SCIENTIFIC FORUM
NUCLEAR ENERGY FOR CLIMATE

JOANNEUM RESEARCH LIFE

Variable Renewable Energy Sources

Innovations in Life Cycle Management Toward Climate Friendly Lifetstyles

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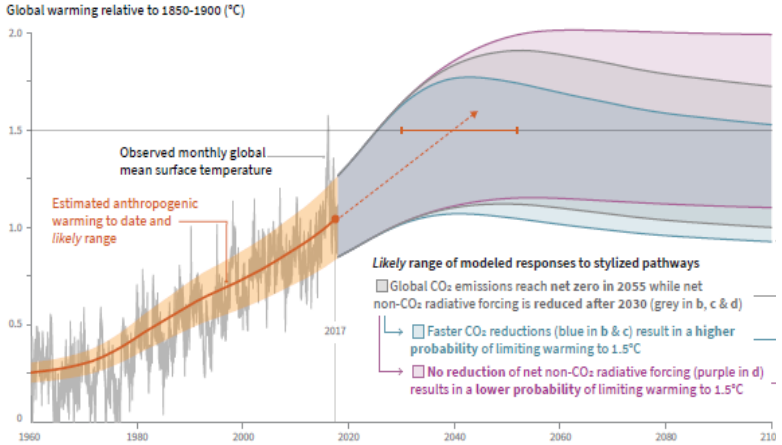
JOANNEUM RESEARCH

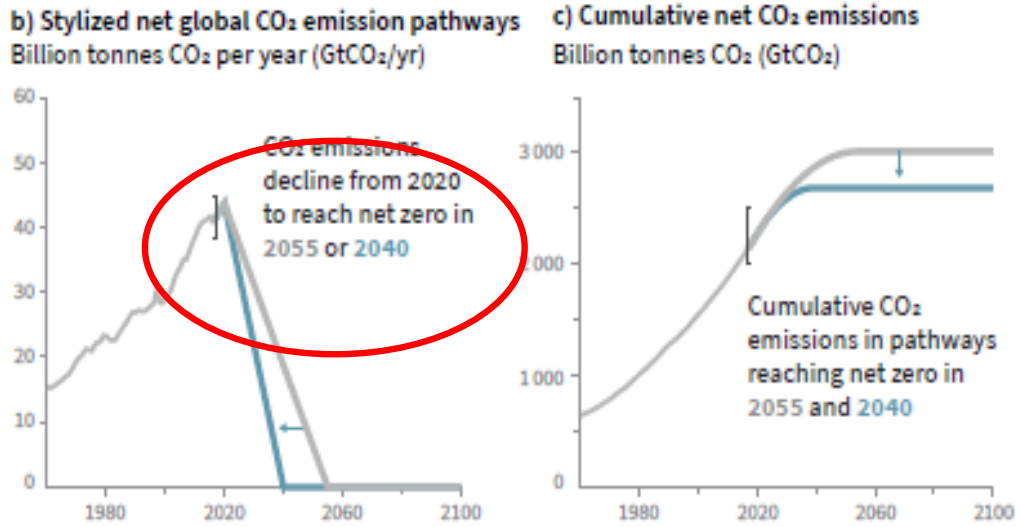
2020

Necessary Reduction of Greenhouse Gas Emissions

Observed and Modelled Global Temperature Change



Paris Target



Source: IPCC 2018

The FOUR Factors Influencing Greenhouse Gas Emissions

Future Energy System

Lifestyle

$$tCO_{2eq} = \frac{t_{CO2eq}}{GJ_{energy}} * \frac{GJ_{energy}}{Service} * \frac{Service}{P} * P$$

1) Emission factor (e.g. renewable energy)

2) Energy-efficiency

3) services per person

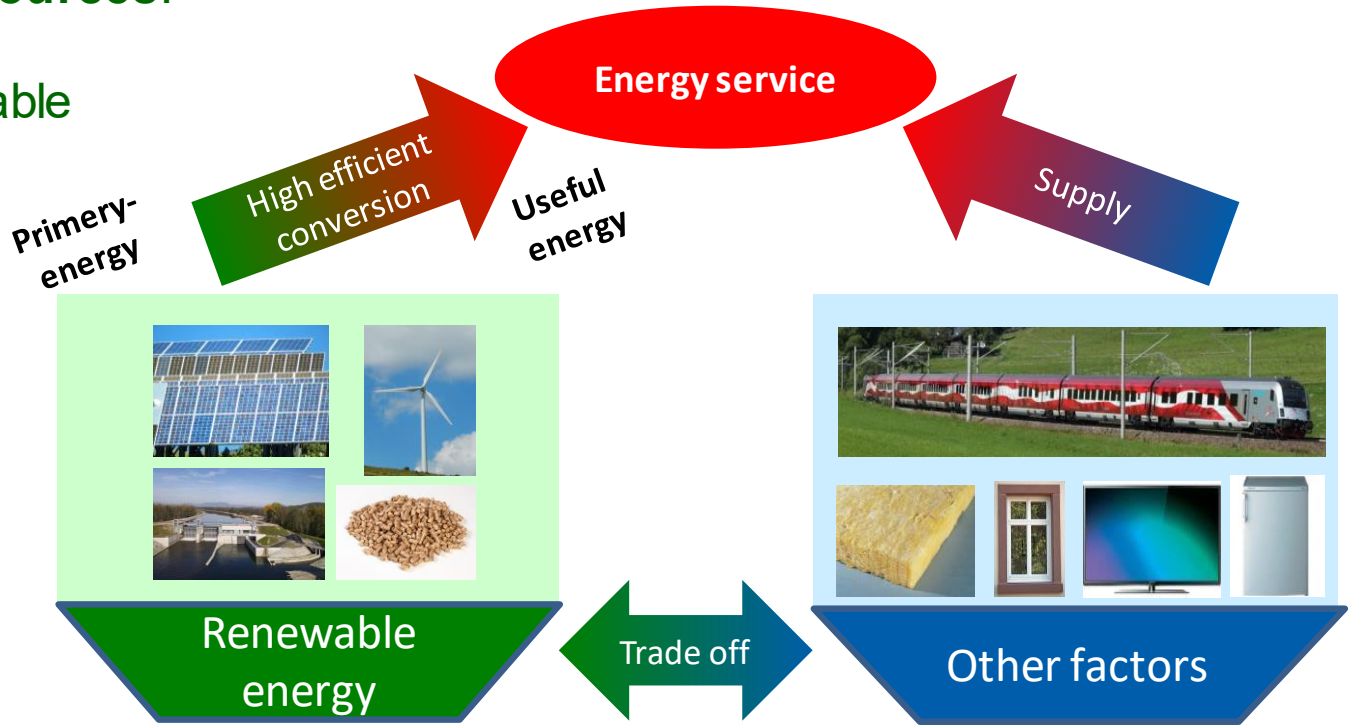
4) number of people

Source: based on "IPAT-Formel" of A. & P. Ehrlich

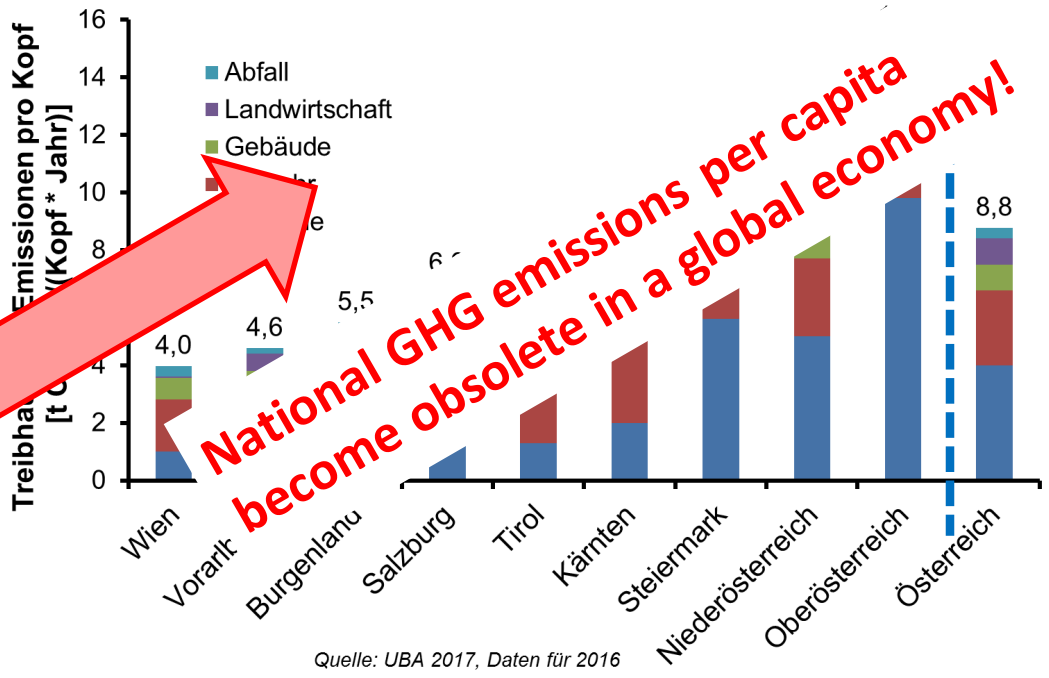
Characteristics of Future Energy Systems

Renewable Energy Sources:

- PV: high variable
- Wind: medium variable
- Hydro: low variable
- Biomass: storage



Characteristics of Lifestyles



Quelle: UBA 2017, Daten für 2016

Environmental Assessment only Possible Based on Life Cycle (LCA)

"There is international consensus that the environmental effects of producst and services can only be analyzed on the basis of Life Cycle Assessment (LCA) including the production, operation and the end of life treatment"

"Life Cycle Assessment (LCA)
is a method to ***estimate*** *the material and energy flows of a product (e.g. transportation service) to analyse* ***environmental effects*** *over the entire life time of the product „from cradle to grave"*

GHG Emissions of Austrian Lifestyle

Example
Carbon Footprint of Food Basket

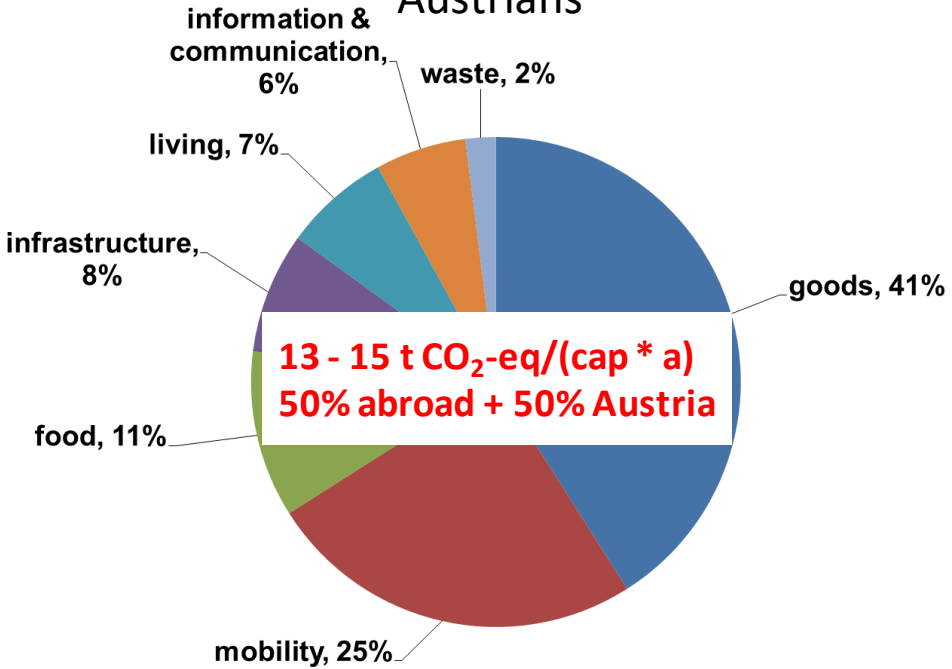
10 €

=

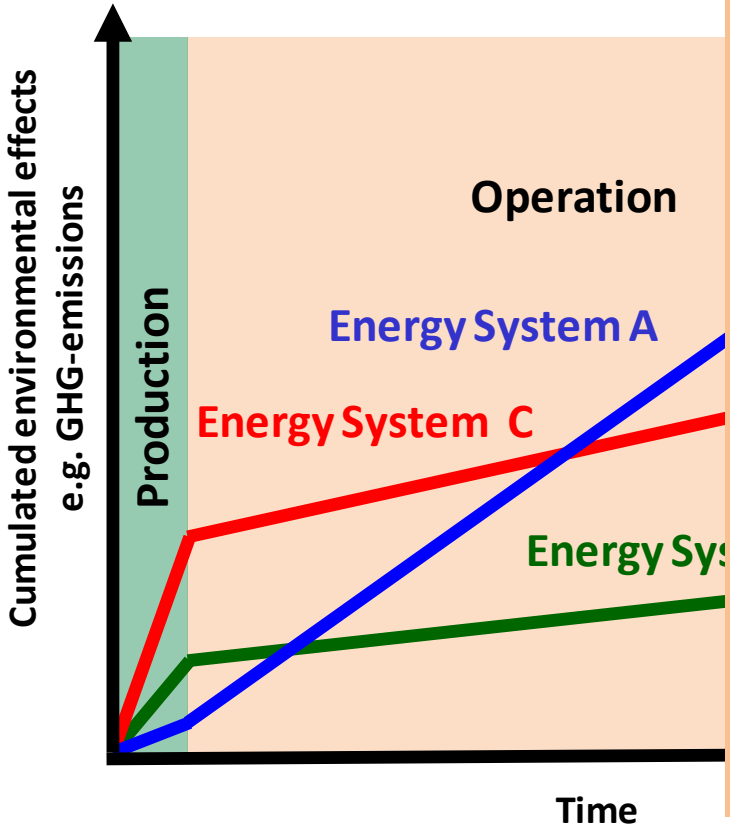
20 vehicle-km

4 kg CO_2-eq.

Consumption Based GHG Emissions of the Austrians



Cumulating



Possible environmental effects:

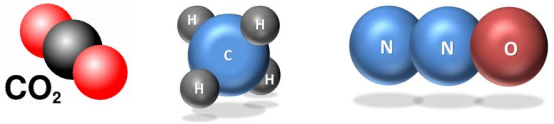
- Climate change (kg CO_2 eq)
- Ionizing radiations (kg U235 eq)
- Resource depletion water (kg water eq)
- Mineral, fossil & renewable resource depletion (kt, GJ)
- Land use (kg C deficit; ha)
- Photochemical ozone formation (kg NMVOC eq)
- Terrestrial eutrophication (molc N eq)
- Freshwater eutrophication (kg P eq)
- Marine eutrophication (kg N eq)
- Ozone depletion (kg CFC-11 eq)
- Human toxicity- cancer effect (CTUh)
- Human toxicity- non cancer effect (CTUh)
- Acidification (mol H+ eq)
- Particulate matter (kg PM2.5 eq)
- Freshwater Ecotoxicity (CTUe)

(Variable) Renewable Energy Sources

Innovations in Life Cycle Management

- **Variable power supply** by PV and wind: inclusion of storage systems to meet demand
- **Bioenergy**: time effects of CO_2-fixation – C-storage – CO_2-emissions
- **End of Life management**: Reuse and recycling of materials/components e.g. rare earth metals e.g. Ni, Co
- Strategies to reach and assure **Climate neutrality** of renewable energy sources in whole life cycle to reach Paris targets

Climate Neutrality



Definition

- A product/service is „climate neutral“, if in the total lifecycle **no greenhouse gas emissions** (in CO_2-eq.: CO_2, CH_4, N_2O, SF_6, FCKW, etc.) occur
- ..and/or the remaining greenhouse gas emissions are **compensated** by activities/measures in other areas permanently
- …in which the **timeline** of greenhouse gas emissions must be taken into account (timing of GHG emissions)

Ways for Realization

- Climate friendly consumption of products/services of **high quality**
- Increasing material & energy **efficiency**
- Substitution of fossil by **renewable energy**
- Reduction of direct **agricultural CH_4- & N_2O emissions**
- Permanent **CO_2-storage**
  - CCS: Carbon Capture and Storage
  - CCU: Carbon Capture and Utilization
  - Additional C-storage in biomass, soils and products: guarantee durability!

Climate Friendly Lifestyles

……..towards
Low Carbon Lifestyle = „Paris-Lifestyle©“

The „Paris Lifestyle“ is an innovative and satisfying „Low Carbon Lifestyle” characterized by having very low greenhouse gas emissions contributing to the Paris Agreement of limiting global warming to below 2°C. The Paris Lifestyle creates new economic opportunities and challenges by stimulating an increasing demand for low/zero Carbon products and services.