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# Are there interactions between a coal phase-out and the new battery capacities created by electric vehicles?

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# Are there interactions between a coal phase-out and the new battery capacities created by electric vehicles?

Potential interactions:

- New demand for electricity
- Reduced electricity generation capacity
- CO<sub>2</sub> intensity of electricity -> Are electric vehicles green?
- Remaining coal: Pressure on system for available CO<sub>2</sub> emissions

➤ Sector coupling: Electricity – (Heat) – Transport

Contribution is based on research in the BMBF research project „Kopernikus – ENAVI“

# Renewable Energy Model – Deutschland »REMod-D«

## REMod-D Renewable Energy Model – Deutschland

- Techno-economic optimization
- Based on system simulation
- Hourly time scale 2015-2050
- Objective: **Minimize total annual cost**

Electricity generation,  
storage and end-use



Fuels (including  
biomass and synthetic  
fuels from RE)



Mobility  
(battery-  
electric,  
hydrogen,  
conv. fuel mix)



Heat  
(buildings,  
incl. storage  
and heating  
networks)

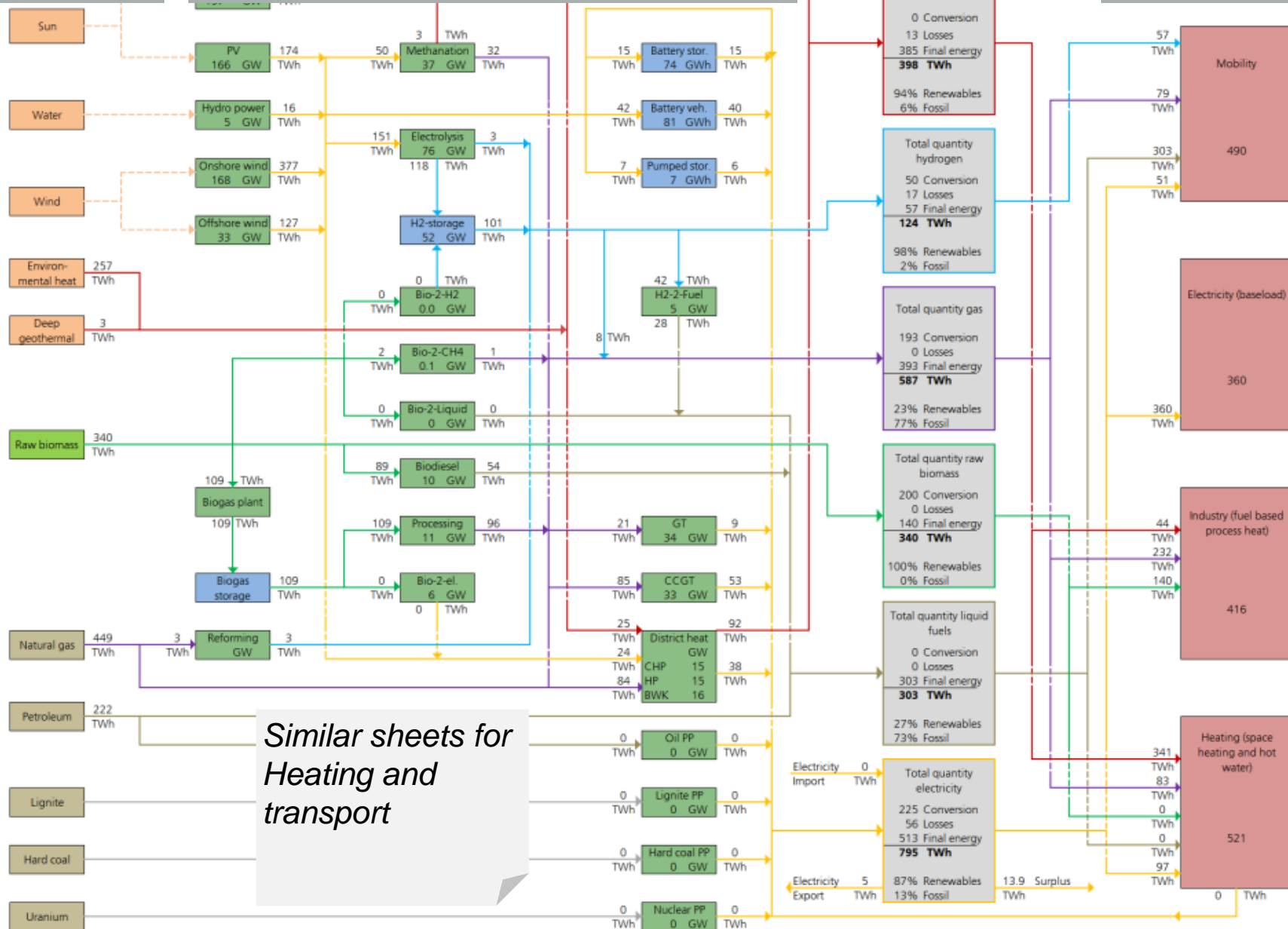


Processes in  
industry and  
tertiary sector

# Primary energy

# Generators and converters

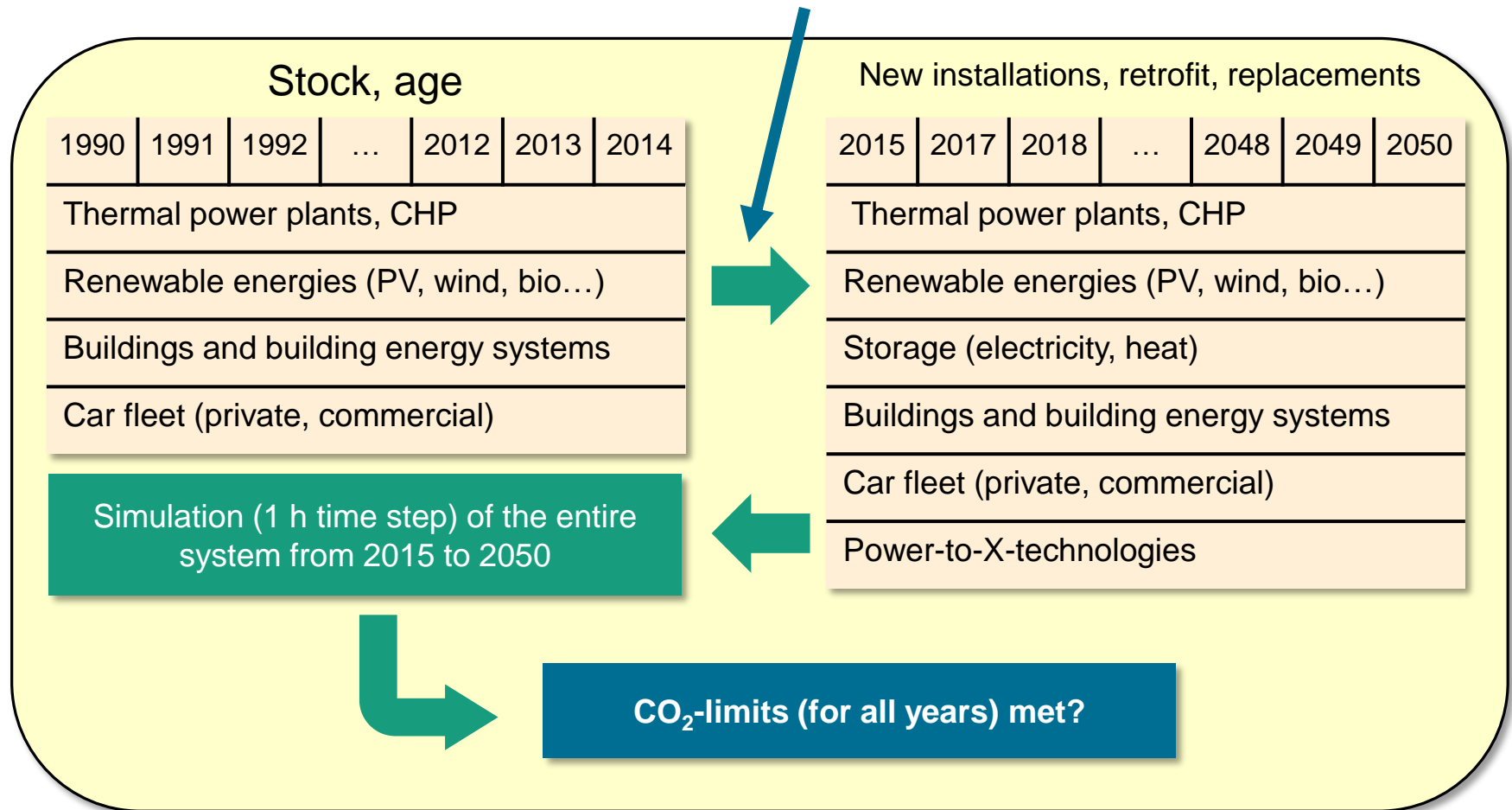
# Consumption



Similar sheets for  
Heating and  
transport

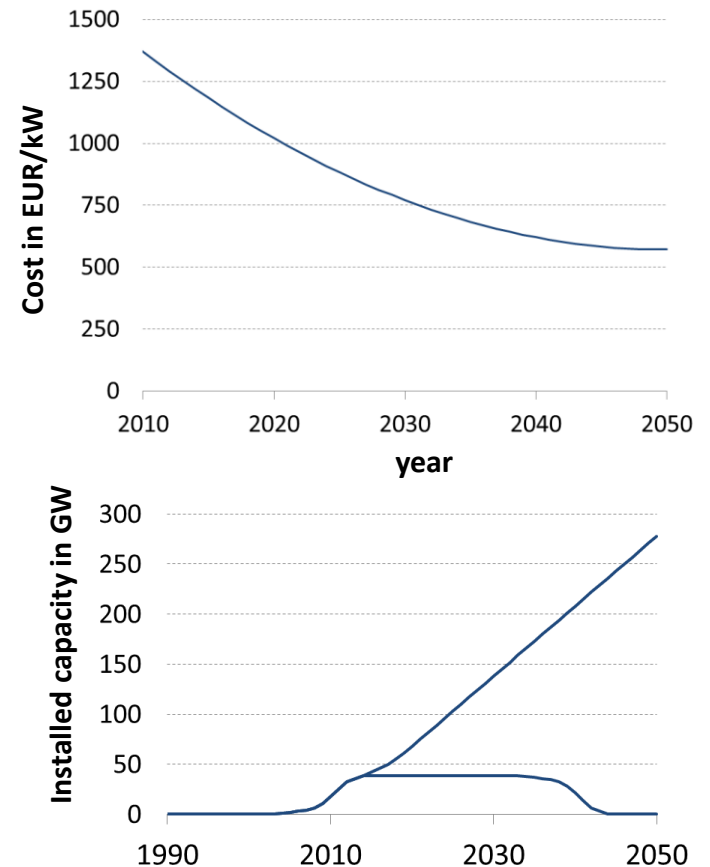
# Methodology REMod

Optimization of new installations, retrofit and replacement  
goal function: minimal cumulative total cost 2015-2050



# Methodology REMod (extended)

- Complete path for total energy system is optimized
- Number of heating systems and vehicles is defined exogenously (=fully optimized)
- CO<sub>2</sub> cap
- Coverage of the model: Germany plus energy imports
- Demand and weather data of 2011, 2012, 2013
- Cost functions for all technologies
- Corridors for expansions for all tech.



# Key assumptions for German case

- Reduction of energy related CO<sub>2</sub>-Emissions: -85 % compared to 1990
- process heat in industry, electricity consumption in today's applications, number of car fleet & houses almost constant compared to today
- No import of electricity based fuels or other renewable fuels
- Biomass (ca. 290 TWh/a)
- Nuclear phase-out: 2022
- No CCS

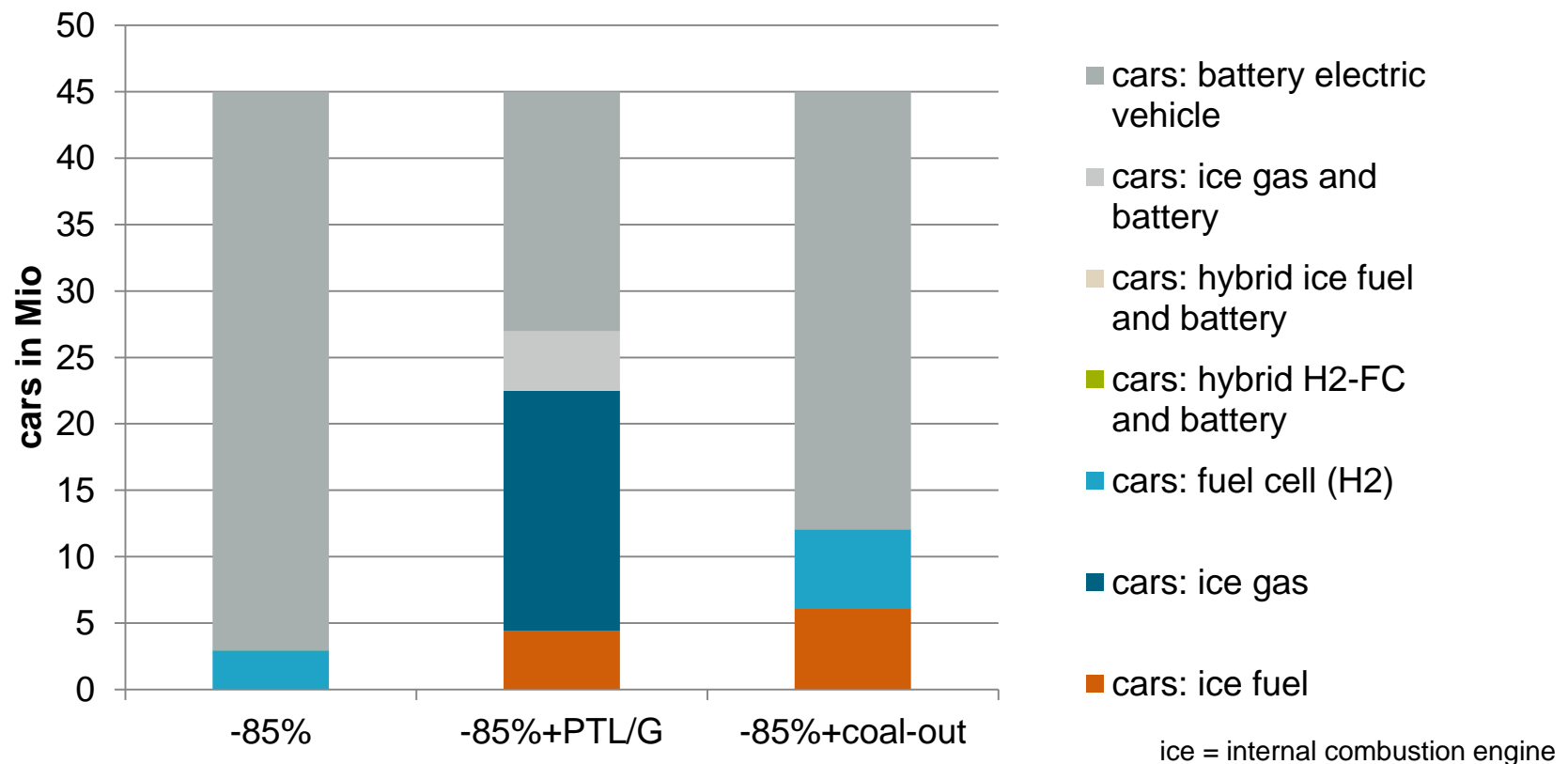
# Analysis of CO2 emissions reduction scenarios with three options

- Analysis of the configuration of potential German energy systems by analyzing three scenario paths
  - (1) -85% CO2 emission reduction with high share of electric vehicles and NO coal phase-out
  - (2) -85% CO2 emission reduction with high share of fuels and NO coal phase-out
  - (3) -85% CO2 emission reduction with high share of electric vehicles and coal phase-out



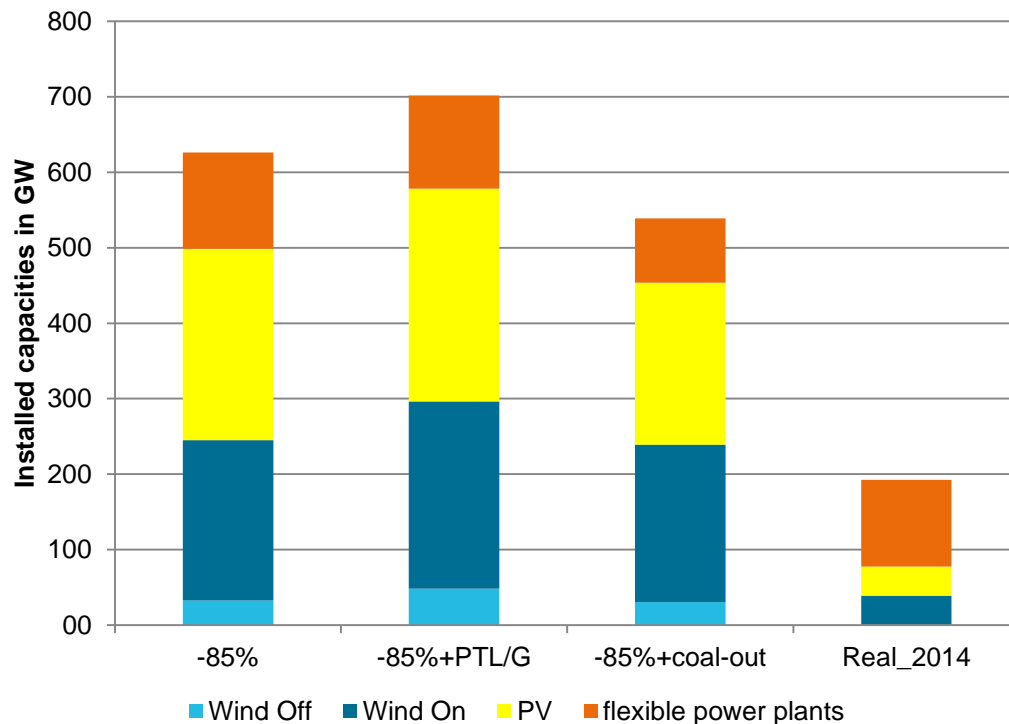
# Electric vehicles are main technology, exogenously calculated, however other technologies are also realistic choices

Car fleet in Germany, distribution of technologies in 2050

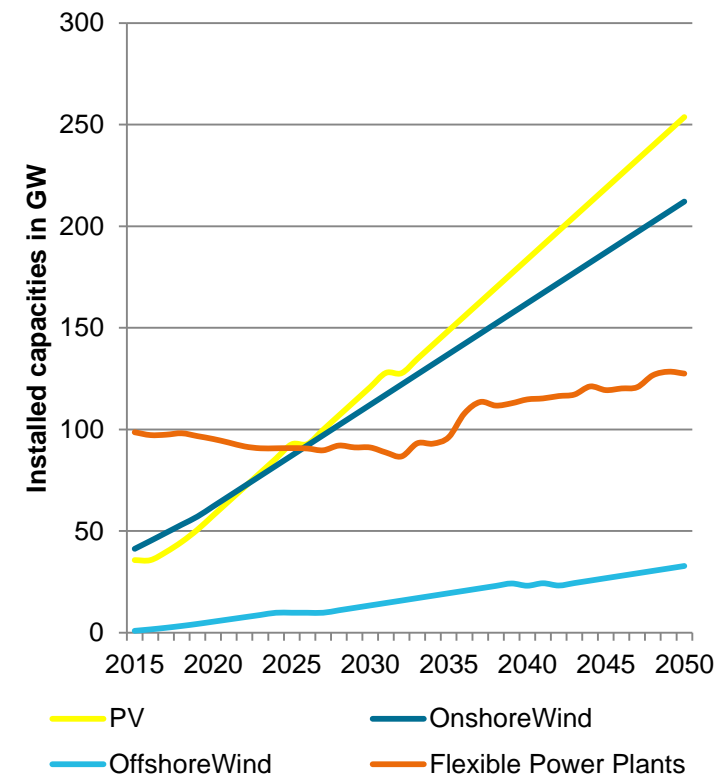


# Electricity generation capacity is strongly depending on sector coupling and role of coal

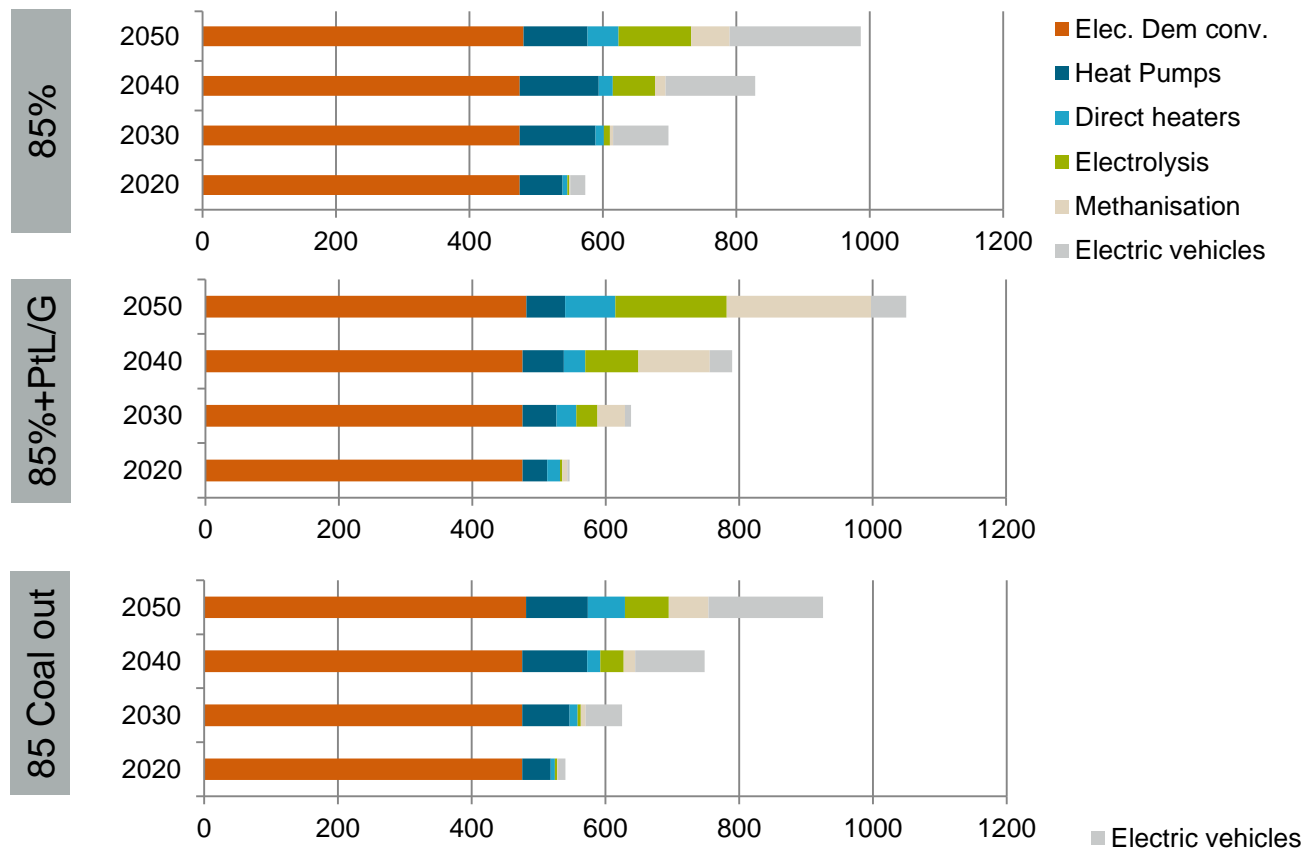
Installed electricity generation in 2050



Development Path (85%)

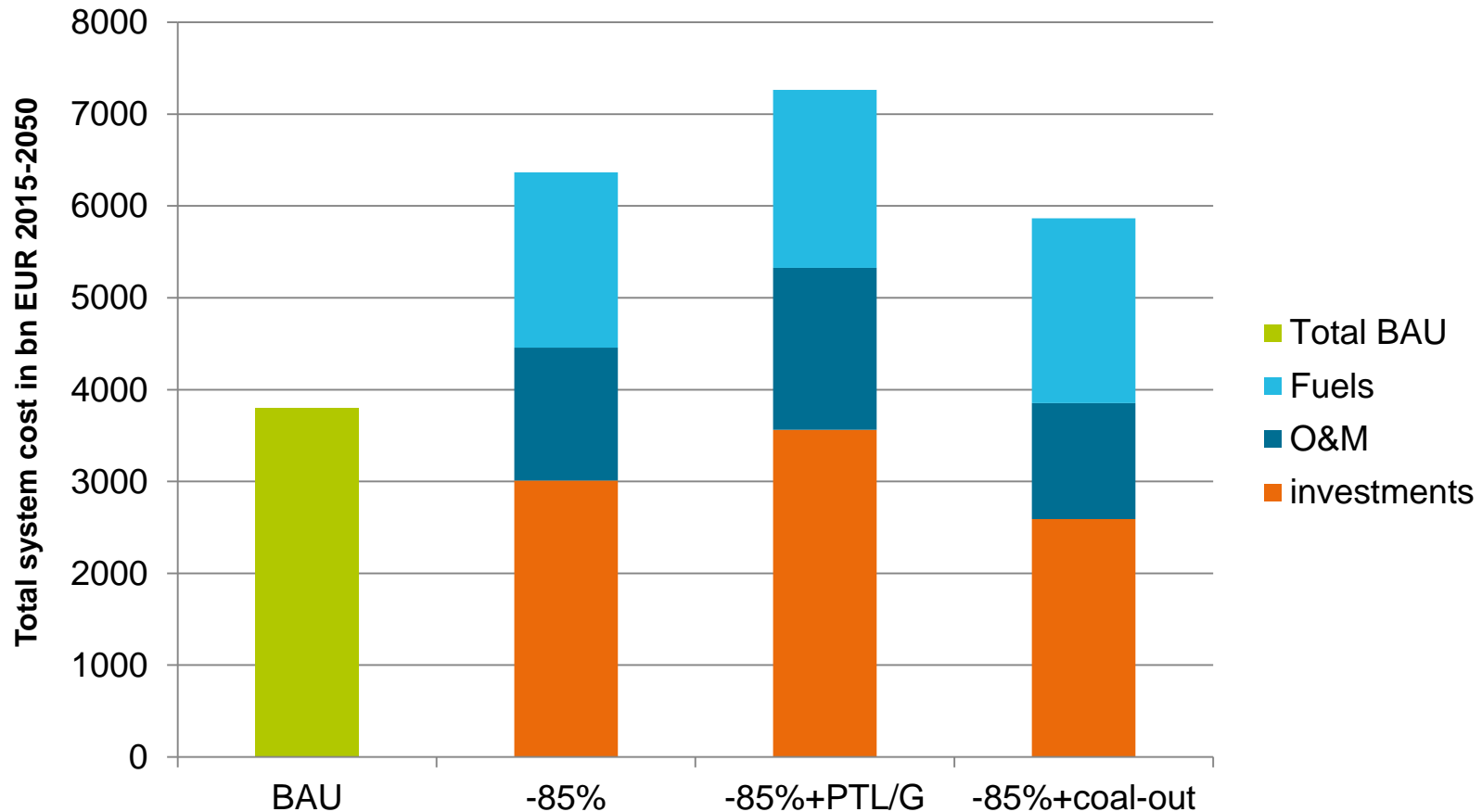


# Electricity use increases strongly with sector coupling! Dependency on transport sector.



# Cost of the development path depends a key drivers: coal phase out or technology choice in transport

Total system cost by 2050

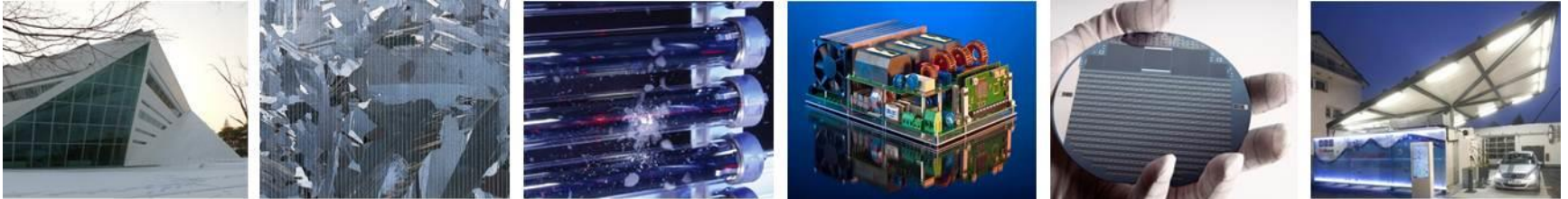


# Summary and conclusion

- REMod approach shows impact between electricity sector and other sectors in a single model
- High temporal (hourly) resolution of technical interactions (2015 – 2050)
- Electric vehicles with direct use of electricity reduces size of electricity system
- Coal phase-out is necessary to use emission rights in other applications
- In general: Different Energiewende paths possible, but strong implications on the system
- Extended analysis in ongoing BMBF research project “Kopernikus-ENAVI”

# Many thanks for your attention!

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