

# Energy & Environment

SUMMARY BASED ON THE LECTURE SLIDES

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# INTRODUCTION

## INITIAL SITUATION

Today, about 7.3 billion people live on this planet and still more than 2 billion are without access to energy as poverty remains a global problem with big differences in the distribution of wealth. Additionally, more and more people live in so-called mega-cities with more than 5 million people per city.

But not only the population is growing, with it there is also rapid growth in energy demand that leads to some societal challenges, that include **local** and **global environmental pollution**, **limited resources** and also the **societal acceptance** and **risk aspects** connected to such a growth in energy providers. Typically, 1% increase in population leads to an 1% increase in emissions. The population is growing nearly everywhere, except for the European union, this leads also to a population pyramid that isn't a pyramid at all any more, more like a vase that keeps getting bigger at the top and shrinking at the bottom. Compared to that India has a much larger base population that may be able to sustain their elderly population.

## GLOBAL AGENDA 2015

This is an **analysis** of the **top 10 trends** and takes key regional challenges and emerging issues into account that will define our future, these trends include the **rising pollution in the developing world**, the **increasing occurrence of severe weather events** and the **increasing water stress**.

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### RIISING POLLUTION IN THE DEVELOPING WORLD

Developing countries will suffer most from weather-related disasters and increased water stress caused by global warming, these countries are expected to bear up to 80% of the impact costs of global warming.

**Solutions** include investing in a cleaner power generation network, ensuring proper regulation and promoting clean energies, funding provided from richer countries and also cooperation to develop new low-carbon technologies. The problem always is that high carbon solutions, once implemented, are difficult to replace, therefore decisions being made today on power generation are crucial.

The cost of the increasing occurrence of extreme weather events will be highest for society's poorest as well as the increasing water stress that will rise quite extraordinarily.

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### EMERGING NUCLEAR POWERS

Electricity demand in developing countries is increasing by about 5% per year, because of that alternatives to meet the electricity demand have to be found, for example nuclear power.

## WORLD ENERGY OUTLOOK

The **International Energy Agency** is an autonomous agency the tries to **promote sustainable energy policies**, **improve transparency** of international energy markets, **support global collaboration** on energy technology and also **find solutions** to global energy challenges.

It takes a look different scenarios, principally the **current policies scenario**, the **new policies scenario** and also the **450 scenario**, that tries to keep the CO<sub>2</sub> concentration below 450 ppm eq. The biggest contributors are China, USA and India.

The power sector offers the largest possibility for additional abatement, now about every third power plan of new capacity was low carbon, to meet the 450 scenario would mean that this needs to shift to 3 out of 4 after 2030.

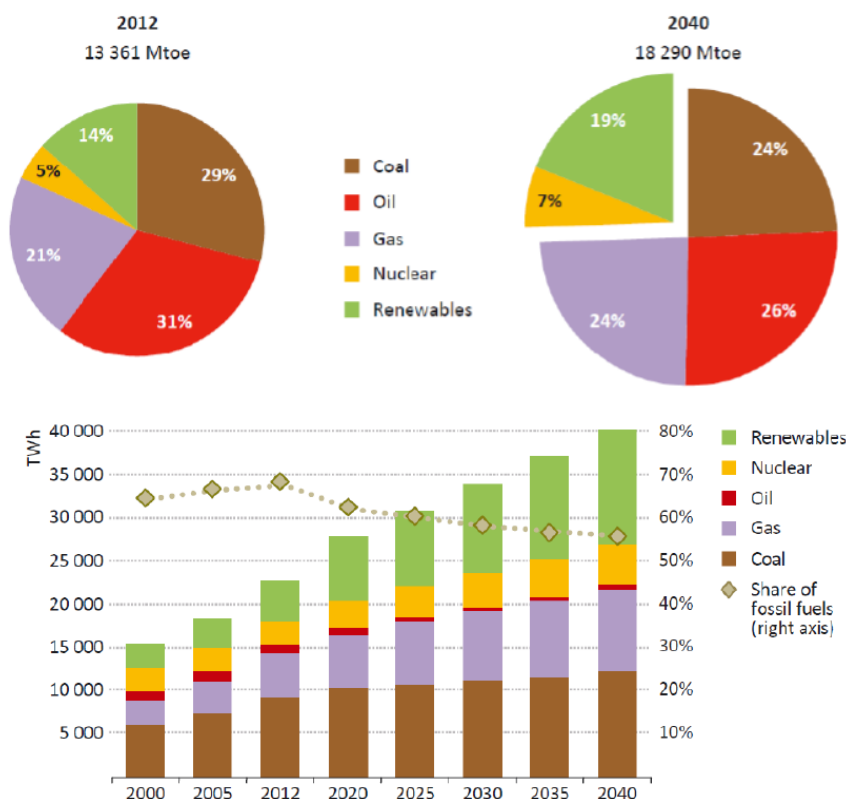
## GLOBAL ENERGY TRENDS

The energy demand is expected to increase by 37% according to the new policies scenario or even 50% according to the current policies scenario in the next 30 years, almost all of this increased demand comes from Non-OECD countries. In general, the share of fossil fuels in the energy mix is expected to fall while the share of low carbon fuels should increase, but in total the world oil supply is also expected to rise.

## MARKET OUTLOOK

Electricity remains the **fastest-growing** final form of energy and will nearly double until 2040, also gas and nuclear will replace the share of coal and oil while the share of renewable energies should nearly triple until 2040.

**Renewable energy** is rapidly increasing and driving up its share, wind power capacity additions are the second largest behind gas fired plants while PV gets the largest increase among RE with the EU remaining the largest financial supporter of RE.



## ACCESS TO ELECTRICITY

Energy poverty is still widespread, in some African countries only 15-30% of the population has access to electricity.

## ENVIRONMENTAL ECONOMICS

As humans cause environmental impacts, it is important to look at the **relations** of a company to its natural environment, assess the **effects on the environment** and work on an **environmental policy** for the company. The goals are always to **reduce input and output** and guarantee a ration supply of scarce goods. The following principles should hold

- **Precautionary principle:** Avoid ecological damage
- **Principle of origin:** Avoid environmental impacts where they occur
- **Sustainability principle**
- **Polluter pays principle**
- **Cooperation principle:** Cooperation of all relevant public, social and private actors
- **Cross-Cutting principle:** Environmental

There are two ways of controlling this, either by **direct behavior control** (via laws, authorizations, obligations...) or by **indirect behavior control** (taxes, subventions, certifications...).

Sustainable development is defined as

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

It contains 2 key concepts, the concept of **needs** and the idea of **limitations**. Itself as a concept is documented since the early 12<sup>th</sup> century and started out in forestry.

### CLUB OF ROME: LIMITS TO GROWTH (1972)

This is a simulation of exponential economic and population growth with finite resource supplies that concluded, that absolute growth limits are reached somewhere in the next 100 years.

The exponential reserve index is defined as the amount of time left for a resource with constant consumption growth.

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

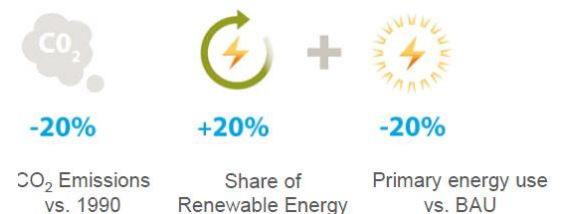
Resource	Consumption growth rate annual	Static index	Exponential index
Chromium	2,6%	420	95
Gold	4,1%	11	9
Iron	1,8%	240	93
Petroleum	3,9%	31	20

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

### INTERNATIONAL CLIMATE TARGETS

The EU set up the so-called 20-20-20 targets, the goal here is to limit global warming to 2°C above the pre-industrial level, in 2010 all member states committed to this goal, the problem remains, that to reach this target, between 2045 and 2060 all GHG emissions have to be 0.

With the newest agreements from Paris, global warming would preferably be limited to 1.5 °C.

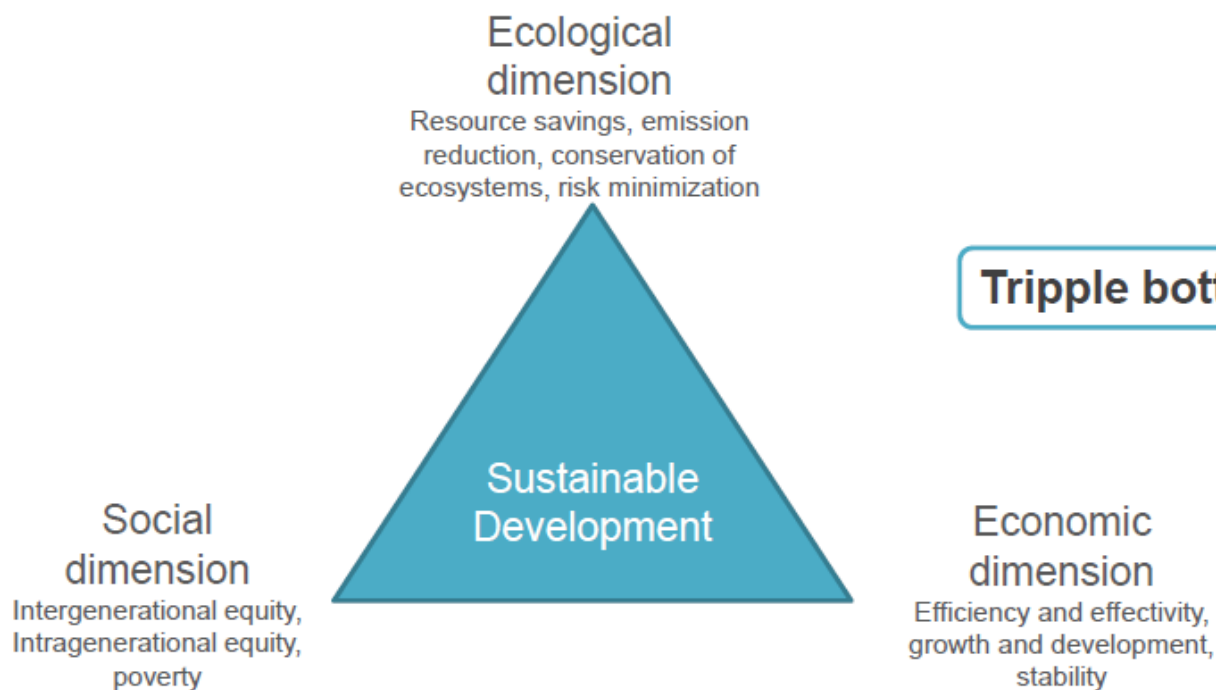
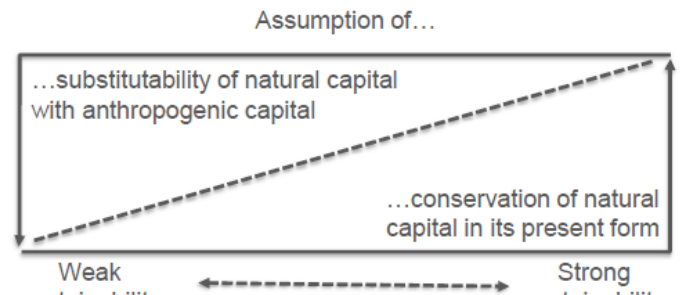


## ASPECTS OF SUSTAINABLE DEVELOPMENT

Sustainable development tries to establish **intergenerational** and **intragenerational equity**, ensure the **regeneration capacity** of renewable resources, **preserving** the **absorption capacity** of the environment and ensure the **protection of species**.

### NATURAL VS ANTROPOGENIC CAPITAL

**Substitutability (weak sustainability)** allows the natural capital to decrease if the anthropogenic capital is created instead, the **complementarity (strong sustainability)** sees a dependency between the anthropogenic and natural capital.



## ECOLOGICAL SUSTAINABILITY

The **degradation rate of renewable resources** should not exceed their regeneration rate, this corresponds to the requirement of maintaining ecological functionality, hence to preserve the ecological real capital. **Non-renewable resources** should only be used to the extent in which a **substitute** in the form of renewable resources is provided or the **productivity of renewable and non-renewable resources** is increased.

**Infiltrated substances** into the environment should be based on the **carrying capacity** of environmental media and the **duration** of the anthropogenic interventions must be weighed against the reaction time for stabilization. **Hazards** for human health are to be **avoided**.

### Ecological sustainability



## ECONOMIC SUSTAINABILITY

The economic system should **satisfy** individual and social needs, therefore it should **promote** personal initiative (**individual responsibility**) and self-interest in the common good (**regulating responsibility**), by that **prices** should undertake a **leading function** on the market in **reflecting scarcity** of resources.

Framework conditions have to be designed so that **functioning markets** are preserved, **innovations** are stimulated and **long-term orientation** is worthwhile and that social change is **encouraged**. The **economic capacity** of a society must at least be maintained and at best increase quantitatively and qualitatively.

### Economic sustainability



### Social sustainability



## SOCIAL SUSTAINABILITY

The goal is to reward **social responsibility** throughout the product life-cycle, this can be achieved by proper management of **human resources**, **regional** responsibilities of companies and by **integrating** concerns of **stakeholders**.

**CSR** (Corporate Social Responsibility) relates to the question of the fundamental task and purpose of the company, its guiding principle assumes that companies **not only have to complete economic tasks** but also fulfill tasks and assume responsibility beyond this.

## CSR

CSR has two definitions, in the European union it is defined as **Corporate Sustainability Responsibility** and in companies also the social dimension of the corporate activity is incorporated.

*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.*

If CSR is understood in a broad sense, then social responsibilities apply equally to the core business, the support of civil society and the development of framework conditions further.

## ECOLOGICAL FOOTPRINT

**Ecological services** are services provided by the planet, including **purification of water/air**, diversification of plants and animals, photosynthesis... and so on, for all these services a piece of land on earth is needed.

The **Ecological footprint** is now the area on the earth necessary to enable a human's lifestyle and standard of living in the long term, this includes production of items, providing energy as well as disposal of waste, it is measured in global hectares per person per year.

1 gha represents the average productivity of all biologically productive areas on earth in a given year, this does not count deserts, glaciers and so on, using this information it is possible to calculate the relative **carrying capacity** of the earth.

This ecological footprint is highest for the western world as well as Australia.

## ECOLOGICAL DEBT DAY

This is the day at which humanity's use of natural resources exceeds what the earth can regenerate in that given year, selected countries consume more than they generate.

## VIRTUAL WATER (WATER FOOTPRINT)

This is a measurement that measures the total amount of fresh water used in order to produce a product or provide a service.

## THE 1950S SYNDROM

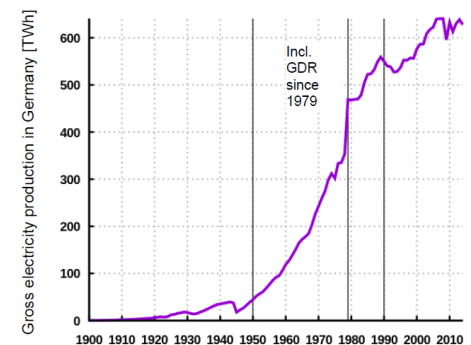
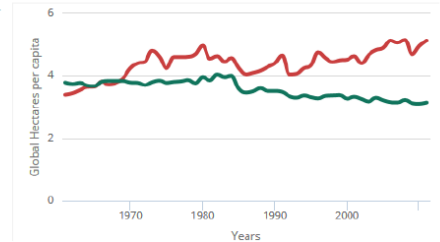
After the second world war, global energy demand increased rapidly, starting in Europe where lifestyle and standards of living changed significantly. The **economic basis** for this is the price decrease of fossil fuels through newly discovered huge resource reserves in the middle east, this lead to an **increase in energy consumption** and a development of a consumer society.

## 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

ECOLOGICAL FOOTPRINT  
AND BIOCAPACITY  
FROM 1961 TO 2011



## ENVIRONMENTAL TARGETS IN COMPANIES

**Reasons for acting sustainable** include economic rationality, external pressure, competitive advantages as well as an ethical rationality, the **goals** are legitimacy and acceptance, increasing productivity and strengthening competitive positions.

It is beneficial to **reduce resource consumption**, **reduce emissions** as well as **deal with future environmental problems**, it is also better to go from pollution control to **pollution prevention strategies** by reducing or eliminating air, water and land pollution in an efficient and sustainable manner. This can save energy, protect the environment, conserve natural resources and tries in general to stop pollution before it is generated in the first place.

## CLEANER PRODUCTION

**Cleaner Production** is similar to pollution prevention and is 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.*

This applies to **production processes** (conserving raw materials, eliminating waste...), **products** (reducing negative impacts along the life cycle of a product) and **services** (incorporating environmental concern into delivering services).



## OBJECTIVES OF CLEANER PRODUCTION

1. **Increase efficiency by reducing pollution**
  - a. Waste Reduction (try to achieve zero waste discharge)
  - b. Non-Polluting production
  - c. Production Energy efficiency
2. **Reduce risks for humans and environment**
  - a. Safe and healthy work environments
  - b. Environmentally sound products
  - c. Environmentally sound packaging
3. **Reduce Costs**

Additional techniques include **improving process efficiency, substituting materials, controlling inventory, performing preventative maintenance, improve housekeeping and in-process recycling.**

## BENEFITS OF CLEANER PRODUCTION

**Environmental and social benefits** are to be expected by reducing the ecological damage from raw material extraction and refining operations and reducing the risk of emissions during production, recycling, treatment and disposal operations. It also reduces the risk of civil and criminal liability by minimizing the amount of waste generated.

**Economic benefits** are expected due to reducing operating costs, reducing material, energy and facility cleanup costs and also by improving a company's image.

## End of pipe technology vs. cleaner production

End of pipe technology	Cleaner production	End of pipe technology	Cleaner production
How can we treat <b>existing waste</b> and emissions?	Where do waste and emissions come from? ( <b>sources</b> )	Environmental protection is a matter for competent <b>experts</b>	Environmental protection is <b>everybody's</b> business
Stands for <b>re-action</b>	Stands for <b>action</b>	Is bought from <b>outside</b>	Is an innovation developed <b>within the company</b>
Generally leads to <b>additional costs</b>	Can help to <b>reduce costs</b>	<b>Increases</b> material and energy <b>consumption</b>	<b>Reduces</b> material and energy <b>consumption</b>
Waste and emissions are <b>limited</b> through filters and treatment units	Waste and emission <b>prevention</b> at the source	<b>Increased</b> complexity and risks	<b>Reduced</b> risks and increased transparency
End of pipe solutions	Avoids potentially toxic processes and materials	Environmental protection comes down to <b>fulfilling legal prescriptions</b>	Environmental protection as a <b>permanent challenge</b>
Environmental protection comes in <b>after</b> products and processes have been developed	Environmental protection comes in as an <b>integral part</b> of product design and process engineering	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
Environmental problems are solved from a technological point of view	Environmental problems are tackled at all levels/in all fields		

## ENVIRONMENTAL BASIC STRATEGIES

There are **passive environmental strategies** like considering environmental protection due to external pressure, as a reactive strategy or **active environmental strategies** like considering environmental protection a-priori in all relevant business divisions and through an active strategy of communication.

