For Our Environment

Umwelt Bundesamt

decarbonization through cross sectoral supply with renewable energies

Goals

40 – 100 – 100Plus - GHG N – RTD

Policy

Dr. Harry Lehmann
General Director at the Federal Environment Agency, Germany
Head of Division I – Environmental Planning and Sustainability Strategies

Germany‘s Energy and Climate Protection Targets

	Climate	Renewable Energy		Efficiency		
	GHG (vs. 1990)	Electric power	Total share	Primary energy	Energy productivity	Modernising buildings
2020	- 40%	35%	18%	- 20%	increase to 2,1% p.a.	double rate 1% → 2%
2030	- 55%	50%	30%			
2040	- 70%	65%	45%			
2050	- 80-95%	80%	60%	- 50%		

The Paris Agreement

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

Aims (Article 4):

- *“Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C”*

- Peaking of greenhouse gas emissions as soon as possible
- Net zero balance in the second half of this century

The Paris Agreement

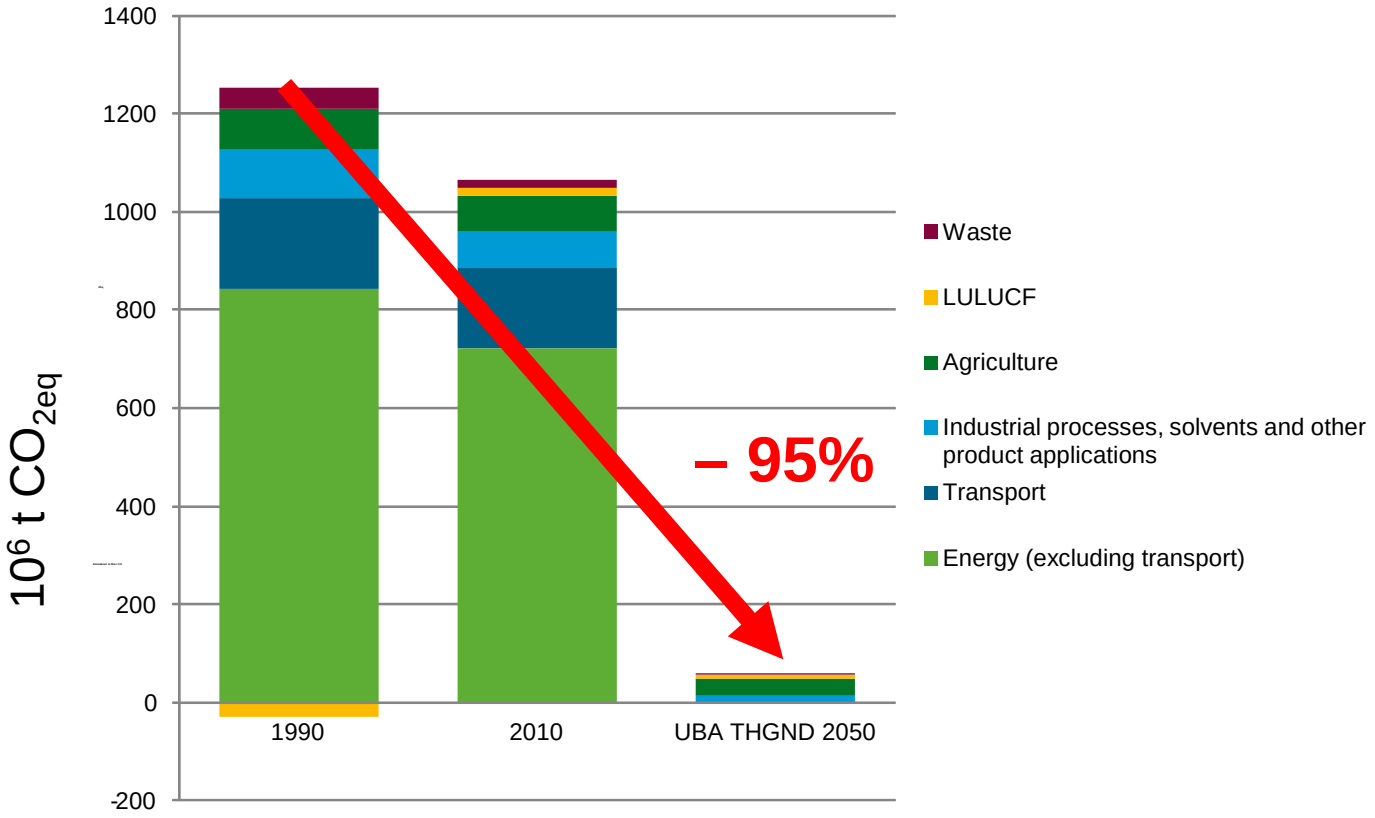
COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

Conseqences (Article 4):

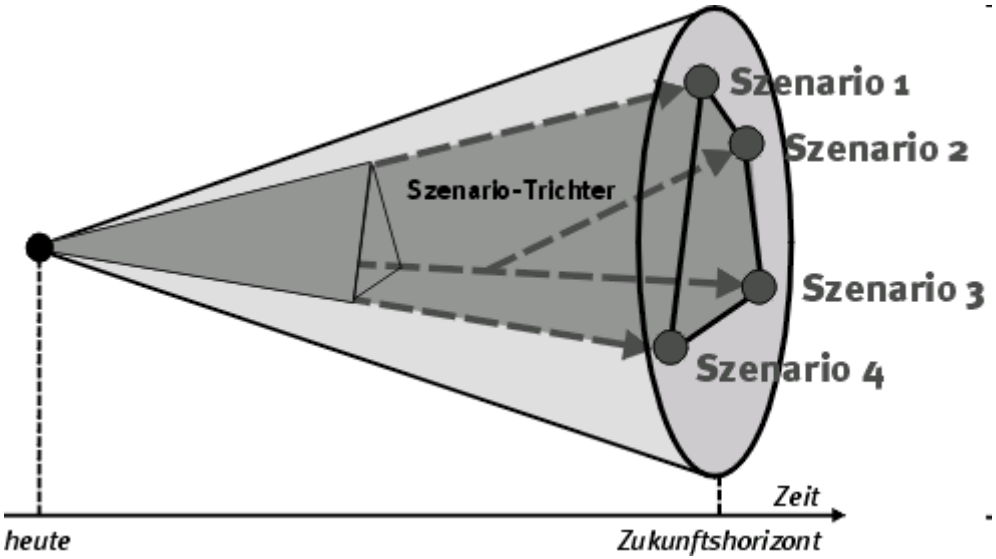
- *“decarbonization” of all societies…*
- *Germany has to increase goals ….*

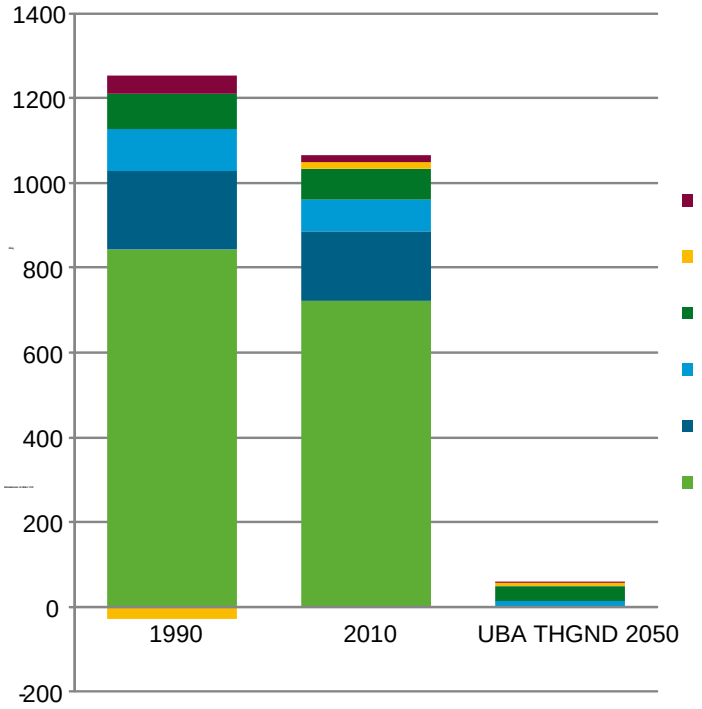
- *-95 % Greenhouse Gas Emission in 2050 (industrialized countries)*

Greenhouse Gas Neutral Germany



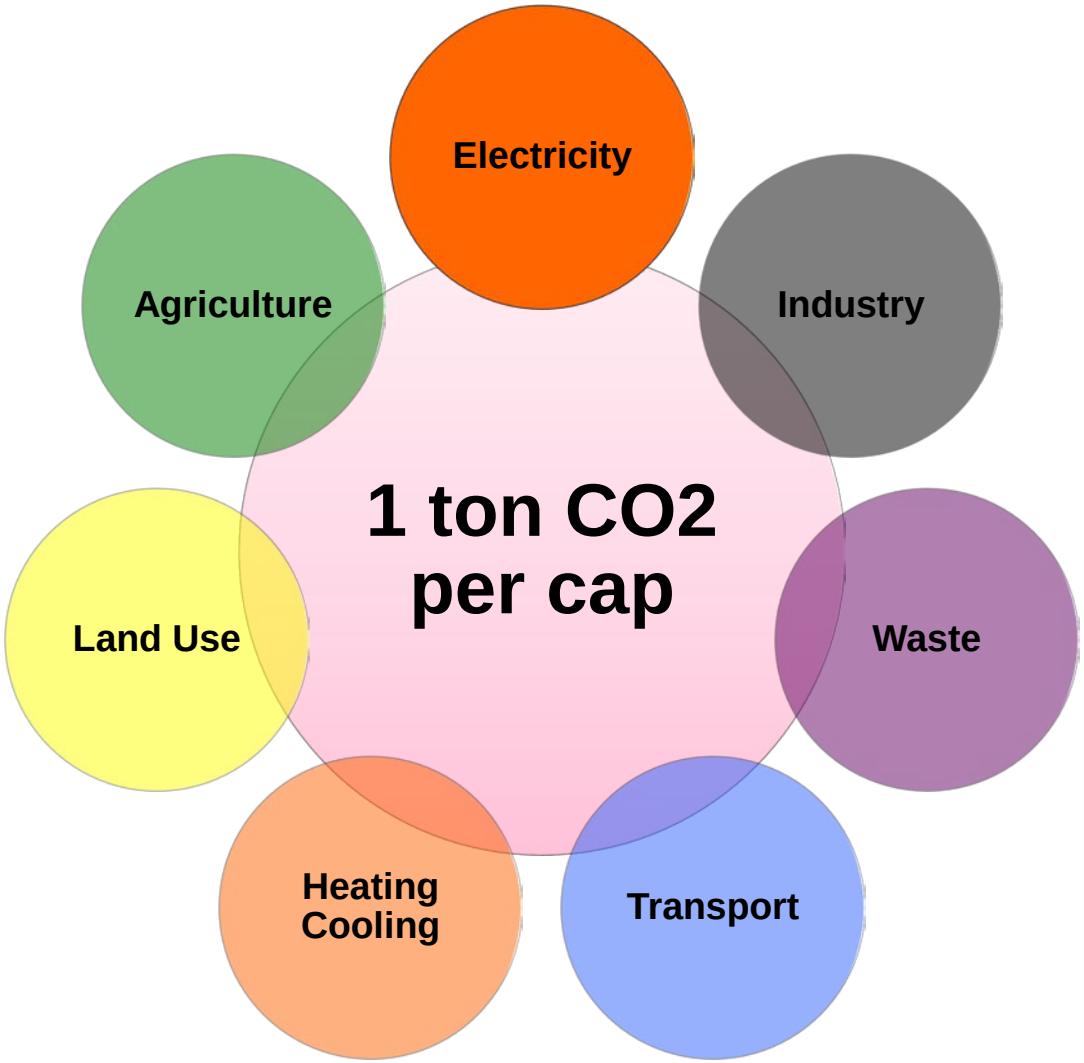
Greenhouse Gas Neutral Germany

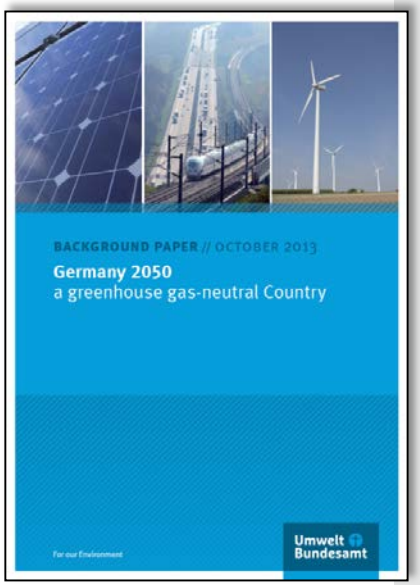




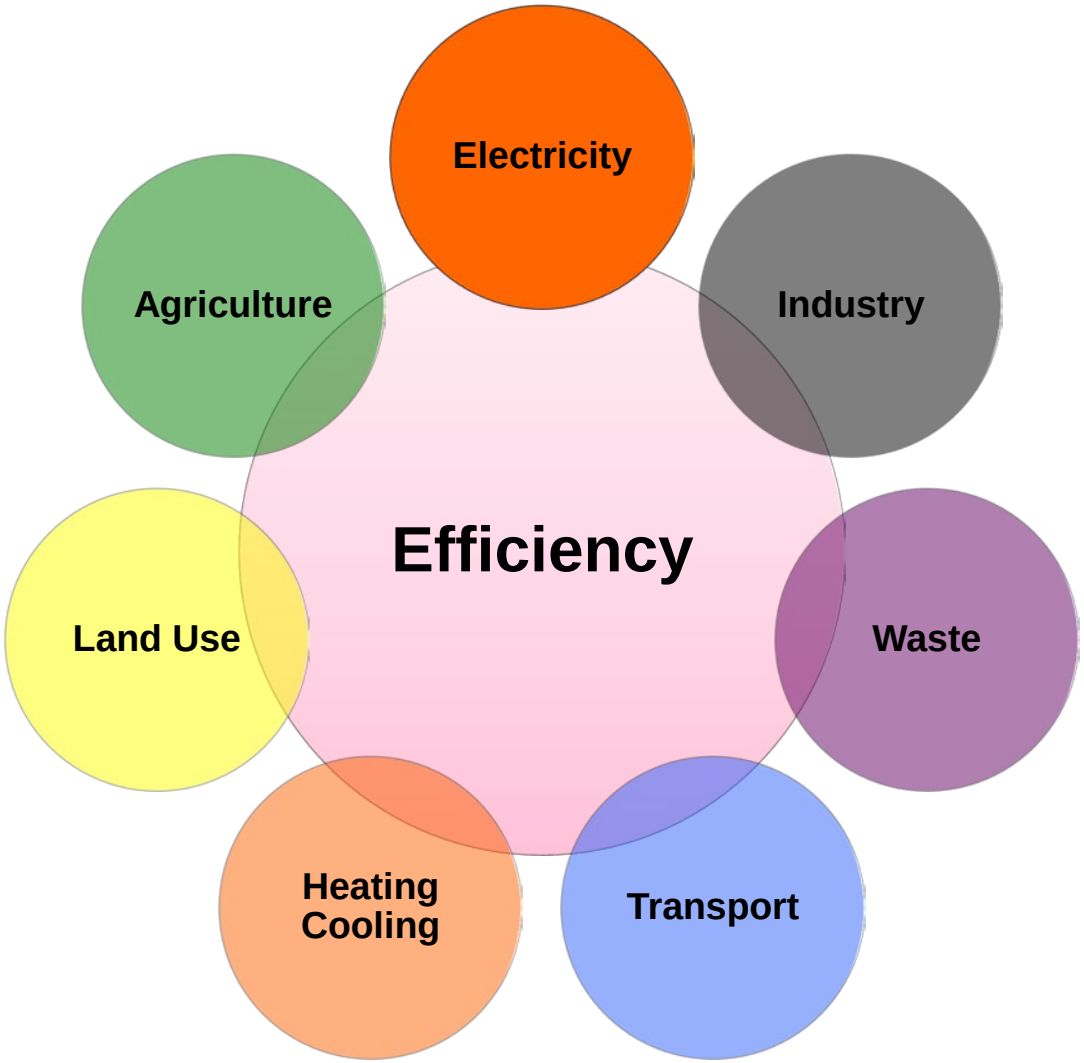
Approach by a systemical / holistic analysis and scenarios

Greenhouse Gas Neutral Germany



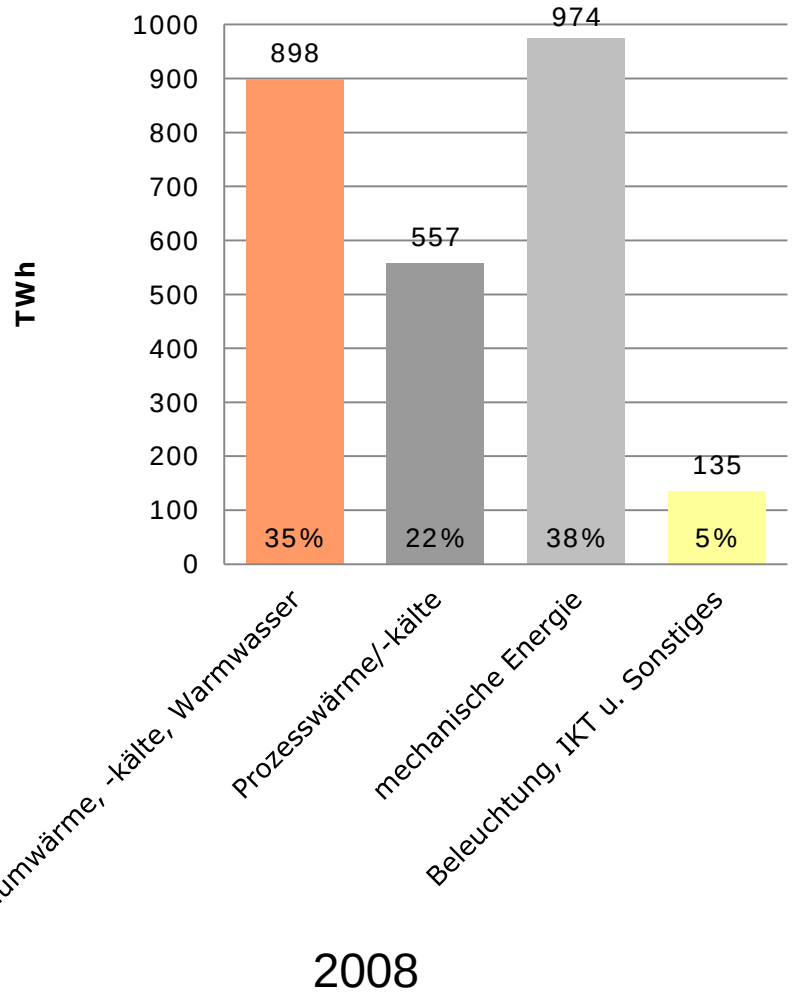


Greenhouse Gas Neutral Germany

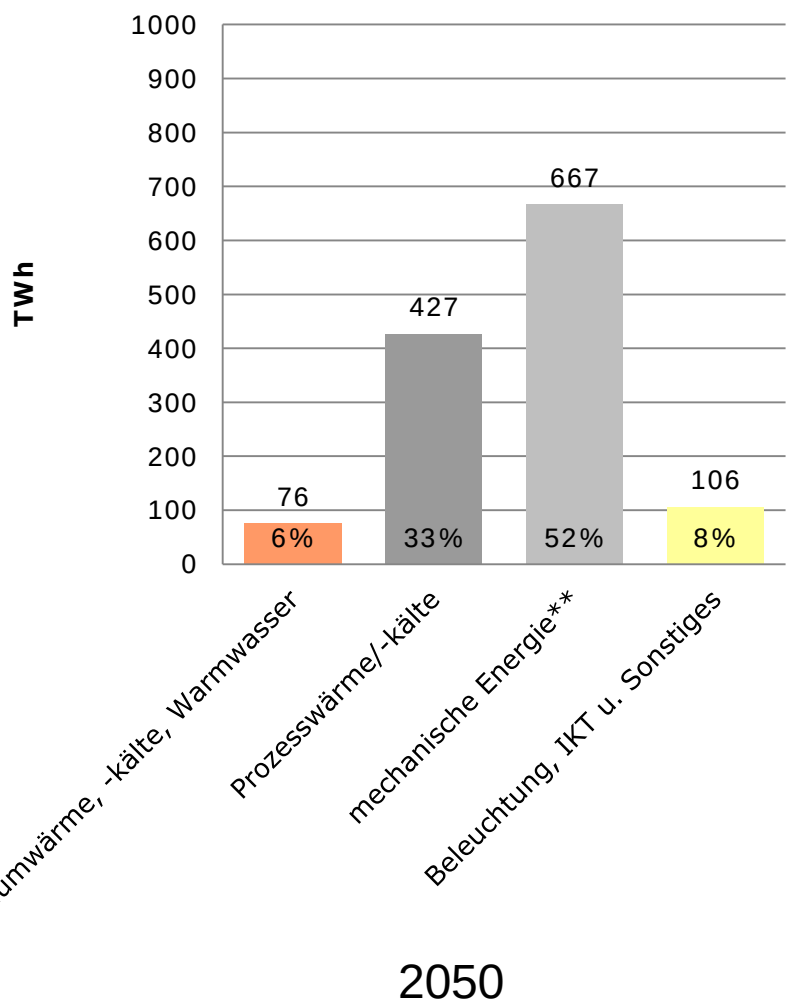


Energy Demand in diff. sectors

Germany 2008 and 2050

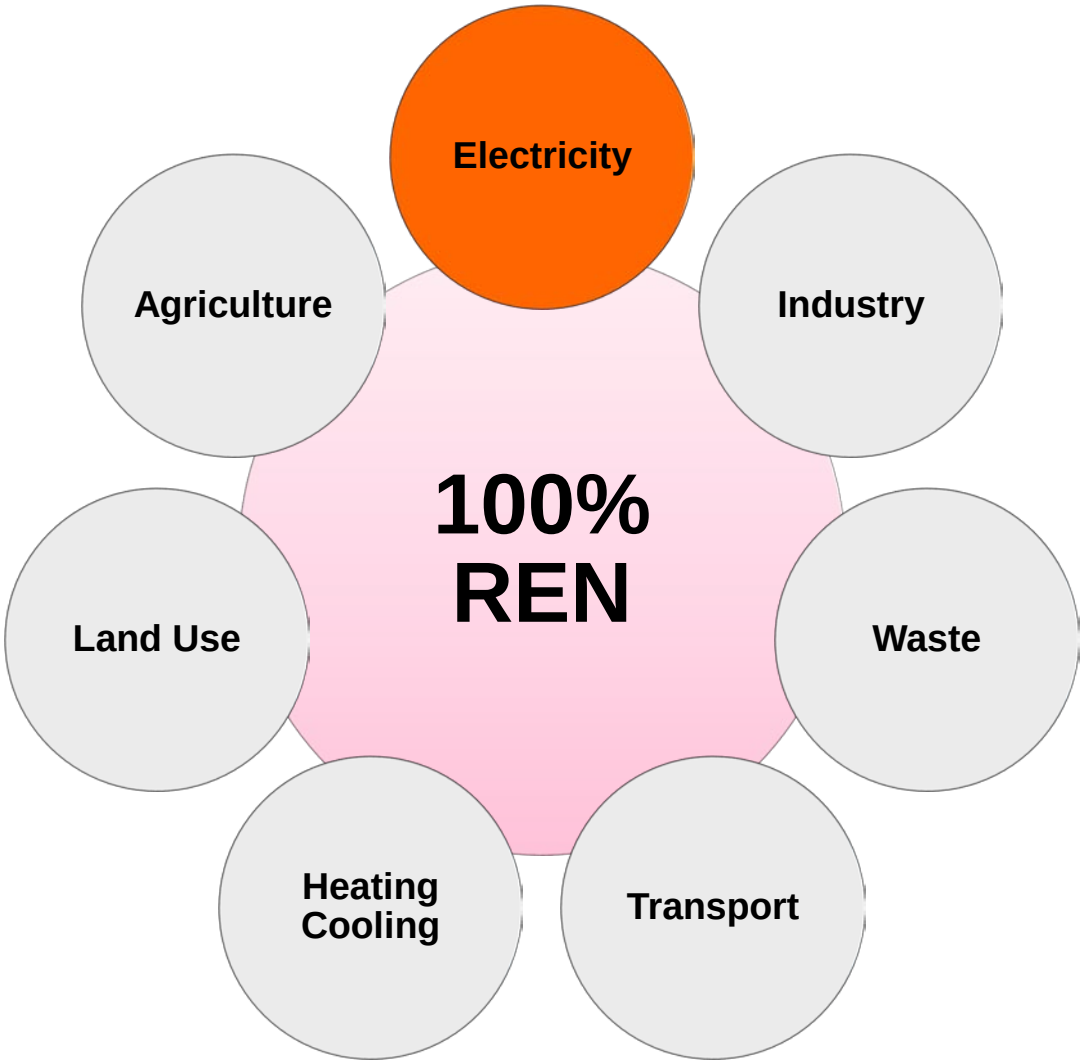


2008

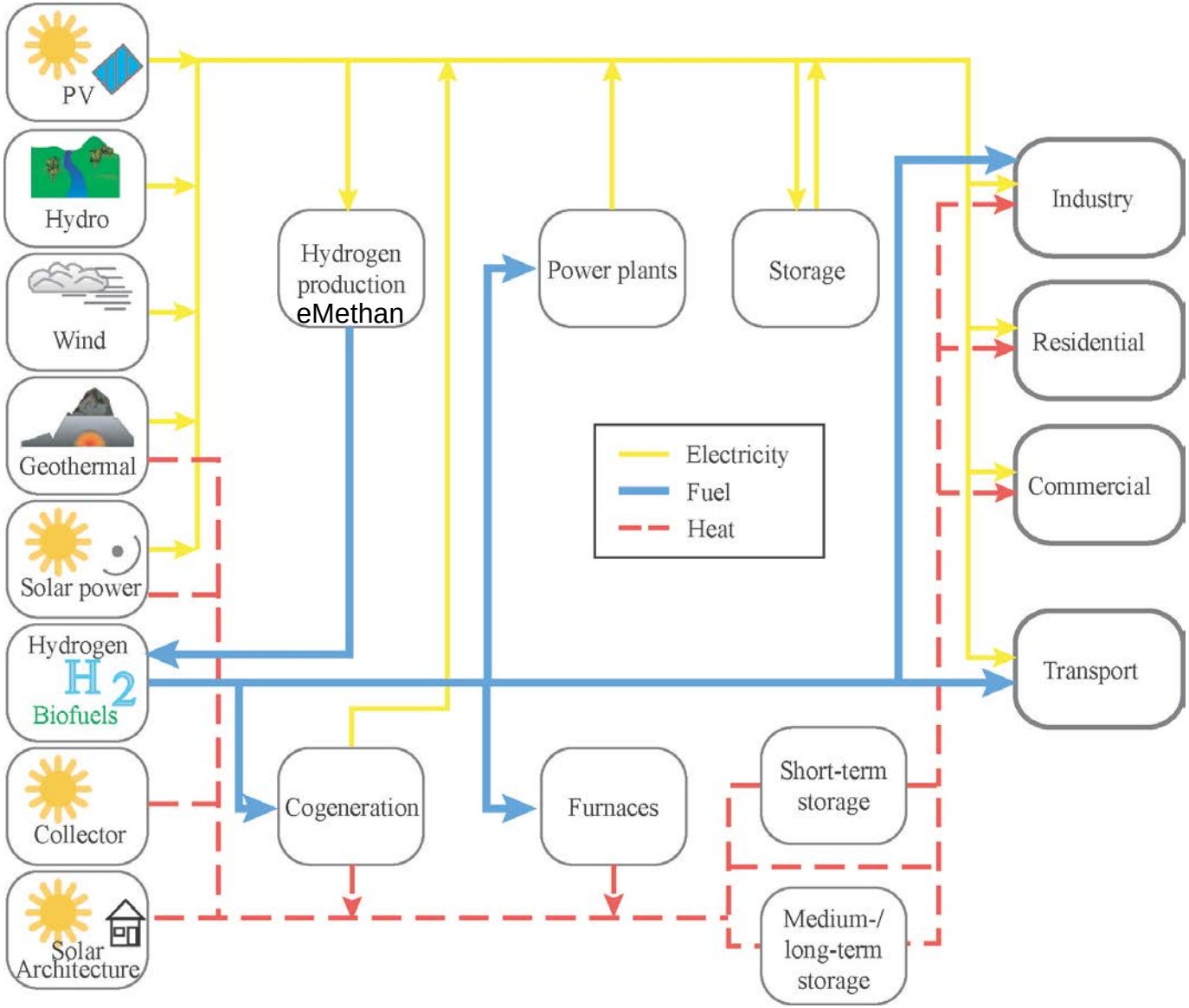


2050

Greenhouse Gas Neutral Germany

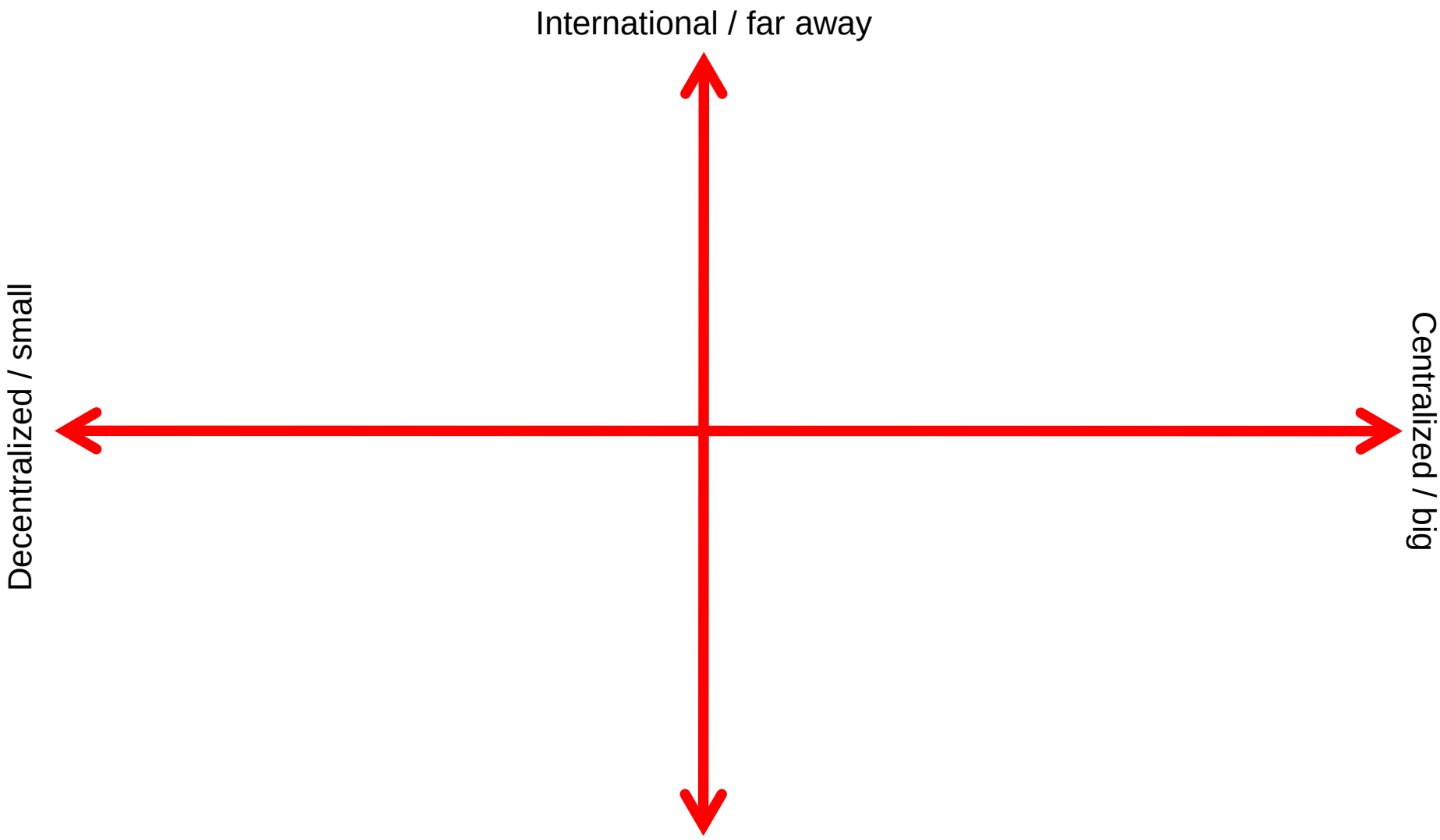


100% Electricity Supply from REN ...



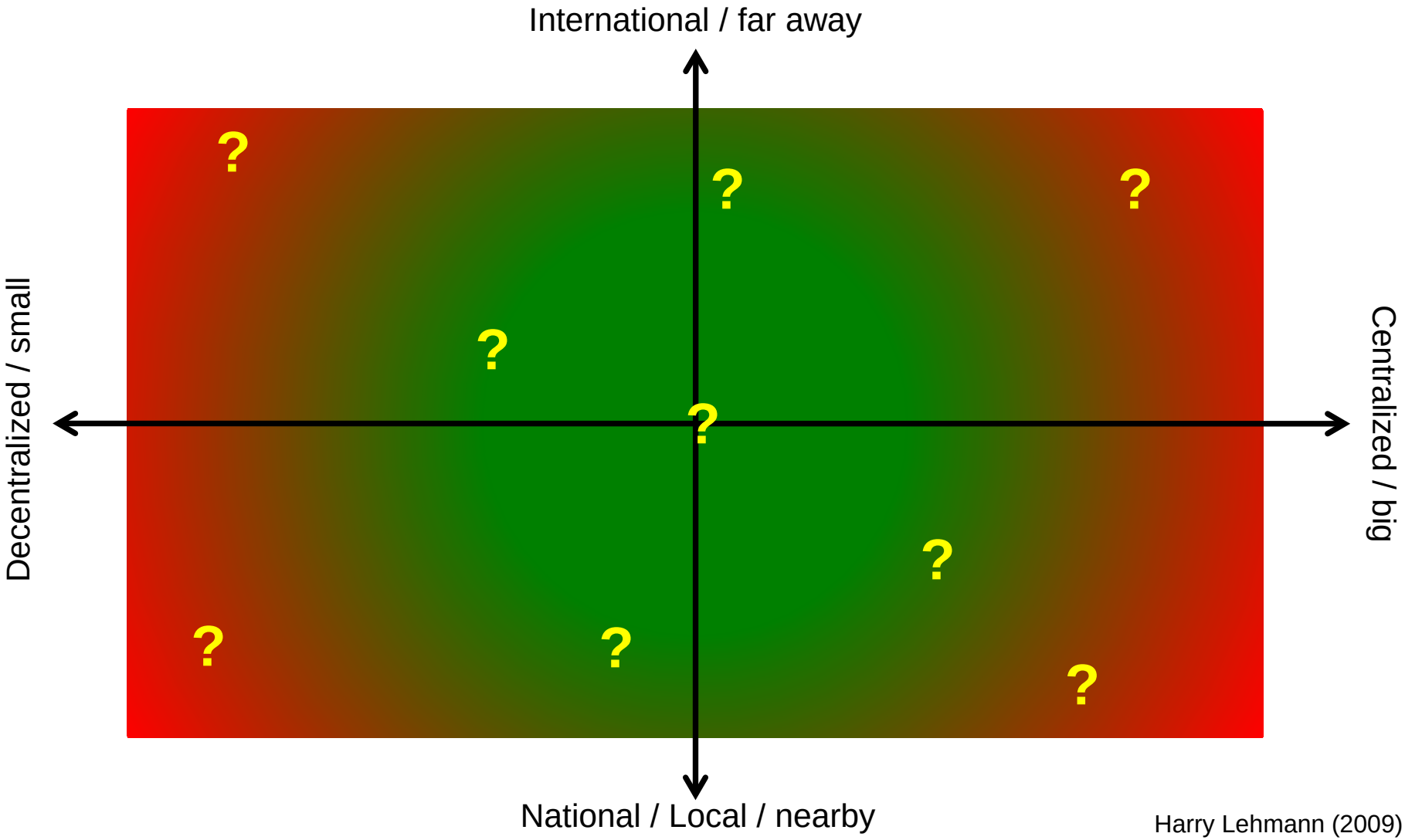
Source: Harry Lehmann, 1996

GHG Neutral Germany - Electricity



GHG Neutral Germany - Electricity

Archetypes of 100% REN



Harry Lehmann (2009)

GHG Neutral Germany - Electricity

International / far away

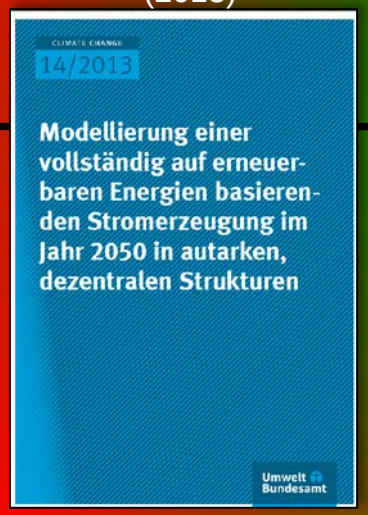
Decentralized / small

Centralized / big

National / Local / nearby

"Local Energy Autarky"

(2013)



"Regions Network"

(2010 - 2014)

"International Large Scale"

(2014)

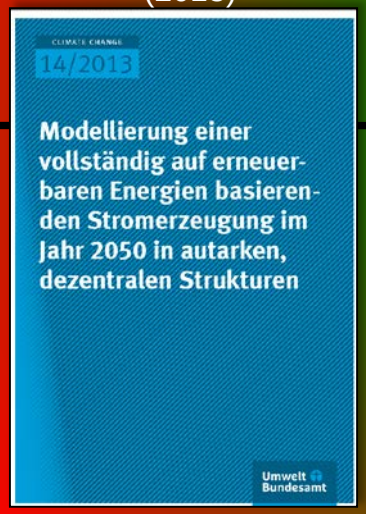
GHG Neutral Germany - Electricity

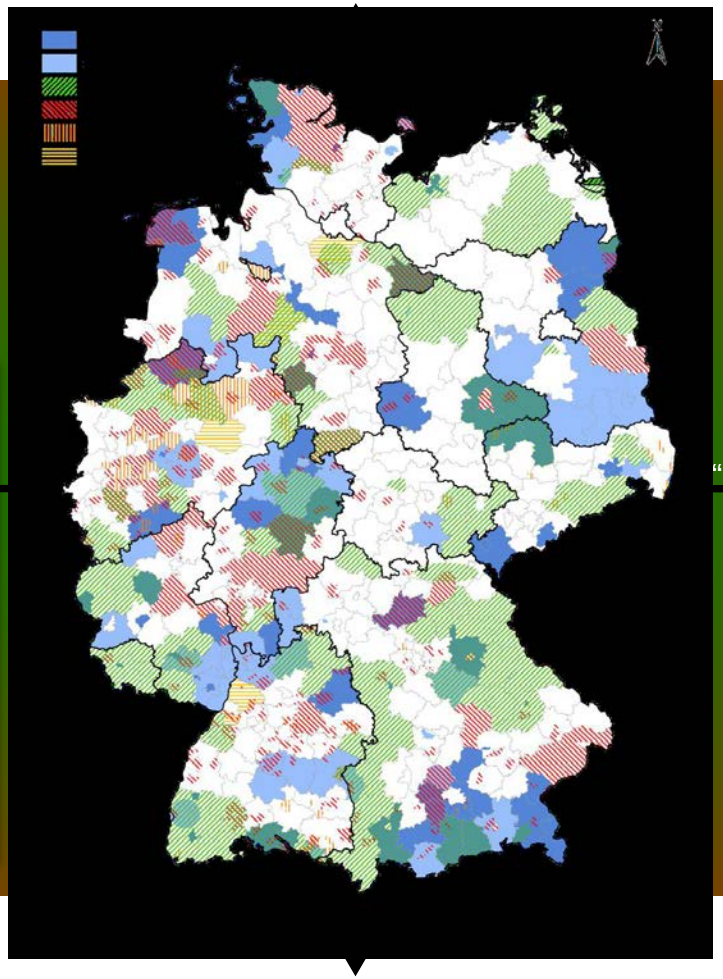
International / far away

Decentralized / small

“Local Energy Autarky”

(2013)





“International Large Scale”

(in progress)

Centralized / big

National / Local / nearby

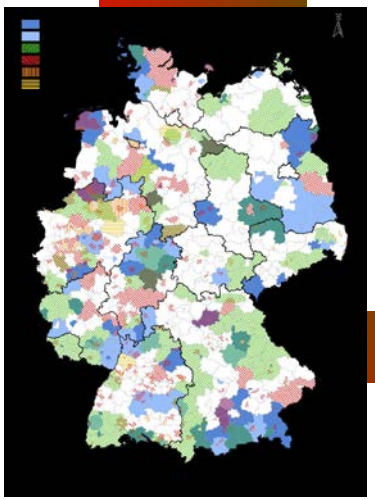
GHG Neutral Germany - Electricity

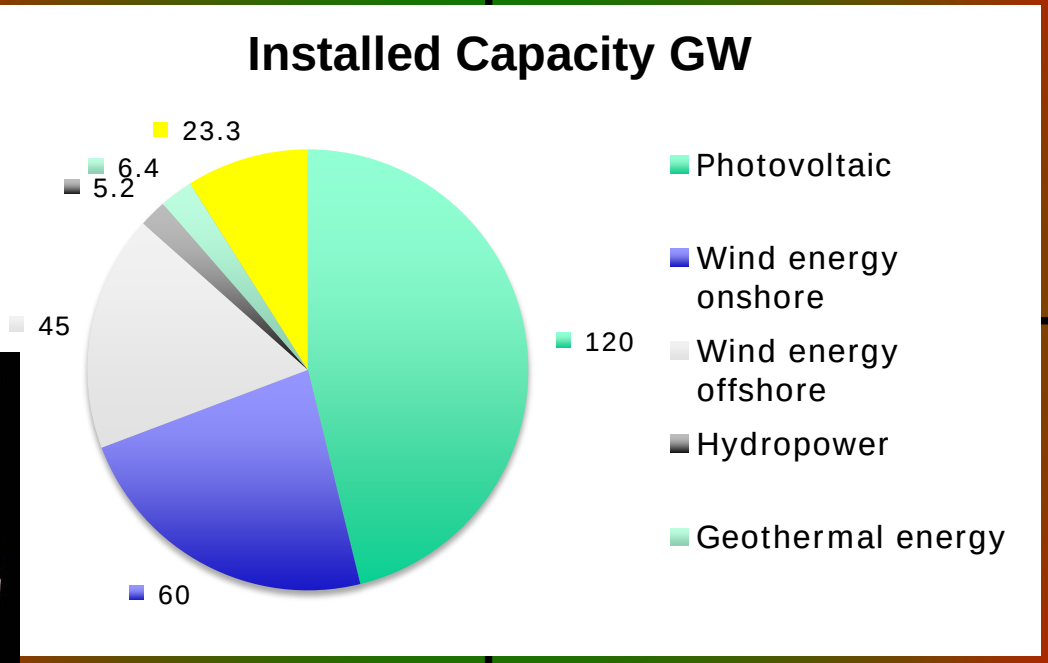
International / far away

Decentralized / small

Centralized / big

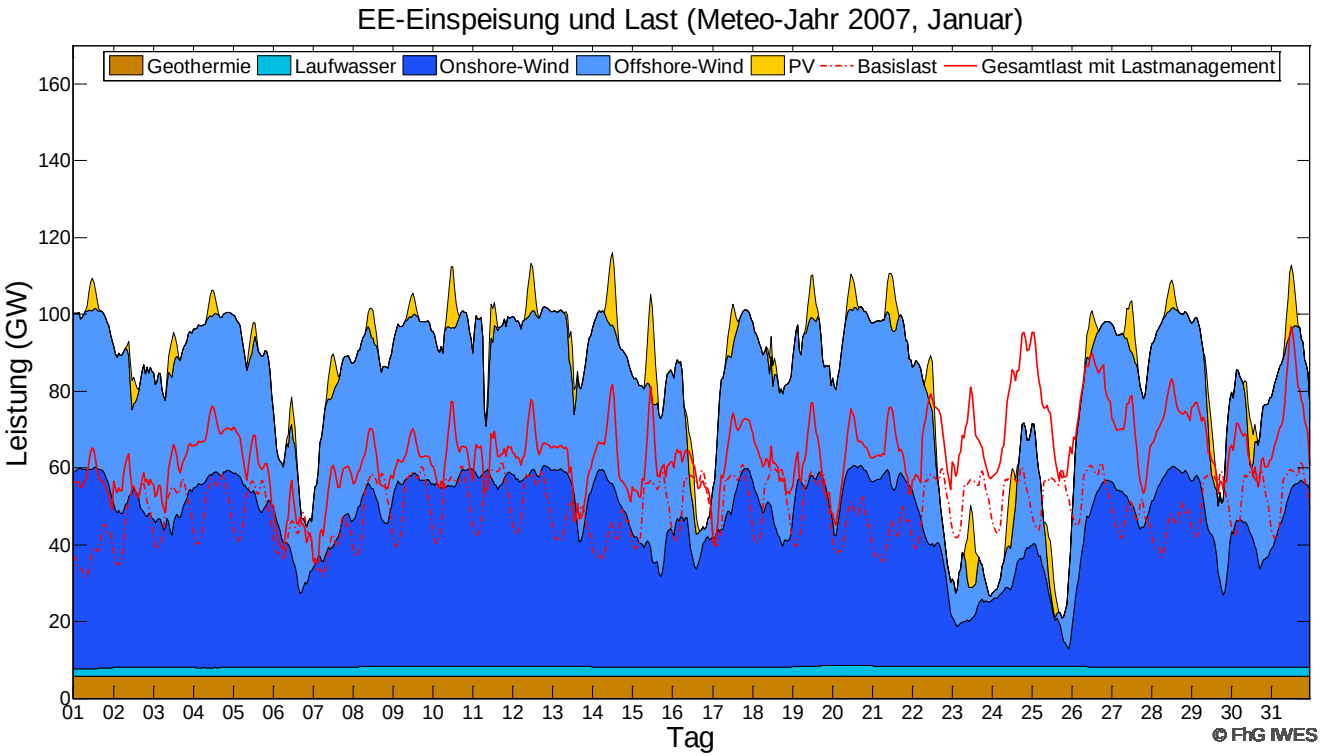
National / Local / nearby





Umwelt Bundesamt

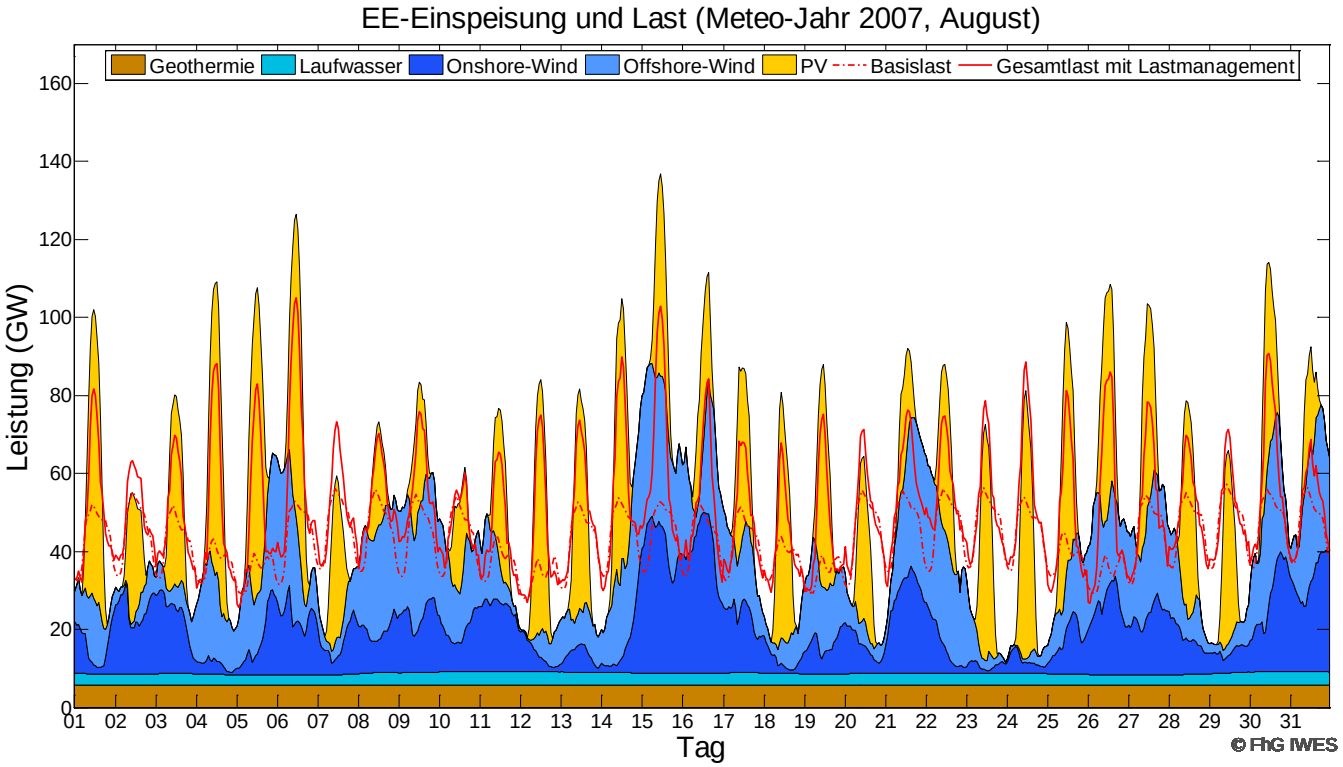
Feed-in of renewable energy and load – per month (winter)



Feed-in [GW] of all RE and the load curve

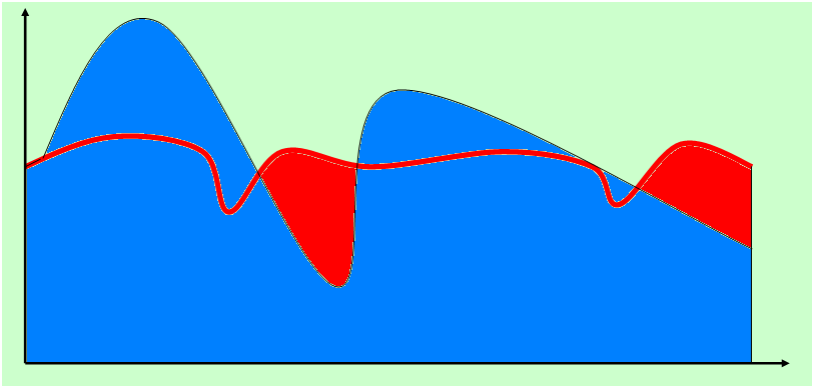
Example „Winter month“ (December) for the feed-in of renewable energies in 2050, based on the meteorological year 2007

Feed-in of renewable energies and load – per month (summer)



Feed-in [GW] of all RE and load

Example „Summer month“ (August) for the feed-in of renewable energies in 2050, based on the meteorological year 2007



Storage needed

Gravitational Storage

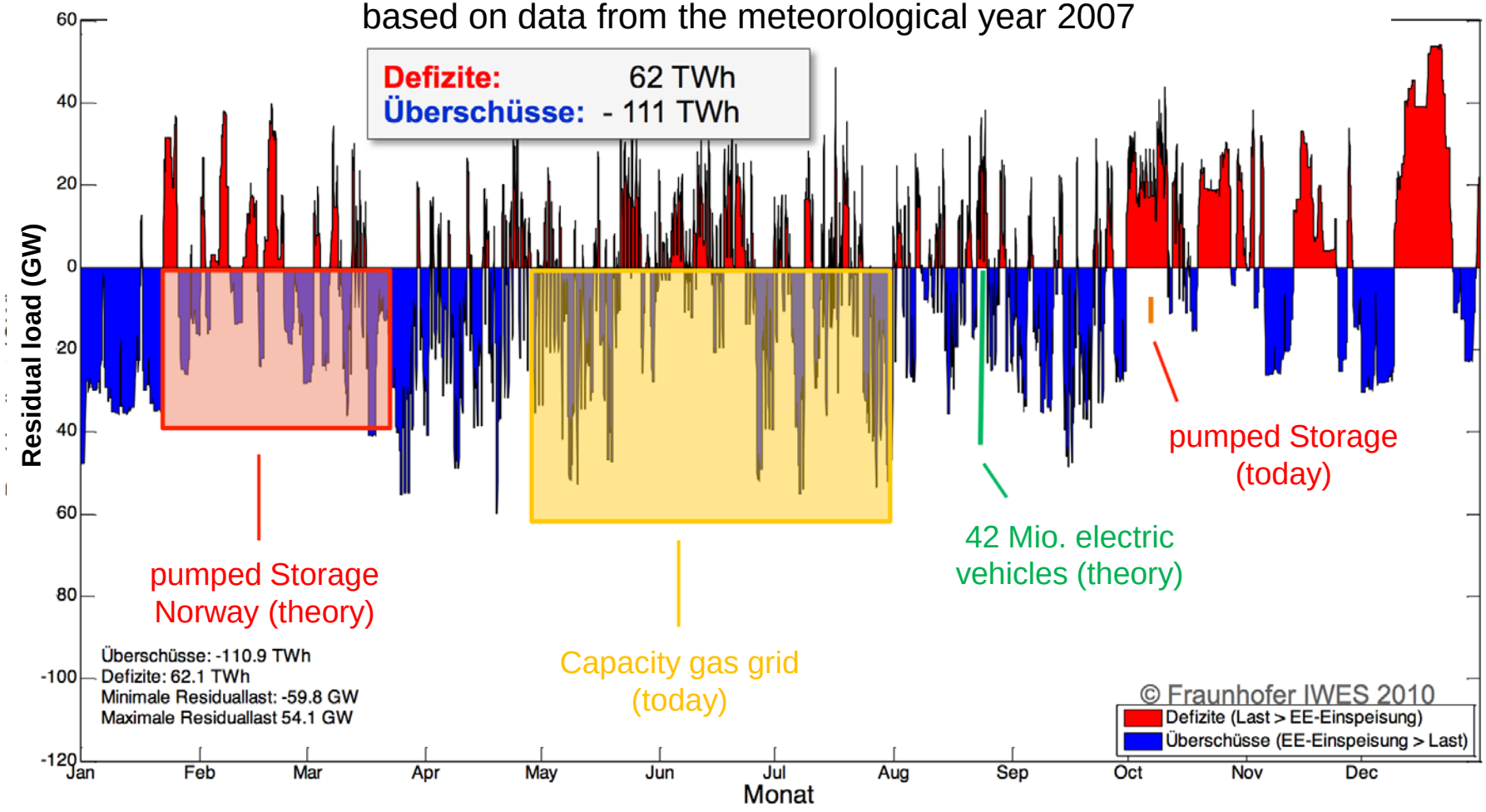
Chemical Storage

H2 or eMethan (SolarMethan)

Electric Storage

Different Storage Systems in a 100% REN Elec. System

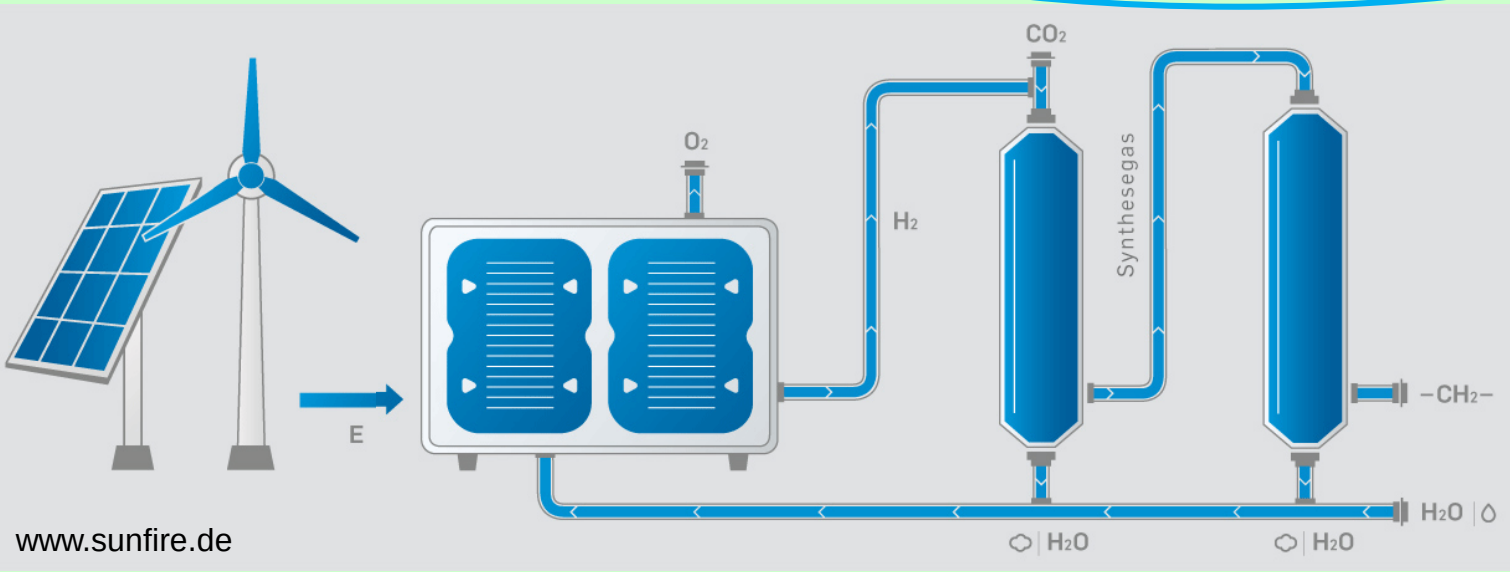
Total residual load (with load management and pump storage) in the year 2050, based on data from the meteorological year 2007



Umwelt Bundesamt

PtL - The Process

ELECTRICITY GENERATION **ELECTROLYSIS** **WATER-GAS SHIFT REACTION** **FISCHER-TROPSCH PROCESS**



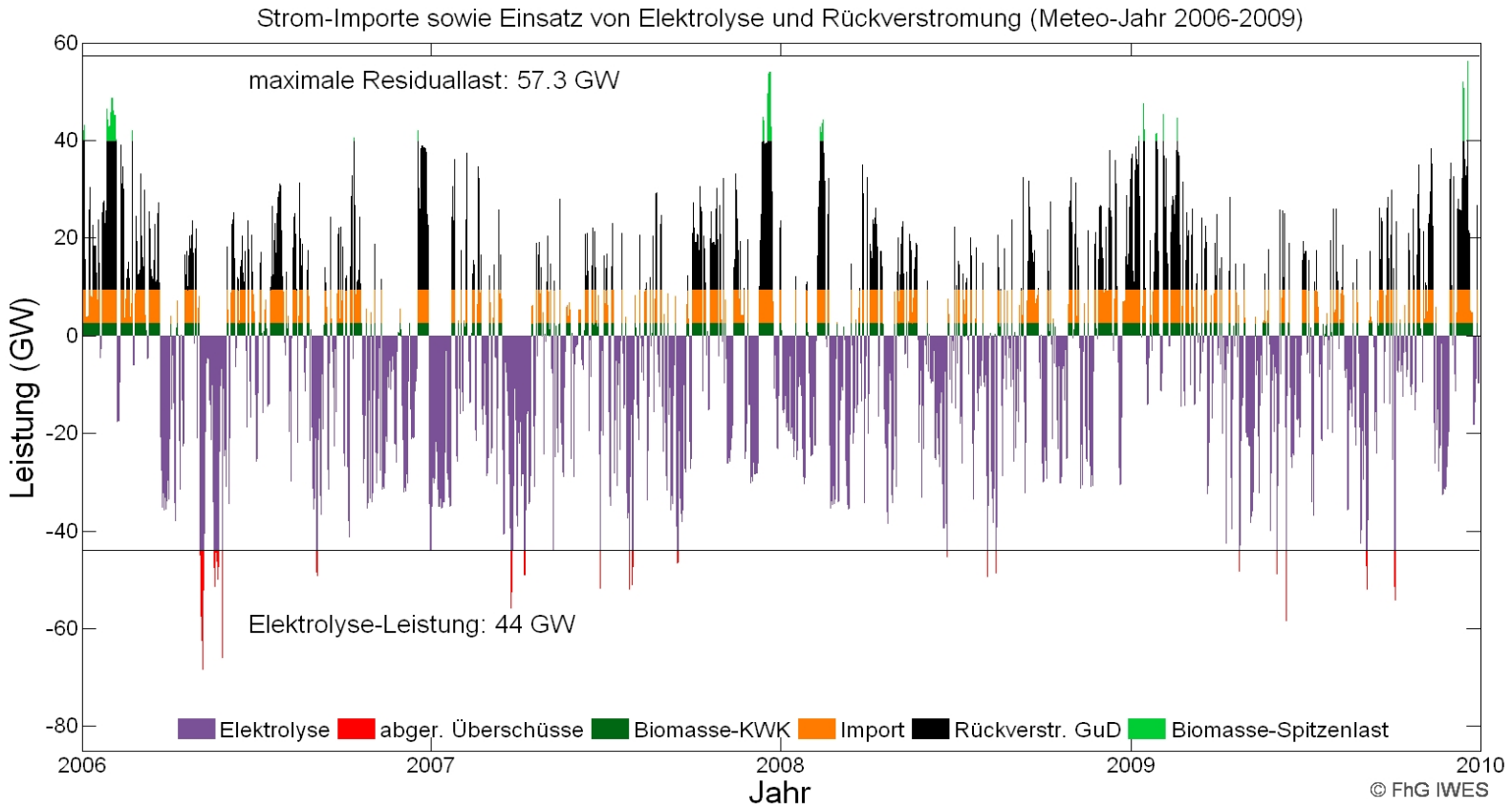
Established from Coal-to-liquid processes

(South Africa)

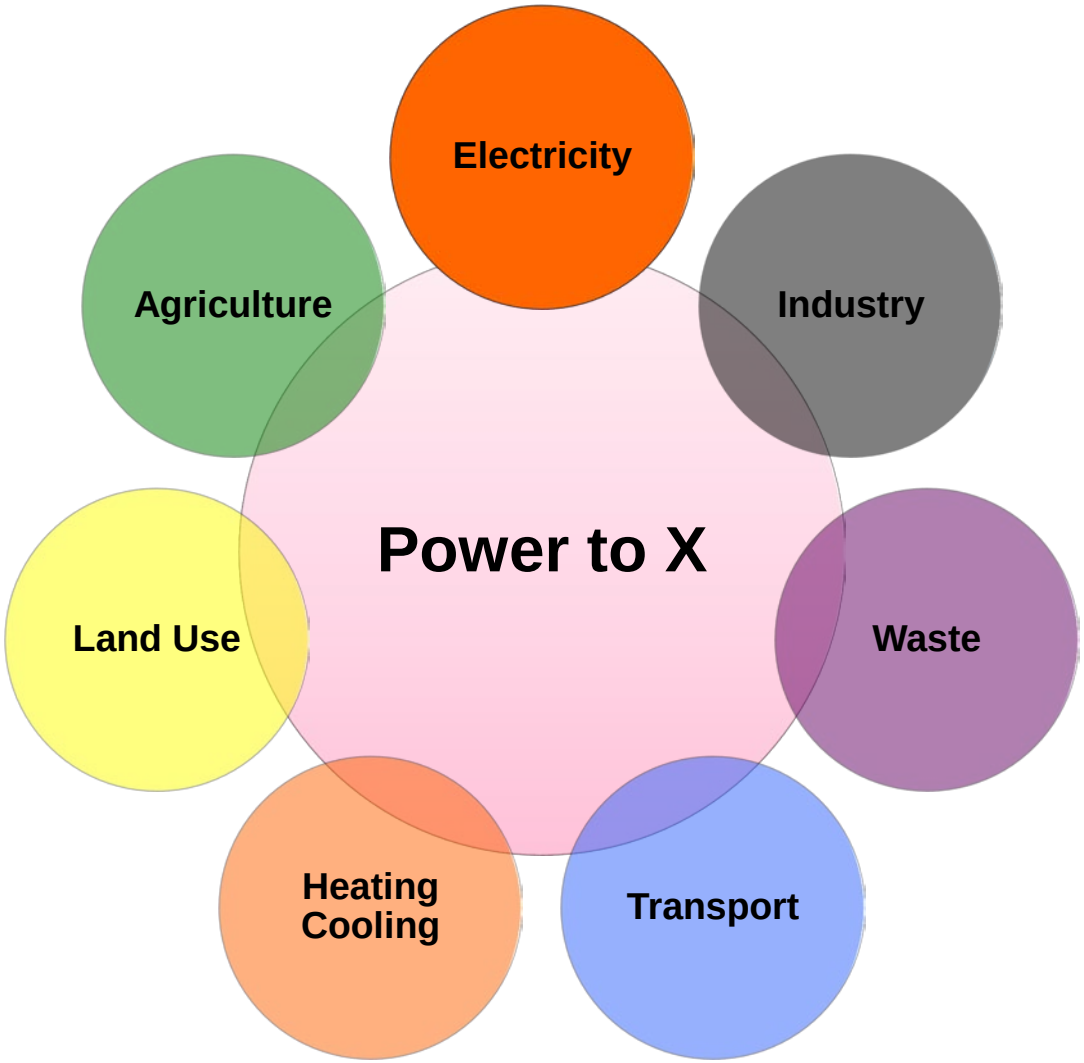
INPUT:
- RENEWABLE ENERGIES
- PURIFIED CO_2
- WATER

OUTPUT:
- SYNTHETIC LIQUID FUELS
- OXYGEN

Security of Supply



Greenhouse Gas Neutral Germany



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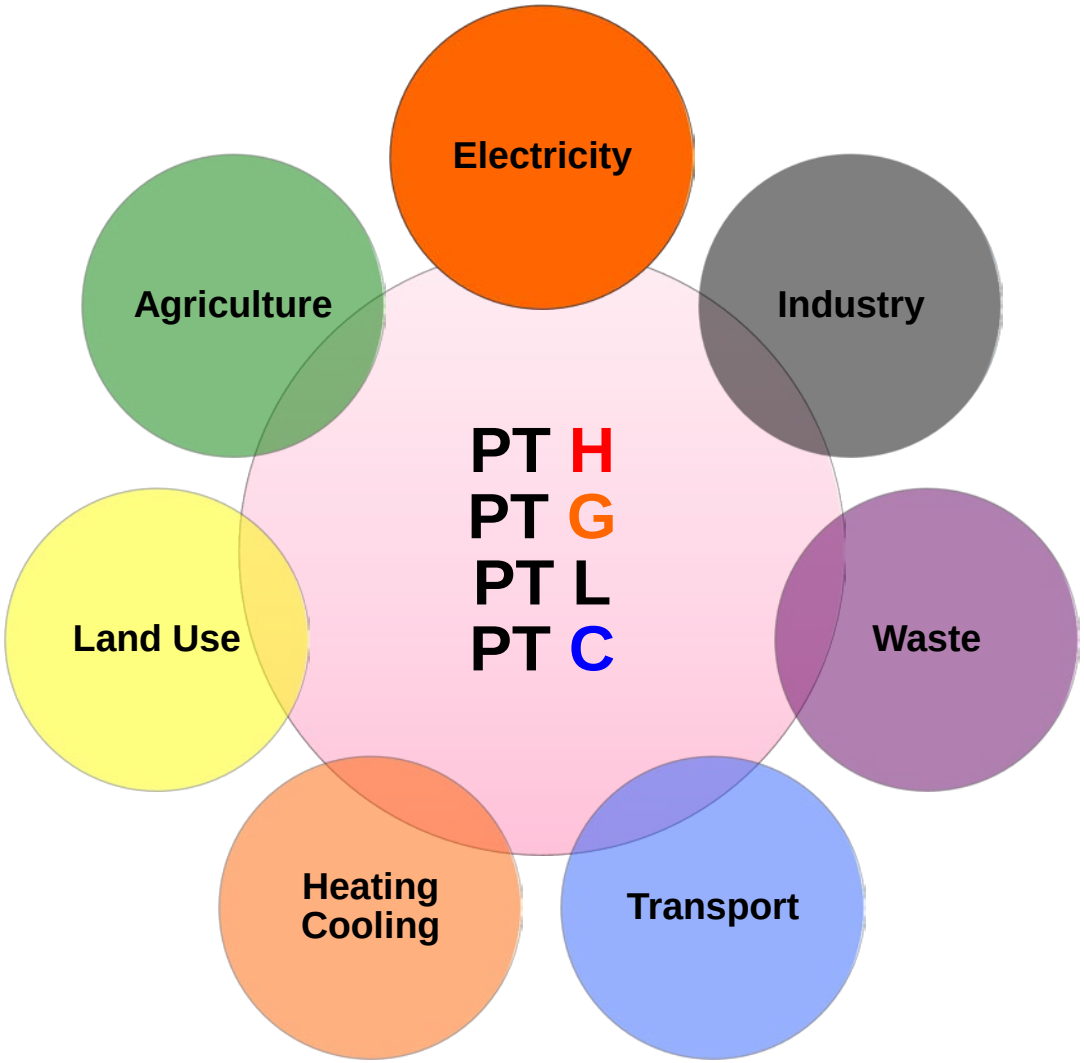

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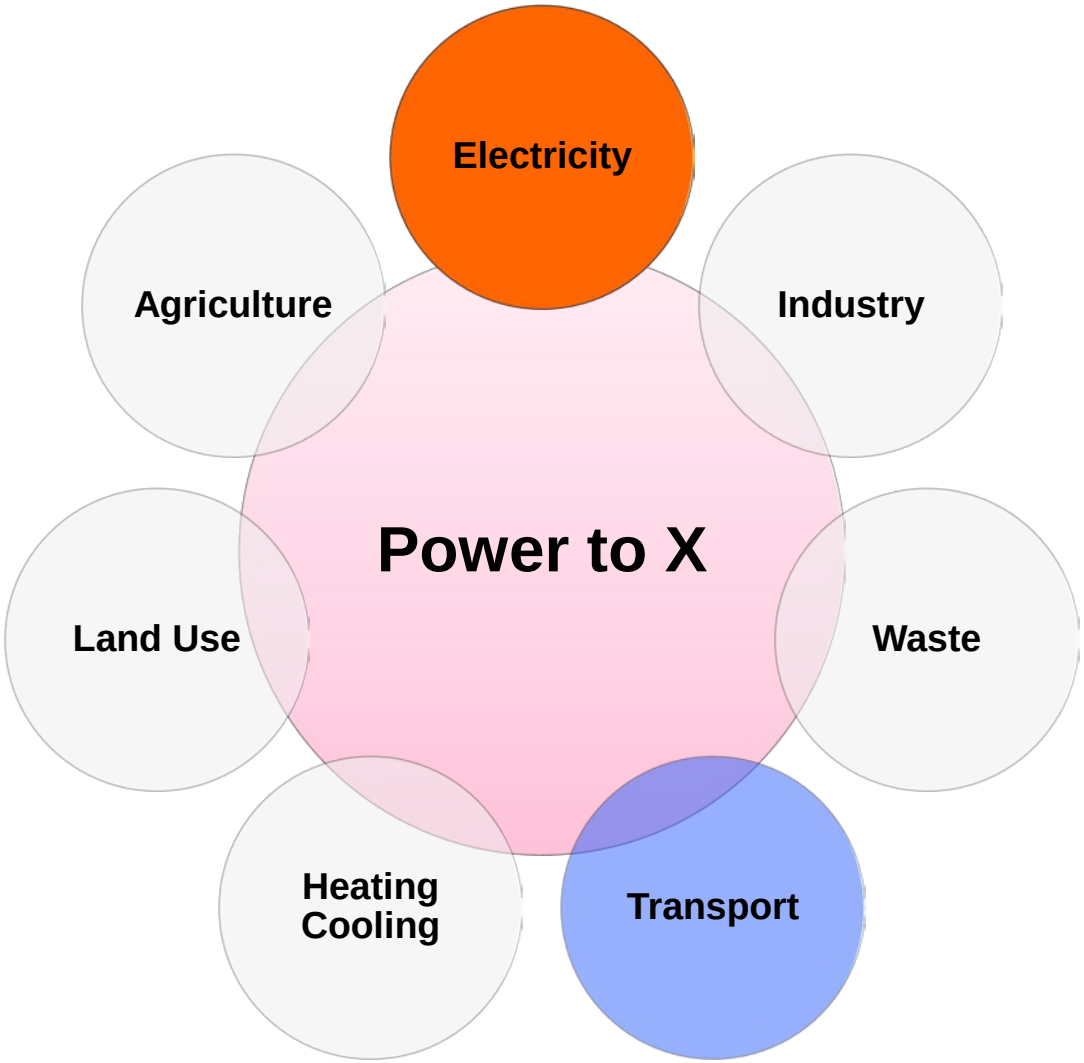


Power to Mobility – direct use of electricity and PTL

Electricity (incl. Plug-in-Hybrid)

- Passenger car
- Trucks short haul
- possibly Trucks long haul as overhead wire
- Urban buses
- Rail traffic


Quelle:urlaubsgur


Quelle:badischeZeitung.de

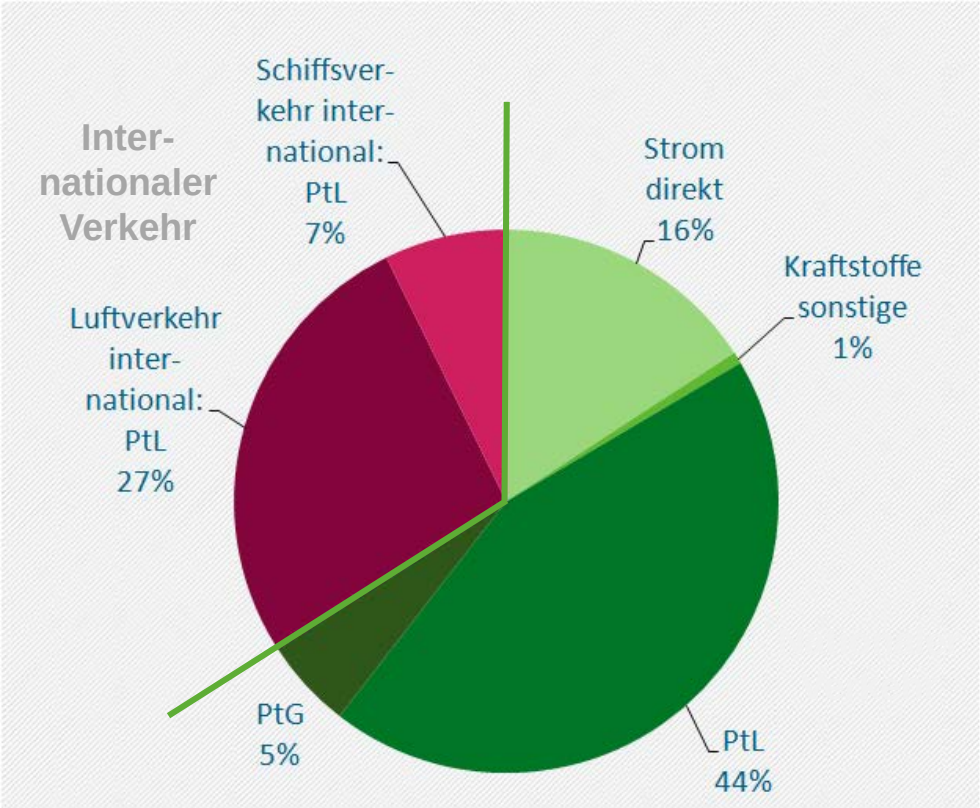
PTL: methanol, kerosene, gasoline, diesel,


Quelle: siemens.com


Quelle: Deutsche Handwerkszeitung.de

Quelle: spieg

Power to Mobility – Scenario 2050 + (1.600 PJ)



Quelle: IFEU/INFRAS/LBST 2016.

Quelle:urlaubsgur

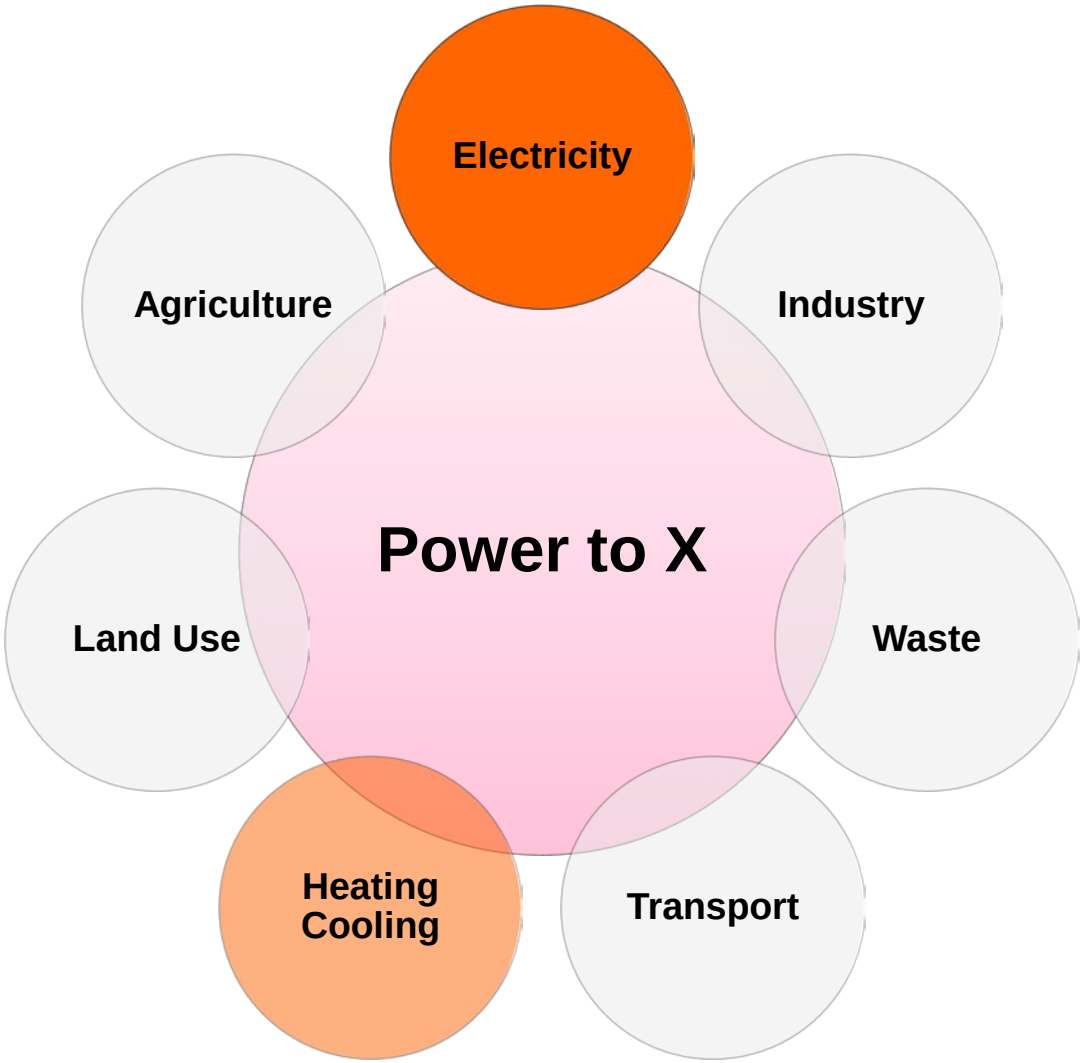
Quelle:badischeZeitung.de

Quelle: siemens.com

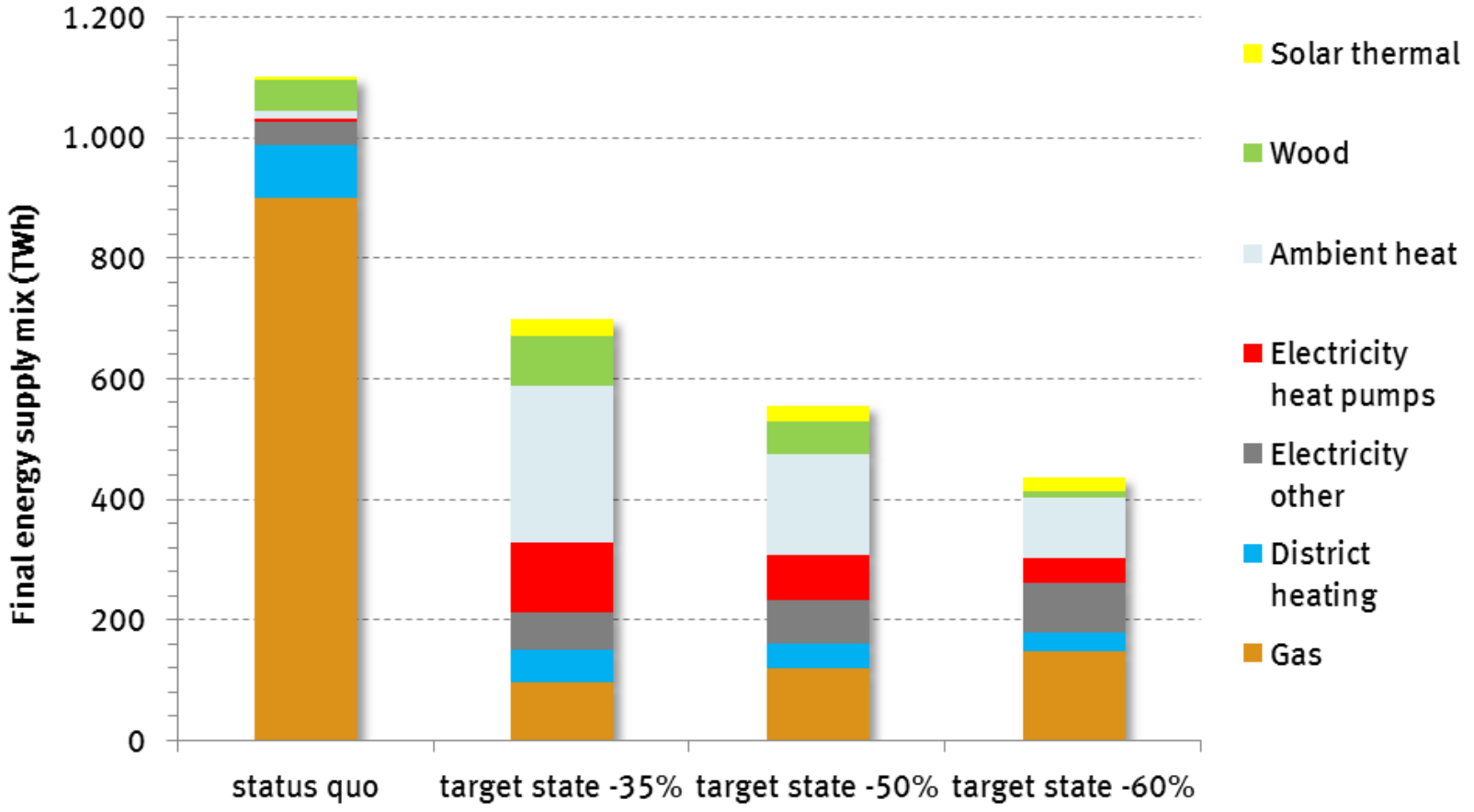
Quelle: Deutsche Handwerkszeitung.de

Quelle: spieg

Greenhouse Gas Neutral Germany

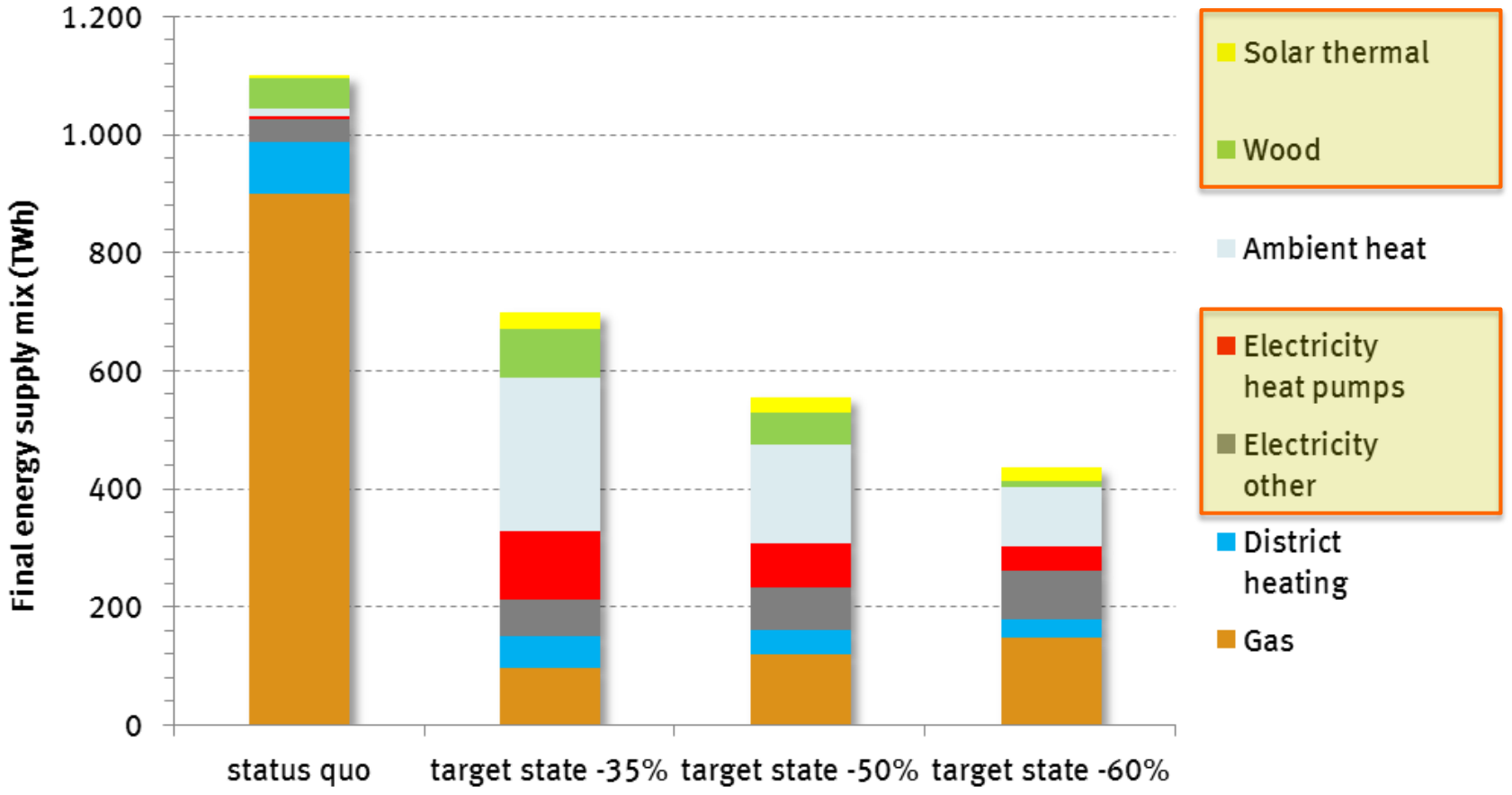


2050 scenarios with different renovation standards



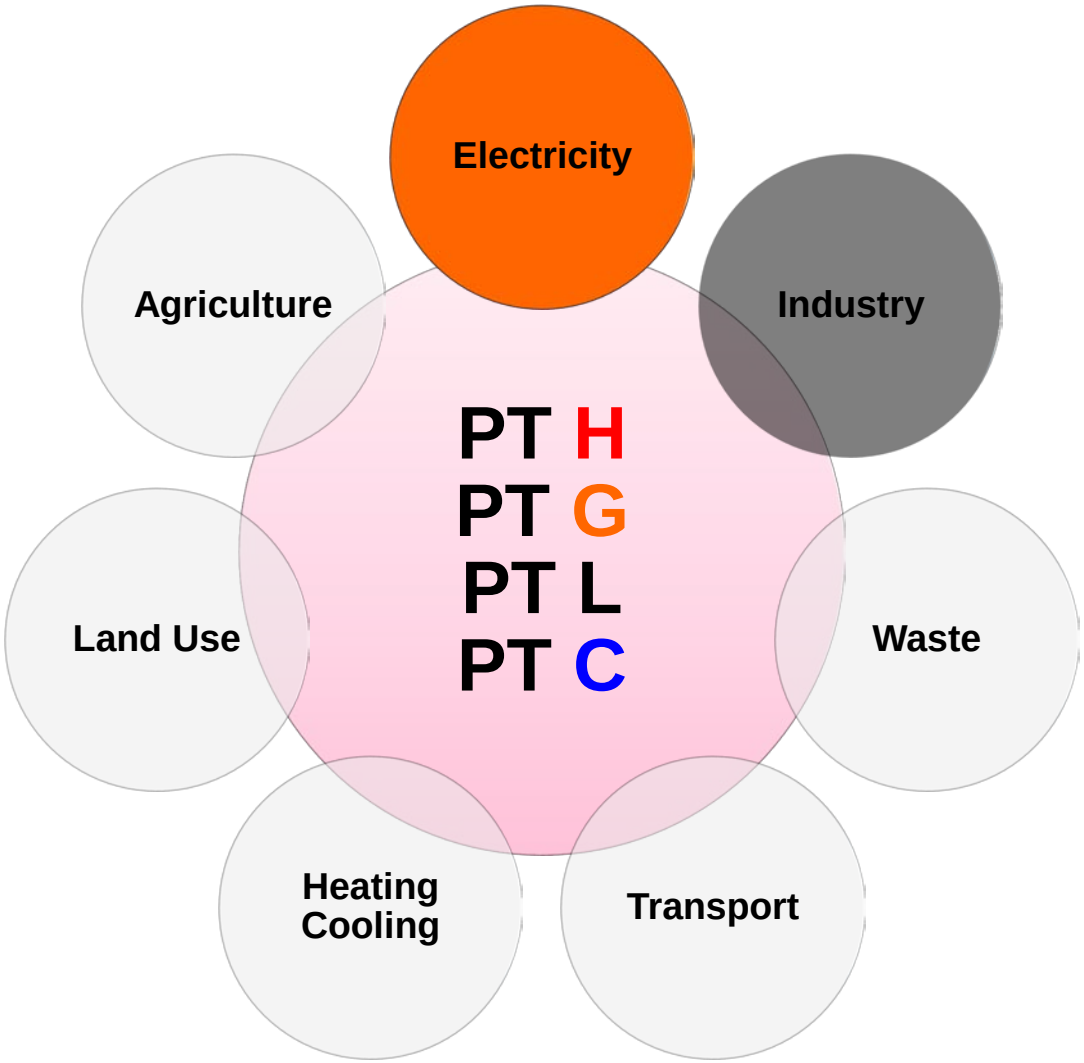
Quelle: UBA – ÖkoInstitut – Fraunhofer Institut 2016

2050 scenarios with different renovation standards

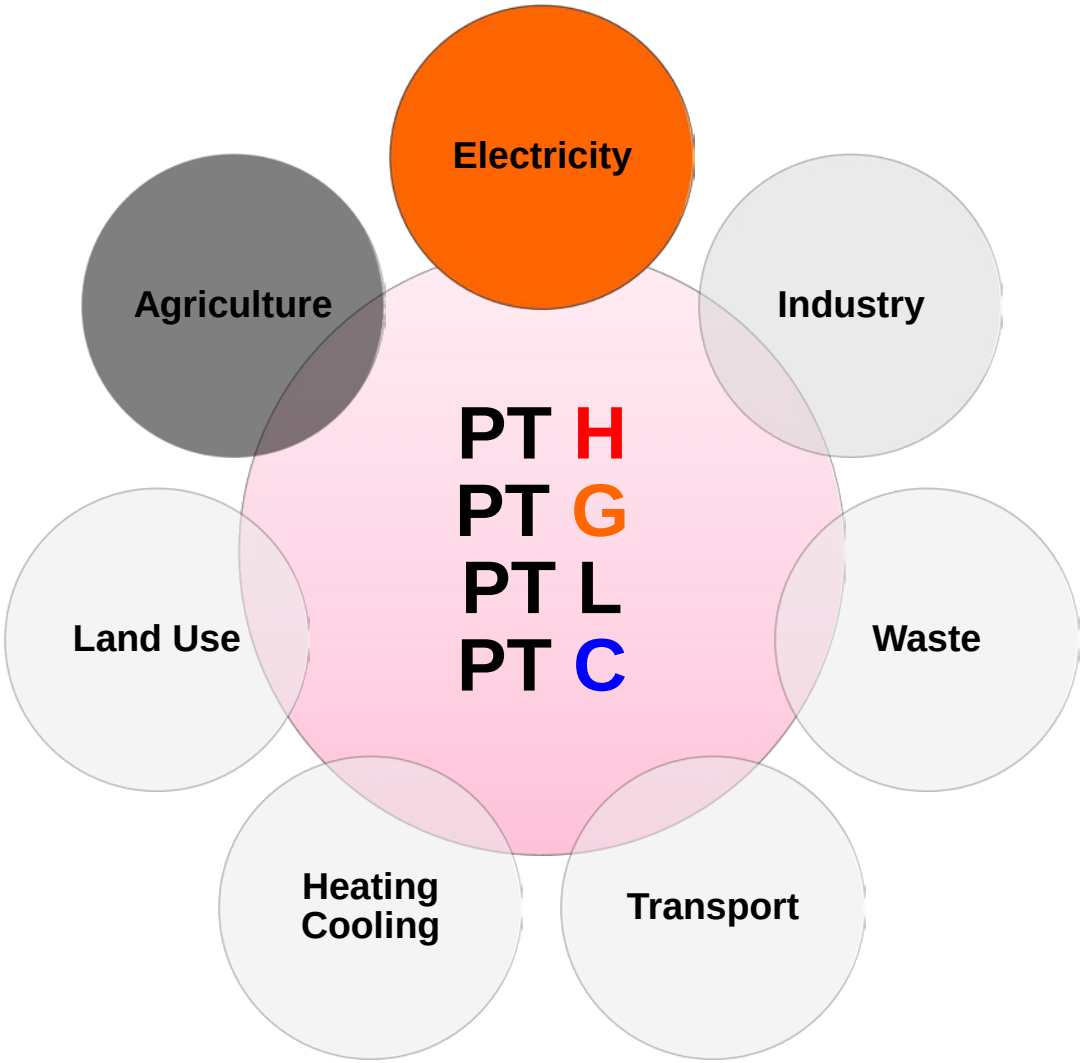


Quelle: UBA – ÖkoInstitut – Fraunhofer Institut 2016

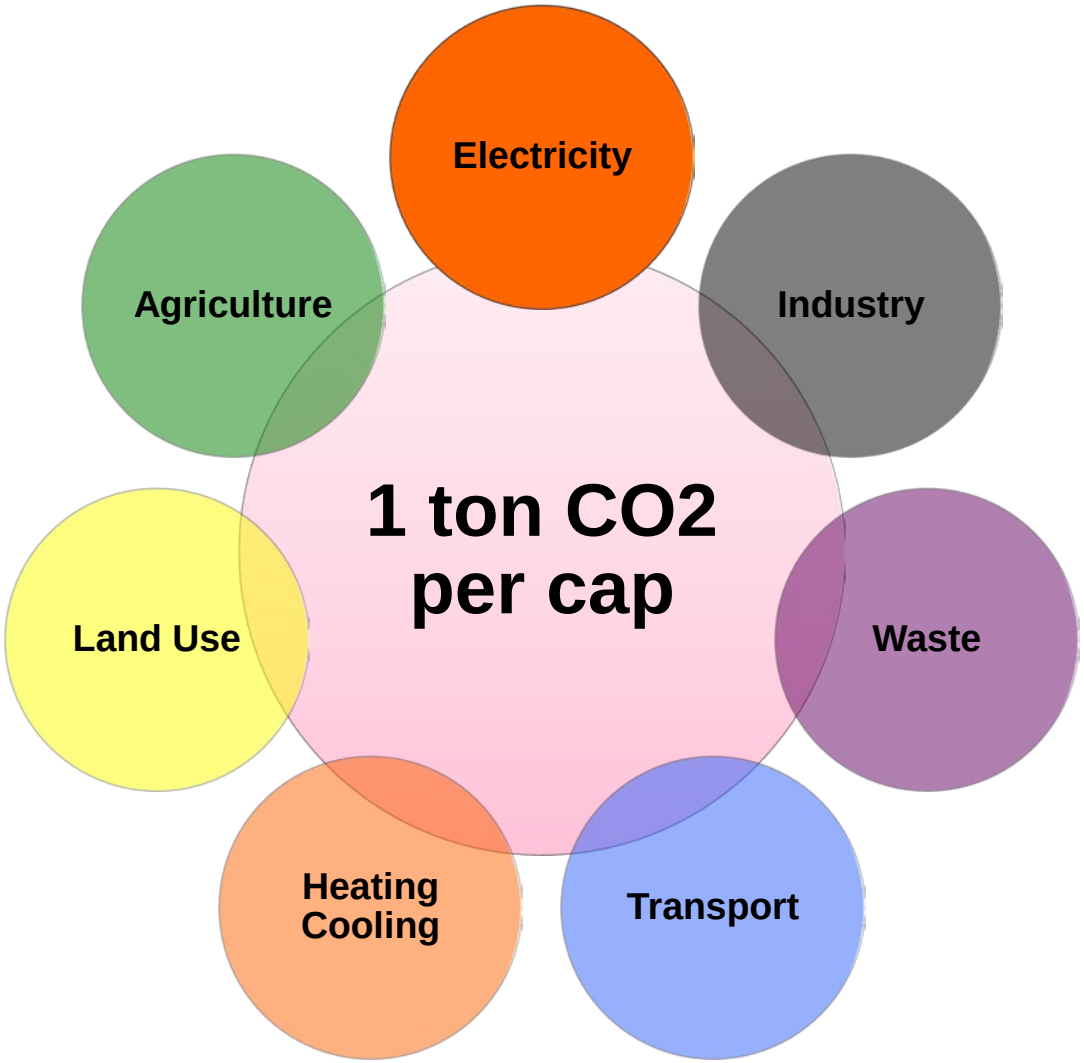
Greenhouse Gas Neutral Germany



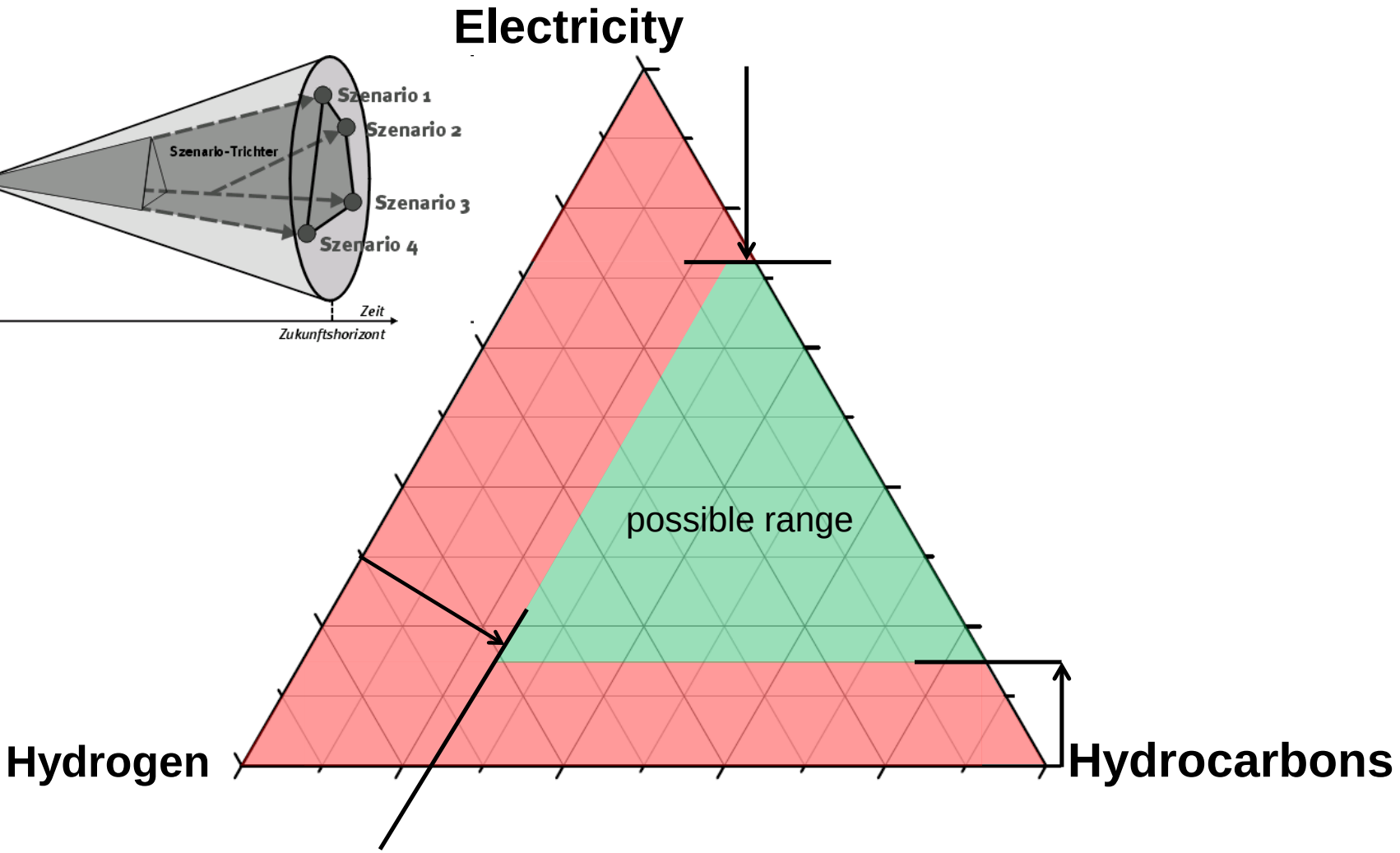
Greenhouse Gas Neutral Germany



Greenhouse Gas Neutral Germany

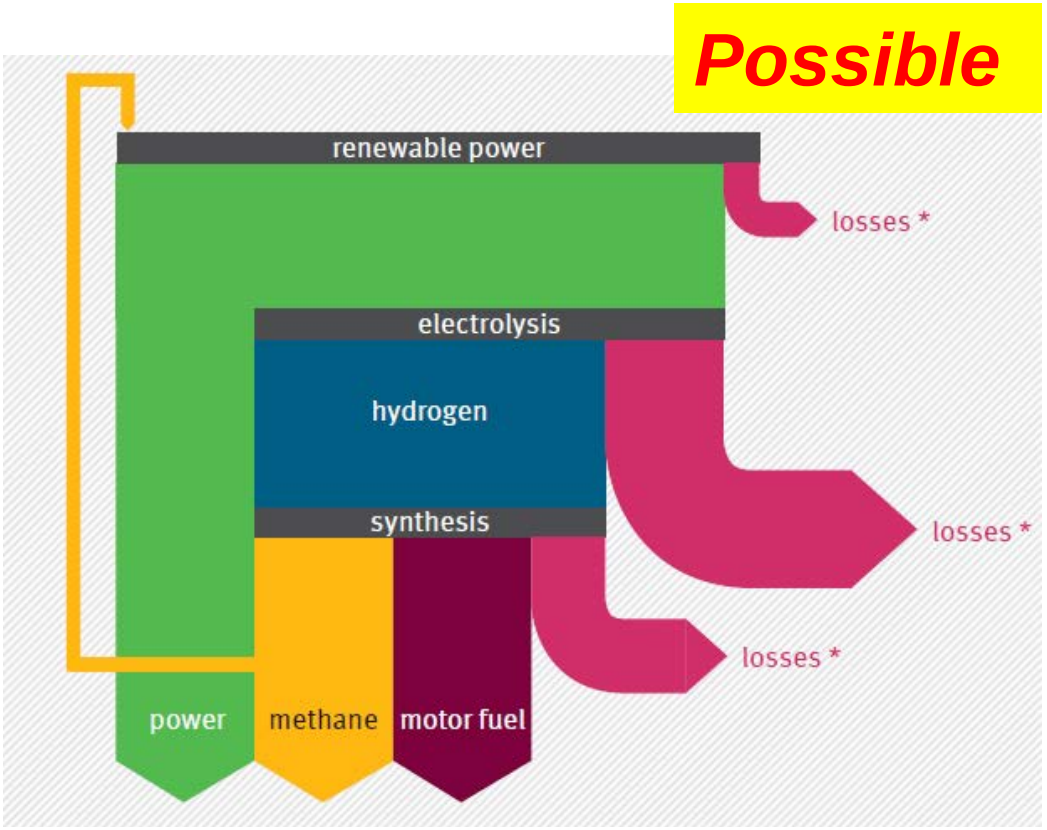


Possible range of GHG-neutral final energy sources

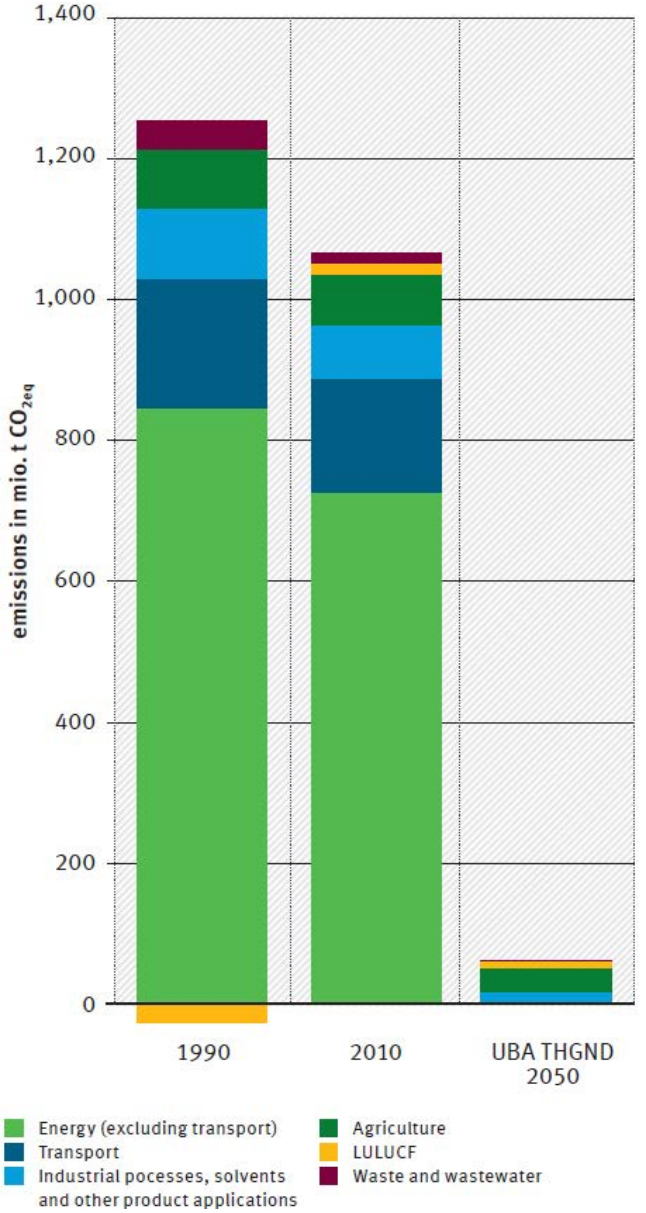


Source UBA, 2014/2016

UBA-Study: GHG-neutral Germany i



Qualitative representation of the energy flow in the UBA THGND 2050 Scenario



Source: UBA

Elements of a Greenhouse Gas Neutral Society

Per capita emissions of just one metric ton of CO_2eq in 2050

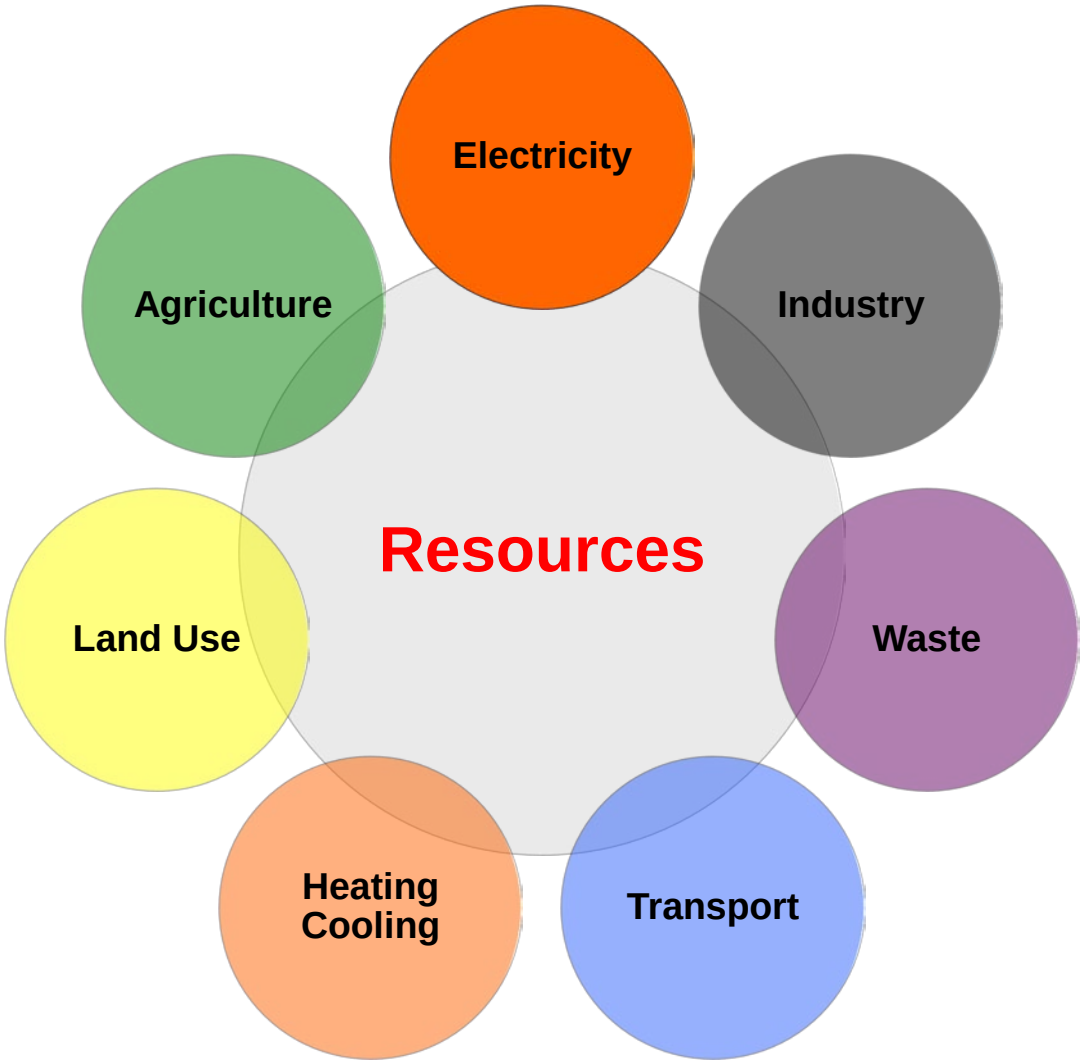
Final energy demand in 2050 reduced by 50 % versus 2010

Sector coupling via "Power to Gas" and "Power to Liquid" implies a steep rise in electricity consumption

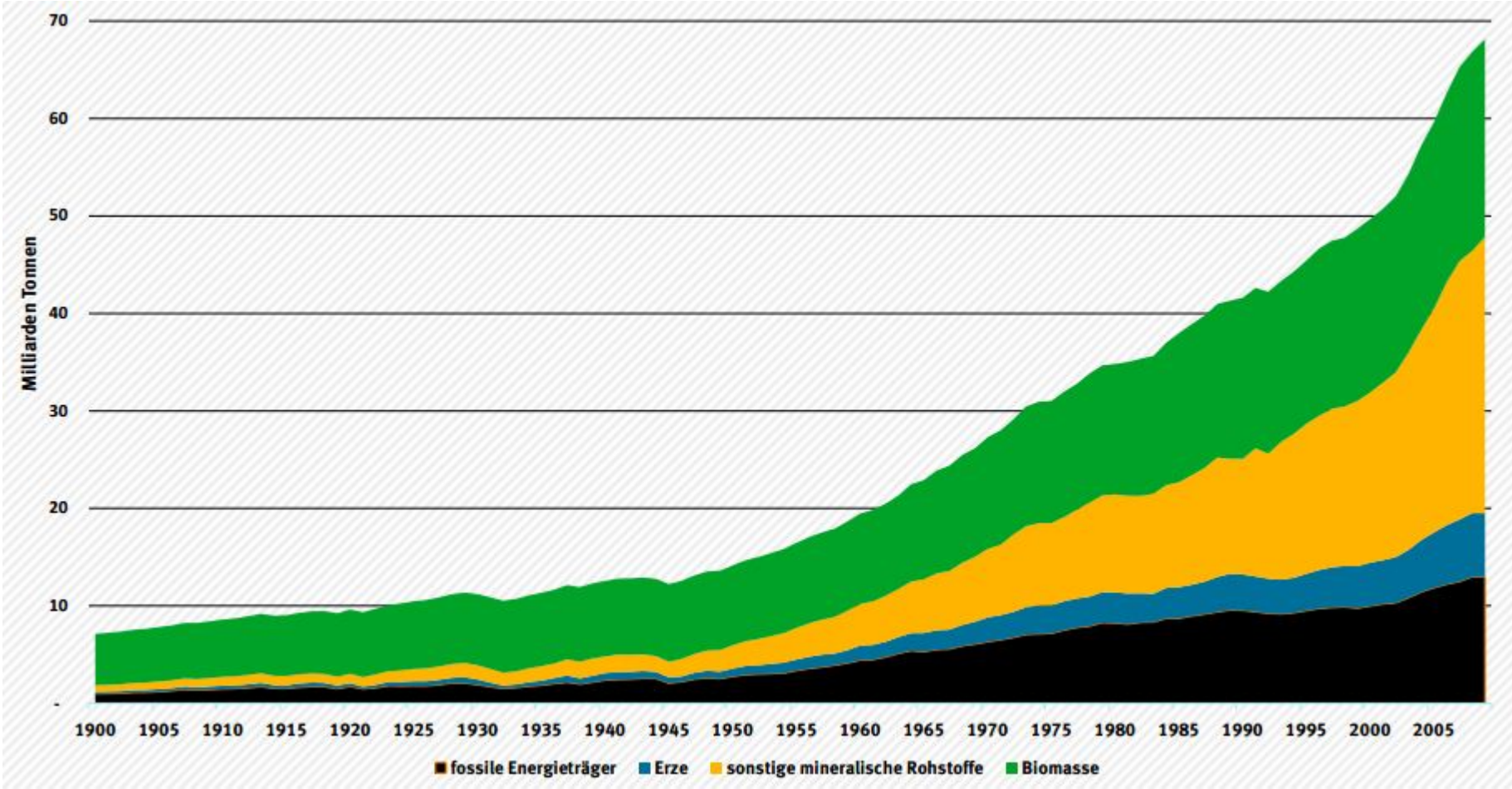
The net energy to be generated amounts to approximately 3.000 TWh p.a. predominantly produced by wind and PV installations (2014: 511 TWh)

No use of neither energy crops nor CCS nor nuclear energy is assumed

Greenhouse Gas Neutral Germany

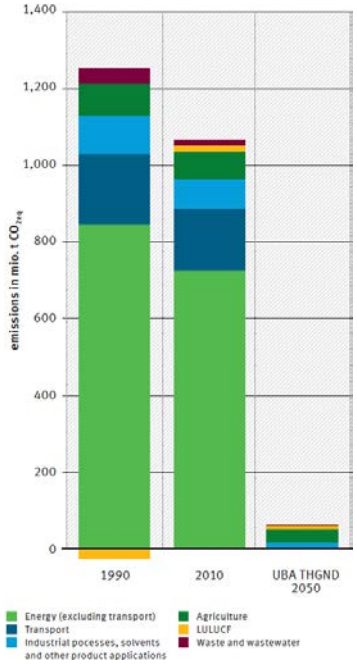


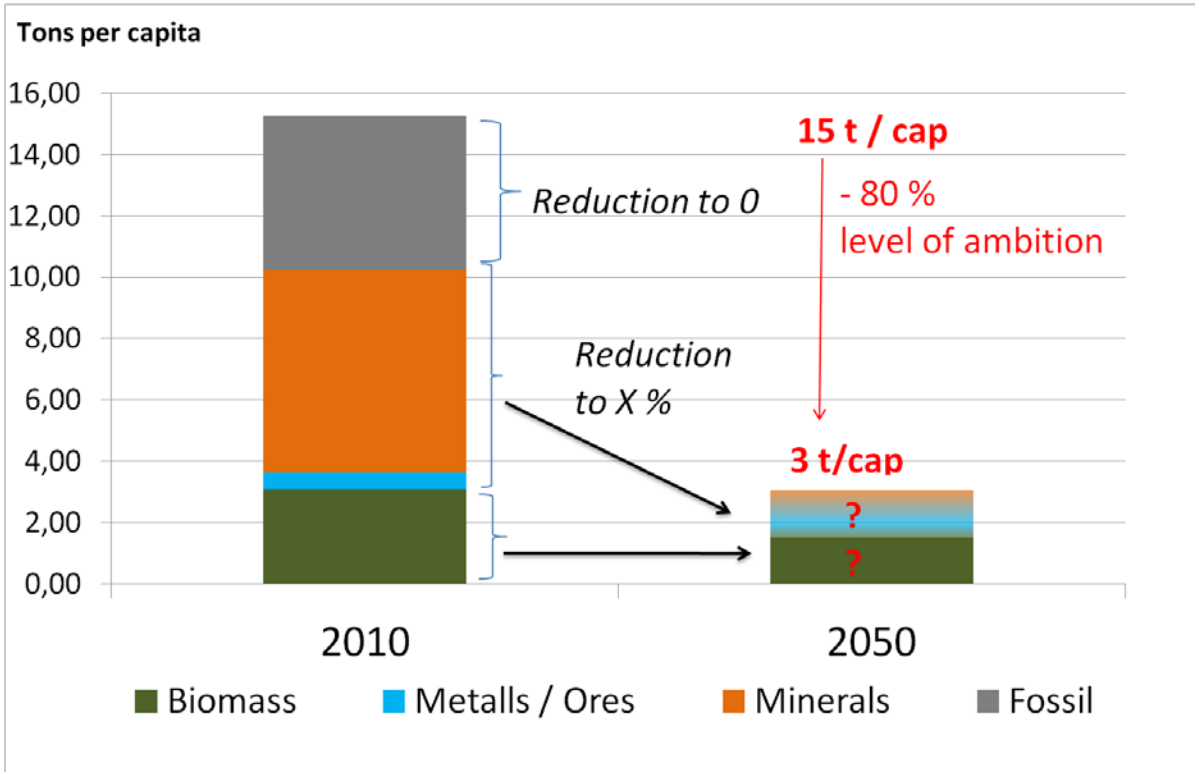
Globale Primärrohstoffentnahme



Quelle: Krausmann et al. (2009): Growth in global materials use, GDP and population during the 20th century, Ecological Economics Vol. 68, Nr. 10, 2696-2705, Version 1.2 (August 2011), www.uni-klu.ac.at/socec/inhalt/3133.htm

Can we reduce resource use to sustainable levels at the same time?

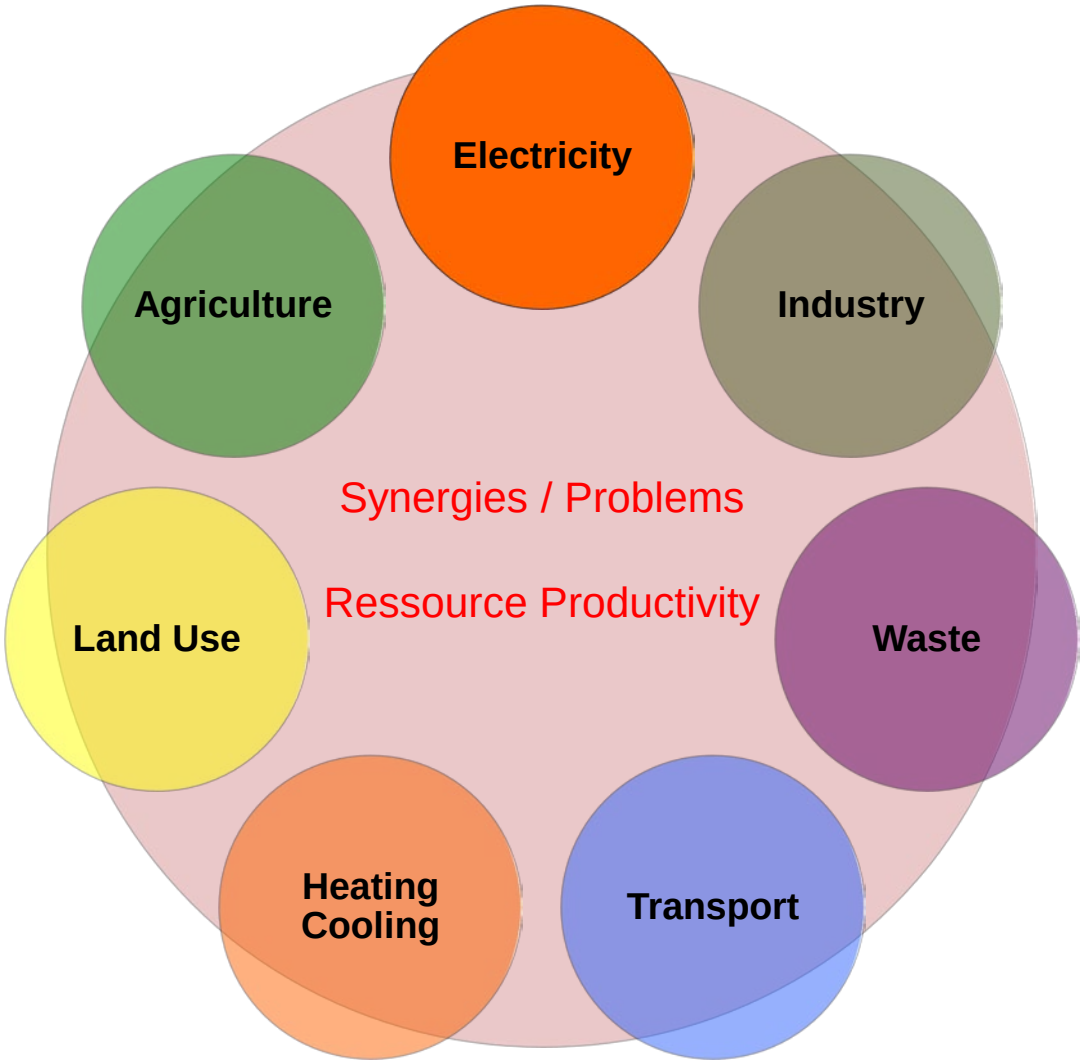




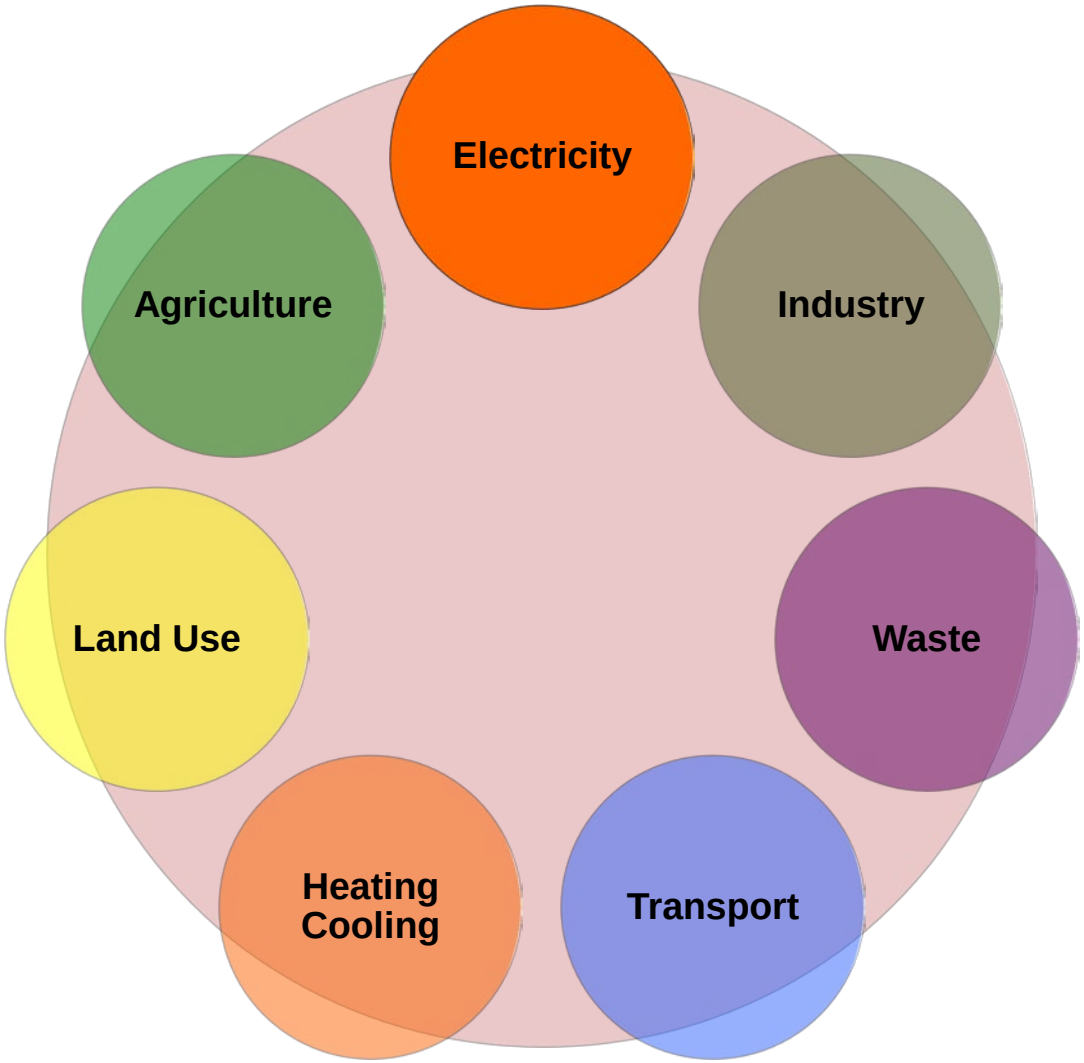
The new project of UBA – RTD2050:

Pathways towards a greenhouse gas neutral and resource efficient country till 2050

- 100 % renewable energy in power, heat, traffic and industry
- especially technical measures for the reduction of ghg emission in all areas
- Ecological and sustainable Agriculture
- Changed meat consumption
- High recycling rates (80%) and use of secondary materials
- Reductions along the whole value chain
- Different Scenarios – e.g. less Efficiency ... More Import ... ???


Electricity
Agriculture
Industry
Synergies / Problems
Ressource Productivity
Land Use
Waste
Heating
Cooling
Transport

Policy


Electricity
Agriculture
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Heating
Cooling
Transport

Climate Action Plan 2050

Target

- 80 to 95% reduction of greenhouse gas emissions by 2050 (below 1990 levels)

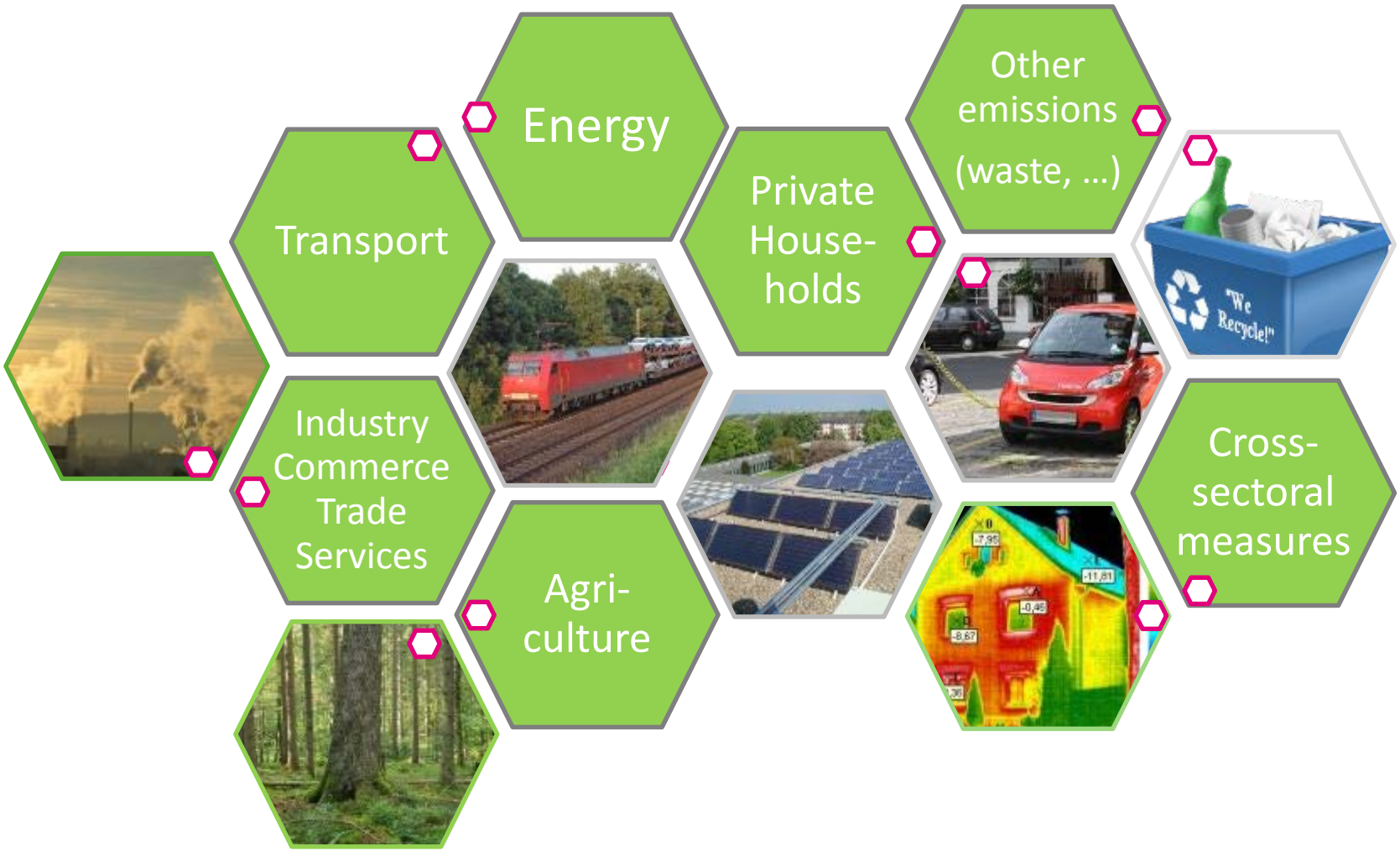
Strategies

- Identification of robust strategies and possible transformative pathways

Measures

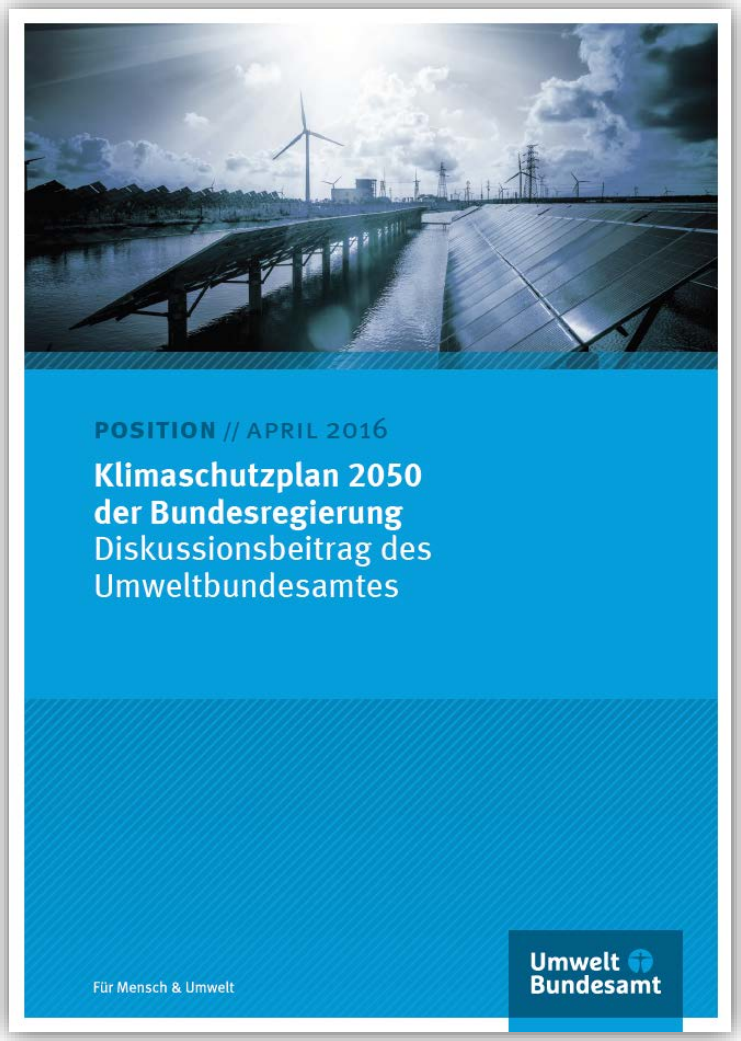
- Building on dialogue and participation
- Recommendations to the government
- Government to assess, comment on recommendations, draft climate action plan by summer 2016

All sectors contribute to emissions reduction



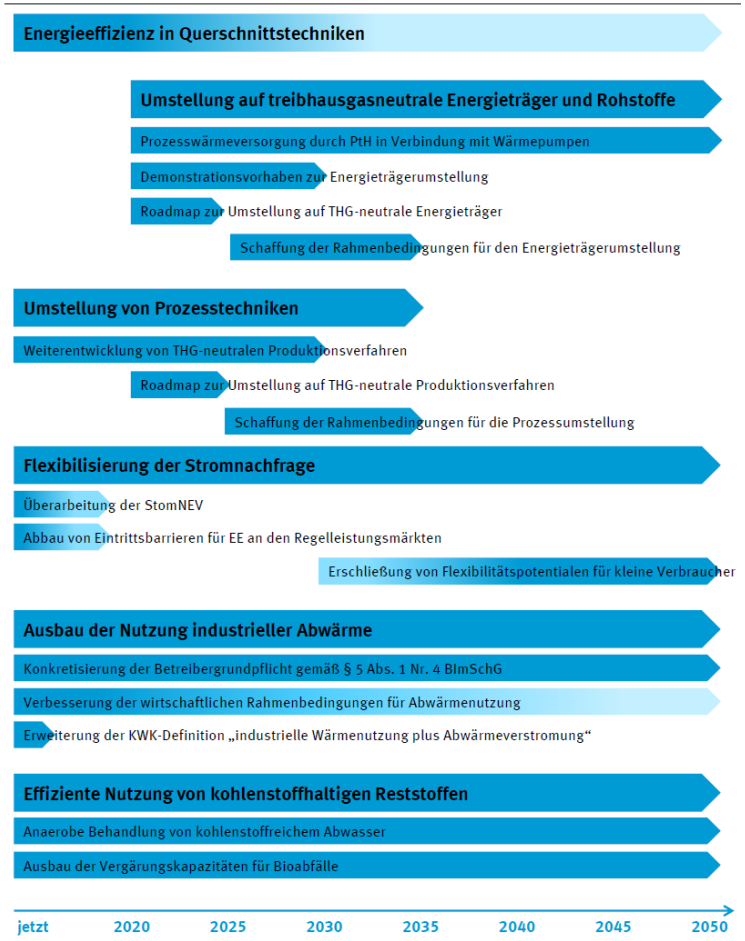
UBA Position paper to the Climate Action Plan 2050

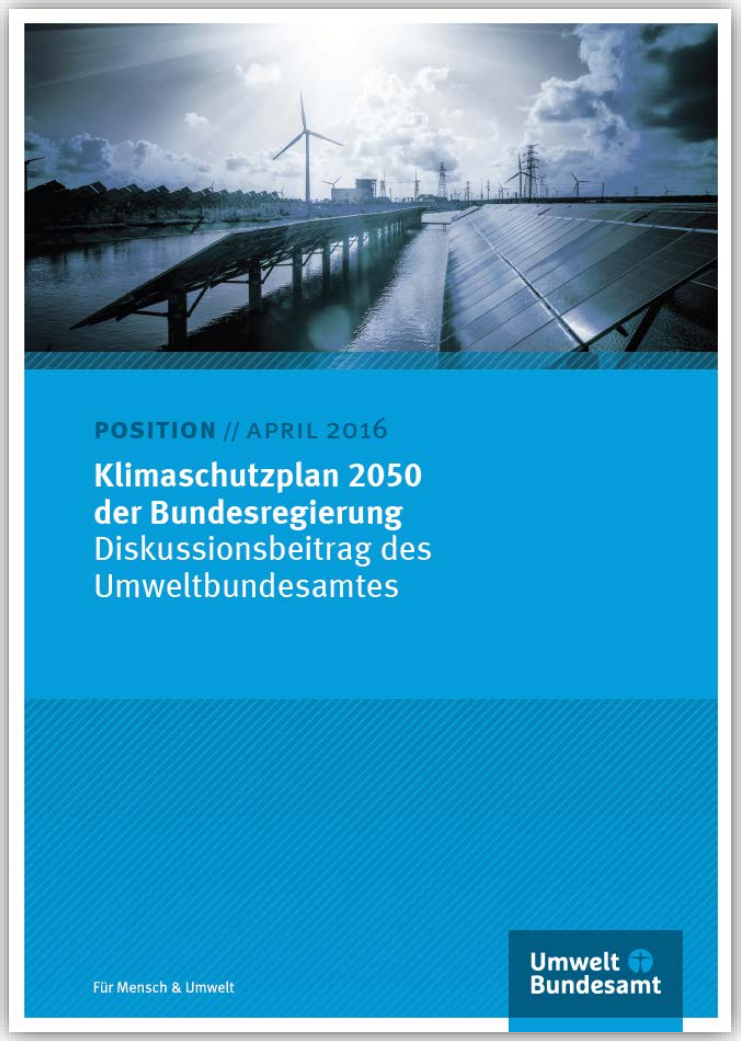
- Designing the transformation process to a GHG neutral society
- Ambitious GHG reduction of 95% (below 1990 levels)
- Recommendation of 32 measures to the German government



English version of this position paper is forthcoming.

UBA Position paper to the Climate Action Plan 2050





English version of this position paper is forthcoming.

Thanks !

8.11.2016 – Berlin – Workshop Decarbonisation + Resource Eff.

Dr. Harry Lehmann (harry.lehmann@uba.de)

http://www.umweltbundesamt.de/en

- Germany 2050 - A Greenhouse Gas-Neutral Country https://www.umweltbundesamt.de/publikationen/germany-2050-a-greenhouse-gas-neutral-country
- Integration of Power to Gas/ Power to Liquids into the ongoing transformation process https://www.umweltbundesamt.de/publikationen/integration-of-power-to-gas-power-to-liquids-into
- Proceedings of the Workshop „Decarbonisation – 100 % Renewable Energy and more“ from November 2015 https://www.umweltbundesamt.de/en/publikationen/proceedings-of-the-workshop-decarbonisation-100