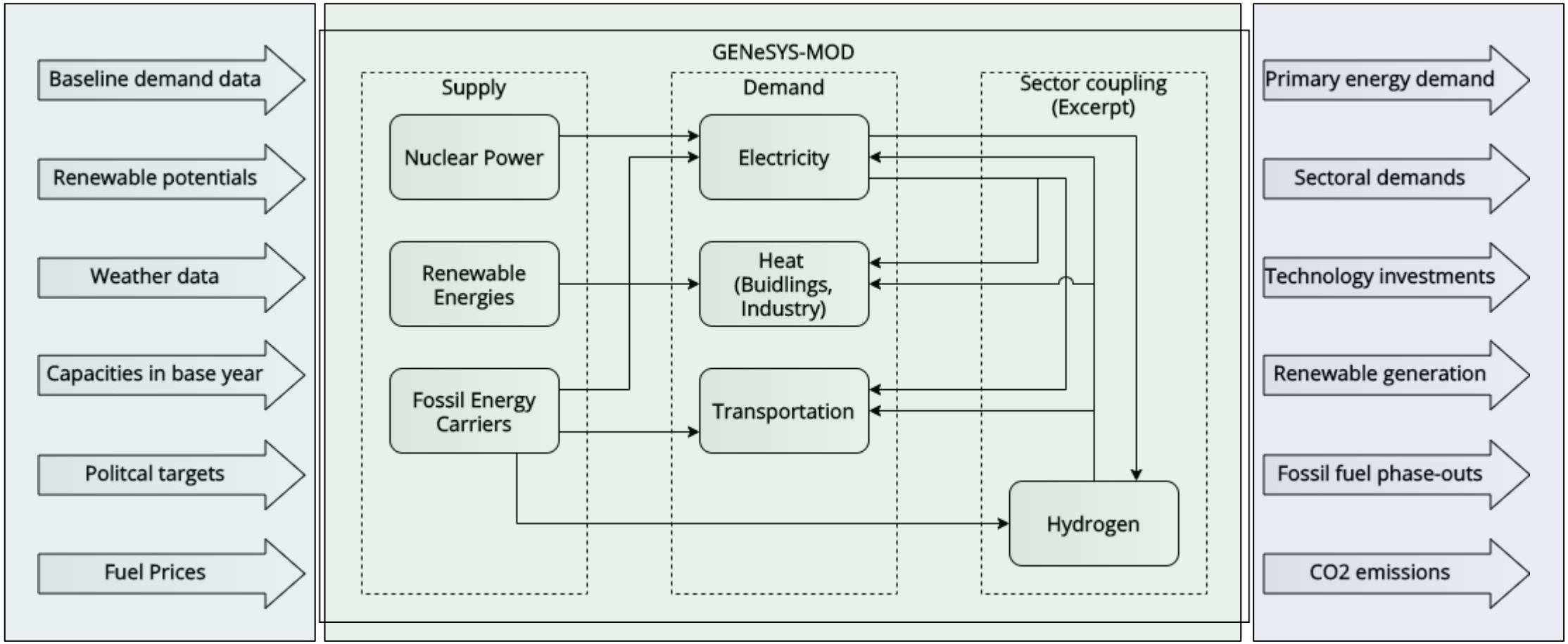
Hydrogen use in the European energy system:
an overview over current and future research efforts using GENeSYS-MOD

03.12.2021

The Global Energy System Model – GENeSYS-MOD



The openENTRANCE Storylines at a Glance

Directed Transition

- Strong policy push

Societal Commitment

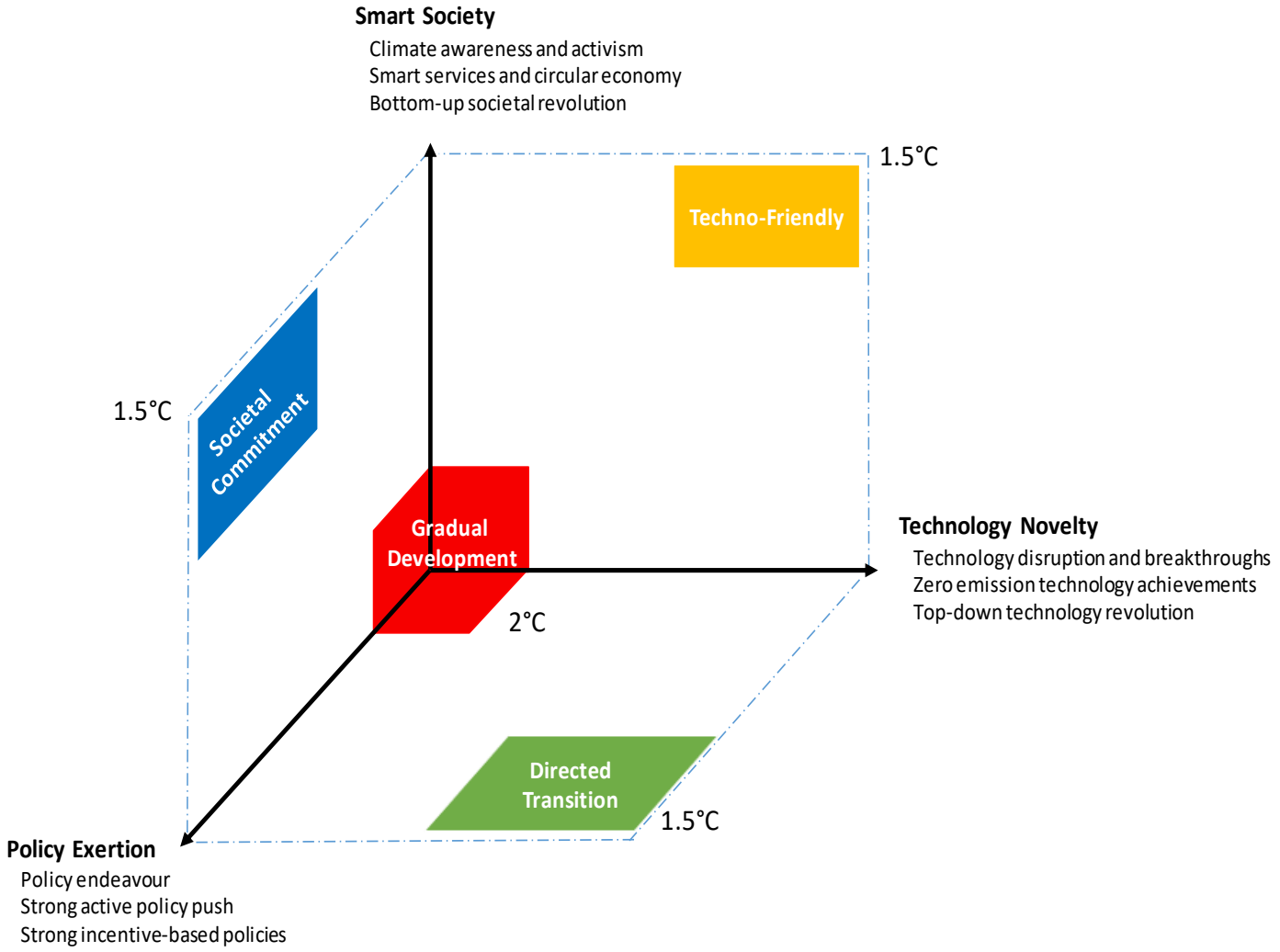
- Willingness of society

Techno-Friendly

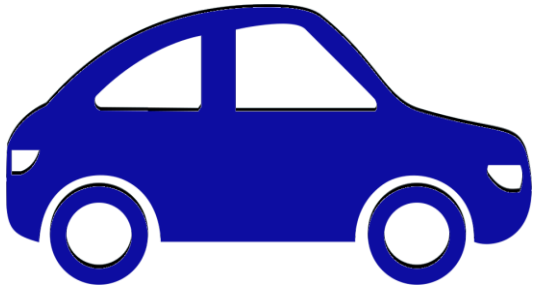
- High technological progress

Gradual Development

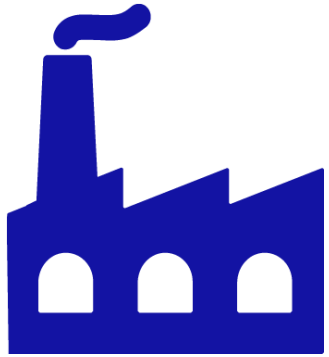
- Little of everything



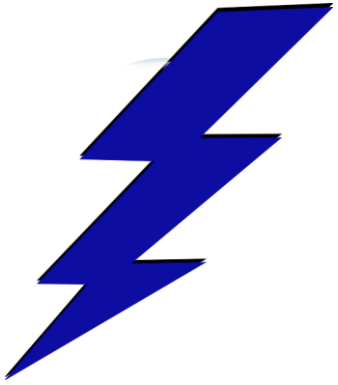
Possible Use-Cases for Hydrogen in the openENTRANCE Scenarios



Transportation



Industry

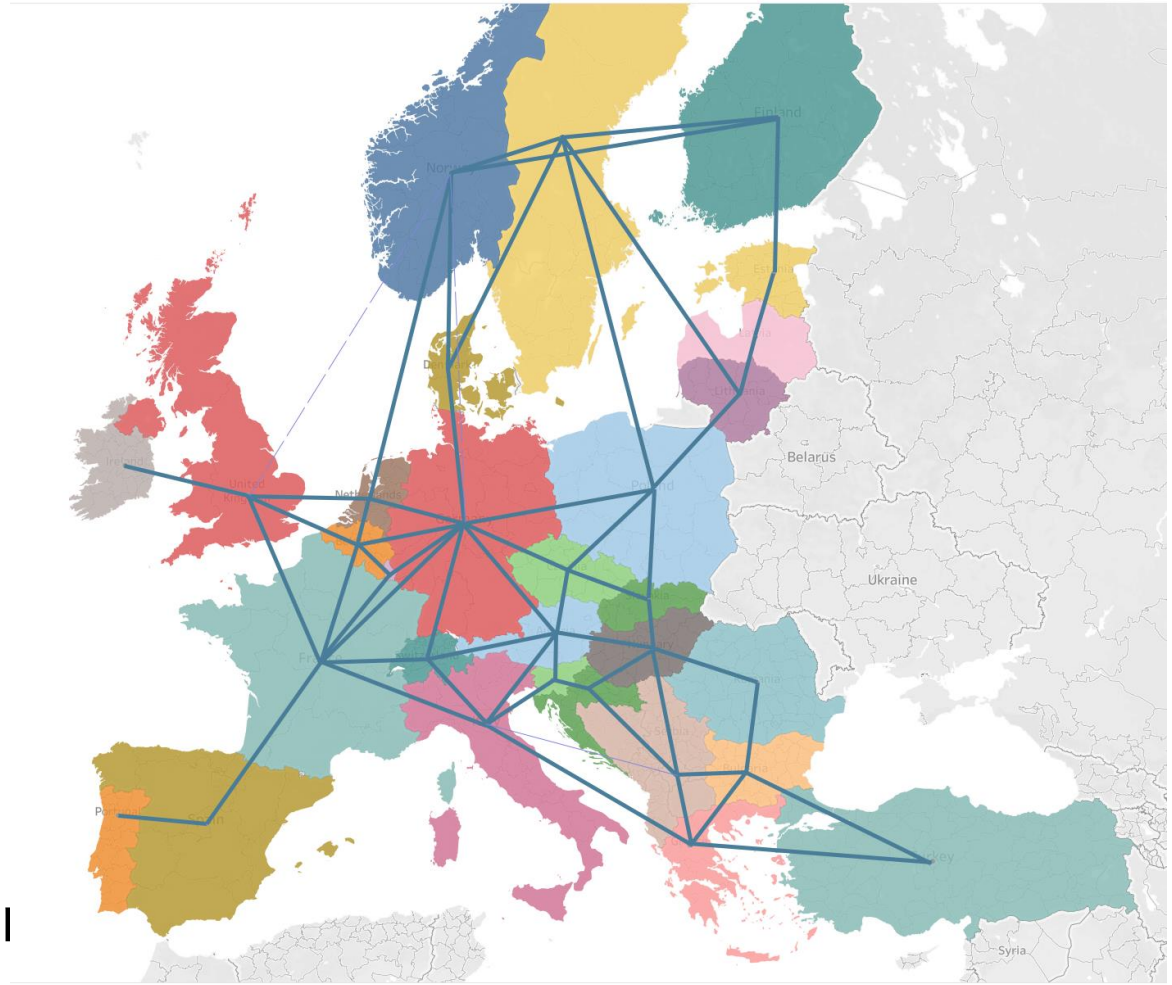


Flexibility in the power system

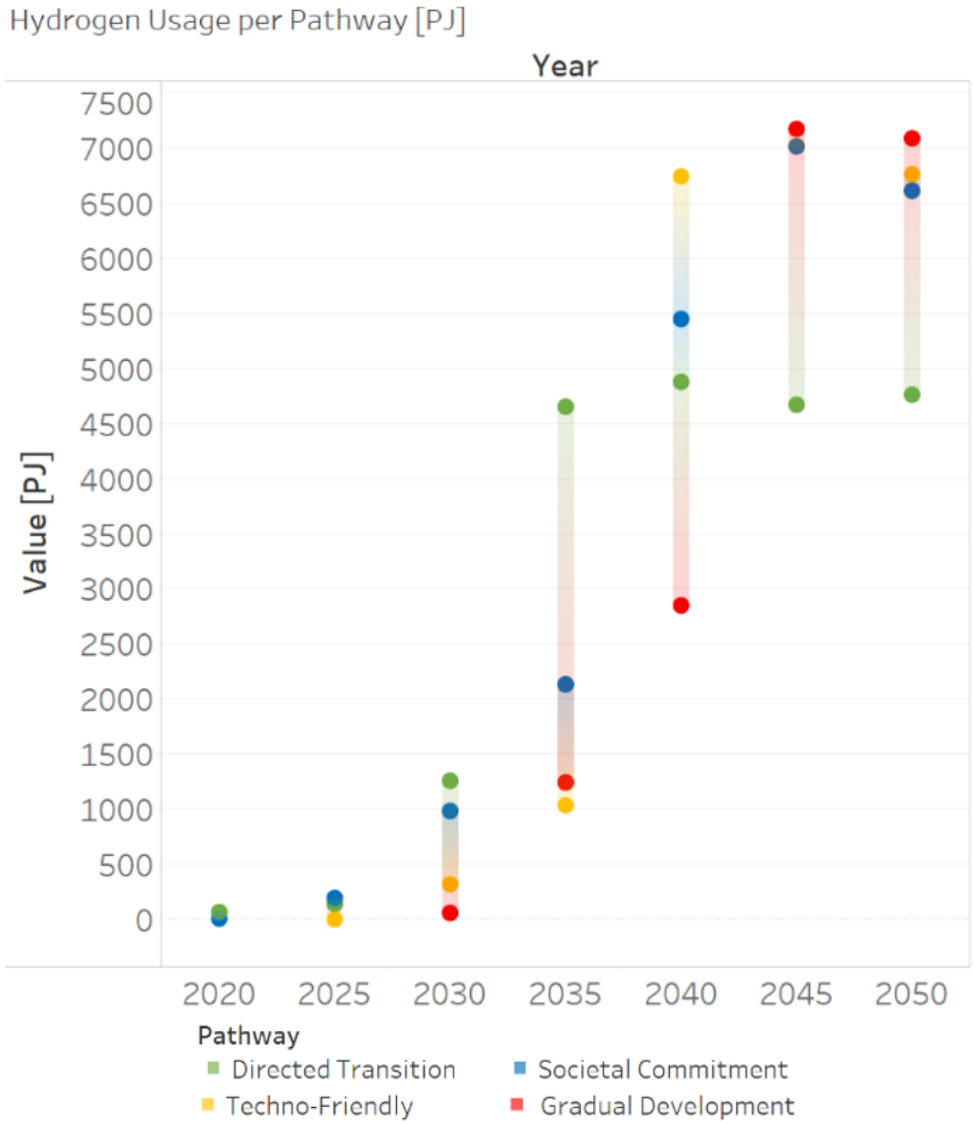
Heating

Model Setup and Specifications of GENeSYS-MOD in openENTRANCE

- 30 Regions (Mainland-EU, UK, Switzerland, Norway, Turkey, and the Balkan region)
- Years 2015-2050 in five year steps
- Hourly resolution with time-clustering algorithm
- Sectors: Electricity, Buildings, Industry and Transportation
- Pathway dependent features (like potential of demand shifting, political climate-targets, or breakthrough of certain technologies)

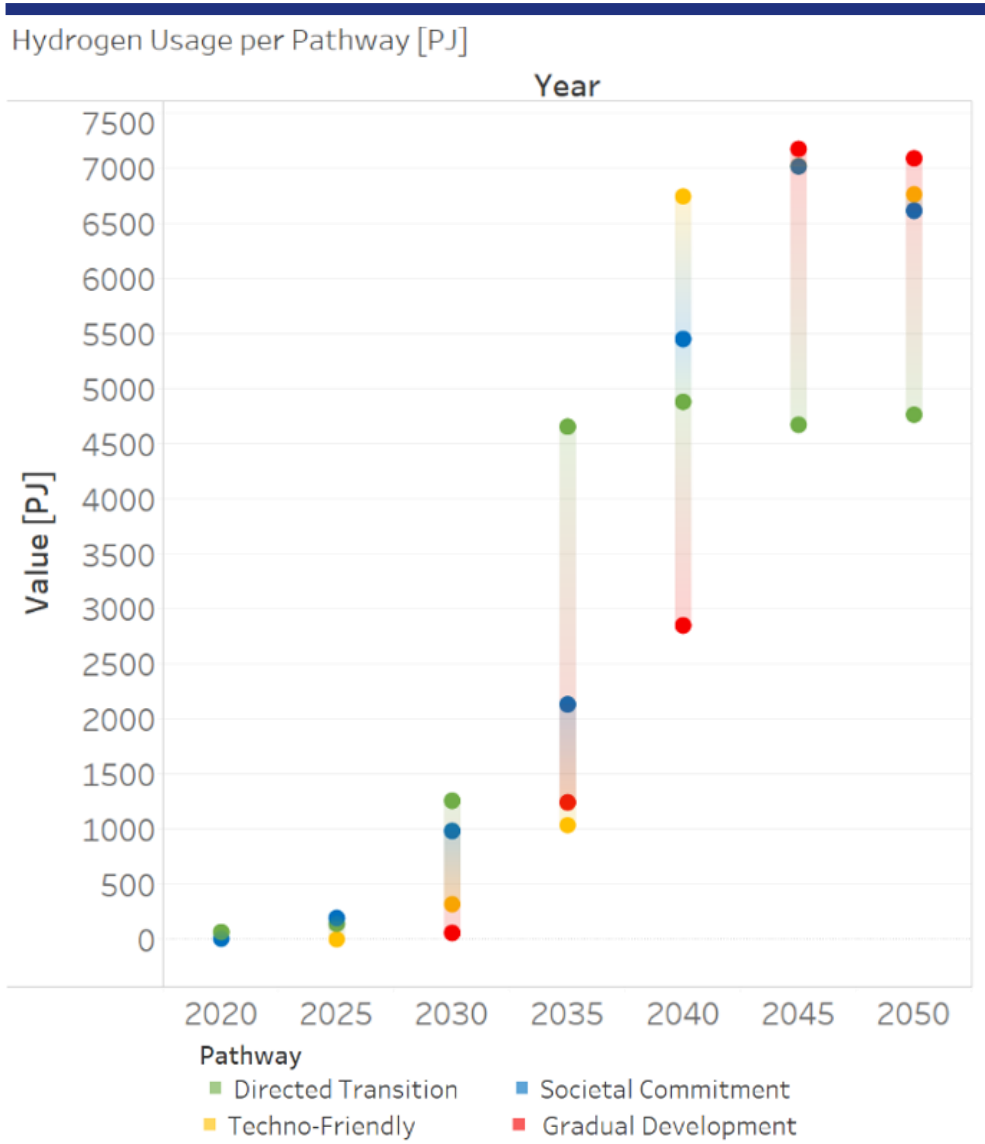


Hydrogen Usage per Pathway – General Results



- Renewable Hydrogen becomes important in all pathways, no matter the climate target or pathway characteristics.
- In all cases, it is used as an expensive option to replace difficult to decarbonize applications.
- Its drastic increase starting in 2035 is fueled by a rapid expansion of REs, which must happen before.

Hydrogen Usage per Pathway – General Results

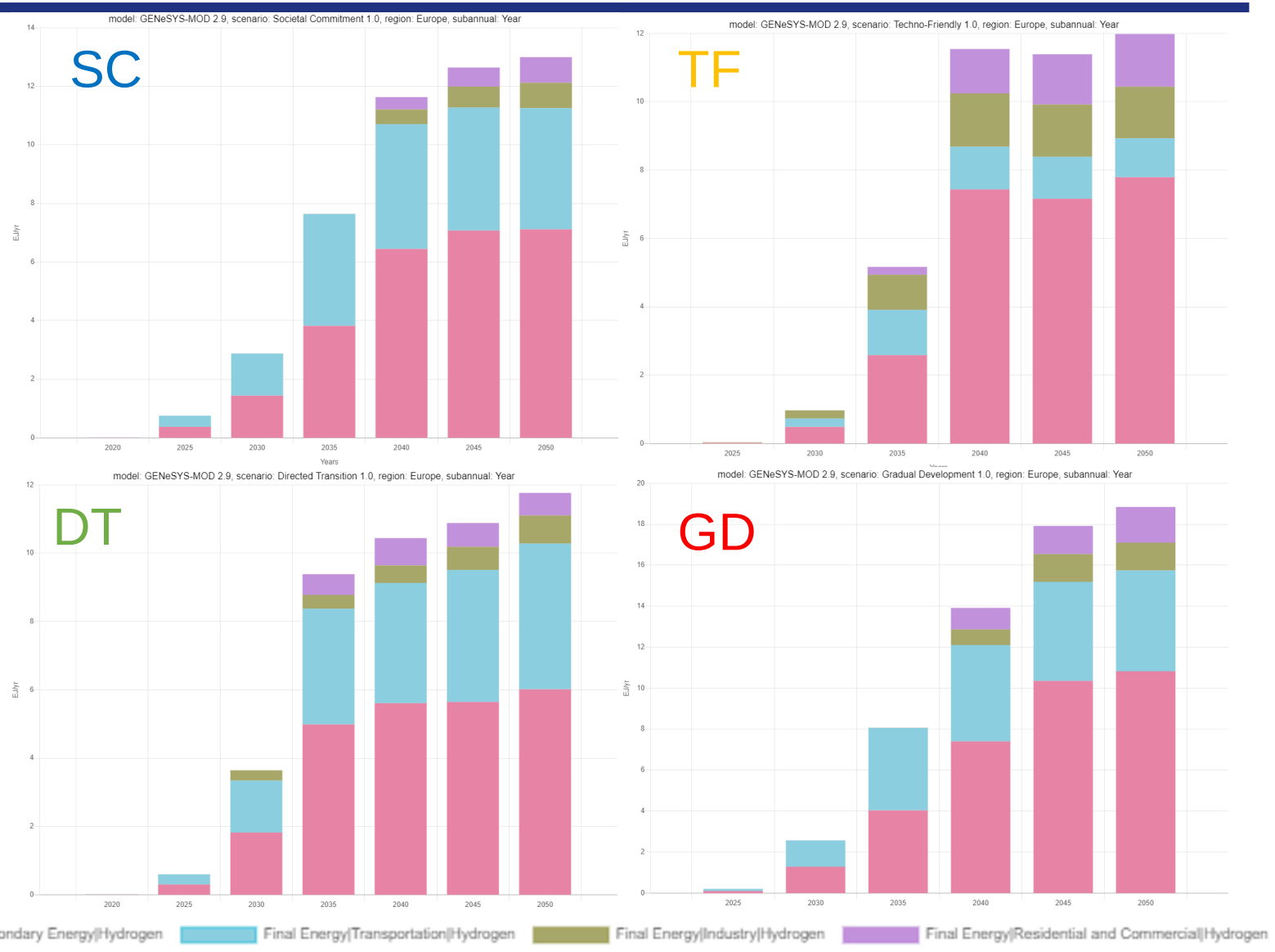


- Societal Commitment: Demand reduction shows the strongest effect for delaying the hydrogen demand.
- Techno-Friendly: Increades efficiencies of hydrogen production lead to more economically feasible use-cases, even though the overall amounts are similar to the other pathways.
- Directed Transition: Hydrogen is heavily forced into the system as a last resort, due to the lack of the other pathways‘ characteristic.
- Gradual Development: After a slower ramp-up, the overall production reaches similar levels at much higher costs and energy requirements.

Hydrogen Usage per Pathway – Sector Results

- Depending on the scenario-based technology assumptions, hydrogen is mostly used *directly* in transportation or industry
- Significant amounts of hydrogen are converted to synthetic natural gas

- Result graphs are from the openENTRANCE scenario explorer: https://data.ece.iiasa.ac.at/openentrance



Current Model Applications: First Conclusions

i. Hydrogen looks to become an essential contributor to the European energy transition – but only in difficult-to-decarbonize sectors.

ii. Only renewable hydrogen will reduce the carbon footprint of the European energy system

iii. An EU-wide strategy is required to evaluate the (potentially) limited renewable hydrogen amounts which could be valuable for many different applications.

iv. Imports can help significantly with the required hydrogen demands. However, the entire generation chain has to be properly considered with regards to economic and technical feasibility as well as socio-political and sustainability aspects.

Future Research: Einstein Research Project

"Open-source modeling of the future role of renewable hydrogen in Germany and Europe"

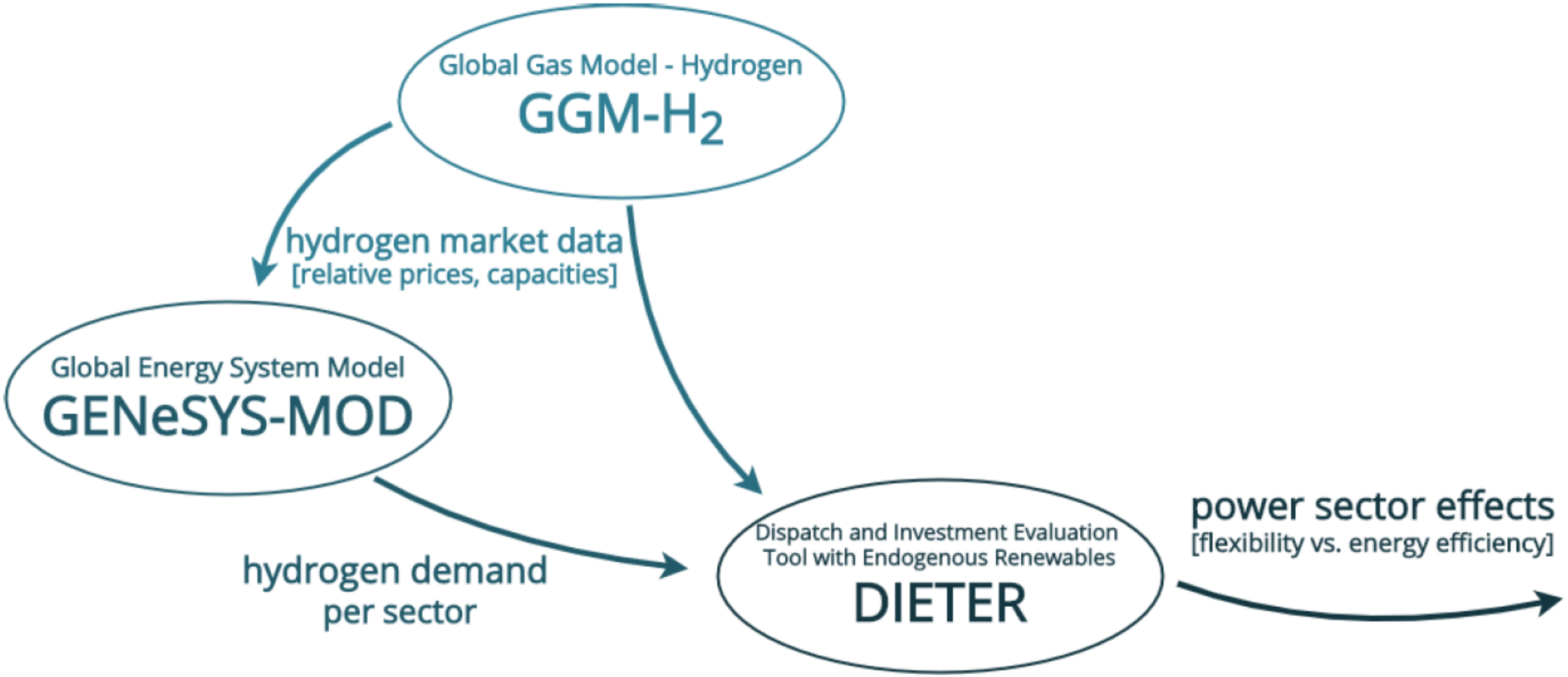
funded by the Einstein Foundation Berlin, TU Berlin & DIW Berlin, 2021-2024

Key

i.

ii.

iii.



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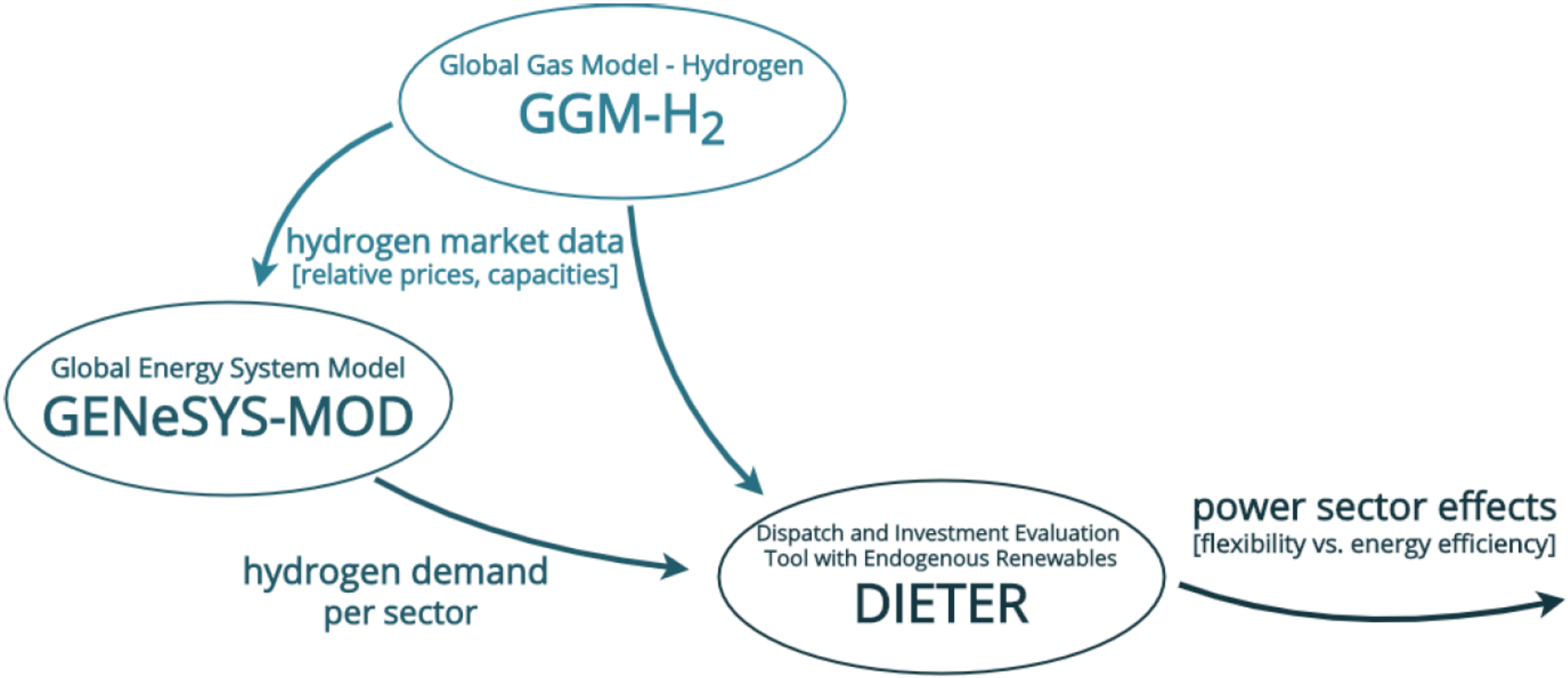

Thank you for your Attention!

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