Energy & Environment

Sustainability

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Content

- Environmental economics
- Sustainability
  - Ecologic sustainability
  - Economic sustainability
  - Social sustainability
- Environmental targets in companies
  - End of pipe technology
  - Cleaner production

Environmental economics

- Humans cause environmental impacts
  - Necessary to intervene in the process to reduce impact
- Environmental economics:
  - **Relations** of the company to its natural environment;
  - The effects on the environment and the **quality** of the environment;
  - The **environmental policy** of the company.
- Externalities
- Goals
  - Reduction of required input (resources and energy)
  - Reduction of undesired output (emissions and immissions)
  - Guarantee a rational supply of scarce goods (satisfaction of needs)

Environmental principles

Precautionary principle

- Avoid ecological damage preventive

Principle of origin

- Avoid environmental impacts where they occur

Sustainability principle

- Sustainability as basic goal

Polluter pays principle

- Polluter: responsible for damage repair, internalize externalities

Cooperation principle

- Cooperation of all relevant public, social and private actors

Cross-cutting principle

- Environmental protection concerns all policy areas

Environmental instruments

Direct behaviour control

- (Environmental) Law
- Authorisation requirements
- Environmental obligations
- Market based instruments (CO_2 certification model)

Indirect behaviour control

- Environmental information
- Subventions
- Taxes
- Certifications
- Environmental liability

Sustainability

Sustainability

- Forestry
- Brundtland-Report 1987 (Our Common Future) by the United Nations World Commission on Environment and Development (WCED)

Sustainable development:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

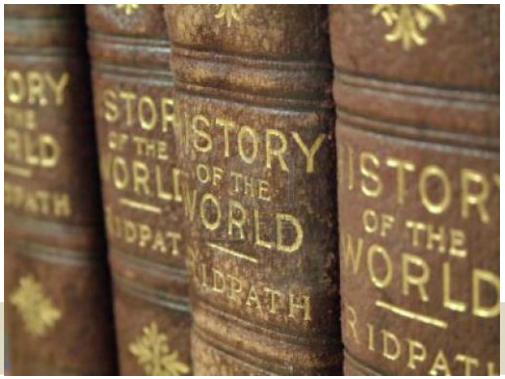
Source: World Commission on Environment and Development 1987

Sustainable Development

Brundtland-Report 1987

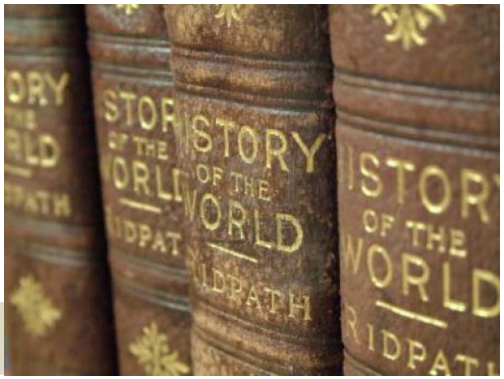
"Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within two key concepts: the concepts of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environments ability to meet present and future needs. Thus the goals of economic and social development must be defined in terms of sustainability in all countries developed or developing."

History of sustainability



Year	Event
1144	The implementation of sustainable development in **forestry** of the monastery “Mauermünster” in Elsass .
1343	Sustainable **forest management**: the city of Dortmund compel its citizens to plant leaf trees.
1359	The **forest** park of Erfurt is divided into different party, which are used and than have time to recover, so that the trees can grow again.
1661	Reichenhall creates a lumbering plan, for ensuring supply of fuel. The concept is called **“everlasting forest”**.
1713	Current definition already used in 1713 by Carl von Carlowitz, referring to the utilization of wood in the mining sector: for the sustainability of the **forest**, no more trees should be cut than can grow again in the same time period .

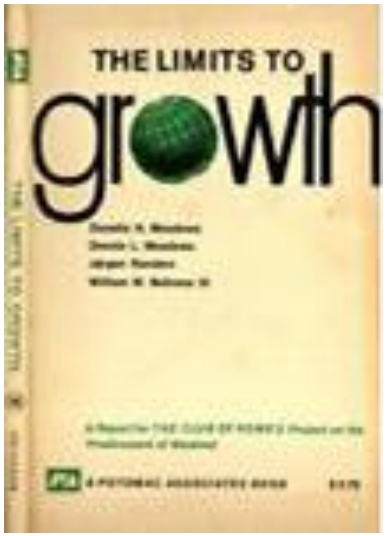
History of sustainability



Year	Event
Since 1750	Systematic use of today's definition regarding sustainable development, where ensuring constant grow of the **forest** in in the center of attention
1843	Otto von Hagen formulated "general economic principles", which ensure that a forest should **not be used for creating profits**, rather it should serve the public welfare.
1972	Report of the Club of Rome "Limits to Growth": about a simulation of exponential economic and population growth with finite resource supplies
1987	Brundtland-Report: includes today's definition of sustainable development

Club of Rome: Limits to Growth (1972)

- Simulation of exponential economic and population growth with finite resource supplies
- 5 issues of global importance:
  - Increasing industrialization
  - Rapid population increase
  - Malnutrition
  - Depletion of non renewable resources
  - Worsening environmental situation
- Conclusion
  - If current increase in world population industrialization, pollution, food production and the exploitation of natural resources continues, the absolute growth limits are reached during the next 100 years.



Limits to Growth

- Exponential reserve index
  - The amount of time left for a resource with constant consumption growth

$$y = \frac{ln((r * s) + 1)}{r}$$

Resource	Consumption growth rate annual	Static index	Exponential index
Chromium	2,6%	420	95
Gold	4,1%	11	9
Iron	1,8%	240	93
Petroleum	3,9%	31	20

- Static reserve: constant usage (R/C)
- Exponential reserve: constant growth rate
- Updates

y…years left
r…continuous compounding growth rate
s…R/C or static reserve
R…reserve
C…(annual) consumption

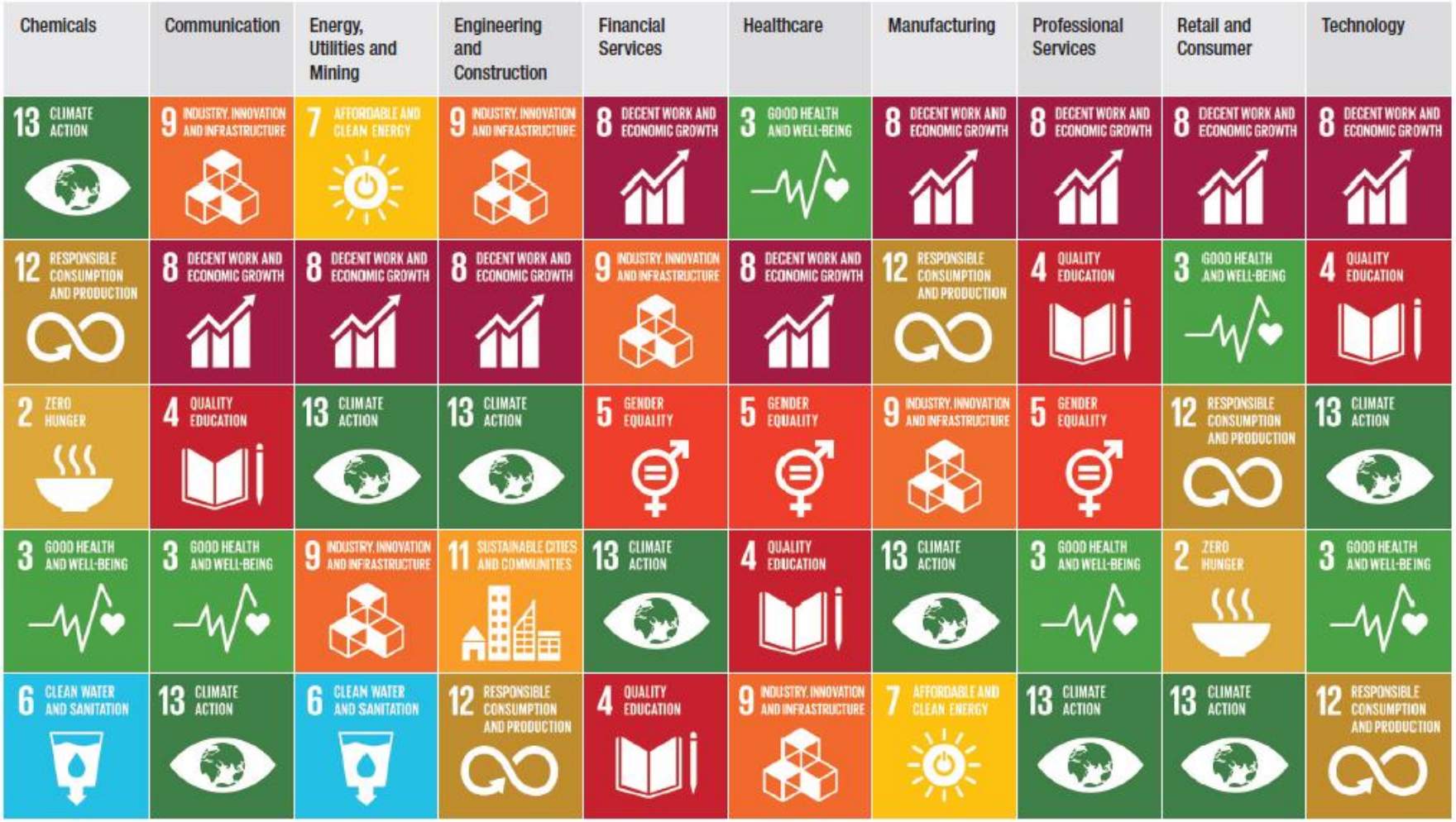
Source: Limits to Growth, Club of Rome 1972

Global Sustainable Development Goals

UN: Transforming our world: the 2030 Agenda for Sustainable Development

Source: http://www.globalopportunitynetwork.org/sustainable-development-goals-reconnecting-businesses-with-society/

Business impacts by industry



Source: PwC SDG Engagement Survey, 2015

„You can‘t manage what you can‘t measure“

Peter F. Drucker (1909-2005)

Source: www.managementjournal.net

Business is planning to assess impact on SDGs

Source: PwC SDG Engagement Survey, 2015

International climate targets

EU 20-20-20 targets

CO_2 Emissions vs. 1990

Share of Renewable Energy

Primary energy use vs. BAU

- Limiting global warming to 2°C above the pre-industrial level
- In 2010 all 194 member states of UNFCCC commit to reach this goal
- To reach the target: Between 2045 and 2060 GHG emissions have to be zero!
- UNO study 2013: 2°C target can hardly be reached
- COP 21 (Paris 2015): limit global warming preferably to 1,5°C

Source: www.daikinme.com

Aspects of sustainable development

- **Inter**generational and **intra**generational equity
- Ensuring the regeneration capacity of renewable resources
- Preserving the absorption capacity of the environment
- Protection of species

➔ Ecological, environmental and social sustainability

Intergenerational equity

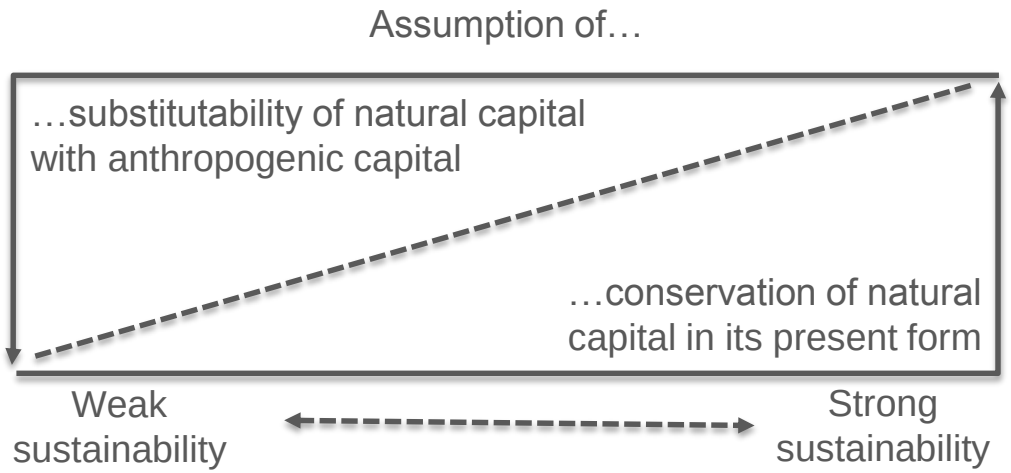
"A society grows great when old men plant trees whose shade they know the shall never sit in"

~ Greek Proverb ~

https://dailyohmmm.wordpress.com/2013/09/16/intergenerational-equity/

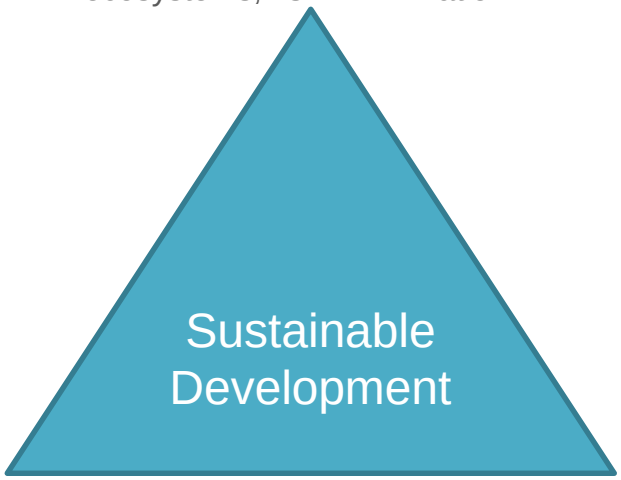
Aspects of sustainable development

- Natural vs anthropogenic capital
  - **Substitutability – weak sustainability**: natural capital can decrease if anthropogenic capital is created instead
  - **Complementarity – strong sustainability**: natural and anthropogenic capital depend on each other
  - Combined position: complementarity for life support systems, substitutability for other resources



Sustainable Development

Ecological dimension
Resource savings, emission reduction, conservation of ecosystems, risk minimization

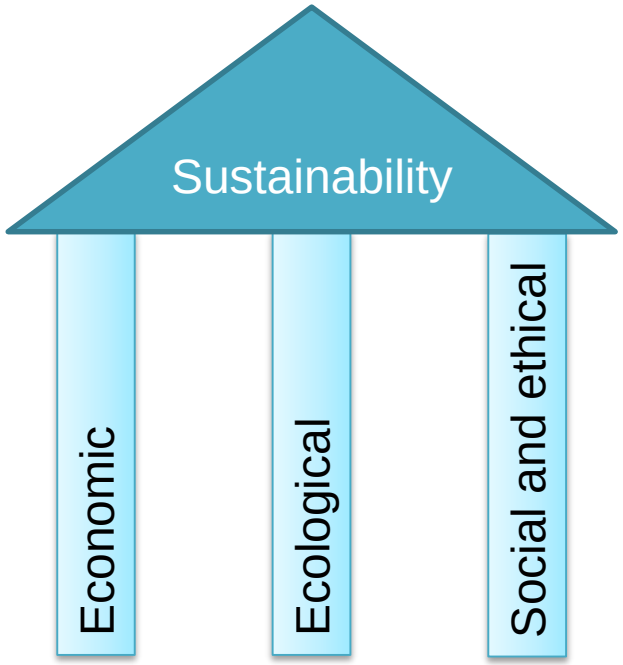


Social dimension
Intergenerational equity, Intragenerational equity, poverty

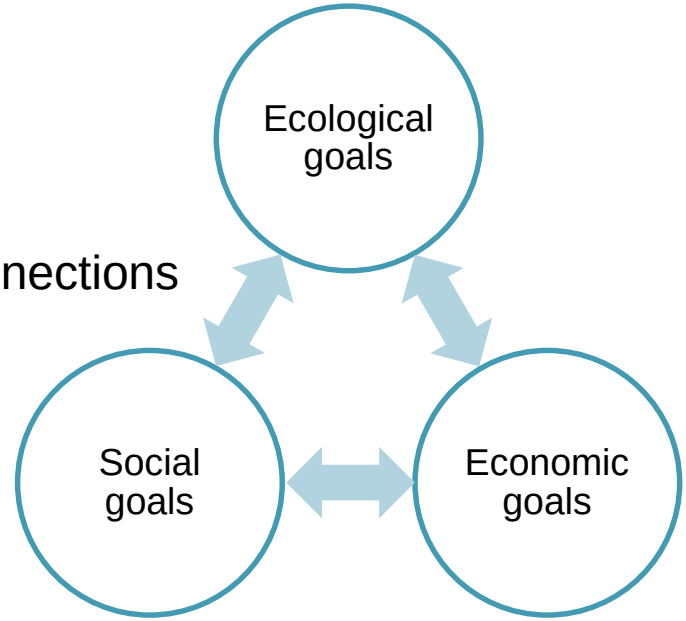
Economic dimension
Efficiency and effectivity, growth and development, stability

Tripple bottom line

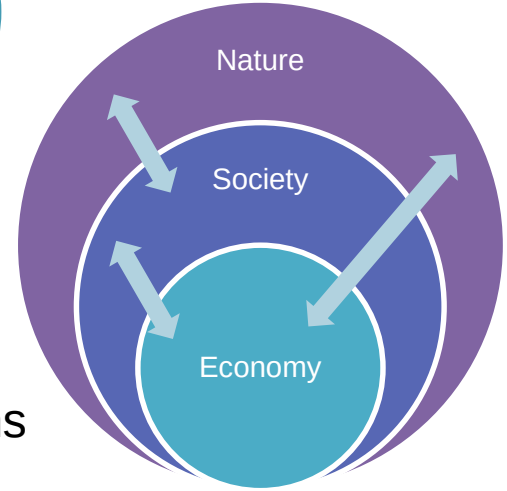
Sustainable development



Connections



Interactions



Ecological sustainability I

The **degradation rate of renewable resources** should not exceed their regeneration rate. This corresponds to the requirement of maintaining ecological functionality, i.e. (at least) to preserve the ecological real capital.

Non renewable resources should only be used to the extent

- in which a physical and functional equivalent **substitute** in the form of renewable resources is provided,
- or **increased productivity** of renewable and non renewable resources is created.

Ecological sustainability II

Infiltrated substances into the environment should be based on the **carrying capacity** of environmental media, whereby all input functions should be taken into account.

The **duration** of anthropogenic interventions in the environment must be weighed against the reaction time required for the environment to stabilize itself.

Hazards and unjustifiable **risks** for human health resulting from anthropogenic impacts are to be **avoided**.

Economic sustainability I

The economic system should efficiently **satisfy** individual as well as social **needs**.

Therefore, the economic system should be designed in a way that it **promotes** personal initiative (**individual responsibility**) and puts self-interest into service for the common good (**“regulating” responsibility**), to ensure and secure the well-being of present and future population.

Prices should permanent undertake a significant **leading function** on markets. Therefore, to a large extent prices should **reflect scarcity** of resources, sinks, production factors, goods and services.

Economic sustainability II

Framework conditions of competition have to be designed in a way that **properly functioning markets** arise and are preserved, **innovations** are stimulated, that **long-term orientation** is worthwhile and the social **change** that is needed to adapt to future requirements will be **encouraged**.

The **economic capacity** of a society and its **productive, social an human capital** must at least be maintained over time. They should not only be increased quantitatively, it is even more important to **improve** them qualitatively.

Social sustainability I

Social **responsibility** throughout the whole product life cycle.

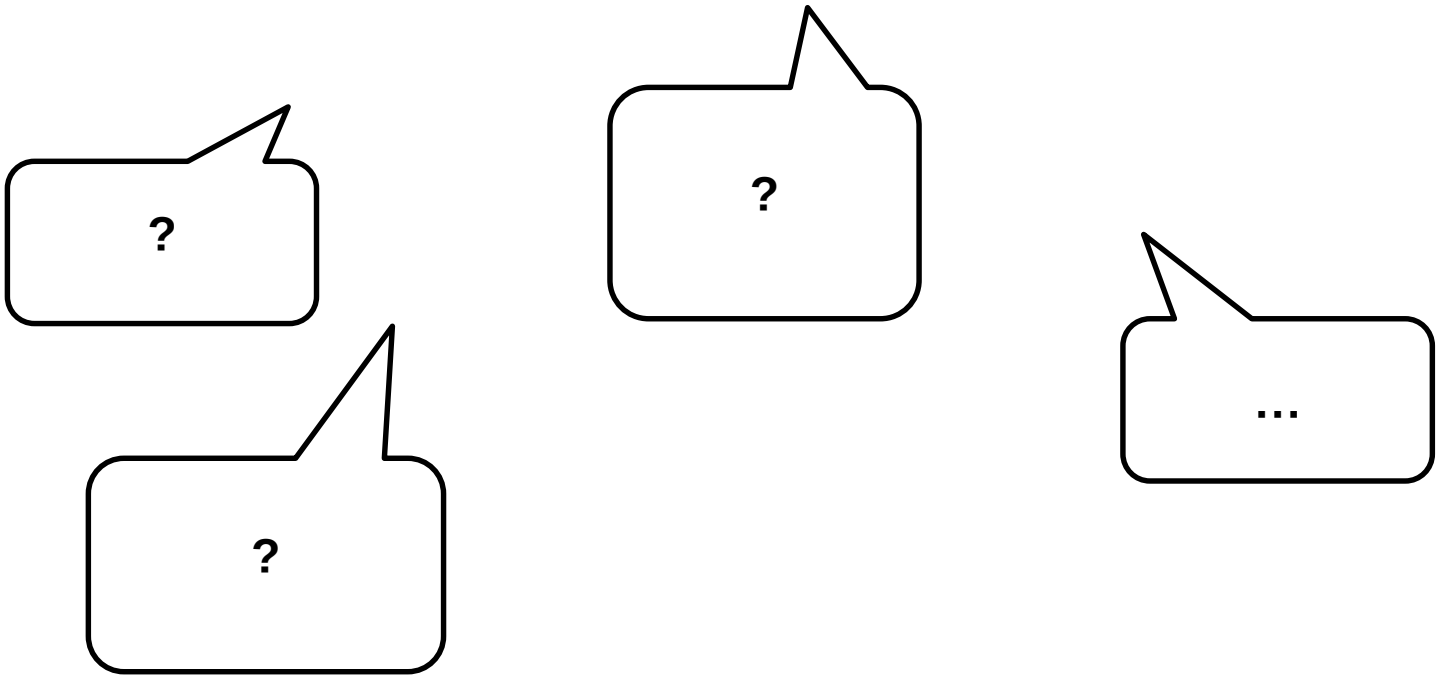
- Management of "**human resources**" (support and promote male and female employees, establish equal opportunities)
- **Regional** responsibility of companies (= Corporate Citizenship, i.e. number and security of jobs)
- Integrate concerns of primary and secondary **stakeholders**

Social sustainability II

Corporate Social Responsibiltiy (CSR) relates to the question of the fundamental task and purpose of the company.

The **guiding principle of CSR** assumes that companies **not only have to complete economic tasks** (perform well in economic terms, increase the company's value for owners), but companies have to fulfill tasks
and assume responsibility beyond this.

How can we make our planet more sustainable?



Ecological sustainability

Using energy & resources efficiently

Protecting biodiversity

Minimizing the use of hazardous substances

Minimizing waste & emissions

Using environmentally sound materials & energy

Economic sustainability

Creating jobs

Investing in infrastructure

Driving innovation

Paying tax responsibility

Combating bribery & corruption

Contribute to local economy

Generating sales & profits

Social sustainability

Treating suppliers fairly

Good community relations

Complying with the law

Good working conditions

Respecting human right

Ensuring product safety

Excursus: CSR

Two definitions:

- CSR = Corporate Sustainability

  Definition of the European Union

  Example: OMV
- CSR = social dimension of sustainability

  In a company: social dimension of corporate activity

  Example: Rio Tinto, BMW
- Corporate sustainability includes also ecological aspects, CSR includes social aspects

Source: kenithaaellison.wordpress.com

*"CSR is a concept which serves companies as a basis to **integrate voluntary social and environmental concerns** in their business activities and in interactions with their stakeholders."*

(Green Paper of the EU Commission, 2001)

Source: kenithaaellison.wordpress.com

Excursus: CSR

If CSR is understand in a broad sense, then social responsibility applies equally to

- the core business,
- the support of civil society and
- the participation in developing the framework conditions further (Hansen, Schrader 2005).

Motivation?

Ecological Footprint

Ecological Footprint

Ecological services

- Regulation of the earth's temperature by the global heat balance
- Purification of water and air
- Diversification of plants and animals
- Photosynthesis
- Formation of soil
- Production of oxygen

Humans use those services

- Production of food
- Disposal of waste
- Consumption of oxygen and water
- Use of materials
- Production of energy

For all of these services a piece of land on earth is needed!

Ecological Footprint

➔ Area on the Earth necessary to enable a human's lifestyle and standard of living in the long term

Areas for

- Production of food
- Production of clothes
- Providing energy
- Disposal of waste
- Absorption of CO_2 emissions caused by human activities
- Unit: global hectares per person per year

www.mein-fussabdruck.at, www.footprintnetwork.org

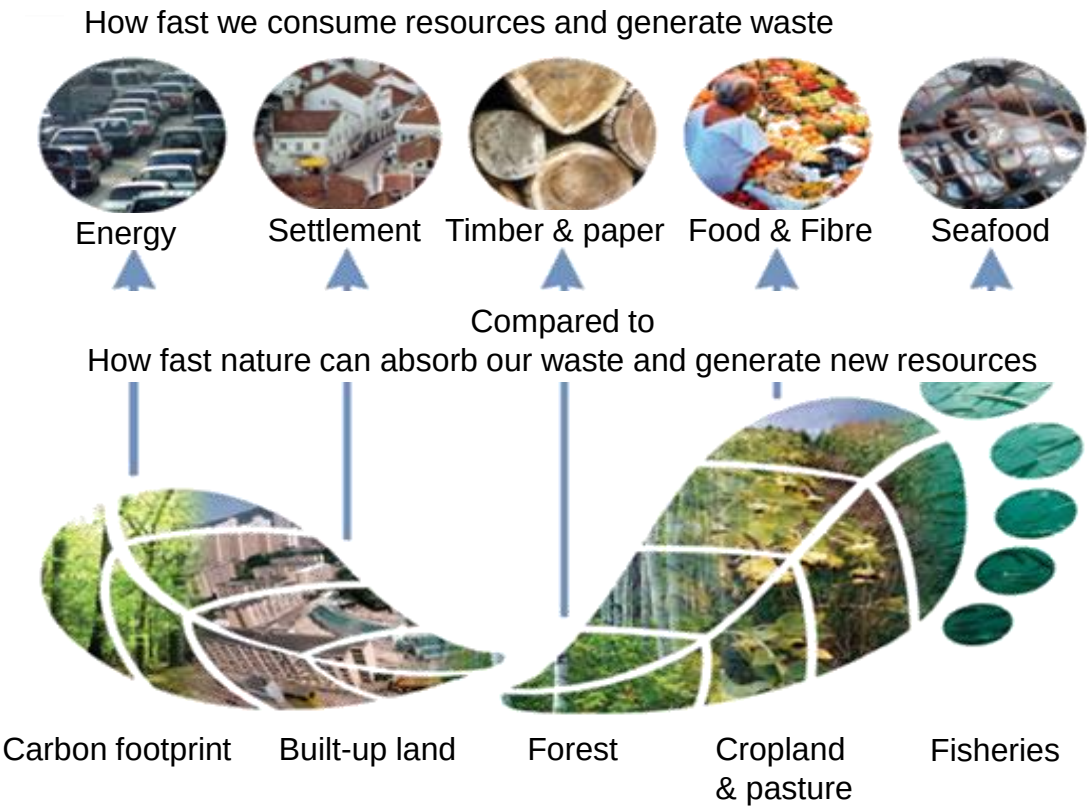
Source: wwf.panda.org

Ecological Footprint

"A country's footprint is the total area required to produce the food and fibre that it consumes, absorb its waste, and provide space for its infrastructure.

People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they are on the planet. The footprint can be compared with nature's ability to renew these resources."

Wackernagel and Rees (1990)



Source: www.footprintnetwork.org

Ecological Footprint

Global hectares

1 gha represents the average productivity of all biologically productive areas on earth in a given year

Biologically productive areas

- ✓ Cropland, forests, fishing ground
- ✘ Deserts, glaciers, open ocean, built-up areas (asphalt courts,…)

Global hectare per person

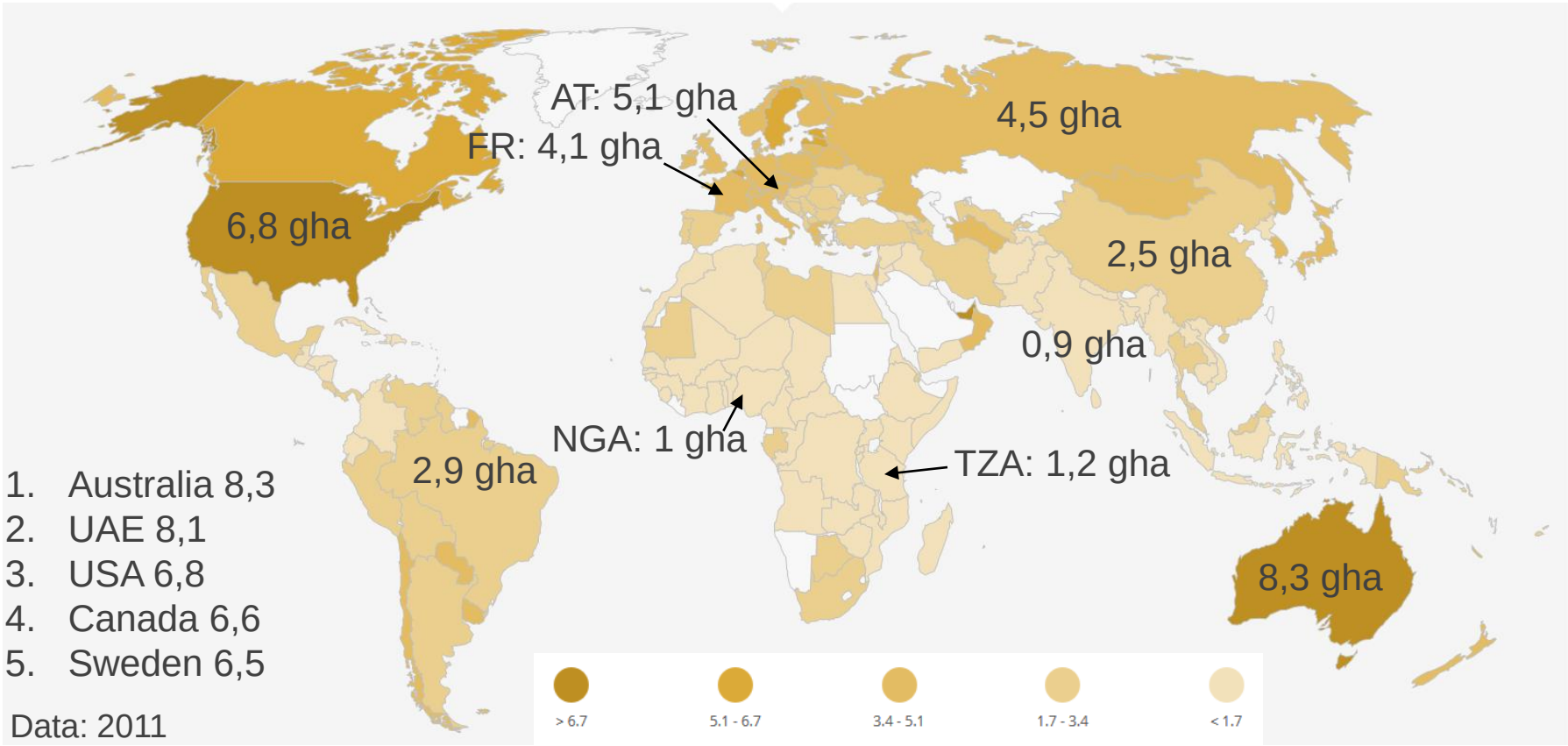
The amount of biologically productive land and water available per person on the planet

Determining relative **carrying capacity** of the earth

➔ How many people on earth can sustain, assuming current technologies and agricultural methods?

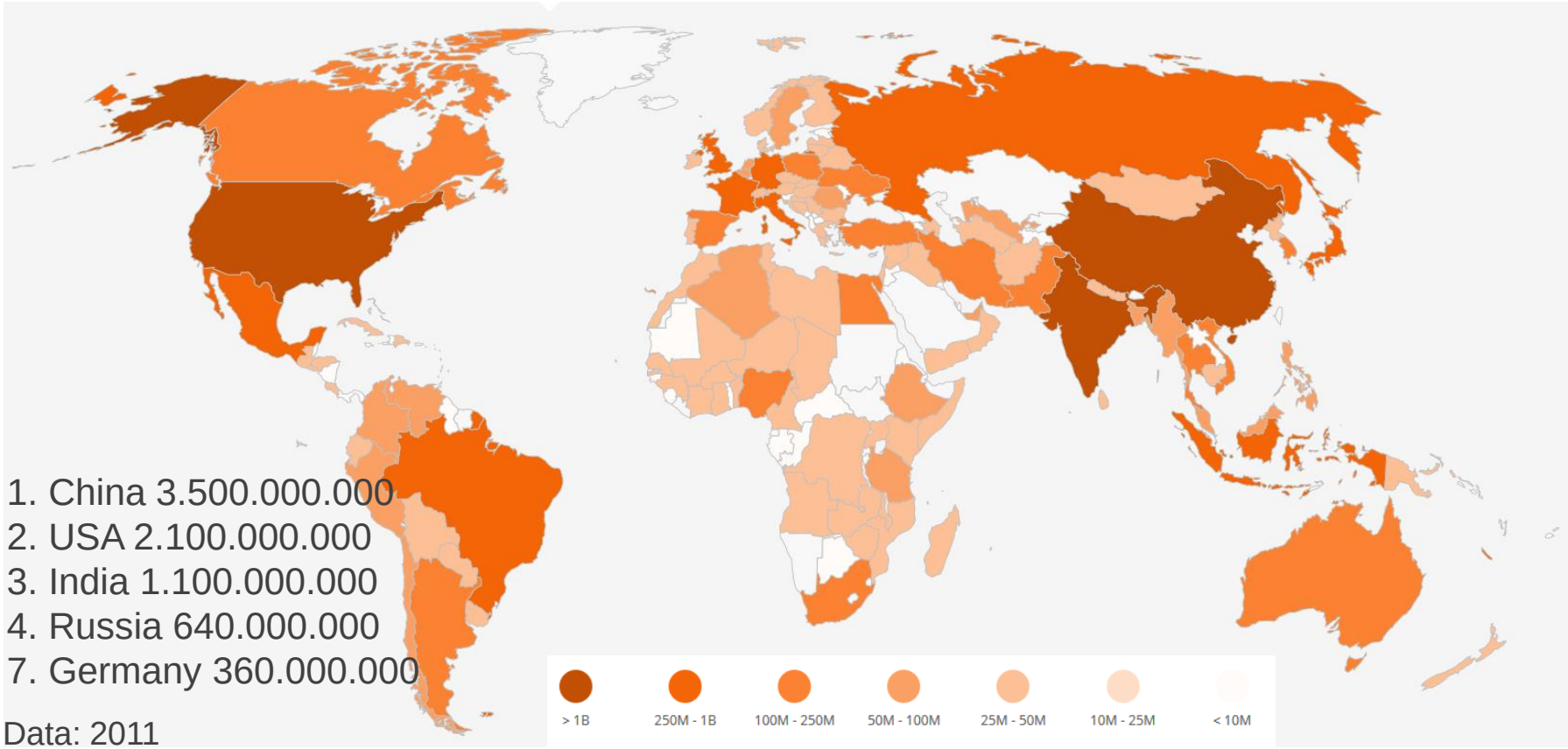
Ecological footprint per capita

To live within the means of our planet‘s resources: **1,7 gha/p**



Source: www.footprintnetwork.org/ecological_footprint_nations/ecological_per_capita.html

Total ecological footprint

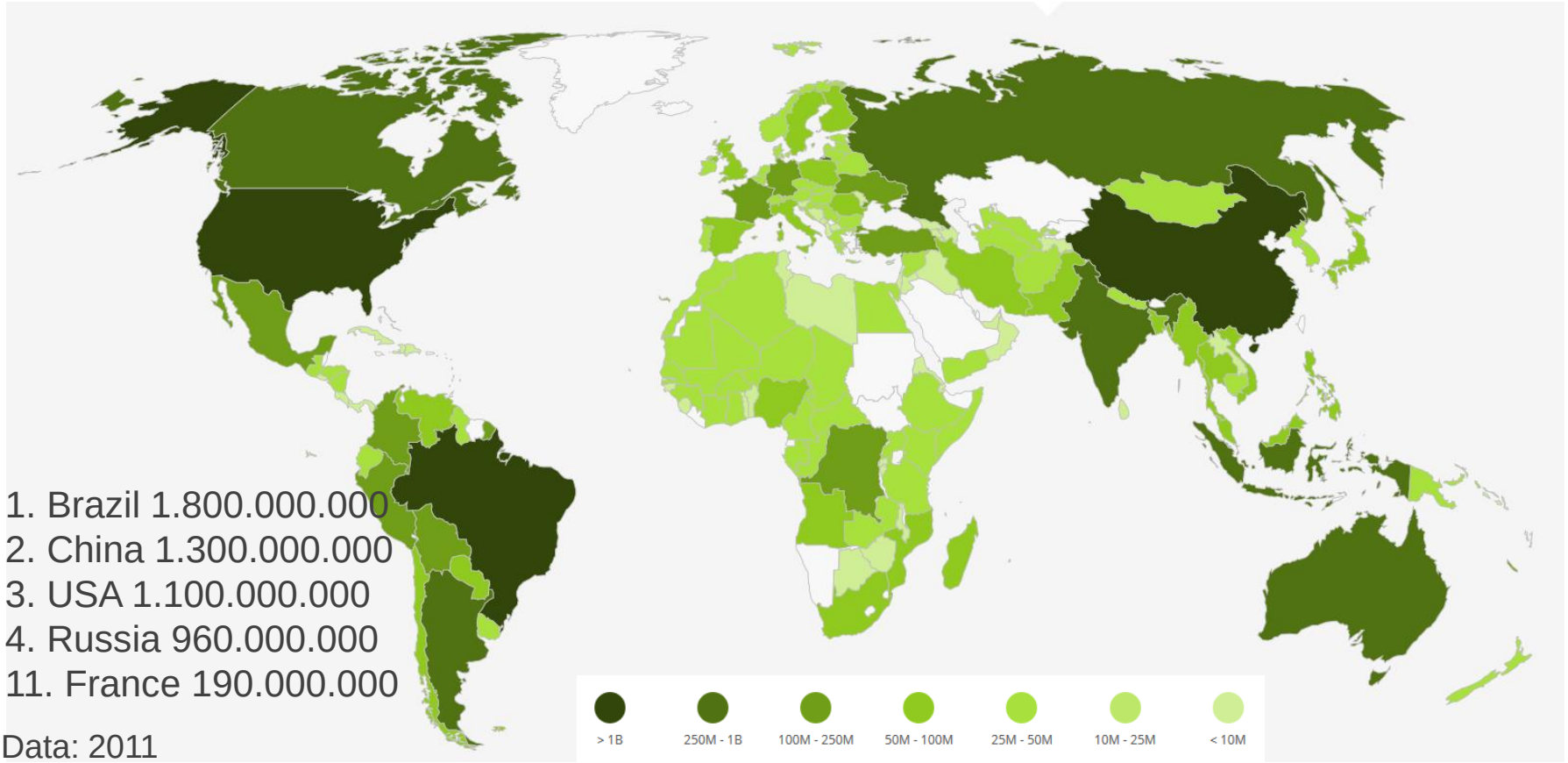


1. China 3.500.000.000
2. USA 2.100.000.000
3. India 1.100.000.000
4. Russia 640.000.000
7. Germany 360.000.000

Data: 2011

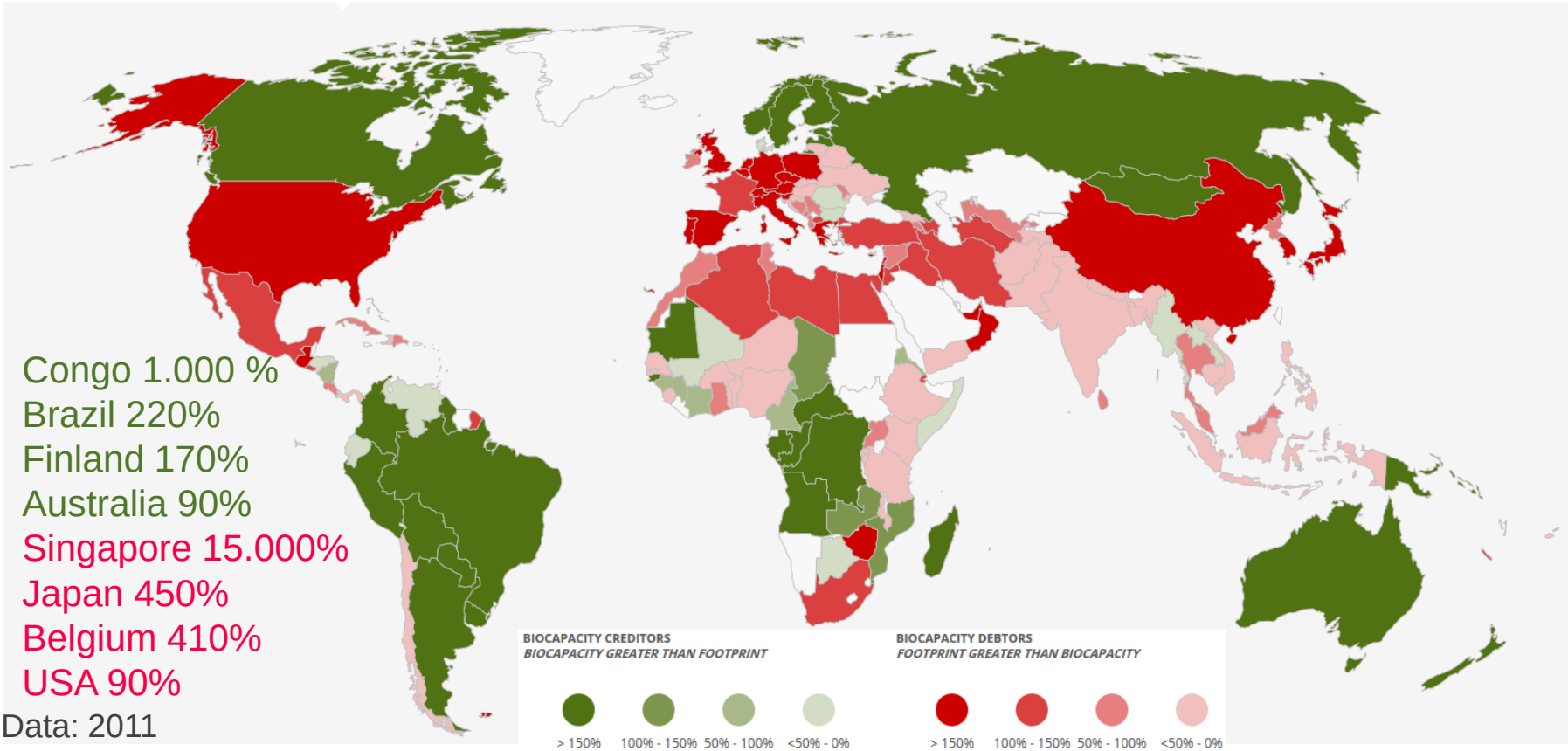
Source: www.footprintnetwork.org/ecological_footprint_nations/ecological.html

Biocapacity



Source: www.footprintnetwork.org/ecological_footprint_nations/biocapacity.html

Ecological deficit/reserve



Congo 1.000 %
Brazil 220%
Finland 170%
Australia 90%
Singapore 15.000%
Japan 450%
Belgium 410%
USA 90%

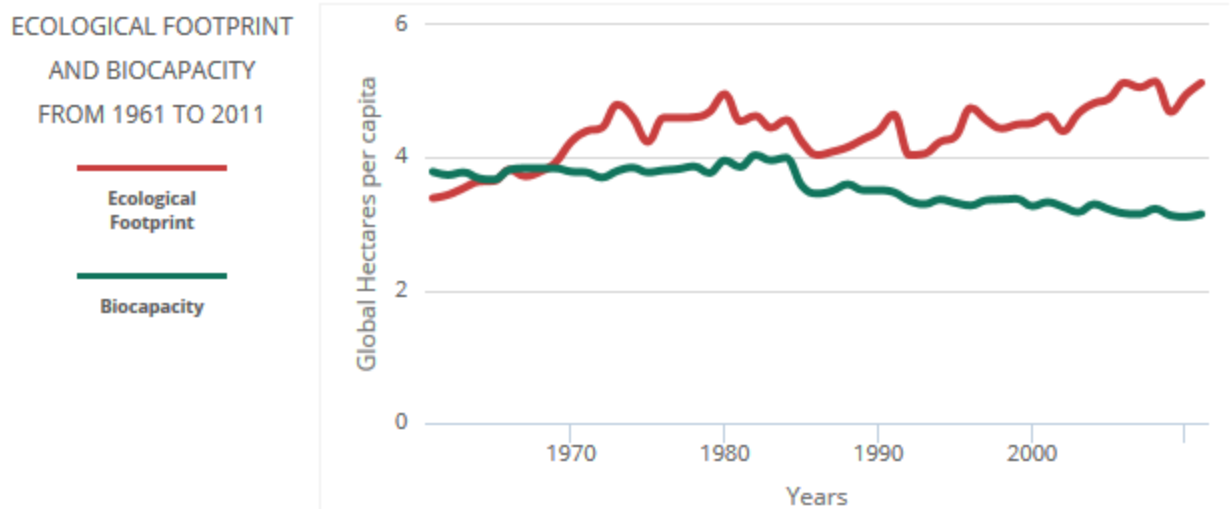
Data: 2011

Source: www.footprintnetwork.org/ecological_footprint_nations/index.html

Ecological footprint and biodiversity

Austria

Ecological footprint per capita:	5,1 gha
Biocapacity per capita:	3,2 gha
Biocapacity deficit:	-2 gha
Population:	8, 43 mio
GDP per capita:	$ 41.120,22

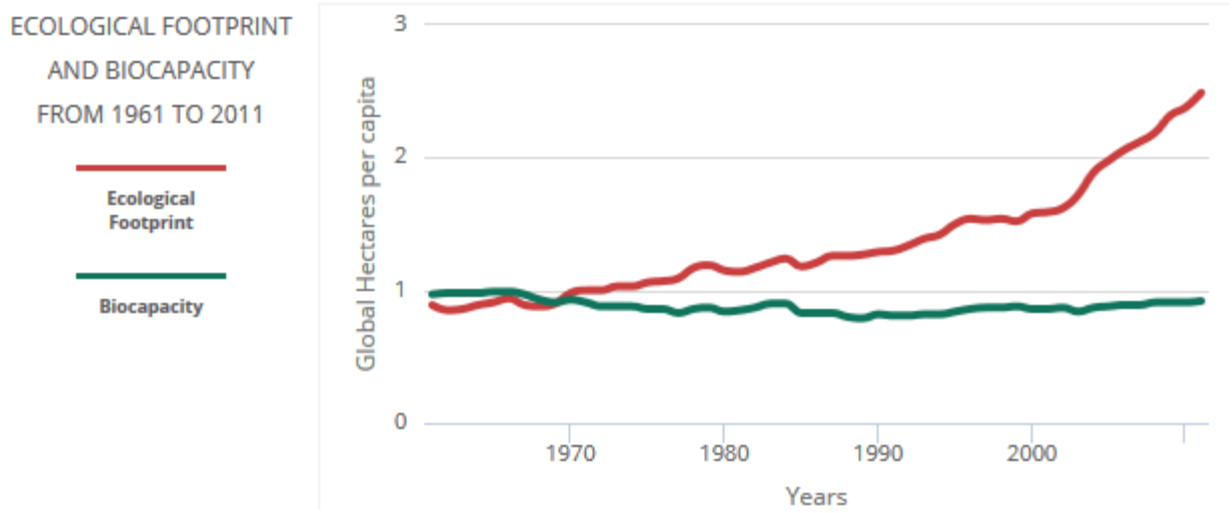


Source: National Footprint Accounts 2015 (Data Year 2011, International Monetary Fund World Ecnomic Outlook Database (October 2014); U.N. Food and Agriculture Organization

Ecological footprint and biodiversity

China

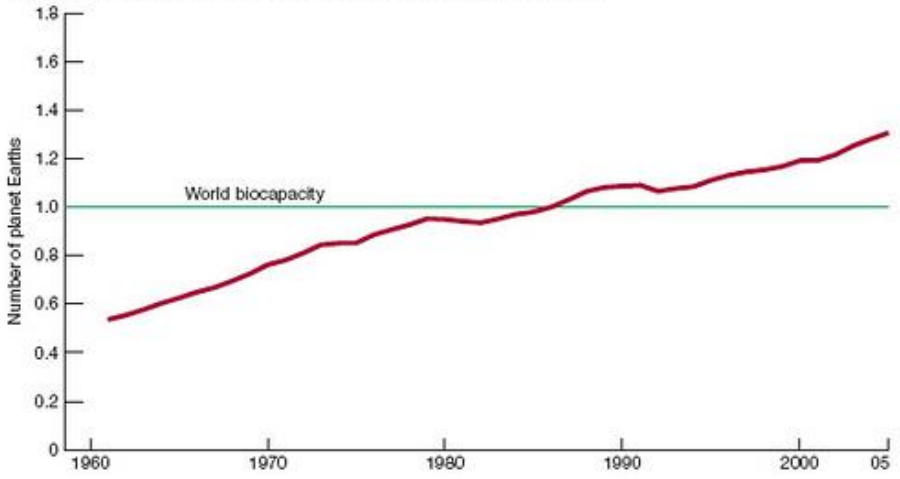
Ecological footprint per capita:	2,5 gha
Biocapacity per capita:	0,9 gha
Biocapacity deficit:	-1,6 gha
Population:	1.399 bio
GDP per capita:	$ 3.121,97



Source: National Footprint Accounts 2015 (Data Year 2011, International Monetary Fund World Ecnomic Outlook Database (October 2014); U.N. Food and Agriculture Organization

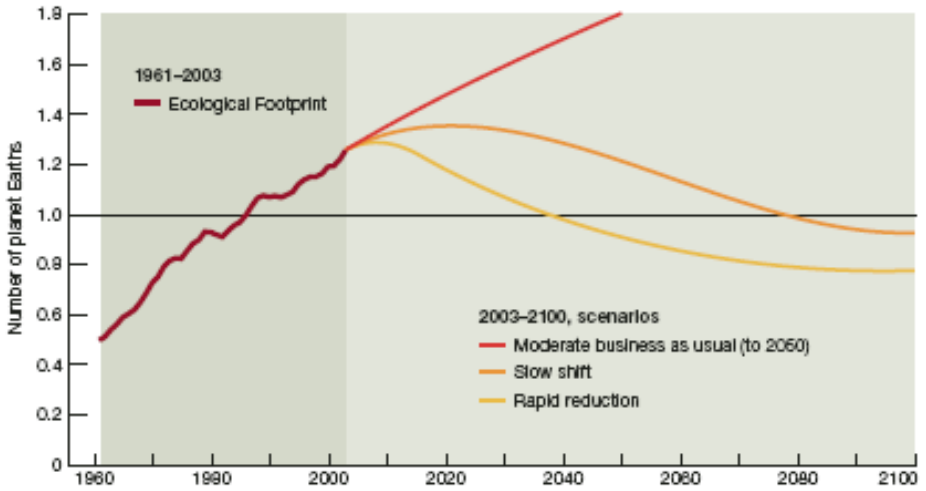
Ecological footprint

Fig. 2: **HUMANITY'S ECOLOGICAL FOOTPRINT,** 1961-2005



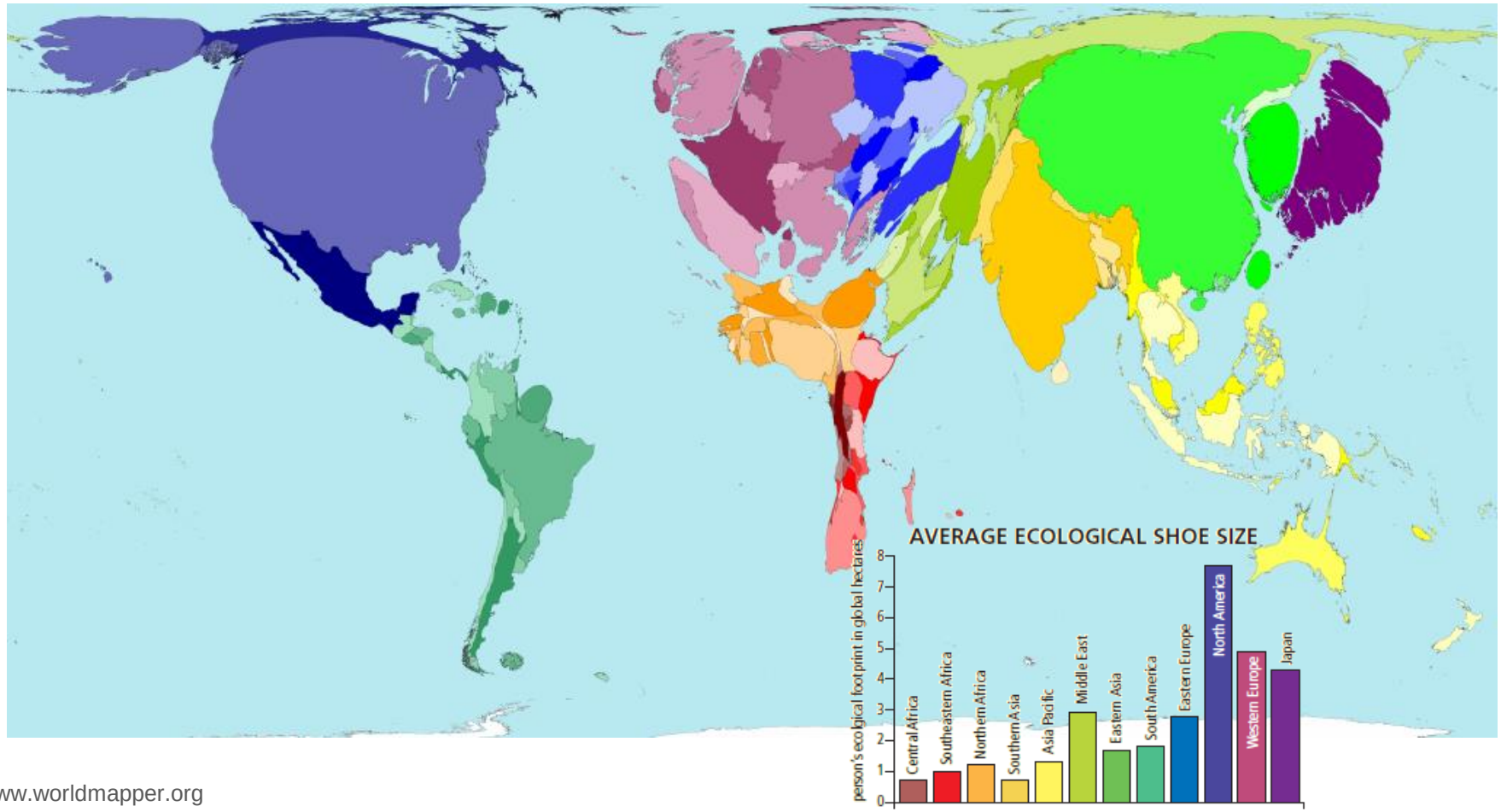
Source: WWF's Living Planet Report 2008
www.makewealthhistory.org

Fig. 3: **THREE ECOLOGICAL FOOTPRINT SCENARIOS,** 1961–2100



Source: WWF Living Planet Report 2008,

Ecological footprint



Source: www.worldmapper.org

Ecological debt day

= Earth overshoot day

The date at which humanity's use of natural resources exceeds what the Earth can regenerate in that given year

1993: 21.10.

2012: 22.08.

2015: 13.08.

Numbers of Earths needed to sustain human activity

If we continue consuming natural resources as at present

If we cut CO_2 emissions by 30%

Source: Global Footprint Network

Ecological debt day

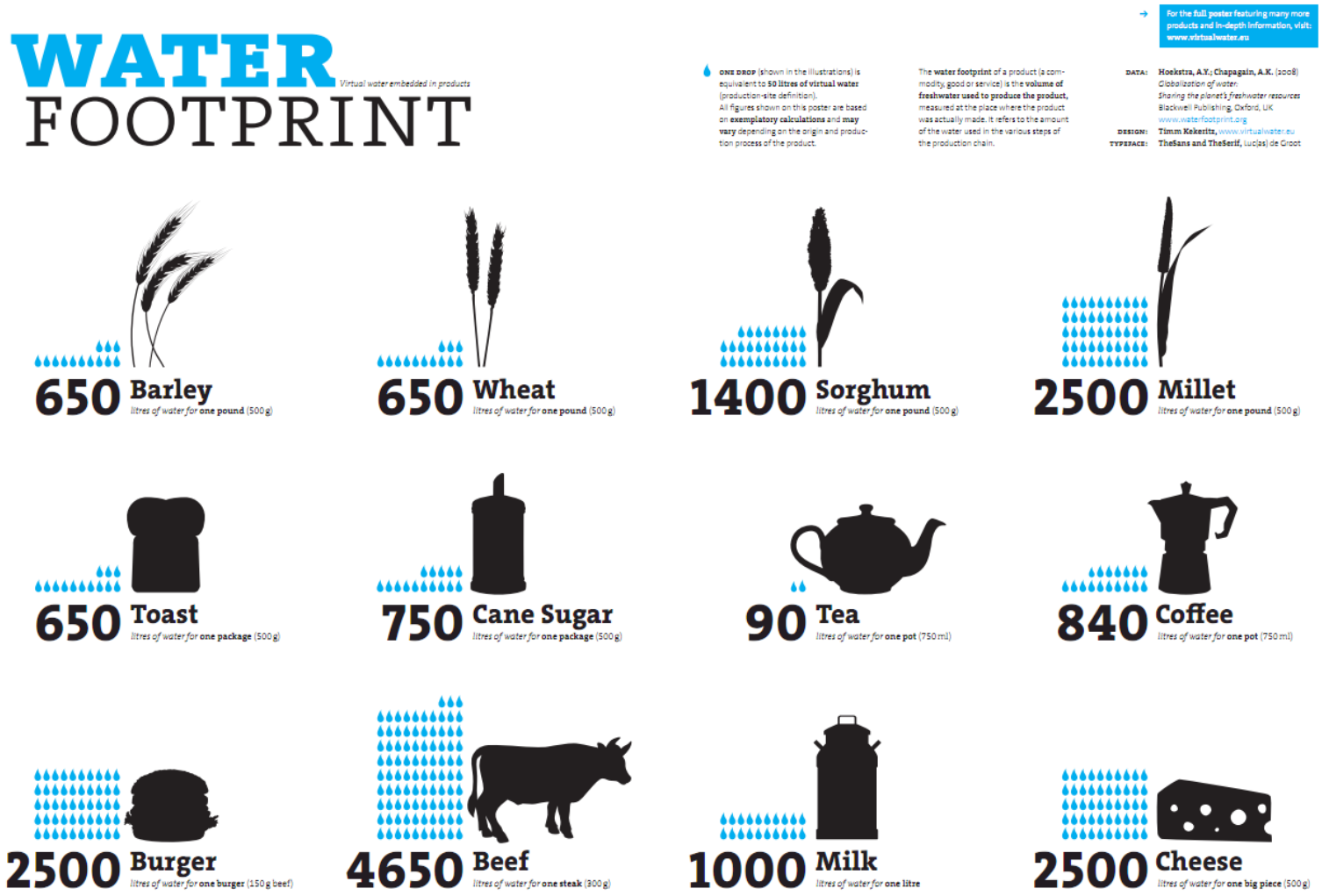
Selected countries consuming more than they can generate

Overshoot day happens earlier each year

Virtual Water (Water Footprint)

- Total amount of fresh water used in order to produce a product or provide a service
- Cradle-to-gate
- Examples see at www.waterfootprint.org
  - 2.495 l for a shirt of 250g

Virtual Water (Water Footprint)

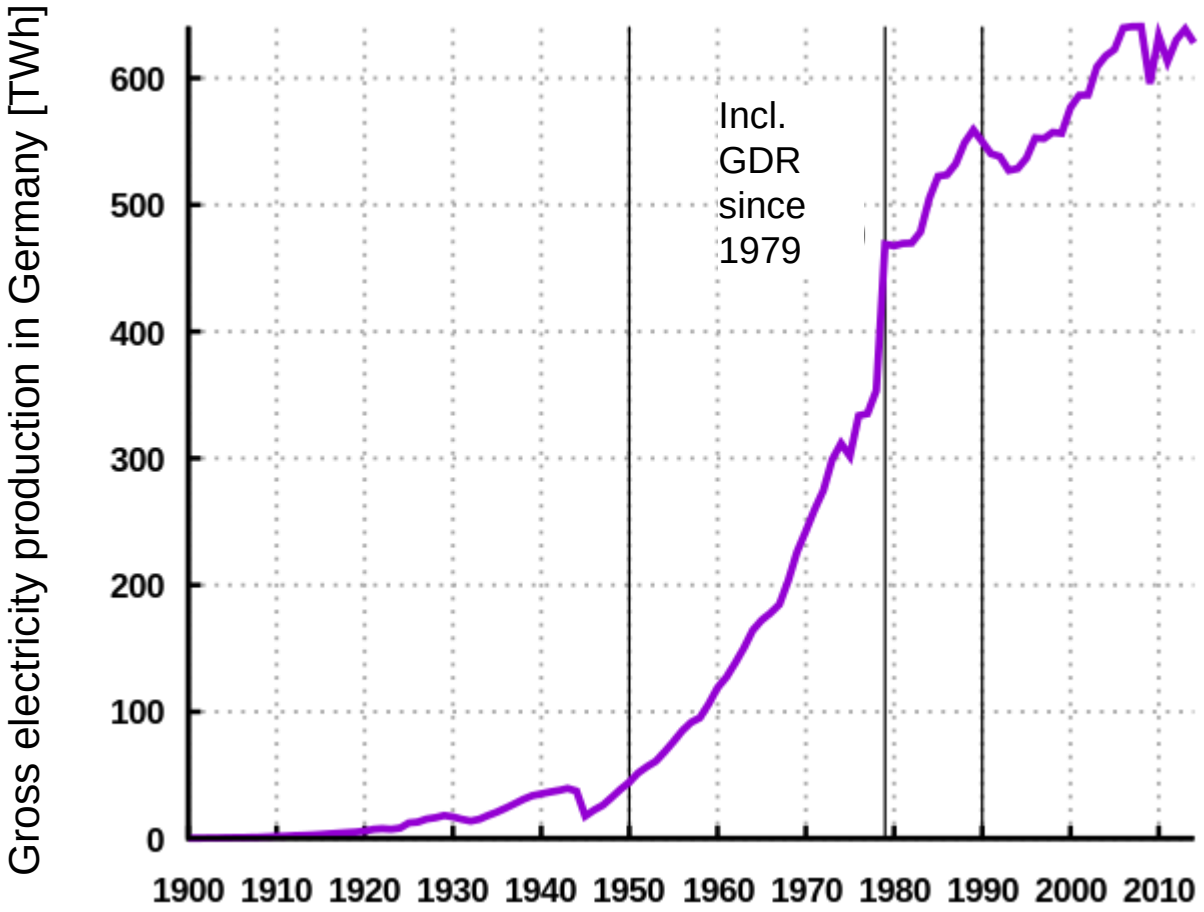


Source: http://blogs.ubc.ca/grswwu/2013/04/19/the-virtual-water/

The „1950s syndrom“

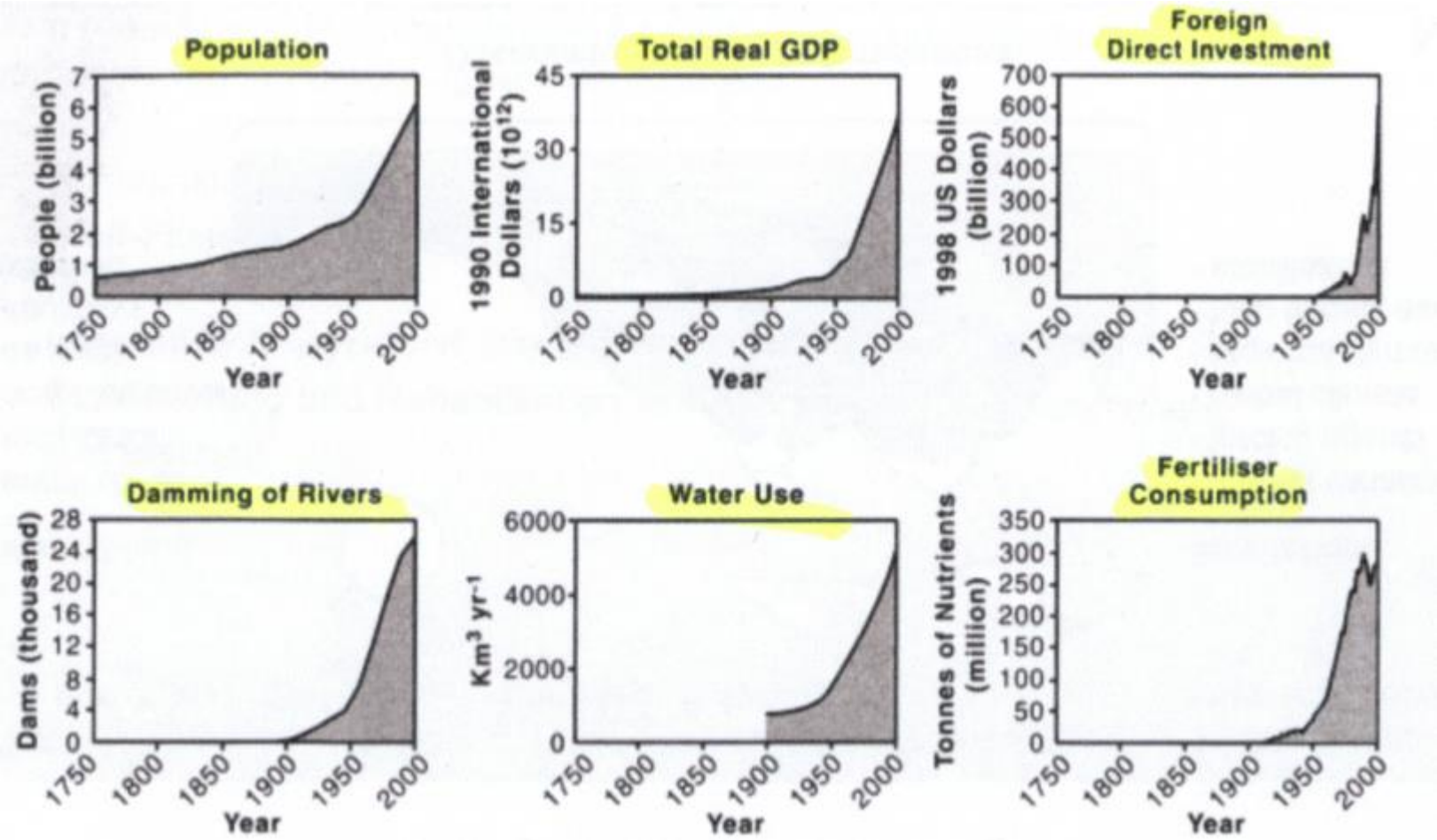
- Rapid increase in global energy demand in industrialized countries after the WWII
- Starting in Europe, lifestyle and standards of living changed significantly
- Economic basis: Price decrease of fossil fuels (especially petroleum) through newly discovered huge resource reserves in the Middle East
  - Increase in energy consumption
  - New resource reserves (especially in the Middle East)
  - Development of consumer society

The „1950s syndrom“

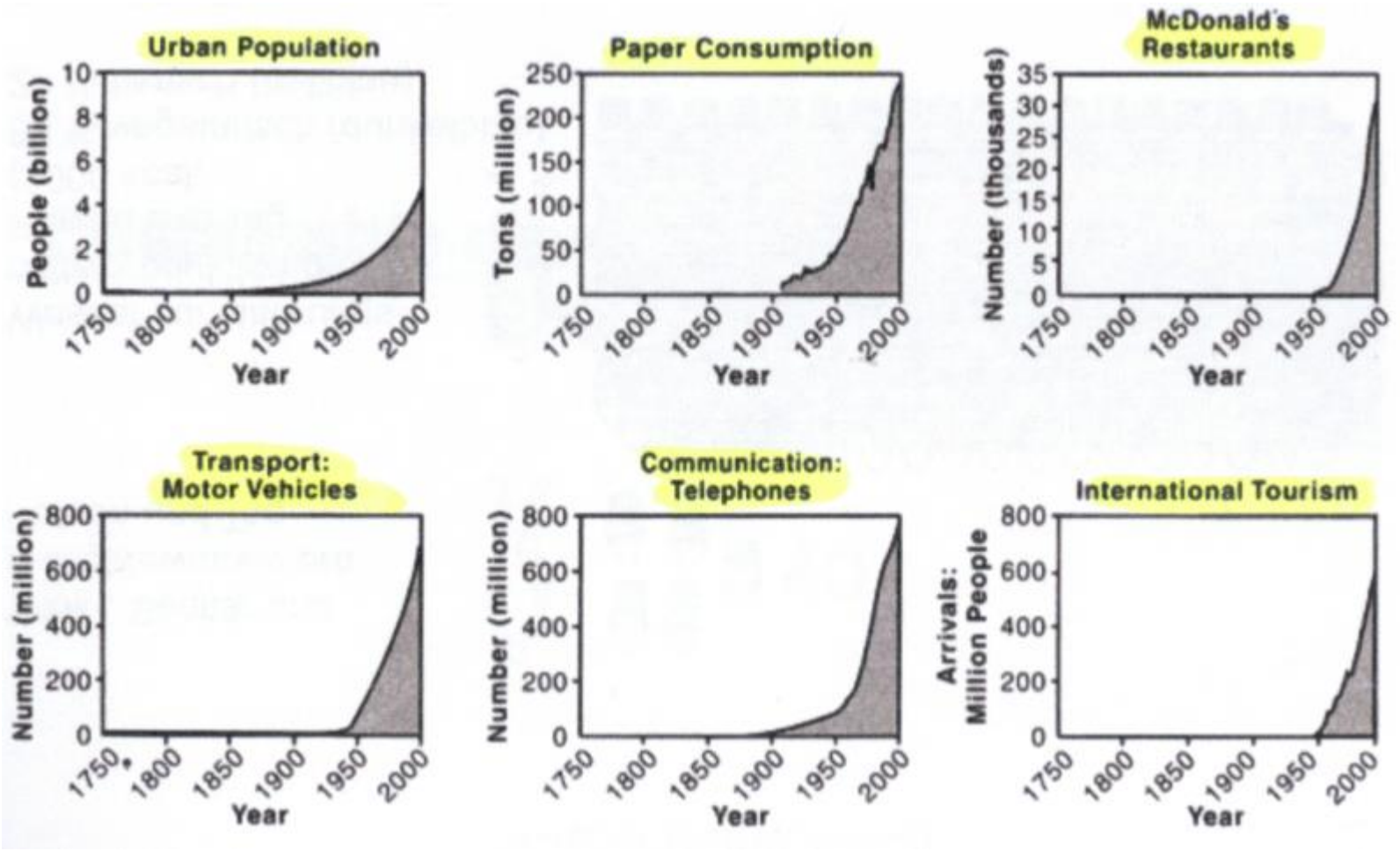


Source: StefanPohl - Eigenes Werk, CC0,
https://commons.wikimedia.org/w/index.php?curid=46228073

The „1950s syndrom“



The „1950s syndrom“



Environmental targets in companies

Motivations

Reasons for acting sustainable

- Normative ethical rationality
- Economic rationality
- External pressure
- Competitive advantages

Goals

- Legitimacy and acceptance
- Strengthening the competitive positions (costs, differentiation, innovation)
- Increase productivity

Source: Baumgartner (2010): Nachhaltigkeitsorientierte Unternehmensführung, München: Rainer Hampp Verlag

Target system of companies

- Market performance (quality, innovations)
- Market position (sales, market share)
- Profitability (turnover, return on assets)
- Financial goals (liquidity, capital structure)
- Prestige (independence, political influence
- Social goals (job satisfaction, income)
- Society oriented goals (environmental protection, jobs)

Source: Ulrich, Fluri (1993): Management, eine konzentrierte Einführung, S. 7ff.

Environmental targets of companies

- Reduce resource consumption
  - Avoid or reduce use of resources (decrease paper consumption in administration department by 25% in 1 year)
- Reduce emissions
  - Avoid, reduce, recycling and proper disposal (increase transport by train from 25 to 40% in 2 years)
- Future environmental problems
  - Avoid, reduce and precaution (all employees receive appropriate training regarding disposal of engine oil)

Source: Funck, Pape (2008): Vision Nachhaltigkeit: Implikationen für Unternehmenspolitik, -ziele und -programm, in: Baumast, Pape (Hrsg.): Betriebliches Umweltmanagement, S. 81-92

Environmental protection strategies

From pollution control (end of pipe thinking) to pollution prevention strategies

Pollution prevention

- Can be adopted within all sectors, from households to large industrial complex

Cleaner production

- Directs activities towards production aspects, focusing on the manufacturing sector

Reduce or eliminate air, water, and land pollution in an efficient and sustainable manner

Pollution prevention

- Elimination and/or reduction of waste into all media (water, land, air) at the source of generation
  - Save energy
  - Protect the environment
  - Conserve natural resources and materials
  - Long term
- Look at all types of waste to protect the environment comprehensively
- Stop pollution before it is generated in the first place

Cleaner production

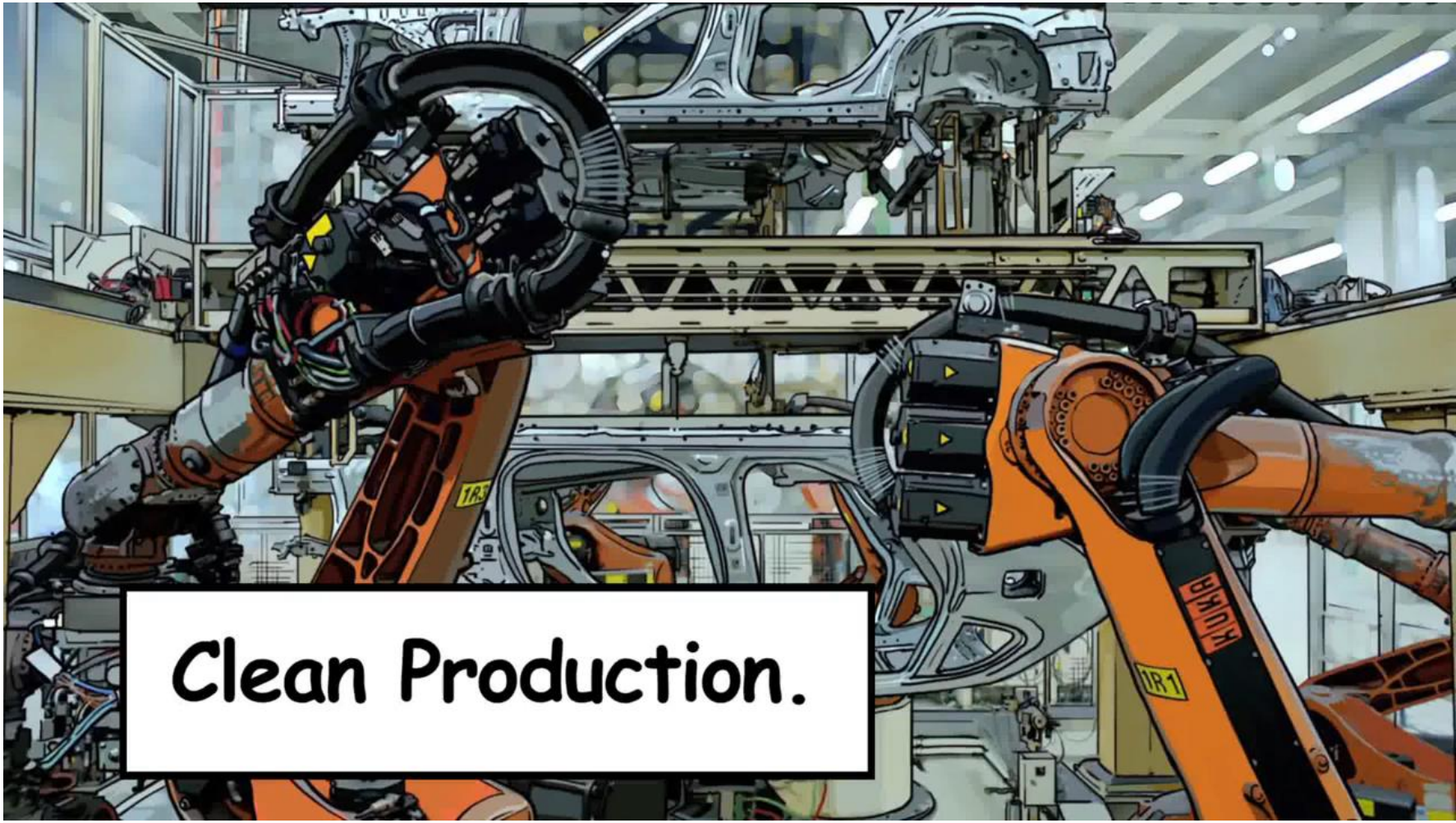
- Similar to pollution prevention
- A process that continually evolves with the introduction of improved technology and innovative ideas

*"Cleaner production is the continuous application of an **integrated preventive environmental strategy** applied to **processes, products, and services** to increase eco-efficiency and reduce risks for humans and the environment."*

Source: United Nations Environment Programme 1991

➔ **AVOID prior to REDUCE prior to DISPOSE**

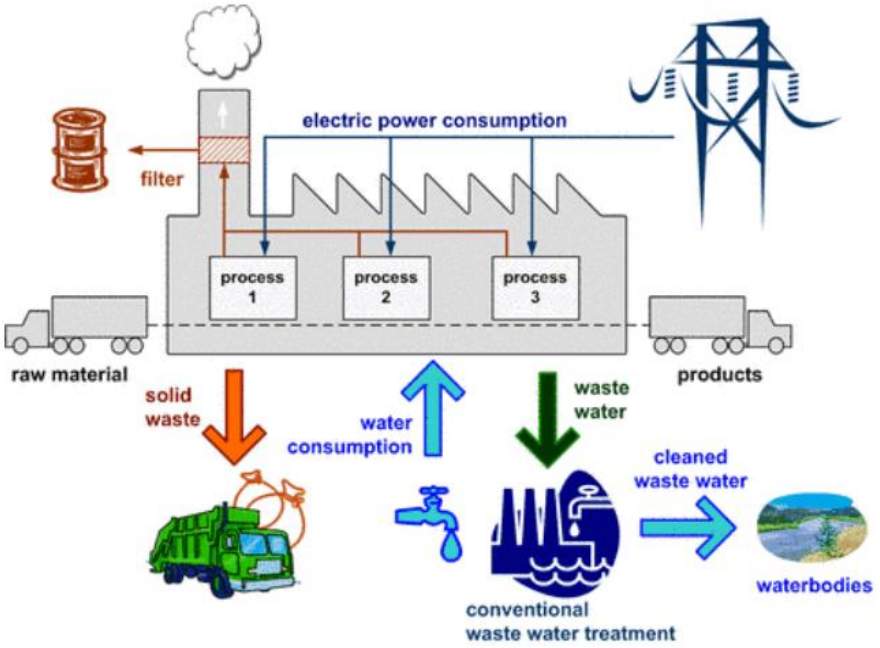
Securing our sustainable future: clean production - BMW Group



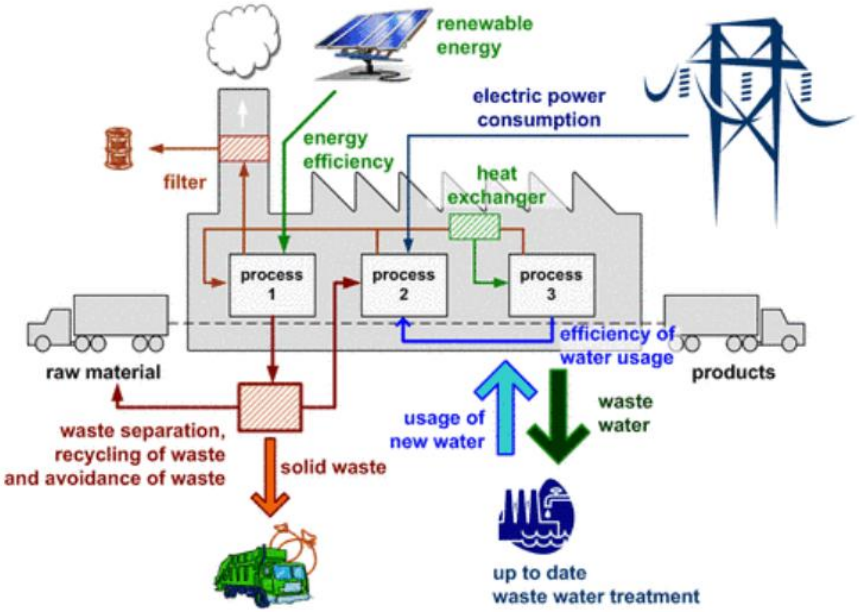
https://www.youtube.com/watch?v=icVTlwbF0_4

End of pipe technology vs. cleaner production

End of pipe technology



Cleaner production



Source: http://www.ruthtrumpold.id.au/destech/?page_id=1474

Cleaner production

Applies to:

- **Production processes**
  - Conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes.
- **Products**
  - Reducing negative impacts along the life cycle of a product, from raw material extraction to its ultimate disposal.
- **Services**
  - Incorporating environmental concerns into designing and delivering services.

Objectives of cleaner production

1. Increase efficiency by reducing pollution

- **Waste Reduction:**
  - Waste refers to all types of waste incl. hazardous and solid waste, liquid and gaseous wastes, waste heat, etc.
    Goal: achieve zero waste discharge
- **Non-Polluting Production**
  - Ideal production processes within the concept of cleaner production take place in a closed-loop with zero pollution release.
- **Production Energy Efficiency**
  - Cleaner production requires the highest level of energy efficiency and conservation. Energy efficiency is determined by the highest ratio of energy consumption to product output. Energy conservation on the other hand refers to the reduction of energy usage.

Objectives of cleaner production

2. Reduce risks for humans and the environment

- **Safe and Healthy Work Environments**
  - Minimize the risks of workers in order to provide a cleaner, safer and healthier working-environment.
- **Environmentally Sound Products**
  - The final product and all marketable by-products should be as **environmentally friendly** as possible. Address health and environmental factors at the earliest point of product and process design and consider them over the full **product life-cycle** (production, use, disposal)
- **Environmentally Sound Packaging**
  - Product packaging should be **minimized** wherever possible. Necessary packaging (to protect the product, to market the product, to facilitate ease of consumption) should be as environmentally friendly as possible.

Objectives of cleaner production

3. Reduce costs

Environmental costs are costs caused by waste and emissions – only a part of them is visible, a much bigger part is hidden!

Cleaner production activities and techniques

Source Reduction Technique	Description	Examples
Process efficiency improvements	**Doing more with less** by designing new systems or modifying existing ones; the most effective means of conserving materials and resources	High volume, low pressure (HVLP) spray guns for painting operations; centralized fluid distribution systems; water flow restrictors; energy-saving light fixtures
Material substitution	**Replace hazardous chemicals** with less toxic alternatives of equal performance	Using water-based paints instead of solvent-based paints; replacing solvent degreasers with aqueous cleaning systems
Inventory control	**Reduce product losses** due to product expiration and over-stocking	Restricting access to supply areas; maintaining accurate inventory records to prevent over-stocking

Cleaner production activities and techniques

Source Reduction Technique	Description	Examples
Preventative maintenance	Includes any activity that might prevent equipment malfunctions and environmental releases	Routinely inspecting equipment and storage containers; fixing problems immediately; following standard operating procedures
Improved housekeeping	Keeping a cleaner shop conserves resources and materials, prevents product losses, and prevents spills and leaks	Keeping aisles clear; cleaning up spills and absorbents immediately; maintaining storage shelves in good order
In-process recycling	In-process recycling is considered source reduction if materials are not removed from the process (i.e., waste is not generated) or if materials are redirected back into the process	Counter-current rinsing in the electroplating process; water recirculation; multi-pass coolant systems.

Benefits of cleaner production

Environmental and social benefits

- Reduce ecological damage from raw material extraction and refining operations, and the risk of emissions during the production process and during recycling, treatment and disposal operations.
- Reduce the risk of civil and criminal liability by minimizing the amount of waste generated
  - This benefit is particularly important, if the waste products are hazardous or toxic in nature. Pollution prevention and cleaner production make compliance with national, provincial, and local regulations easier.

Benefits of cleaner production

Economic benefits

- Reduce operating costs
  - For example, the costs connected with waste treatment, storage, and disposal are often reduced through pollution prevention and cleaner production programs and the savings can be used to offset the development and implementation costs of the program
- Reduce material, energy and facility cleanup costs
- Improve a company's image
  - For example, employees, regulators, and local residents are likely to feel more positive towards a company when they recognize that the management is committed to provide a safe working-environment and to minimize pollution.

End of pipe technology vs. cleaner production

Common waste management

I have waste!
What am I doing with it?

Cleaner production

I have waste!
Where does it come from?

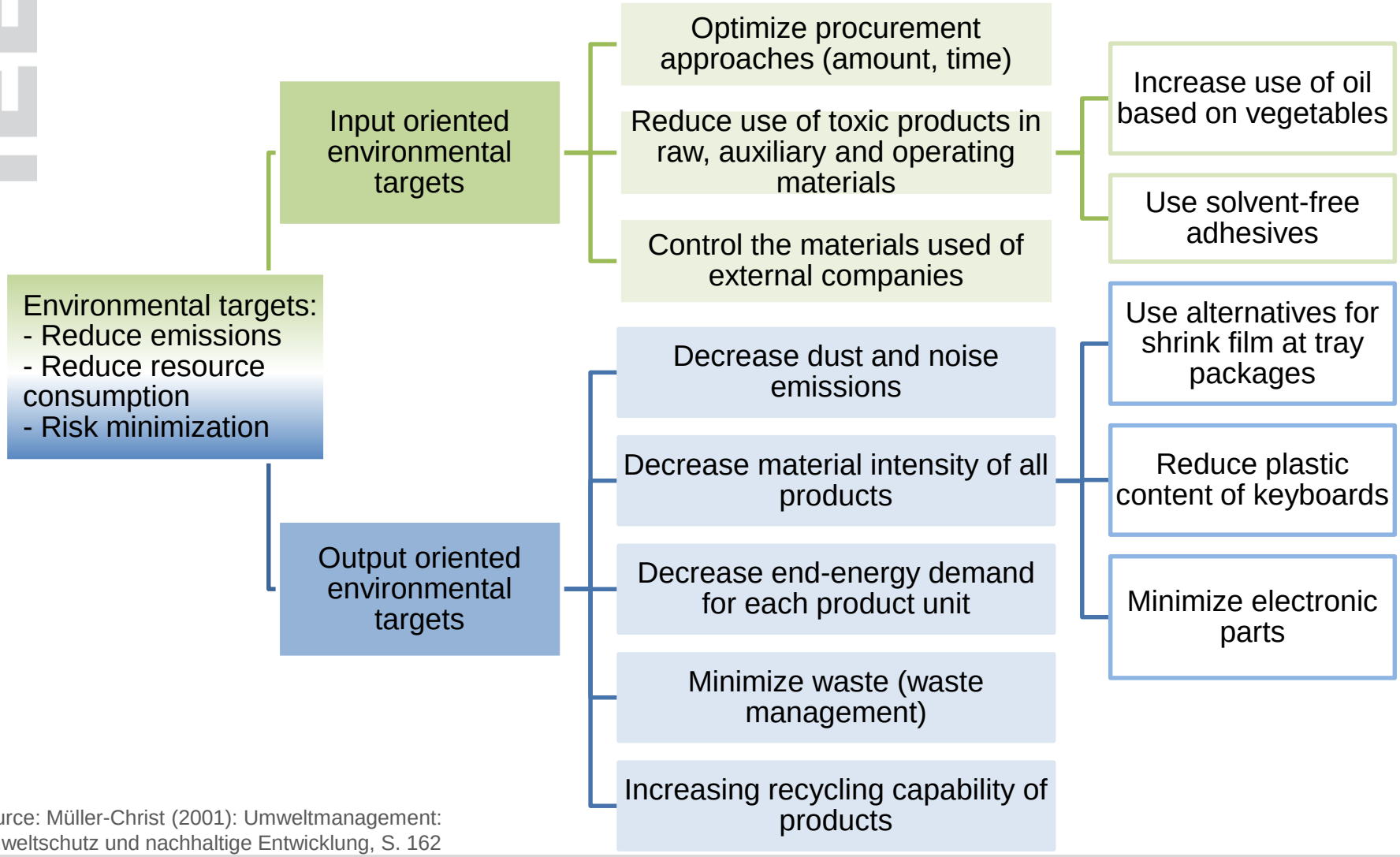
End of pipe technology vs. cleaner production

End of pipe technology	Cleaner production
How can we treat **existing waste** and emissions?	Where do waste and emissions come from? (**sources**)
Stands for **re-action**	Stands for **action**
Generally leads to **additional costs**	Can help to **reduce costs**
Waste and emissions are **limited** through filters and treatment units	Waste and emission **prevention** at the source
End of pipe solutions	Avoids potentially toxic processes and materials
Environmental protection comes in **after** products and processes have been developed	Environmental protection comes in as an **integral part** of product design and process engineering
Environmental problems are solved from a technological point of view	Environmental problems are tackled at all levels/in all fields

End of pipe technology vs. cleaner production

End of pipe technology	Cleaner production
Environmental protection is a matter for competent **experts**	Environmental protection is **everybody‘s** business
Is bought from **outside**	Is an innovation developed **within the company**
Increases material and energy **consumption**	**Reduces** material and energy **consumption**
Increased complexity and **risks**	**Reduced risks** and increased transparency
Environmental protection comes down to **fulfilling legal prescriptions**	Environmental protection as a **permanent challenge**
Is the result of a production paradigm dating from a time when environmental problems were not as yet known	Is an approach intending to create production techniques for a more sustained development

Targets and ways to reach them



Source: Müller-Christ (2001): Umweltmanagement: Umweltschutz und nachhaltige Entwicklung, S. 162

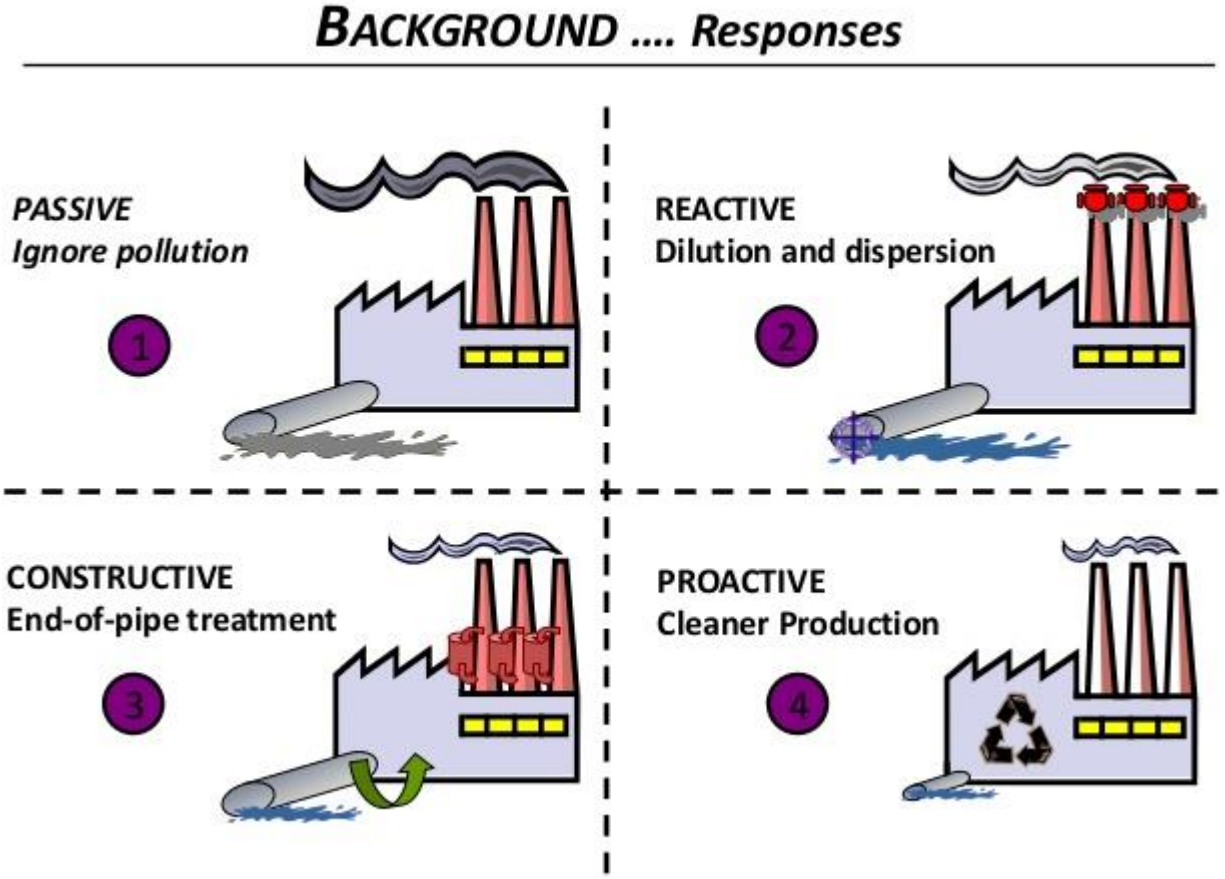
Environmental basic strategies

- Passive environmental strategy
  - Considering environmental protection due to external pressure
  - reactive strategy
  - No or very passive strategy of communication (green washing)

- Active environmental strategy
  - Considering environmental protection a-priori in all relevant business divisions
  - Environmental oriented innovations
  - Active strategy of communication

Source: Hopfenbeck (1997): Allgemeine Betriebswirtschafts- und Managementlehre: das Unternehmen im Spannungsfeld zwischen ökonomischen, sozialen und ökologischen Interessen. 11. Aufl., Landsberg/Lech: moderne Industrie

Environmental basic strategies



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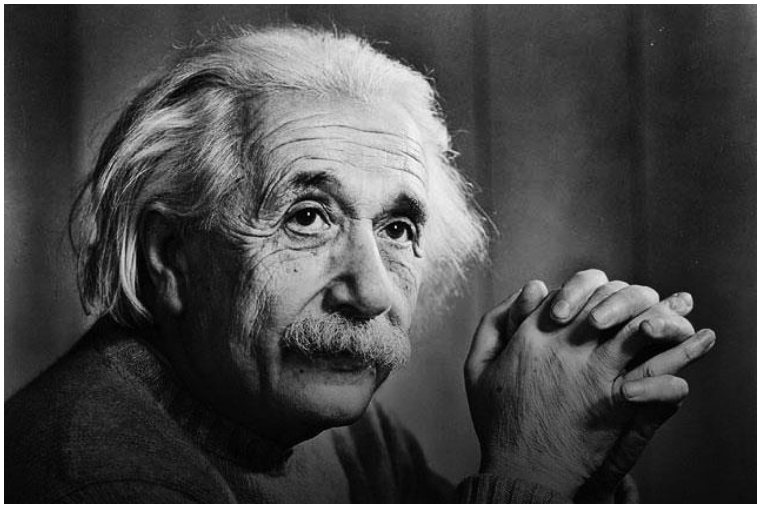

Albert Einstein (1879-1955)

„If you don‘t want to change anything, you will always find an excuse.

If you want to change something, there is always a way.“

Thank you for your attention!

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