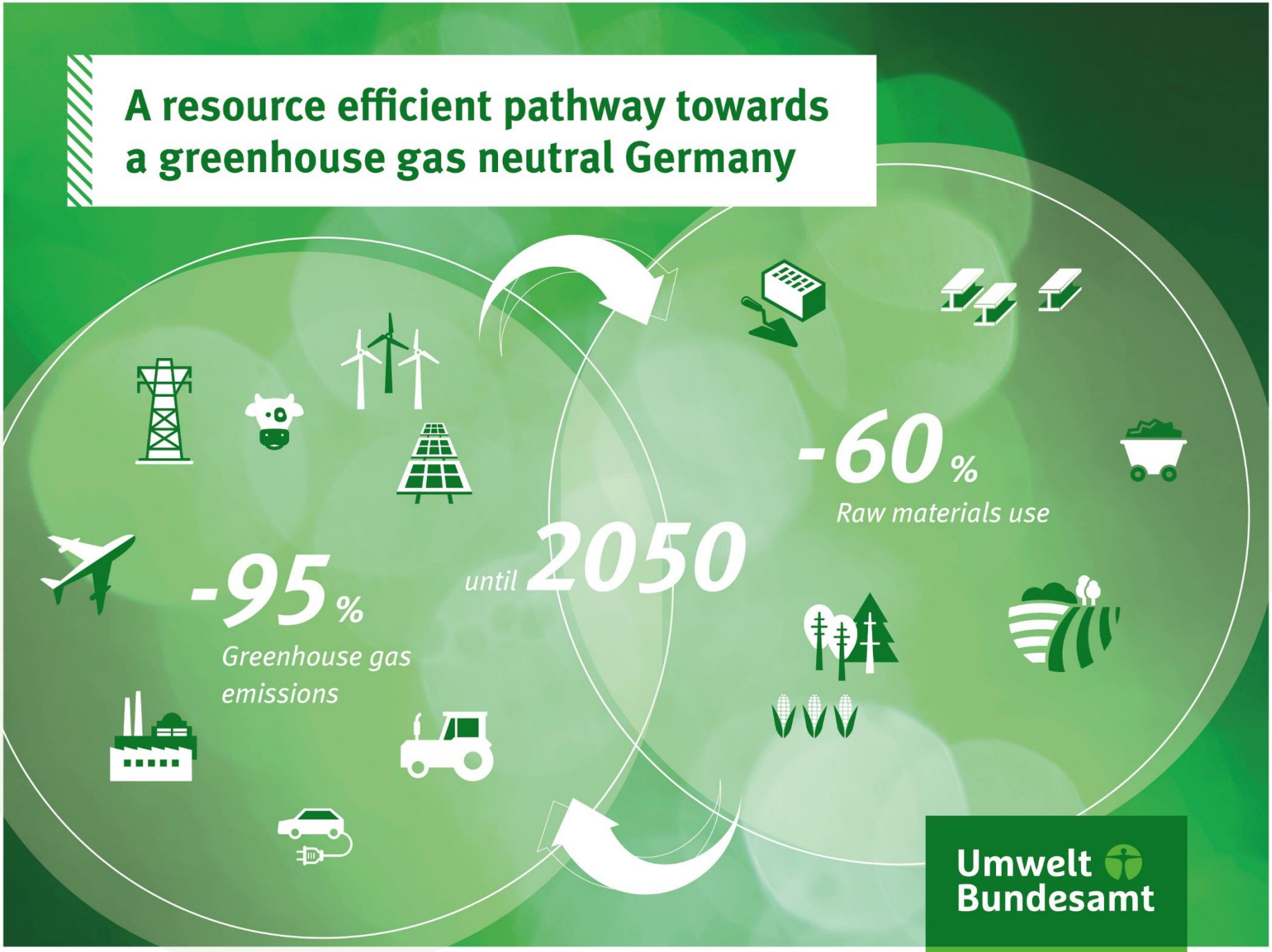
A resource efficient pathway towards a greenhouse gas neutral Germany



German Environment Agency

Umwelt Bundesamt

Decarbonisation - 100 % Renewable Energy and more

Designing a resource efficient pathway towards a greenhouse gas neutral Germany

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What to expect?

1 INTRODUCTION

1.1 UBA scenario Greenhouse gas neutral Germany in 2050

1.2 Going forward – designing the pathway

2 „THE JOURNEY IS THE REWARD“

2.1 GreenEe - Scenario

2.2 Pathway

2.3 Raw materials demand

2.4 Think outside the box

3 CONCLUSION AND RECOMMENDATIONS FOR ACTION

Based on research projects edited by

ifeu INSTITUT FÜR ENERGIE- UND UMWELTFORSCHUNG HEIDELBERG

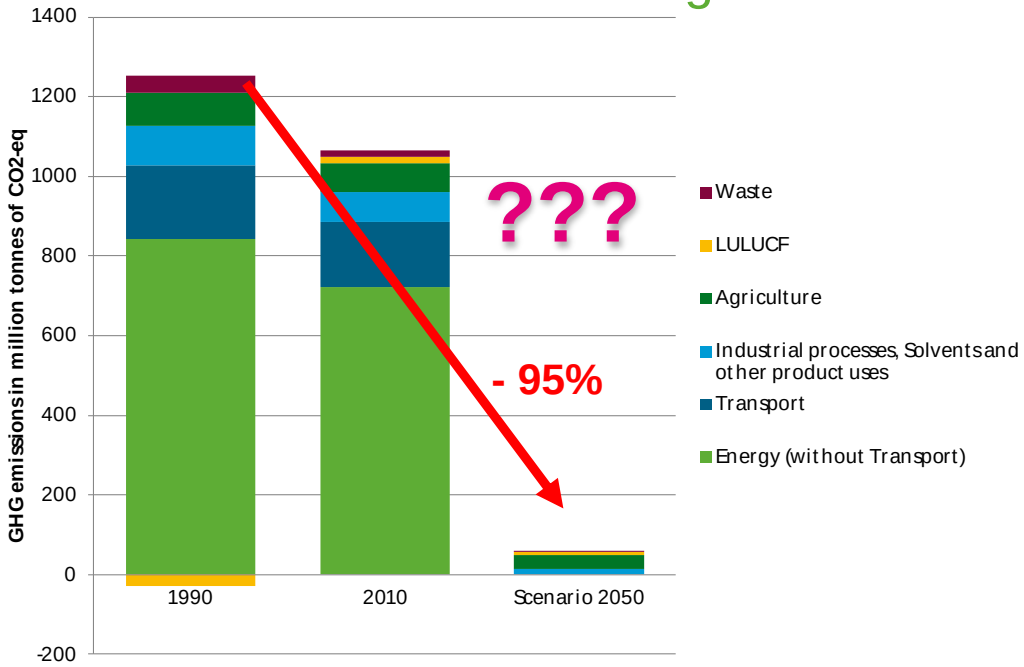
Fraunhofer IWES

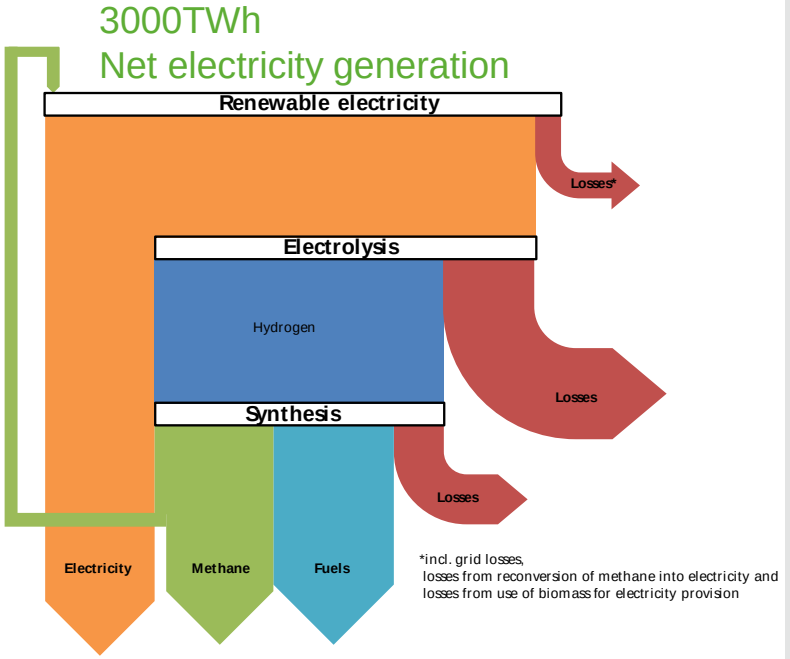
Umwelt Bundesamt

SSG Sustainable Solutions Germany-Consultants GmbH

CONSIDEO

UBA scenario Greenhouse gas neutral Germany in 2050

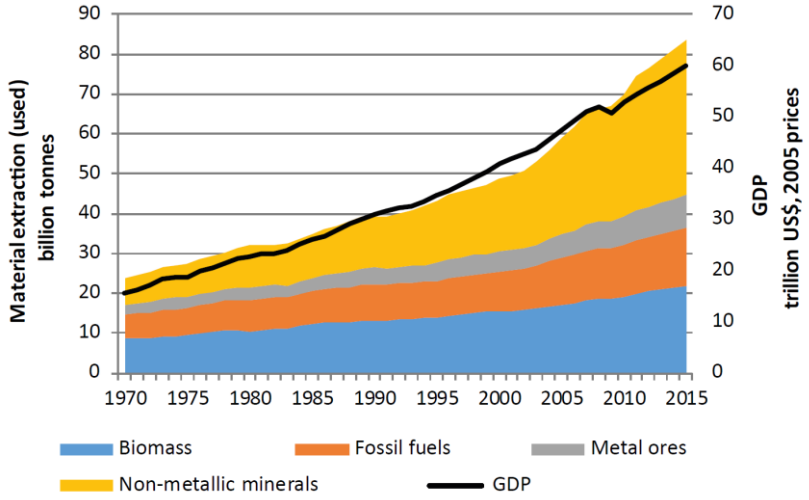




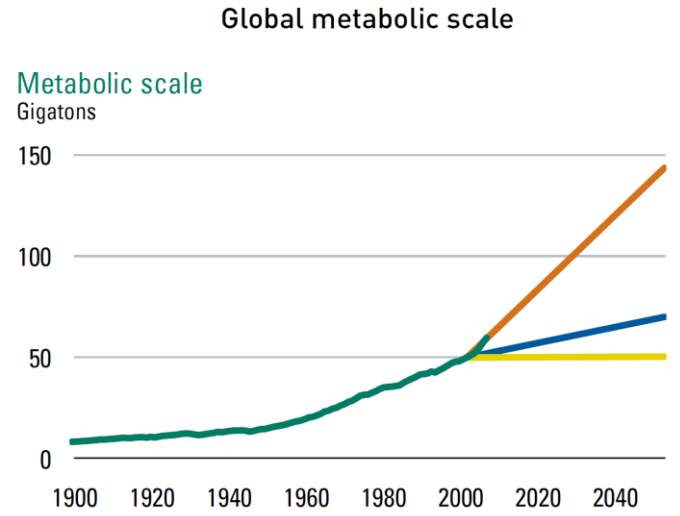
- It is technically possible to achieve a greenhouse-gas neutral Germany.
- looked at emissions arising within Germany, in line with the method for emissions reporting
- sustainable energy supply (without CCS, nuclear energy and no use of biomass crops for energy production) based completely on renewable energy

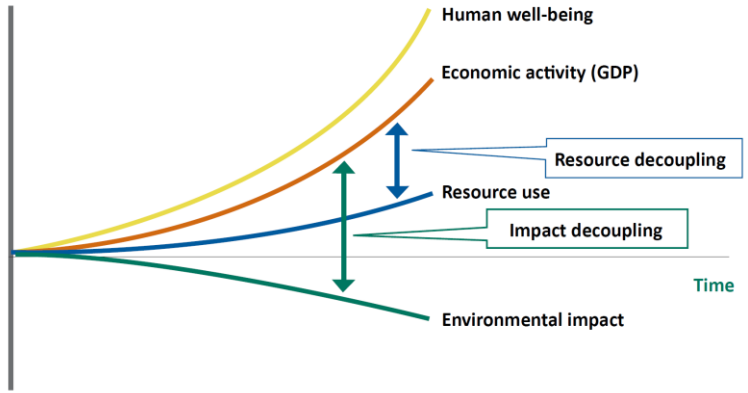
What are feasible and sustainable pathways to a greenhouse gas neutral Germany?

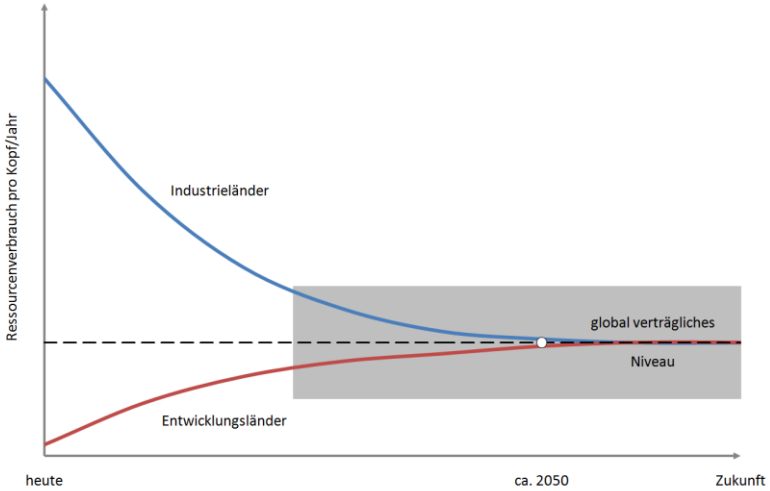
Resource policy: tasks and challenges



Source: Material extraction data from UNEP (2016a), GDP data from UNSD (2015).

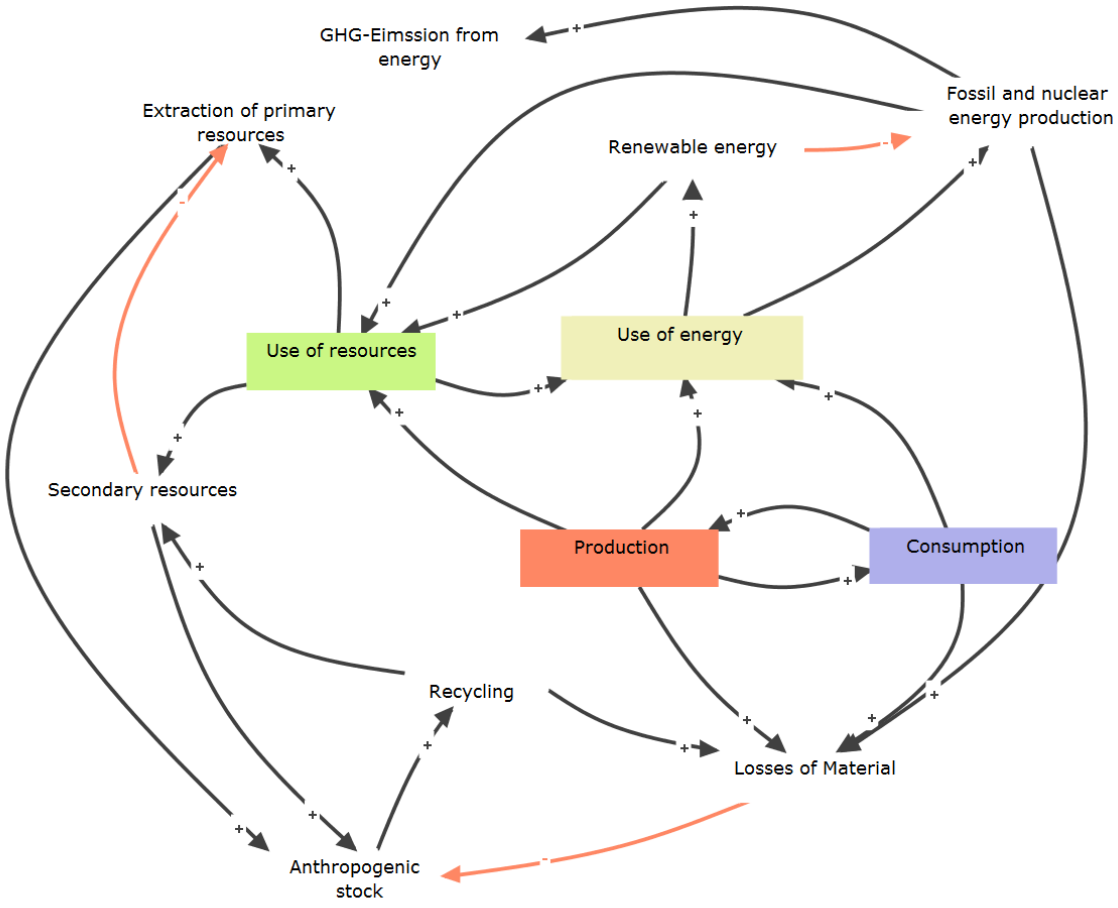






Sources: UNEP (2016): Resource efficiency: Potenztial and Economic Implications (top left); UNEP (2011): Decoupling natural resource use and environmental impacts from economic growth (top right, bottom left); Kora Kristof (bottom right)

Systematic interrelation between raw material use and climate protection



- How is the interacting of climate protection and sustainable resource use?
- How is the development of raw material use in a greenhouse gas neutral Germany until 2050
- How can we design the pathway(s) resource efficient?
- Are barriers already observable?
- Do we have resource efficient approaches to achieve a greenhouse gas neutral economy?

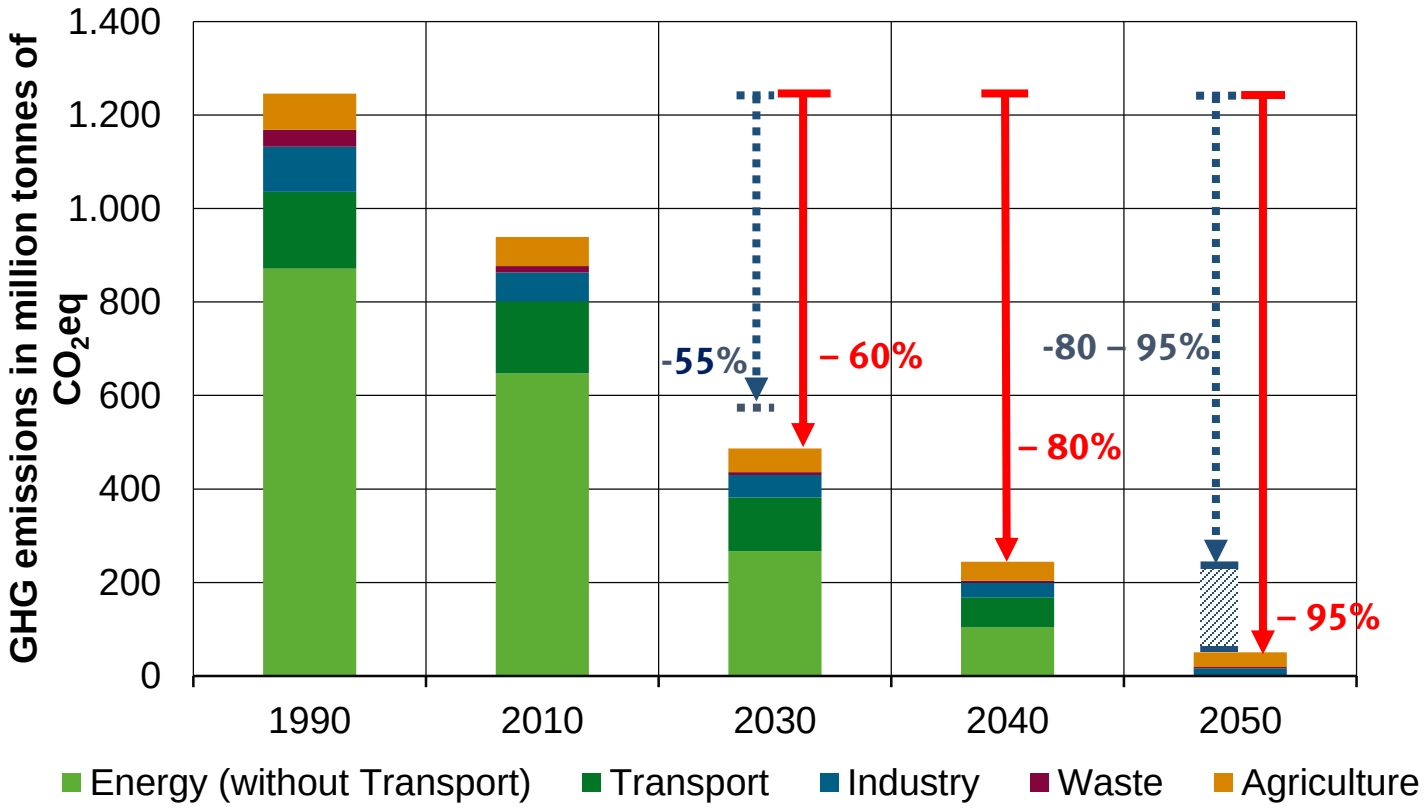
Scenario variation in the project

	GreenEe	Green	GreenMe	GreenLife	GreenSupreme
Greenhouse gas reduction 2050	very high	very high	very high	very high	very high
Level of ambition on climate protection measures in the pathway (2030 and 2040)	high	medium	high	high	very high
Ultimate energy demand	low	high	low	very low	low
Raw material use	medium	high	low	low	low
Raw material efficiency	high	medium	very high	high	very high
Behavioral changes	medium	medium	medium	very high	high

Basic assumptions in the GreenEe - Scenario

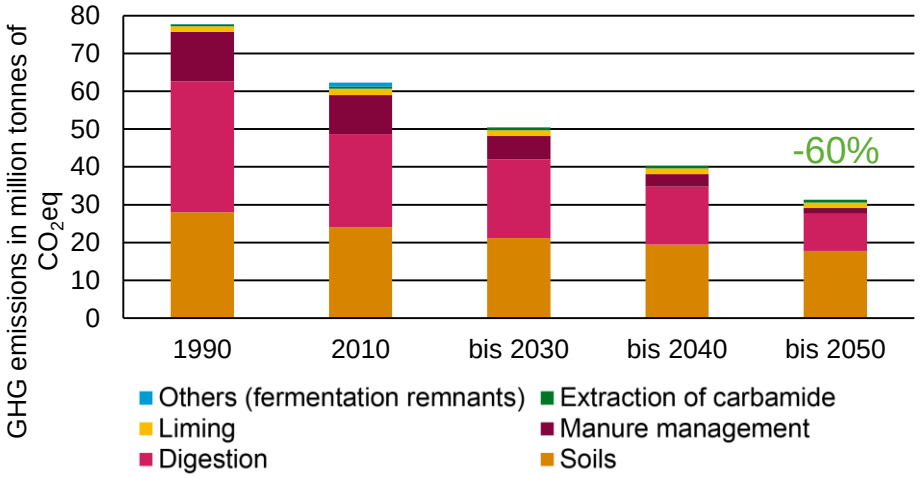
- population in 2050 around 72 Mio.
- Germany is still a strong industrialised country with an export orientation
- Economic development 0,7 % annual growth in GDP
- Distinctive and future-proof ICT-technologies are inherent parts in society and in all economic sectors
- Net zero built-up are in 2050
- Demand on net dwelling area in 2050 equal to 2010

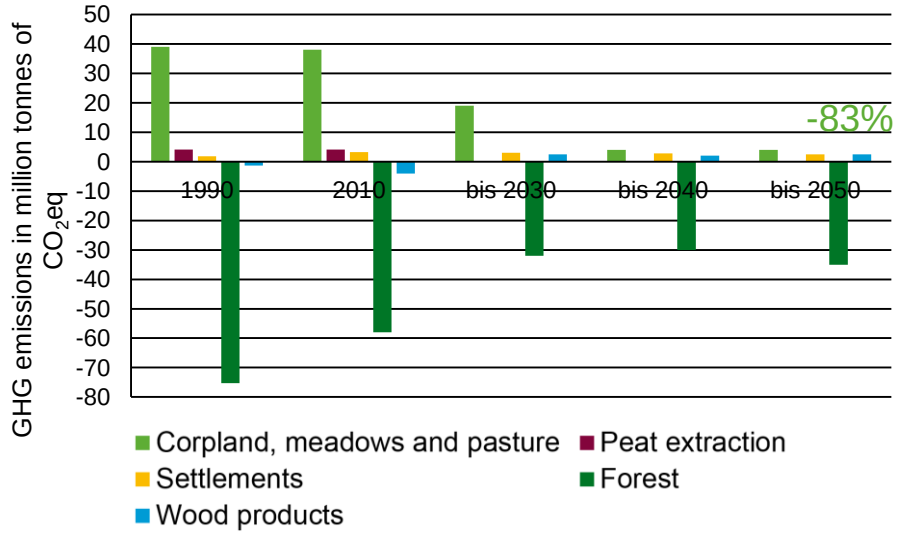
GHG emissions reduction in the GreenEe - Szenario



- the energy sector released a disproportionately large reduction; 2030 only 7% of the electricity is covered with coal; until 2030, already faster development of renewables
- Only the transport sector does not reach the goal 2030 (around 30 % compared 1990)
- GreenEe-Scenario - reach the lower long term goal of the government for 2050 already in 2040 (reduction by 80% compared to 1990)

Subdomains of the GreenEe-Szenario – Agriculture and LULUCF



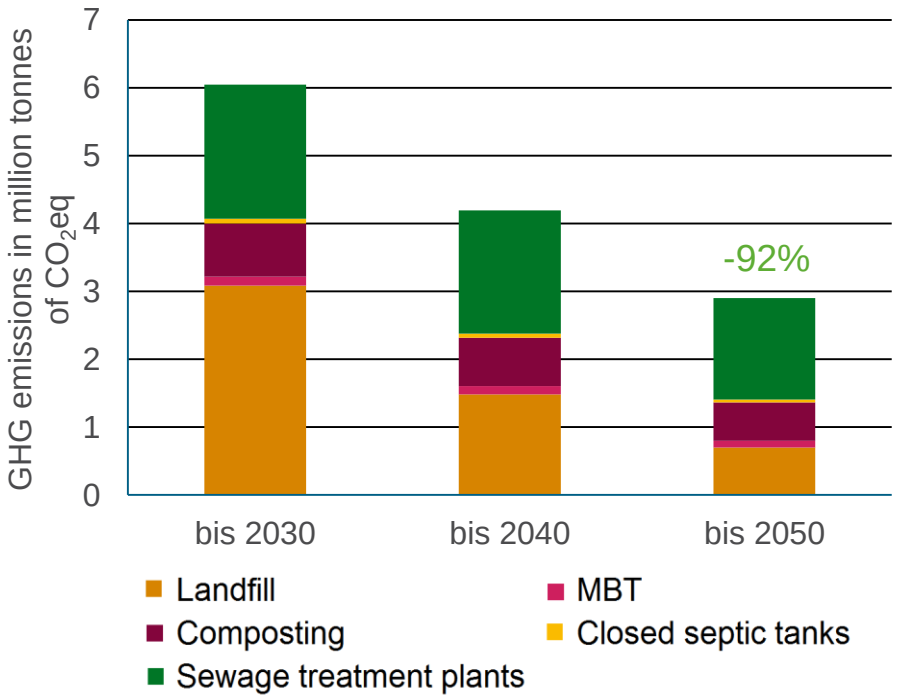


- mainly based on the former study
  - share of organic farming 20 % in 2050
  - diet with less meat according to the recommendations of the German Nutrition Society
  - slight live stock reduction up to 2030, afterwards continuous reduction until 2050
- effective management of farm fertilizer
- no energy crops after 2030

- energetic use of forest residues decrease to zero until 2050
- rehydration of swamps (5 % annualy)
- turf depletion is stopped in 2050
- extented rotation length in mix stands dominated by broadleaves
- active forest conversion
- 7 % of forest area with natural forest development

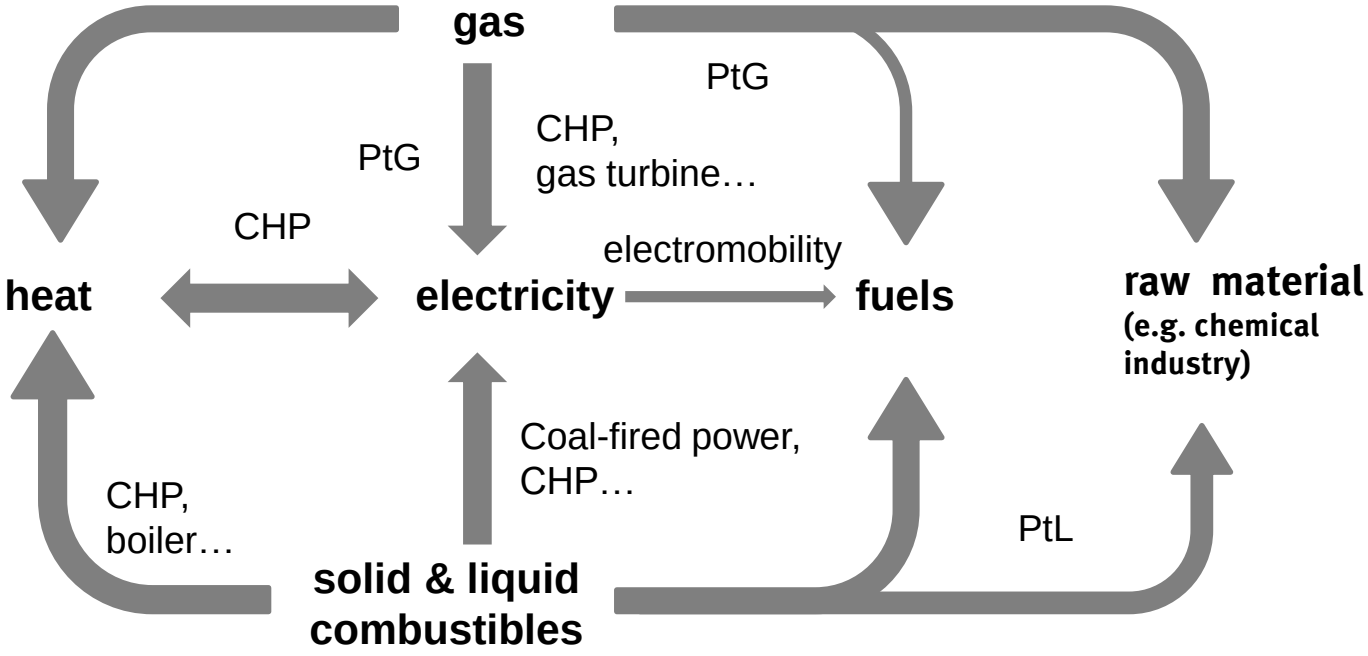
Subdomains of the GreenEe-Szenario – Waste and waste water

- continuation of the decreasing trend of methan emissions from waste sites
- from 2020 onwards continuous conversion to mechanical-bilogical stabilization (MBS), 2050 only MBS is operating
- GHG emissions from energetic recovery decrease to zero in 2050 → early supply of GHG neutral raw materials
- from 2020 onwards increase fermentation and decreasing composting of bio-waste
- continuous improvement of waste water treatment
- flexible energetic use of sewage gas (power and gas)



Subdomains of the GreenEe-Szenario – Energy

- **Sustainable energy system** – without CCS, nuclear energy and crop-based bioenergy (to end after 2030)
- **an increase development pathways for renewables**, first electricity (78% 2030, 7% coal)
- full exploitation of the potential for increasing **efficiency** and economy of energy across all fields of application and
- **efficient sector coupling**



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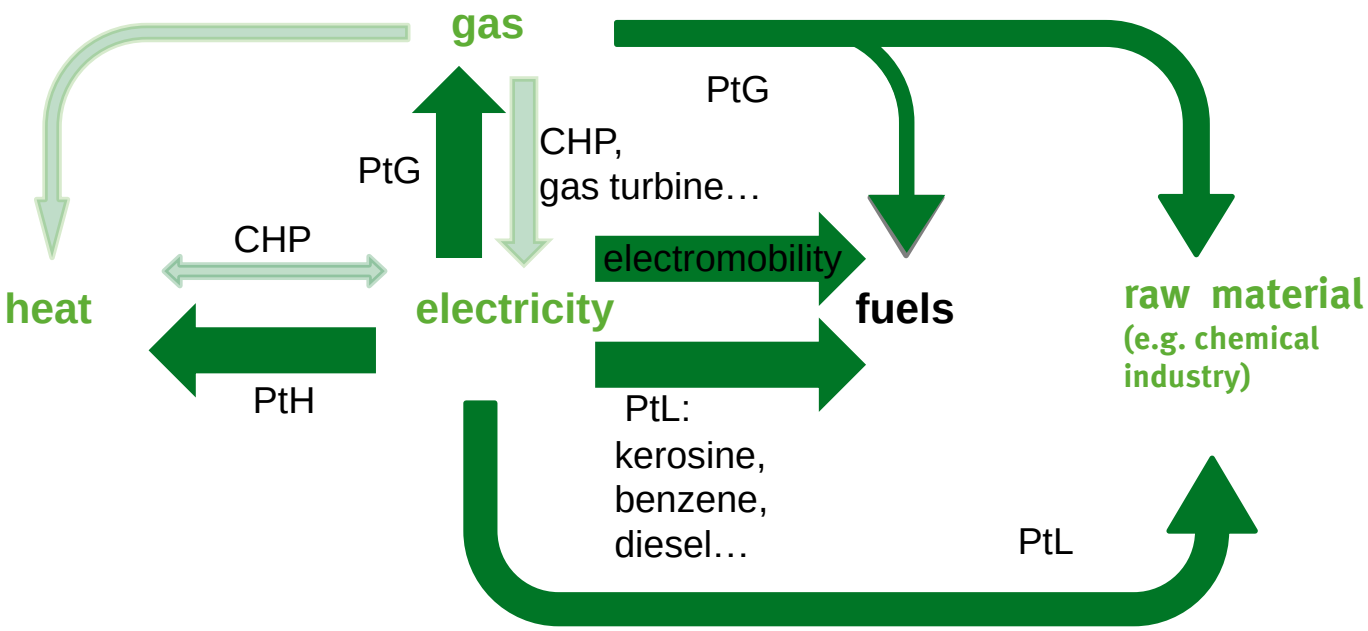
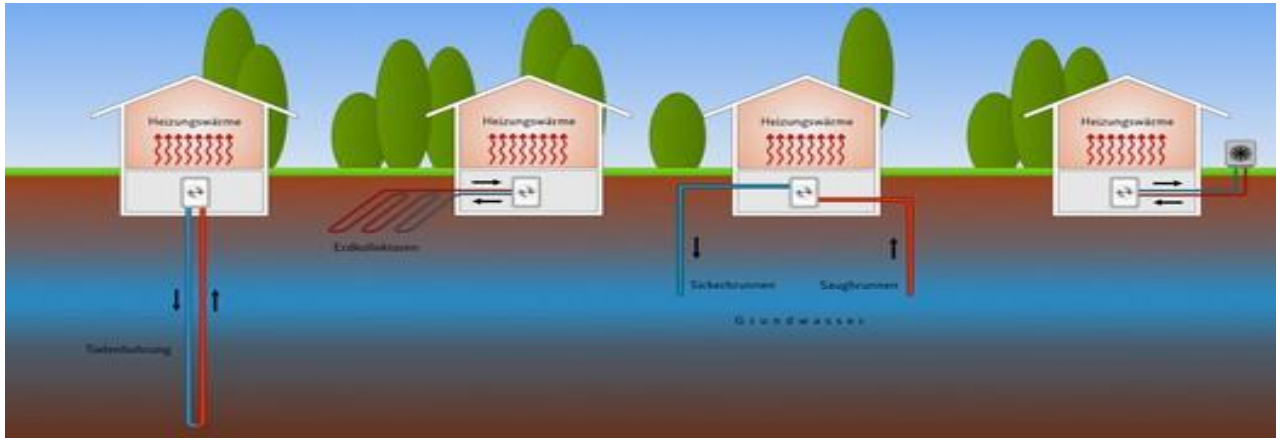


Subdomains of the GreenEe-Szenario – Buildings

- Very ambitious **energy standards for refurbishment:** Passive house quality
- Increase of annual **refurbishment rate from 2.2 % (2020) to 3 % (2050)**
- space heating: heat pumps and district heat replace gas and oil boilers completely by 2050
  - by 2020: no new installation of oil boilers
  - by 2030: no new installation of biofuel boilers
  - by 2040: no new installation of gas boilers



Subdomains of the GreenEe-Szenario – Industry

- **process-related GHG-emissions down to the technical minimum**
- **energetic GHG emissions disappear completely**

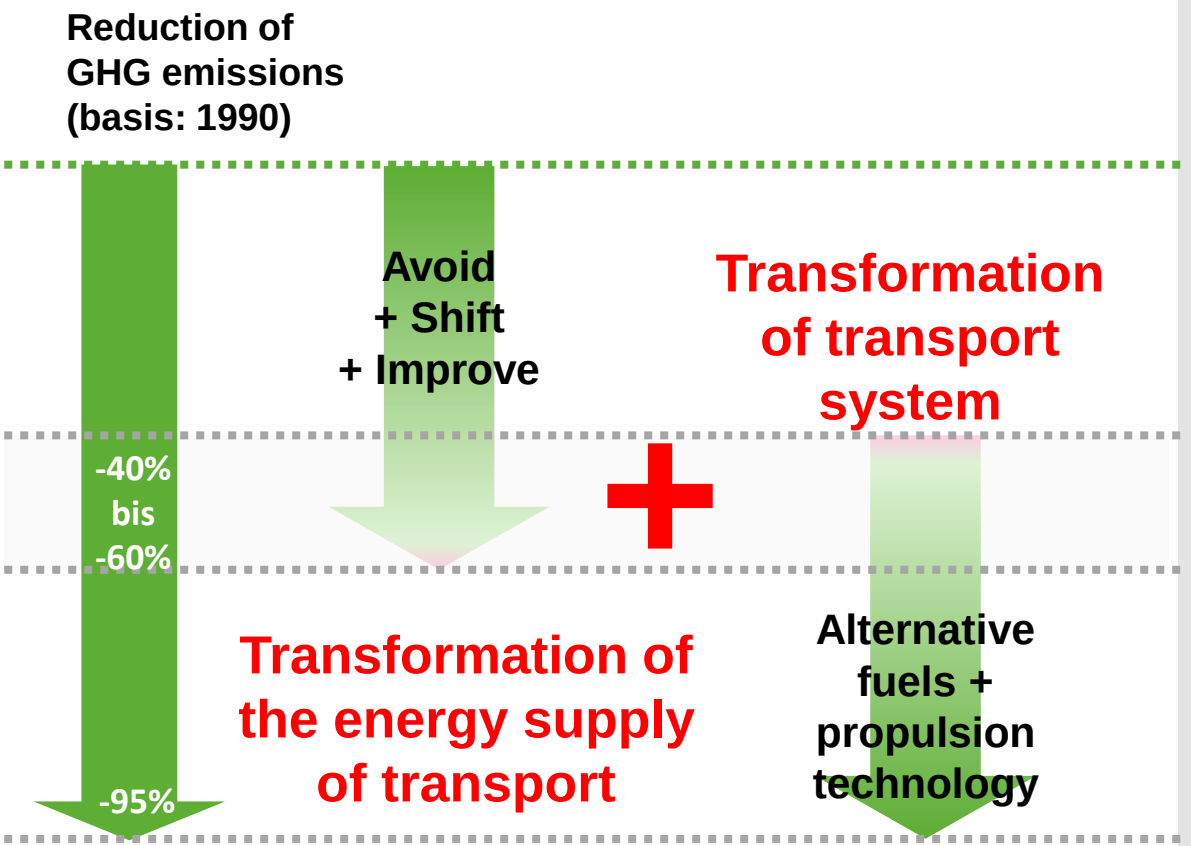
- By 2030 entire exploitation of the efficiency potential, e.g. industrial waste heat
- Power to Heat: a shift towards electricity-based heat generation after 2030
- Power to gas/Power to liquid: in industrial processes that cannot be converted to using power or that require the use of carbonaceous energy carriers
- PtG-H2: by 2030 the gradual integration in chemical industry and by 2040 in steel industry

Properties of the GreenEe-Szenario – Transport

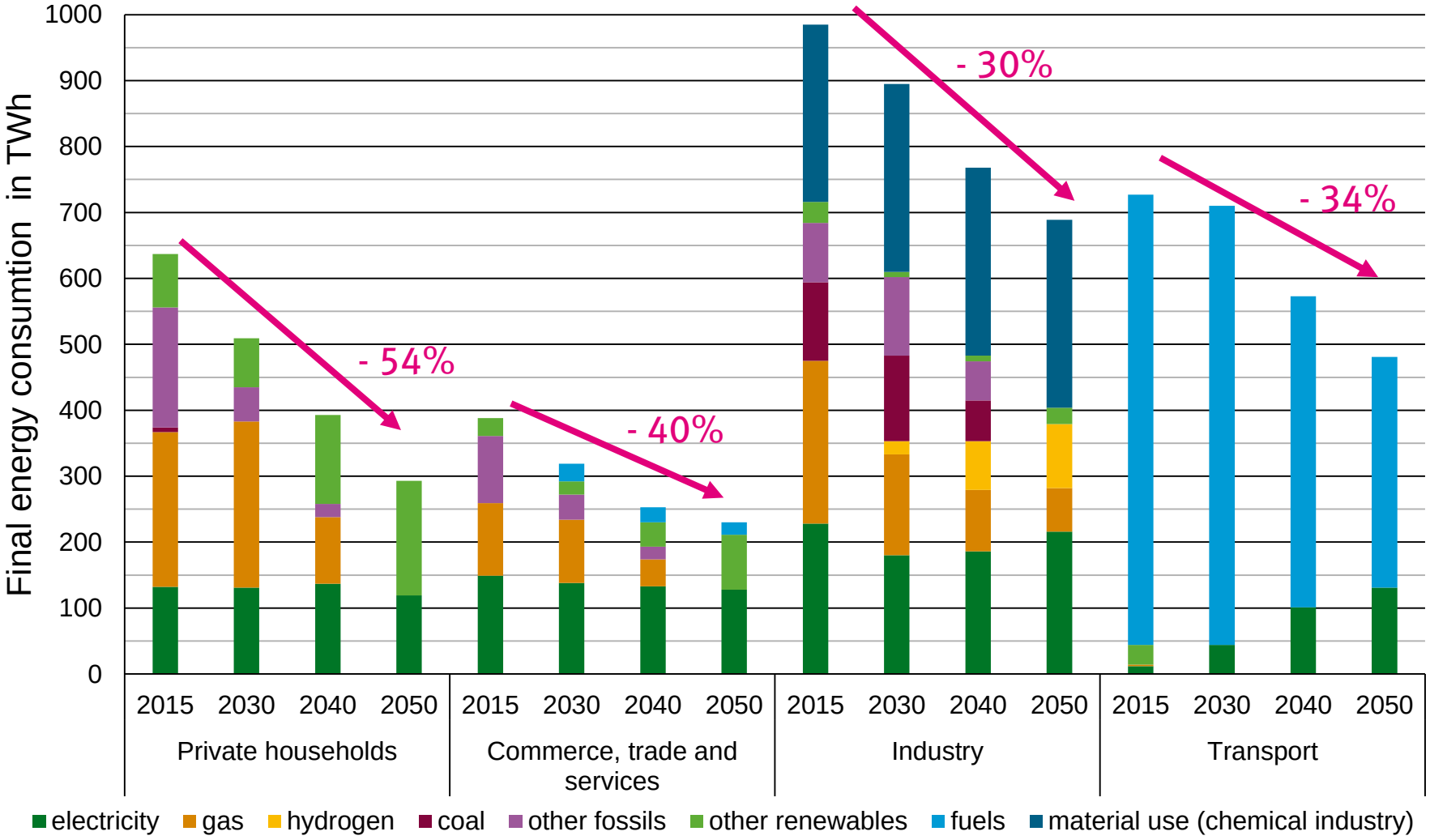
- two central elements:

Transation of transport system (avoid, shift and improve measures (ASI)) and Transformation of the energy supply

- If technically possible, combustion engines are replaced
  - by 2030 around 8 million pure electric vehicles and plug-in hybrids in operation
  - After 2030 fast Integration of hybrid trolley truck
  - from 2040 onwards, only electric vehicles are newly registered
  - Especially for aviation and for marine shipping PtG/PtL is needed

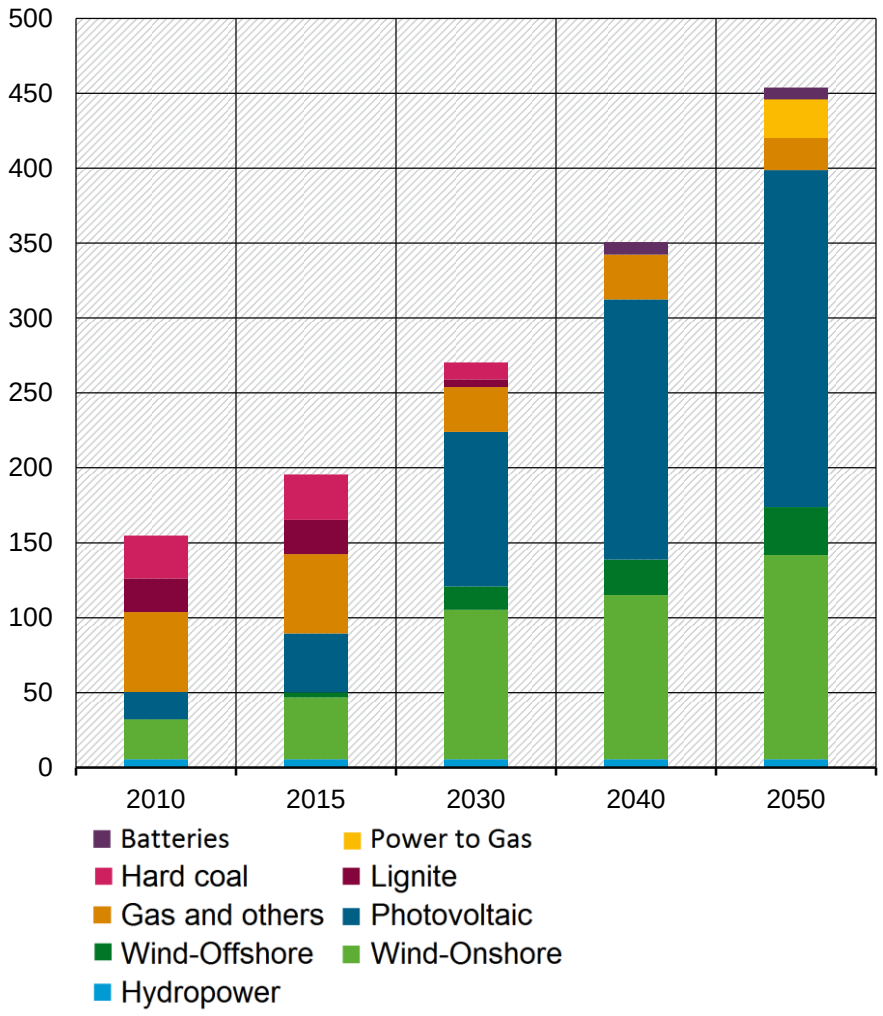


GreenEe-Scenario - Final energy consumption

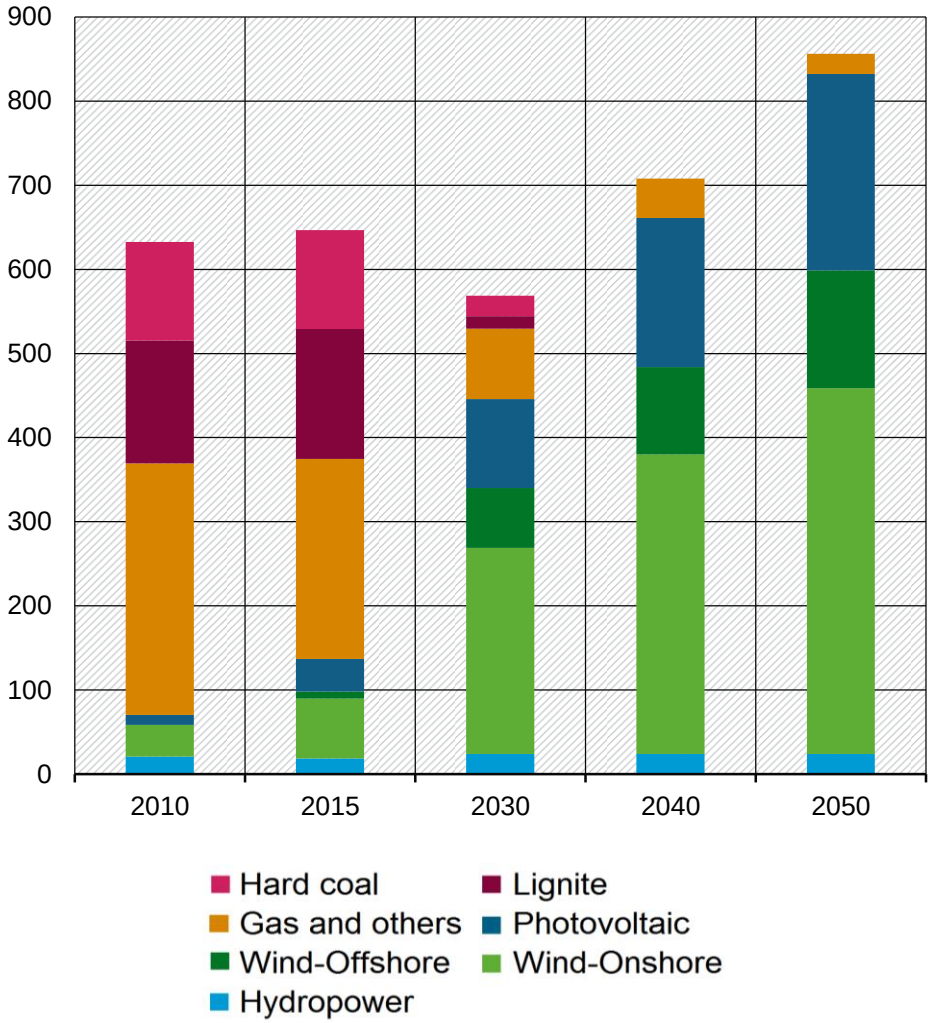


GreenEe-Scenario - Energy supply in germany

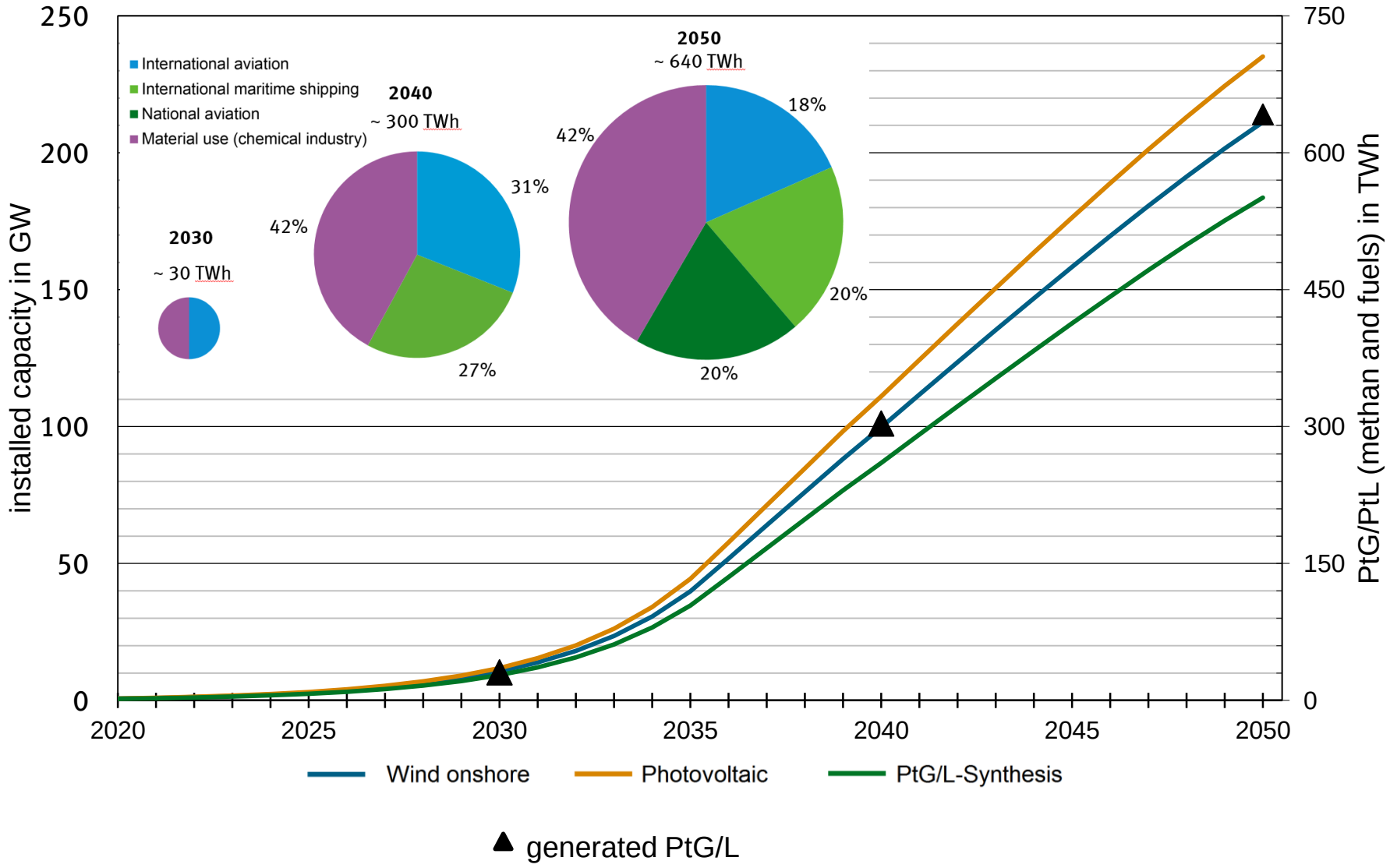
Installed capacity in GW



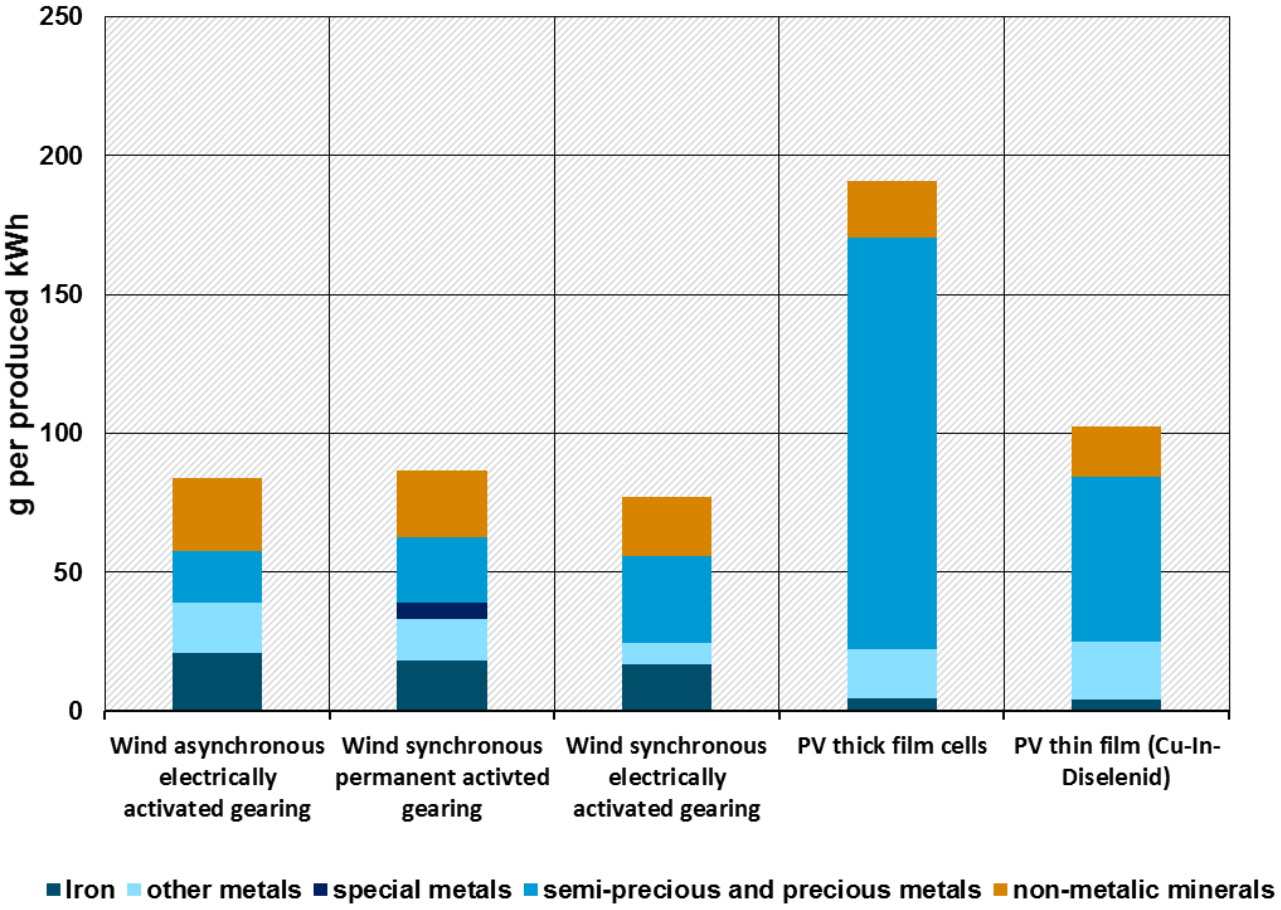
Electricity in TWh



GreenEe-Scenario - import



Technology assumptions has significant effects on raw material demand



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

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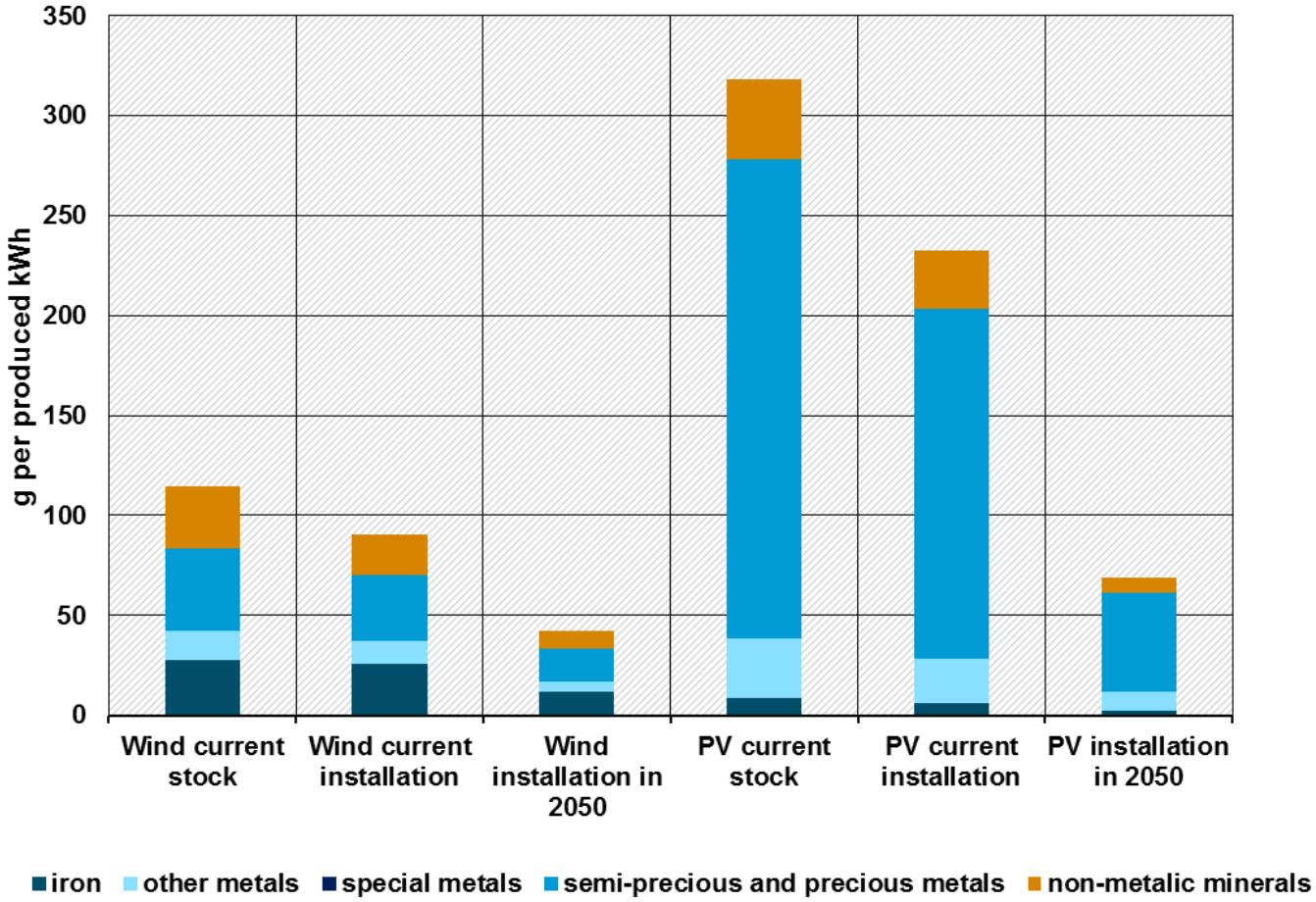

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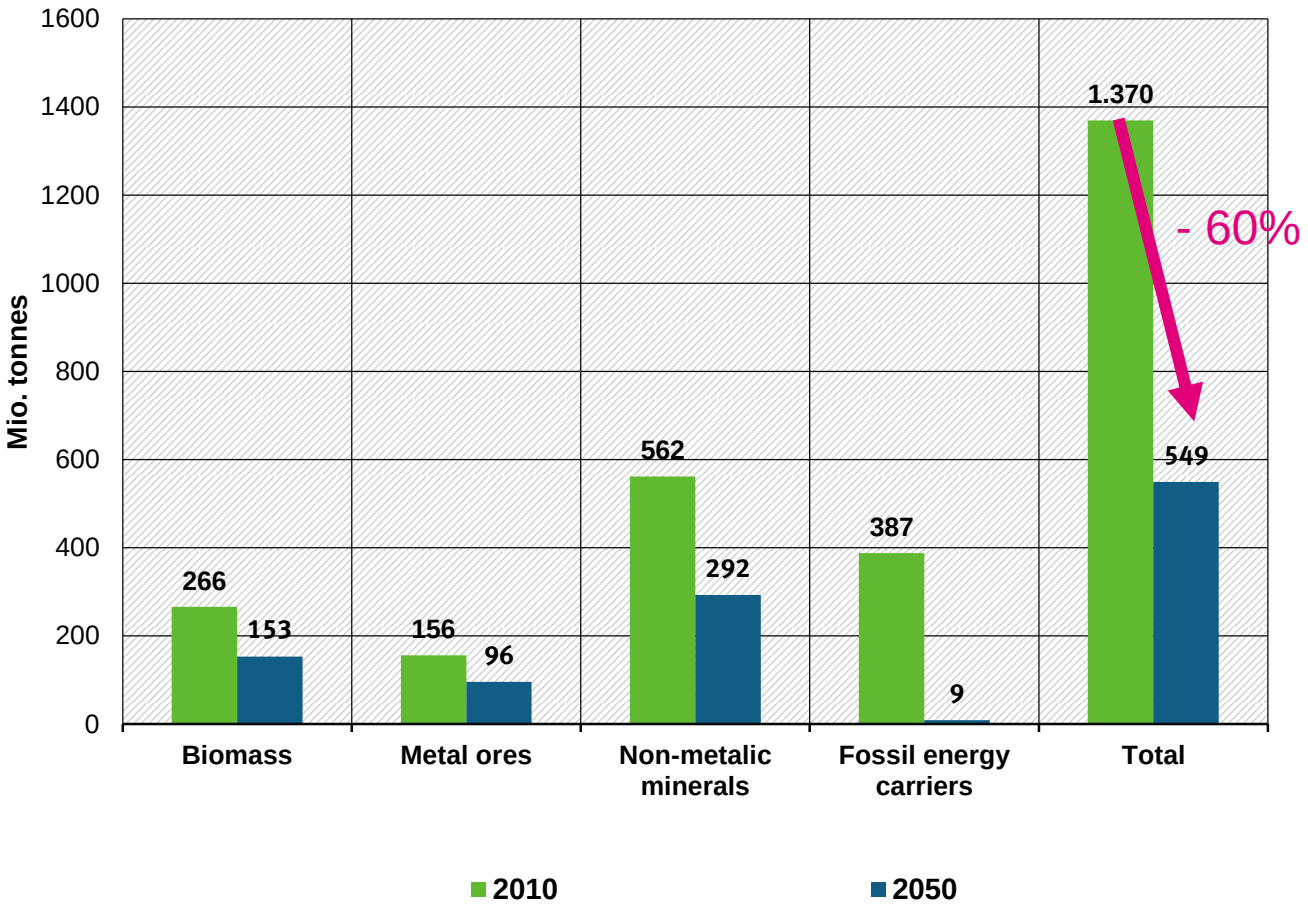
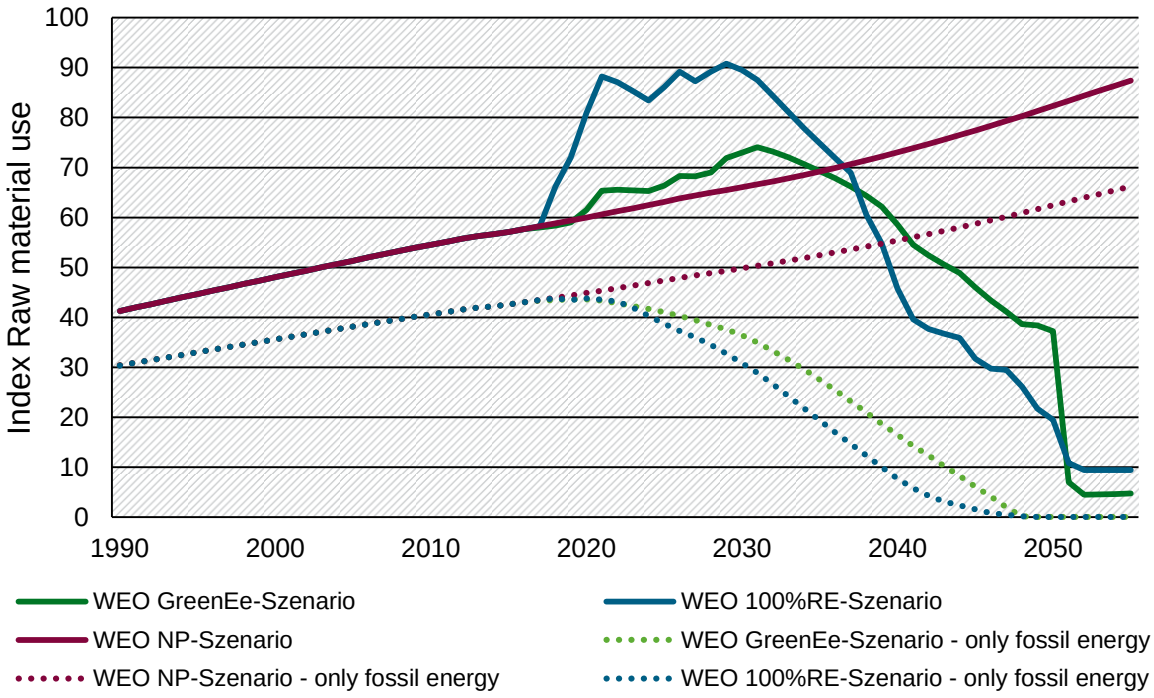
Raw materials use 2050 in the GreenEe - Szenario



- Raw material use decrease by 60 %
- RMC per capita 7,6 tonnes
- Fossil energy carriers minus 98 %
- Non-metallic minerals minus 48 %
- biomass minus 43 %
- Metal ores minus 39 %
- Increase of total raw material productivity by 2,5 % per year

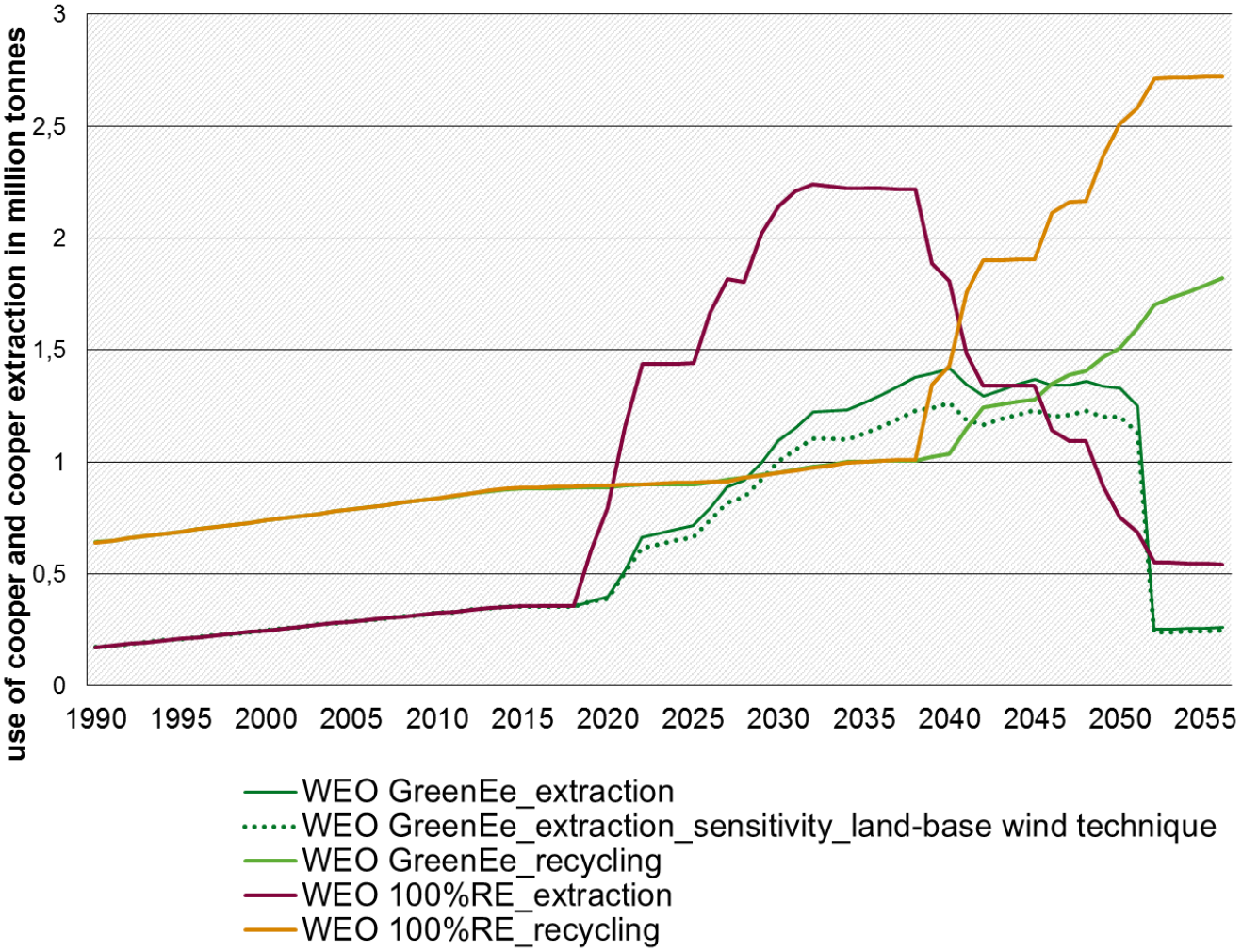
Global transferability – a system dynamic view

	WEO NP-Scenario	WEO 100% RE-Scenario	WEO GreenEe-Scenario
Final energy demand	high	high	low
Share of renewable energy	low	maximum	maximum
Use of nuclear and fossil power	yes	no	no
Sector coupling – direct power use	minor	medium	very high
Sector coupling – indirect PtG/PtL	none	very high	high



- dynamic modelling of raw material use of the energy system
- WEO „New Policies“ - Scenario and variations
- WEO „New Policies“ shows no reduction of raw material demand
- temporarily strongly increasing raw material demand due to the extention of renewable energy system
- 1 to 1 conversion and using today‘s technologies (WEO 100% RE) leads to higher raw material deman in the transformation pathway
- conversion to direct power use through Power to Heat and electromobility in all application areas
- in 2050 reduction of raw material demand by factor 4-5 compared to 1990

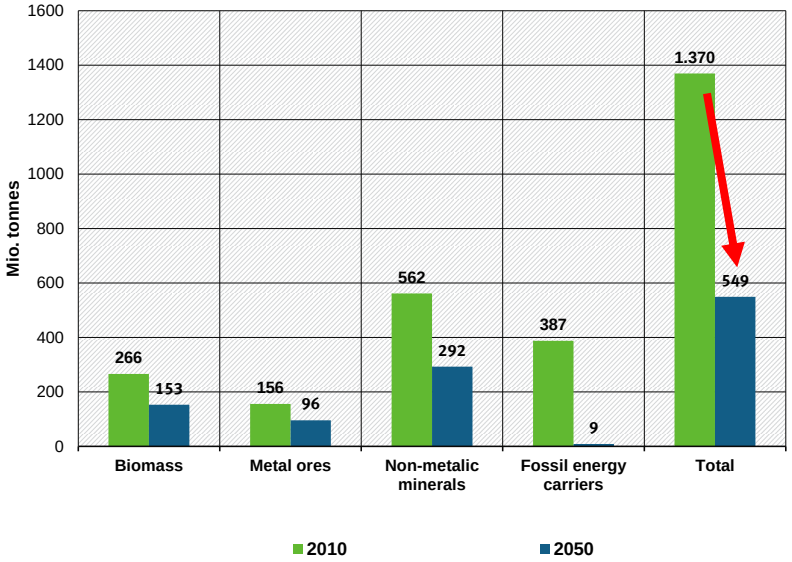
Global transferability– a system dynamic view (II)

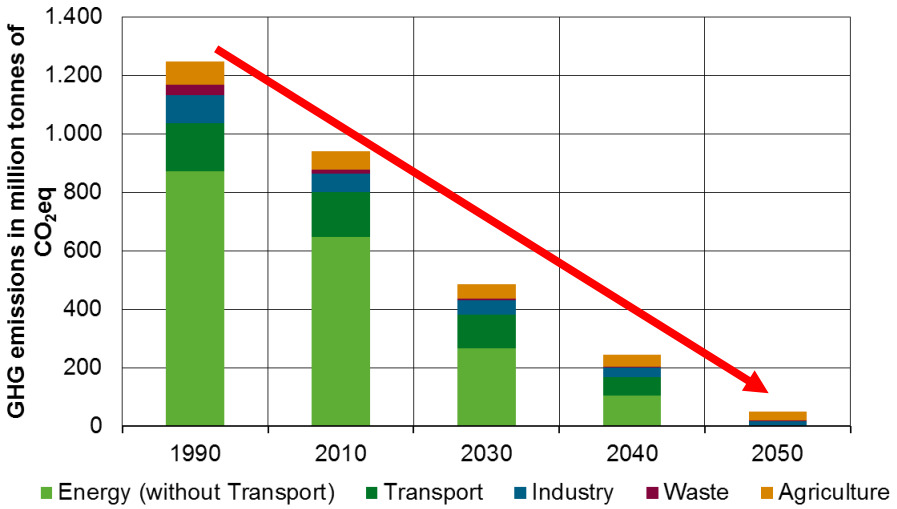


- „Zooming in“ semi-precious metals
- demand(= extraction) strongly increase through extention of renewable energies(„copper mountain“)
- recycling capacities need to follow rapidly
- Persisting „gap“ must be closed with primary raw materials
- Sensitivity (green dotted line) shows influence of technological assumptions

Conclusion and recommendations for action

- „GreenEe“ scenario shows the possiblity to transform German economy greenhouse gas neutral AND resource efficient at the same time





- the scenario demonstrates, that a joint ambitious climate and resource protection fosters to acieve the goals in both policy areasand therefore should be more politicaly discussed and realised
- But this scenario can not answer all important questions and options for a transformation towards a sustainable Germany; this will be done and studied within the other Green scenarios

Conclusion and recommendations for action

- ambitious targets for Germany
- full exploitation of the potential for increasing efficiency, efficient sector coupling and an increase development pathways for renewables
- Technological selection influence raw material use & resource efficiency potentials need to be realised
- Joint international proceed is needed
- Continuation of this study
- Further research – especially analysis of raw material demand and systemics interrelations

Thank you for your attention!

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