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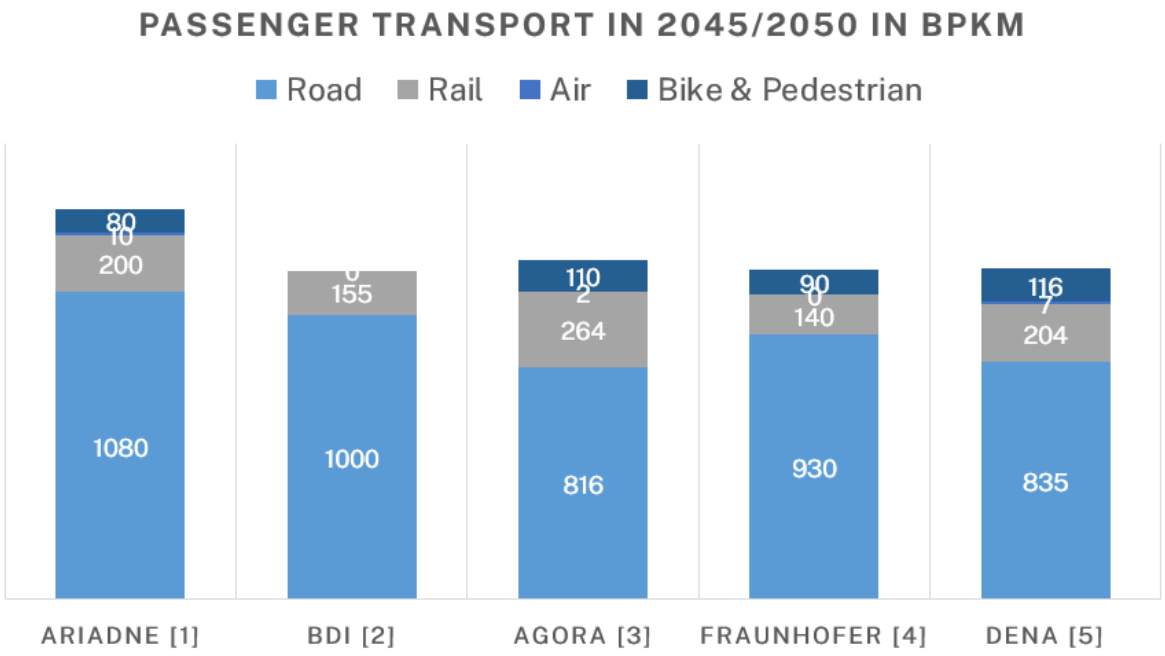
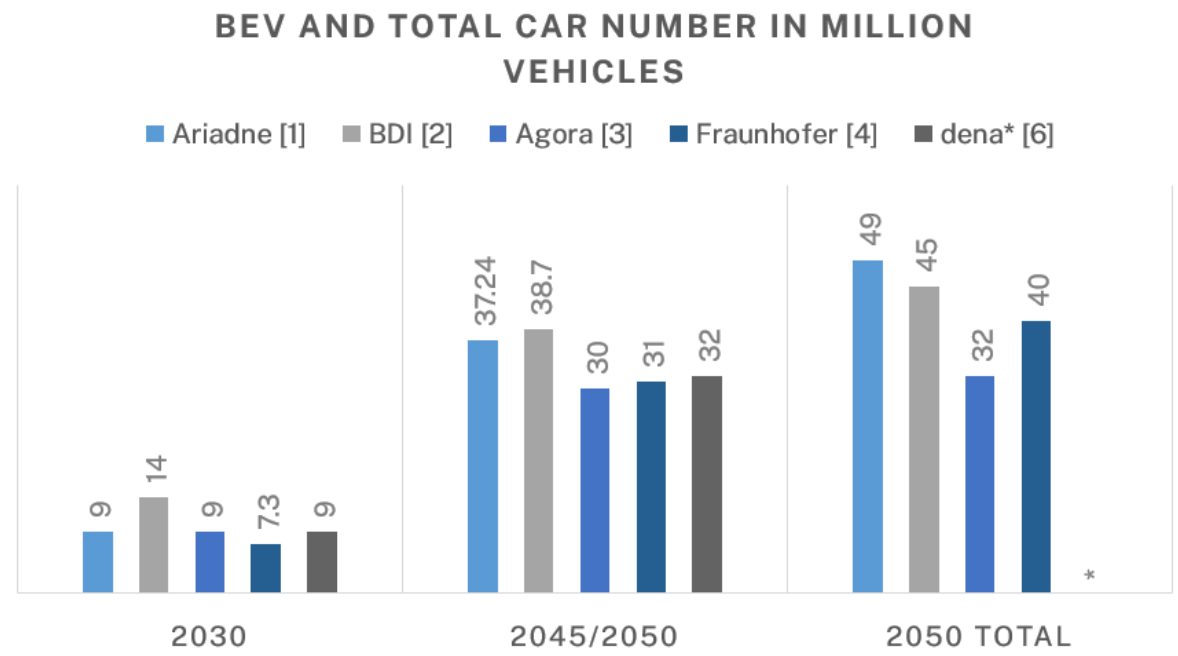
Sensitivity analysis on the future low-carbon transportation sector in Germany and policy recommendations

Transportation sector in ESM analyses

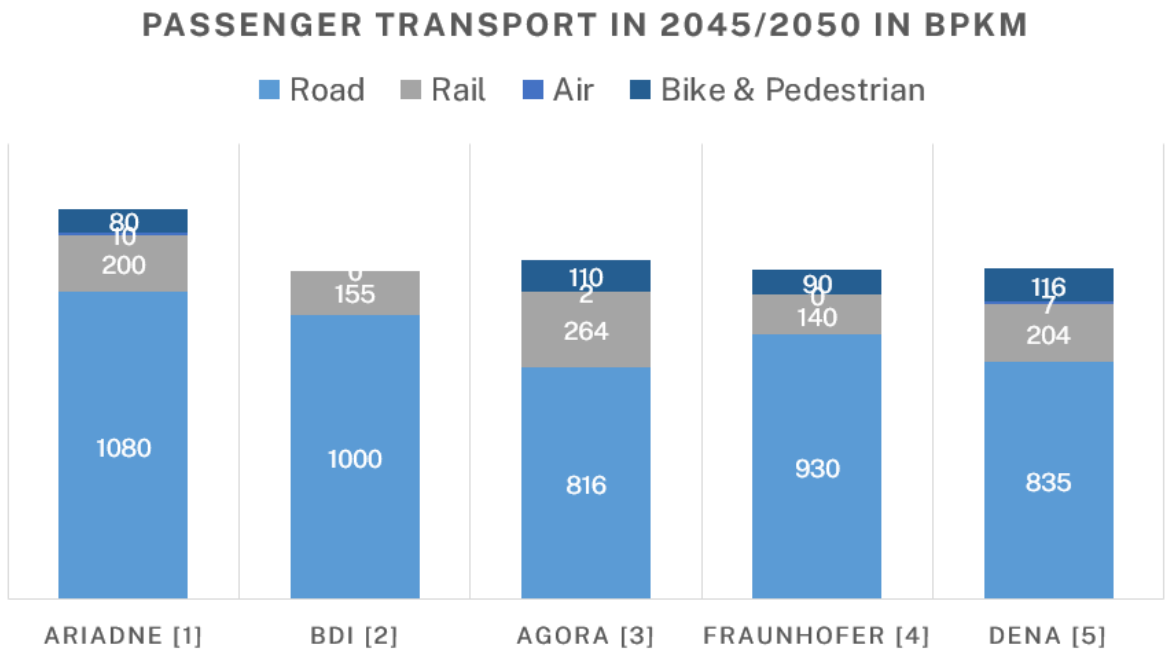


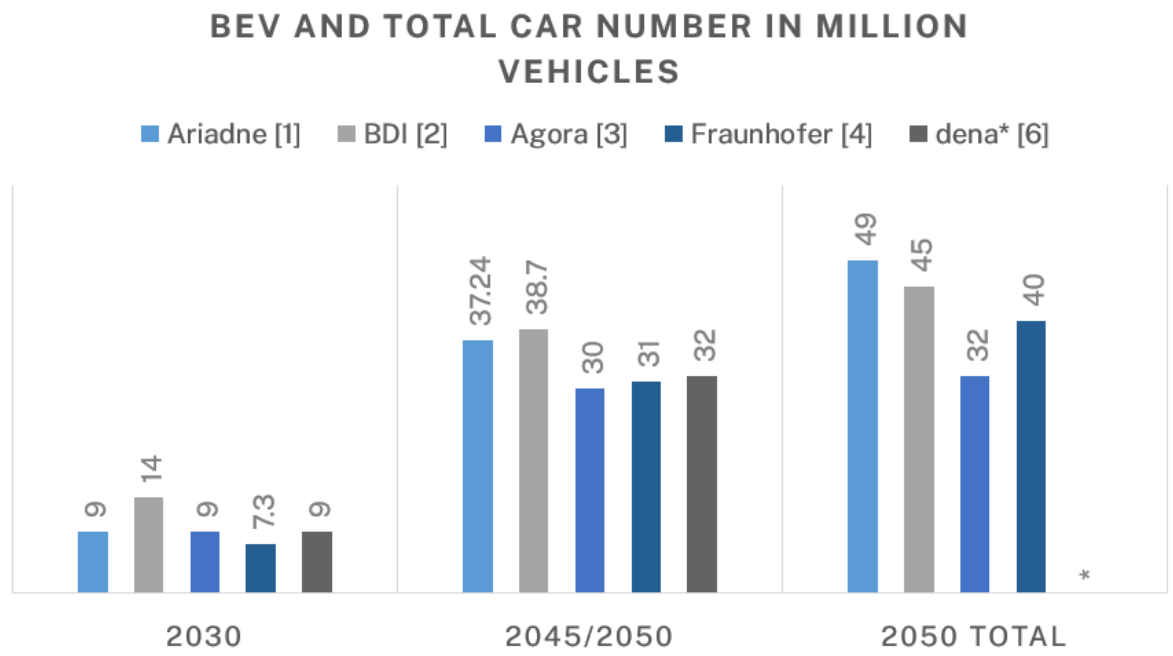


Transportation sector in ESM analyses

Many results for the future transportation sector exist, but ...

- ... studies differ immensly in their assumptions and scope,
- ... they are often communicated without putting them in perspective,
- ... particularities of the transportation sector are usually not considered adequately,
- ... they are dominated by (inherent) uncertainty.





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  - Focus on model formulation and optimization method
  - *Model comparison*

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Types of uncertainty

Model uncertainty

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Data uncertainty

- How accurate is the data?
  - Focus on parameter values (past/present/future)
  - *Sensitivity Analysis*
  - *Scenario Analysis*
  - *Stochastic programming*

System uncertainty

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  - Fokus on the unknown unknowns
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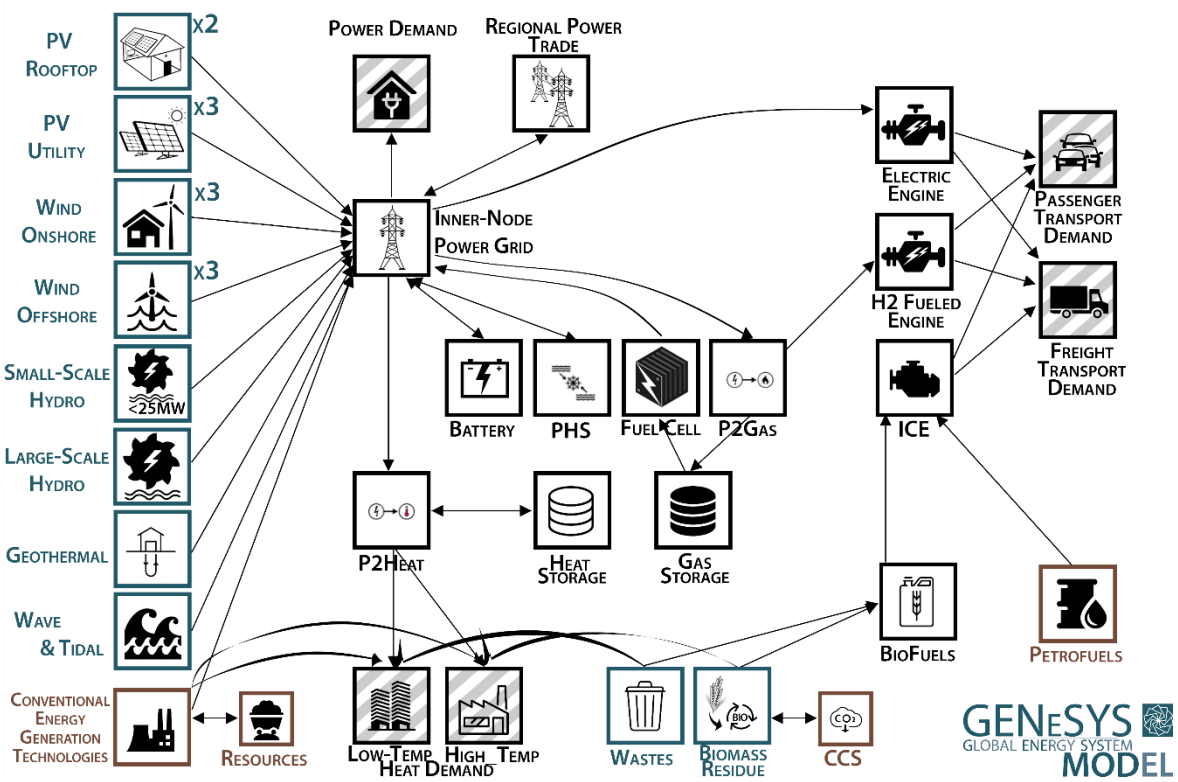
  - *If-then analysis*

The Global Energy System Model (GENeSYS-MOD) Overview

- ...is based on the Open-Source Energy Modeling System (OSeMOSYS) and enhances the framework with multiple additional features.
- ...is a linear program which optimizes the net present value of a future energy system based on the given assumptions and bounds (cost-optimizing).
- ...is publicly available to the community with both code and model data.

(https://git.tu-berlin.de/genesysmod/genesys-mod-public/-/releases/genesysmod3.0)



Sensitivity analysis for key parameters in the German transportation transition and the Avoid-Shift-Improve (A-S-I) Framework

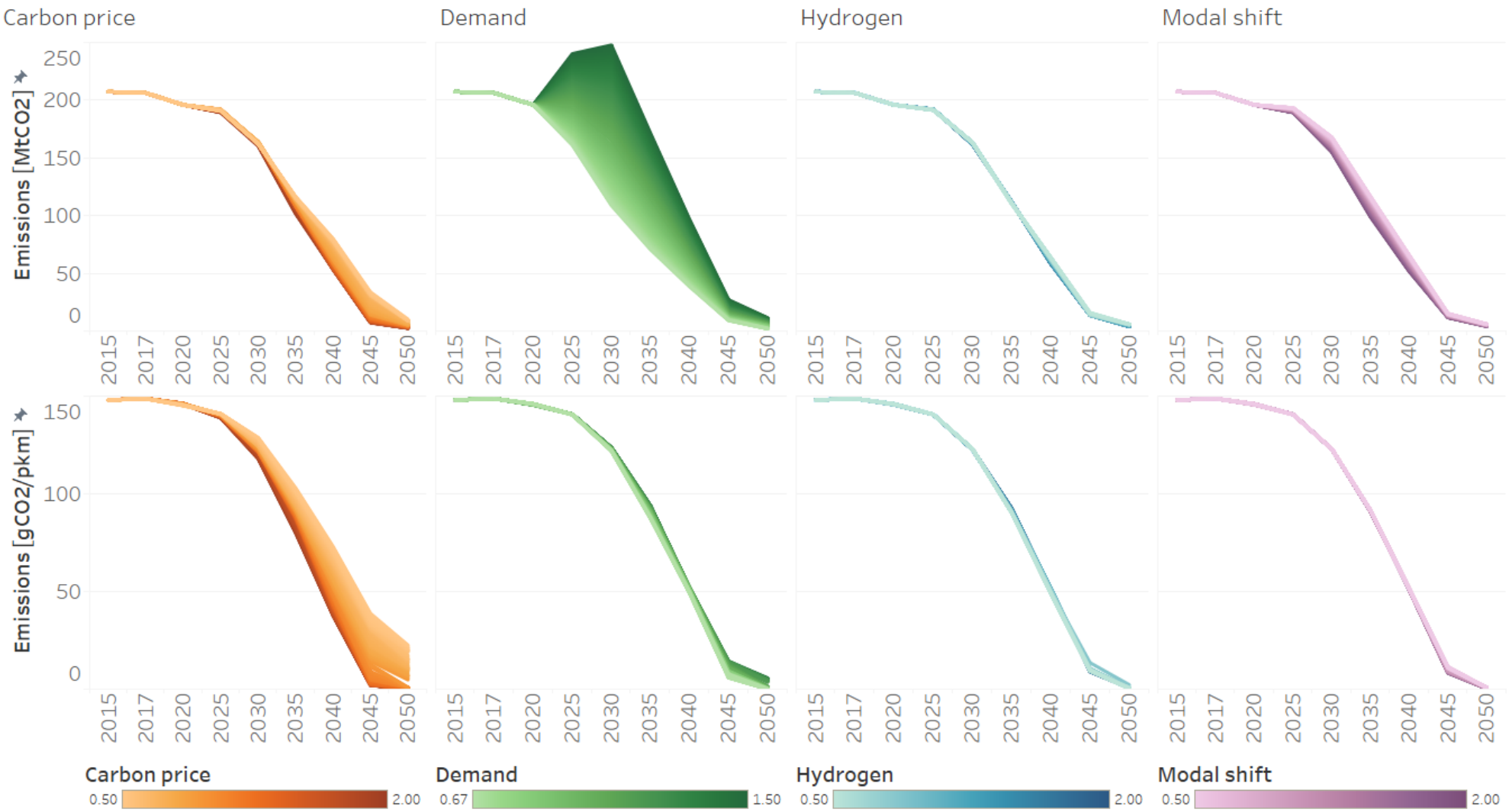
The Avoid-Shift-Improve Framework defines sustainable transportation planning and policies

- Avoid: Reduce overall transportation demand by removing the need for transportation
- Shift: Move transportation demand to modes with lower environmental impact
- Improve: Reduce fuel consumption, improve carbon intensity of single modes

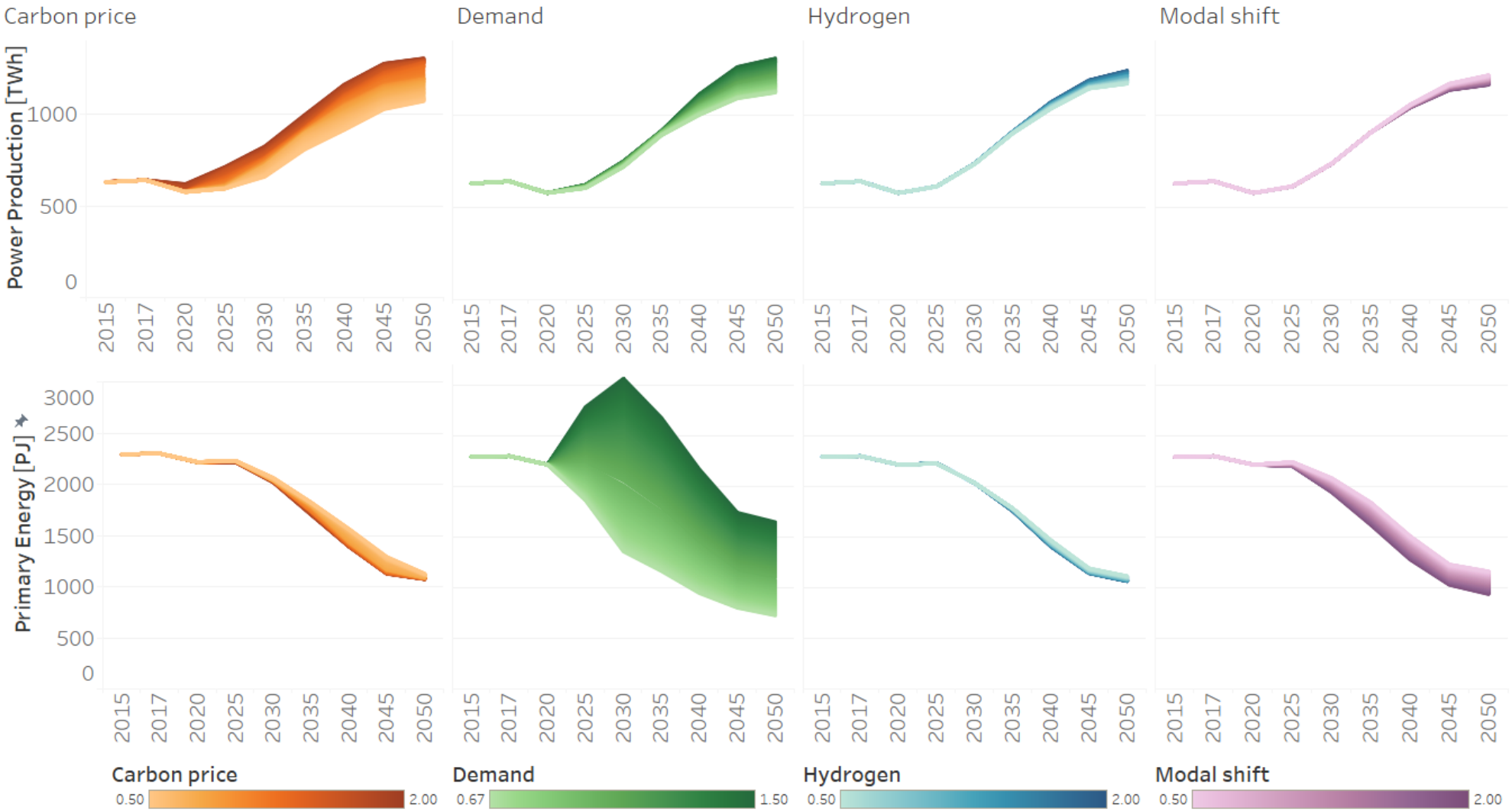
Table 1: Analyzed sensitivities, corresponding model parameters and intervals of values for the year 2030.

	Parameters	Min	Default	Max	Factor
Carbon price	Emission cost	40 €/ton	80 €/ton	160 €/ton	2
Transportation demand	Total demand for freight and passenger transportation	66.66%	100%	150%	1.5
Hydrogen costs and efficiencies	Efficiencies for hydrogen generating technologies	50%	67%	80%	2
	Costs of hydrogen imports	18€/kg	9€/kg	4.5€/kg	
Modal shift	Share of flexible transportation demand compared to overall transportation demand	3%	6%	12%	2

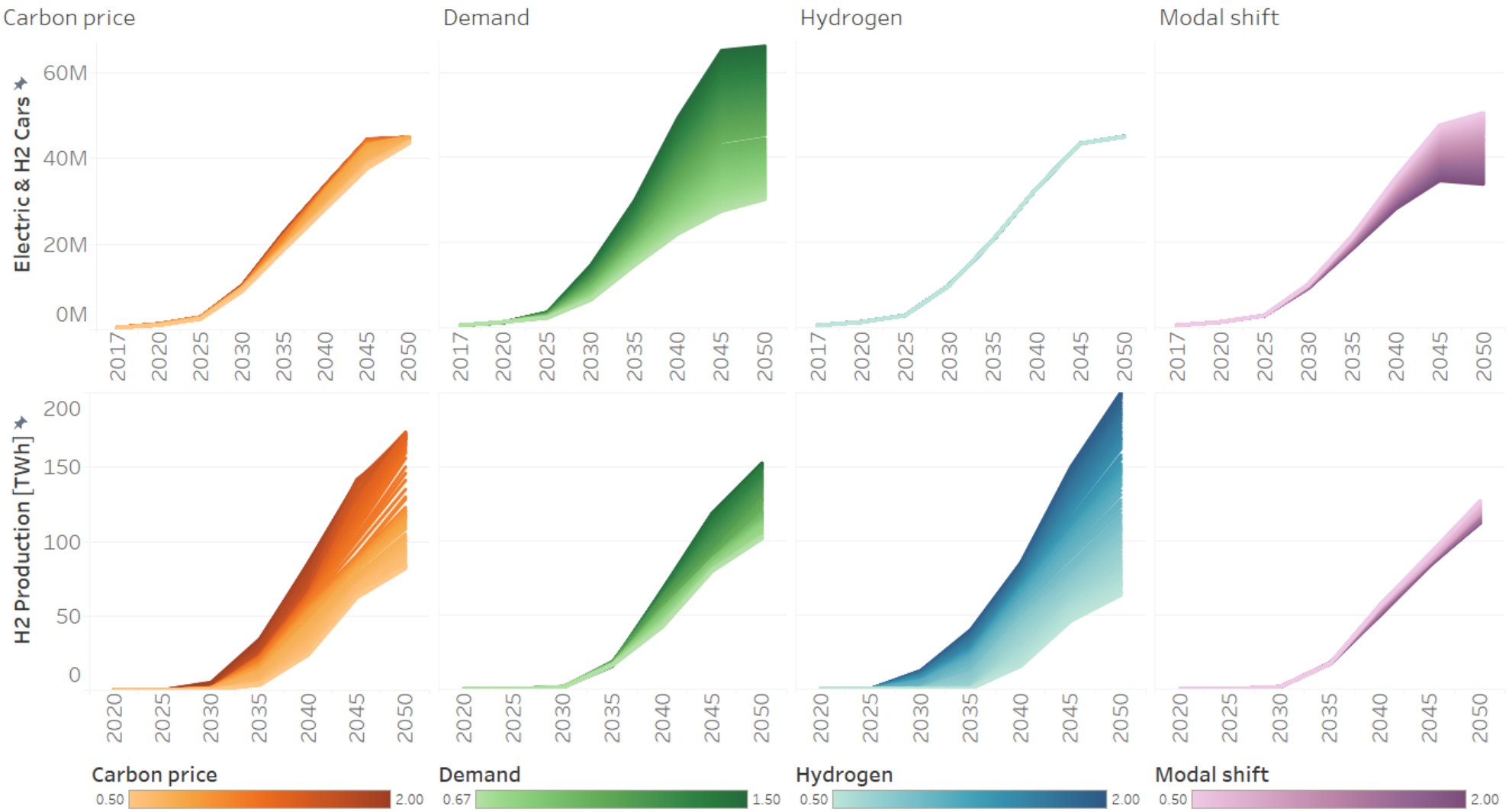
Sensitivity Results I



Sensitivity Results II



Sensitivity Results III



Policy Implications

- Demand reductions show high effects on most KPI‘s. The *avoid* category of policies therefore promise high impact but are accompanied by questions regarding acceptance in society.

- Modal *shift* proves to be especially effective in the medium term, since it allows emission reduction by moving from fossil fuel combustion (road transport) to already mostly electrified (rail).

- A carbon price affects many areas in the energy system including the transportation sector. Removing fossil fuel subsidies has a similar effect.

- Hydrogen can help with reducing emissions but its role seems limited to heavy duty freight traffic.

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Want more?

References

[1] Ariadne Project (2021). Deutschland auf dem Weg zur Klimaneutralität 2045 Szenarien und Pfade im Modellvergleich.

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[4] Fraunhofer (2021). Langfristszenarien für die Transformation des Energiesystems in Deutschland. Treibhausgasneutrale Hauptszenarien Modul Verkehr.

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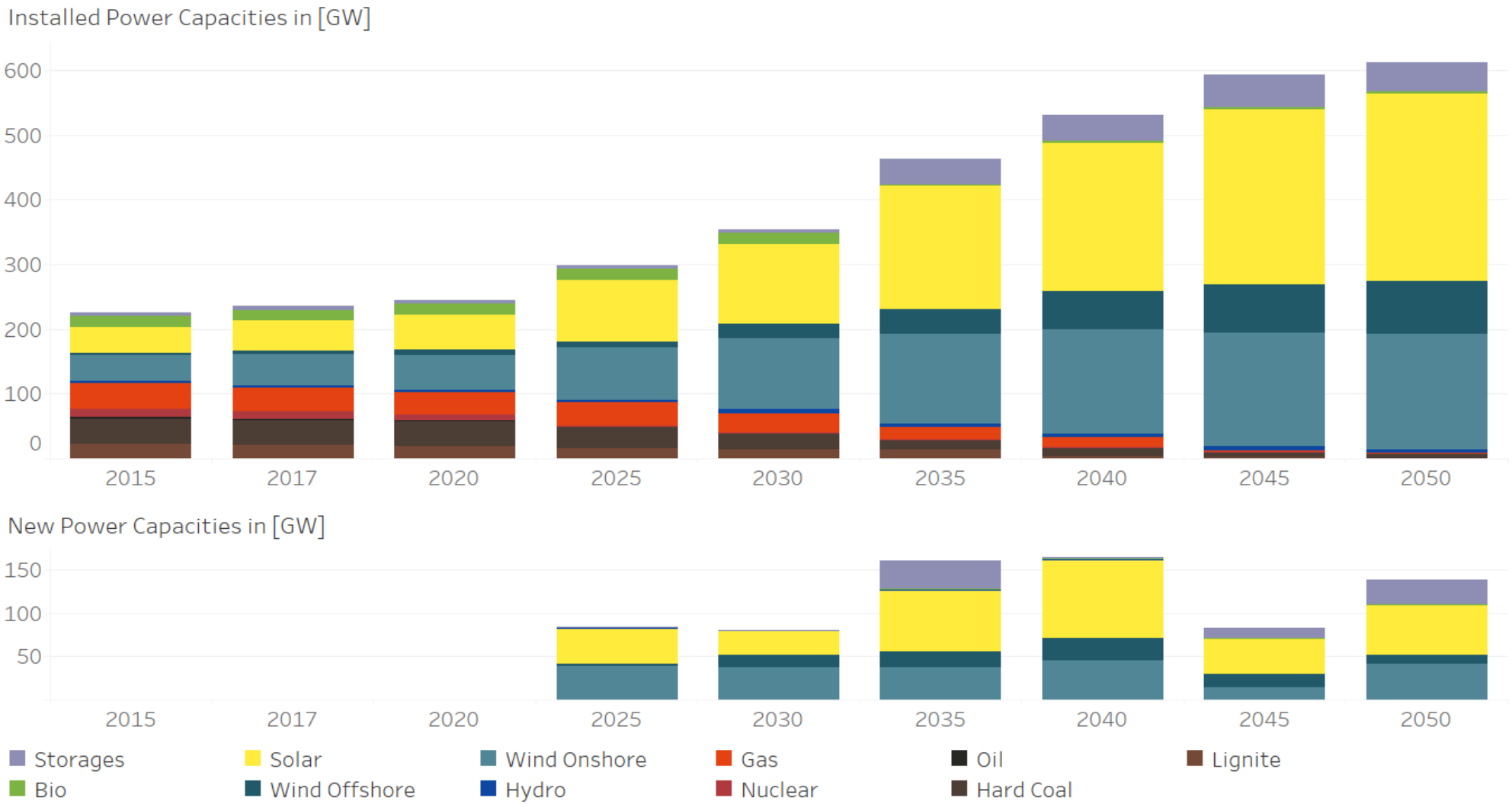
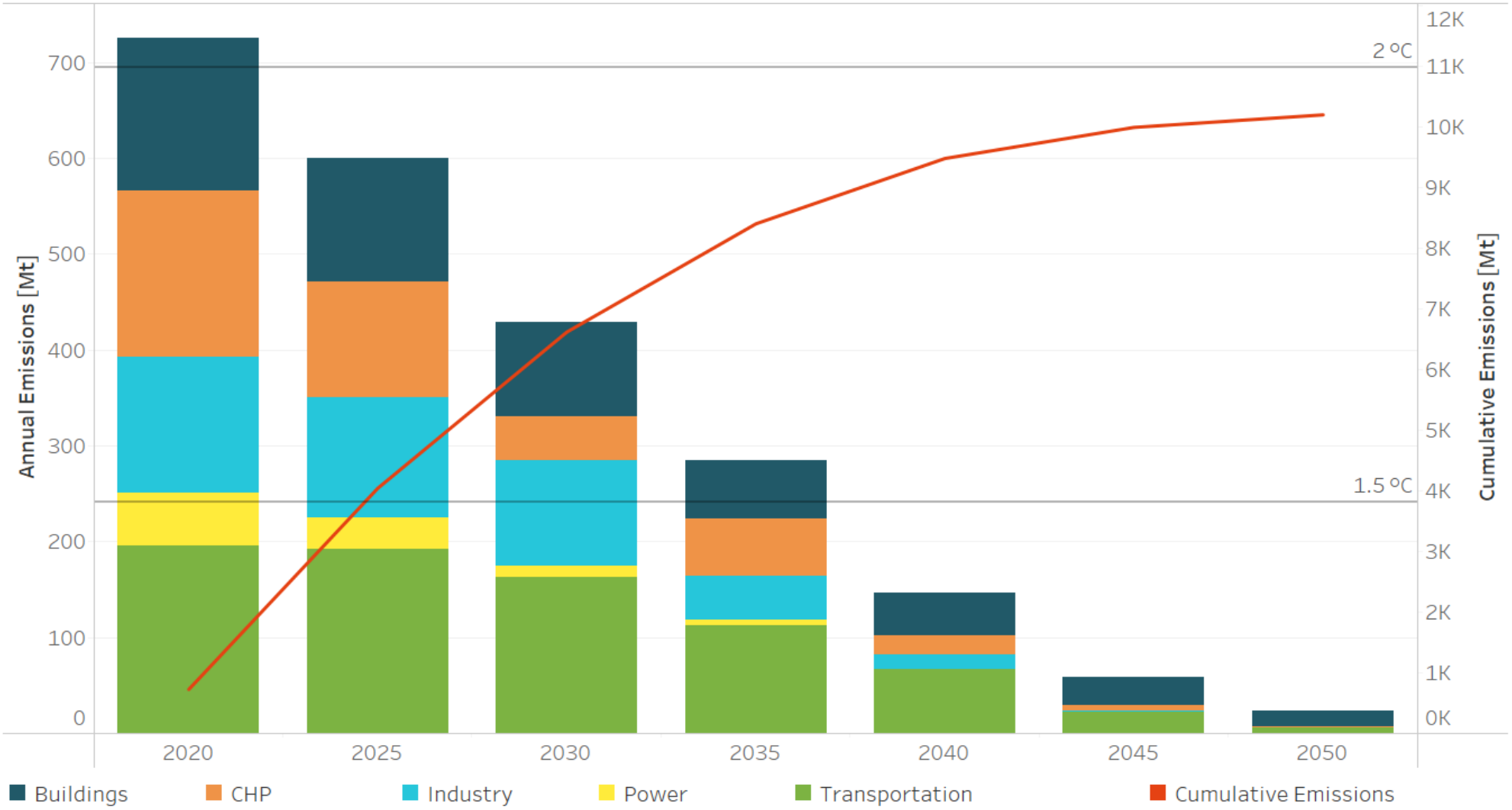
[6] Deutsche Energie-Agentur GmbH (Hrsg.) (2021). „dena-Leitstudie Aufbruch Klimaneutralität“

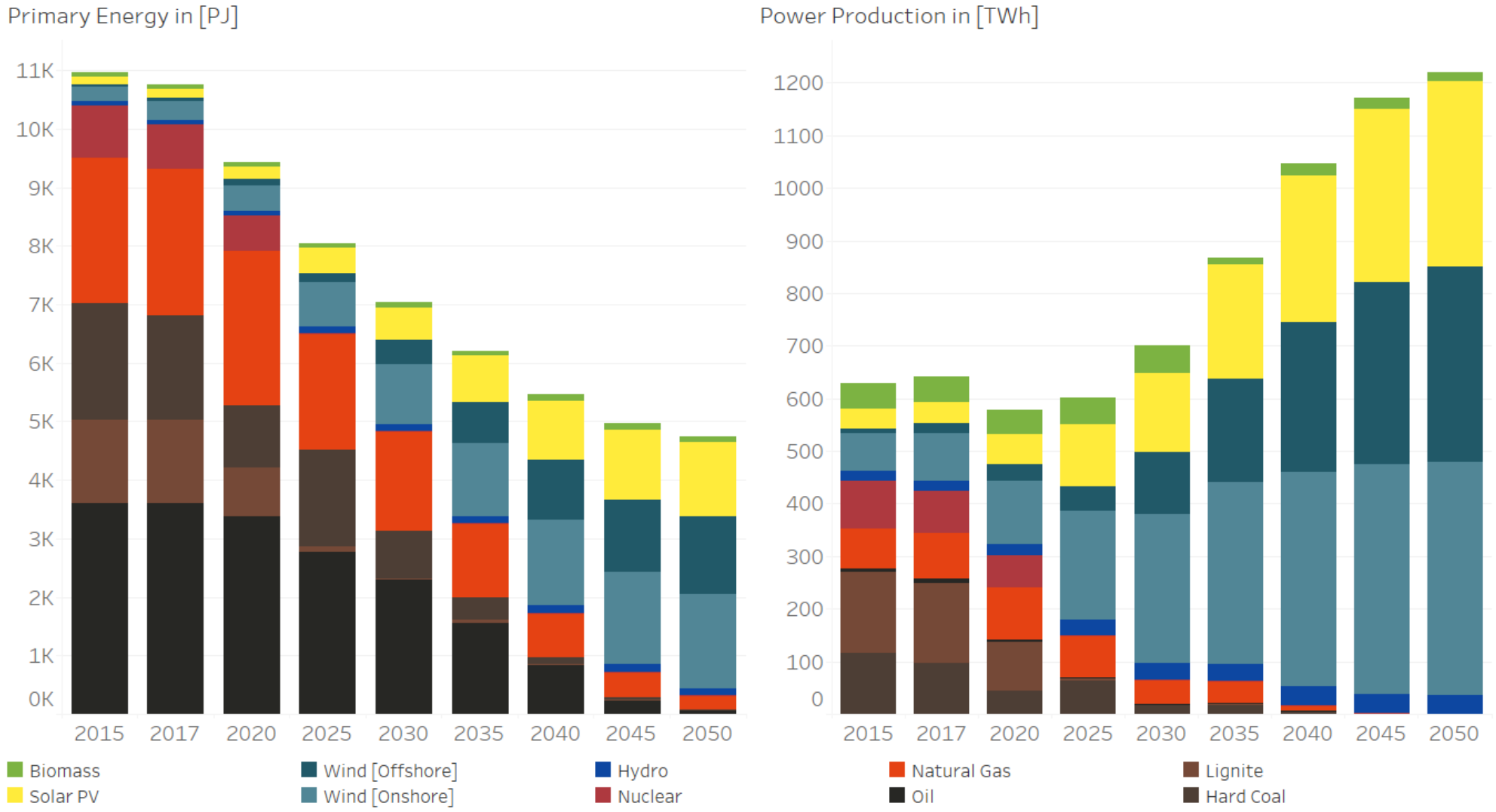
Power Capacities



Emissions in base case



Primary energy consumption and power generation



Transport generation