Session 3: Technology for a Resource-efficient Circular Economy Technology for a Consumer-empowered Circular Economy

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Member, International Resource Panel

Delegation to Rio+20, Republic of the Philippines

DECOUPLING IS THE IMPERATIVE OF MODERN ENVIRONMENTAL AND ECONOMIC POLICY

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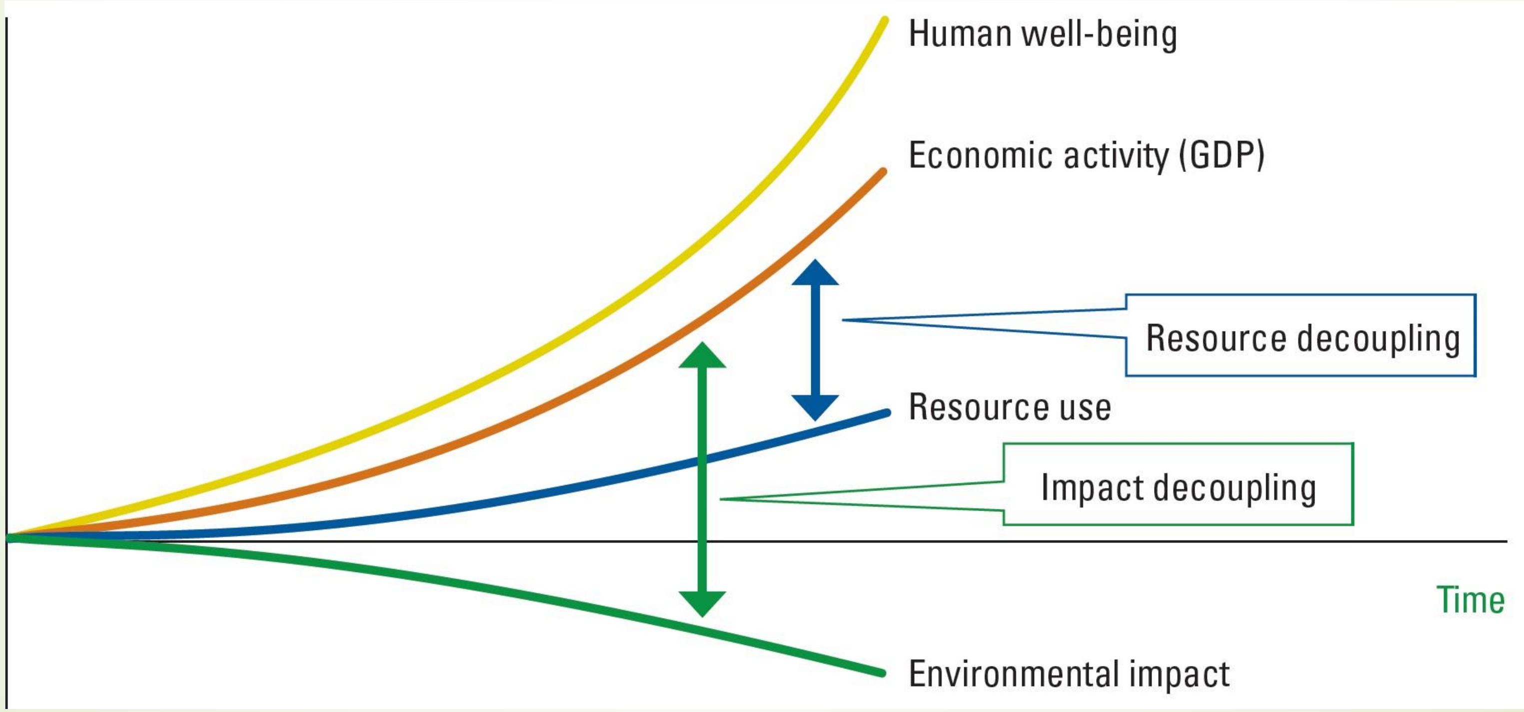
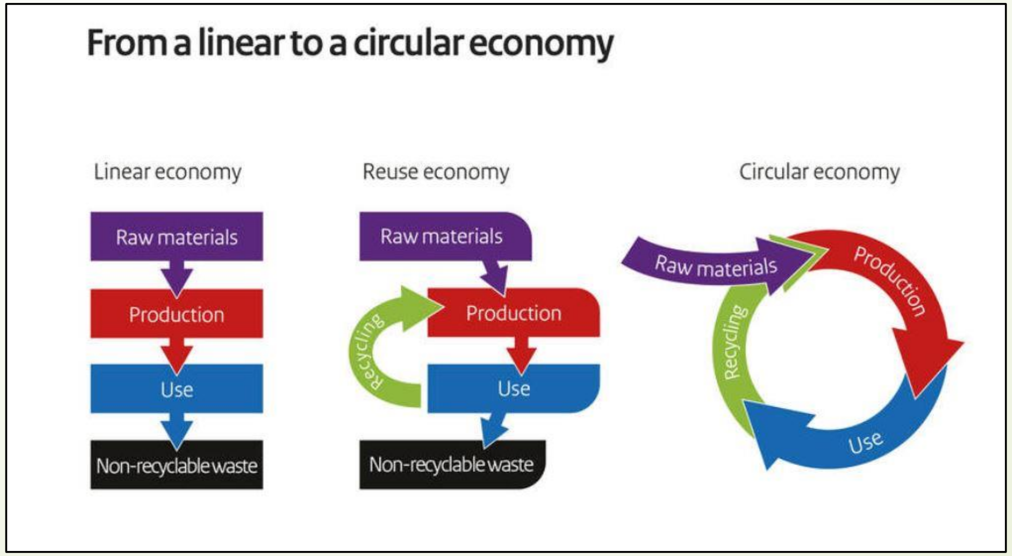


Eco-civilization, Sufficiency Economy, De-growth

Difference between Conventional and Innovative Solutions

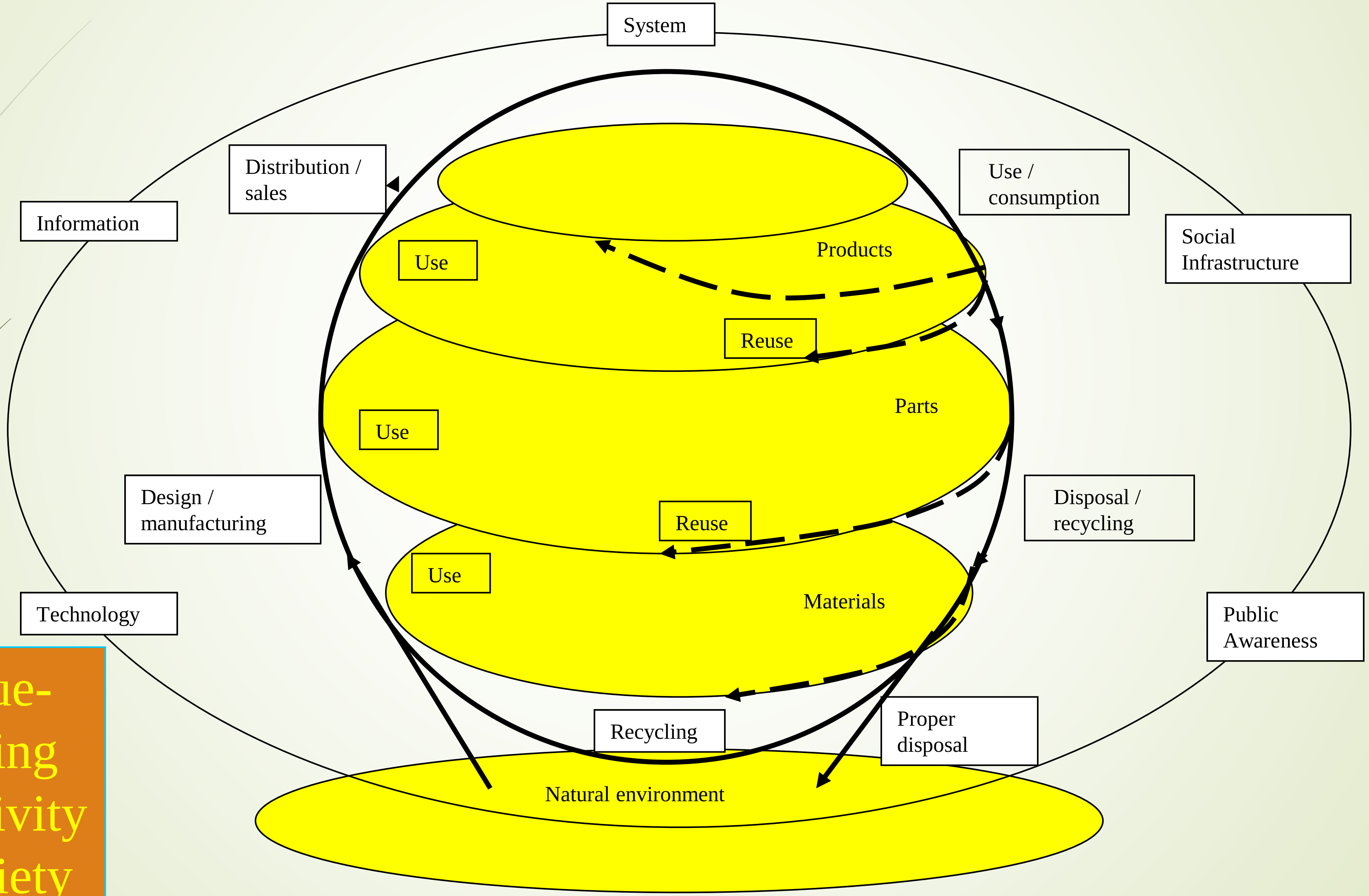
- **Conventional Solution** refers to the traditional linear economy of take – make and dispose. This means that raw materials are used to make a product, and after that the waste is thrown away.

- **Innovative Solution** refers to the transition from linear economy to a circular economy. Circular economy was enacted into Law in China during 2000s and revisited / defined by Ellen MacArthur as "an industrial economy that is restorative and regenerative by design and intention".



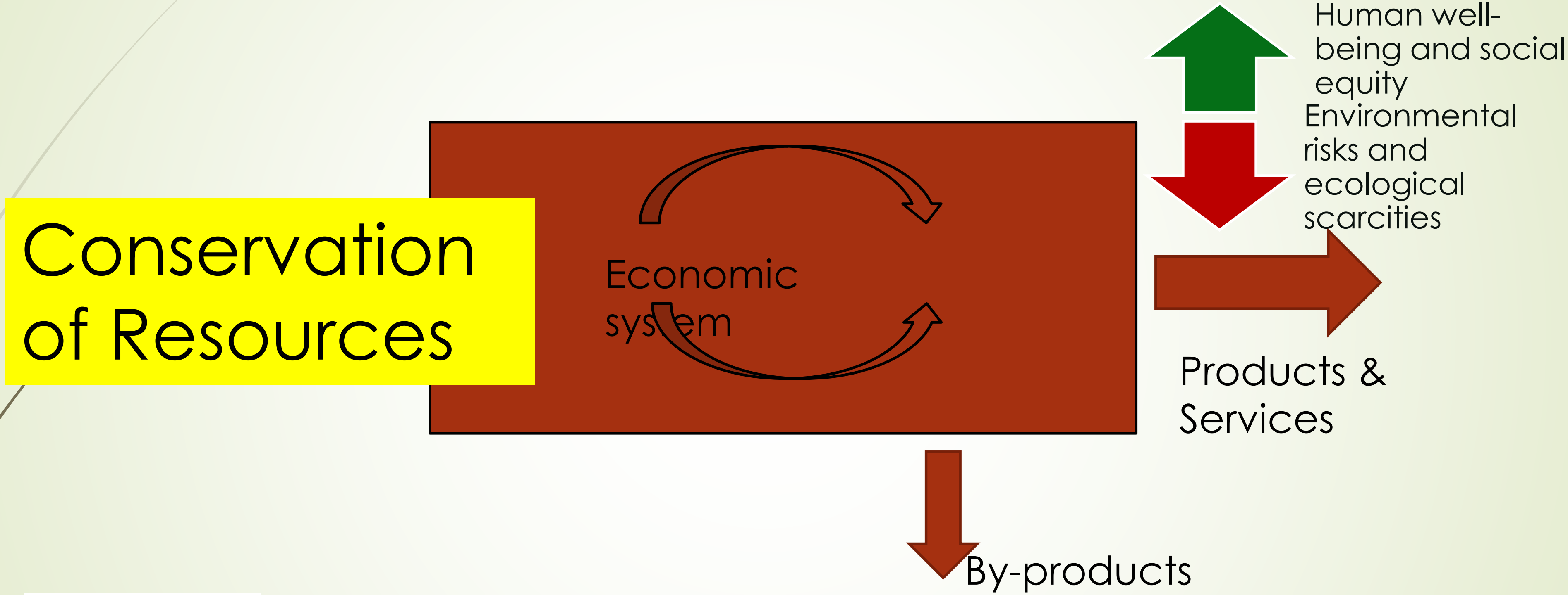
Source: https://www.government.nl/topics/circular-economy/from-a-linear-to-a-circular-economy

Recycling-Oriented Economic Society: A Knowledge-based Society



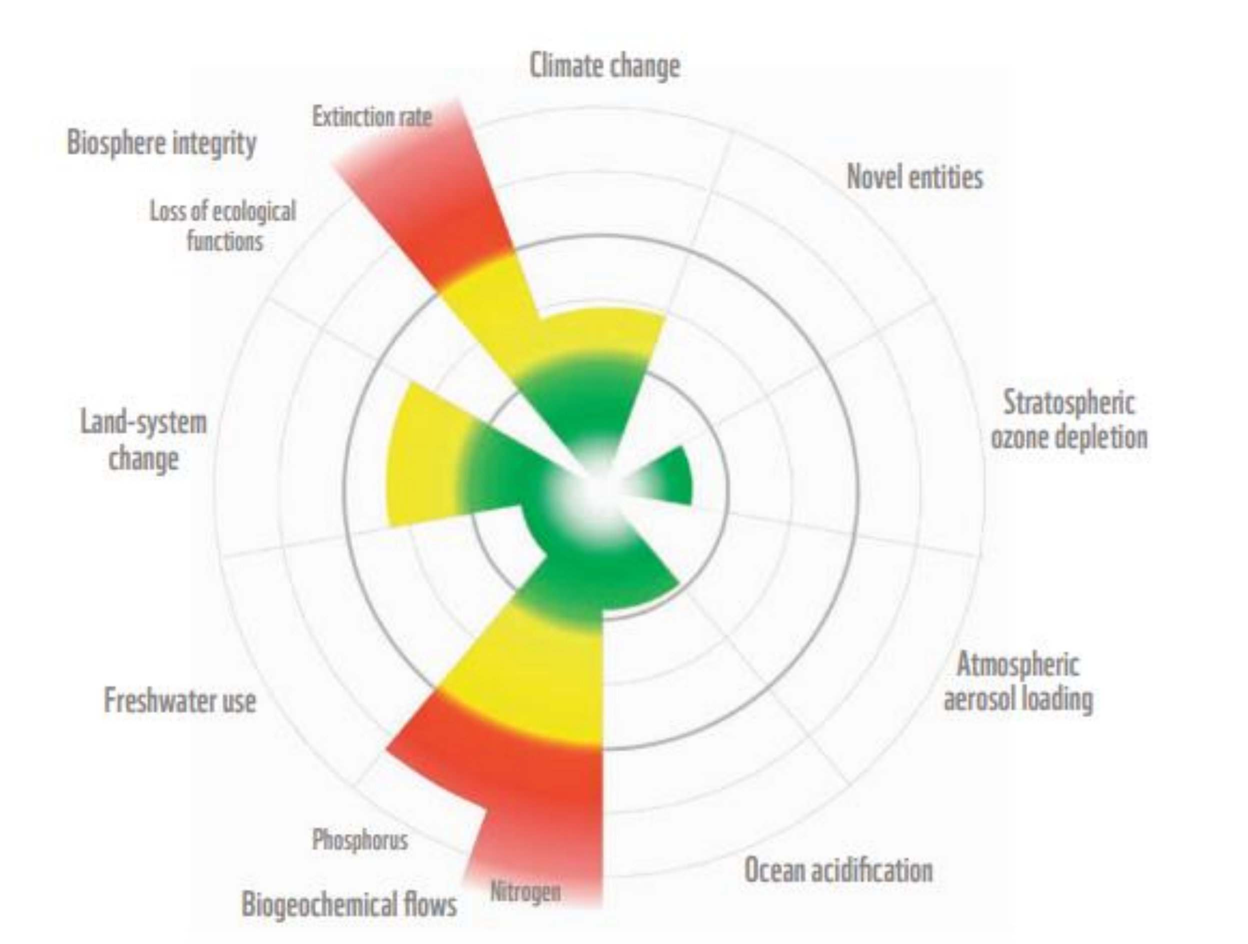
Value-adding Activity Society

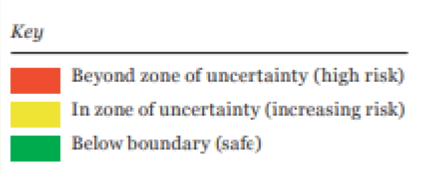
Technology for a Resource-efficient Circular Economy



Objectives:
to MAXimize output with MINimum input, and operating within the carrying capacity of the eco-system

Planetary Boundaries





GLOBAL MATERIAL USE HAS ACCELERATED

- *Annual global extraction of materials grew from 22 billion tonnes in 1970 to around 70 billion tonnes in 2010*
- *Non-metallic minerals used in construction was the fastest growing group of materials*

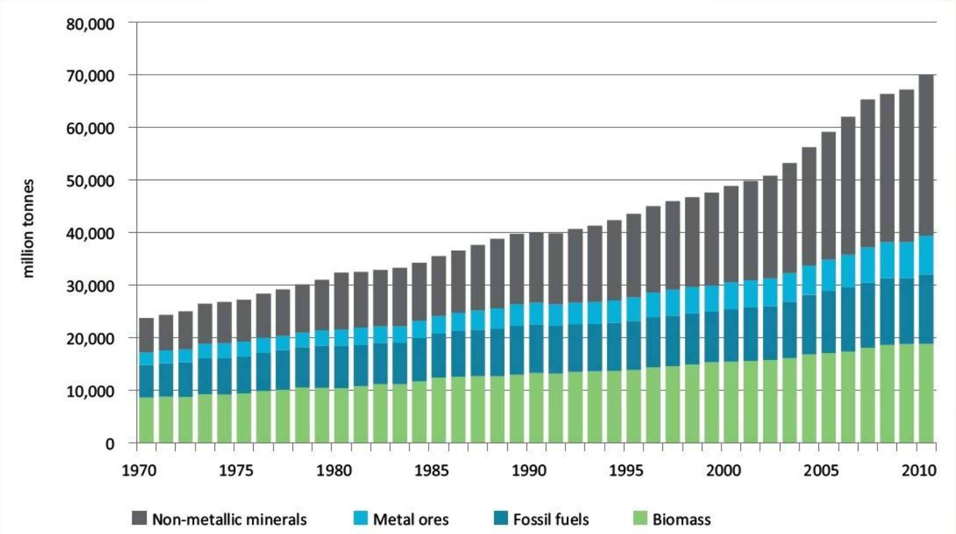


Figure 1. Global material extraction (DE) by four material categories, 1970–2010, million tonnes

MATERIAL EXTRACTION GREW UNEVENLY IN THE GLOBAL ECONOMY

- *Asia and the Pacific had the largest growth, especially China and Southeast Asia*
- *Growth in Asia and the Pacific reverberated in Latin America and Africa who supplied materials to Asia*

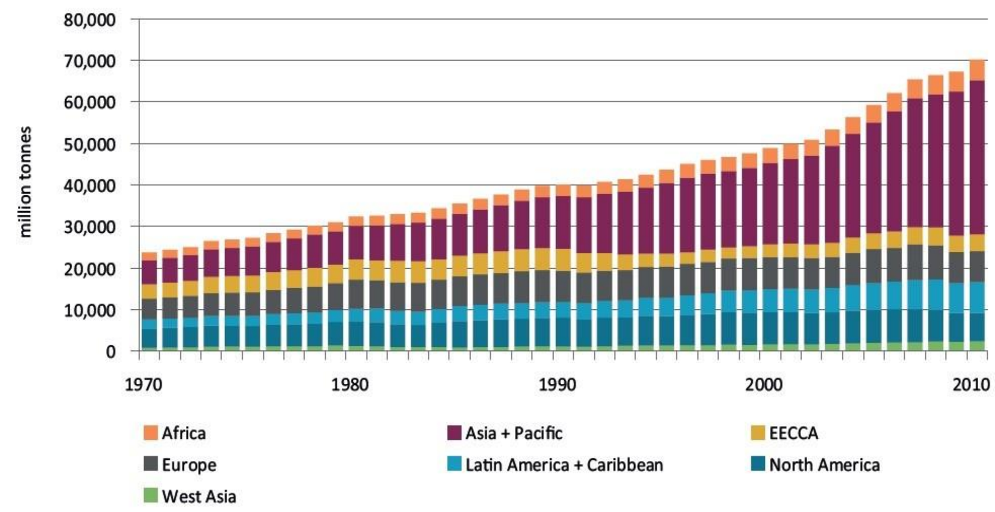
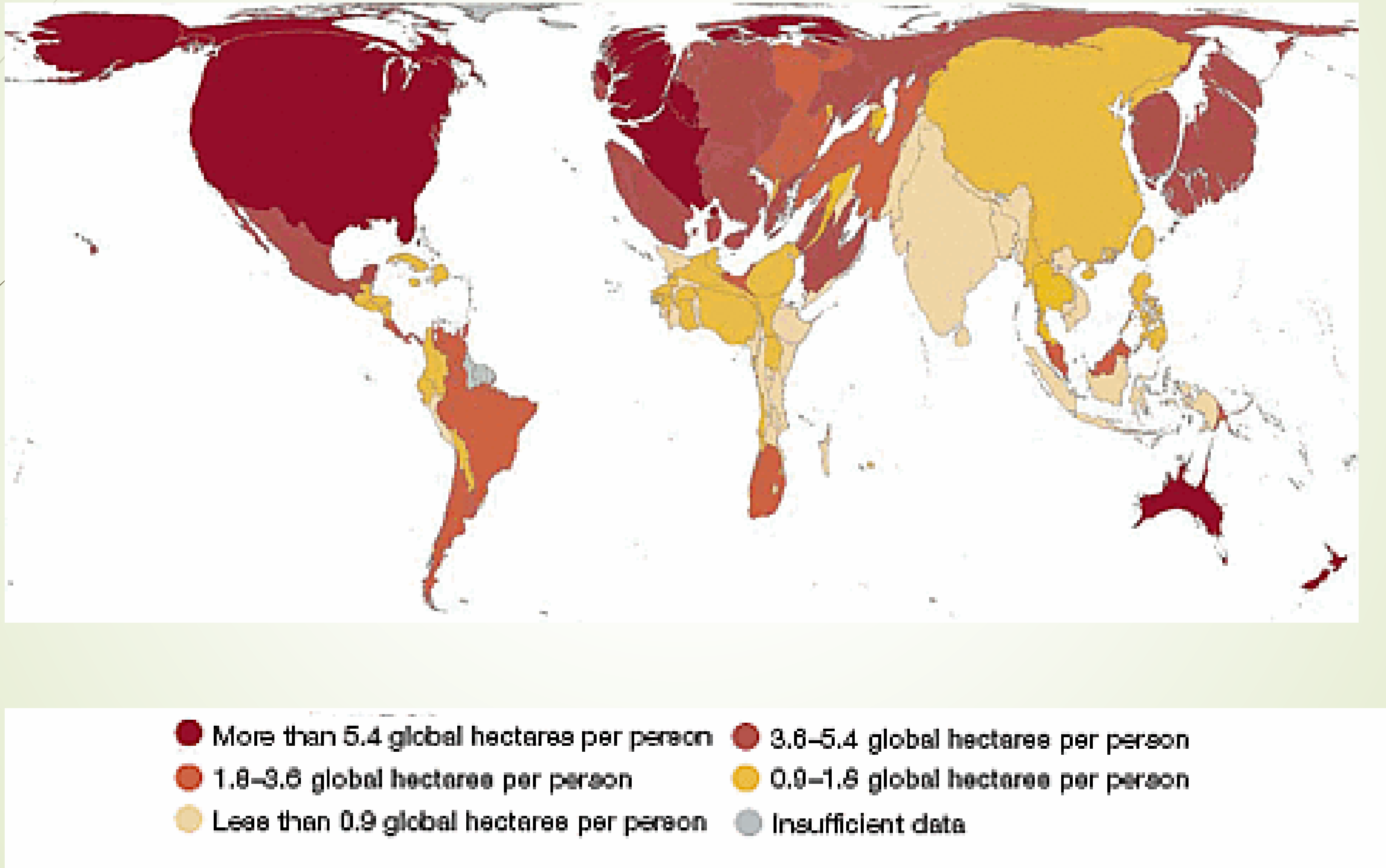


Figure 2. Domestic extraction (DE) by seven subregions, 1970–2010, million tonnes

Eco Footprint 2006



2016 Eco-footprint

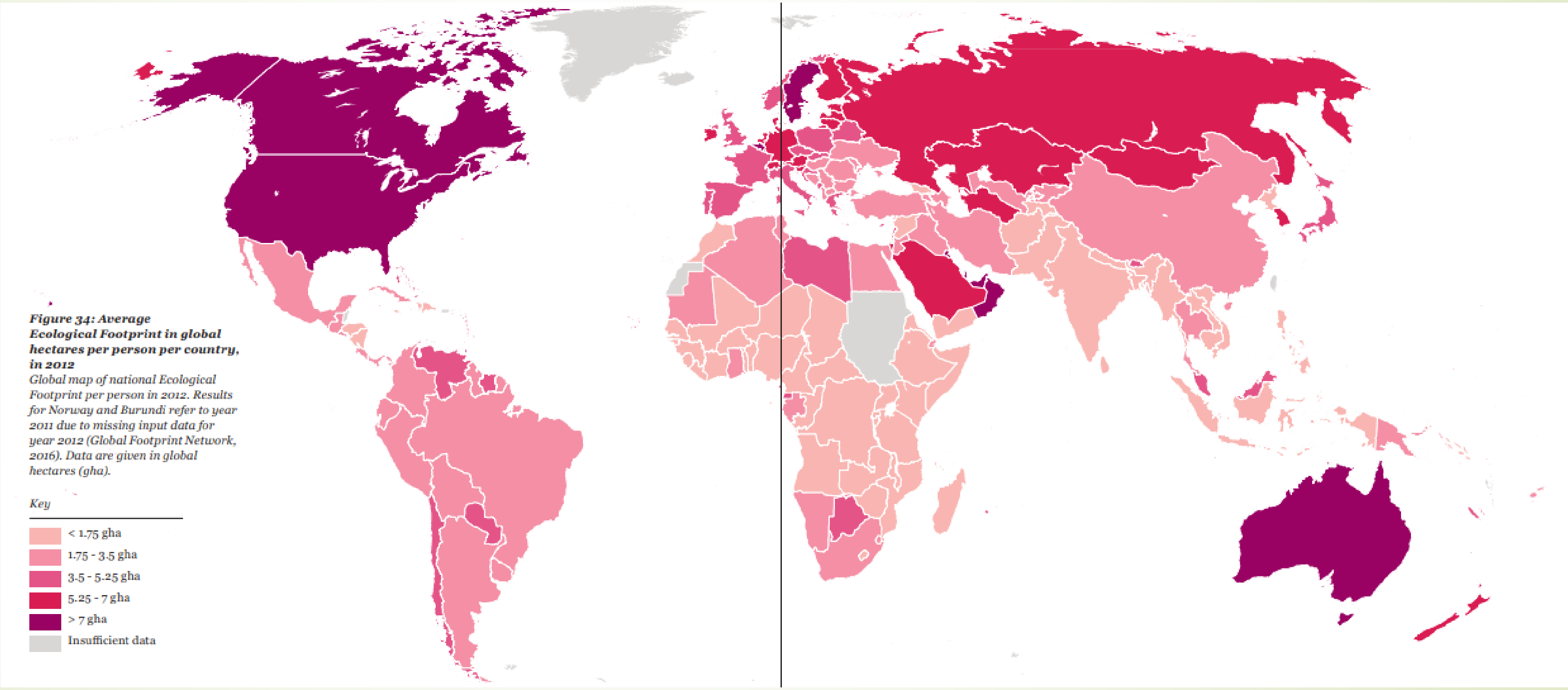
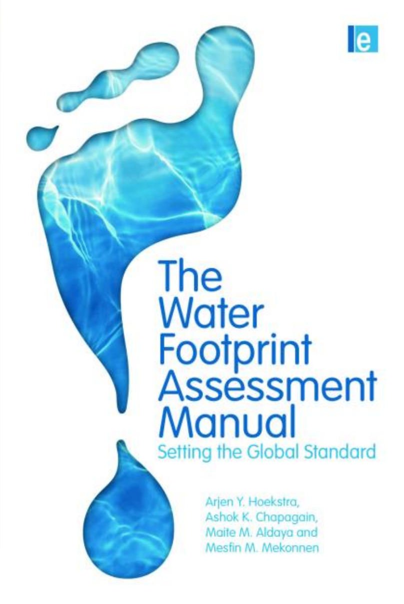
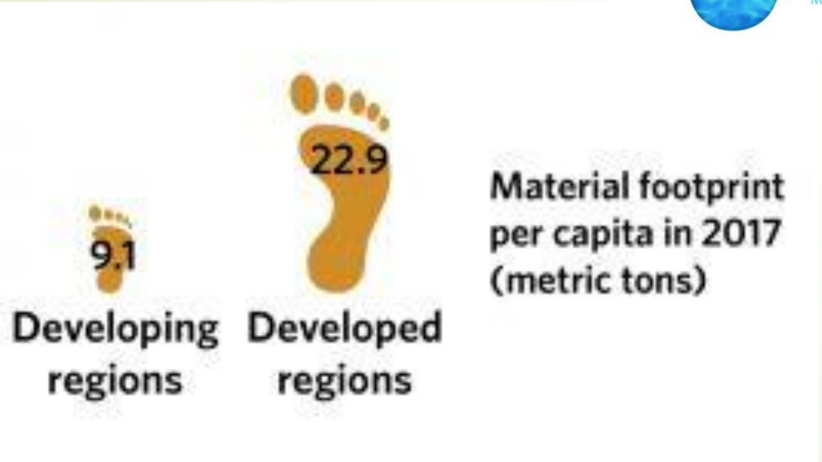
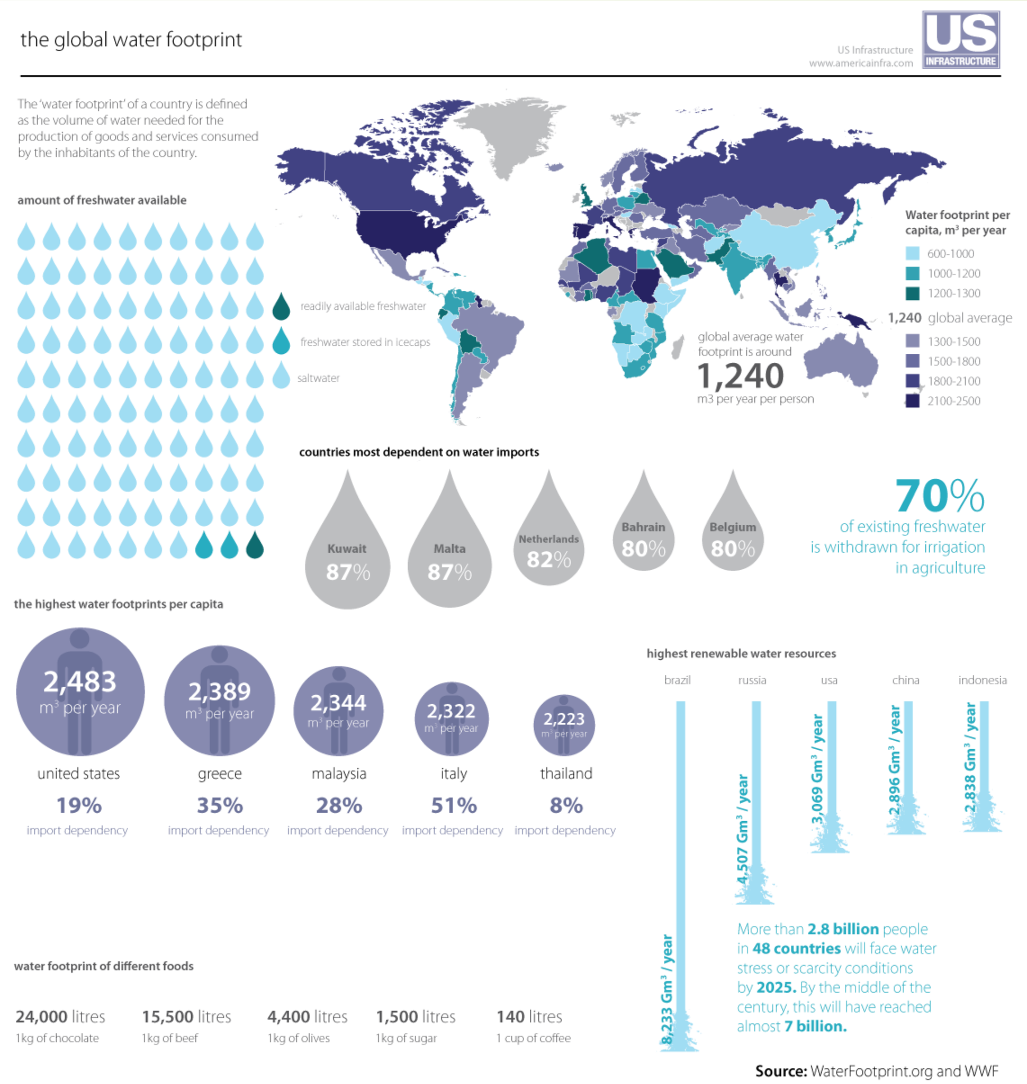


Figure 34: Average Ecological Footprint in global hectares per person per country, in 2012
Global map of national Ecological Footprint per person in 2012. Results for Norway and Burundi refer to year 2011 due to missing input data for year 2012 (Global Footprint Network, 2016). Data are given in global hectares (gha).

More scrutinies







RICHEST COUNTRIES CONSUME ON AVERAGE 10 TIMES THE MATERIALS AS POOREST COUNTRIES

- *Average material footprint of medium HDI countries has grown slowly over past two decades, reaching 5 tonnes per capita, while material footprint in low HDI countries has been stagnant for the past two decades at 2.5 tonnes per capita*

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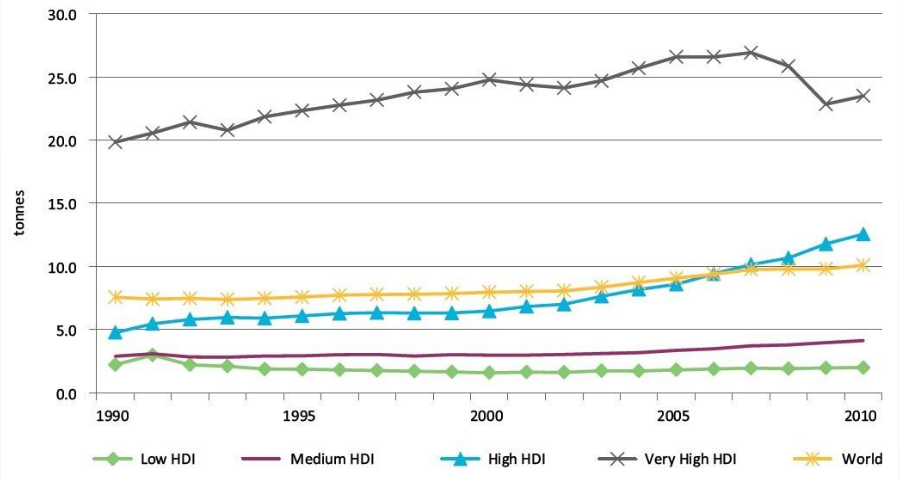

UN environment

Figure 8. Per capita material footprint (MF) by HDI level, 1990–2010 (the HDI is a compound index on life expectancy, literacy and income)

CONSUMPTION IS DRIVING GLOBAL MATERIAL USE

- *Growth in per capita income and consumption have been the strongest driver of growth in material use, even more important than population growth in recent decades*

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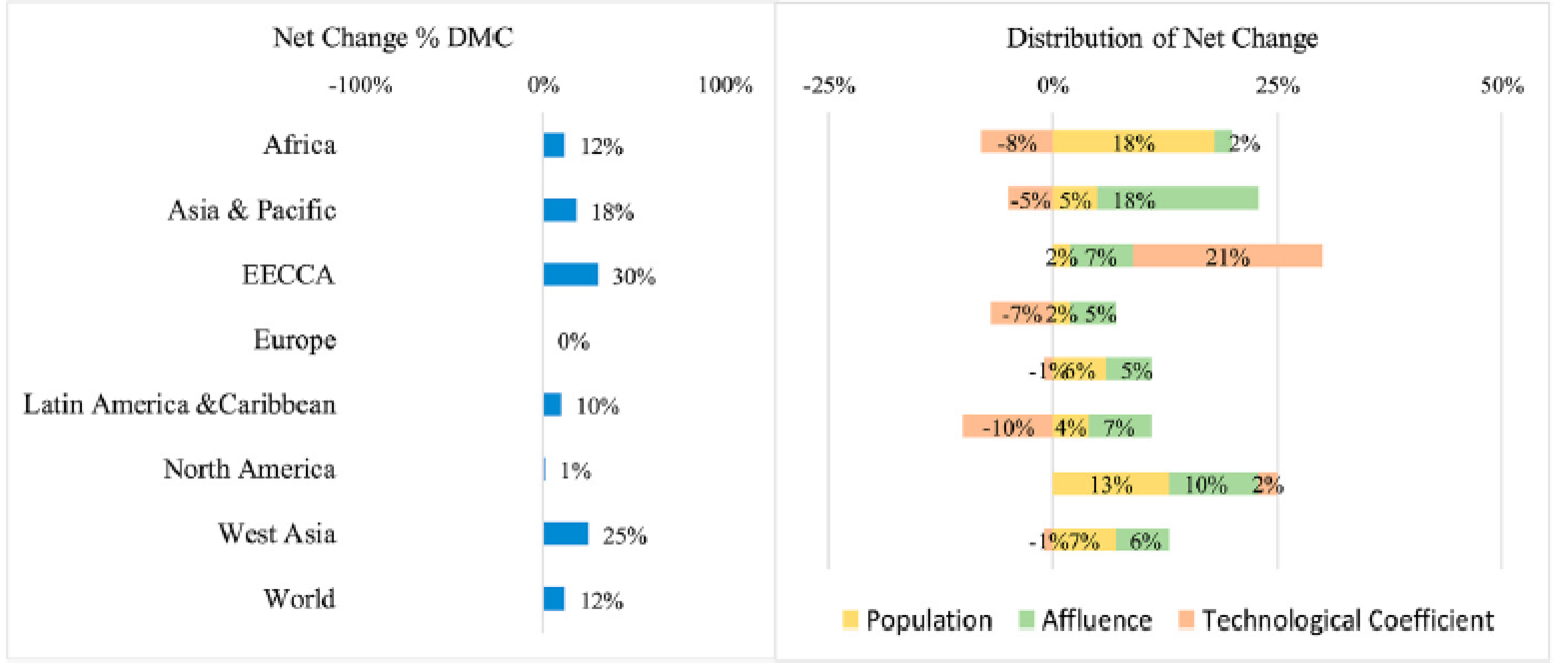
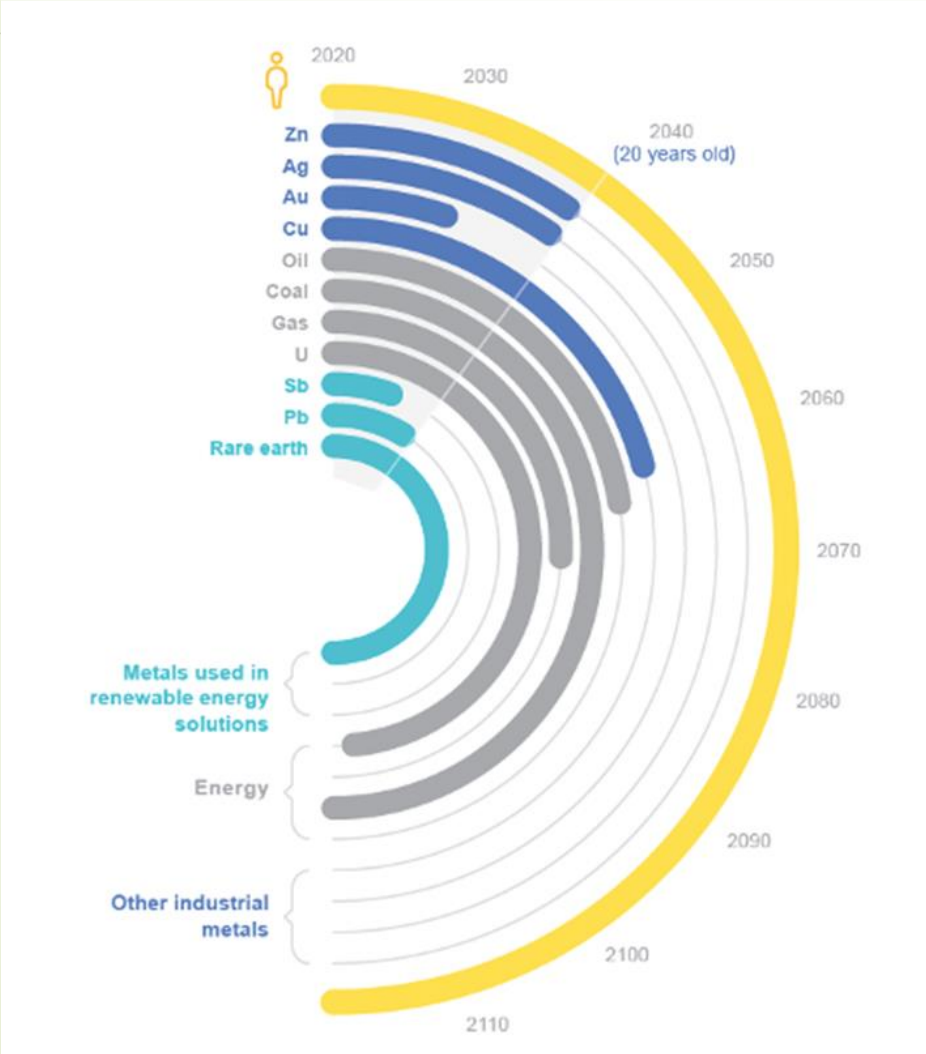
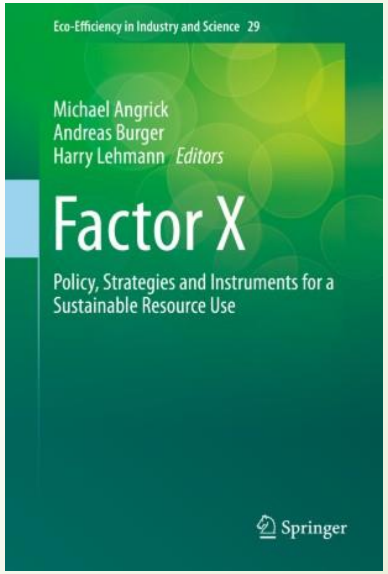


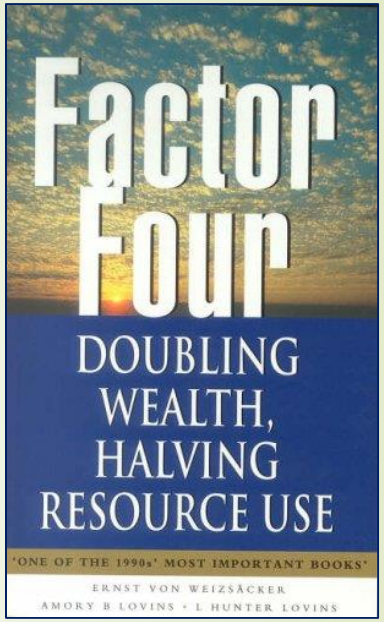
Fig. 2. Drivers of material footprint, 2010–2015 (percentages) (adapted from IRP, 2017).

Source: CLRC 2000 Chiu et al

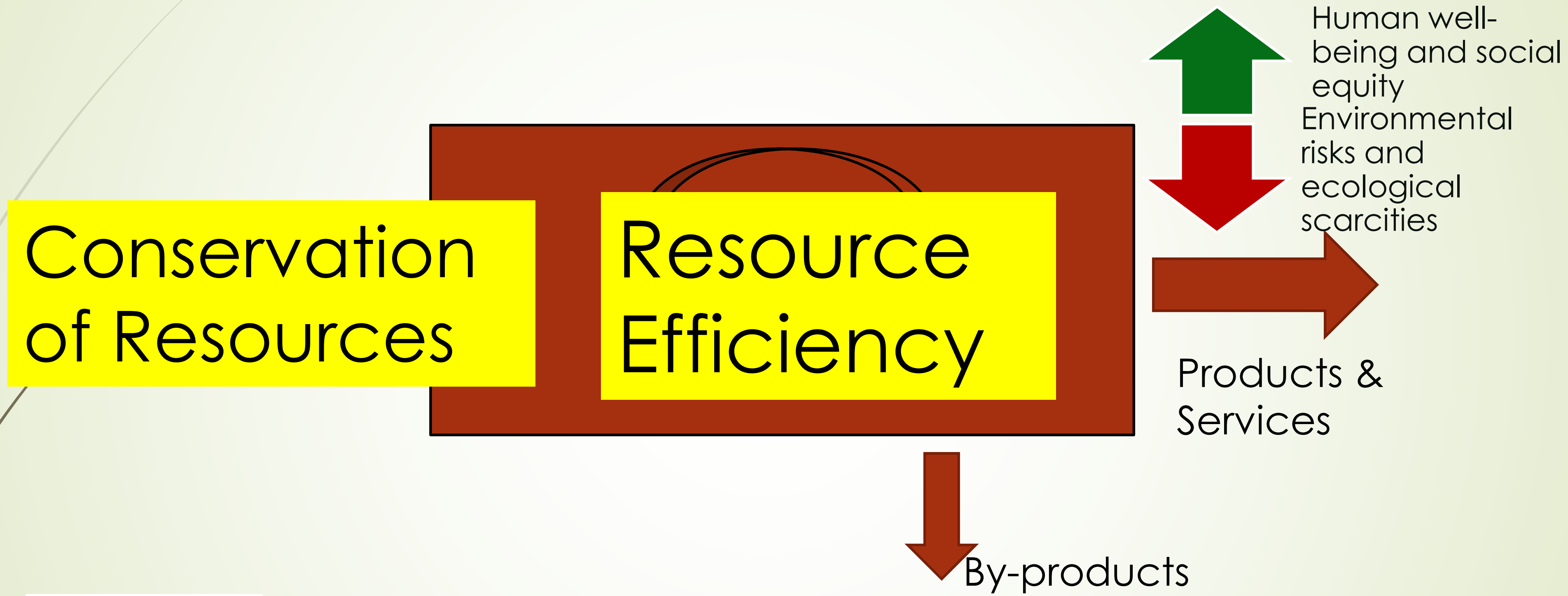
Factor 4 or Factor X ?







Systems Thinking



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Objectives:
to MAXimize output with MINimum input, and operating within the carrying capacity of the eco-system

OVERALL DECLINE IN MATERIAL EFFICIENCY

- *Global economy now needs more materials per unit of GDP than it did at the turn of the century*
- *This has been caused by large shift of economic activity from very material-efficient economies such as Japan, the Republic of Korea and Europe to the much less material-efficient economies of Asia and the Pacific*

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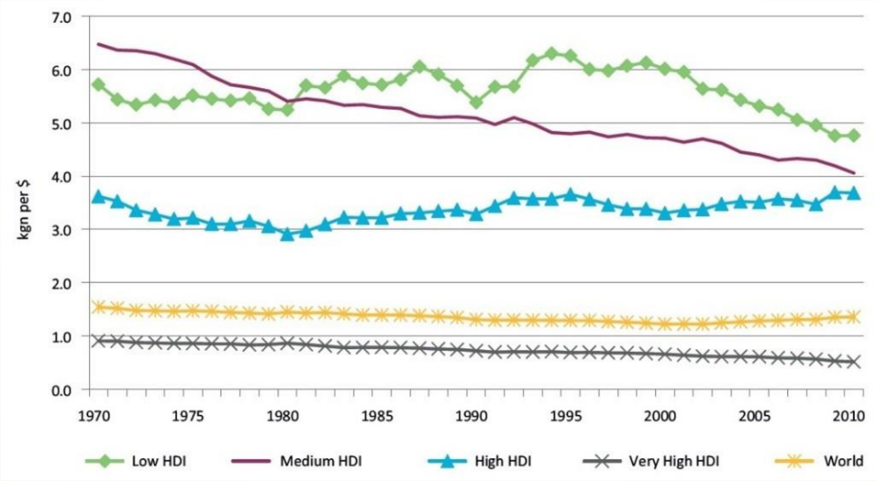

Figure 7. Material intensity by development status and global material intensity, 1970-2010

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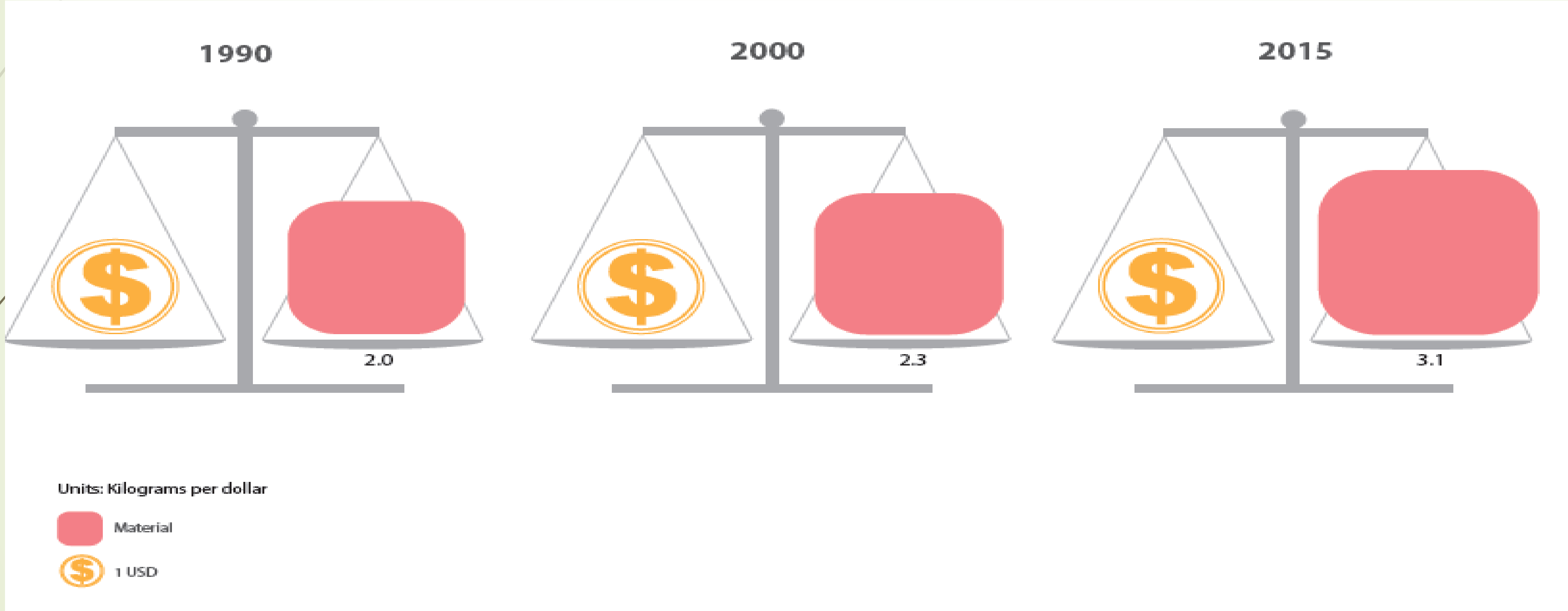
Increasing intensity of resource use in Asia Pacific



THE LEVEL OF WELL-BEING ACHIEVED IN WEALTHY INDUSTRIAL COUNTRIES CANNOT BE GENERALIZED GLOBALLY BASED ON THE SAME SYSTEM OF PRODUCTION AND CONSUMPTION

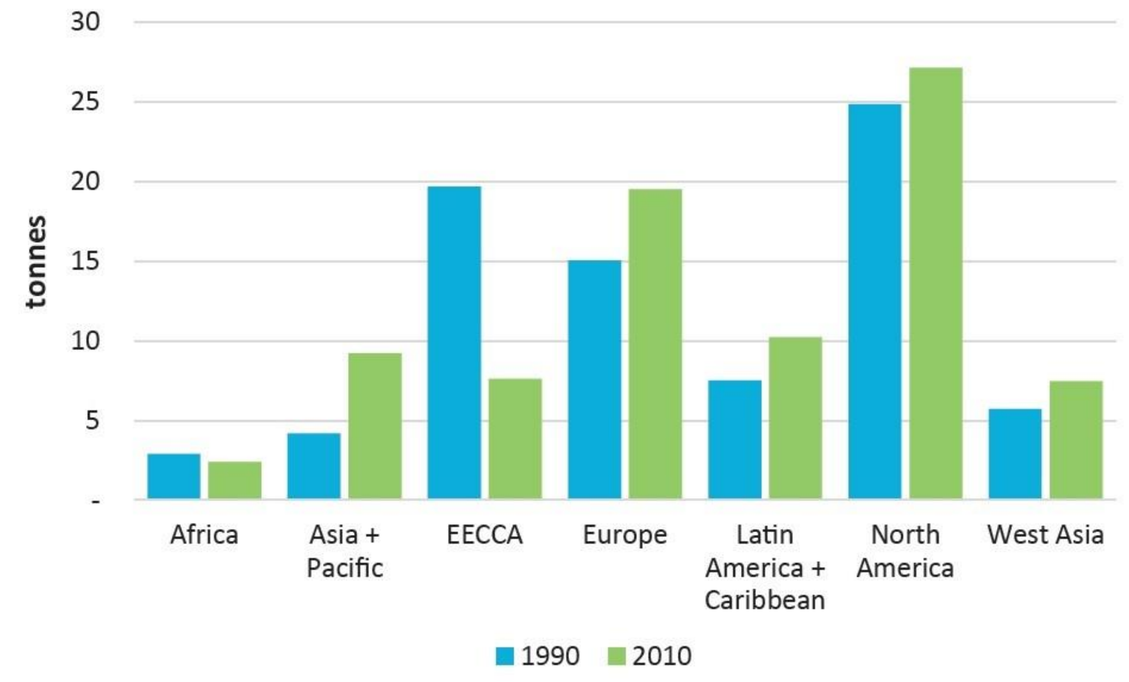
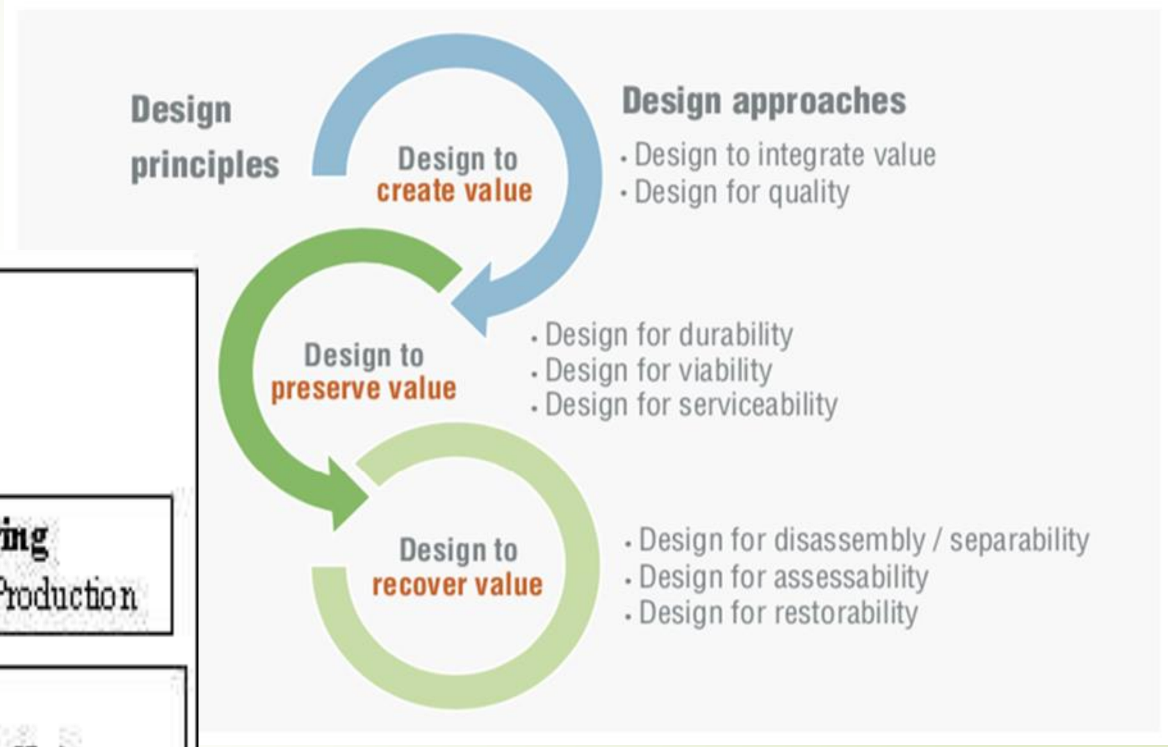
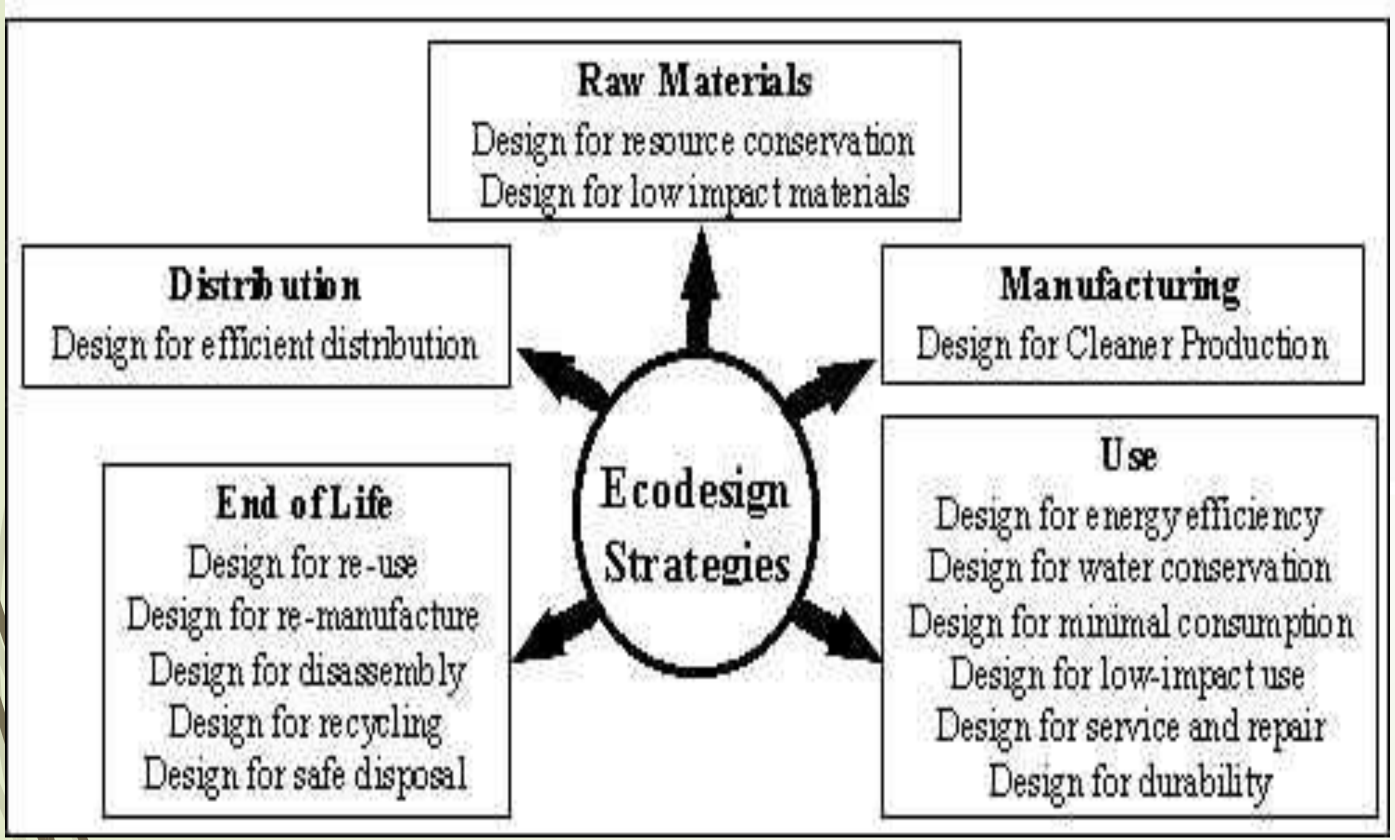


Figure 6. Per-capita material footprint (MF) by seven world regions, 1990 and 2010, tonnes

If current systems of production and provision for major services will not be changed, nine billion people would require about 180 billion tonnes of materials annually by 2050, almost three times today's amounts

Sustainable Product Innovation (SPIN)





Circular Design Strategies (also see Circular Design Guide)

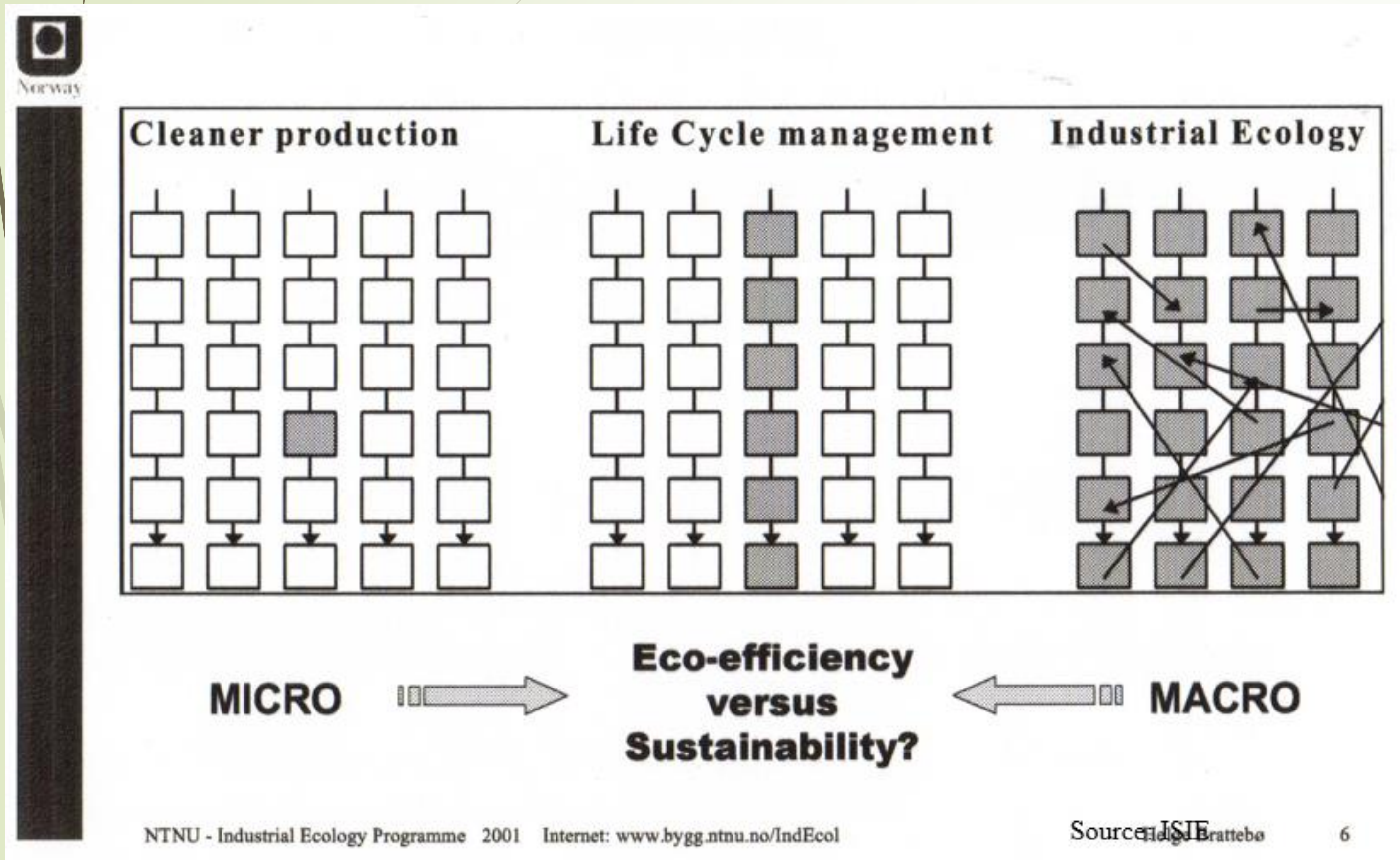
- Dematerialization
- Product-as-a-Service
- Design for extended product life
- Circular material choice
- Modular design

Material Innovation

(1) **New materials could improve resource efficiency by replacing conventional materials that have higher carbon footprints.**

(2) **New materials could be less harmful to the environment and human health.**

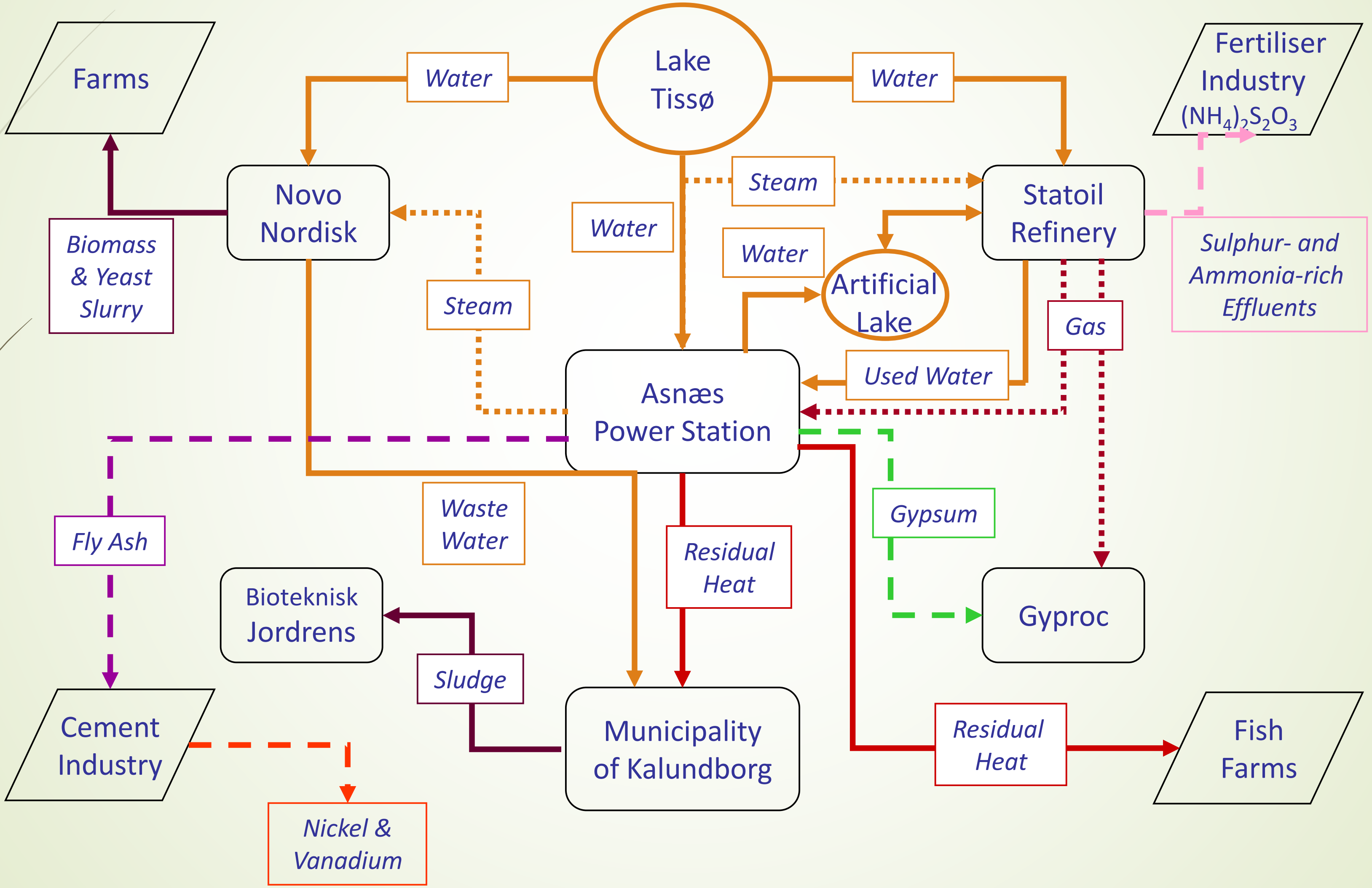
Extended Principles and Ideas



Zero Emission (or industrial symbiosis)

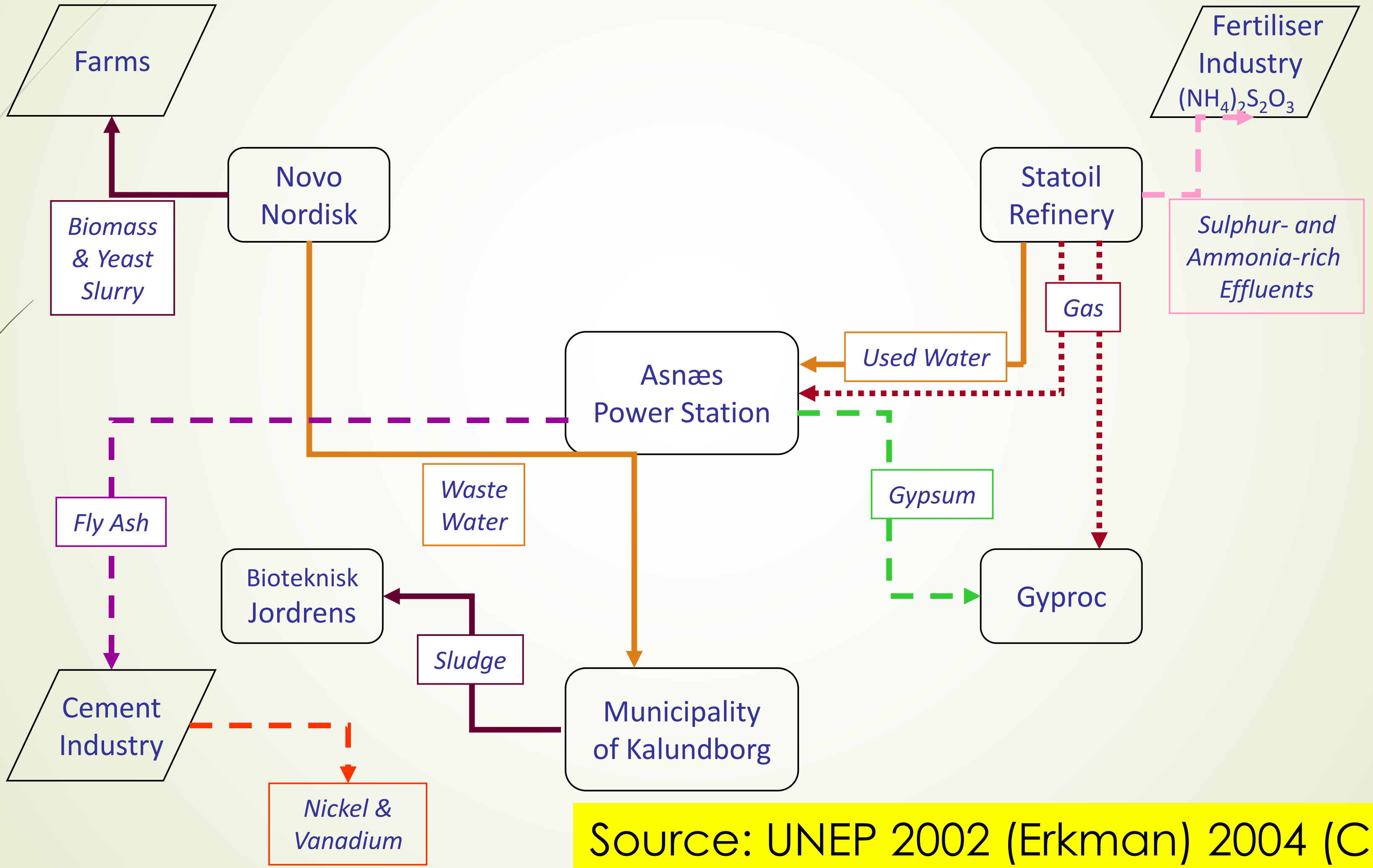
Zero-emission can be defined as a vehicle, engine or energy source that does not produce any dangerous gases that could pollute the environment. It is a key fundamental concept in Consumer Sustainability. It can be extended to an enlarged system, such as an industrial park, a city, or ….

Kalundborg Industrial Symbiosis



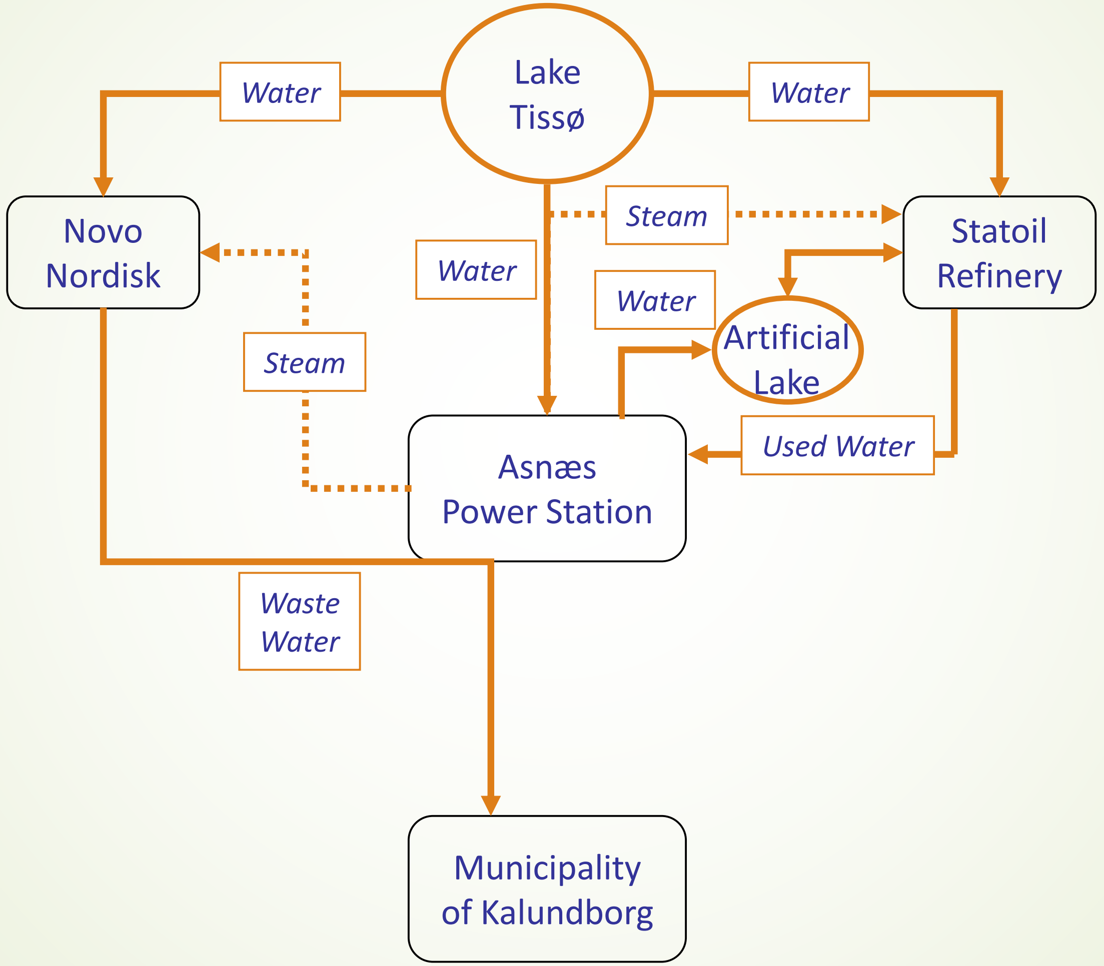
Source: UNEP 2002 (Erkman) 2004 (Chiu)

Kalundborg Industrial Symbiosis - Waste Flow



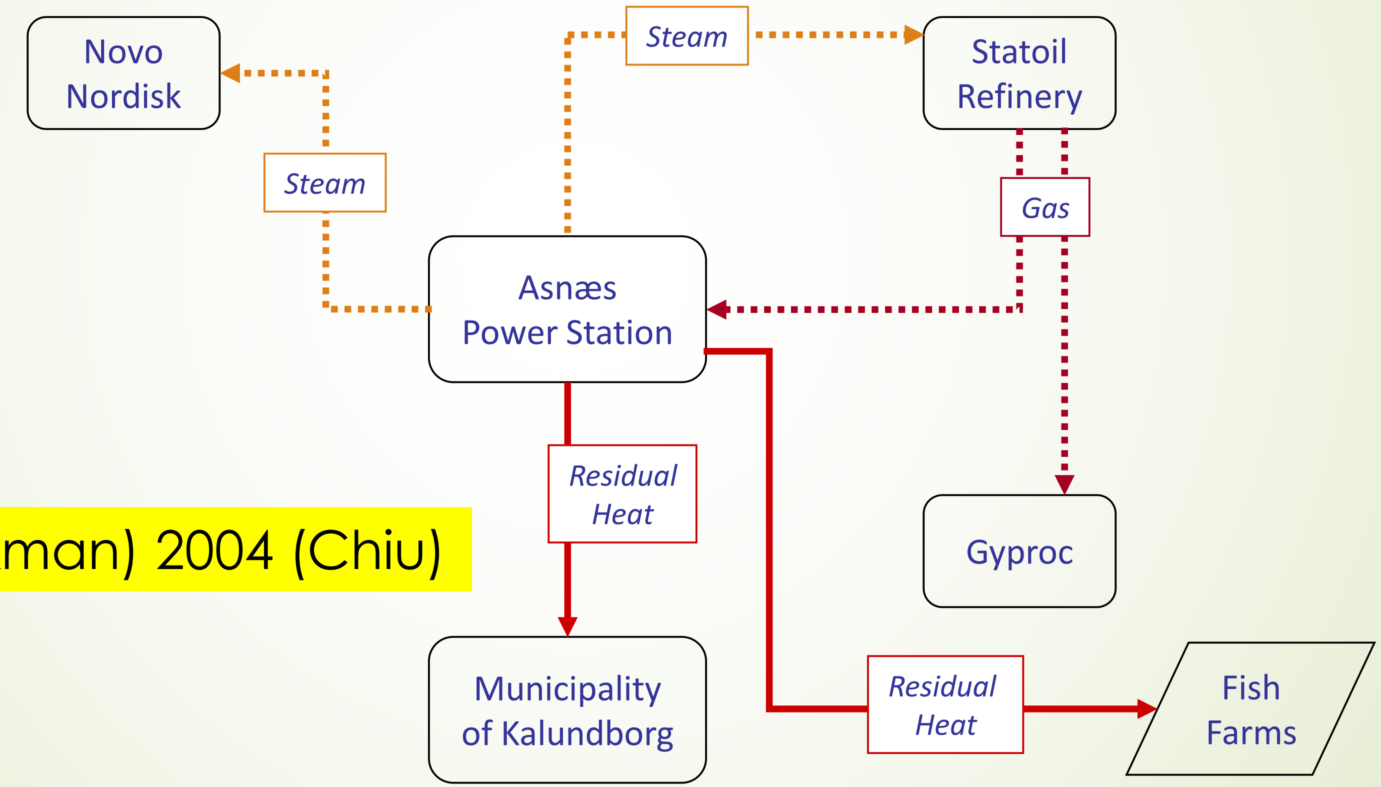
Source: UNEP 2002 (Erkman) 2004 (Chiu)

Kalundborg Industrial Symbiosis - Water Flow



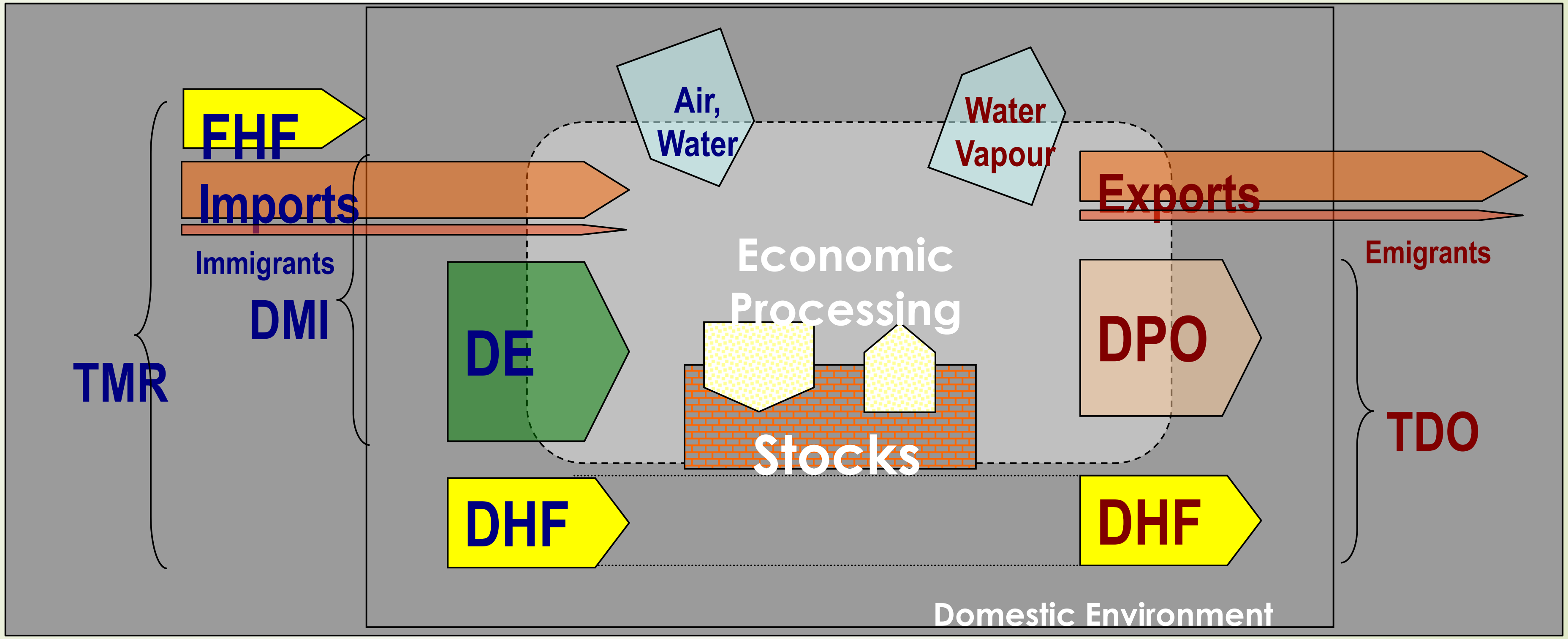
Source: UNEP 2002 (Erkman) 2004 (Chiu)

Kalundborg Industrial Symbiosis - Energy Flow



Source: UNEP 2002 (Erkman) 2004 (Chiu)

Technology for a consumer-empowered Circular Economy



Source: WRI et al.,2000, 2016; Rapera, Chiu, et al.

Globalize the Circular Economy

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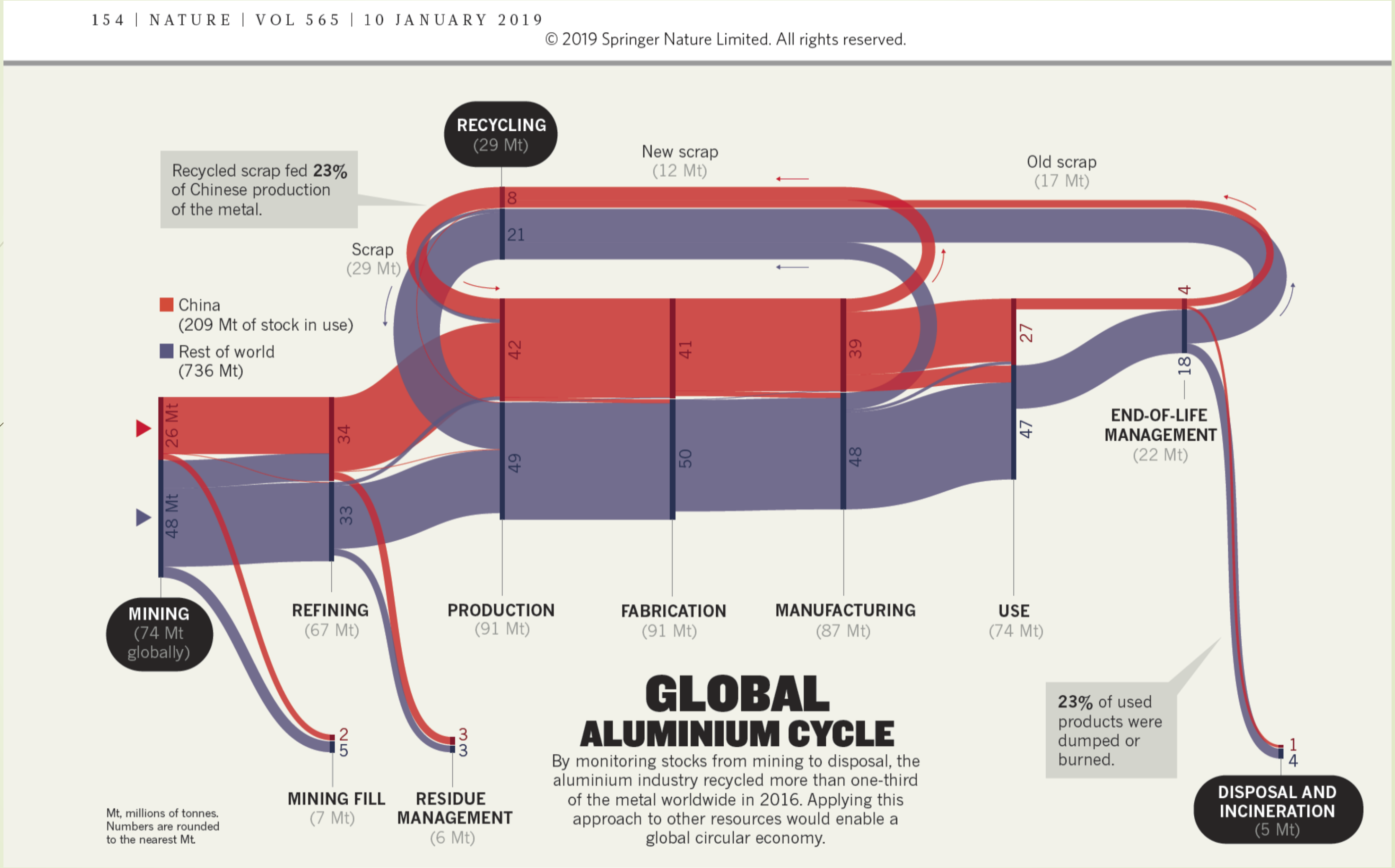

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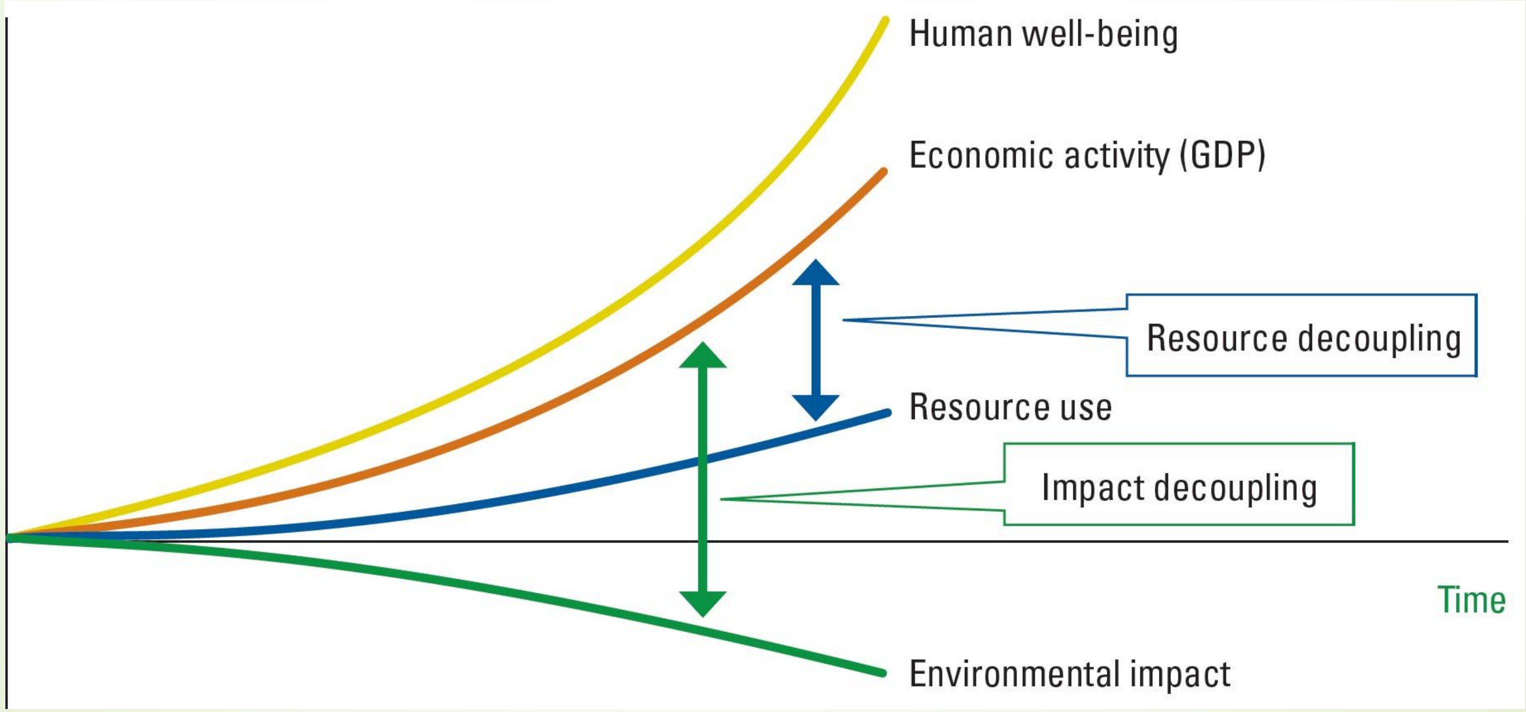
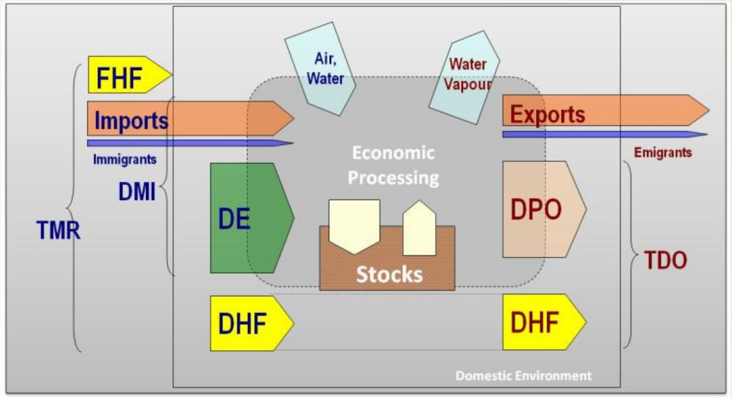


Eco-civilization, Sufficiency Economy, De-growth

INDICATORS



INPUT

Total Material Requirement (TMR)

Direct Material Input (DMI) = Domestic Extraction (DE) + imports

Domestic Hidden Flows (DHF)

Foreign Hidden Flows (FHF)

OUTPUT

Domestic Processed Output (DPO)

Total Domestic Output (TDO) = Domestic Processed Output (DPO) + DHF

Direct Material Output (DMO)

Total Material Output (TMO)

BALANCE

Net Addition to Stocks (NAS) = DMI + Air and Water – Exports – DPO – Water Vapour

Imports and Exports

Air, Water, Water Vapour

MFA Components

Domestic

- Non - Renewable
  - ✓ Energy Carriers
  - Metal Ores
  - ✓ Industrial Minerals
  - ✓ Construction Materials
  - Excavation
- Renewable
  - ✓ Plant Biomass
  - ✓ Animal Biomass
- Soil Erosion

Imports

- Non - Renewable
  - ✓ Energy Carriers
  - Metal Ores
  - ✓ Industrial Minerals
  - ✓ Construction Materials
  - Excavation
- Renewable
  - ✓ Plant Biomass
  - ✓ Animal Biomass
- Semi-Manufactures
- Final Products
- Hidden Flows
  - Imported Raw Materials
  - Imported Semi-Manufactures

Comparisons between China and Other Countries

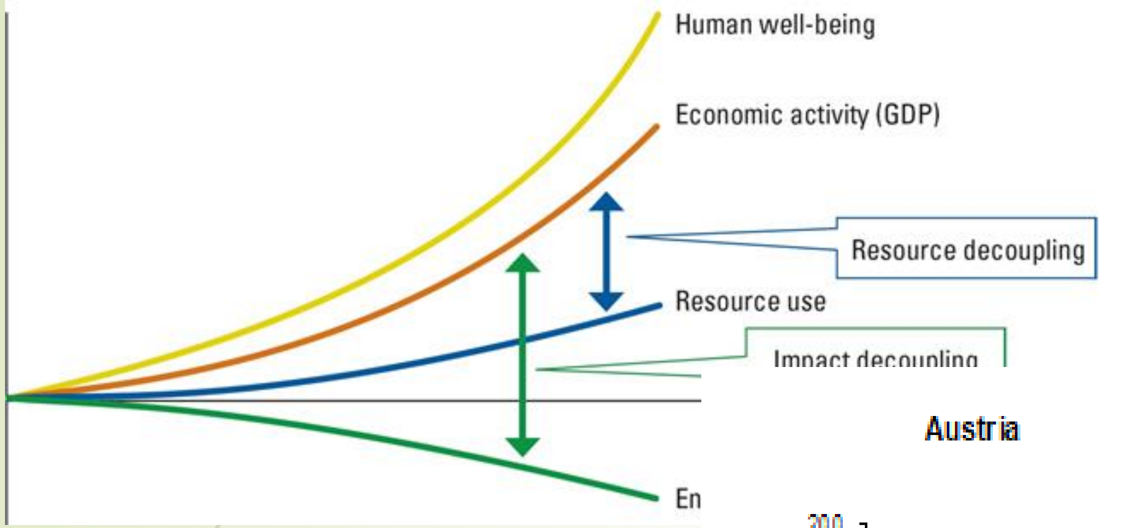
Countries	US	Canada	Japan	Australia
SO_2 emission(kg/1000US$GDP)	2.3	3.7	0.3	4.7
NOx emission(kg/1000US$GDP)	2.7	2.9	0.6	5.5
Countries	**France**	**Germany**	**OECD**	**China**
SO_2 emission(kg/1000US$GDP)	0.8	0.7	2.0	18.5
NOx emission(kg/1000US$GDP)	1.4	1.0	2.1	16.6

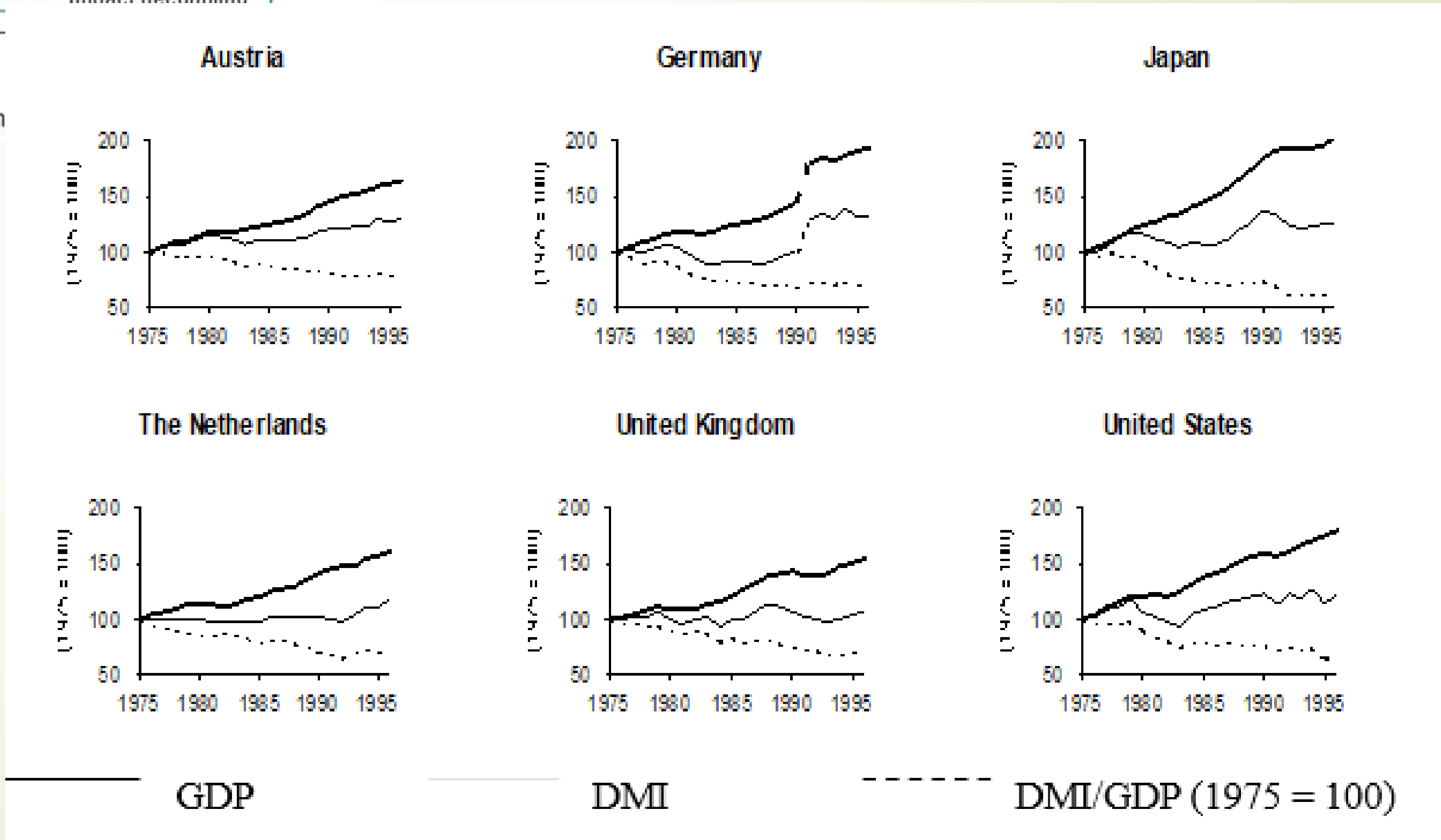
Geng, ISIE 2005

Energy Comparison

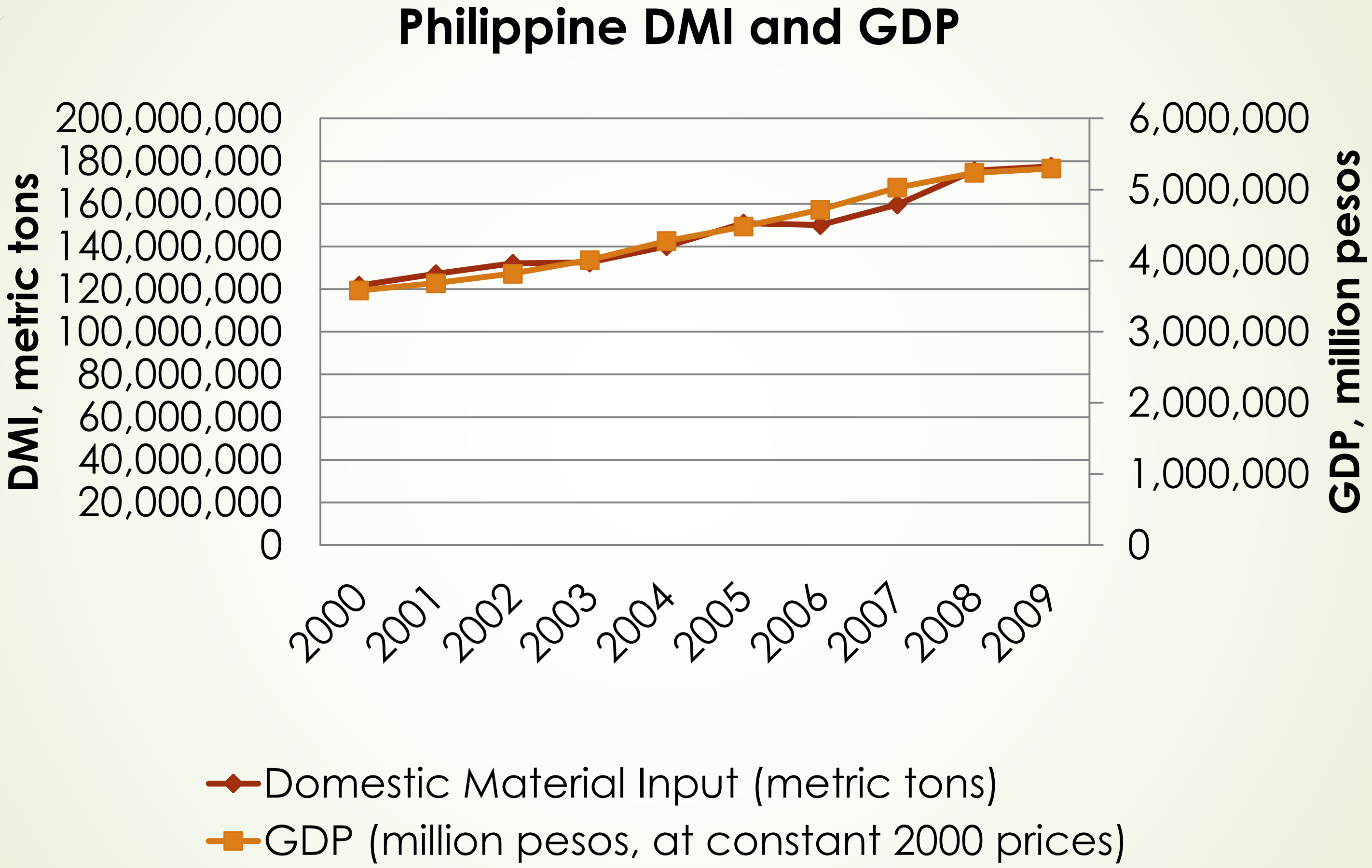
Geng, ISIE 2005

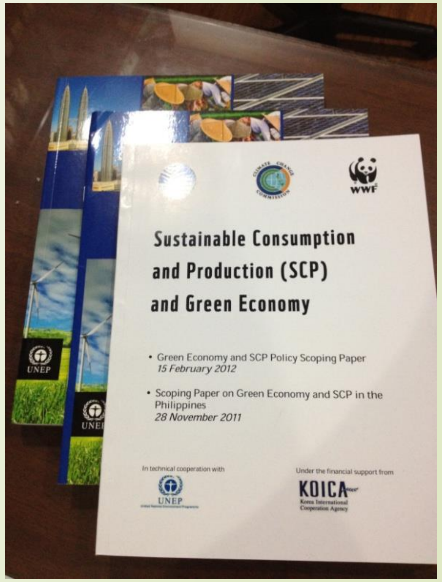
COUNTRY	JAPAN	ITALy	FRANCE	GERMANY	UK	US	CANADA	CHINA
Energy Consumption Per USD	1.00	1.33	1.50	1.50	2.17	2.67	3.50	11.5


Human well-being
Economic activity (GDP)
Resource decoupling
Resource use
Impact decoupling
En

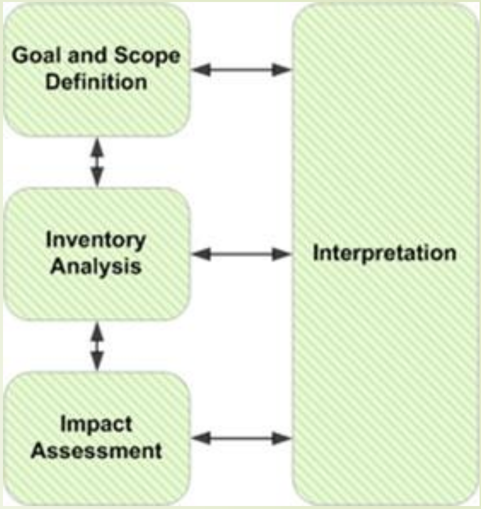

Austria
Germany
Japan
The Netherlands
United Kingdom
United States
200
150
100
50
1975
1980
1985
1990
1995
GDP
DMI
DMI/GDP (1975 = 100)

Resource Utilization





Life Cycle Assessment



There are generally four main stages in an LCA study:

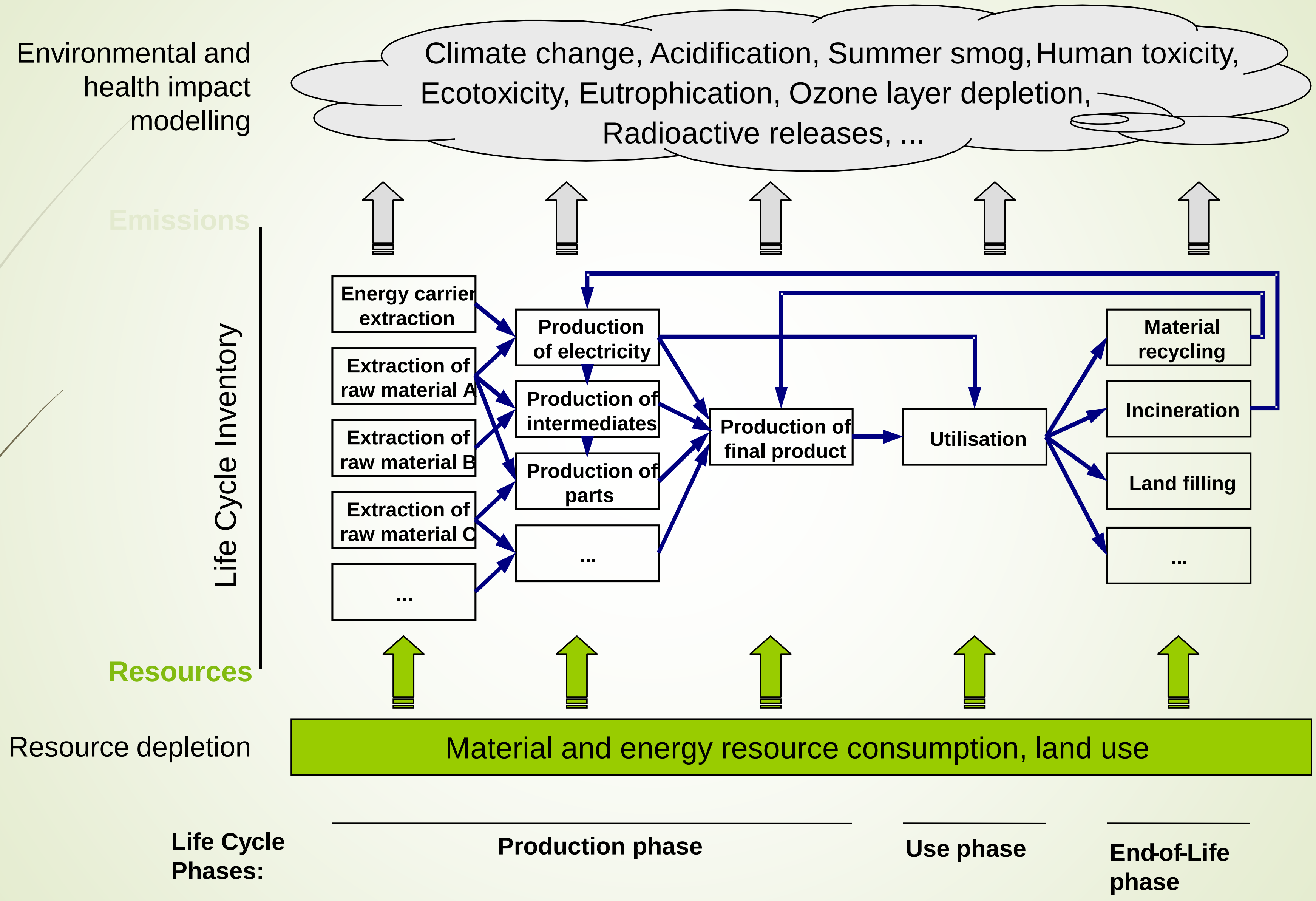
(a) Goal and Scope Definition, where the objective and boundaries of the study are decided;

(b) Inventory Analysis, where a model of the life-cycle is made and data on environmental emissions and resource consumption from the different processes across the life-cycle are collected or calculated;

(c) Impact Assessment, where the impact on the environment is assessed;

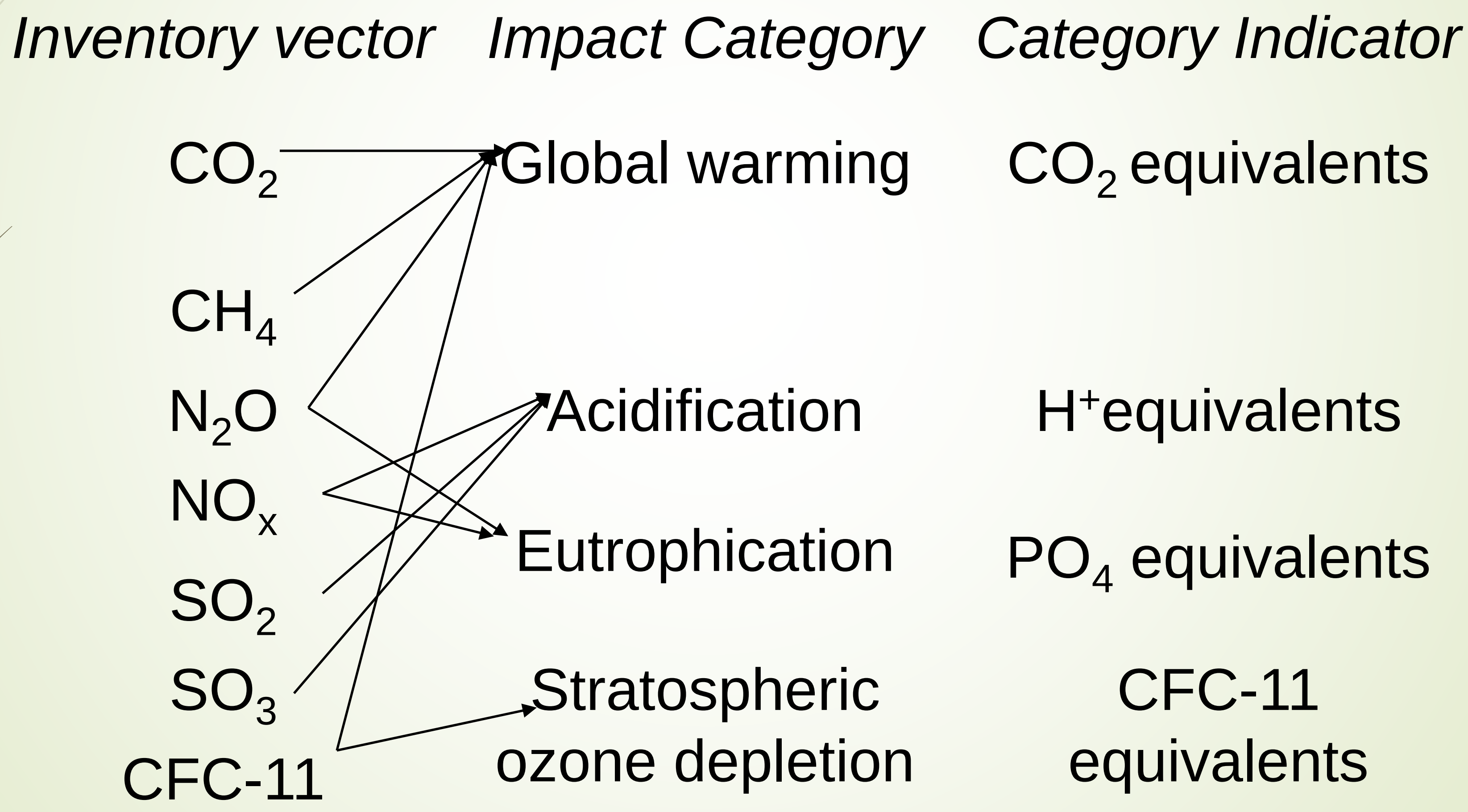
(d) Interpretation, where significant issues are identified and conclusions are drawn. Sensitivity analyses, identification of significant data gaps and major uncertainties can also be included.

Life cycle thinking and Life Cycle Assessment
Source: Wolf, EC JRC

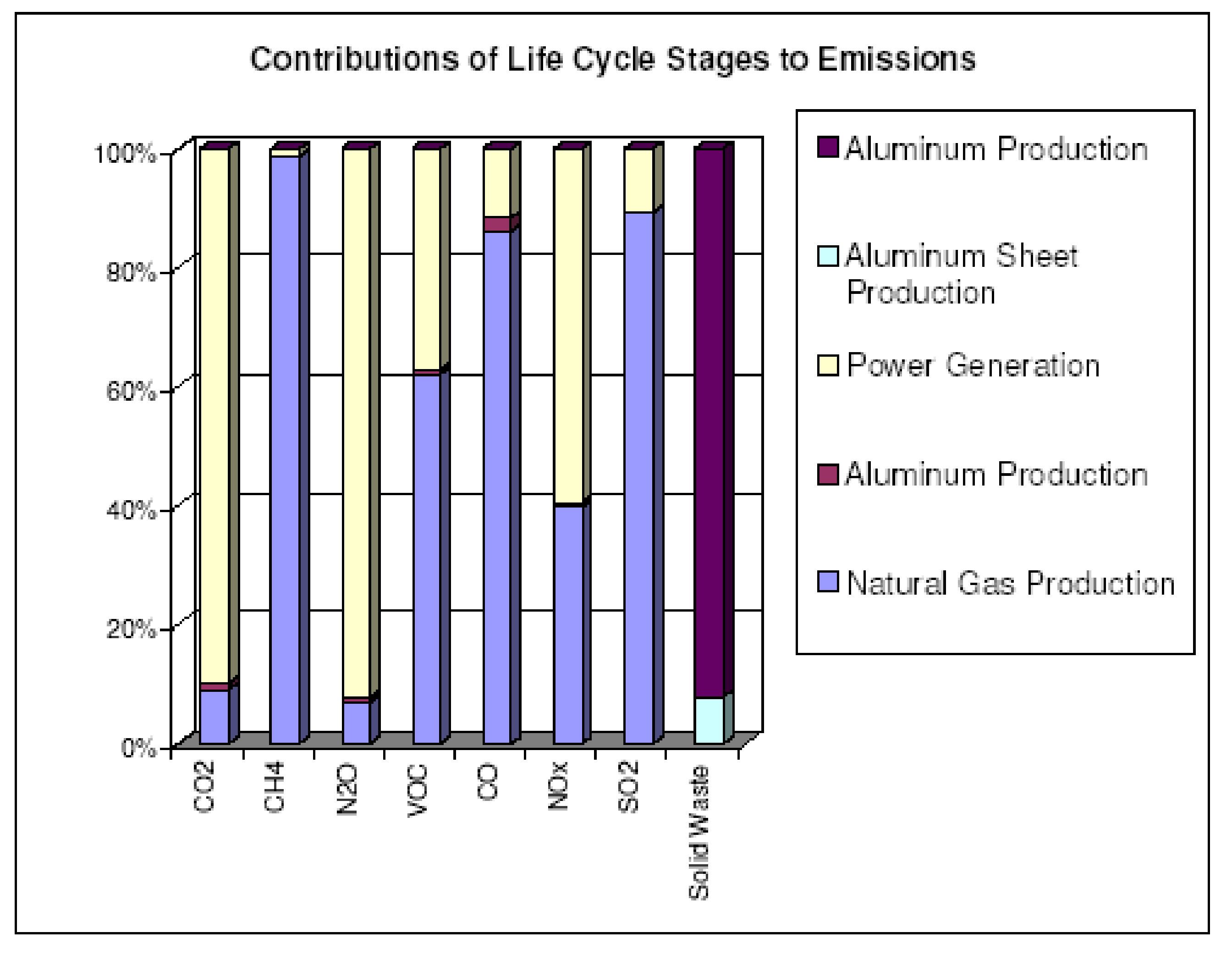


Scheme of Life Cycle Thinking and Assessment

Characterization



Contributions of Processes



Circular Supply Chain

It all starts with a tip

Consumers can directly tip their farmer, rewarding responsible and sustainable practices

That improves livelihoods

Producers, in-turn, gain additional direct income, driving more diverse consumer markets

Creates jobs

A new generation of producers emerges when economic benefits ease access to agriculture insurance and a financial credit history

Improves brand reputation

Processors, distributors, wholesalers and retailers can trace product provenance, creating market differentiation for sustainability and food security.

And mitigates environmental impact

Visibility into consumer demands enables effective inventory and harvest management, reducing enormous amounts of waste.

SCP Push-Pull Scenario

SUPPLY

Eco-design
Green Procurement
Circular Economy
RECP
LCA
Technology Progress
Policy Options

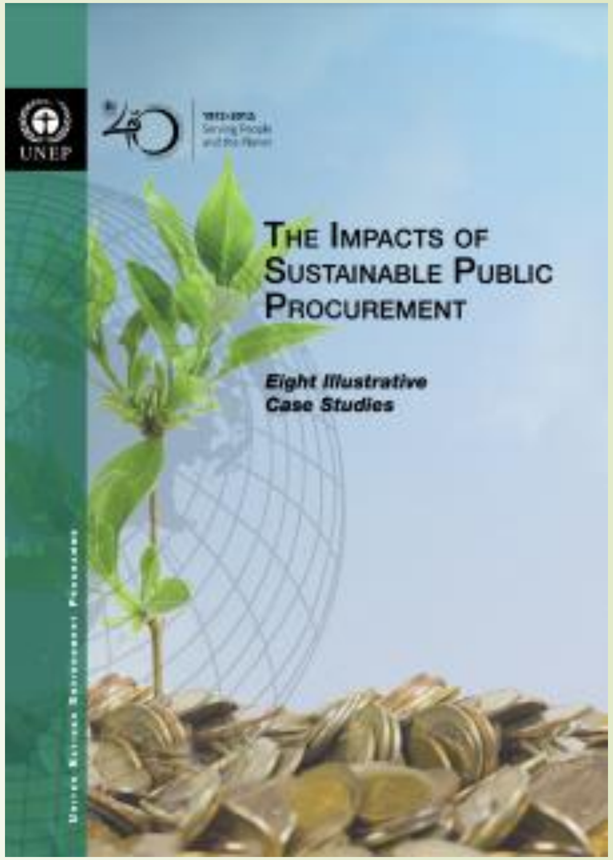
DEMAND

Lifestyle
Marketing ads
'Mesolimbic
Dopaminergic
Reward System'
Human needs
Human wants
Human desires

Related Principles and Ideas

- Green / environmentally friendly consumption,
- ethical consumption,
- choice editing,
- lock-in pokayoke, and
- sustainable consumption

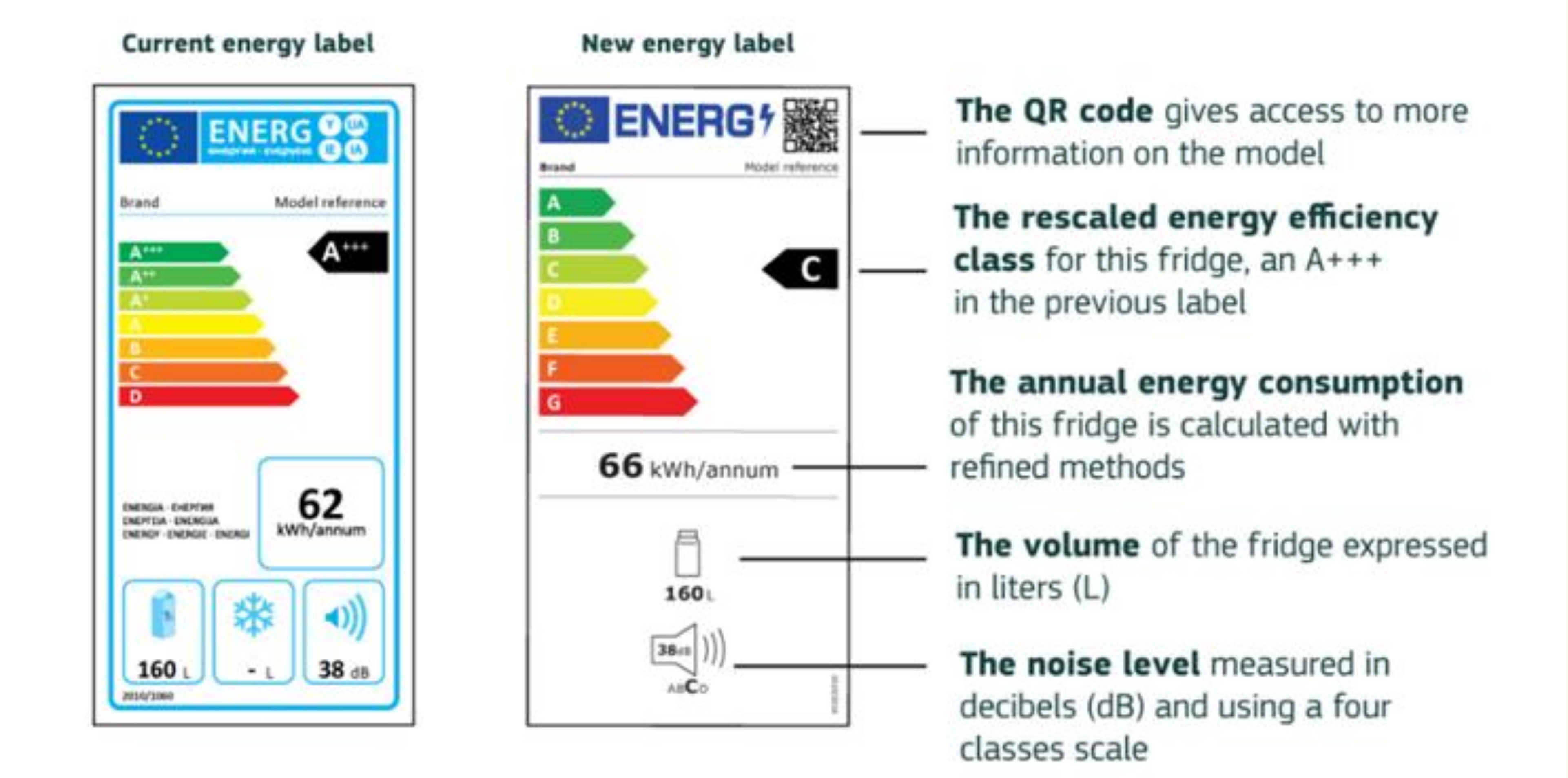
Related Principles and Ideas

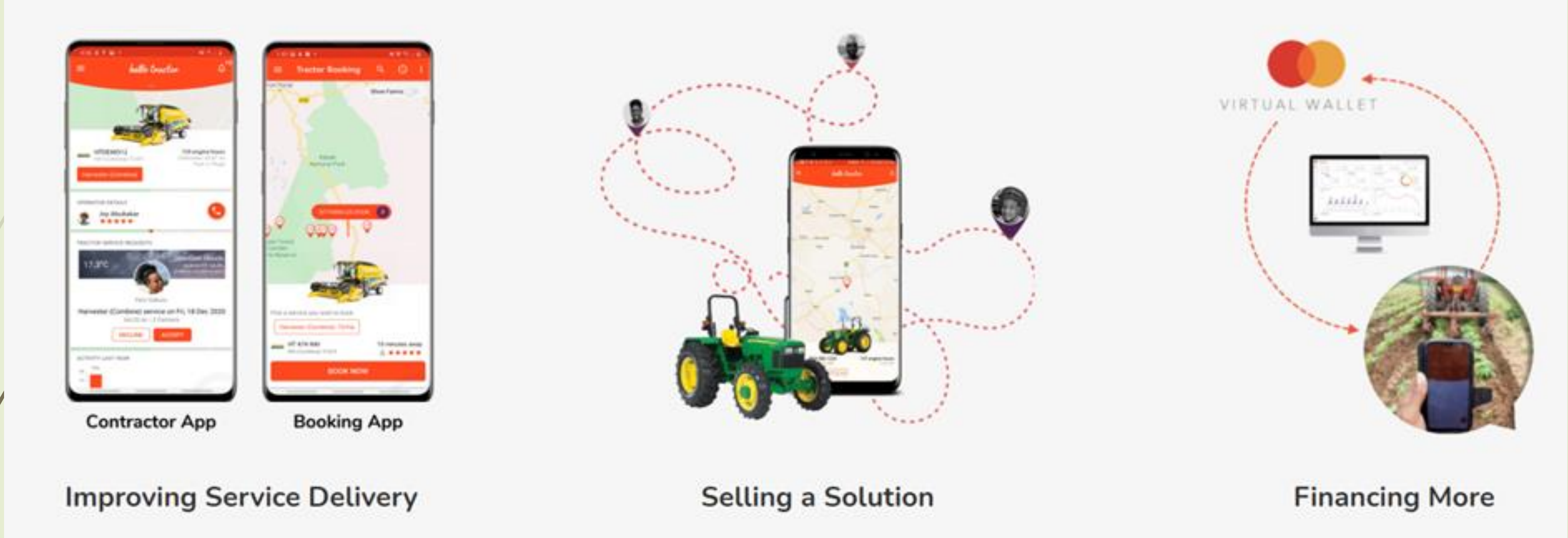


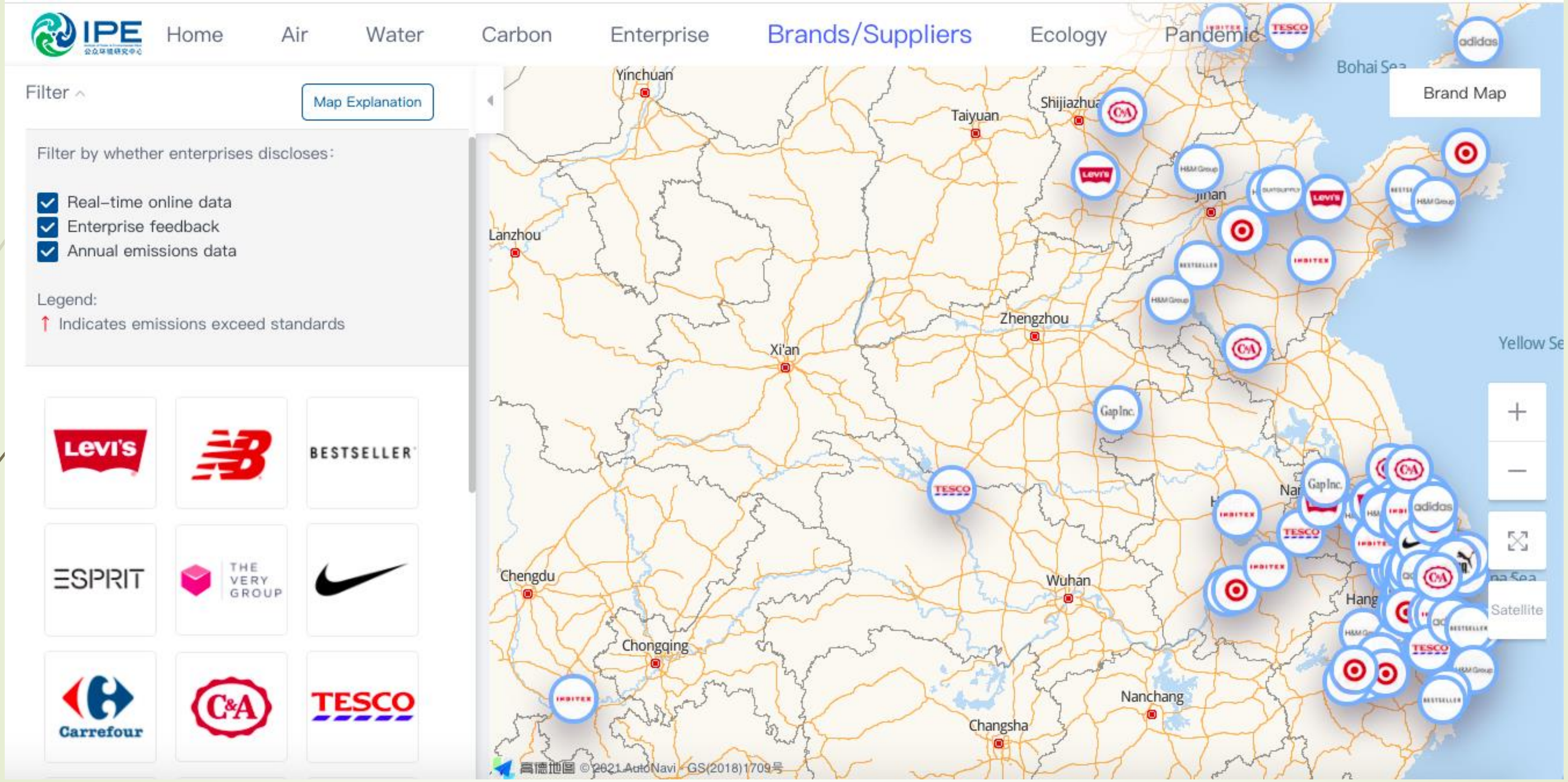
Ecolabel and Sustainable Public Procurement

Ecolabelling is defined by the International Organization for Standardization (ISO) as a voluntary method of environmental performance certification and labelling. It is practiced around the world. An ecolabel identifies products or services proven to be environmentally preferable within a specific category.

Shaping a Circular Lifestyle: A Consumer's Choice




Contractor App
Booking App
VIRTUAL WALLET
Improving Service Delivery
Selling a Solution
Financing More


IPE
Home
Air
Water
Carbon
Enterprise
Brands/Suppliers
Ecology
Pandemic
Filter
Map Explanation
Filter by whether enterprises discloses:
Real-time online data
Enterprise feedback
Annual emissions data
Legend:
Indicates emissions exceed standards
Brand Map
Satellite
Bohai Sea
Yellow Se
Yinchuan
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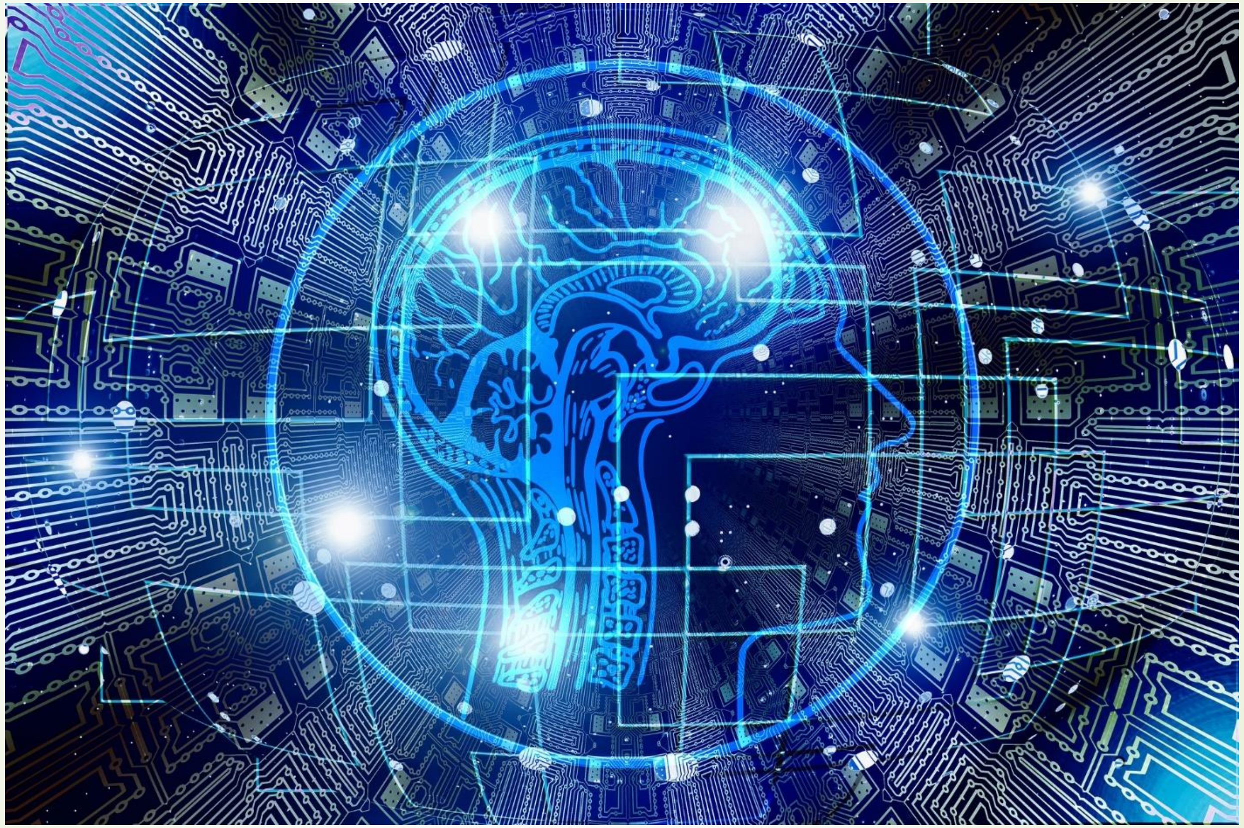
Innovative Technology



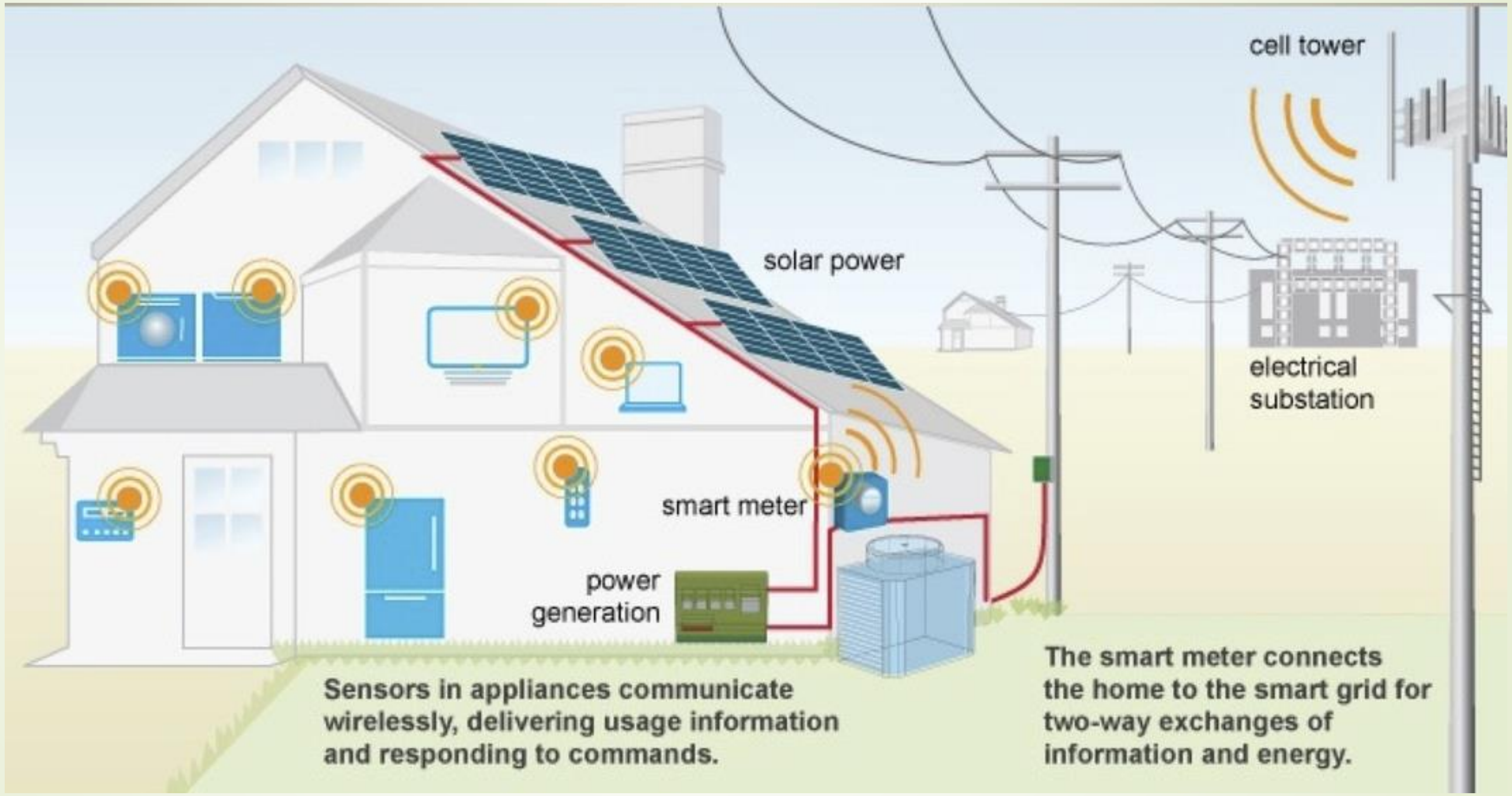
Innovative Technology

Some of the key technologies and trends expanding their influence on society are:

1. Internet of Things (IoT)
2. Blockchain
3. Big Data
4. Artificial Intelligence

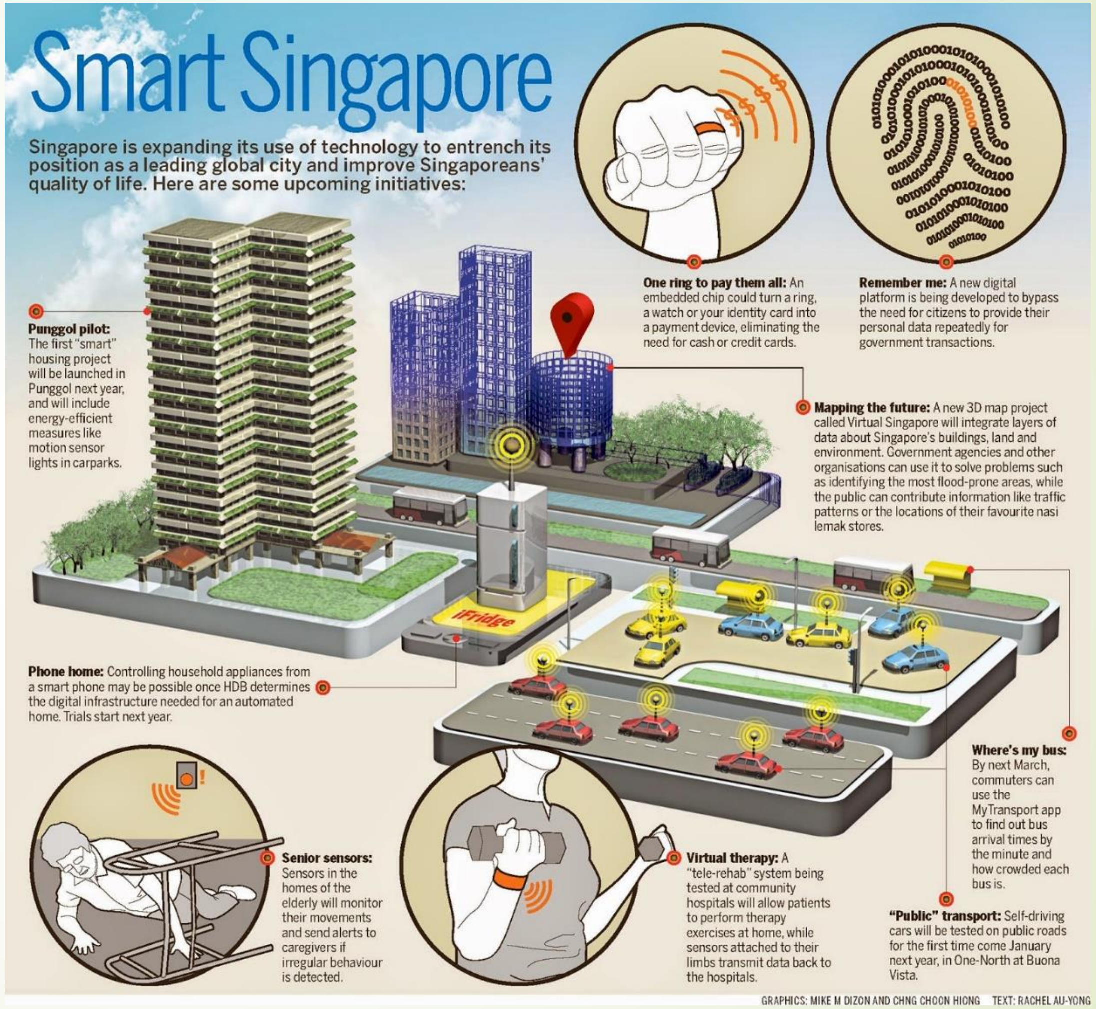
These technologies are both disruptive and exponential. That is, they are set to replace well-established ways of doing things with new process and markets; and they become more effective and cheaper extremely fast—which will see their adoption skyrocket rapidly.

Smart Meters

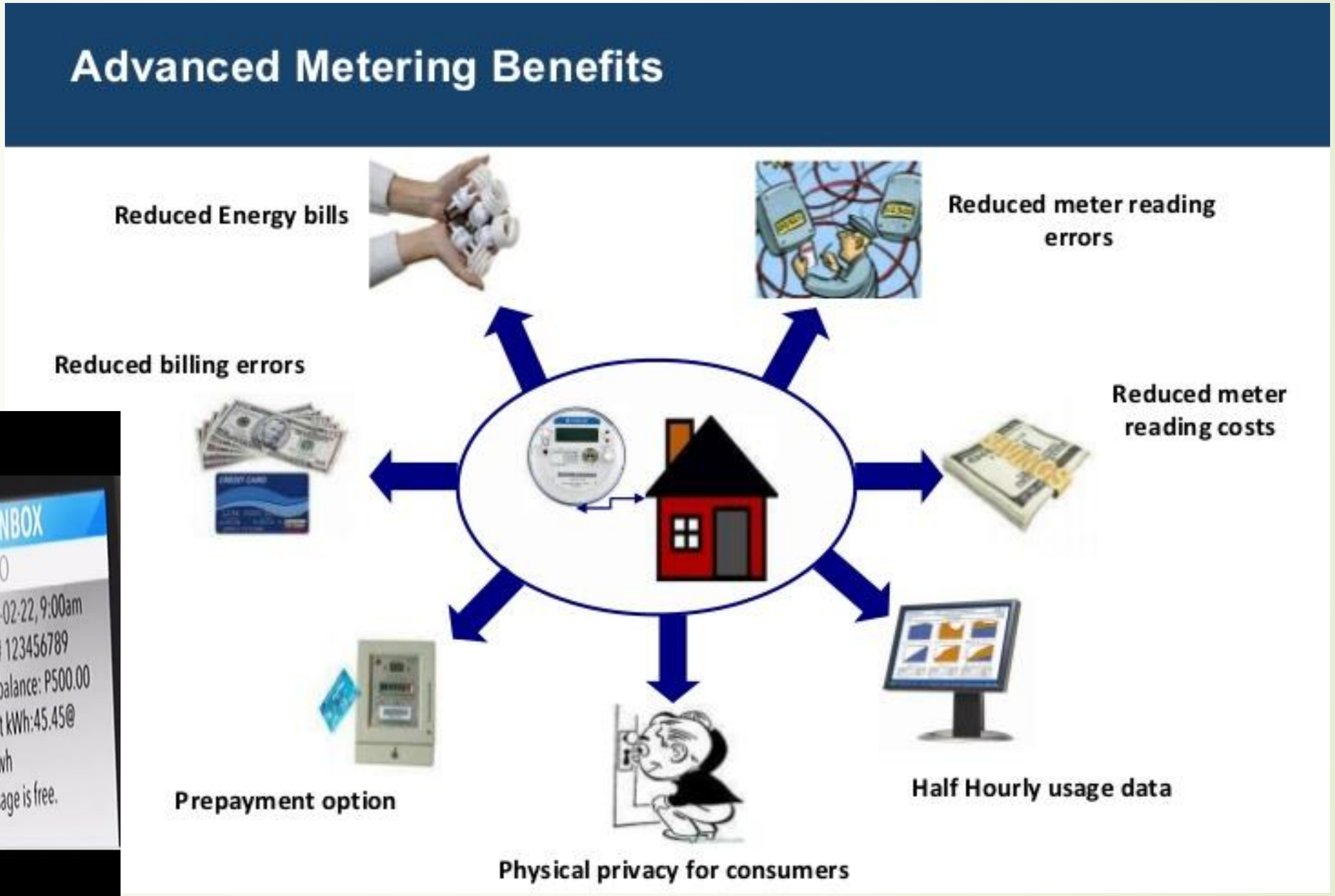


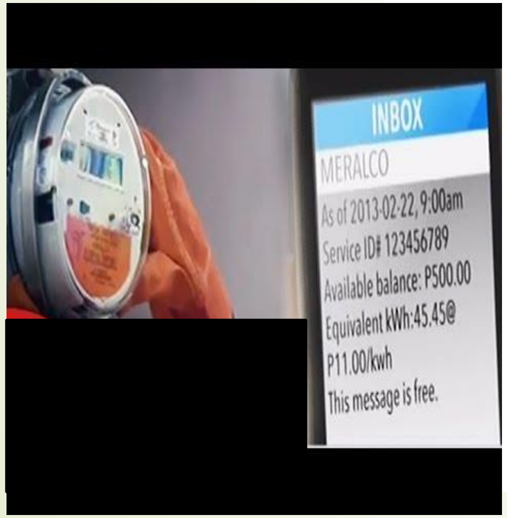
Singapore's Jurong Lake District

- Aims to demonstrate how technology can enable a liveable and sustainable urban environment, and a key feature is IoT technology…. But ….. Wifi bandwidth, stability, etc necessity
- Data from farecards and sensors throughout the district will give planners a clearer sense of the location, types, and frequency of transport services that are needed and cater to these needs more effectively.

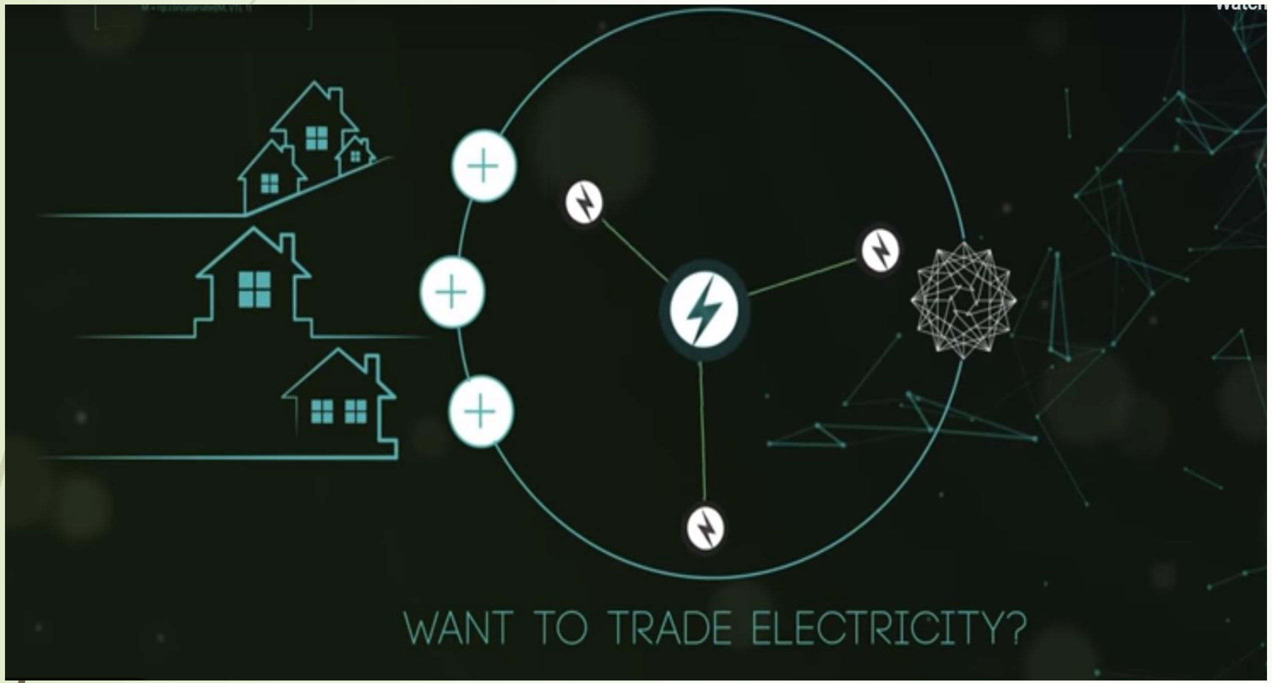


IoT Example 2: Manila Electric Co. (Meralco)





Applications of Blockchain: Peer to peer clean energy sharing

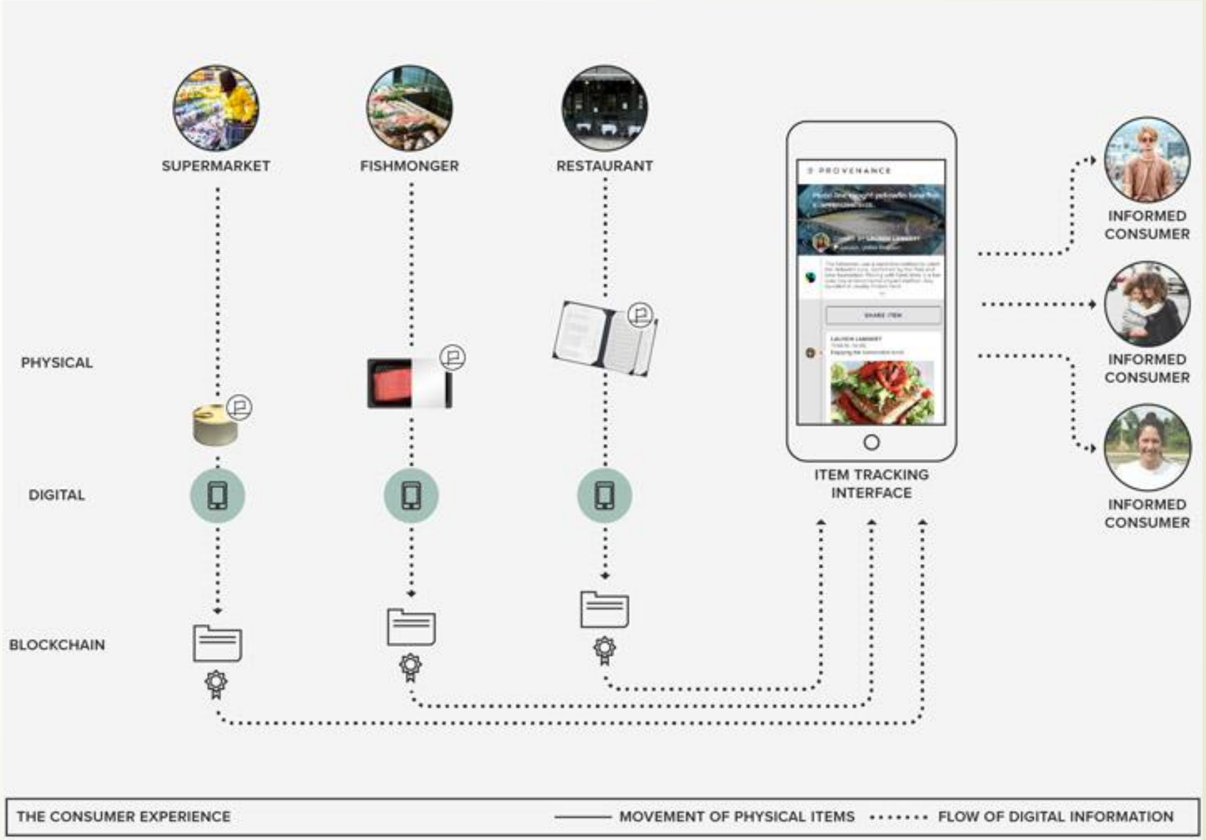


- Australian firm Power Ledger commenced a trial in Bangkok’s Sukhumvit neighbourhood where an apartment complex, a school, a mall, and a dental hospital with solar panels trade clean energy with one another, and the city’s electricity grid, over a blockchain marketplace.
- the system is one of the world’s largest peer to peer renewable energy trading platforms using blockchain.

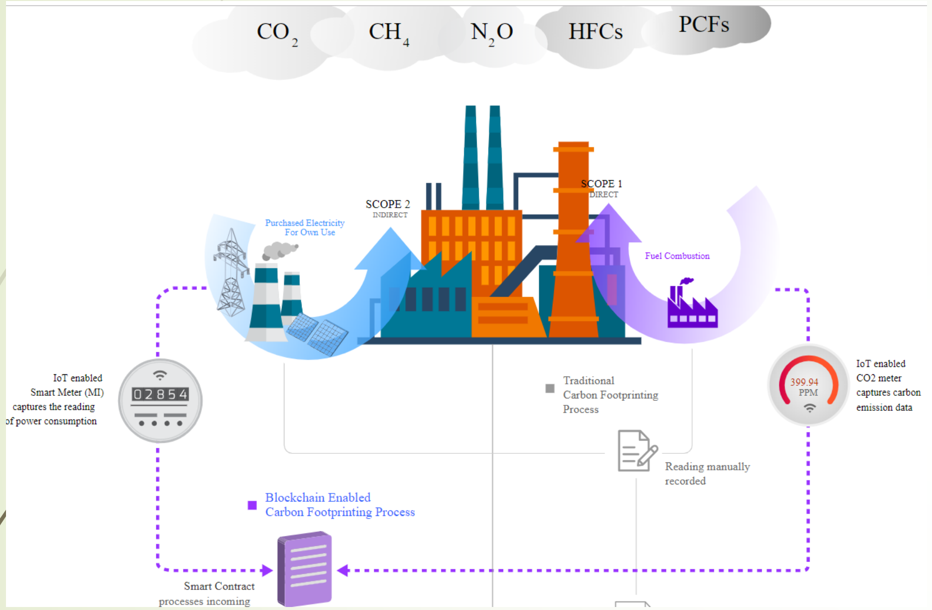
Innovative Technology

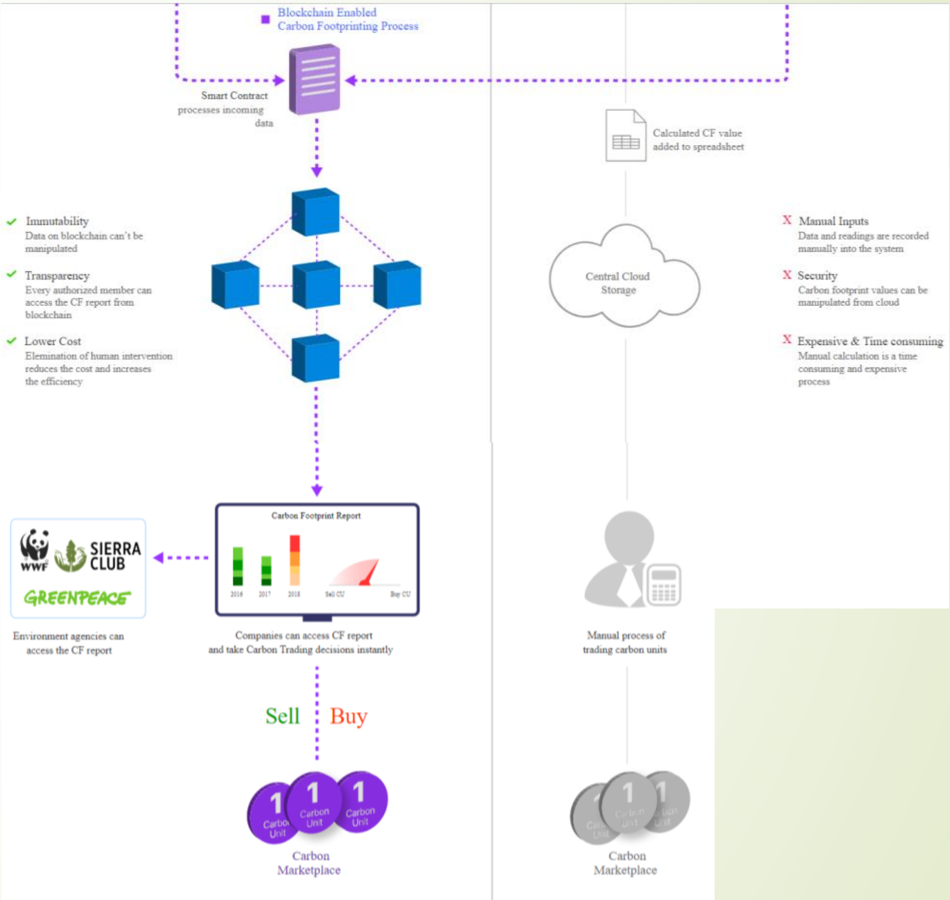
2. Blockchain

Provenance



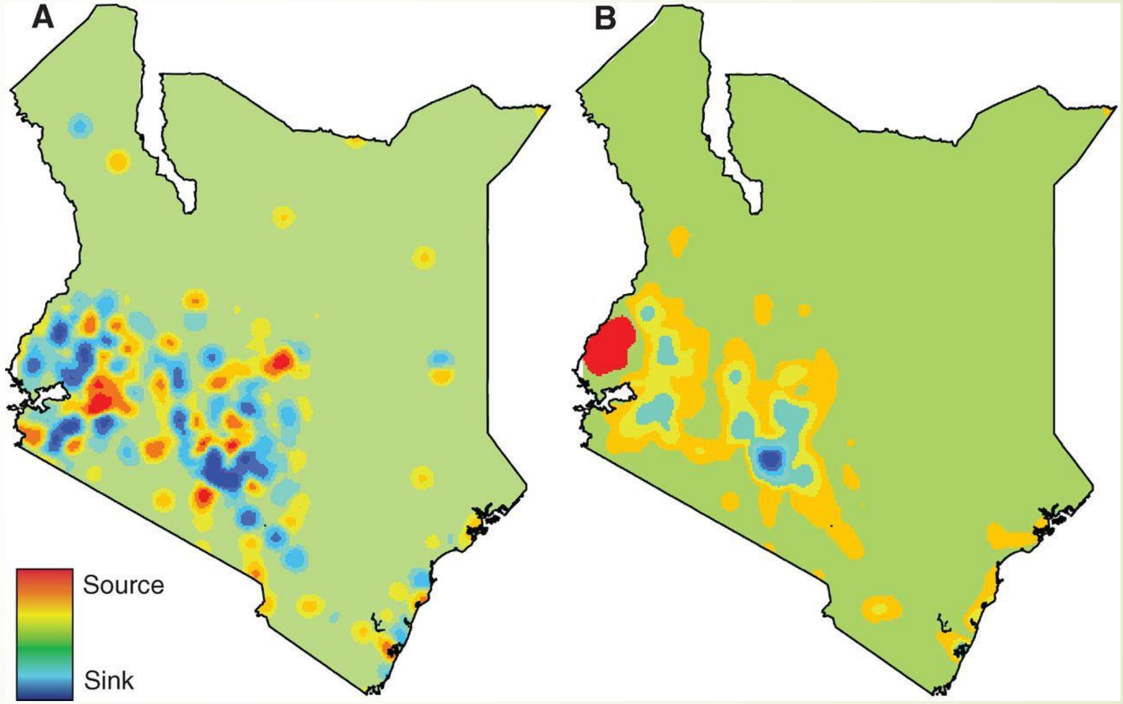
Applications of Blockchain: Carbon Footprinting





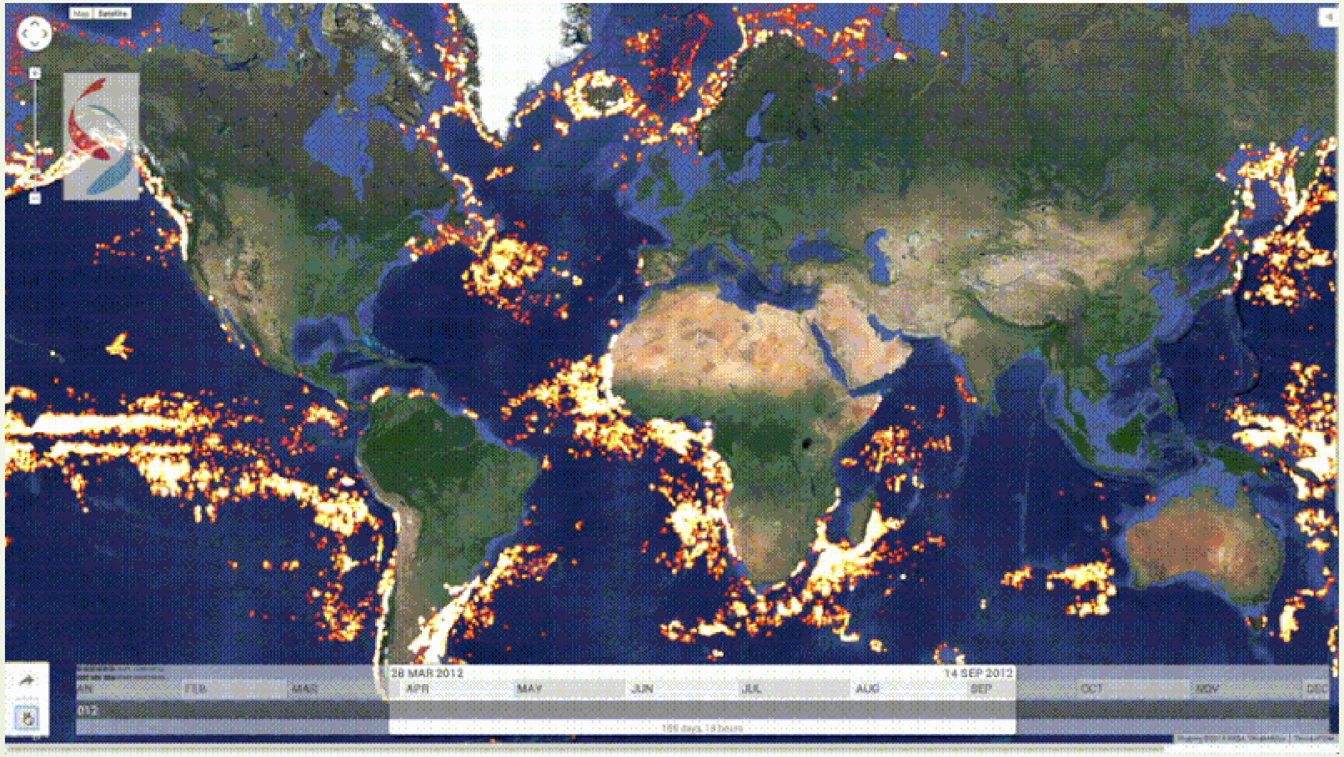
Big Data Applications

1. **Human travel patterns and malaria-** In Kenya, Caroline Buckee, a Harvard University researcher processed data from 15 million cell phones in 2012 to identify how human travel patterns contributed to the spread of malaria—this helped officials allocate resources to disease control efforts.



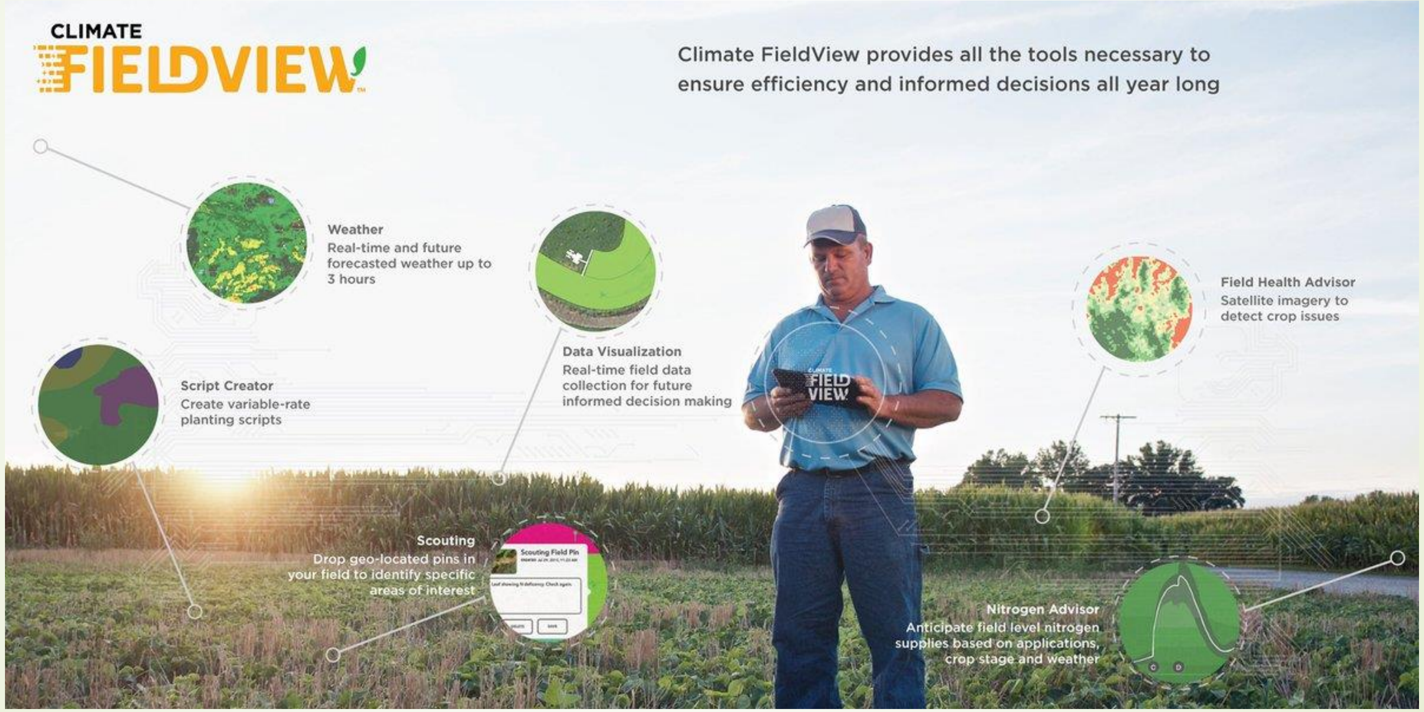
(A) Travel sources and sinks. (B) Parasite sources and sinks.

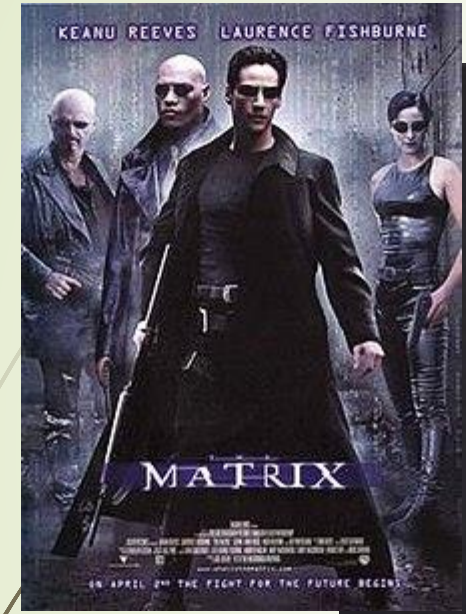
Global Fishing Watch - launched in 2016, the platform processes over 22 million position messages from more than 200,000 ships ever day to detect patterns that signify which vessels are fishing, when and where. This allows anyone with an internet connection to see fishing activity anywhere in the ocean in near real-time, for free.



4. Artificial Intelligence

The Climate Corporation's Climate Fieldview software




KEANU REEVES LAURENCE FISHBURNE
MATRIX


I'M AFRAID
YOU HAVE
HUMANS...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