FFF Conference: What is the Future of Fossil Fuels

in Times of Greenhouse Gas Neutrality?

Transitioning Europe and Germany to 100% renewable energy

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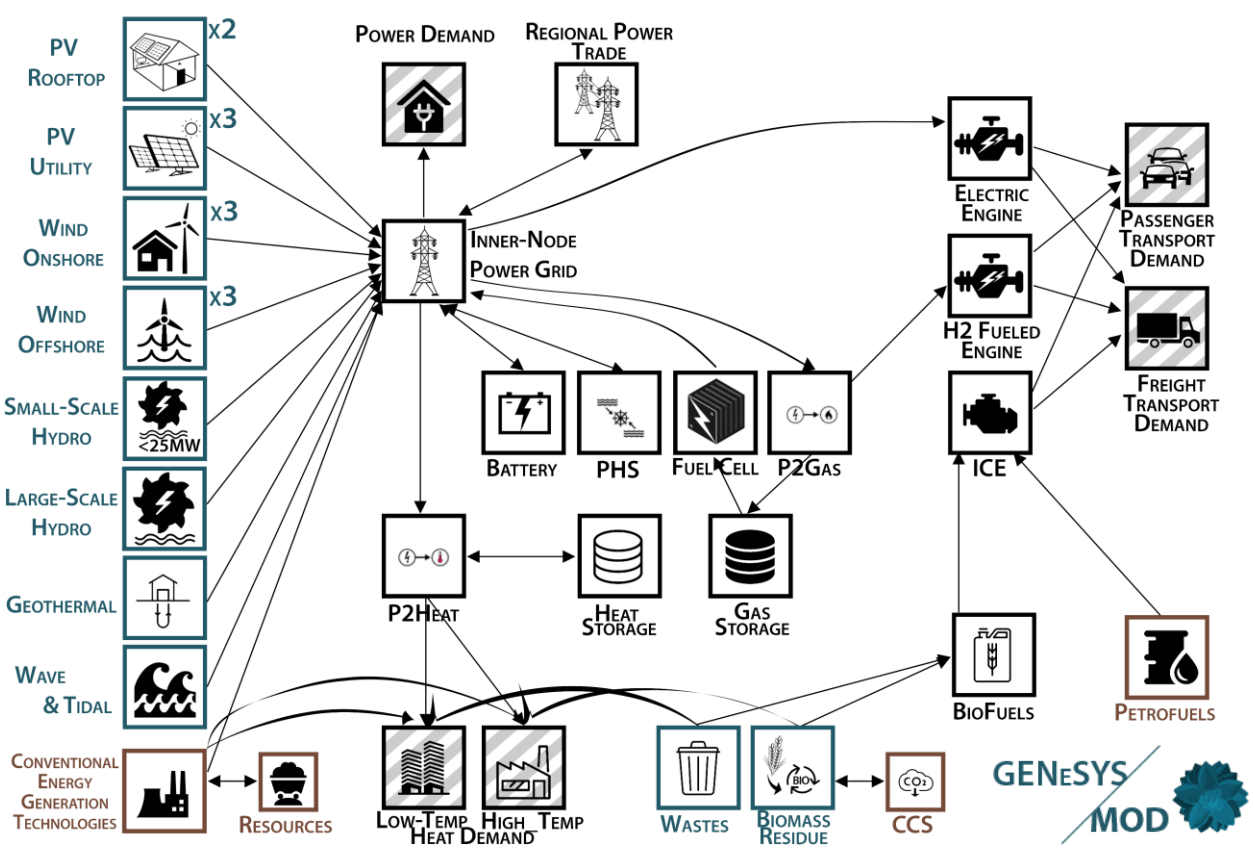
Introduction/Motivation

- Over the last years, the discussion of 100% renewable scenarios shifted from general feasibility issues to specific assumptions and aspects.
- Until 2019, the were more than 200 academic peer-reviewed articles examining 100% renewable pathways.
- In recent years both the EU and Germany pledged to reach GHG-neutraility by midst of the century
- In this presentation, three different case studies will be presented:
  - 100% renewable energy system for Europe until 2040 using two different energy system models
  - 100% renewable energy system for Germany building on this and other previous work
  - A sensitivity analysis of different drivers for the Germany energy system transformation

The Global Energy System Model (GENeSYS-MOD)

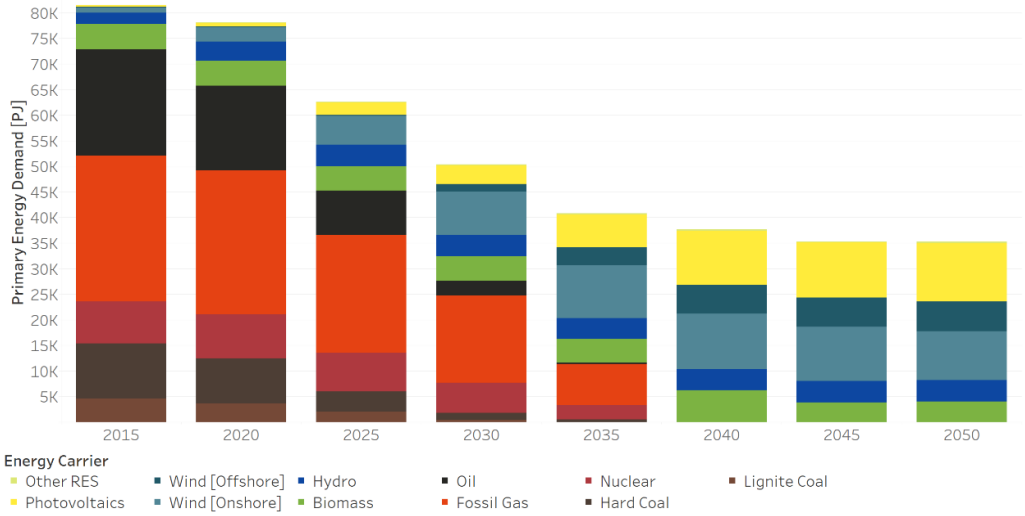


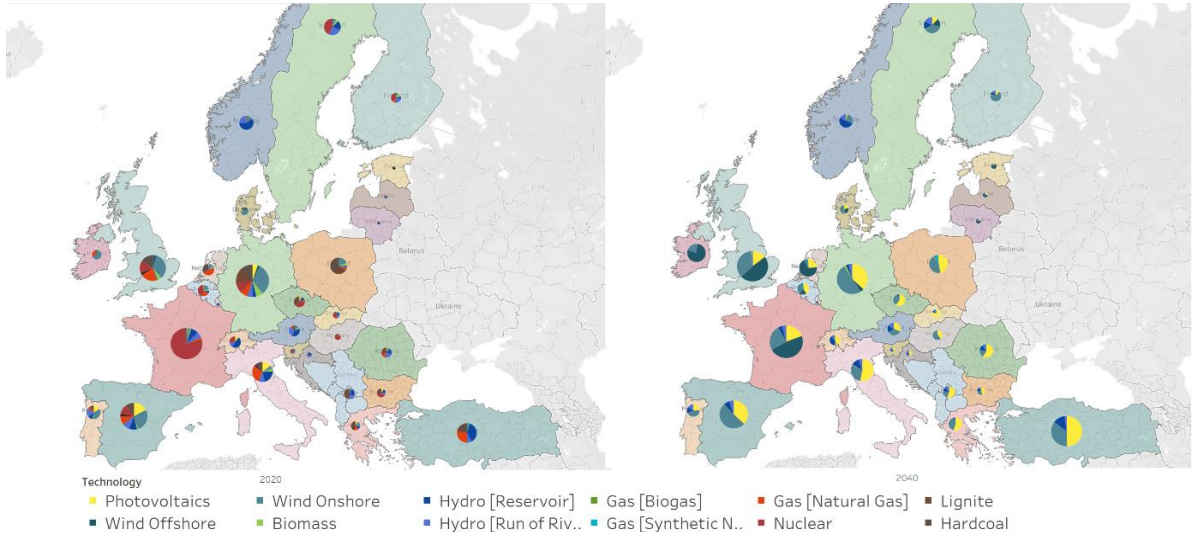
GENeSYS-MOD (Global Energy System Model)…

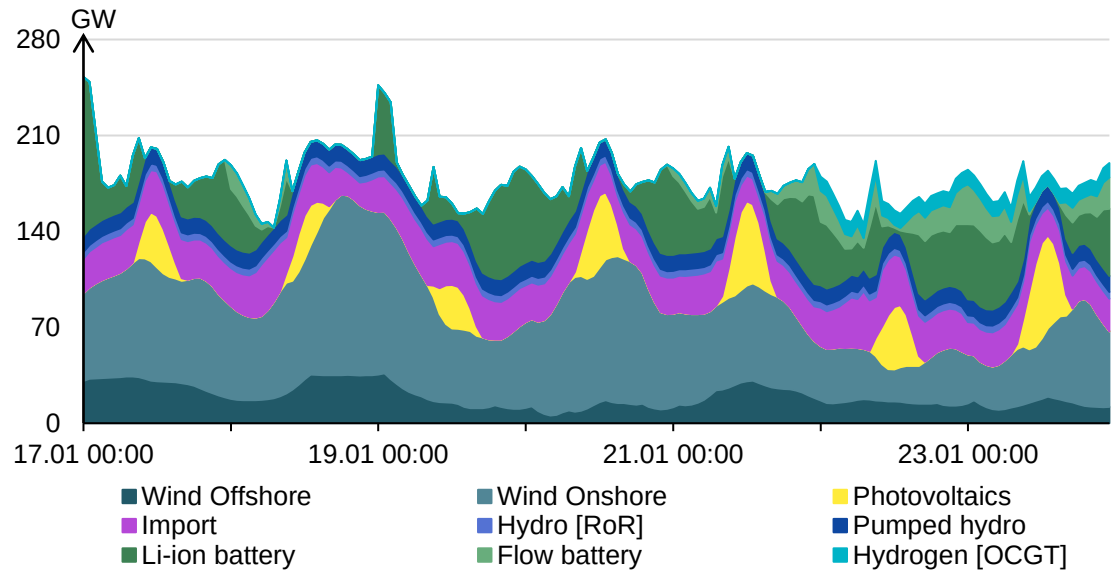
- …is based on the **Open-Source Energy Modeling System (OSeMOSYS)** and enhances the framework with multiple additional features.
- …is a **linear program** which **optimizes the net present value of a future energy system** based on the given assumptions and bounds (cost-optimizing).
- …is **publicly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

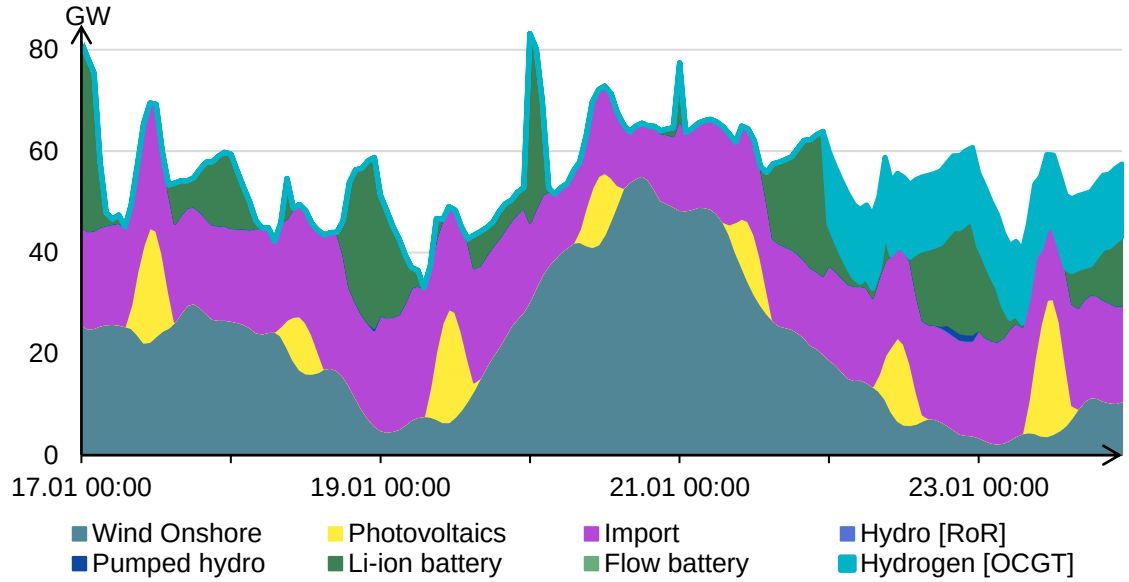
(https://git.tu-berlin.de/genesysmod/genesys-mod-public/-/releases/genesysmod3.0)

Primary energy demand (top left), electricity generation (top right), and hourly load cuves for France (bottom left) and Poland (bottom right) in 2050

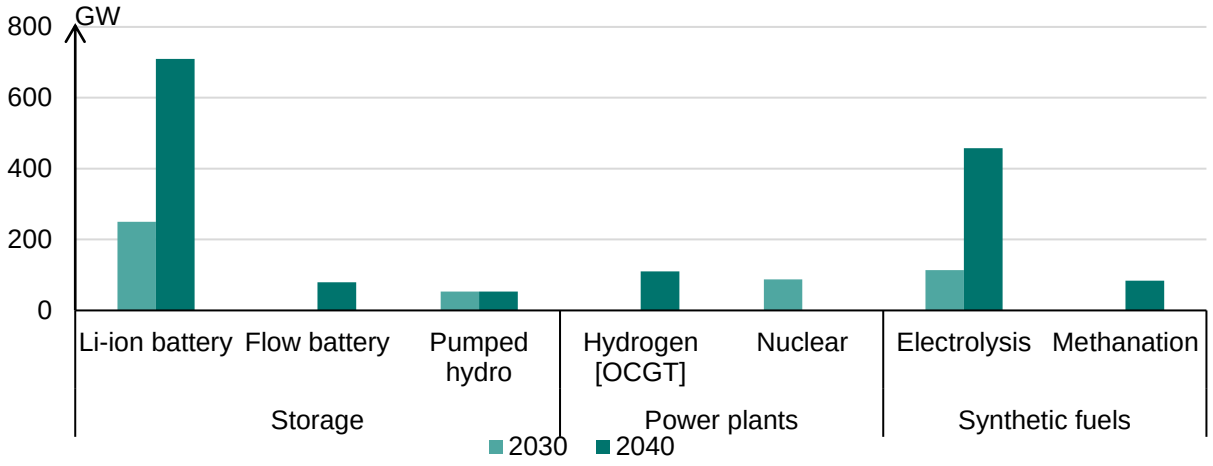


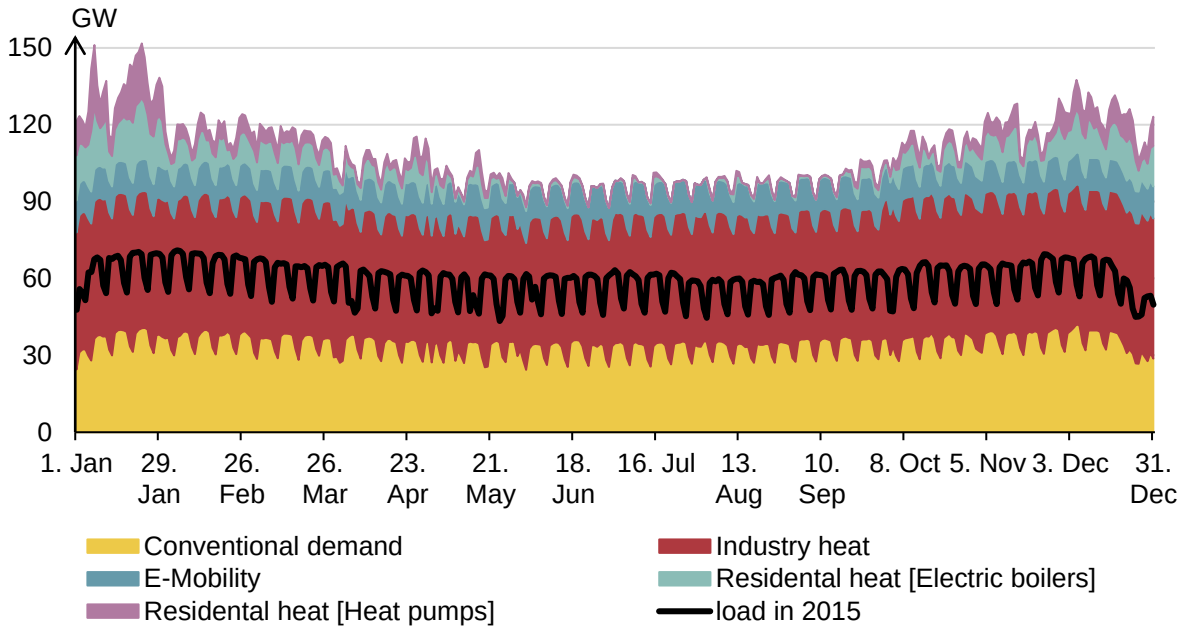






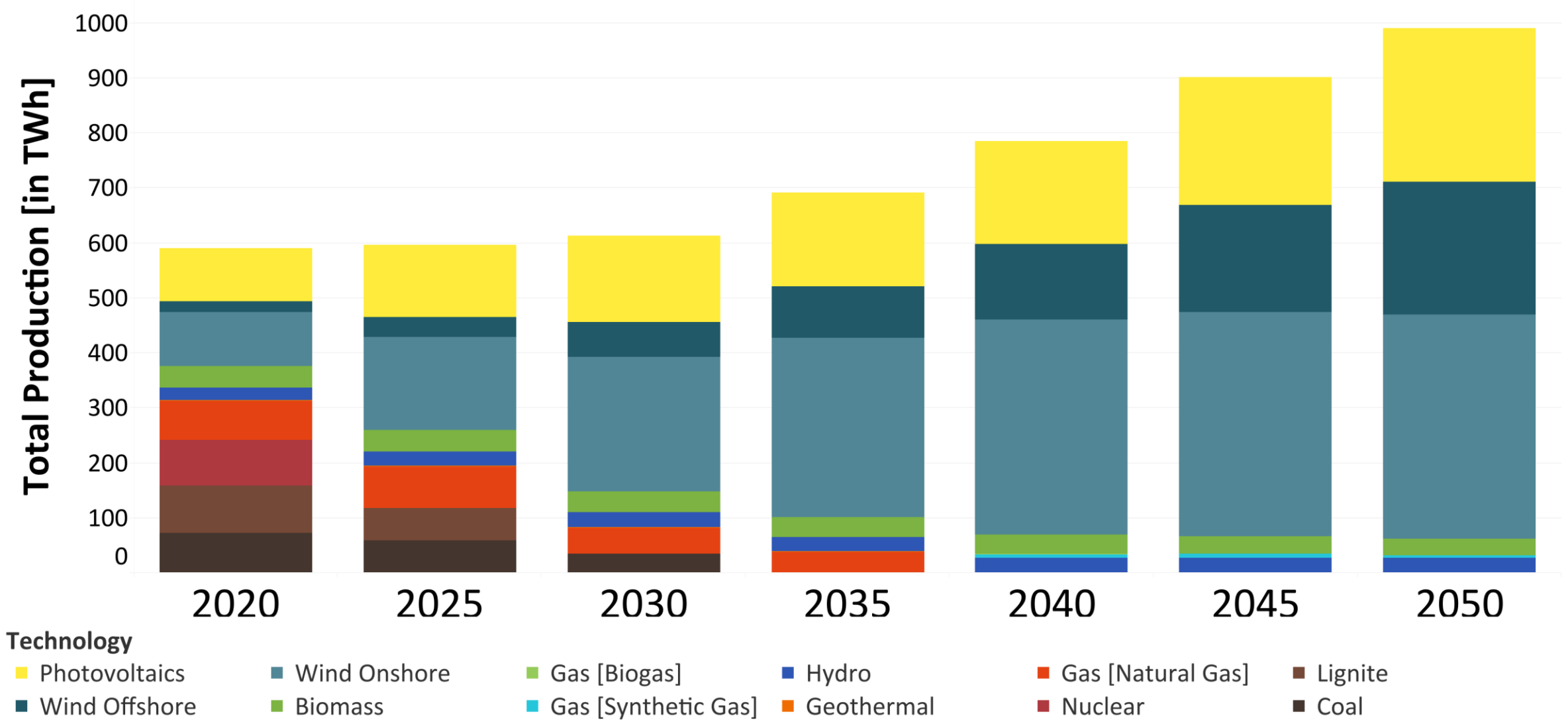
Non intermittent capacities in EU27 (top) and electricity demand profile for Germany 2040 (bottom)



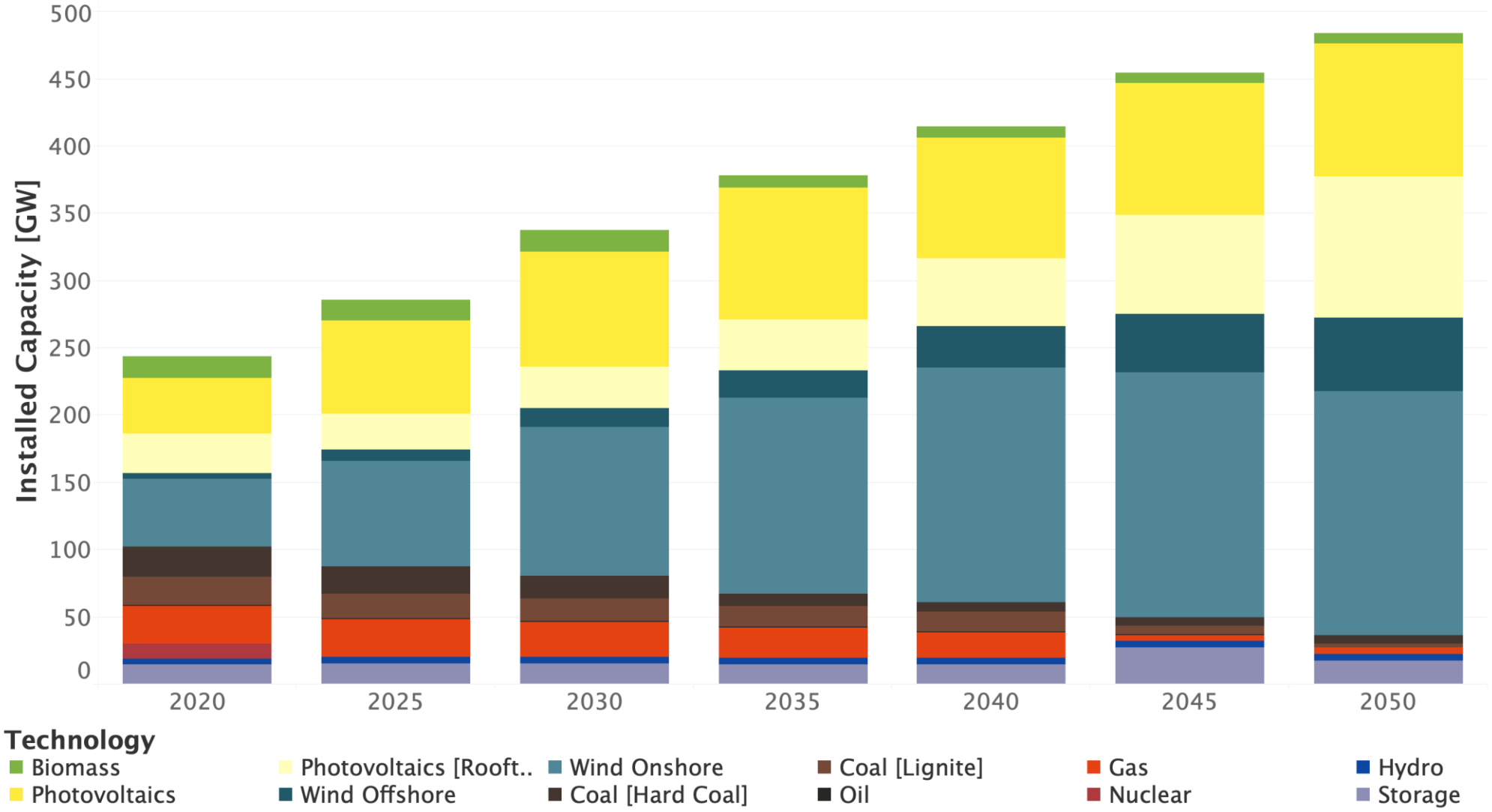


- Energy (and more specifically electricity) storage becomes the main reason for non-intermittent capacities.
- While conventional power demand (e.g. for appliances) decreases until 2040, overall power demand increases.
- In addition to daily fluctuations in demand, seasonal variance becomes more important due to increased electric heating possibilities.

Power generation for Germany 100% case



Power capacities for Germany 100% case



Chances and Barriers for Germany's Low-Carbon Transition

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


Open Access Editor's Choice Article

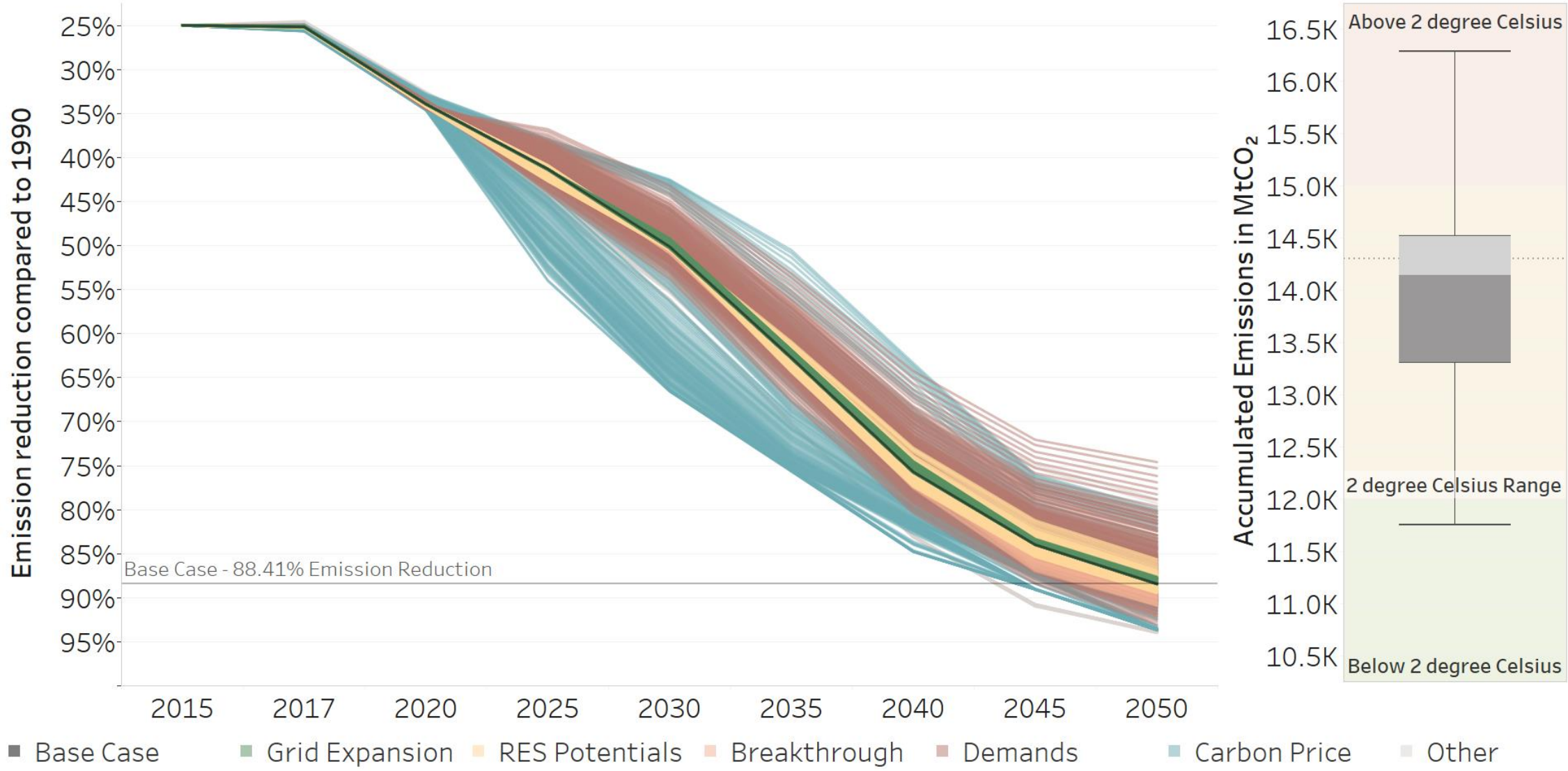
Pathways for Germany's Low-Carbon Energy Transformation Towards 2050

by Hans-Karl Bartholdsen [1,†], Anna Eidens [1,†], Konstantin Löffler [1,2,†], Frederik Seehaus [1,*,†], Felix Wejda [1,†], Thorsten Burandt [1,2,3], Pao-Yu Oei [1,2], Claudia Kemfert [2,4,5] and Christian von Hirschhausen [1,2]

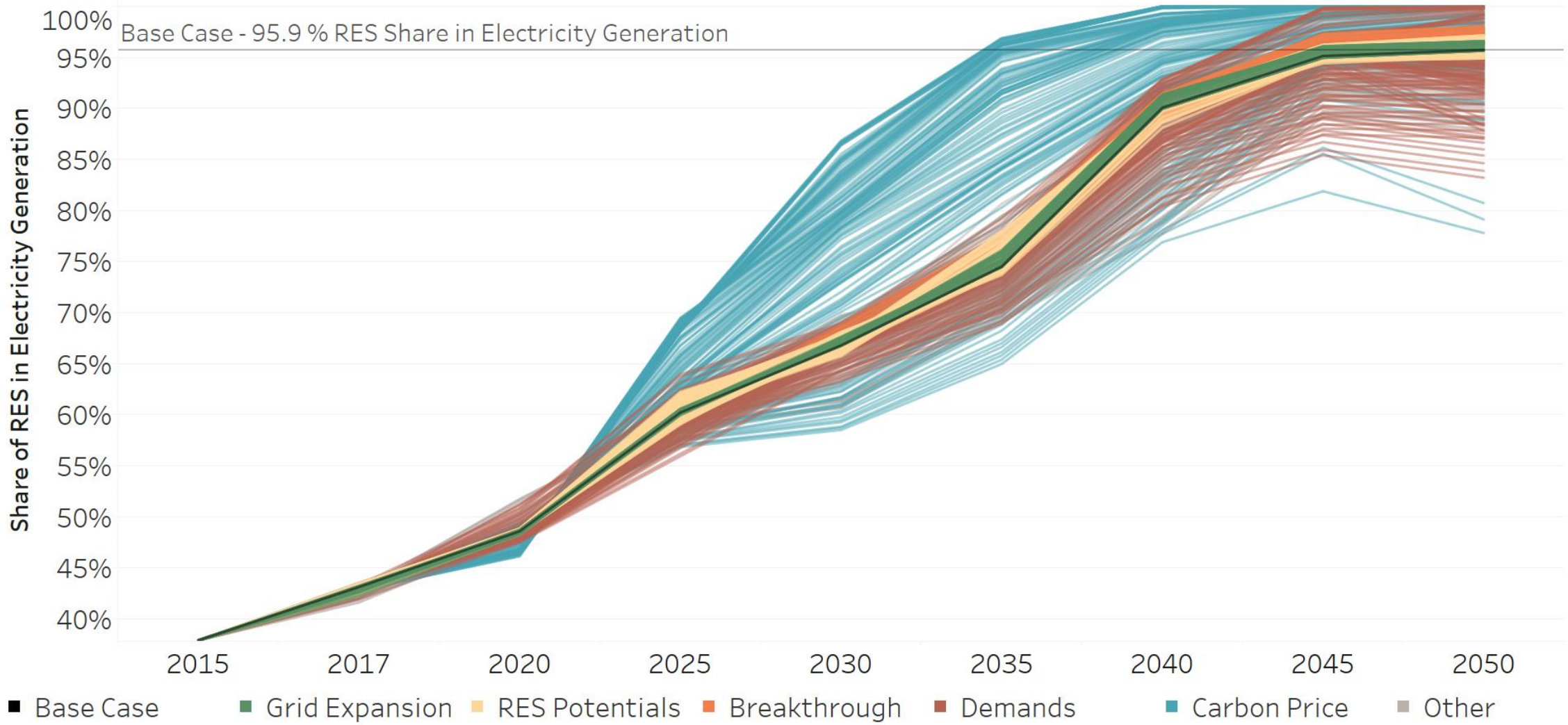
- Paper concept:
  - When modeling pathways for energy system development, we, as modelers, have to deal with many unknowns
  - This is especially true for input assumptions such as demand or cost data, which can heavily influence results
  - While results are often represented as one singular pathway, accounting for these unknowns would lead to a pathway *range* instead

- Main research question:
  - What are the key influential factors on the energy transition in Germany and how much do they affect the modeling results until 2050? What implications does that have on energy policy advice?

Results: Emissions



Results: Renewable Share in Electricity



Conclusion of our Results

- 100% renewable energy is not only a vision but a necessity for the energy transition
- Reducing energy demand (sufficiency and efficiency) shows the highest effects
- New investments into fossil technologies or infrastructure must be avoided
- Benefits of the transition outweigh the costs

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Chances and barriers for Germany's low carbon transition - Quantifying uncertainties in key influential factors

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Lessons from Modeling 100% Renewable Scenarios Using GENeSYS-MOD

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Thank you for your attention.

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