STRATEGIC POLICY TARGETS AND THE CONTRIBUTION OF HYDROGEN IN A 100% RENEWABLE EUROPEAN POWER SYSTEM

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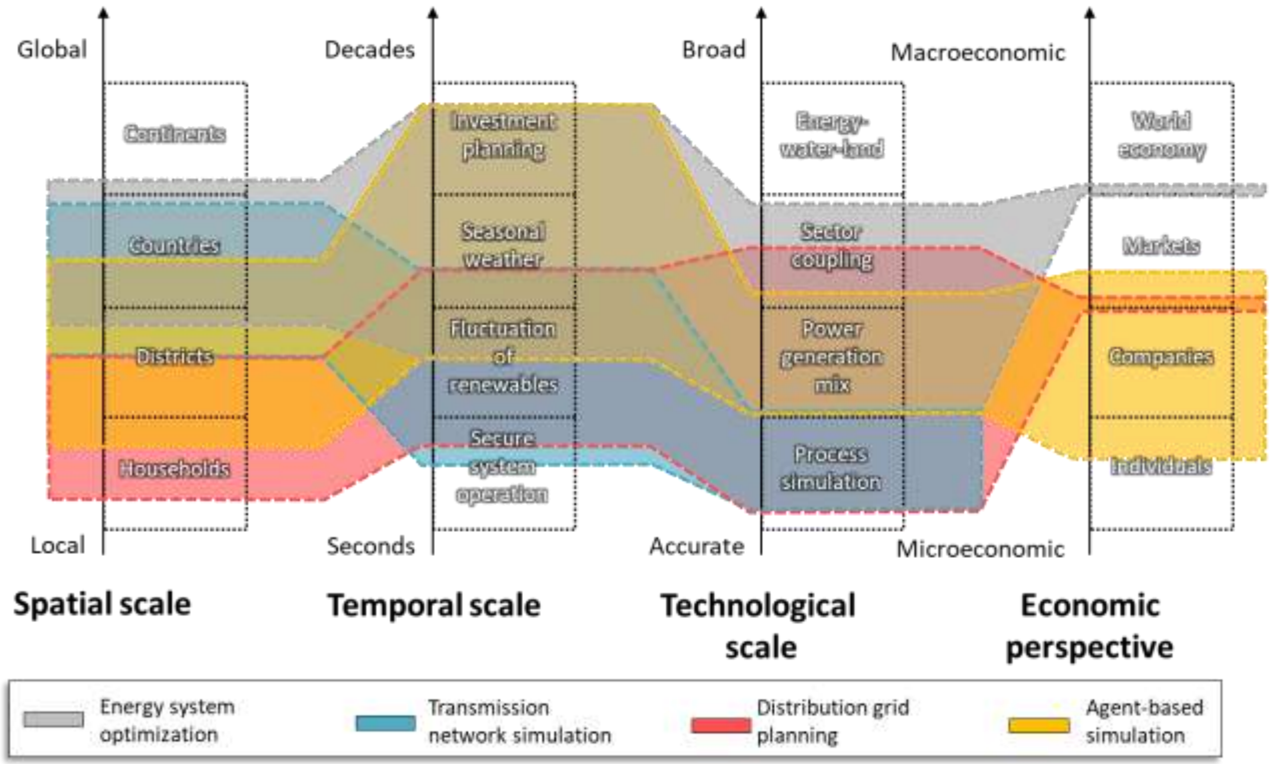
DLR

BACKGROUND

Project background



Source: Cao et al. (2021), [10.1002/ese3.891](https://doi.org/10.1002/ese3.891)

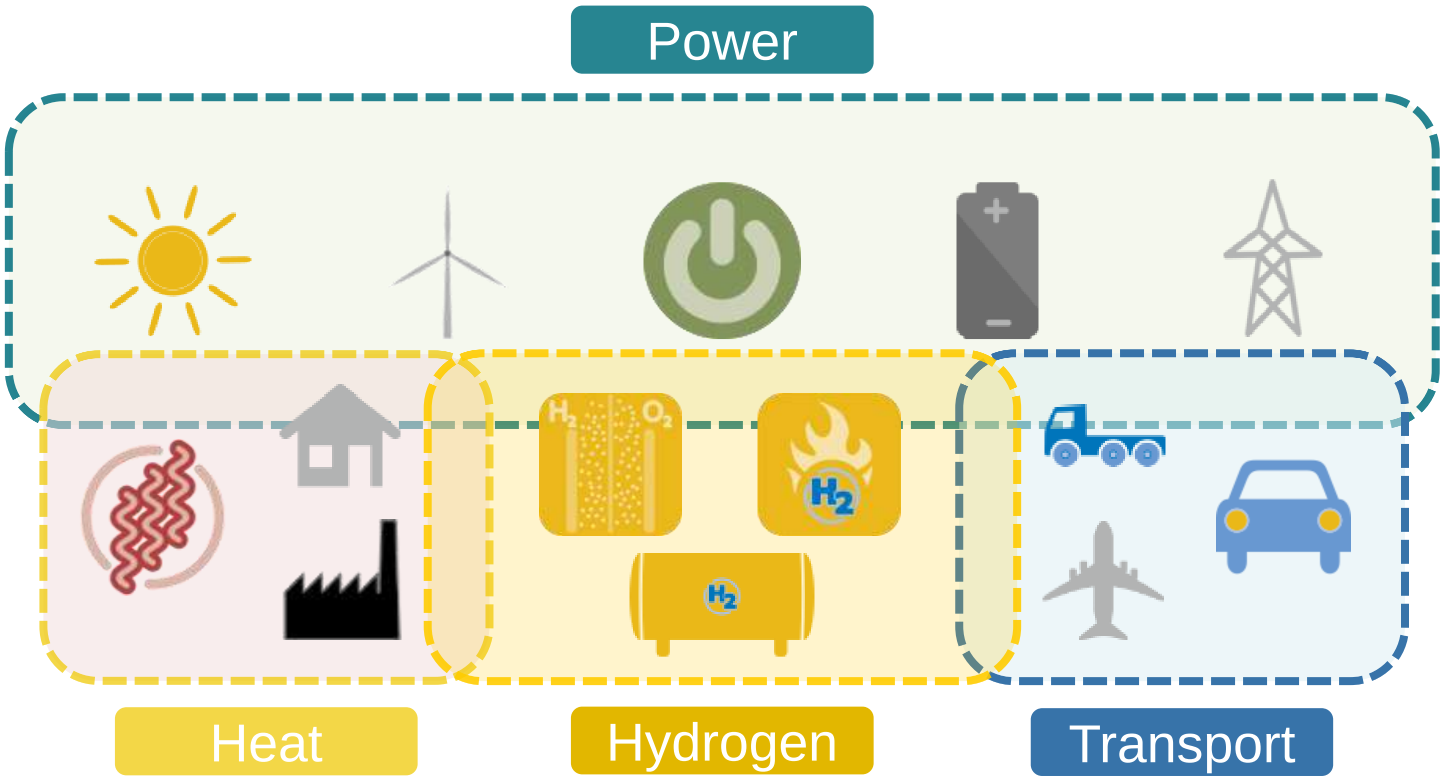
- **INTEEVER-II:** Analysis of the integration of renewable energies in Germany and Europe, taking into account the security of supply and decentralized flexibilities
- 2018-2022
- Collaboration with the University of Stuttgart and Fraunhofer IEE

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Decarbonizing the energy system



Uncertainties

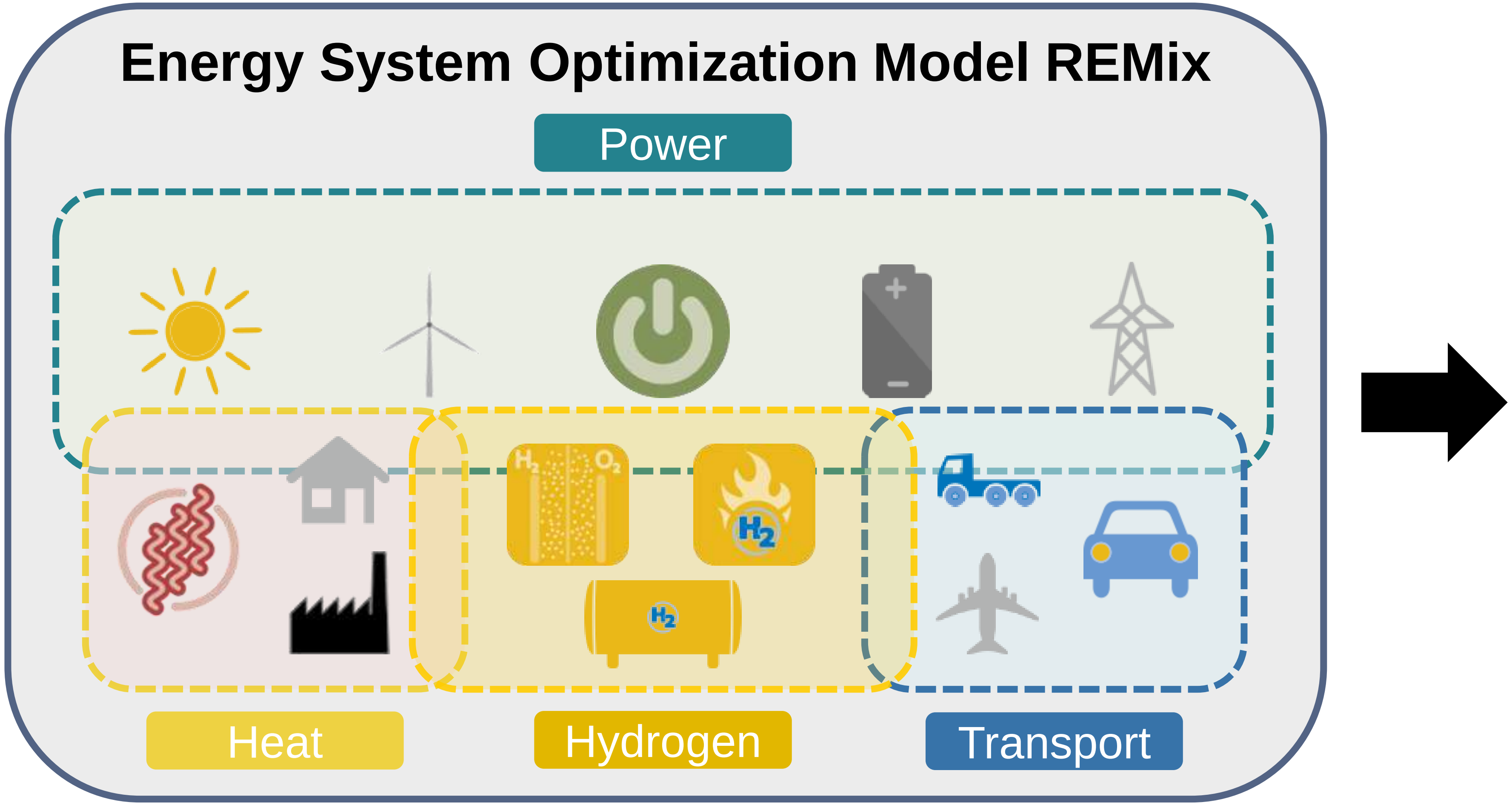
Utilization of hydrogen?
- Crucial applications
- Flexibility option

Hydrogen source?
- Import
- Domestic production

Infrastructure
- What is needed?
- How much is needed?
- When does it need to be available?

METHODS

Modelling the decarbonization



min (C_{exp} + C_{op})

Cost-optimal expansion and operation

C_{exp}…	Expansion cost
C_{op}…	Operational cost

Strategic policy targets

European Green Deal

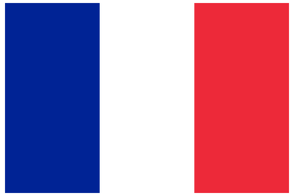
*"Further **decarbonising** the energy system is critical to reach climate objectives in 2030 and 2050."*

Zero CO_2

National long-term strategies

More **independence** from energy imports

Self-sufficiency



Diverse electricity production

Diversity

Back-up capacity

Secured capacity

Model setup

Region: Europe and Maghreb

Optimization model: REMix

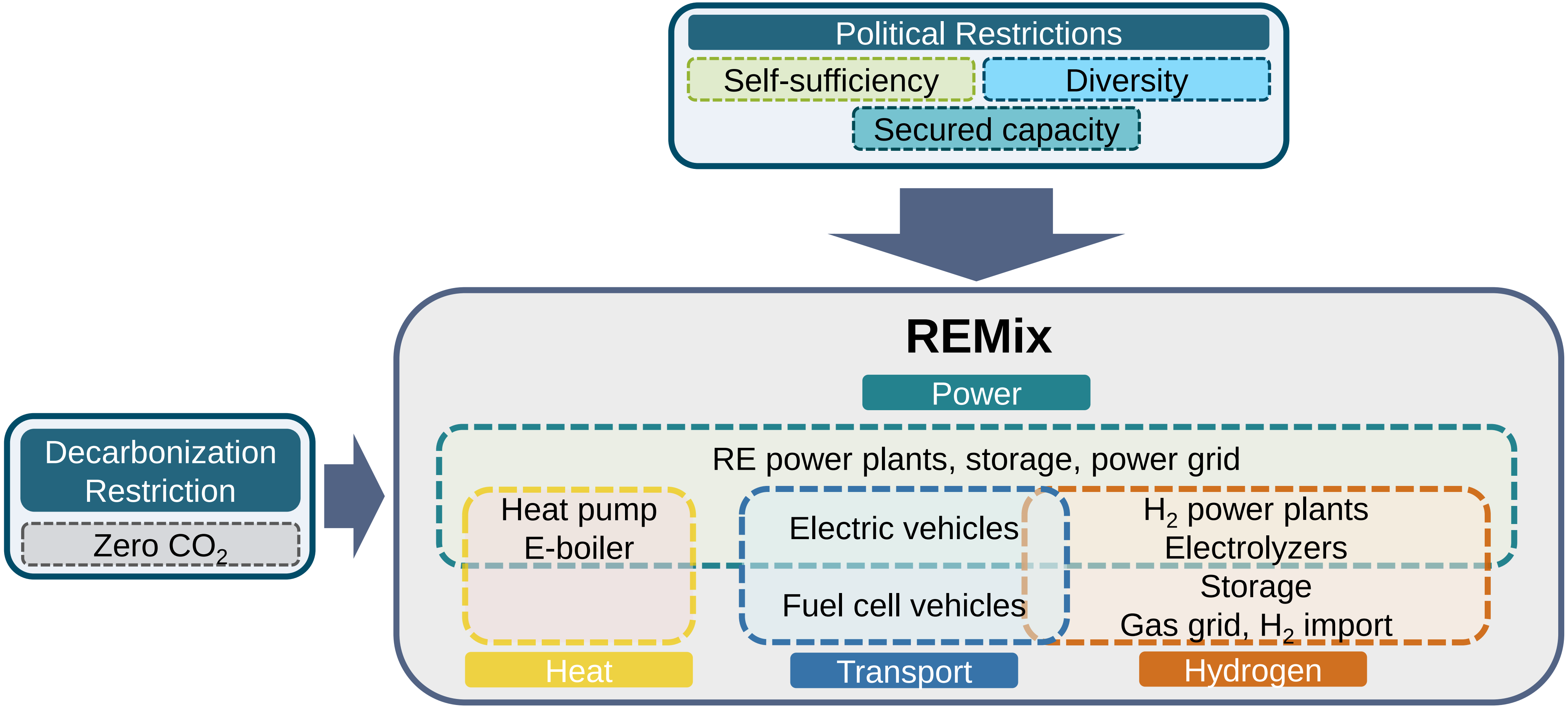
Goal: Zero CO_2 emission in the power supply

Scenarios: with/ without H_2
+ additional policy targets

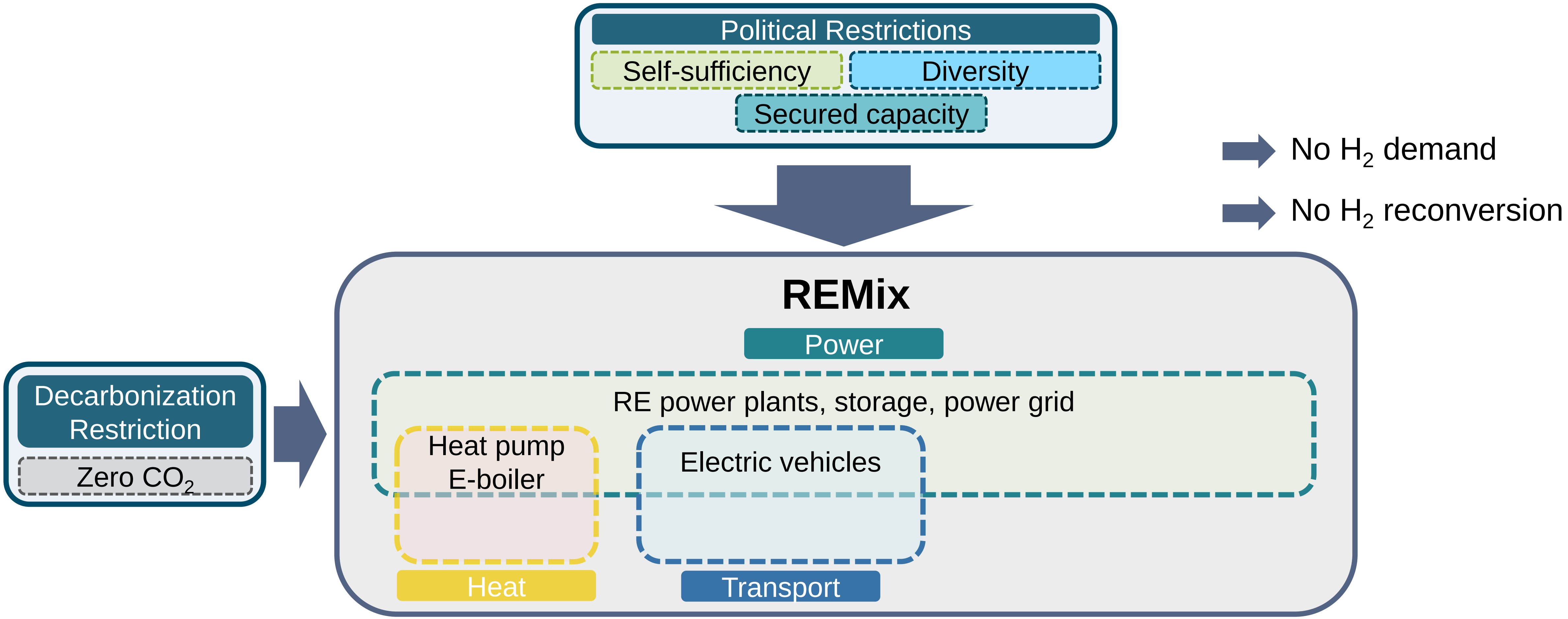
Base scenario: No strategic policy targets

Power plants:
- Renewables
- Nuclear
- Gas turbines and fuel cells in H_2 scenarios

Setup – Scenarios with H_2



Setup – Scenarios without H_2

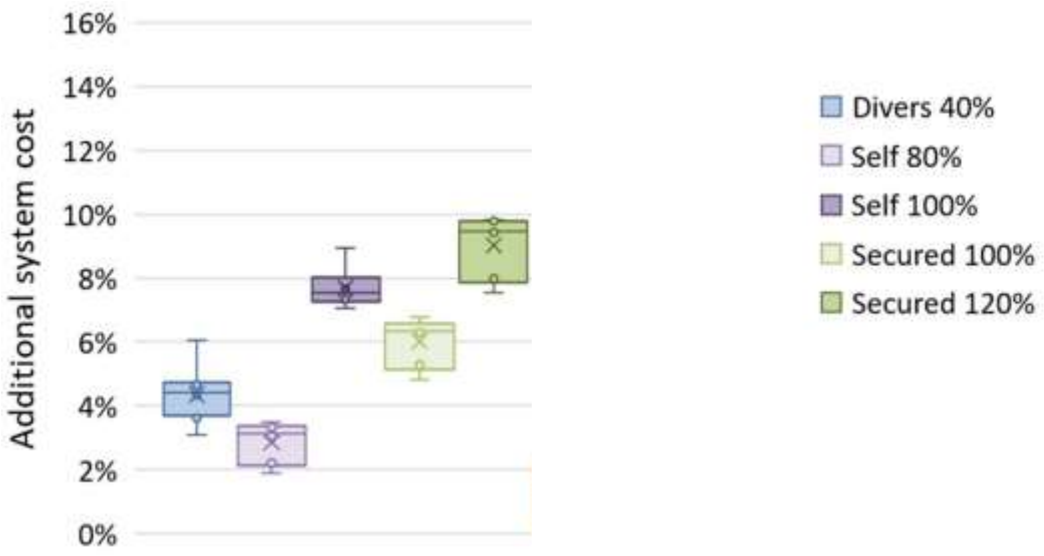


RESULTS

Scenario	Restriction
Divers x%	Max. share of x% per tech.
Self x%	Min. x% self-sufficiency
Secured x%	Min. x% secured capacity

System cost and feasibility

System cost



Feasibility

Scenarios with hydrogen

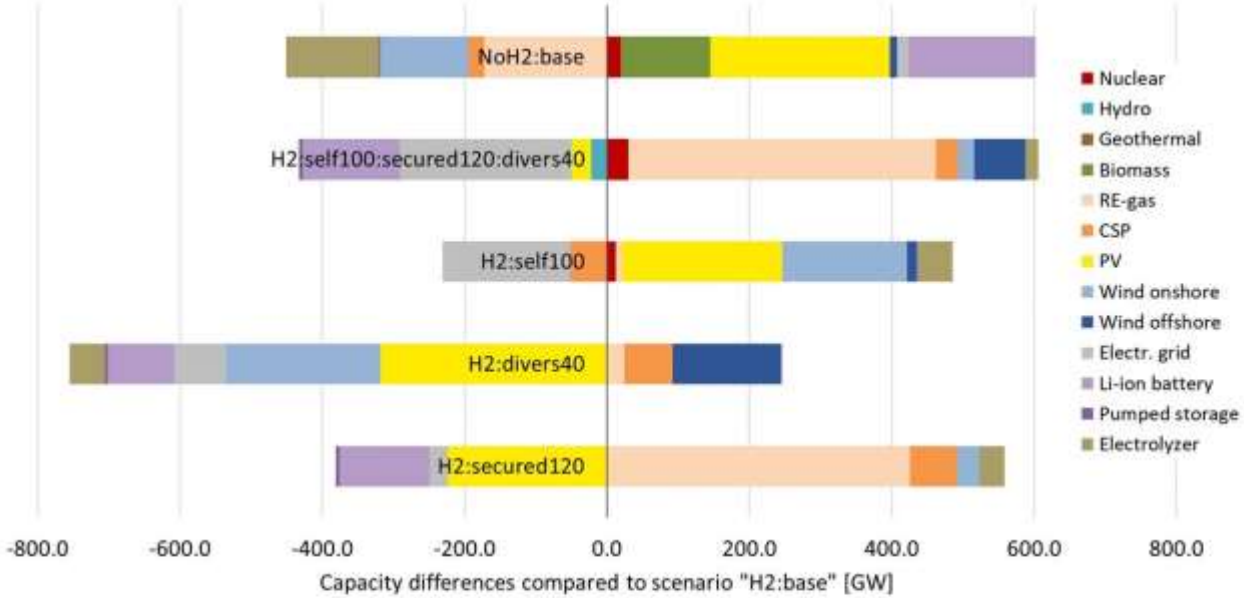
Scenarios without hydrogen

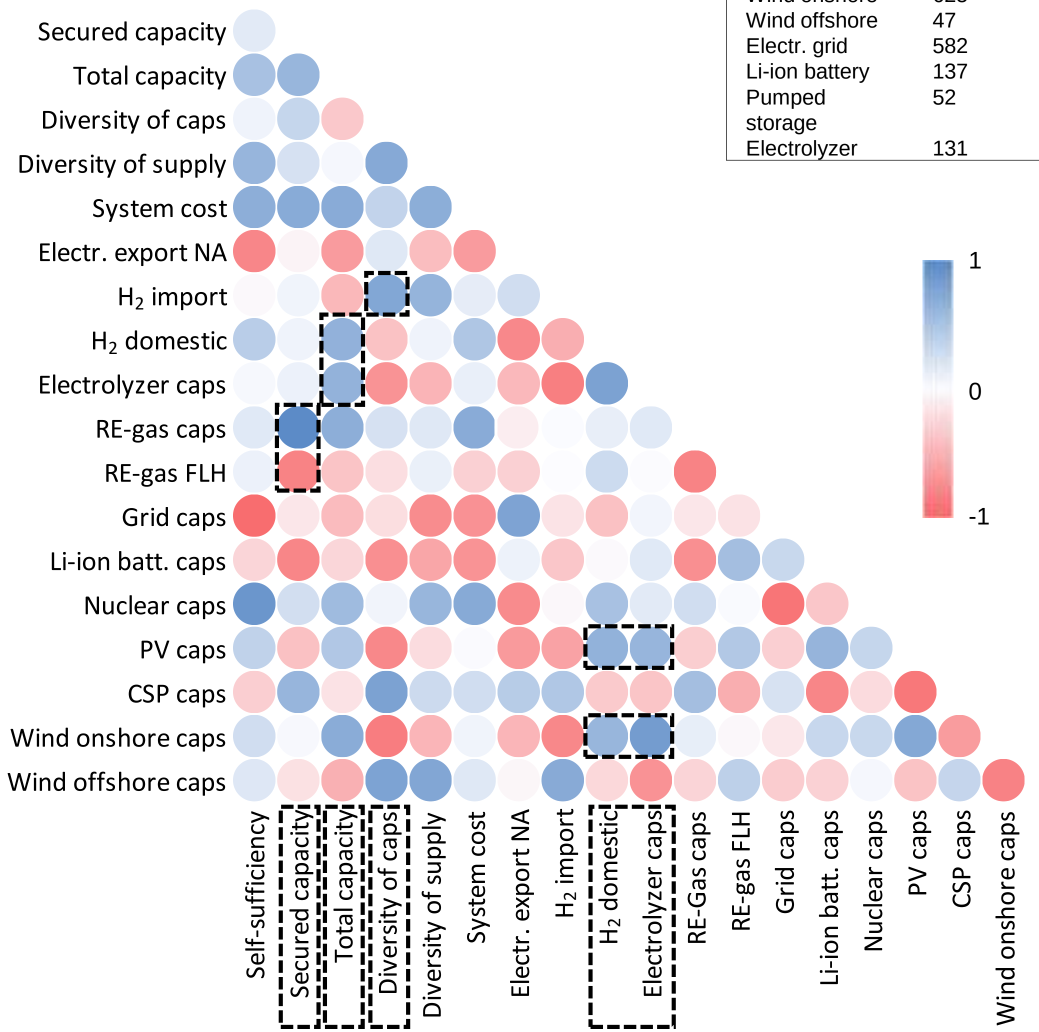
- System cost lower when hydrogen is considered in the power sector
- More policy targets can be implemented with hydrogen in the power sector

Source: Sasanpour et al. (2021), 10.1016/j.egyr.2021.07.005

Impact on the structure of the energy system

Technology	Capacity C [GW] in “H2:base”
Nuclear	3
Hydro	219
Geothermal	< 0.1
Biomass	< 0.1
RE-gas	172
CSP	96
PV	686
Wind onshore	625
Wind offshore	47
Electr. grid	582
Li-ion battery	137
Pumped storage	52
Electrolyzer	131

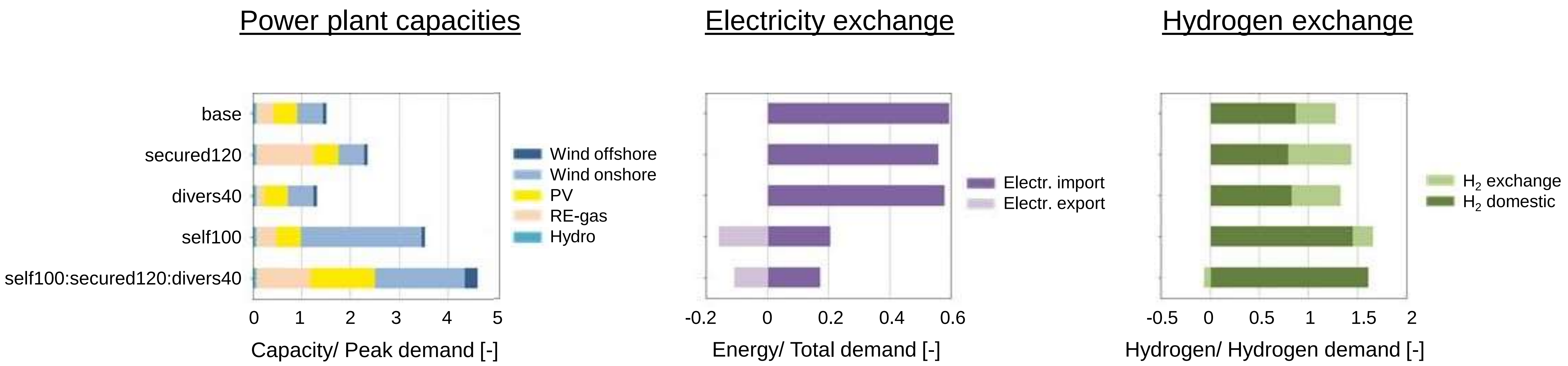




- **Secured capacity** → more flexible gas power plants, less batteries
- **Diversity** → CSP and wind offshore substitute PV and wind onshore
- **Self-sufficiency** → less electricity grid expansion
- **No H_2** → more biomass and nuclear power plants, more batteries

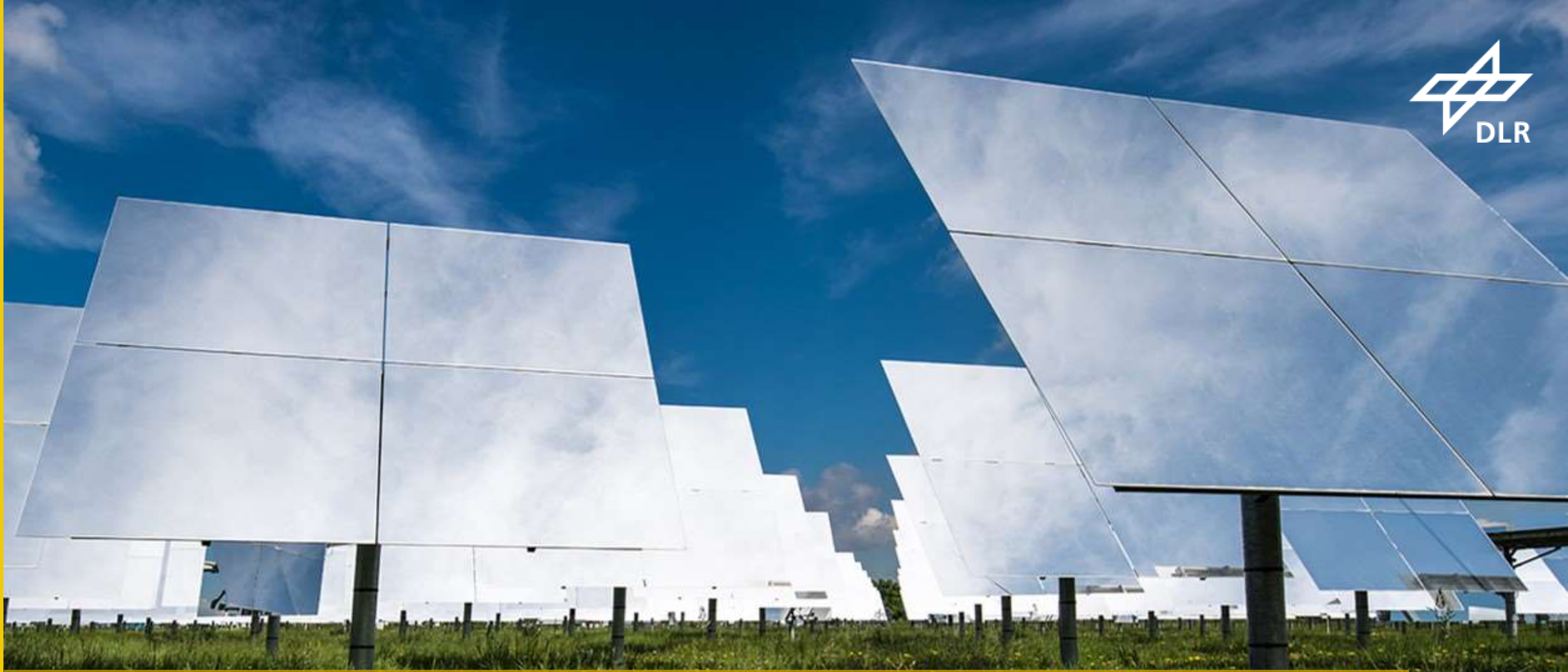
Source: Sasanpour et al. (2021), 10.1016/j.egyr.2021.07.005

Power system with H_2 in Germany



- Without self-sufficiency: up to 60% of electricity demand imported
- With self-sufficiency: capacity doubled/tripled
- Hydrogen used for reconversion

Source: Sasanpour et al. (2021), 10.1016/j.egyr.2021.07.005



CONCLUSIONS

Summary and outlook

- Strategic policy targets influence structure of energy system on an overall and national level
- Fully decarbonized energy system profits from H_2 in the power sector
  - Total system costs lower
  - More flexibilities and long term storage available
  - More strategic policy targets can be implemented
- Required hydrogen transport and import infrastructures need further attention
- Resilience of different system designs with sector coupling has to be assessed

Impressum

Topic: **Strategic policy targets and the contribution of hydrogen in a 100% renewable European power system**

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