

12. Internationale Energiewirtschaftstagung (IEWT) Wien 2021



Session: Energiepolitik II

Chances and barriers for Germany's low carbon transition

Quantifying uncertainties in key influential factors

08.09.2021

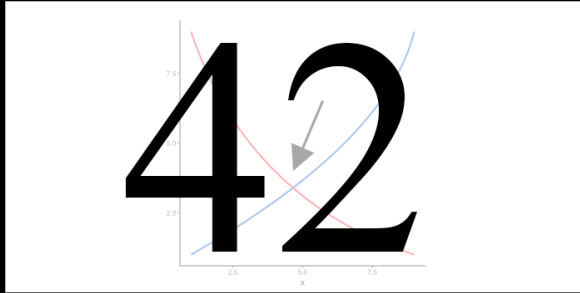
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Frederik Seehaus, Felix Wejda

Technische Universität Berlin, Workgroup for Economic and Infrastructure Policy (WIP)

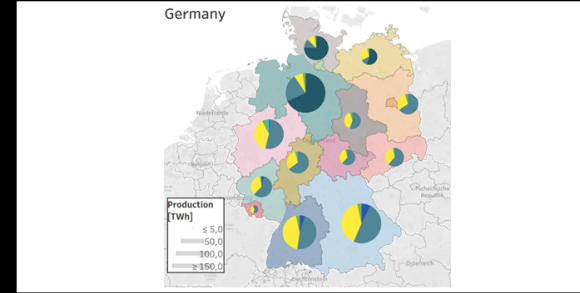
DIW Berlin, Department Energy, Transport, Environment

Motivation

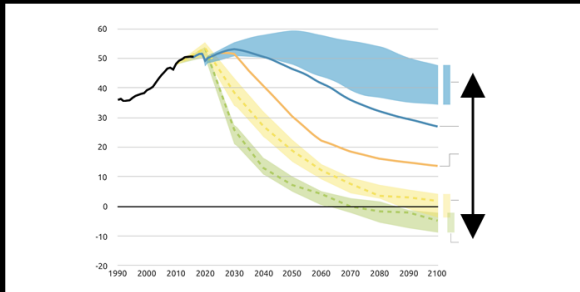
UNCERTAINTY IN QUANTITATIVE MODELS



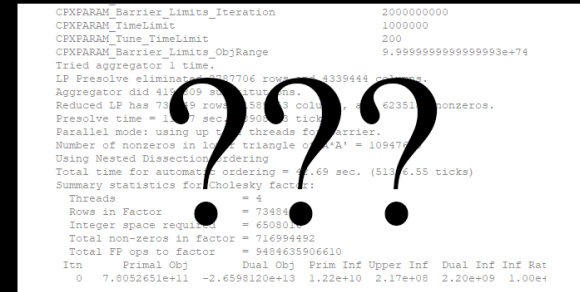
WHAT POLICY MAKERS WANT
OUR MODEL TO GENERATE



WHAT ACADEMIC JOURNALS
WANT OUR MODEL TO GENERATE



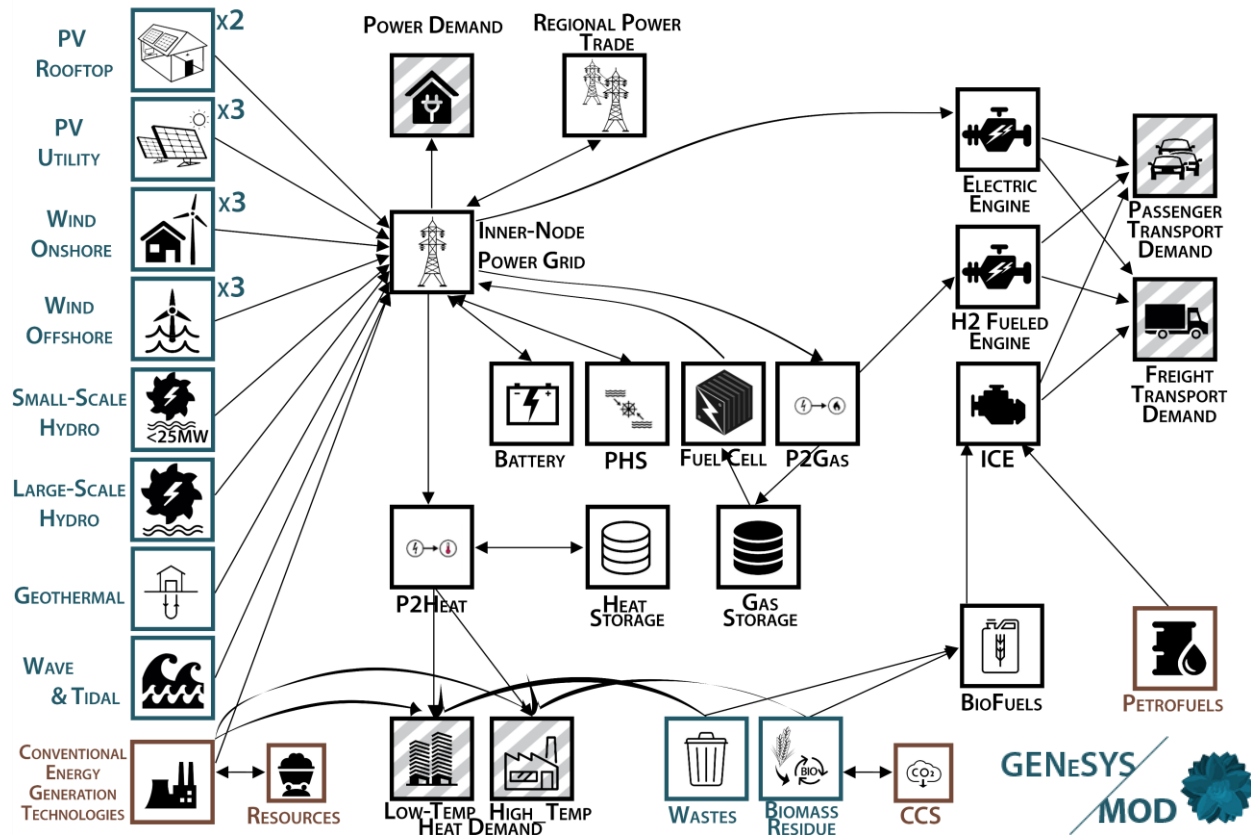
WHAT WE THINK OUR MODEL
GENERATES



WHAT OUR MODEL ACTUALLY
GENERATES

Or as George Box famously put it: “All models are wrong, but some are useful”

The Global Energy System Model (GENeSYS-MOD)

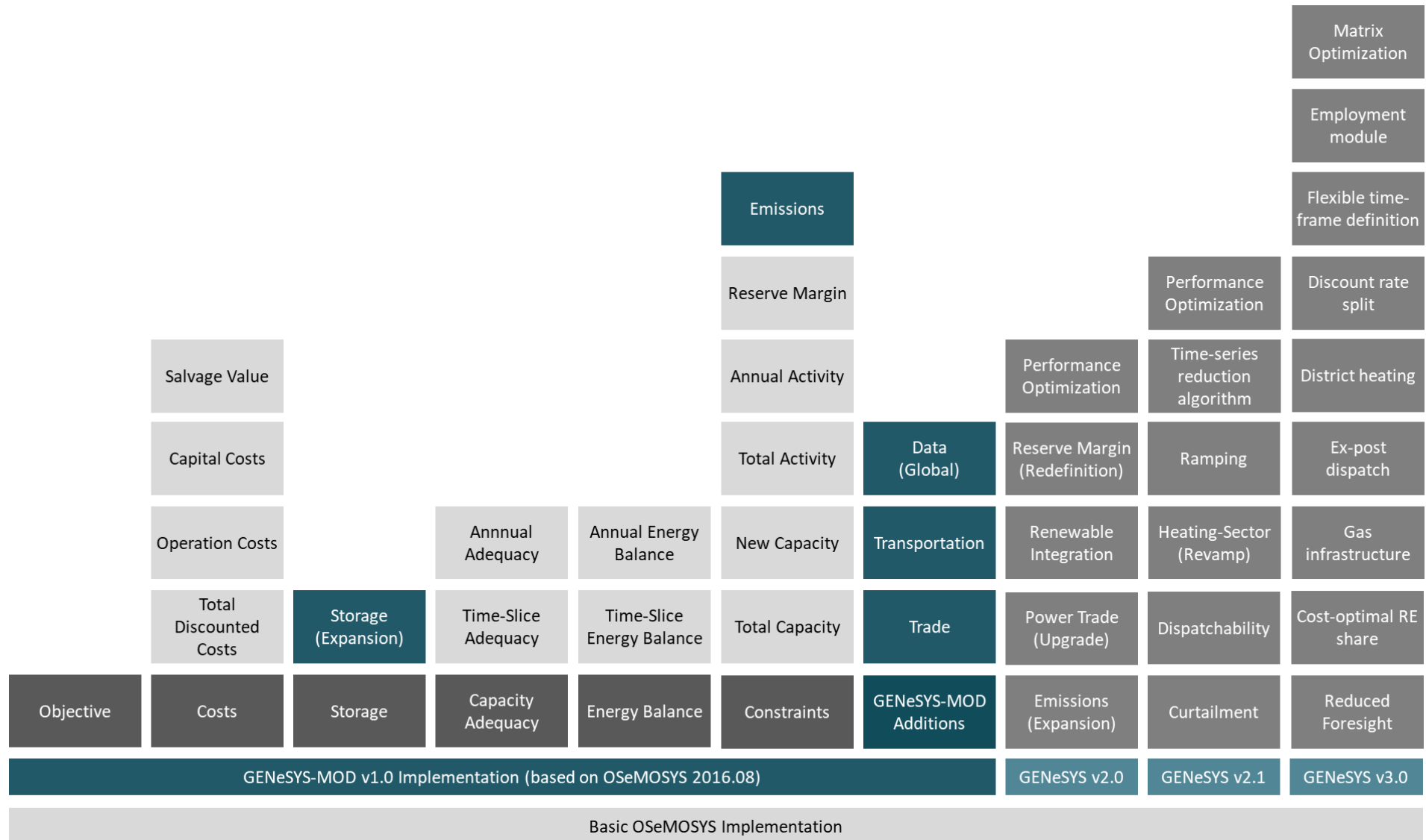


GENeSYS-MOD (Global Energy System Model)...

- ...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>)

Overview: GENeSYS-MOD Additions



Chances and Barriers for Germany's Low-Carbon Transition

- Updated base-case for Germany, based on paper published in 2019:



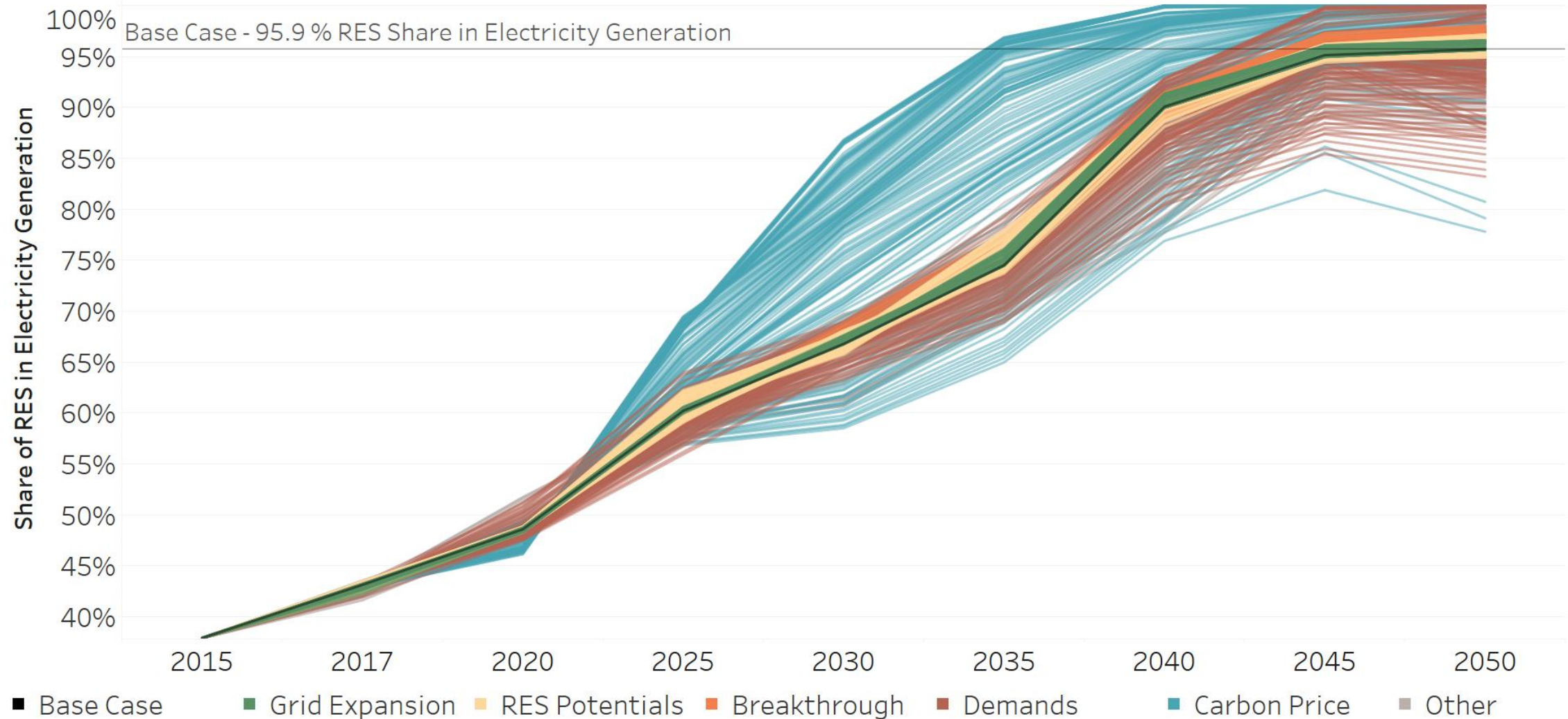
- Paper concept:
 - When modeling pathways for energy system development, we, as modelers, have to deal with many unknowns
 - This is especially true for input assumptions such as demand or cost data, which can heavily influence results
 - While results are often represented as one singular pathway, accounting for these unknowns would lead to a pathway *range* instead
- Main research question:
 - What are the key influential factors on the German *Energiewende* and how much do they affect the modeling results until 2050? What implications does that have on energy policy advice?

Model Setup: Choice of Sensitivities

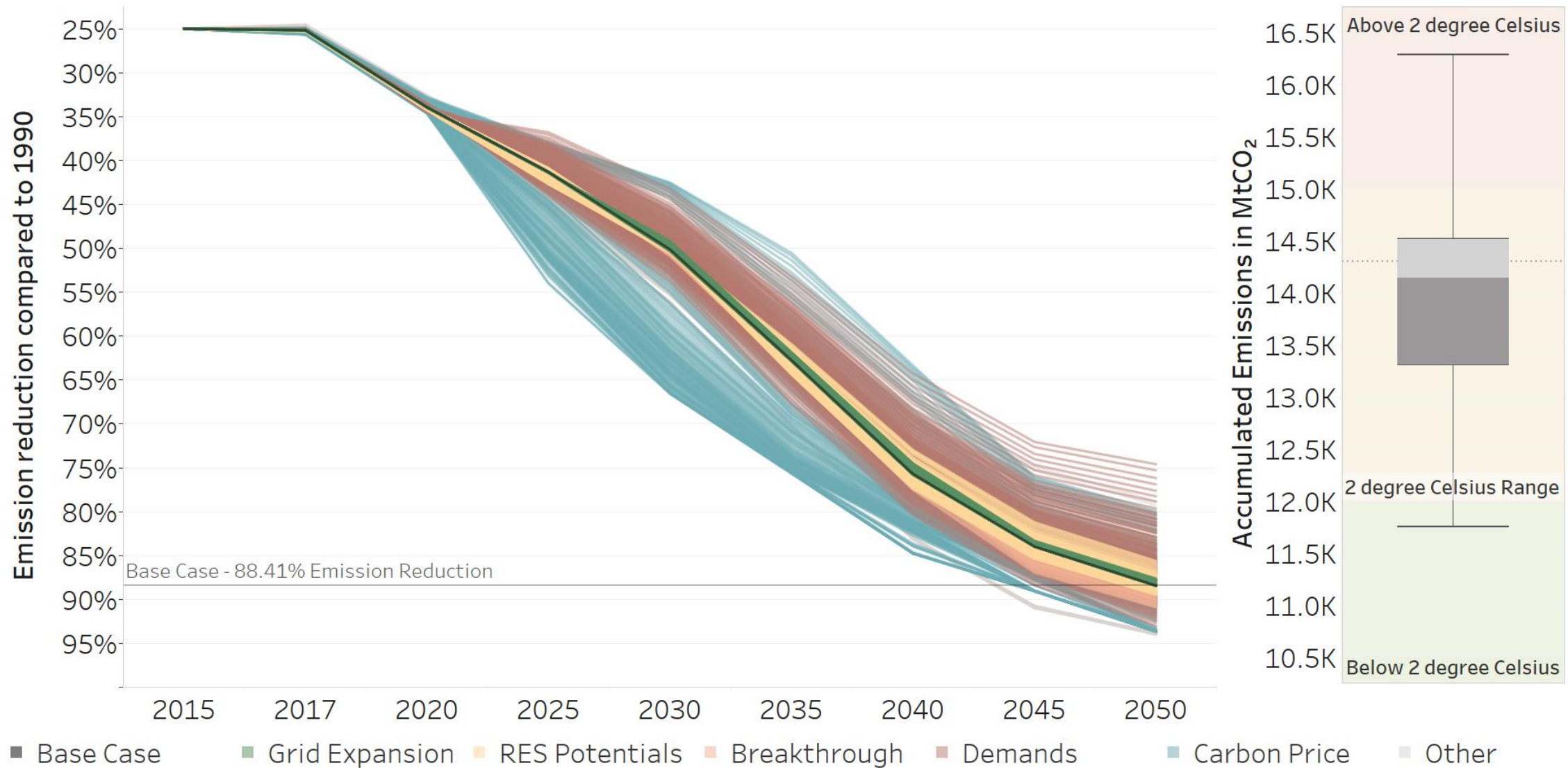
		#	Min value	Default value	Max value	Step size
Demands	per sector	231	70%	100%	150%	2.5%
Costs of breakthrough techs	per technology	243	50%	100%	250%	2.5%
RES integration	max increase/year	131	3.5%	5%	10%	.05%
Grid expansion	max increase/year	121	0%	3%	6%	.05%
RES potentials	per technology	264	70%	100%	150%	2.5%
Carbon price	[€/tCO ₂]	133	20 €	85 €	350 €	2.5€
Renovation rate	max share/year	77	0.5%	1.50%	7.5%	.125%
Hydrogen import price	[€/kg H ₂]	88	1.2 €	N/A	10 €	.1€/kg H ₂
Modal shift		77	80%	100%	120%	0.5%
RES costs	for solar & wind	145	80%	100%	150%	2.5%
Biomass availability		81	50%	100%	150%	.125%
Total		1591				

Analyzed sensitivities in this study, including quantity and value ranges for each chosen parameter

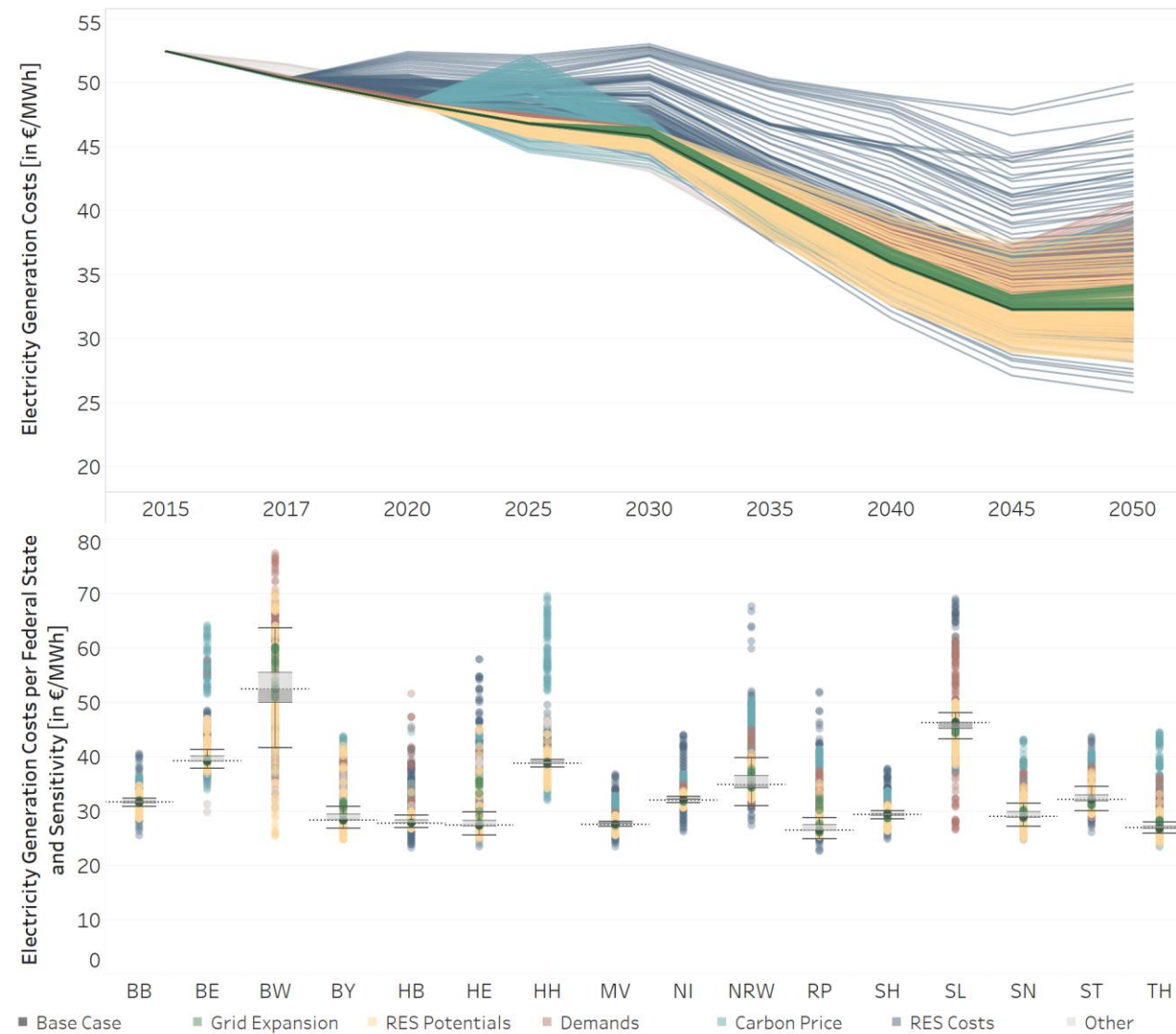
Results: Renewable Share in Electricity



Results: Emissions



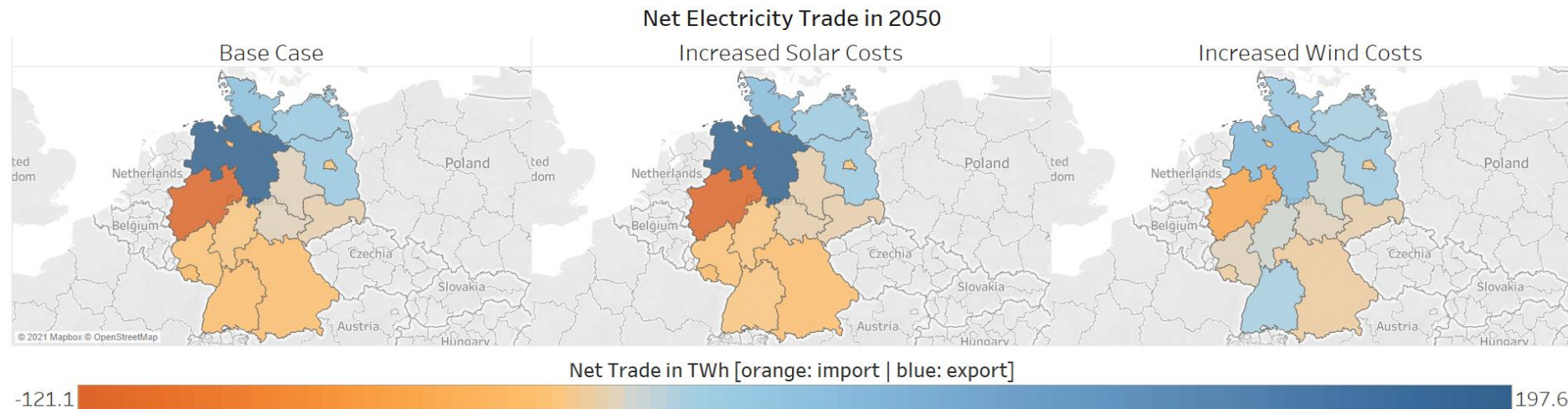
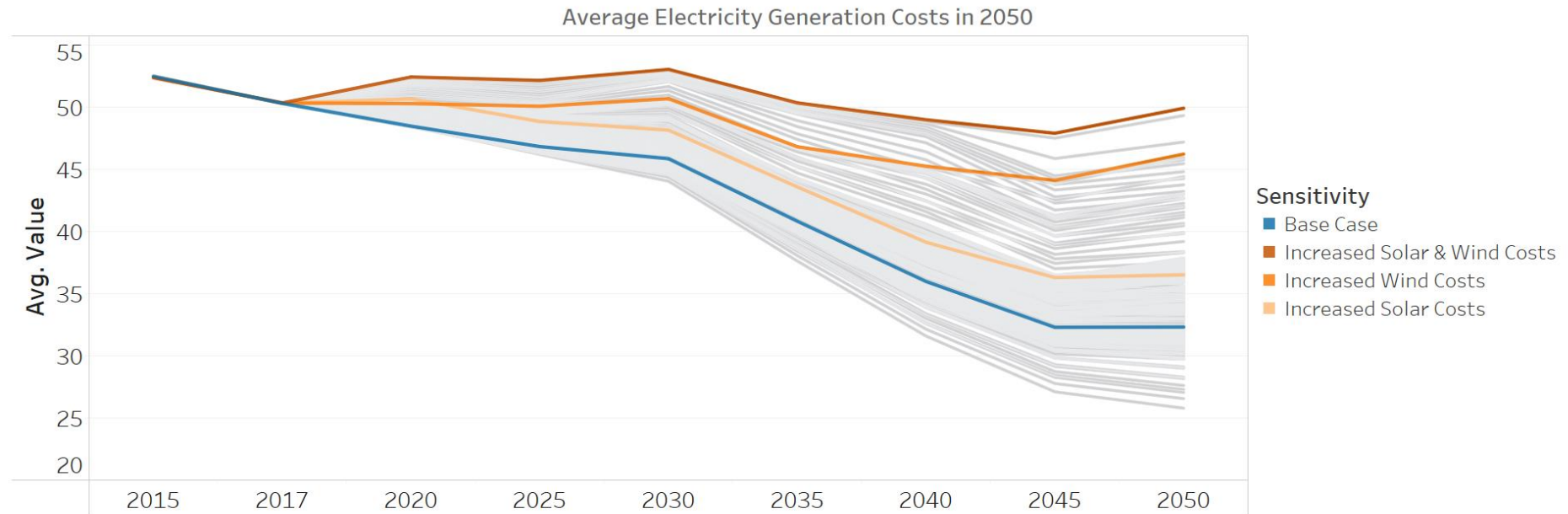
Results: Power Generation Costs



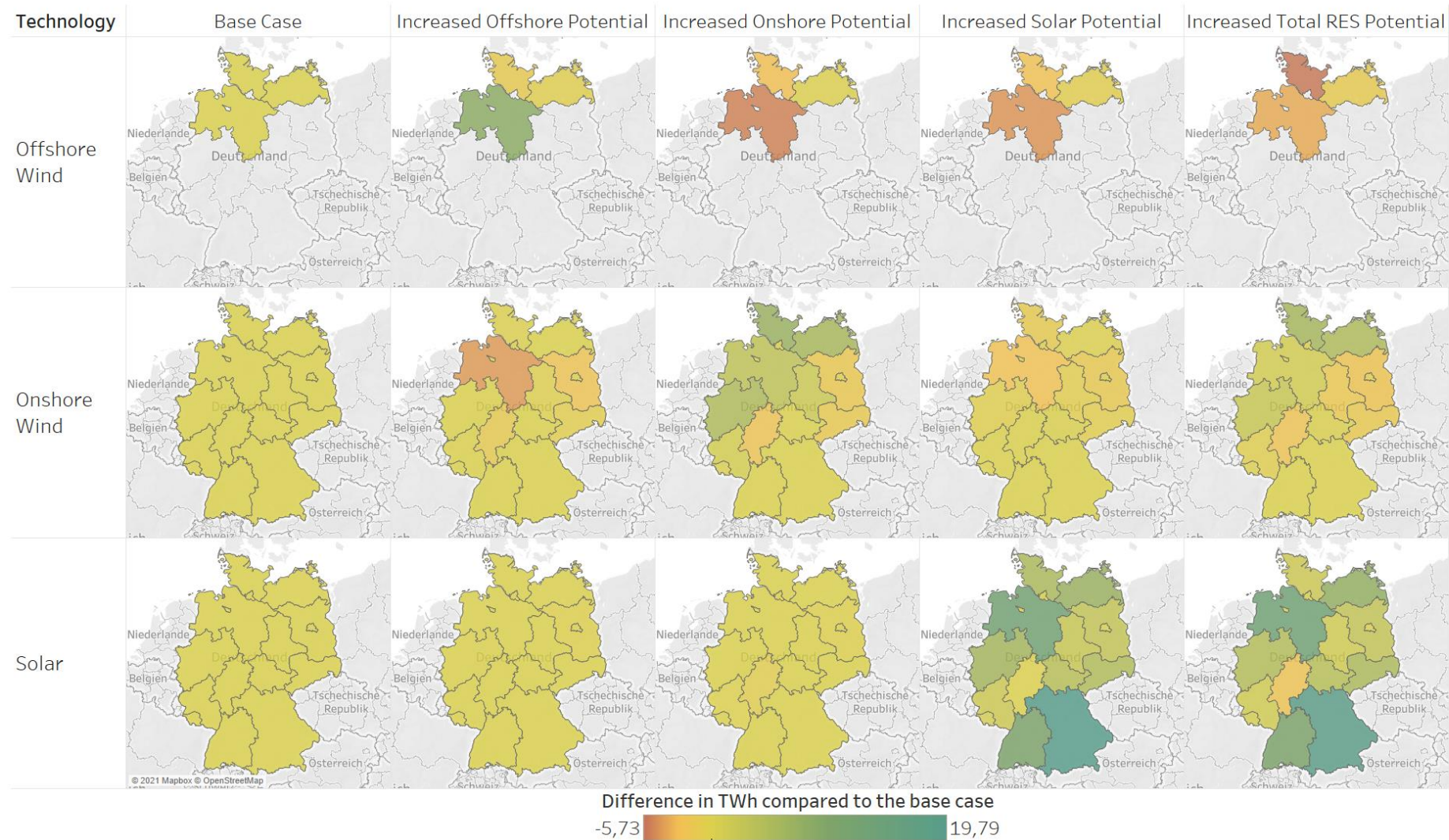
Results: Costs for Breakthrough Technologies



Results: Costs of Renewables



Results: Renewable Potentials



Conclusion of our Results

- Final energy demands, renewable potentials, and carbon pricing are among the main influential factors for the pathway results
- Future energy generation costs are mostly dependent on learning curves for RES, but remain at 2015 levels in the worst case
- Changing only a single influential factor at a time was not sufficient to reach a full decarbonization, indicating that a mixture of policy targets is required



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Thank you for your attention.

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