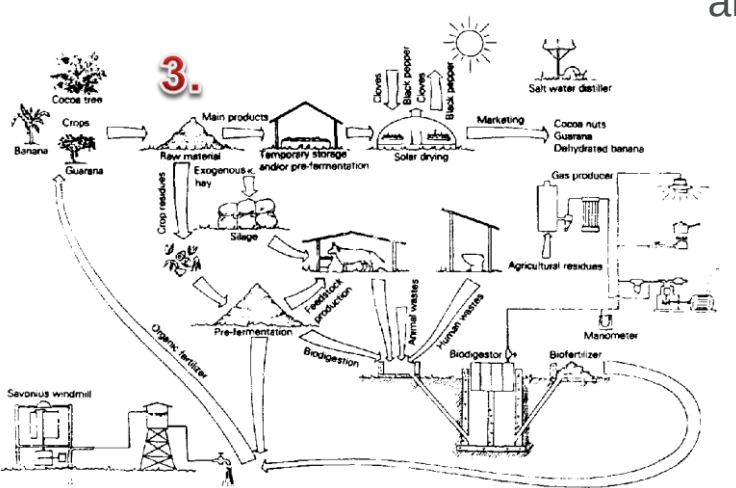
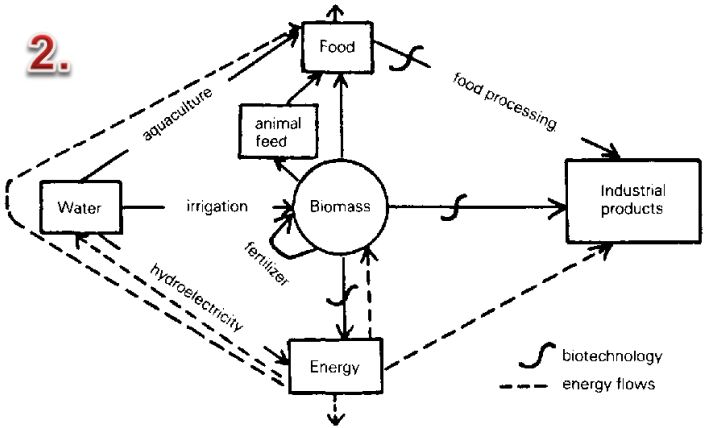
In summary

1. Production: efficient, lean, informed by demand, and reflected on prices - Use less produce more by reuse, recycle, circular flows.
2. Waste in the nexus of energy, water , food – a systems approach to rural economy, society and environment.
3. Industrial symbiosis – Collaboration/Cooperation
4. Literate society that is more aware of sustainability
5. Scientific research that is participatory, ethical and anticipatory with regard to potential impacts on health and the environment and that is guided by the principles of accountability.








THANK
YOU
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