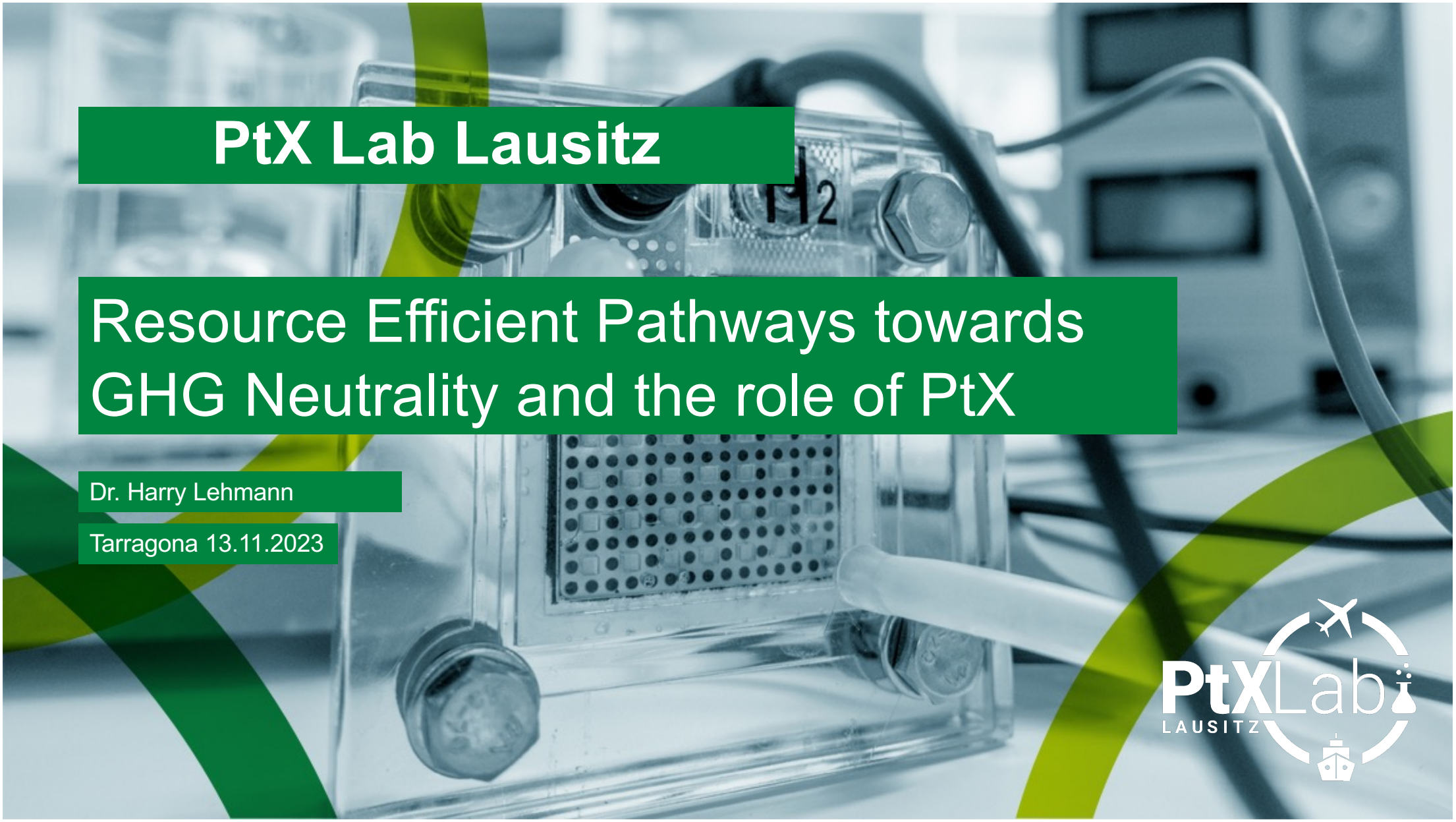


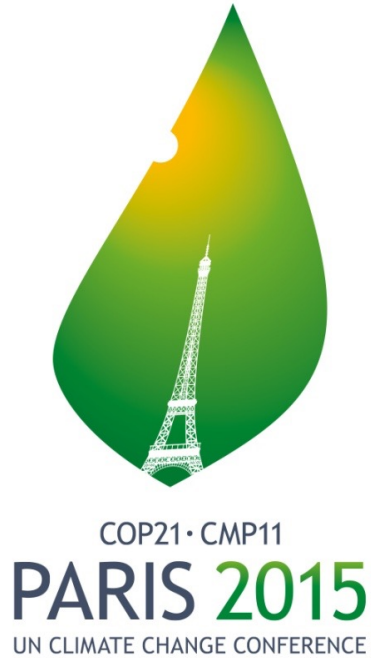
PtX Lab Lausitz

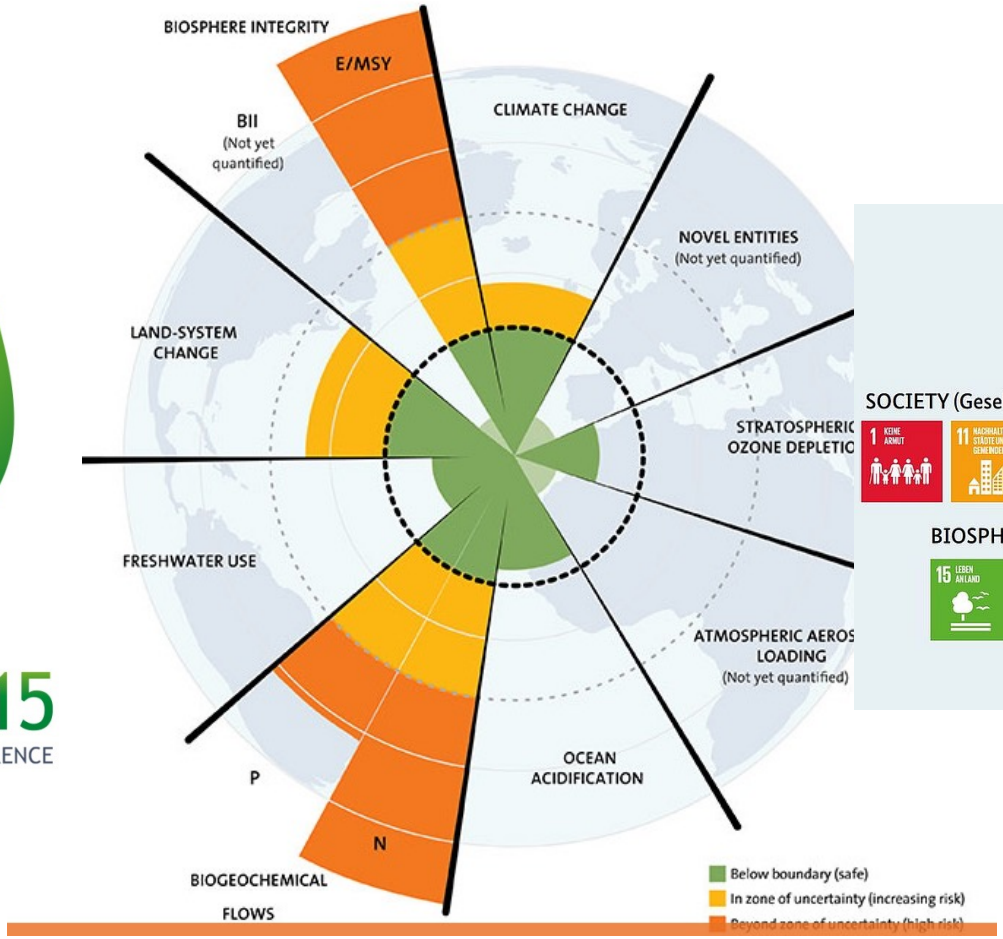
Resource Efficient Pathways towards GHG Neutrality and the role of PtX

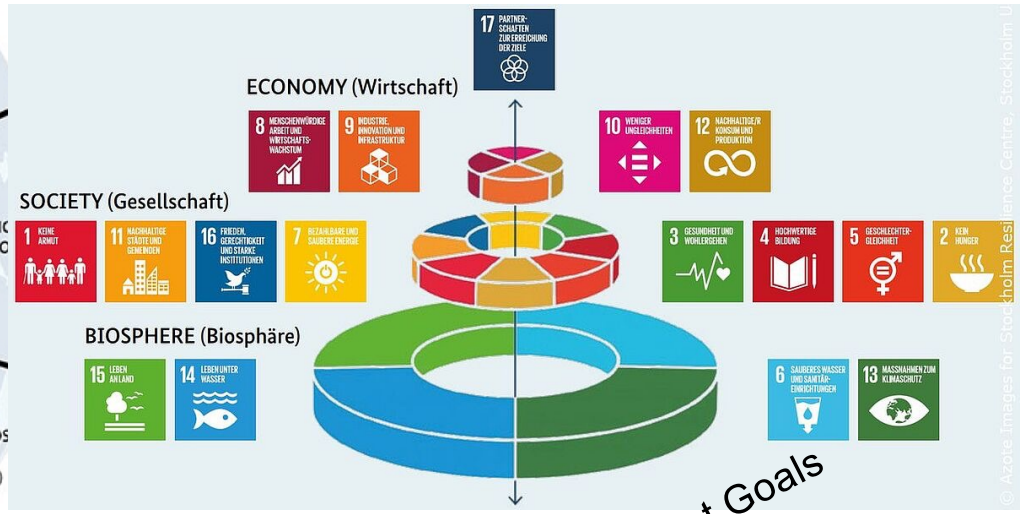
Dr. Harry Lehmann

Tarragona 13.11.2023

Climate neutral *and* sustainable!



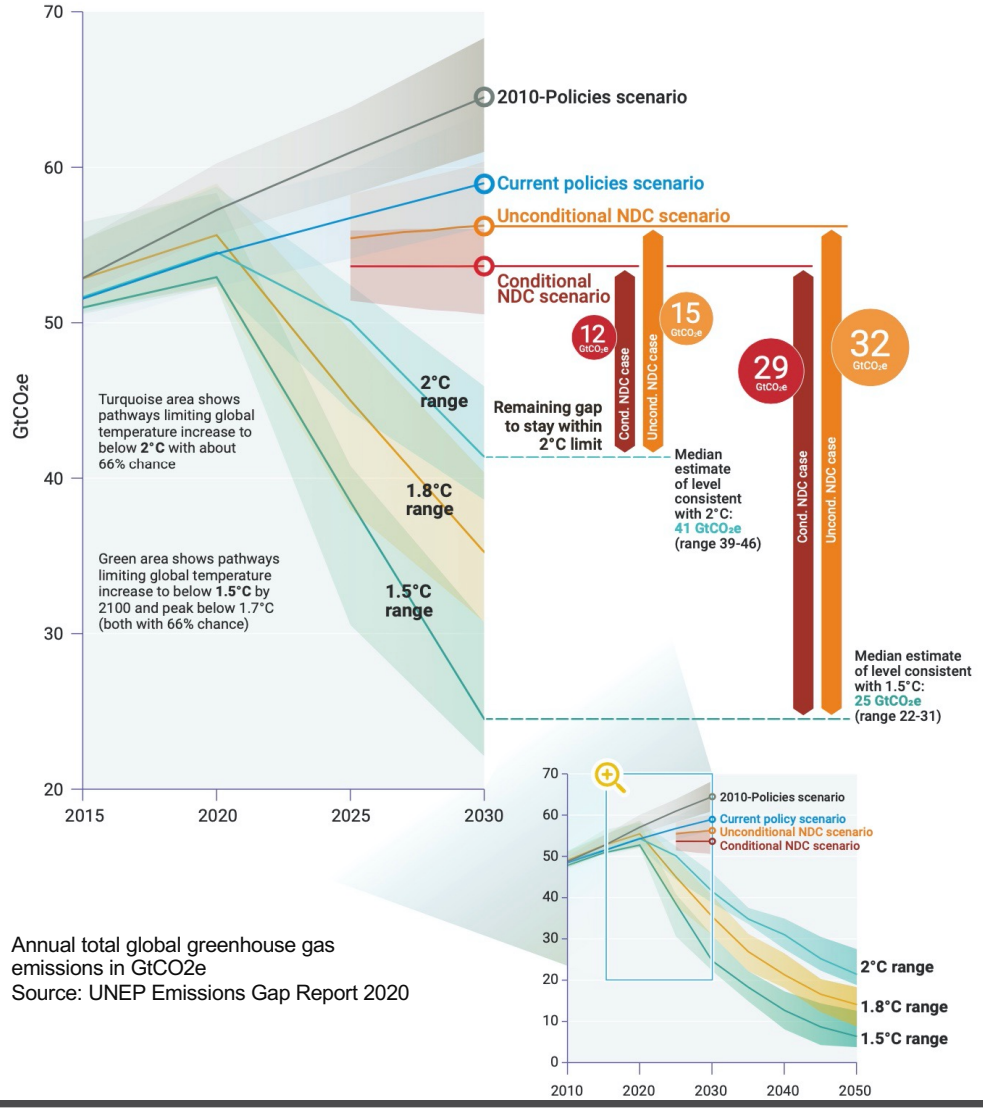




Sustainable Development Goals

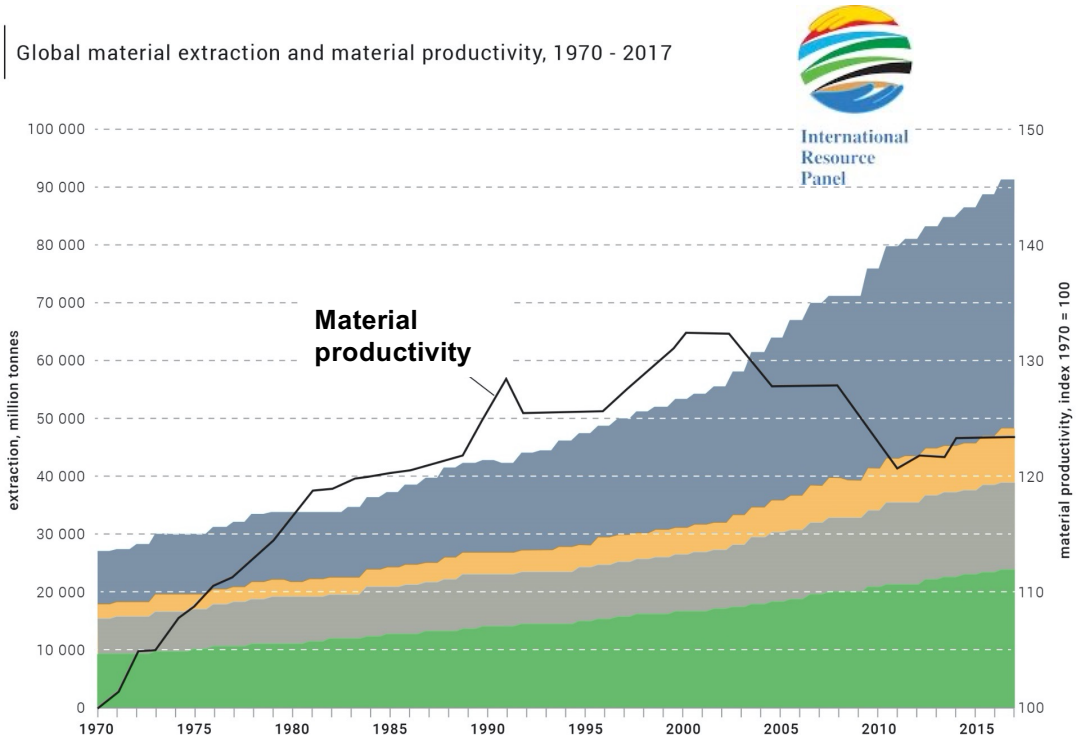
Credit: J. Lokrantz/Azote based on Steffen et al. 2015.

Global Tasks … Emission Gap still to big.



Annual total global greenhouse gas emissions in GtCO2e
Source: UNEP Emissions Gap Report 2020

Resource use and its upward trend



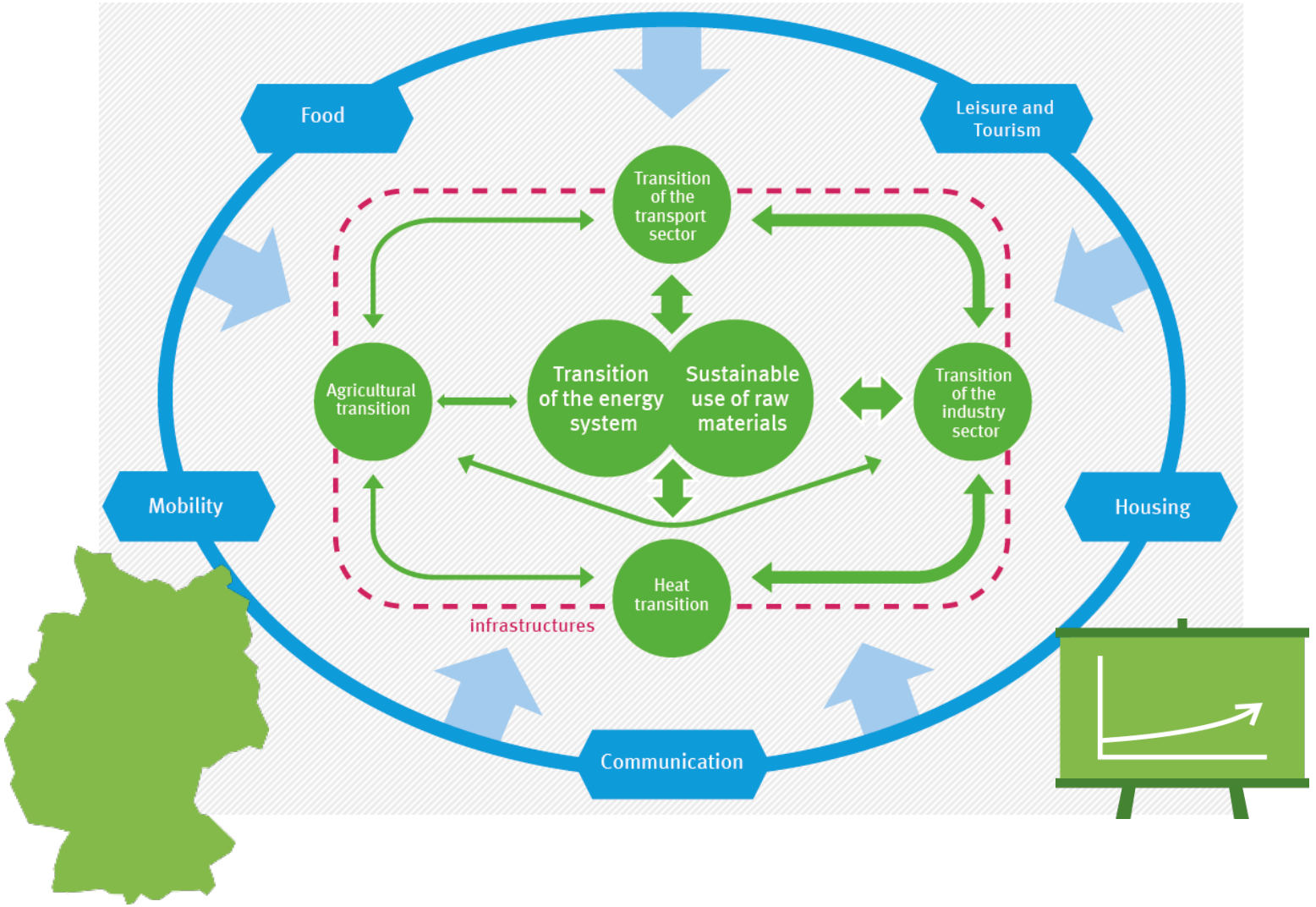
- Global resource use: more than tripled since 1970
- Global material demand per capita: 7.4 tonnes in 1970; 12.2 tonnes in 2017
- Material productivity: started to decline around 2000 and stagnated in recent years

Non-metallic minerals
Metals
Fossil fuels
Biomass

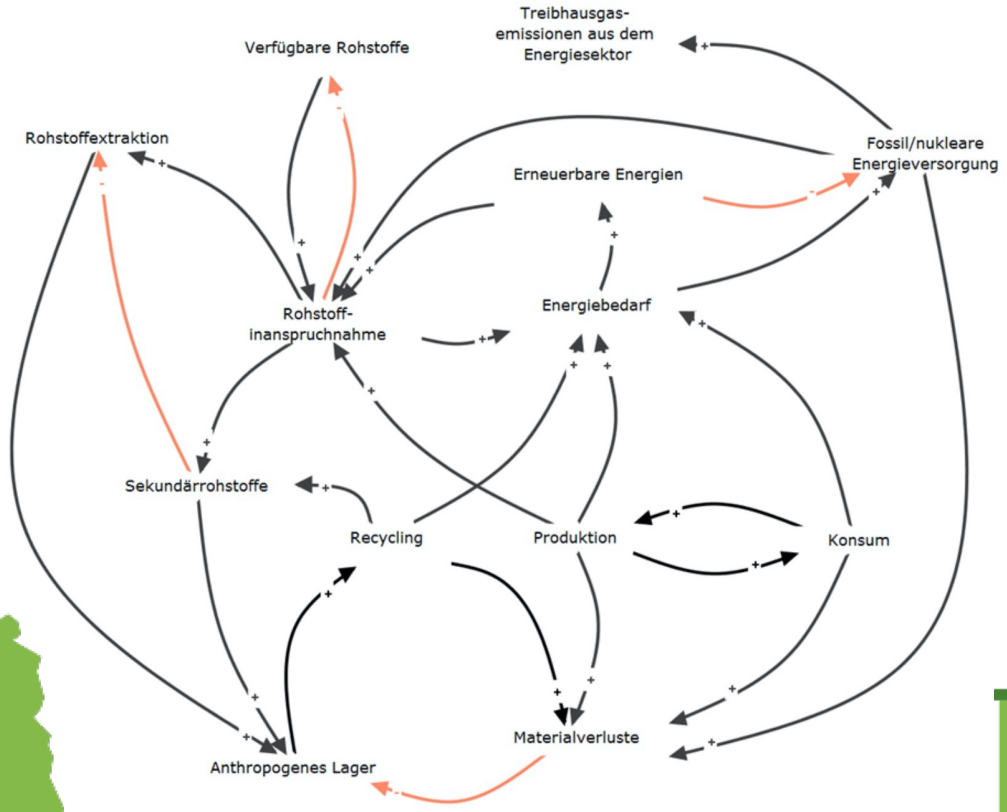
European Environment Agency

Science Based Analysis ... Scenarios and Models

RESCUE – Resource-Efficient Pathways towards Greenhouse-Gas-Neutrality

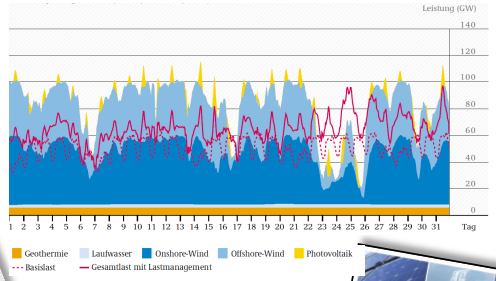


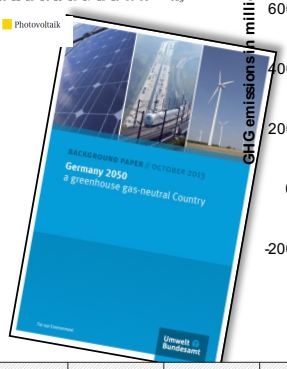
RESCUE – Resource-Efficient Pathways towards Greenhouse-Gas-Neutrality

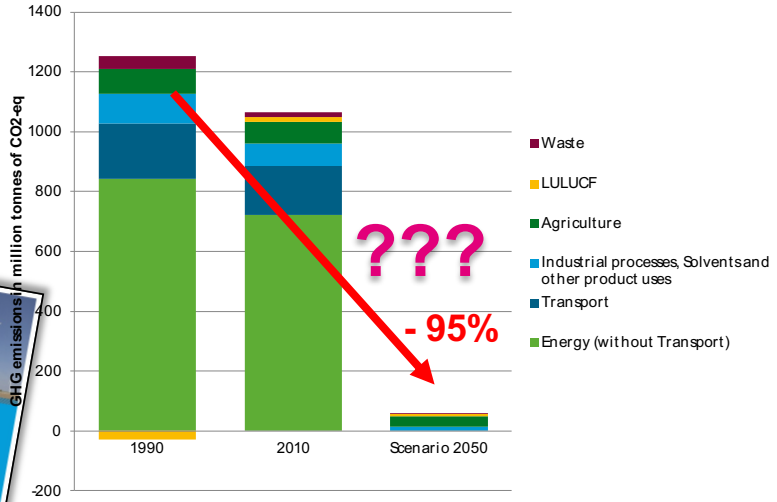


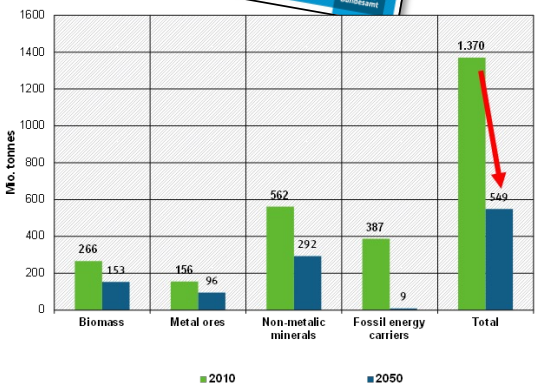
GREEN-SCENARIOS

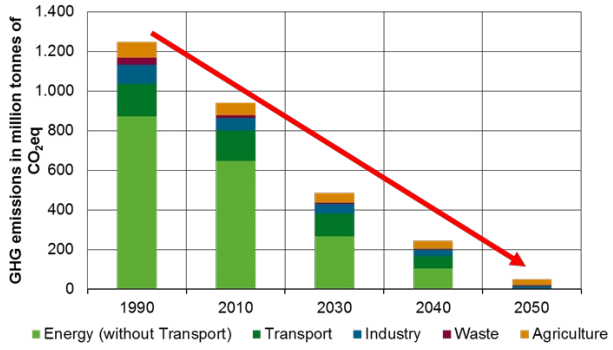
RESCUE-Project







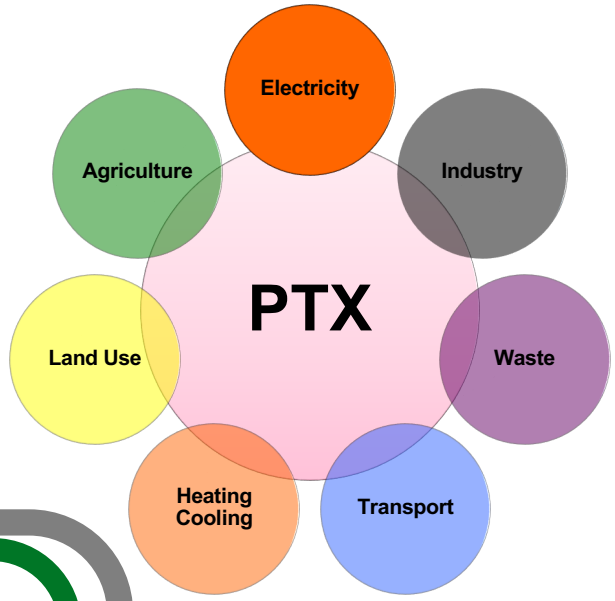


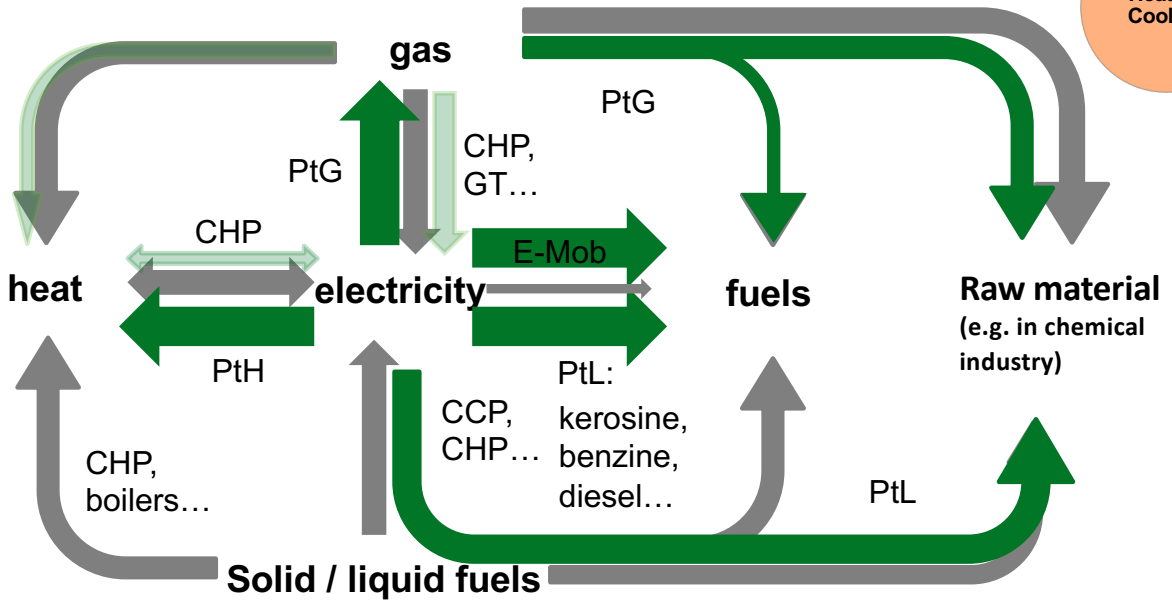


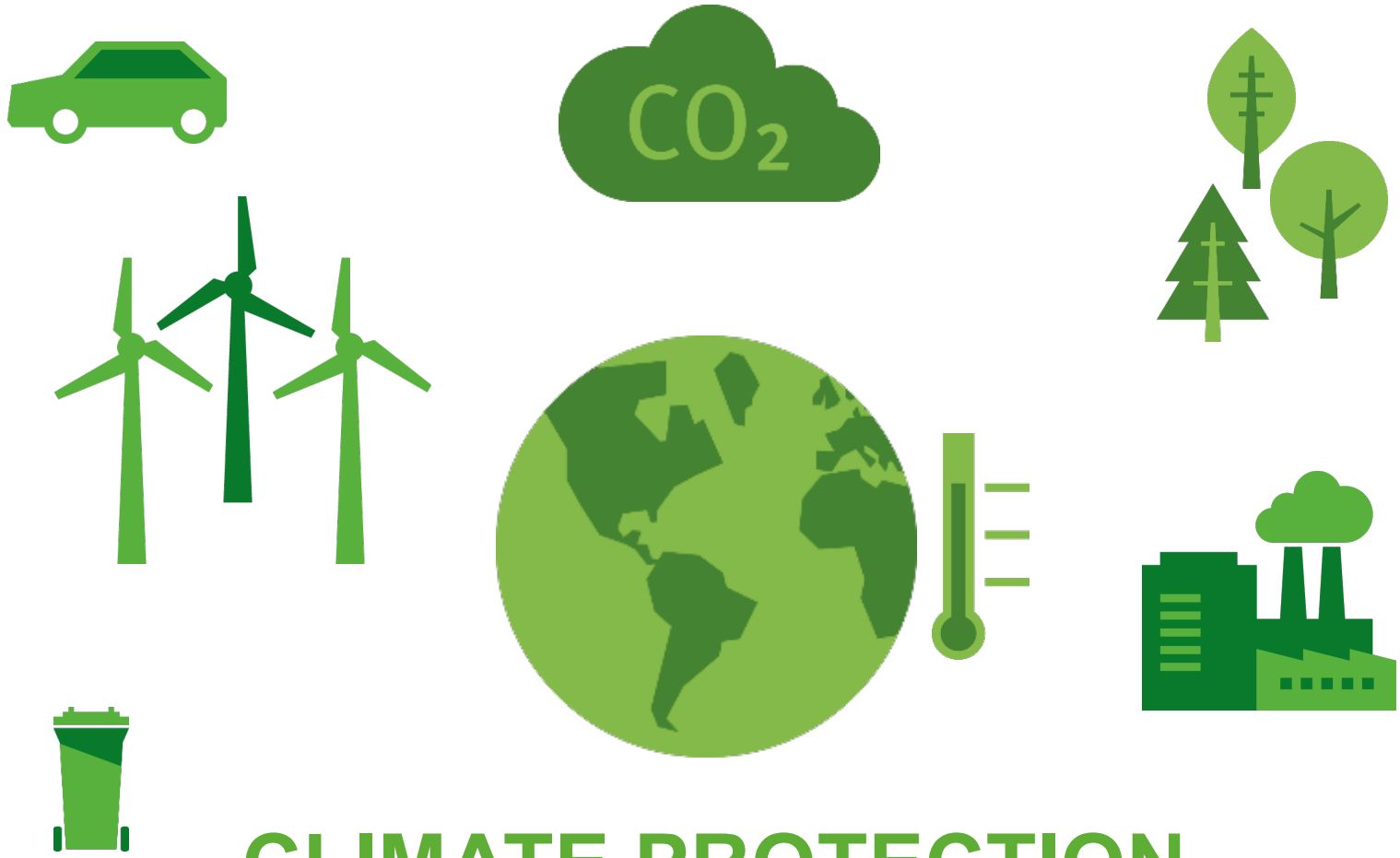
Lessons ?

Transformation

energy- and material-supply in the future

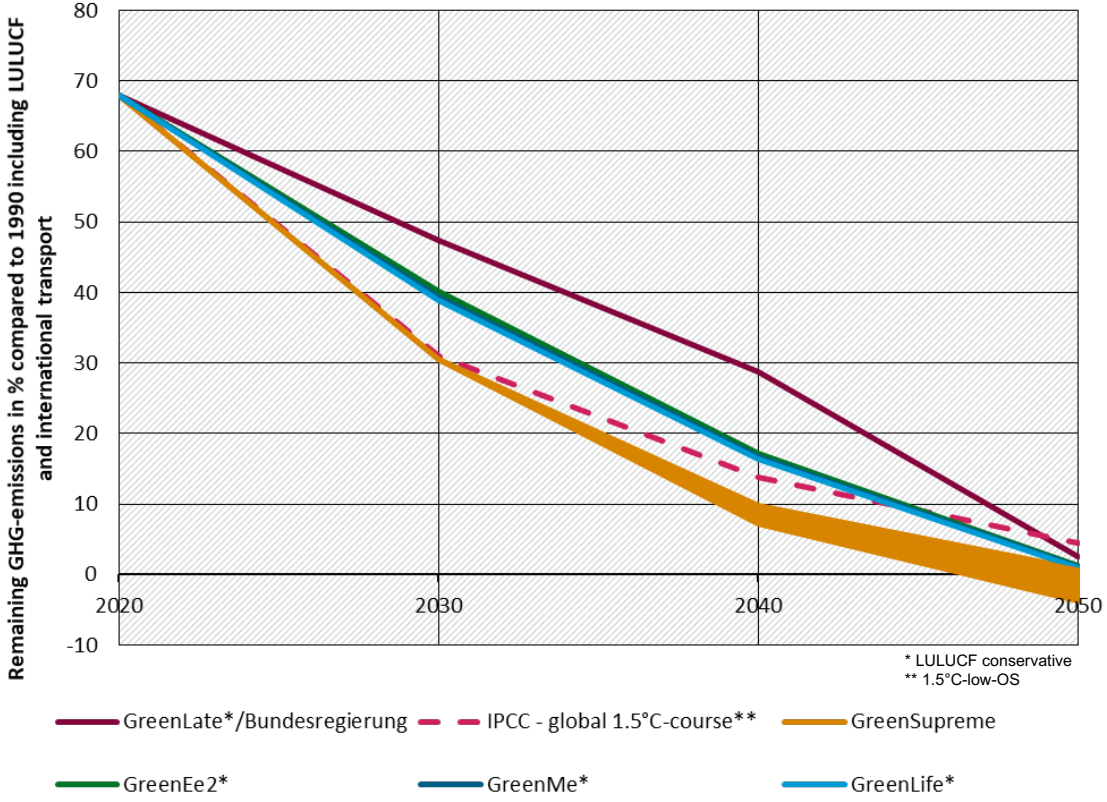






CLIMATE PROTECTION

Pathways to Greenhouse Gas Neutrality in the global context



Additional GHG mitigation measures beyond Germany

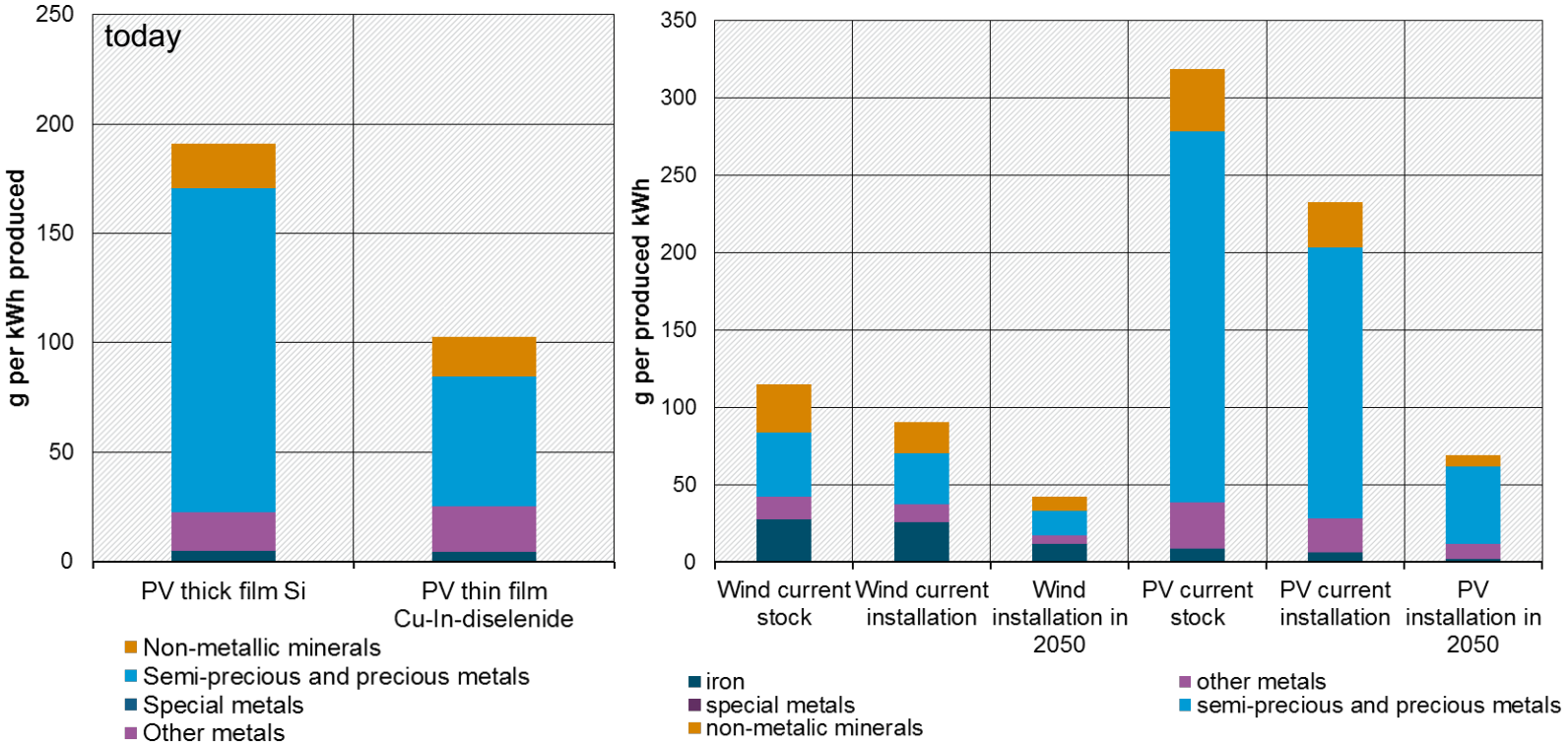
- **Only <u>GreenSupreme</u>, represents a nearly compatible transformation path.**

MATERIALS

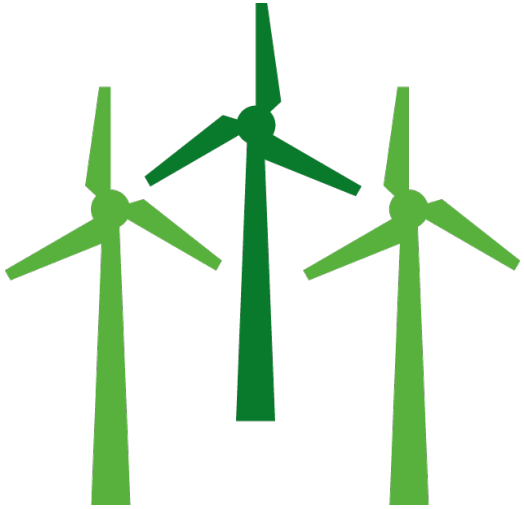
ENERGY

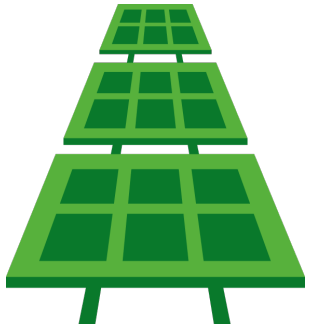
RESCUE – Interaction of renewable energies and raw materials

- The temporary additional demand for raw materials can be reduced by a technology mix and corresponding technological developments for substitution and avoidance.



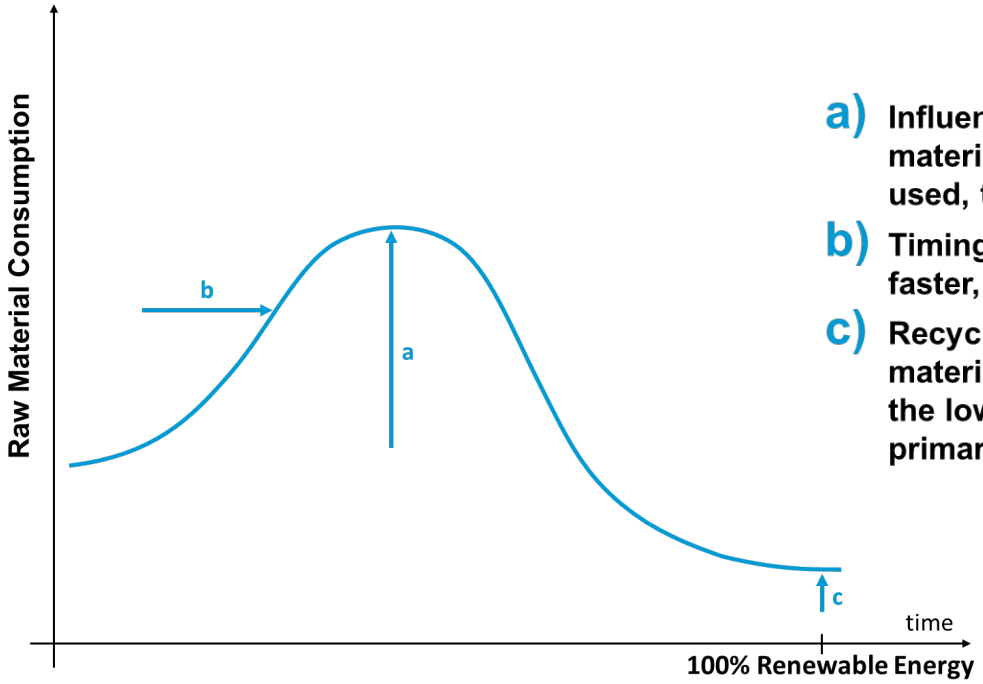
Source: Wiesen et al (2017). Analyse des Rohstoffaufwands der Energieinfrastruktur in Deutschland. Sachverständigengutachten für das Umweltbundesamt





GLOBAL OUTLOOK ENERGY-SYSTEM

RESCUE – Interaction between Material Needs and REN

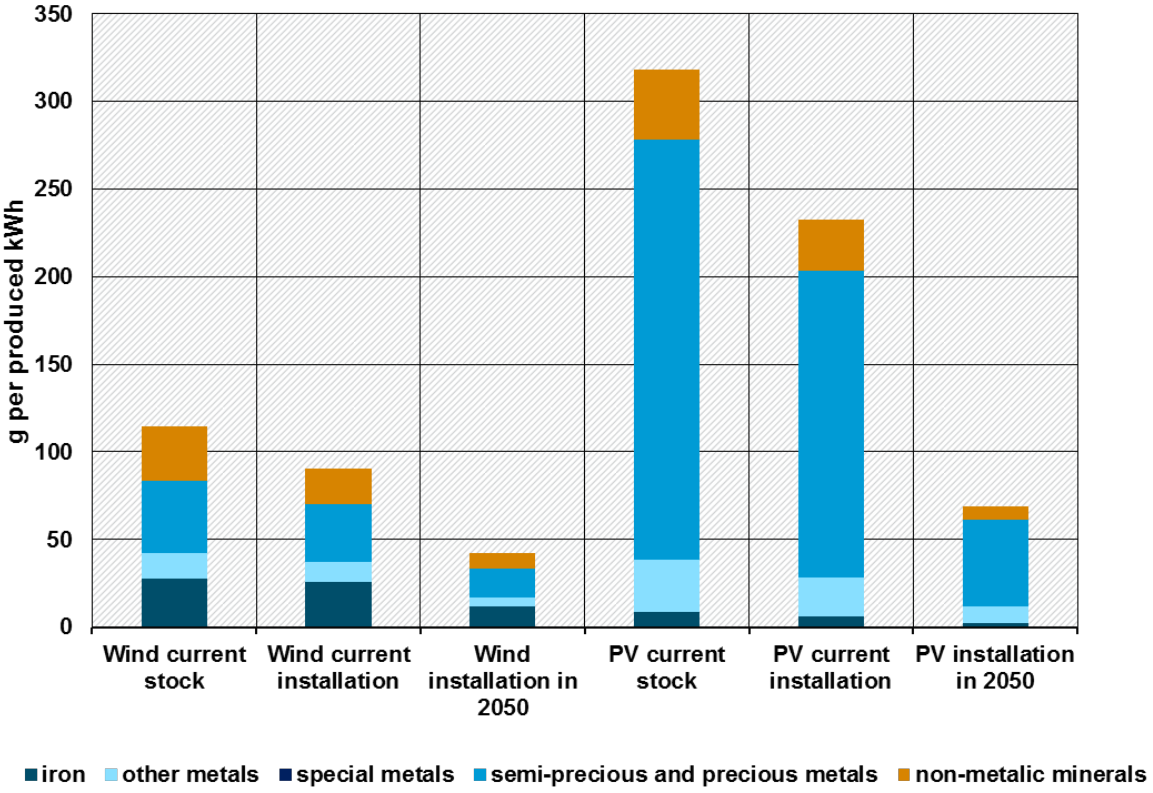


a) **Influenced by efficiency (energy and material) – the more efficiently material is used, the lower the curve**

b) **Timing & speed of RE integration – the faster, the steeper the curve**

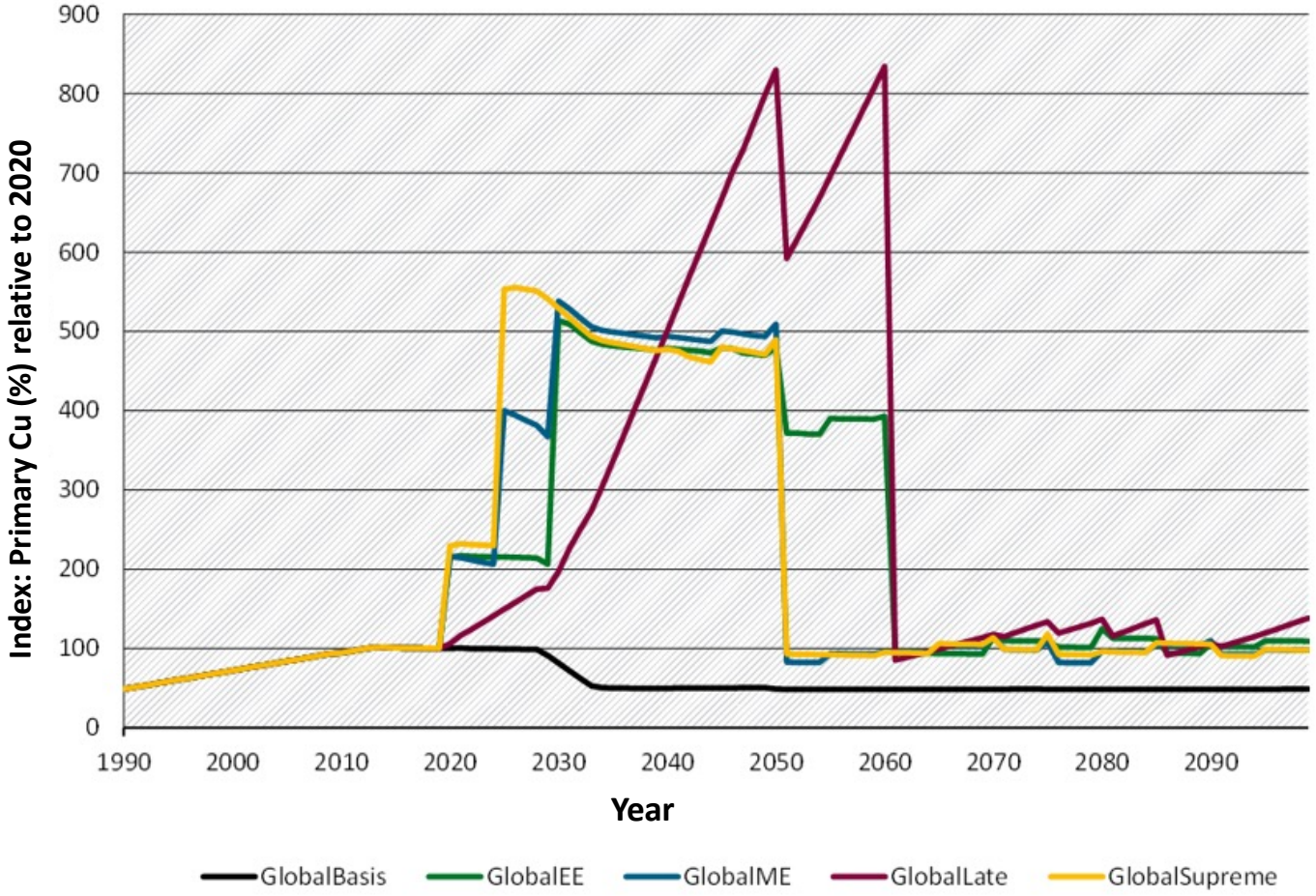
c) **Recycling or saving of primary raw materials – the higher the recycling rate, the lower the permanent extraction of primary raw materials**

Choice of technology effects raw material demand II



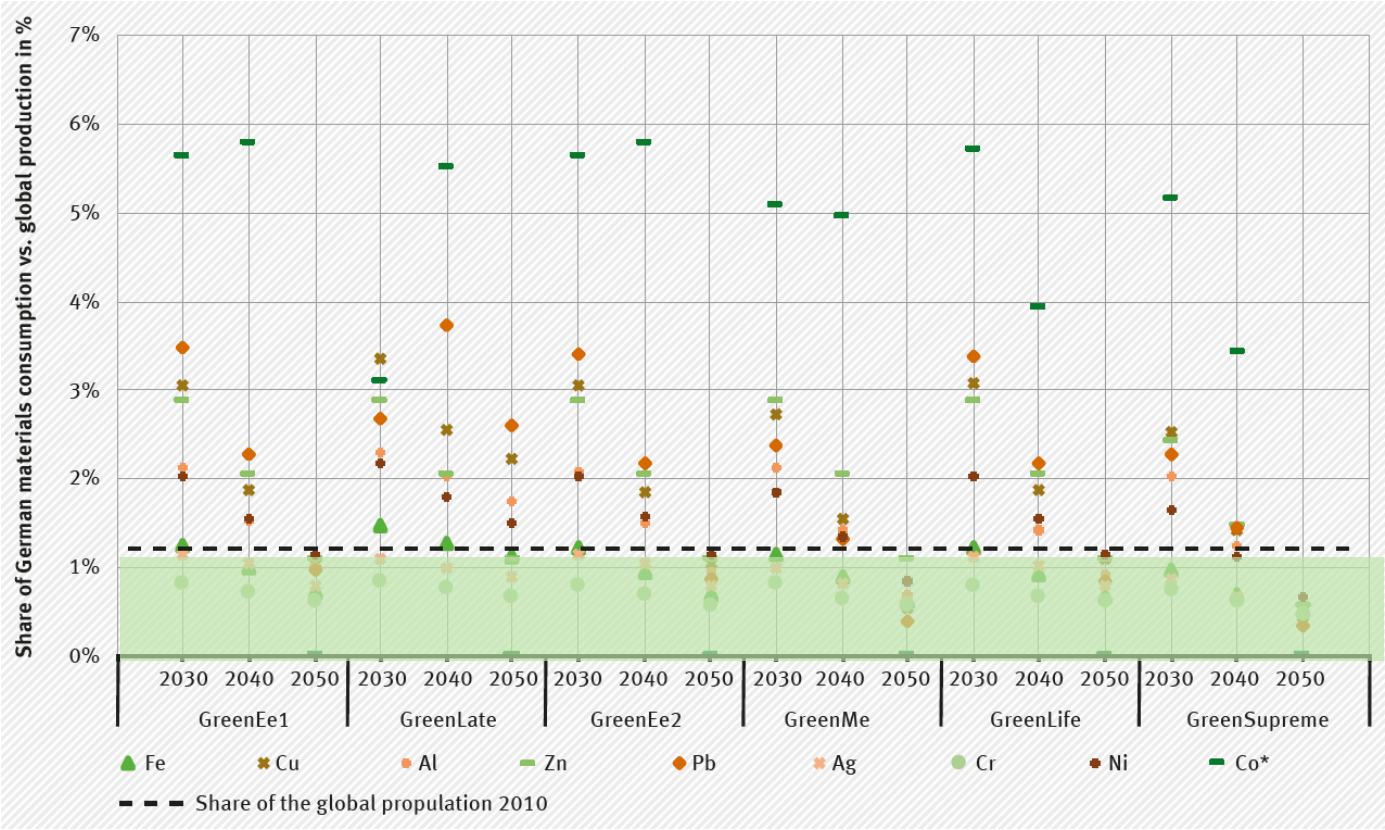
Source: Wiesen et al (2017). Analyse des Rohstoffaufwands der Energieinfrastruktur in Deutschland. Sachverständigengutachten für das Umweltbundesamt

Global copper (Cu) demand for the renewable energy system



RESCUE – Resource-Efficient Pathways towards Greenhouse-Gas-Neutrality

Final demand of selected raw materials as a share of global prim. Production in 2015/16 to reach GHG Neutrality



* Estimate only for batteries used in transportation.

** Germany's population in 2010 was 81.75 million people and the global population equaled 6.96 billion people (81.75 million people / 6.96 billion people = 1.17 %).

Note: Global production estimates were taken from USGS for the latest year available. For chromium, the production data from chromite was used and a metal content of 30 % assumed.

RESCUE – Resource-Efficient Pathways towards Greenhouse-Gas-Neutrality

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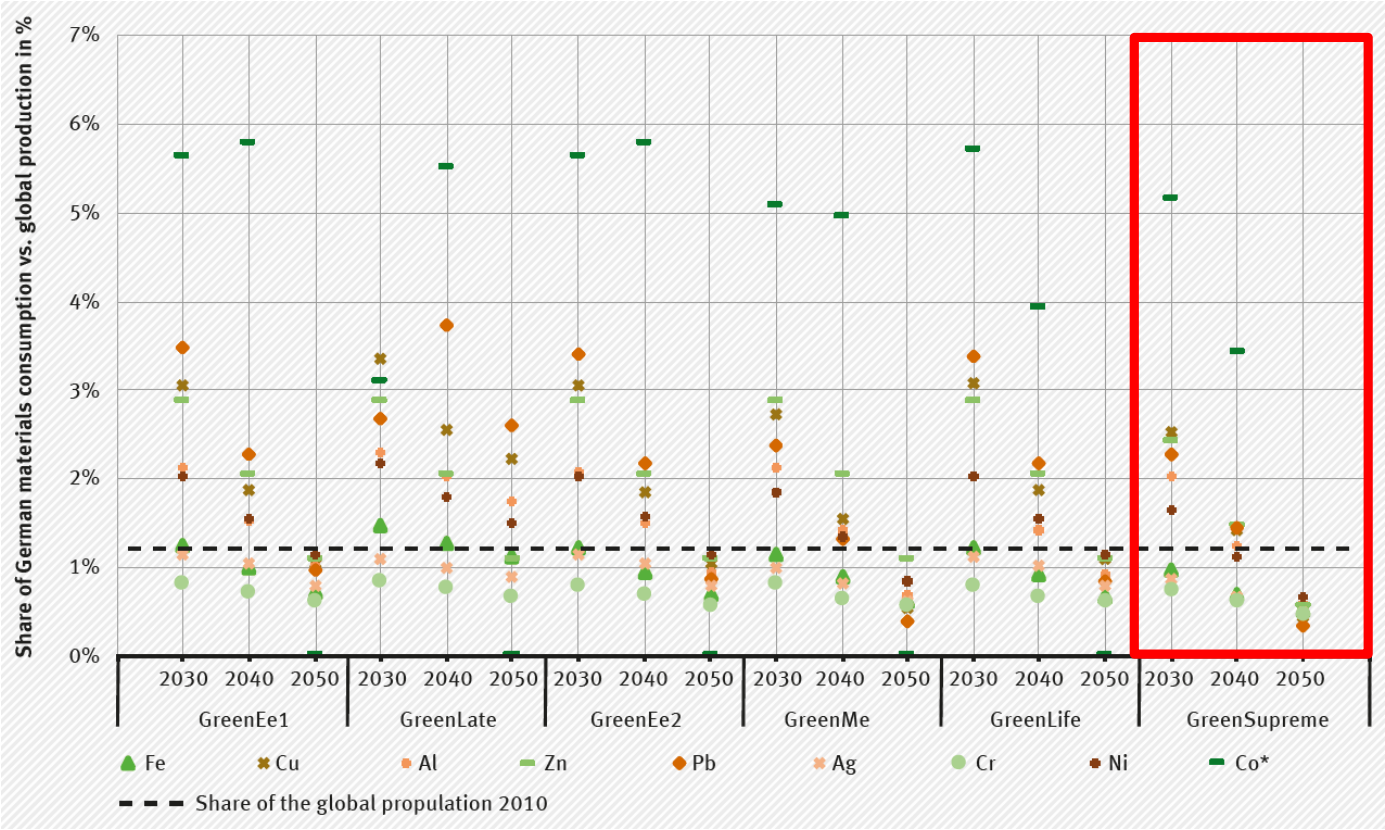

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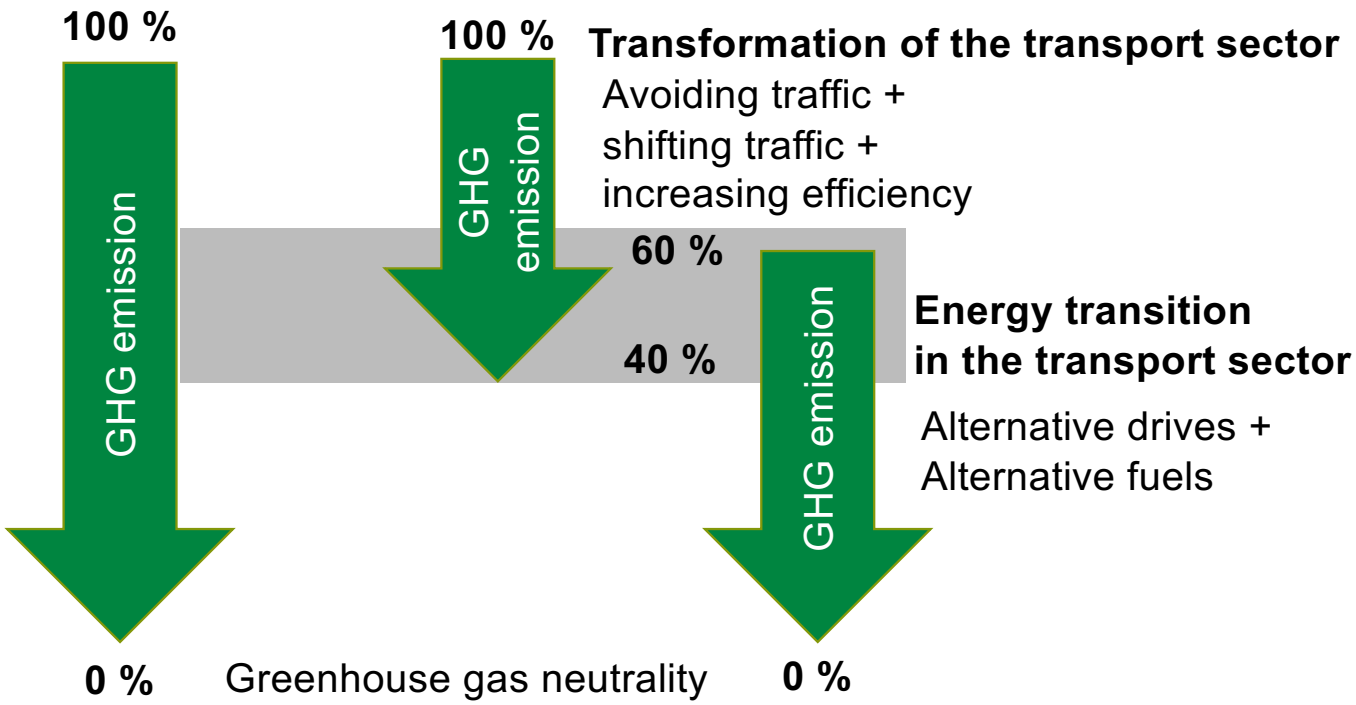
Lessons ?

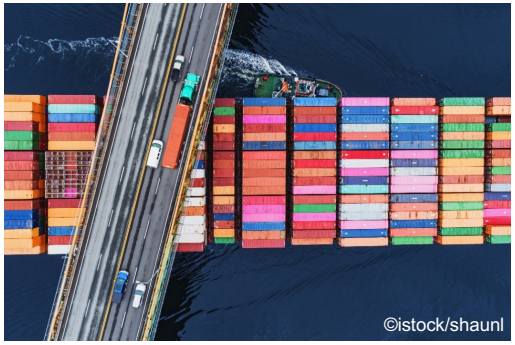
Our mission

- Knowledge platform, initiator and contact for industry, politics and science
- Market ramp up of PtX and deployment in aviation, shipping and chemical industry → green-hydrogen-based fuels (e-kerosene, e-methanol, …)
- Investigation of environmentally compatible and sustainable production and use of climate-neutral PtX products
- Economic and legal framework conditions for a successful and rapid market introduction
- Focus on the entire value chain of the relevant technologies and sectors and their integration into the circular economy
- Construction and operation of a PtL demonstration plant in Lusatia

Why aviation and maritime transport?

Global GHG emission: **2.8 % international aviation (+ non-CO_2 effects)**
2.9 % international maritime transport

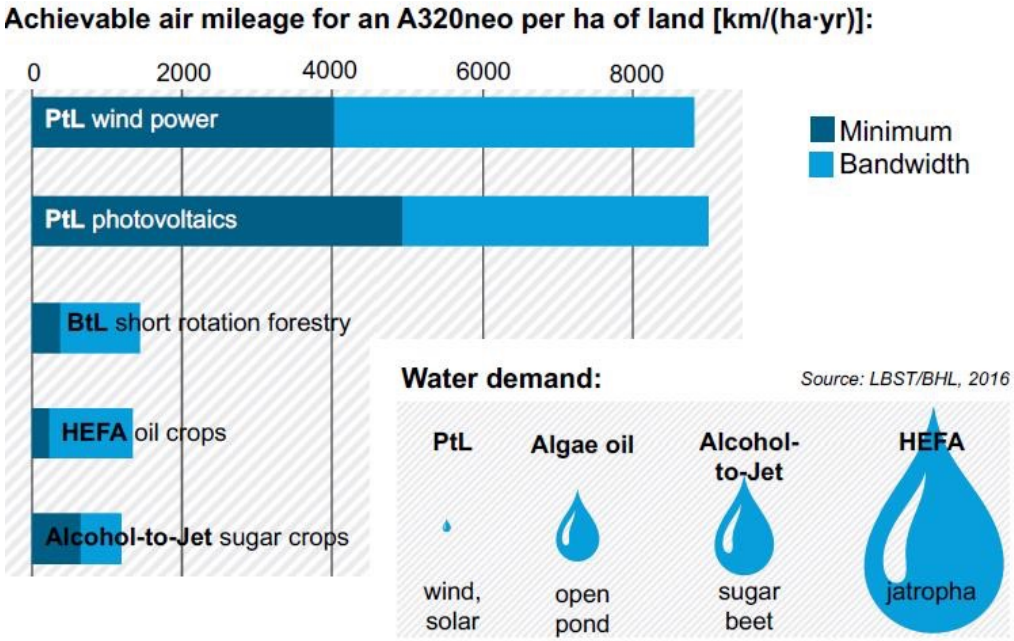


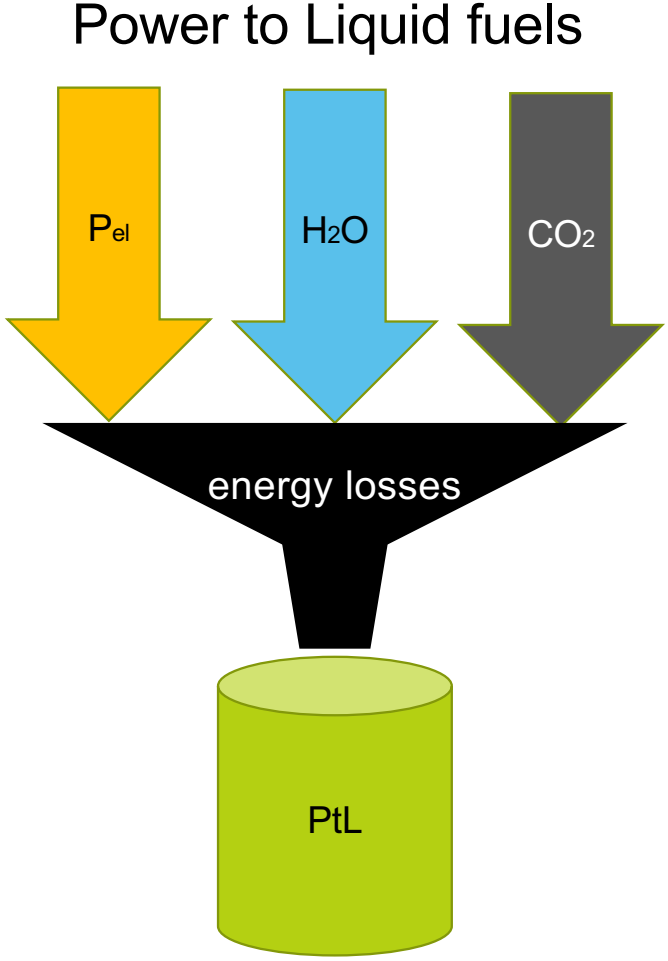


BtL – PtL – Synthetic Fuels – Priorities

- Biomass to Liquid →Land intensive
  + high water demand

- Power to Liquid → Energy intensive

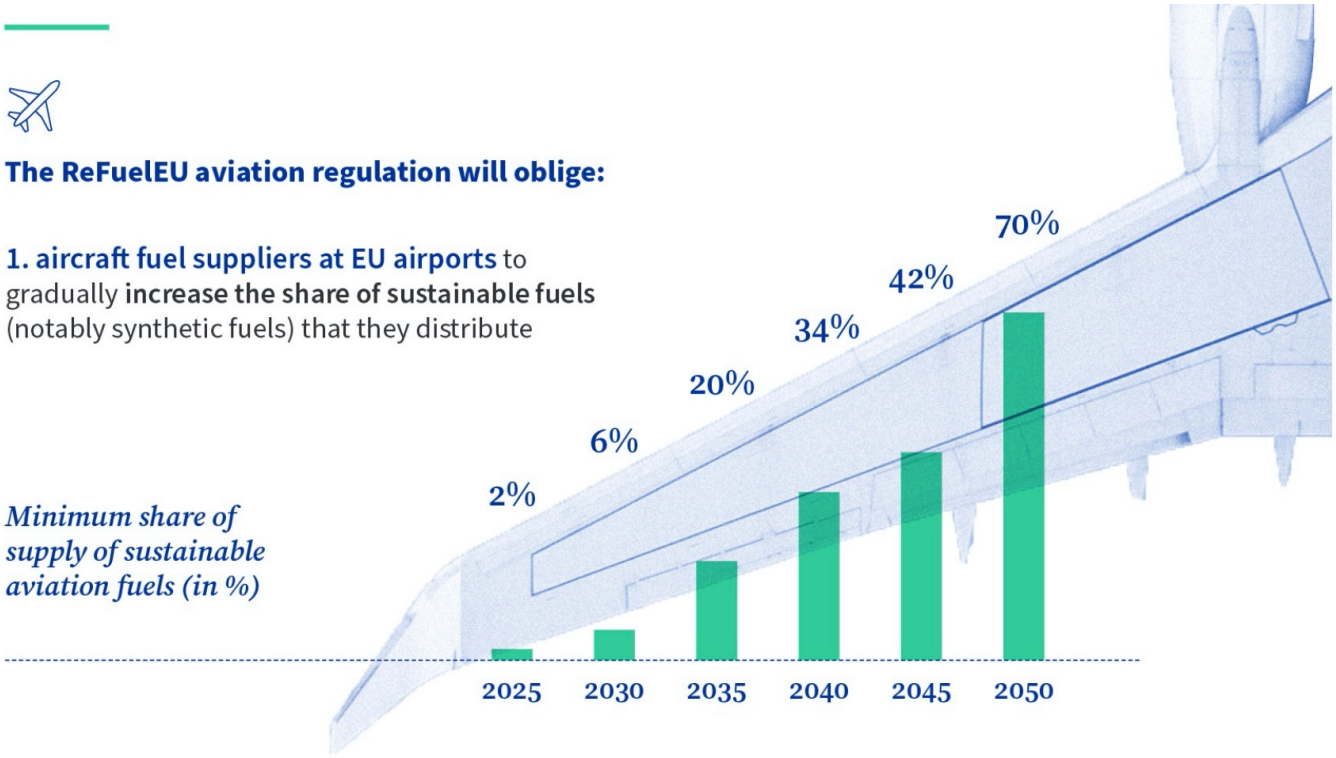




ReFuel EU

The ReFuelEU aviation regulation will oblige:

1. aircraft fuel suppliers at EU airports to gradually **increase the share of sustainable fuels** (notably synthetic fuels) that they distribute

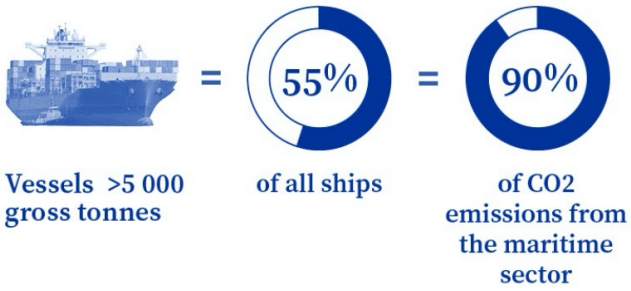


Source – EU https://www.consilium.europa.eu/en/infographics

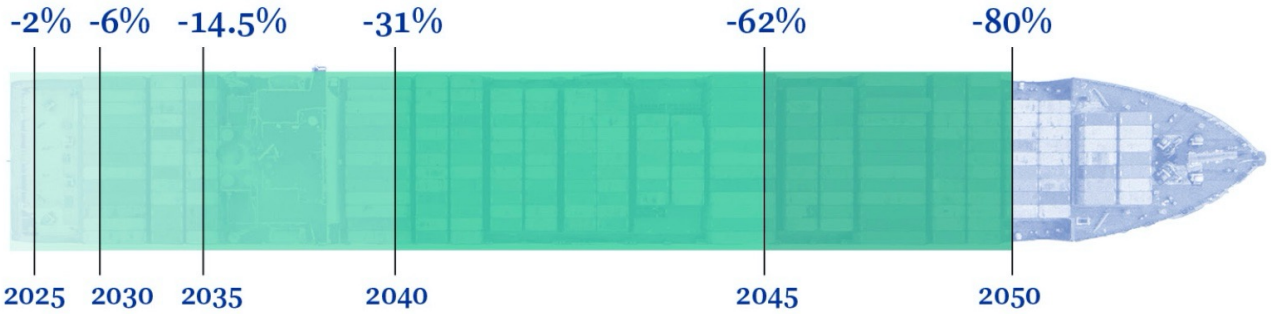
ReFuel EU Martime

The FuelEU maritime regulation will oblige vessels above 5000 gross tonnes calling at European ports (with exceptions such as fishing ships):

→ to **reduce** the **greenhouse gas intensity** of the energy used on board as follows



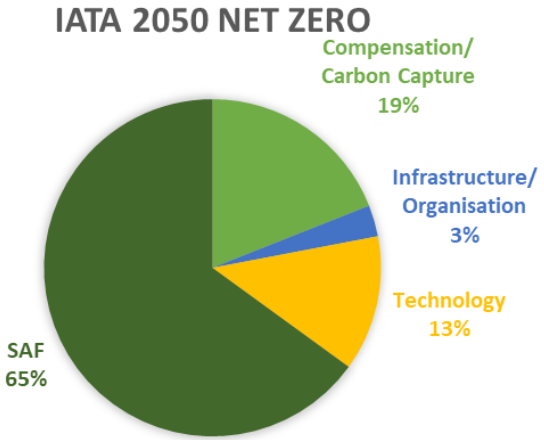
Annual average carbon intensity reduction compared to the average in 2020

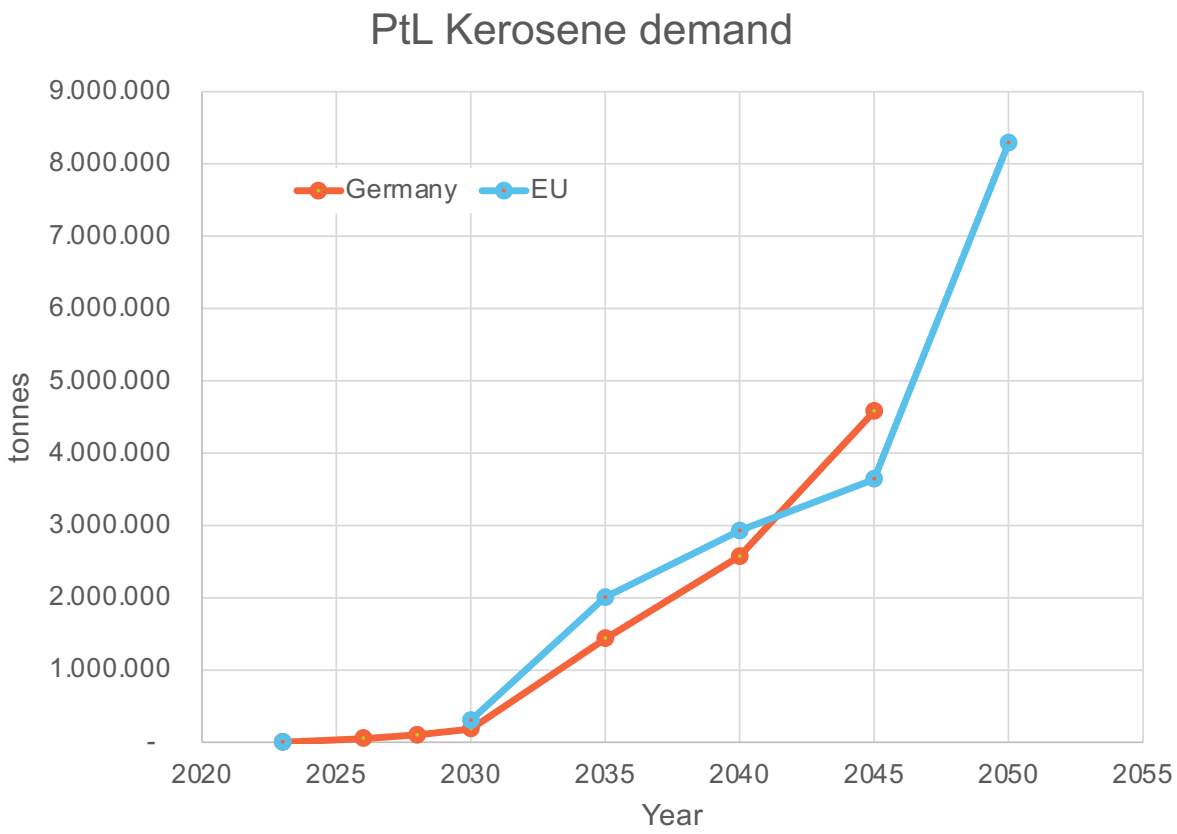


Source – EU https://www.consilium.europa.eu/en/infographics

Projected PtL Kerosene Demand

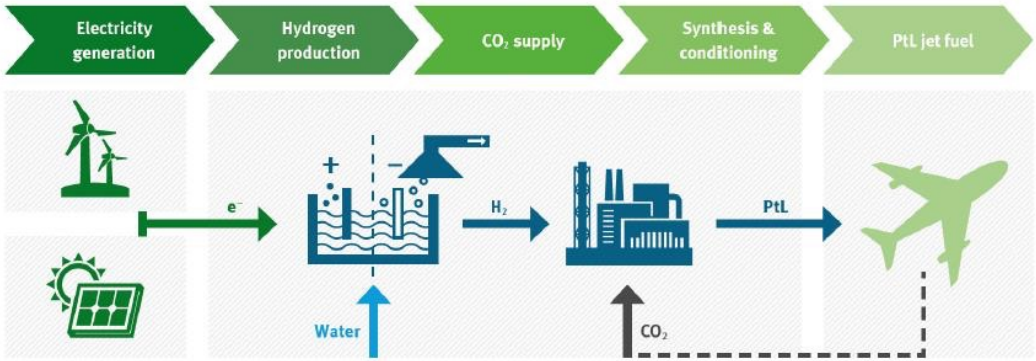
- Planning and construction time of 2 to 5 years
- **We need to start building production capacity now!**





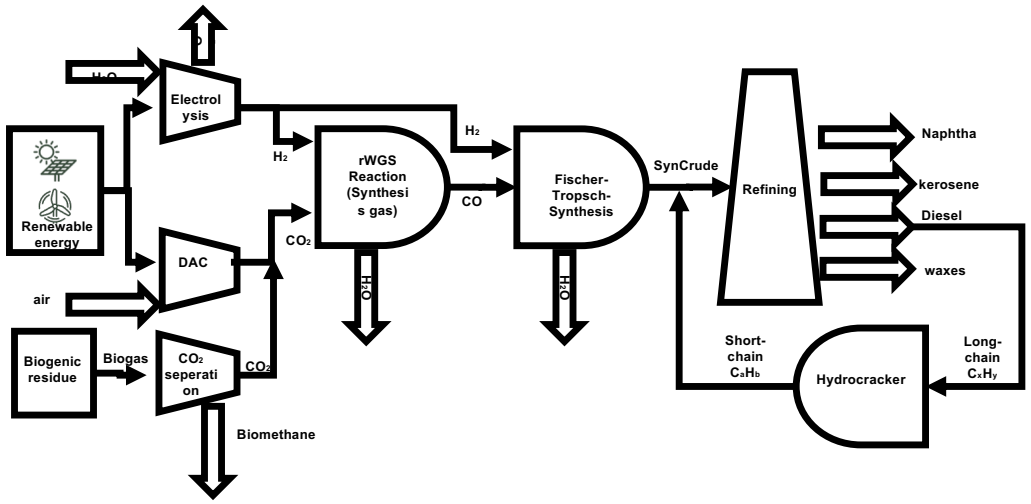
PtL demonstration plant in Lusatia

- **Sustainable** production of PtL kerosene close to an industrial scale.
- Production target: 10,000 t/a (kerosene)
- Green hydrogen: approx. 9,000 t/a
- Closed CO_2 cycle: approx. 66,000 t/a
- Energy-efficient and flexible operation
- All individual processes are available
  → **now it is a question of combining all the processes and realize it.**



- **Aim of this study:**
  - Identification of suitable sites in Lusatia for a PtL demonstration plant.
  - Qualified site recommendation as starting point for further planning

Source: UBA and LBST/BHL, 2016

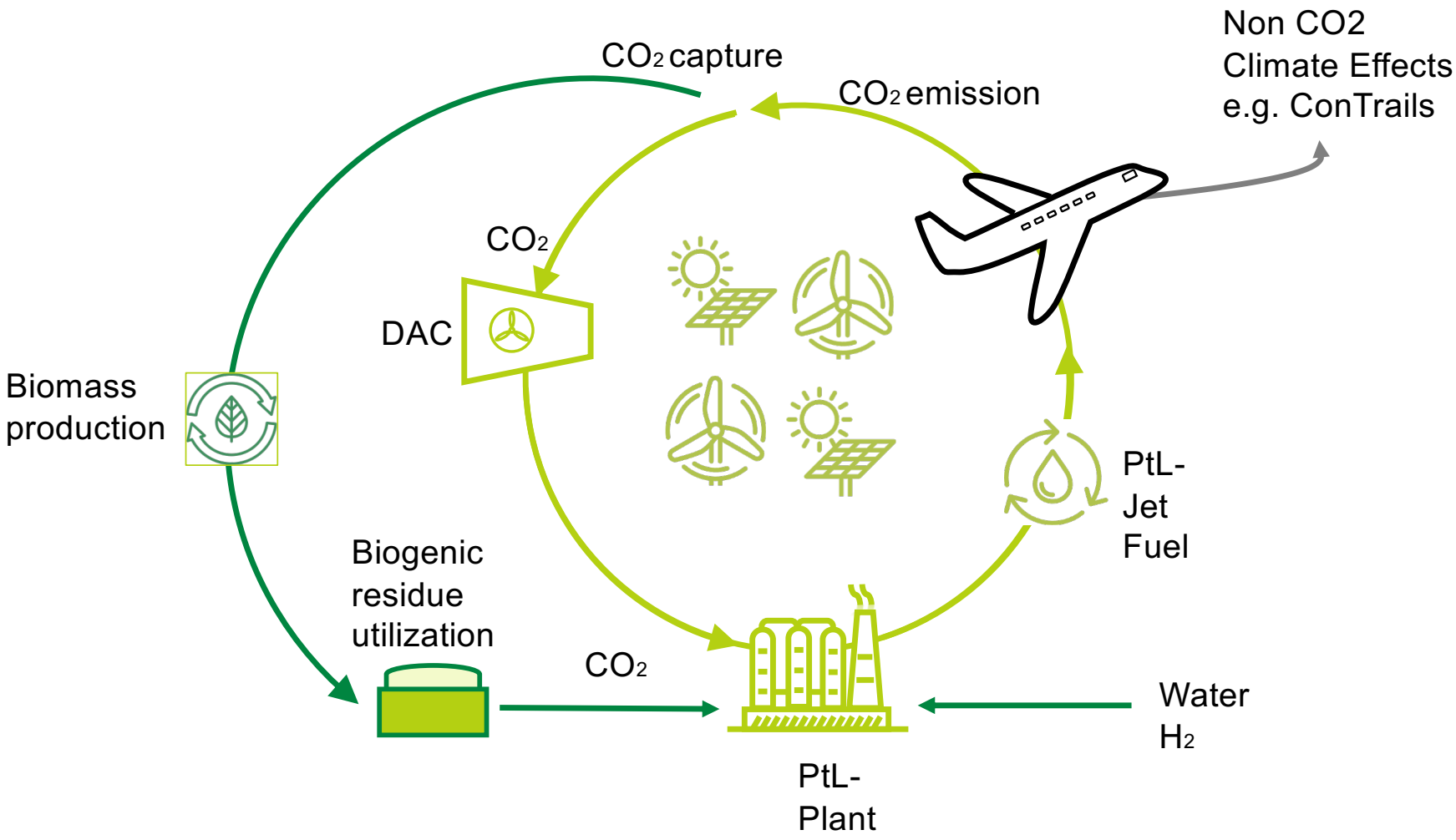


Sustanability - Smart Indicators -> certification

Dimension / Criterion
▪ *CO_2-Source*
▪ GHG Mitigation
▪ *Resource efficiency*
▪ Availability of water
▪ Land use or change of land use
▪ *Social Standards*
▪ Requirements for electricity (renewability & additionality)

Criterion *CO_2-Source*	
▪ Direct Air Capture (DAC)	+
▪ Geothermal sources	o
▪ Biogenic CO_2 from residues (no factory farming)	o
▪ Biogenic CO_2 from biogas from factory farming	-
▪ Biogenic CO_2 from biogas or bioethanol from crops	-
▪ CO_2 from other industrial sources	-

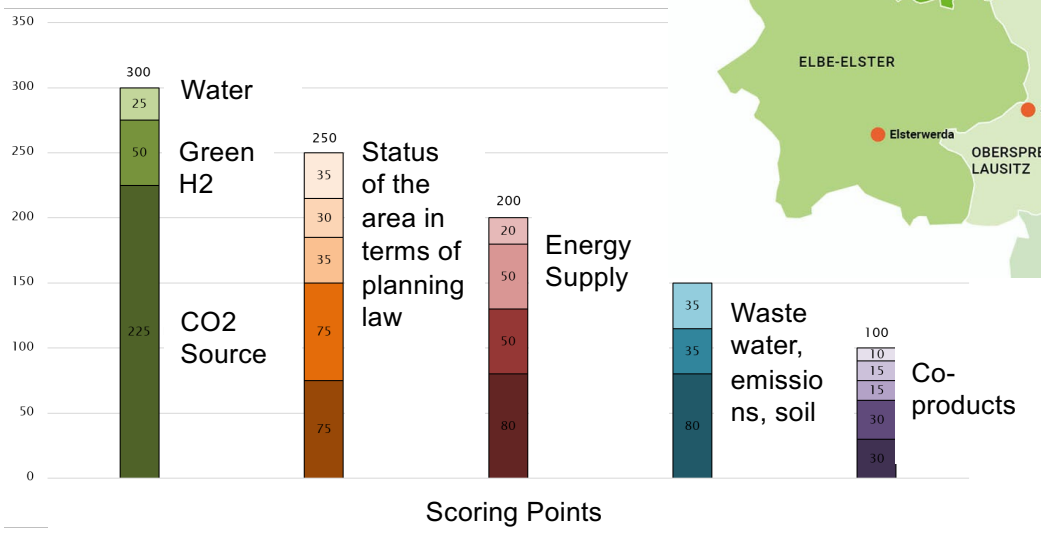
Sustainability – E.G. Closed CO2 cycle



Quelle: istock/Peacefully7

Project Status Demonstrator

1. Study to find suitable locations (done)
   - Special look to the CO_2 source
2. Feasibility Study (in progress)
   - Evaluation of 3 particular suitable sites
   - Evaluation of possibilities for H_2 production and CO_2 availability
   - Compliance with sustainability criteria
3. Basic Engineering
4. Detail Engineering
5. Plant Construction
6. PtL delivery

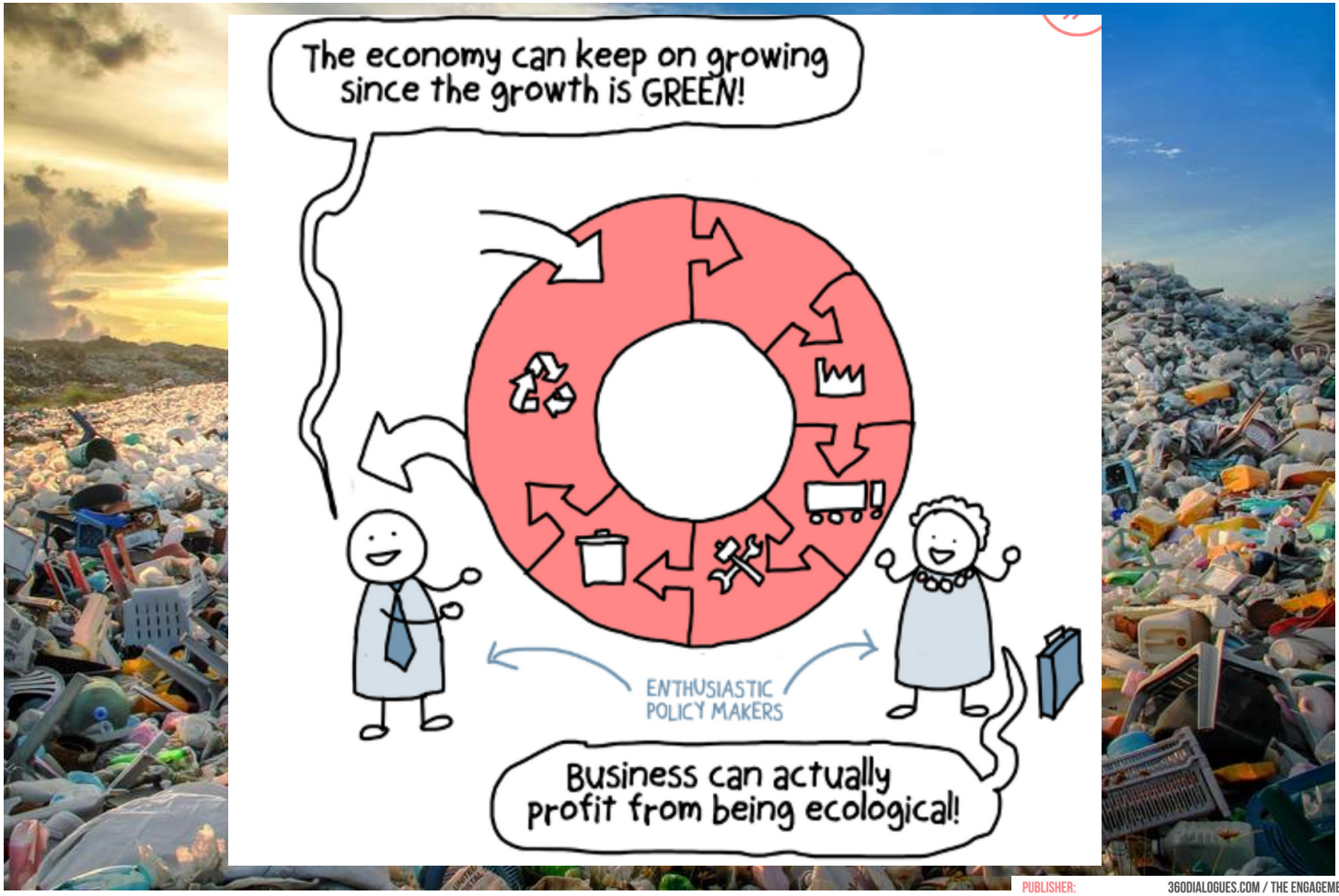


Lessons ?

Factor X

Quellen : retail.be, dreamstime.co , kaffeepads

Factor Circularity ??



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Lifestyles... wellbeing

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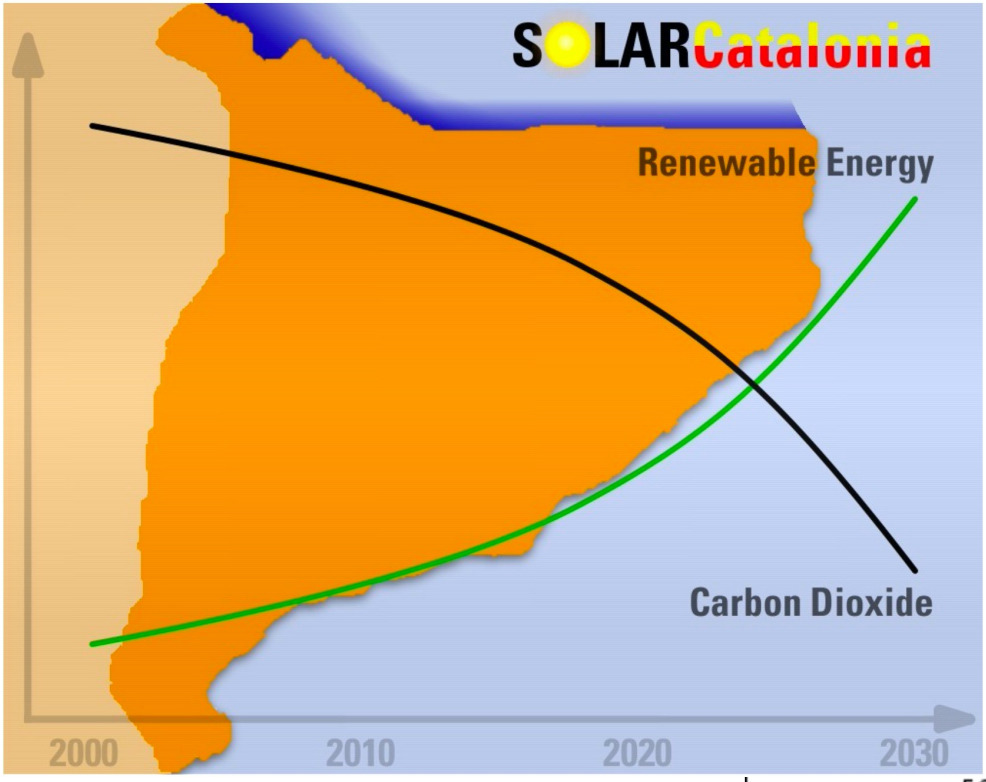
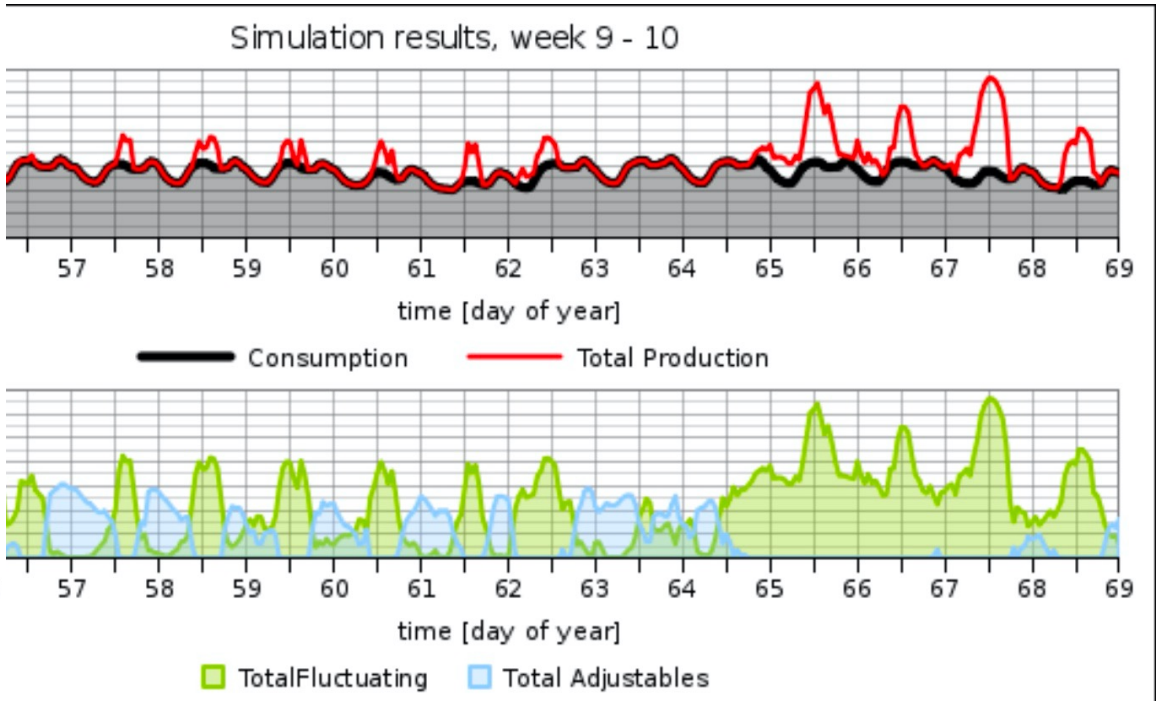
Solar Catalunia – move on !!!

A Pathway to a 100% Renewable Energy System for Catalonia





Conclusions

- **Sufficiency – Efficiency – Substitution – Redesign – Reuse – Circularity**

► ***Substitution***: Replacing greenhouse gas- and resource-intensive technologies and products with greenhouse gas-neutral or greenhouse gas- and resource-poor alternatives.
► ***Avoidance***: Reduced consumption of products and activities through efficiency , sufficiency and consistency, leading to low greenhouse gas emissions, low primary raw material consumption and resource consumption.
► ***Carbon sinks***: The removal of CO2 already emitted from the atmosphere by carbon sinks (CDRs) to reduce greenhouse gases.

Next to material efficiency approaches, changes to our consumer behavior are important in reducing the overall consumption of primary raw materials

The earlier we act, the more leeway we have.

Thank you very much for your attention

Dr. Harry Lehmann

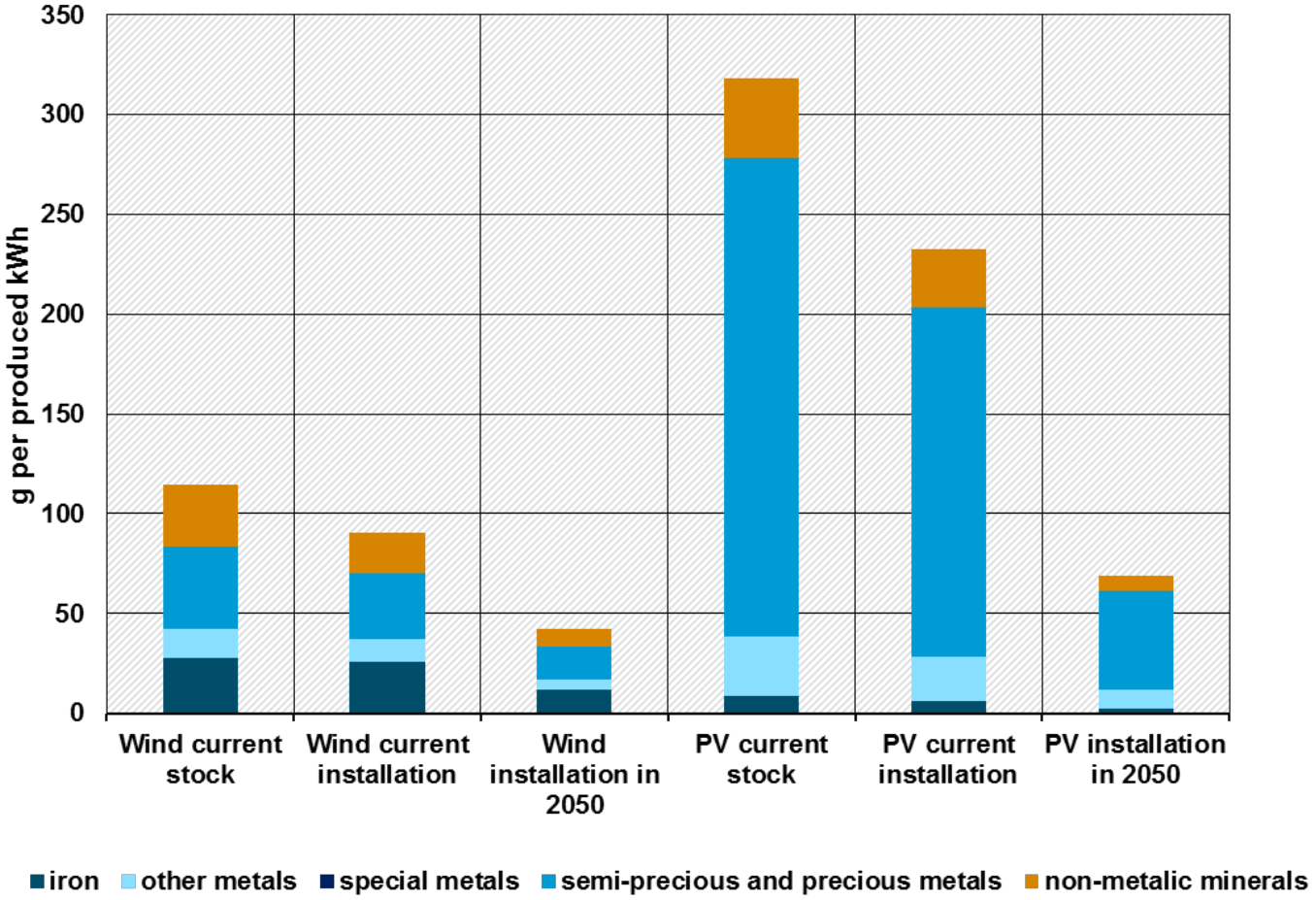
Cottbus – 26.10.2023

www.ptxlablausitz.de

PTX_LAB@z-u-g.org

PtXLab LAUSITZ

Study of Ressources and crit. Krit. Materials needed



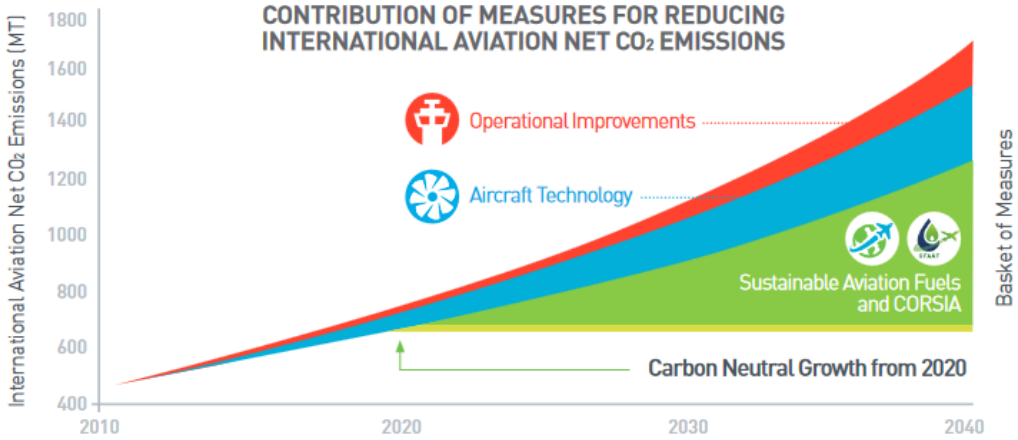
Source: Wiesen et al (2017). Analyse des Rohstoffaufwands der Energieinfrastruktur in Deutschland. Sachverständigengutachten für das Umweltbundesamt

Summary

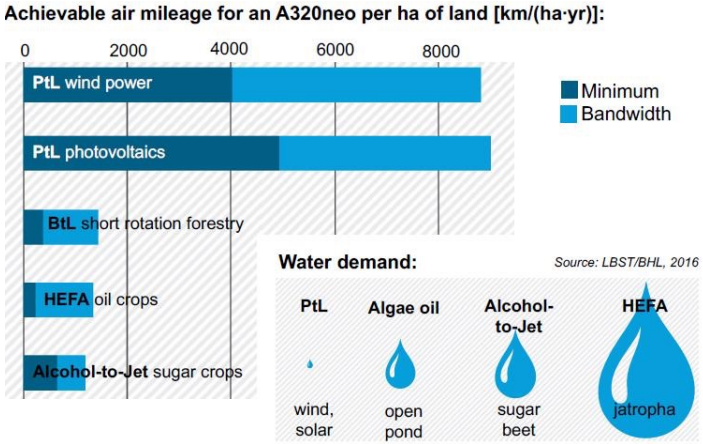
- Transformation and energy transition in the transport sector is necessary
- The use of PtL must be prioritized: if possible, direct electrification should be implemented
- In long-haul aviation (and maritime) transport, direct electrification is not feasible in the near future
- A fast ramp up of PtL production is necessary to substitude fossil fuels
  → renewable energies are needed!
- Production of Power to Liquids (and SAF in general) has to be realized in a sustainable way
  - Hydrogen must be green
  - CO2 cycle must be closed
  - Social Standards must be covered
  - Ressources efficiency
  - Land use and change
  - Water availability
  - GHG emissions …

Focus on PtL-Kerosene

- International aviation is responsible for 2.8 per cent of global greenhouse gas emissions
- Alternative aviation propulsion systems are not expected to become widespread until after 2040
- PtL are energy-intensive and should only be used where direct electrification is not possible



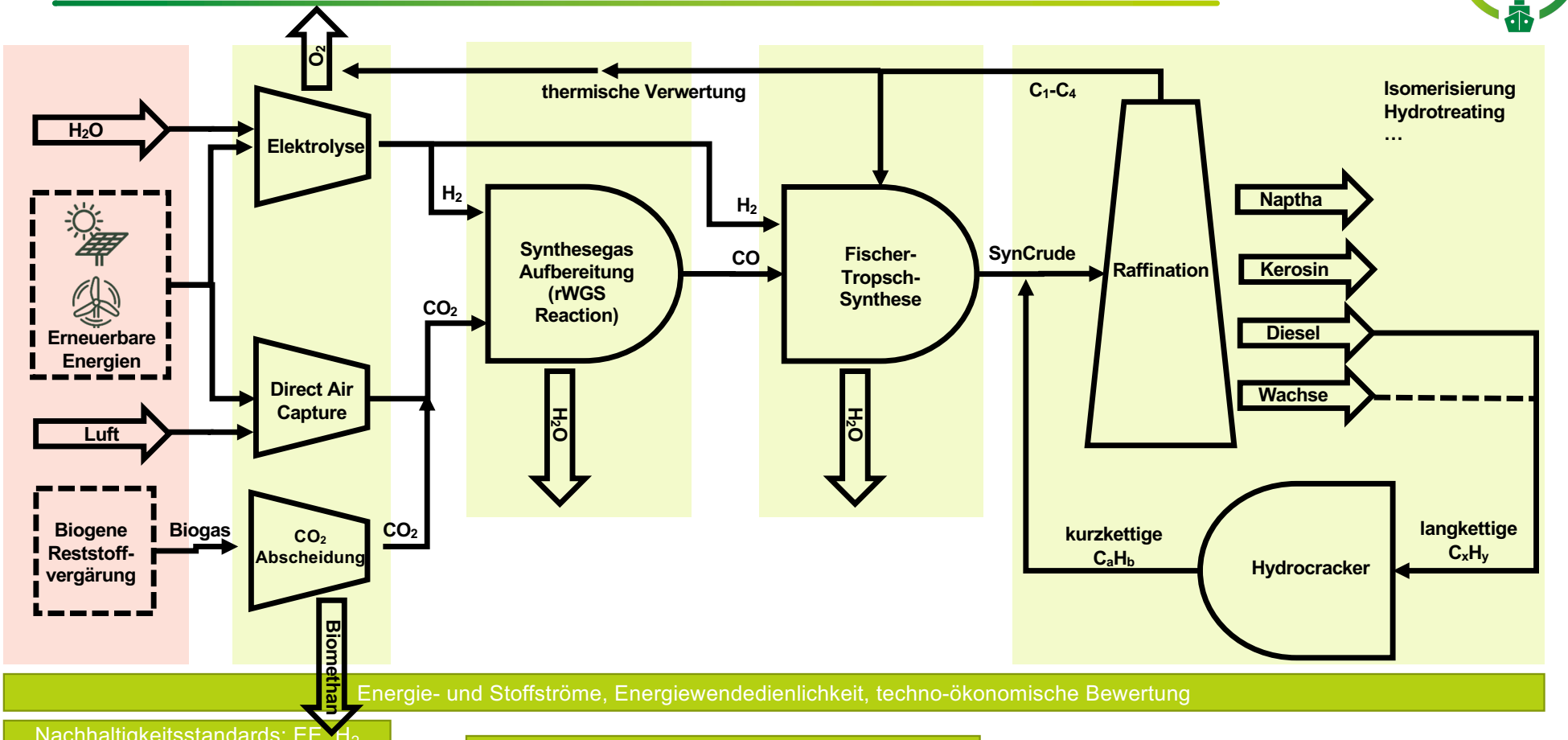
https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA%20Brochure/CorsiaBrochure_ENG-Mar2019_Web.pdf



Structural Strengthening Act

- Implements the structural policy recommendations of the "Growth, Structural Change and Employment" Commission
- Defines the Lusatian mining area at the district level:
  Dahme-Spreewald, Spree-Neiße, Oberspreewald-Lausitz, Elbe-Elster, Görlitz, Bautzen and the city of Cottbus.
- PtX Lab Lausitz and the PtL demonstration plant are anchored in the Structural Strengthening Act for Coal Regions
- PtX Lab Lausitz realises the planning, construction and operation of the PtL demonstration plant in Lausitz)

Ziel: Prozesskonfiguration Fischer-Tropsch-Route



Energie- und Stoffströme, Energiewendedienlichkeit, techno-ökonomische Bewertung

Nachhaltigkeitsstandards: EE, H_2 Quelle, Gasaufbereitung → DAC, Biogene CO_2 Quelle

Synthesegaszusammensetzung

AEL/PEM Co-Elektrolyse, rWGS ?

Kerosinausbeuteoptimierung: Katalysator, Reaktor, Produktaufbereitung, Rezirkulierung, … → 10.000 t/a synth. Kerosin

Summary

- Transformation and energy transition in the transport sector is necessary
- The use of PtL must be prioritized: if possible, direct electrification should be implemented
- In long-haul aviation and maritime transport, direct electrification is not feasible in the near future
- A fast ramp up of PtL production is necessary to substitude fossil fuels → renewable energies are needed!
- Production of Power to Liquids has to be realized in a sustainable way (green hydrogen, closed CO2 cycle)

Sustainability criteria for PtL for aviation

Dimension / Criterion
CO_2 Source
GHG Mitigation
Resource efficiency
Availability of water
Land use or change of land use
Social Standards
Requirements for electricity (renewability & **additionality**)