



open ENTRANCE

Open low emission scenarios for Europe until 2050: Energy system results and balancing measures

openENTRANCE WORKSHOP

16.01.2023



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 835896



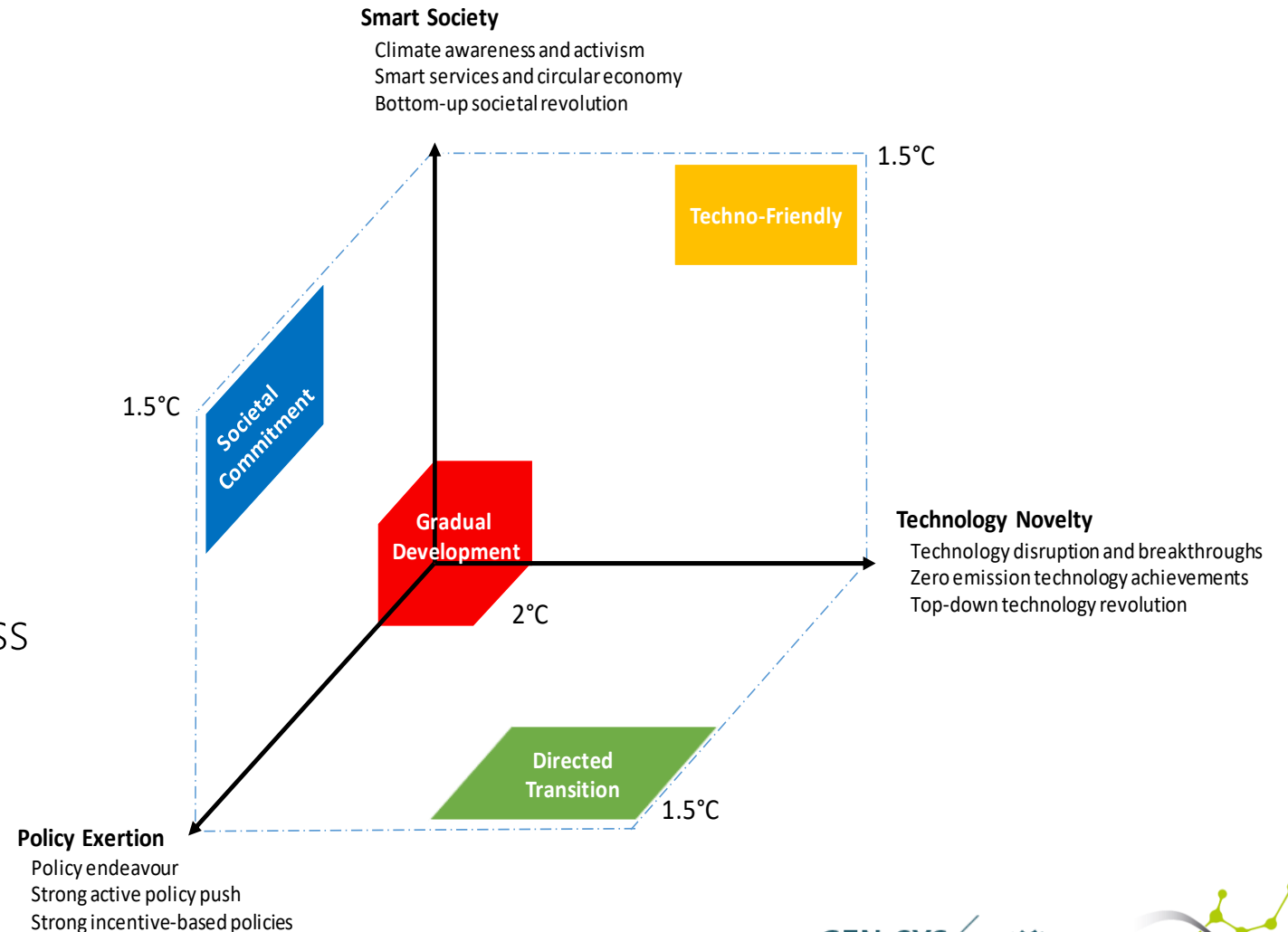
GENESYS

MOD

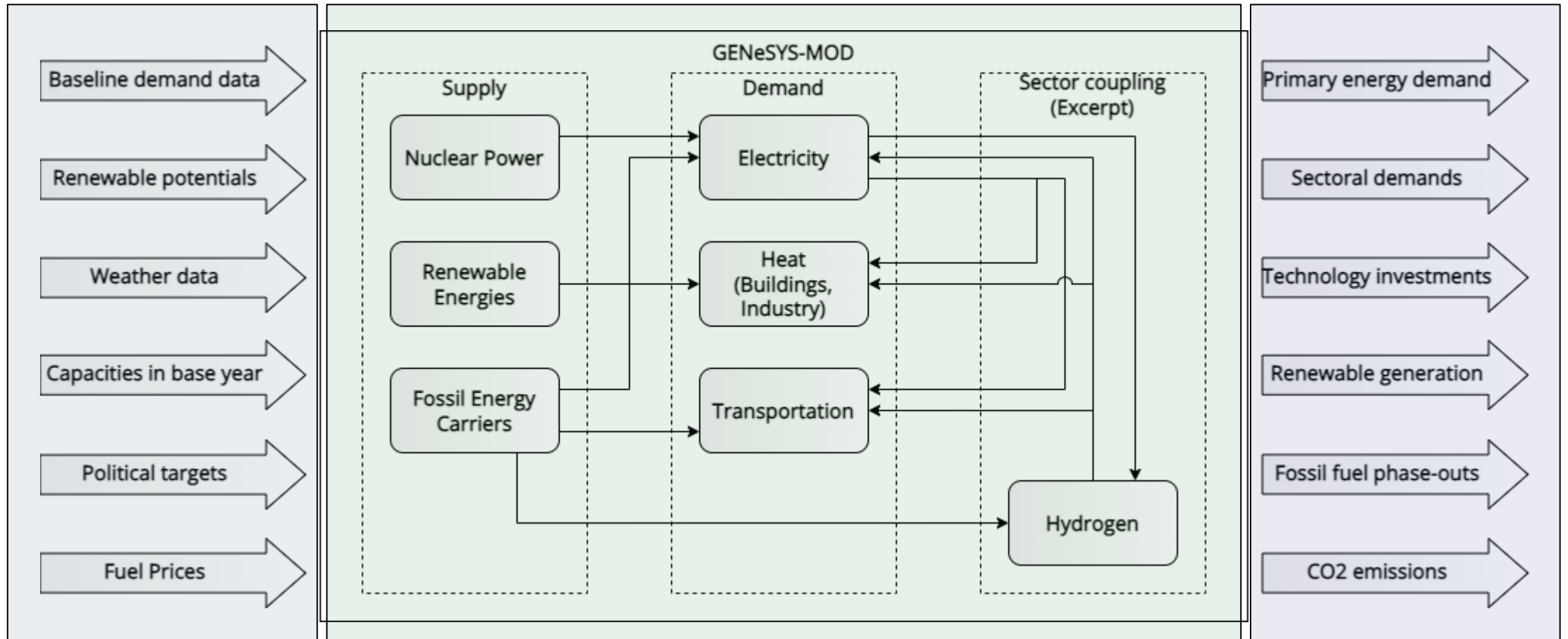


The openENTRANCE storylines

- **Directed Transition**
 - Strong policy push
- **Societal Commitment**
 - Willingness of society
- **Techno-Friendly**
 - High technological progress
- **Gradual Development**
 - Little of everything



The Global Energy System Model – GENeSYS-MOD



The Global Energy System Model – GENeSYS-MOD

GENeSYS-MOD > GENeSYS-MOD public > Releases > GENeSYS-MOD v3.0 - Public release

GENeSYS-MOD v3.0 - Public release

Assets 4

- Source code (zip)
- Source code (tar.gz)
- Source code (tar.bz2)
- Source code (tar)

Evidence collection

genesysmod3.0-evidences-1.json 2F4c9c71

Collected 2 months ago

GENeSYS-MOD - The Global Energy System Model

Version 3.0

Including source code, documentation, and Middle-Earth sample data set.

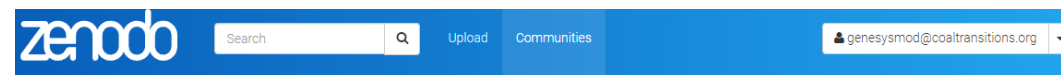


Documentation (also included in release files):



GENeSYS-MOD v3.0 [Global Energy System Model] ~ December 2020

Based on OSEMOSYS 2011.07.07 conversion to GAMS by Ken Noble, Noble-Soft Systems - August 2012



GENeSYS-MOD Community

Recent uploads

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July 28, 2022 (v1) Preprint Open Access

View

Identifying policy areas for the transition of the transportation sector

Hainsch, Karlo;

Abstract: Being the only energy sector where emissions are still at 1990 levels, the German transportation sector requires rapid decarbonization to achieve ambitious climate targets. Policy makers need to put the framework in place which enables and supports this transition. This work analyzes which

Uploaded on July 28, 2022

July 28, 2022 (v1) Dataset Open Access

View

GENeSYS-MOD Transport Sensitivities: Data and model code for Hainsch (preprint): Identifying policy areas for the transition of the transportation sector

Hainsch, Karlo;

This dataset contains all GENeSYS-MOD input data for Hainsch (preprint): Identifying policy areas for the transition of the transportation sector. doi: 10.5281/zenodo.6919452. With the input data files and the GAMS files, the model results presented in the preprint can be replicated. Furthermore,

Uploaded on July 28, 2022

August 31, 2021 (1.0) Dataset Open Access

View

GENeSYS-MOD Germany: Technology, demand, and renewable data

Löffler, Konstantin; Burandt, Thorsten; Hainsch, Karlo;

This dataset contains renewable potentials, timeseries, technology data, and additional data tables for the current implementation of GENeSYS-MOD Germany.

Uploaded on September 2, 2021

New upload

Community



GENeSYS-MOD Community

The Global Energy System Model (GENeSYS-MOD) is a cost-optimizing linear program based on the Open Source Energy Modelling System (OSEMOSYS).

Curated by: genesysmod-admin

Curation policy: Not specified

Created: December 9, 2020

Harvesting API: OAI-PMH Interface

Want your upload to appear in this

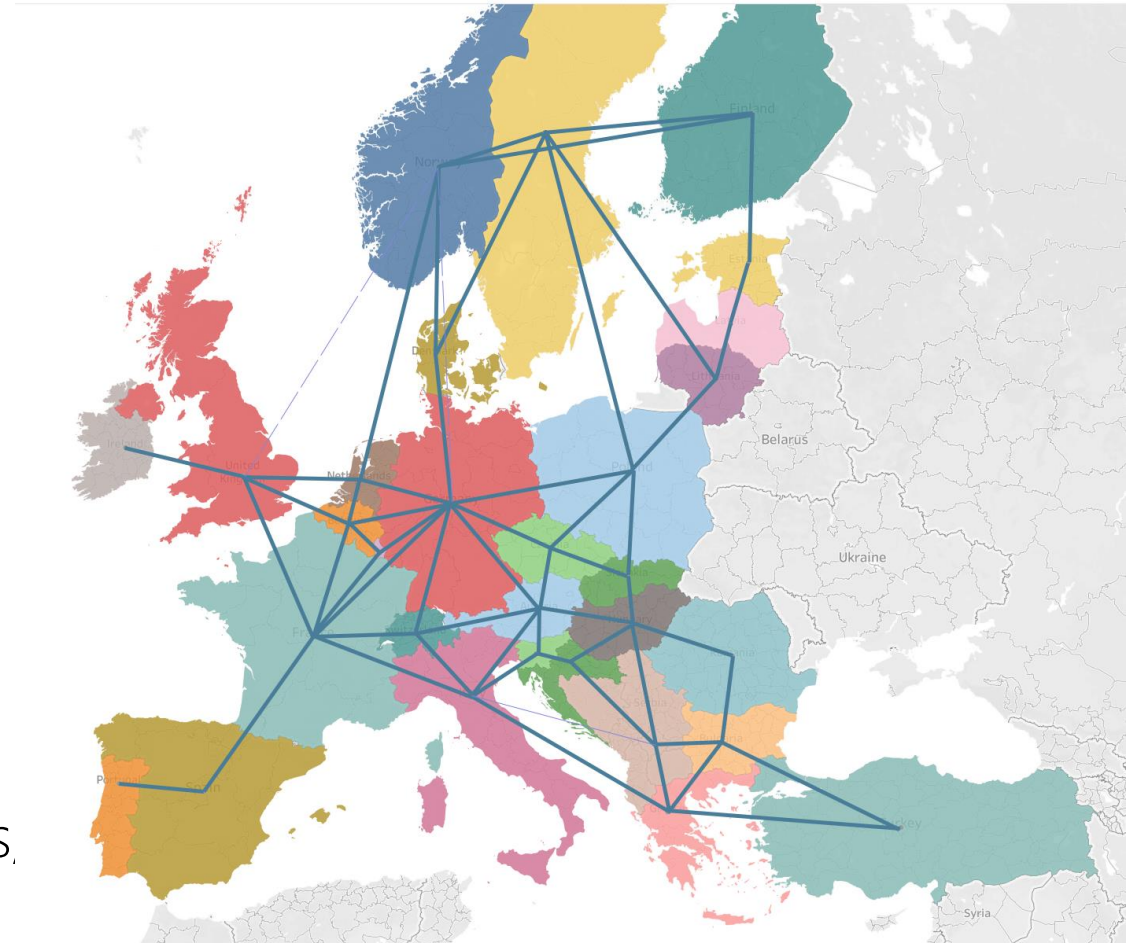


Results on the openENTRANCE scenario explorer

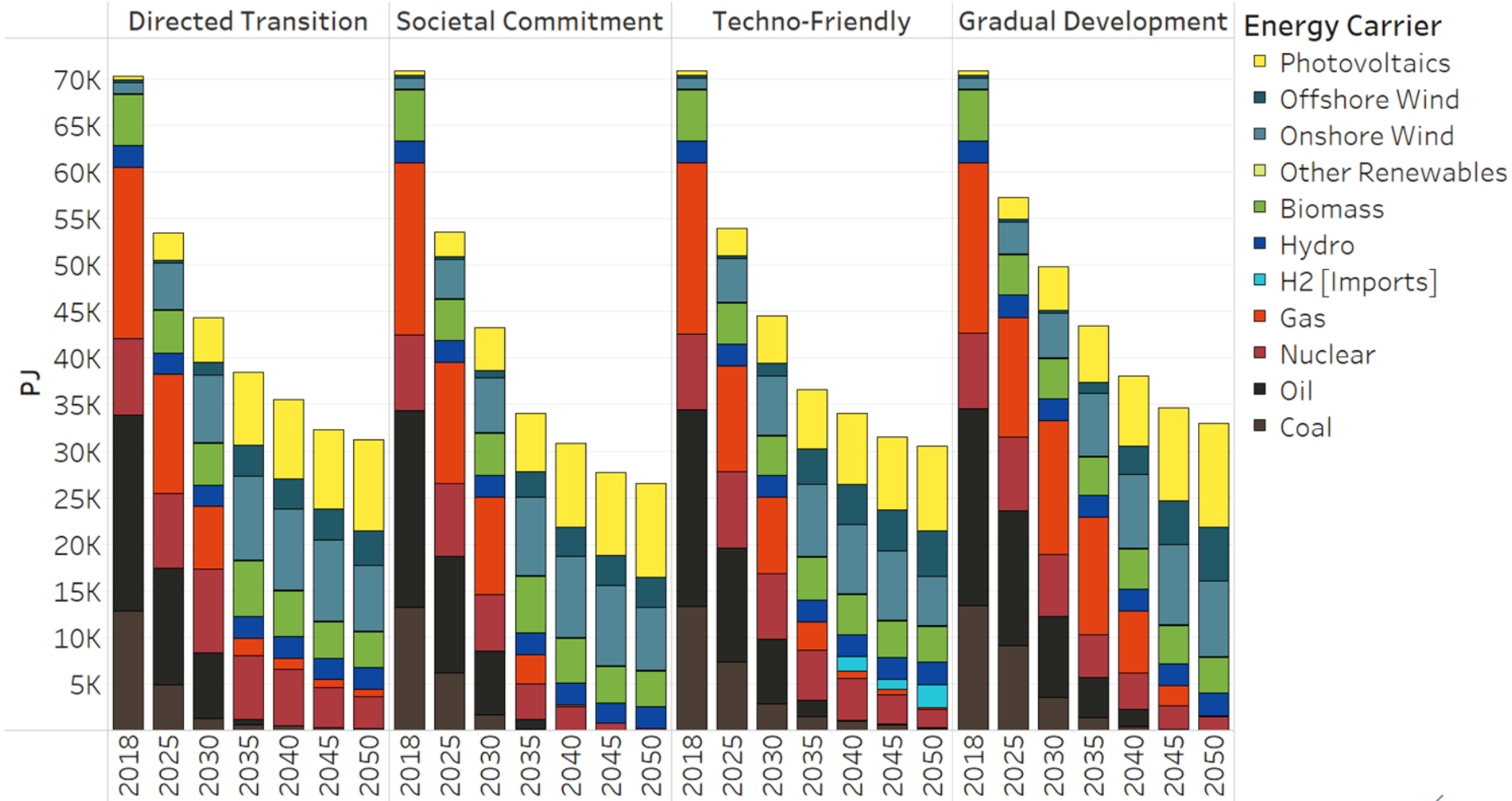


Outline of the model set-up

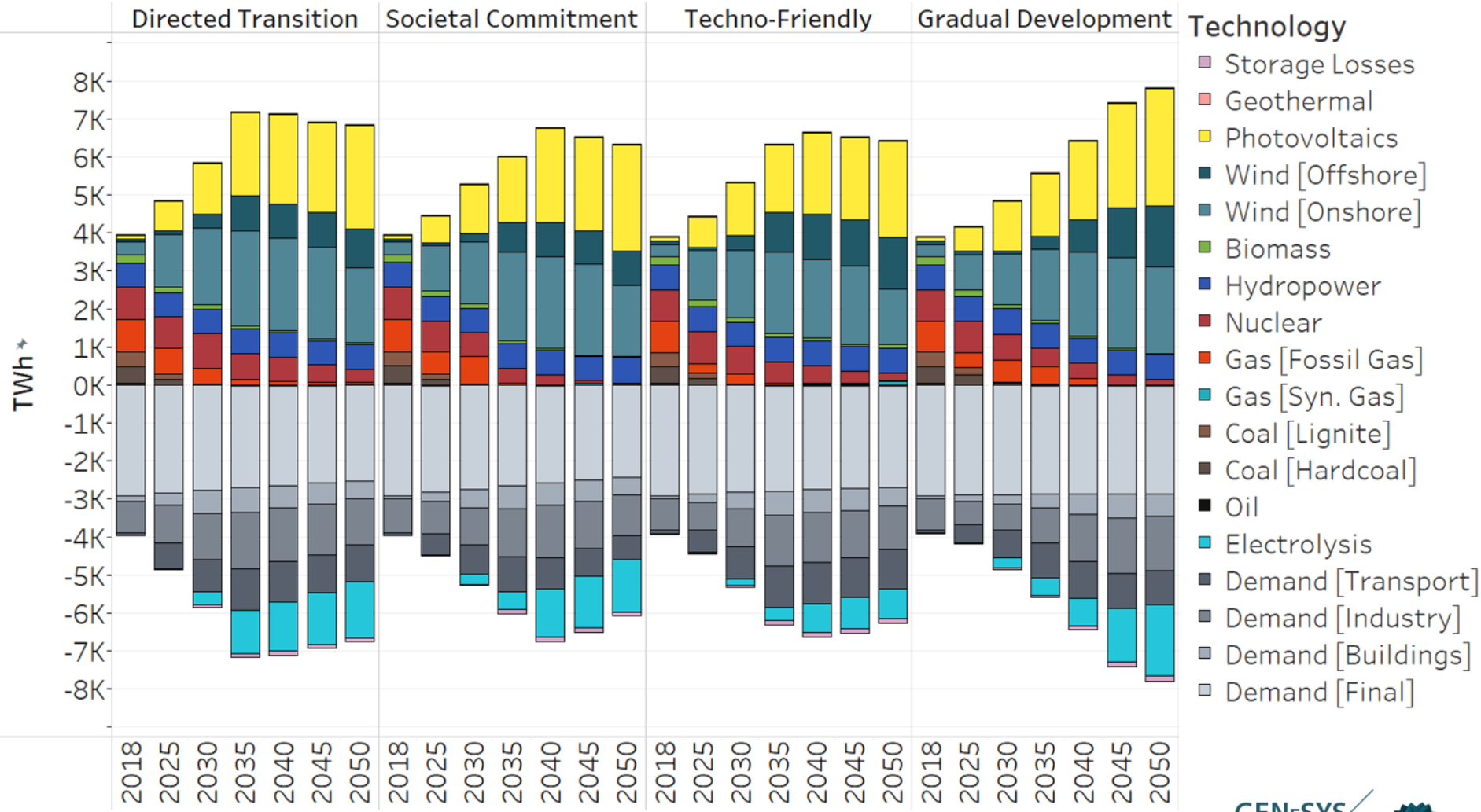
- 30 Regions (Mainland-EU, UK, Switzerland, Norway, Turkey, and the Balkan region)
- Modeled timeframe: 2018-2050
- Reduced hourly timeseries, via a reduction algorithm
- Covers the sectors: Electricity, Buildings, Industry and Transportation
- Pathway dependent features (like potential of demand shifting, political climate-targets, or breakthrough of certain technologies)



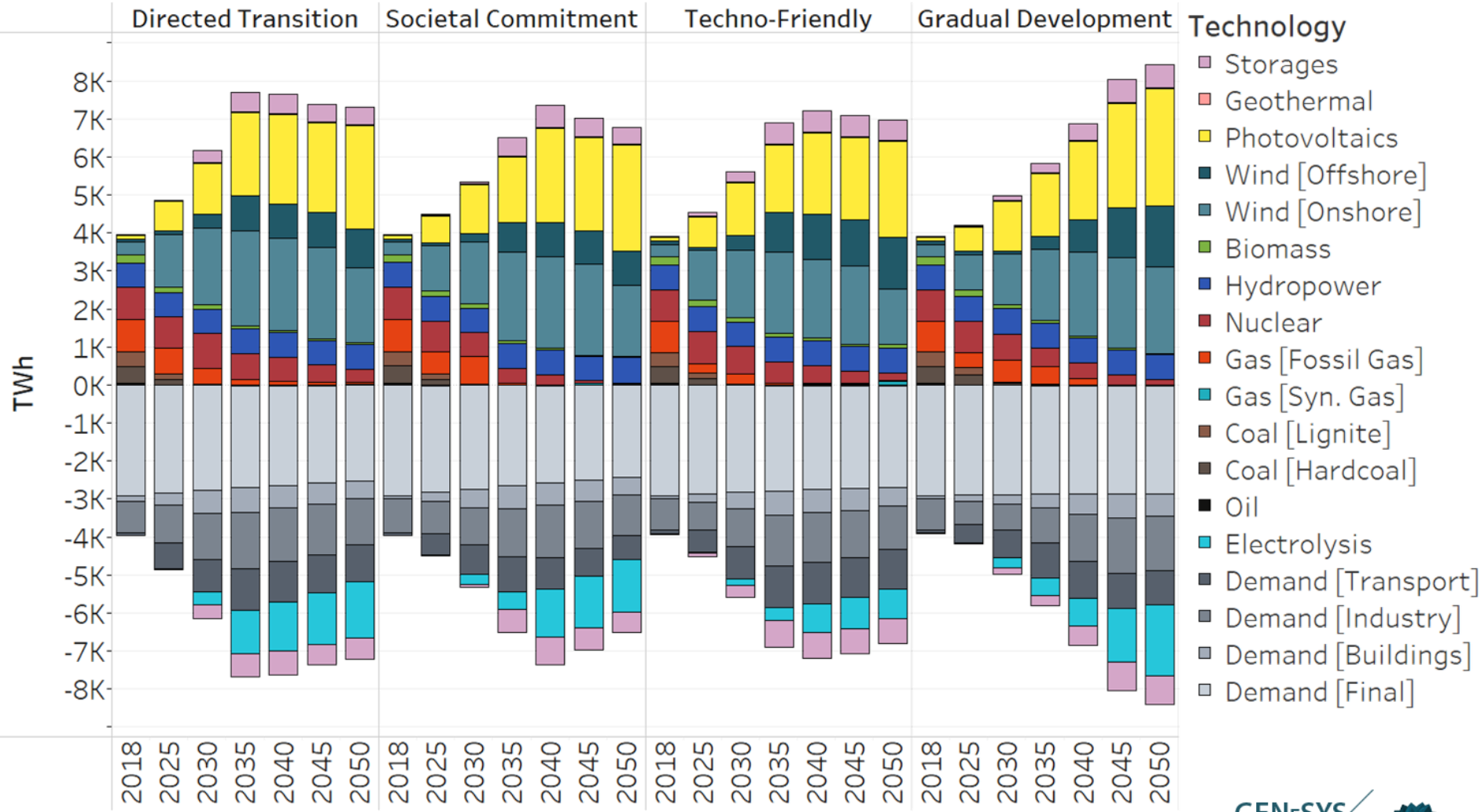
Results: Primary Energy



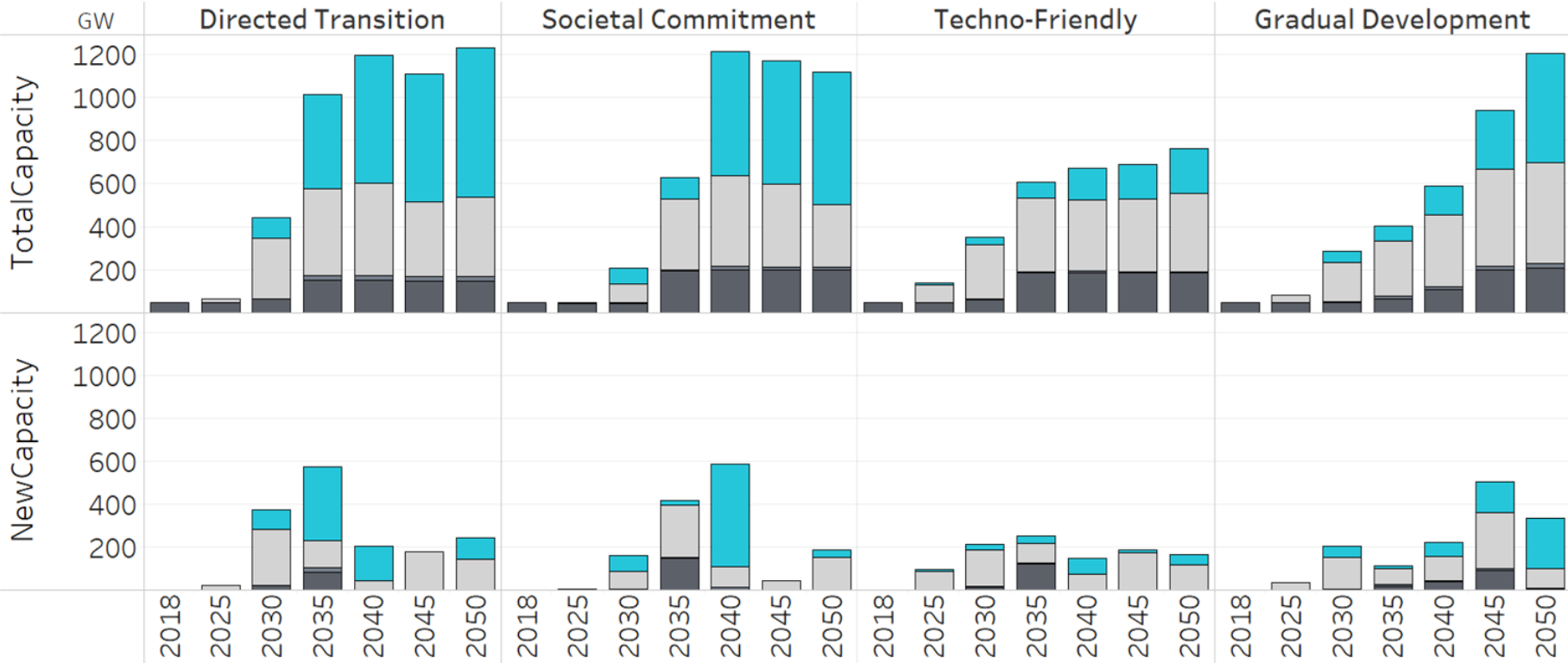
Pathway results - Electricity



Pathway results - Electricity

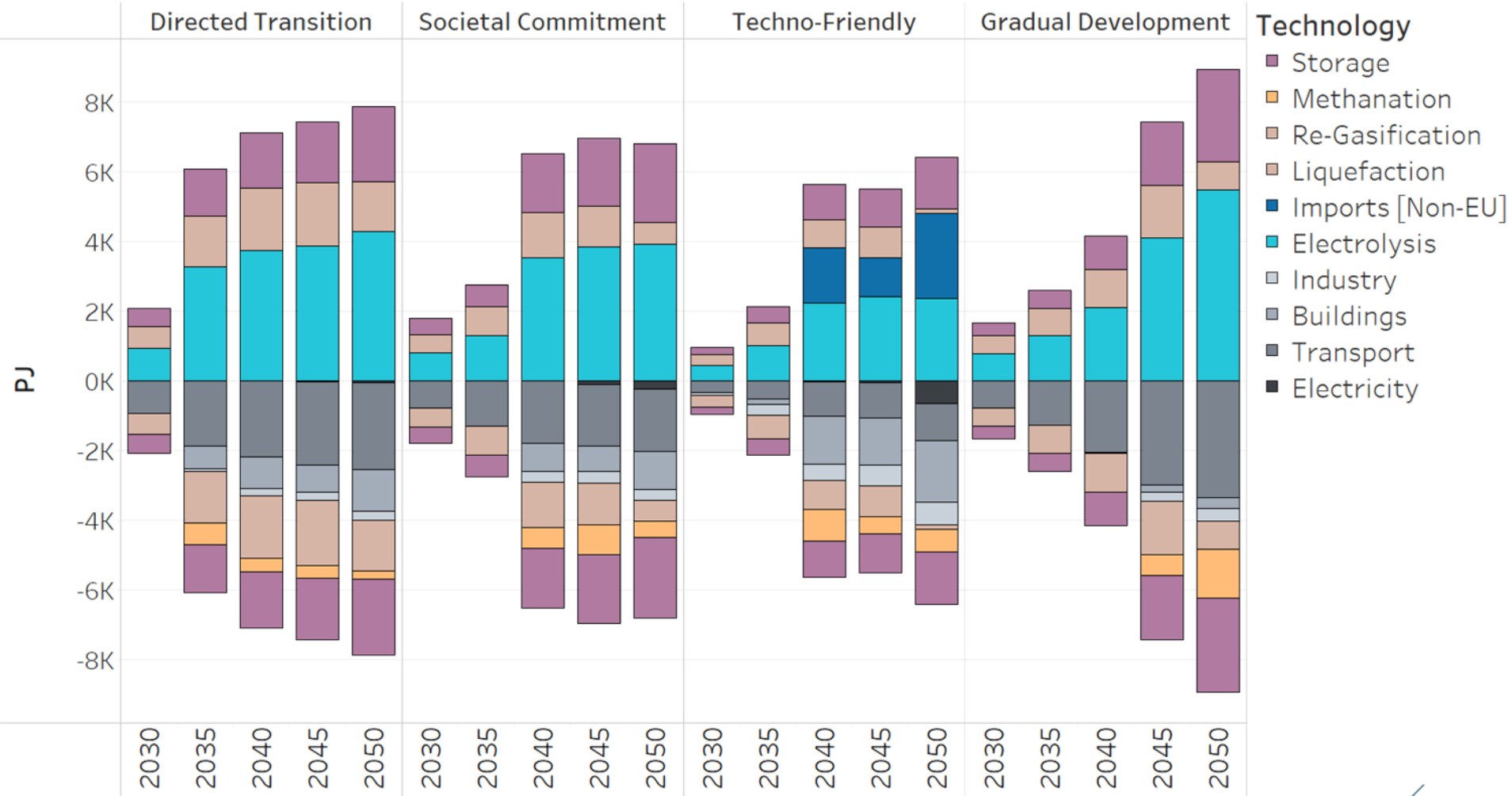


Results: Electric and hydrogen storages

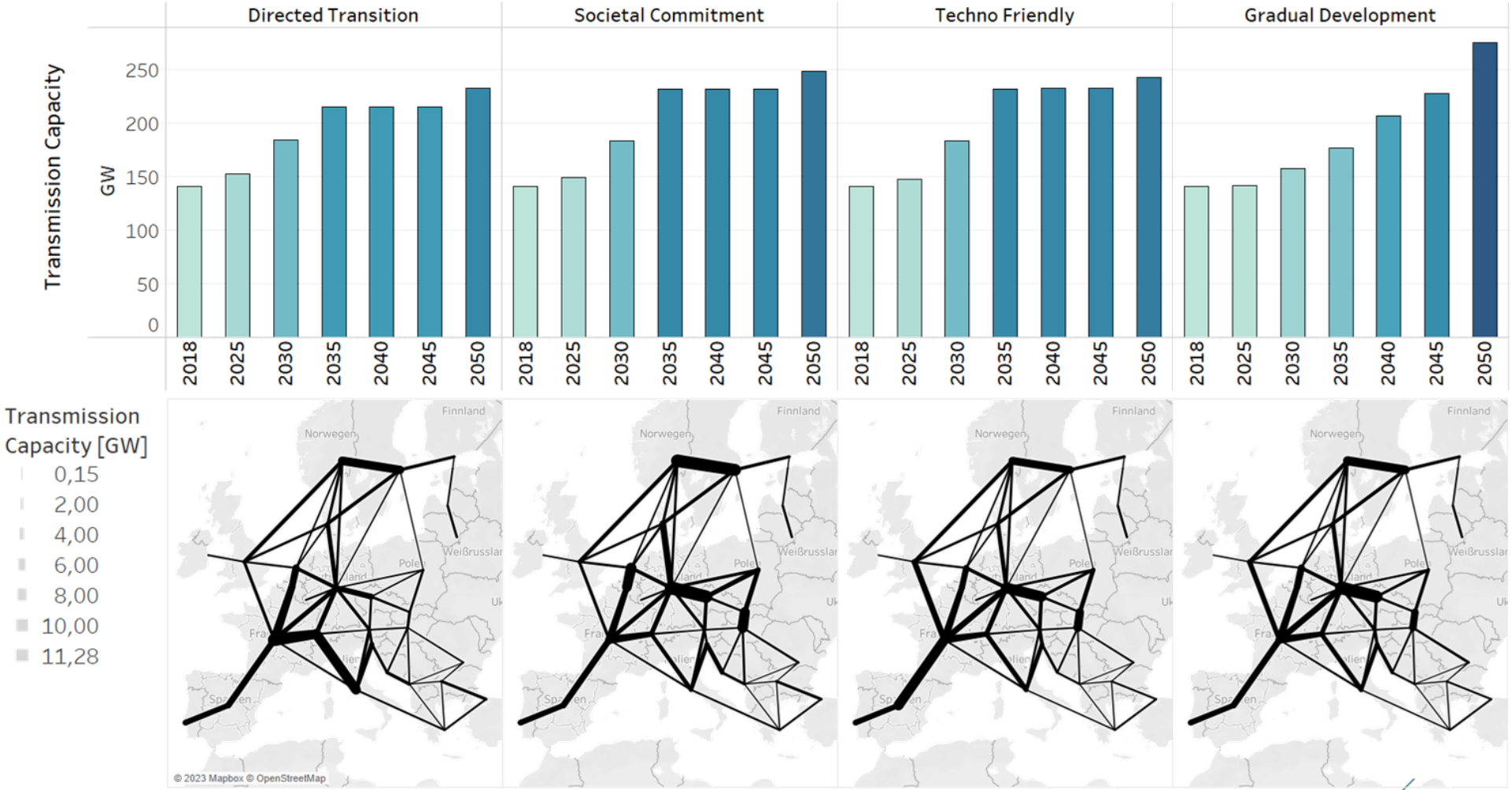


- Technology**
- H2 Storage
 - Electric Storage [Battery]
 - Electric Storage [CAES]
 - Electric Storage [Pumped Hydro]

Results: Hydrogen generation and use



Results: Transmission capacity



Conclusions

- To reach the ambitious climate targets of 1.5-2°C, the energy system needs to be based on 100% renewables by 2040-2050
- With a strong focus on electrification as a sector-coupling option, this leads to a significant increase in variable renewable generation
- To balance these variabilities, different flexibility options, both short- and long-term, are required
- We cannot rely only on one type of flexibility, instead, the optimal mix of flexibility options includes a sharp increase of all available options, including electric storages, hydrogen, transmission expansion, and demand side management

Thank you for your attention!

Dr. Konstantin Löffler

kl@wip.tu-berlin.de

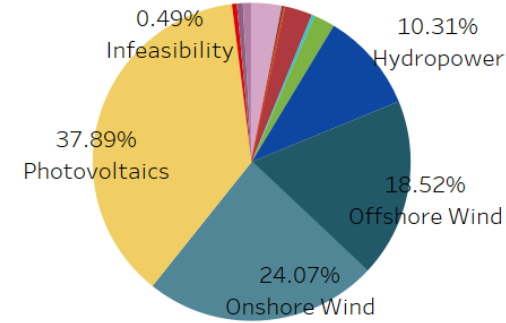


Additional Slides: openENTRANCE pathway results



Feasibility Check: Dispatch Results

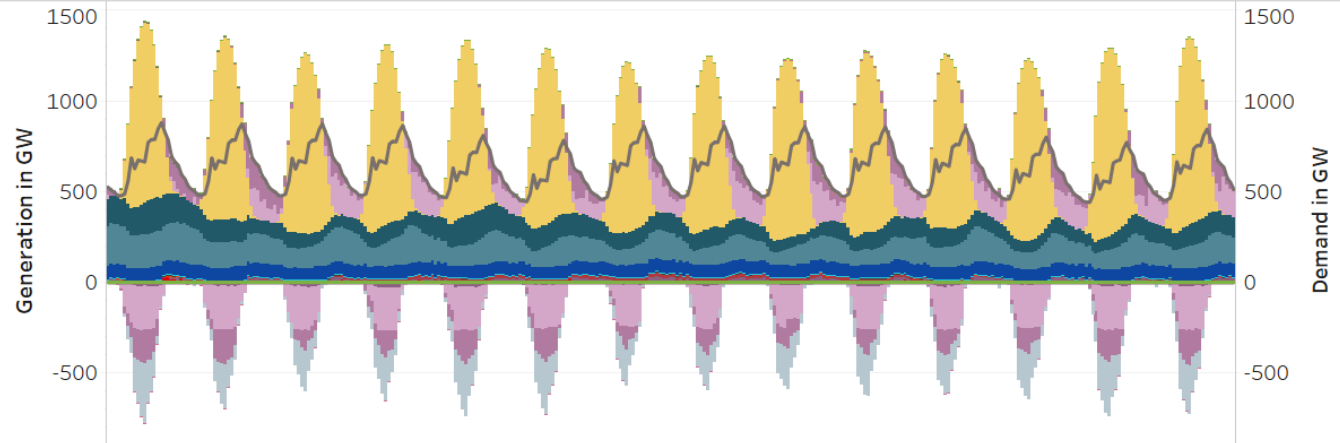
Yearly Summary



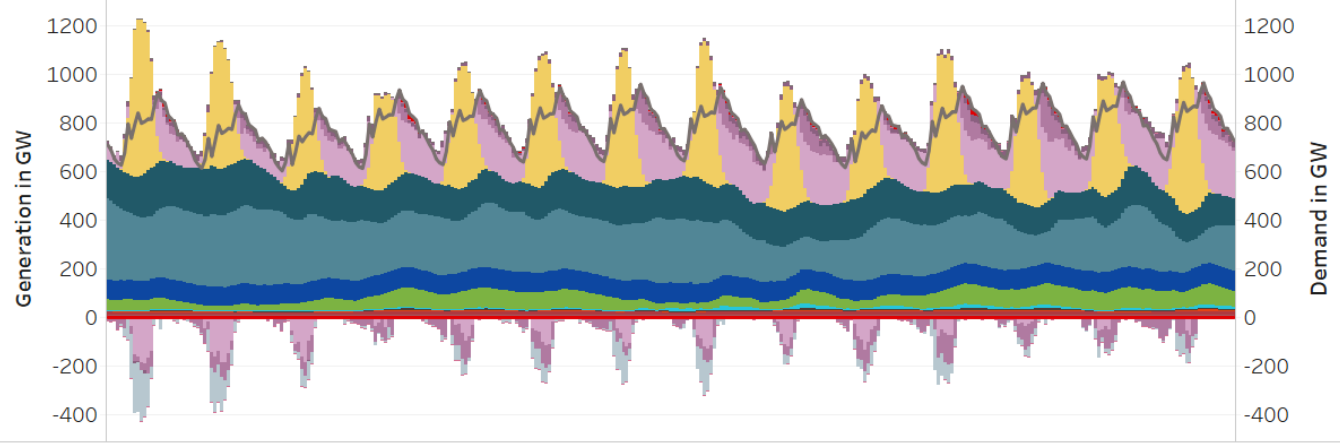
Technology

- Demand [Line]
- Infeasibility
- Transmission
- Curtailment
- Compressed-Air Electricity Storage
- Battery Storage
- Pumped Hydro Storage
- Photovoltaics
- Offshore Wind
- Onshore Wind
- Hydropower
- Biomass & Biogas
- Coal [w/ CCS]
- Fossil Gas [w/ CCS]
- Nuclear

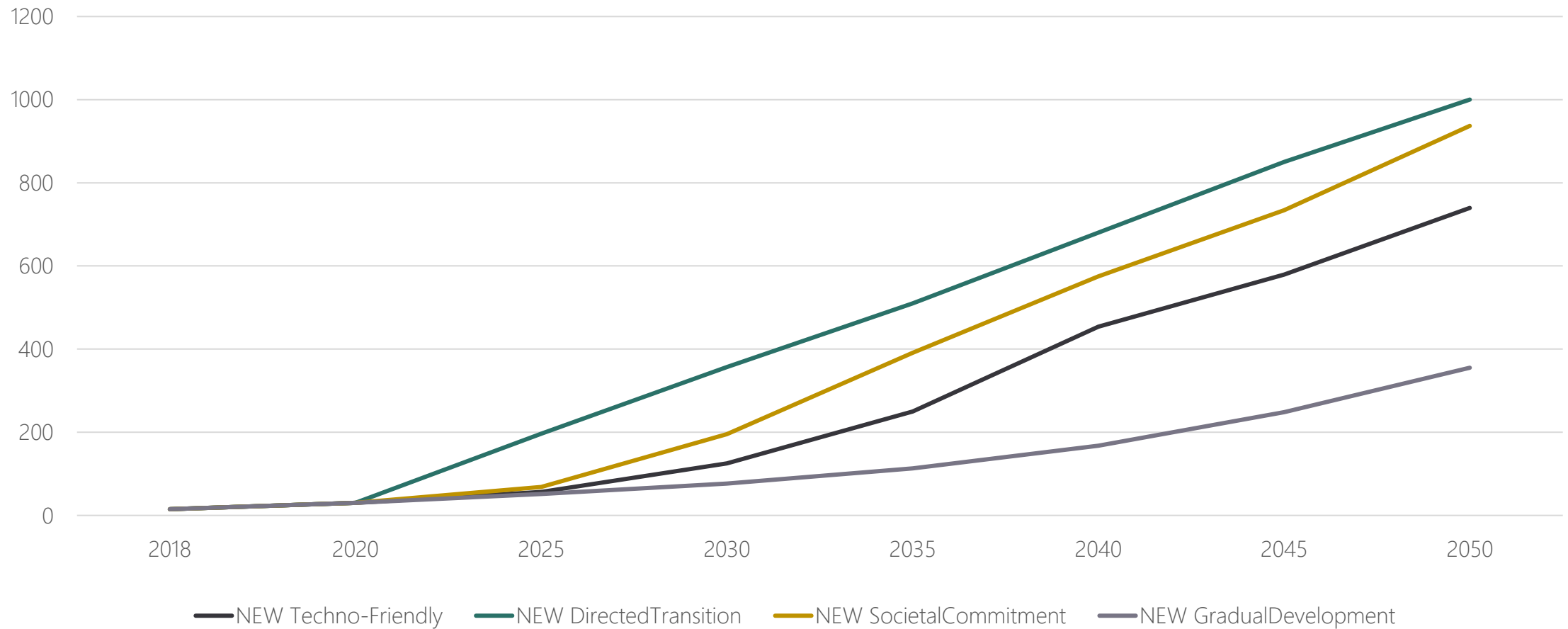
Dispatch for the first two weeks of July



Dispatch for the first two weeks of February

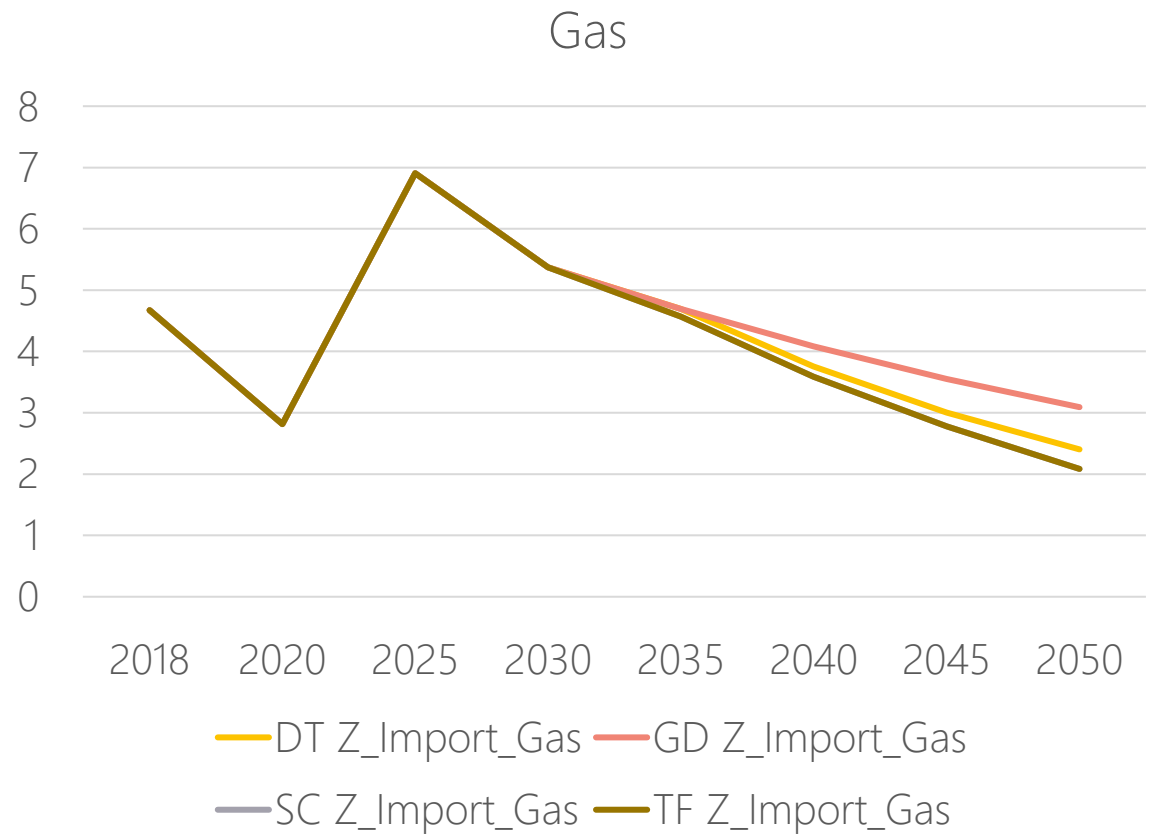
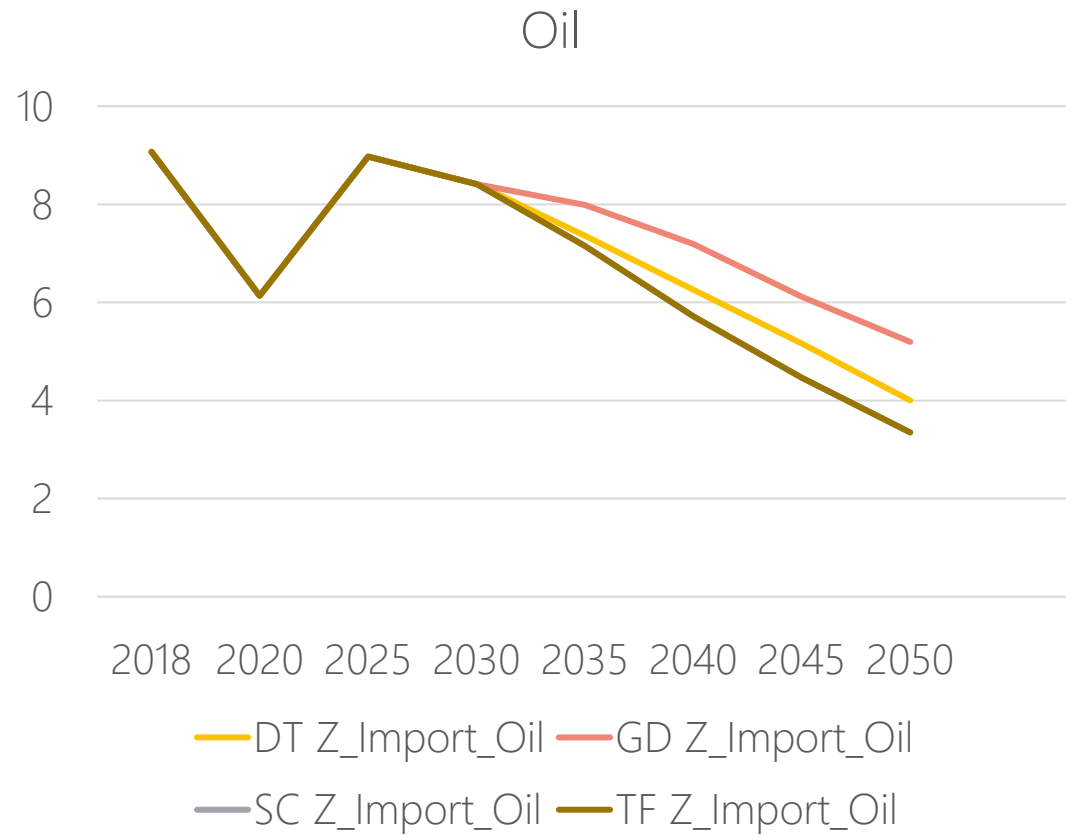


Pathway settings – CO₂ prices

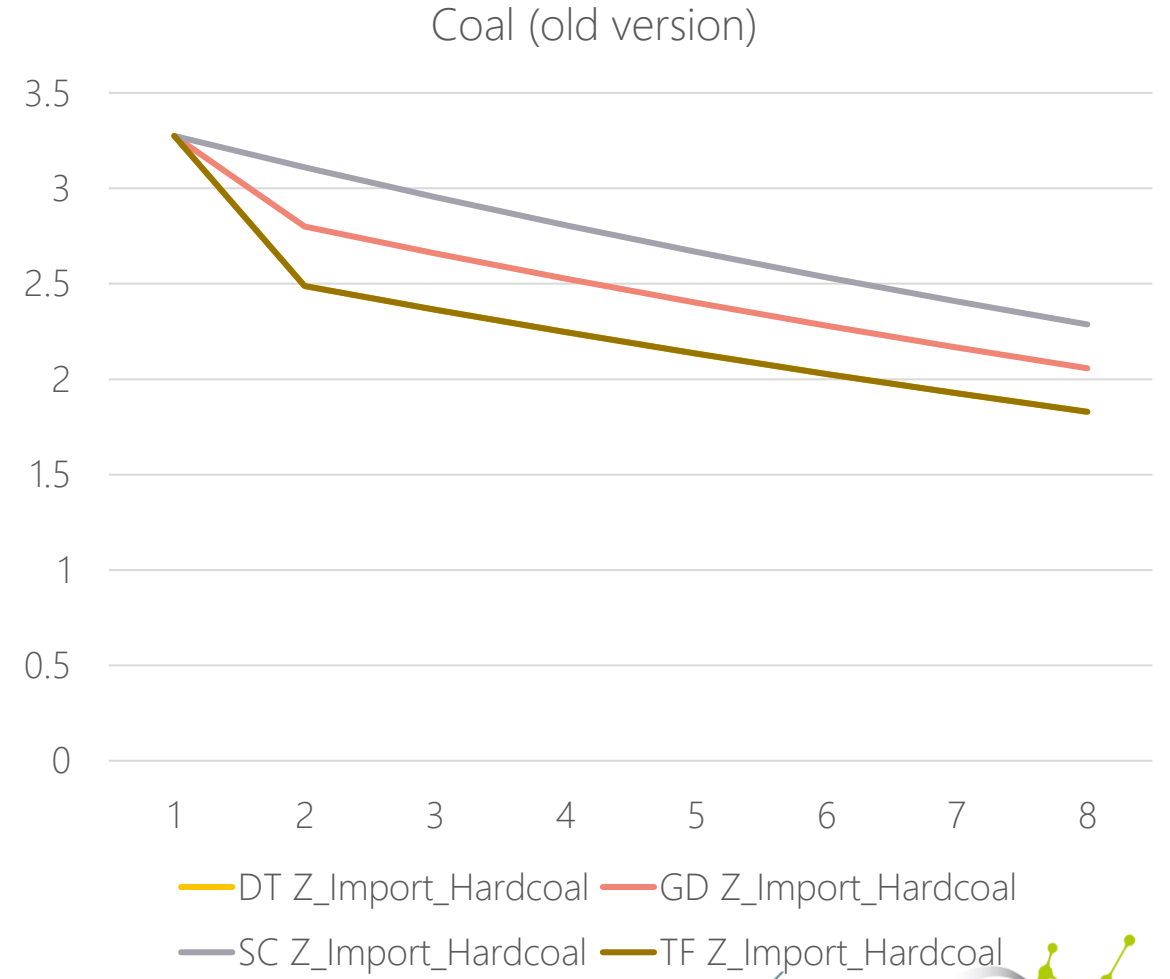
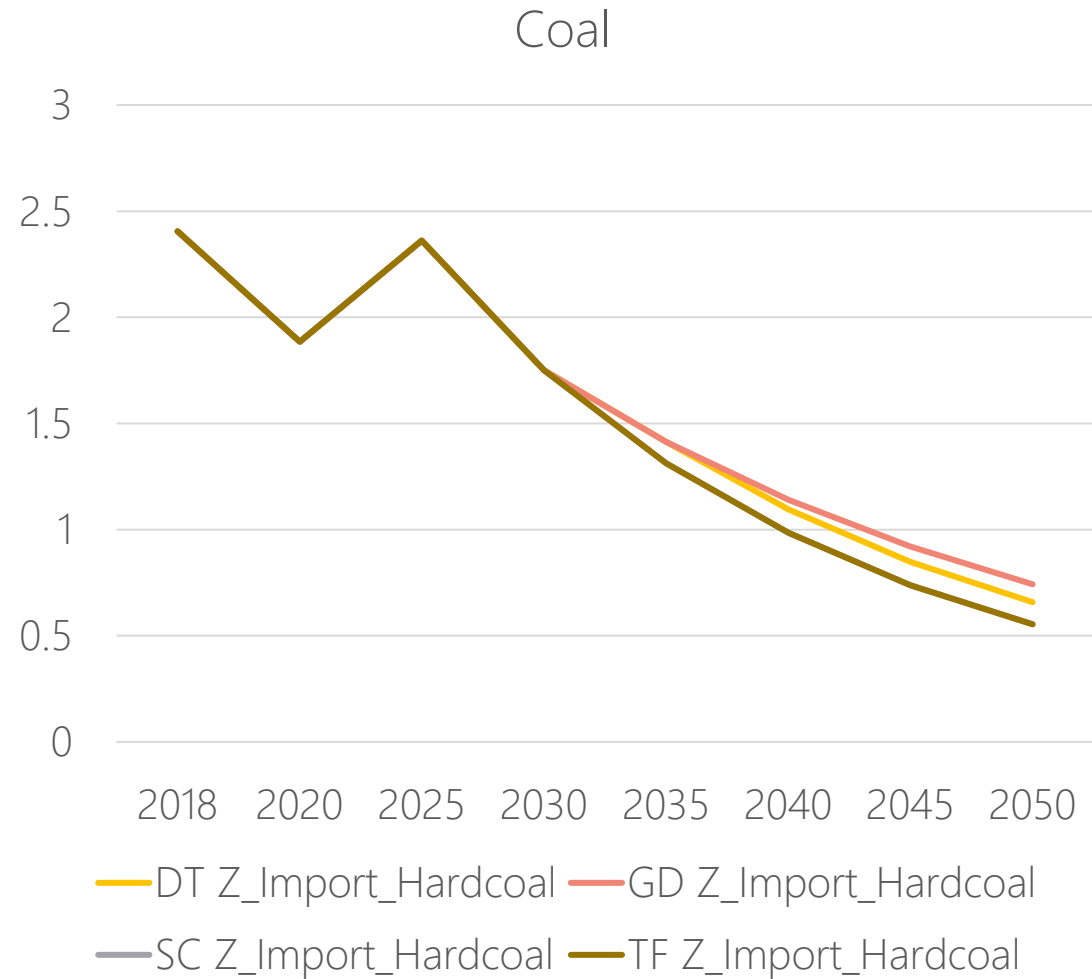


CO₂ price in €/t

Additional Slides – Fossil fuel prices [in M€/PJ]

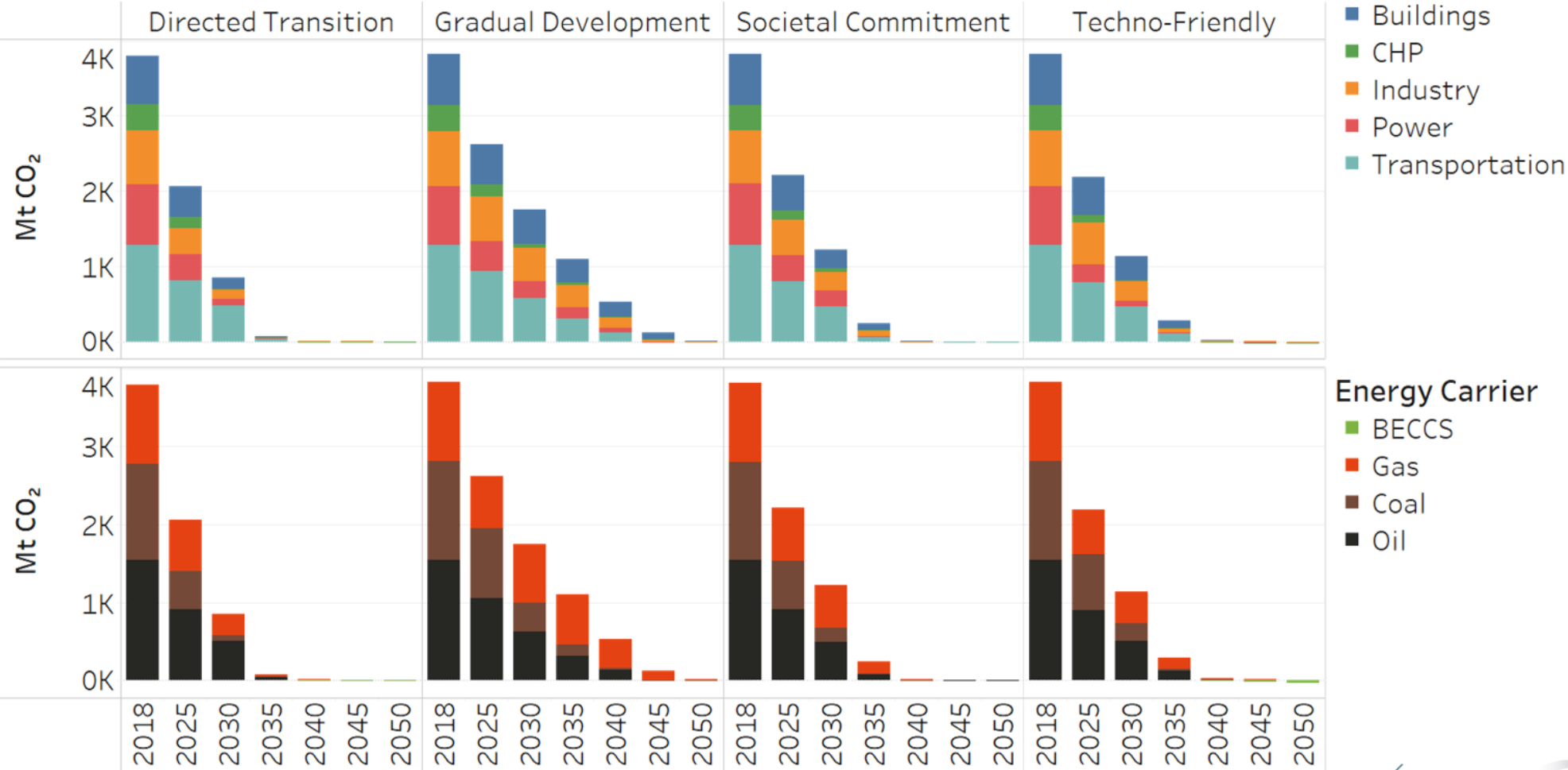


Additional Slides – Fossil fuel prices [in M€/PJ]

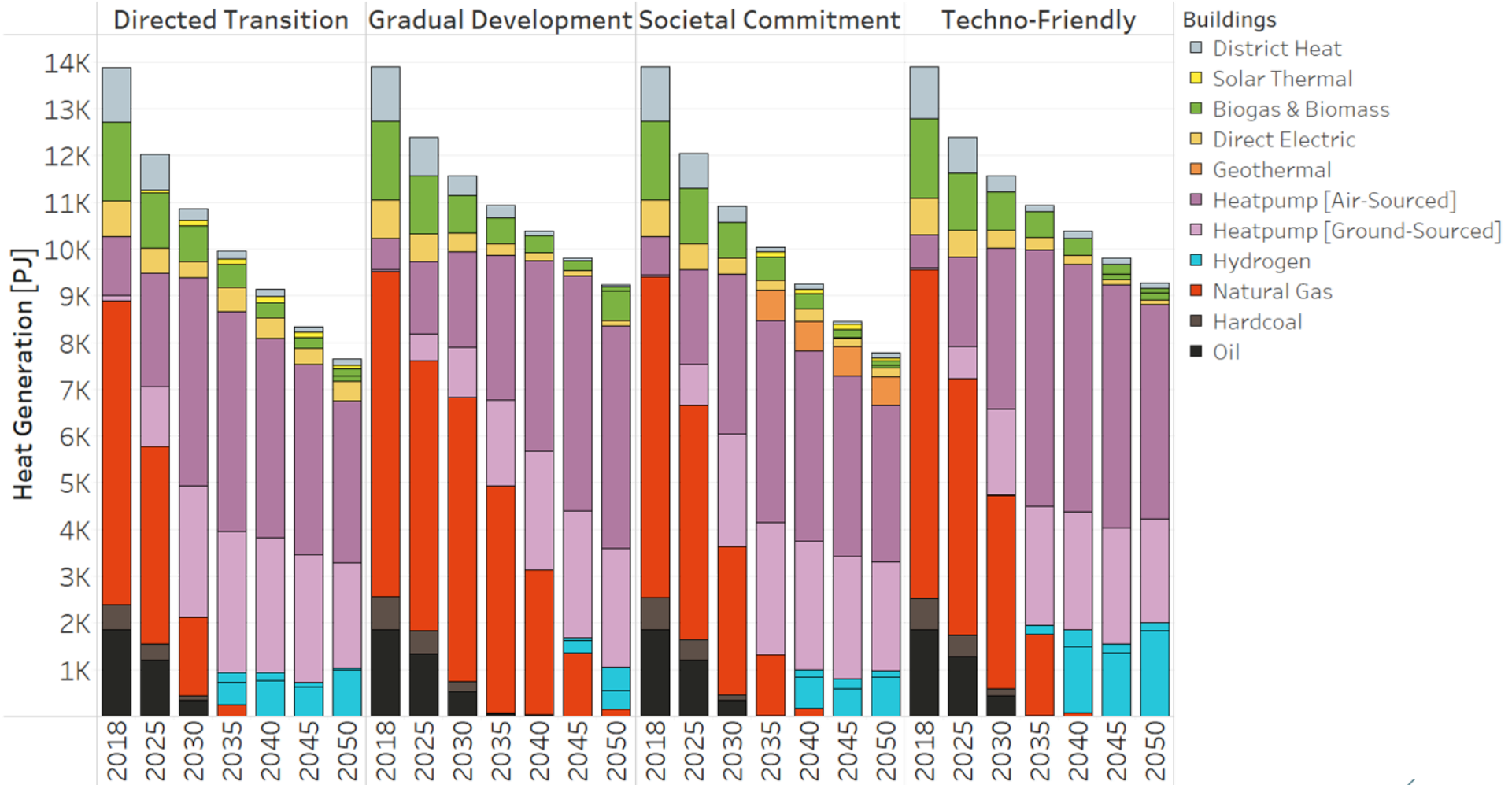


Results: Emissions

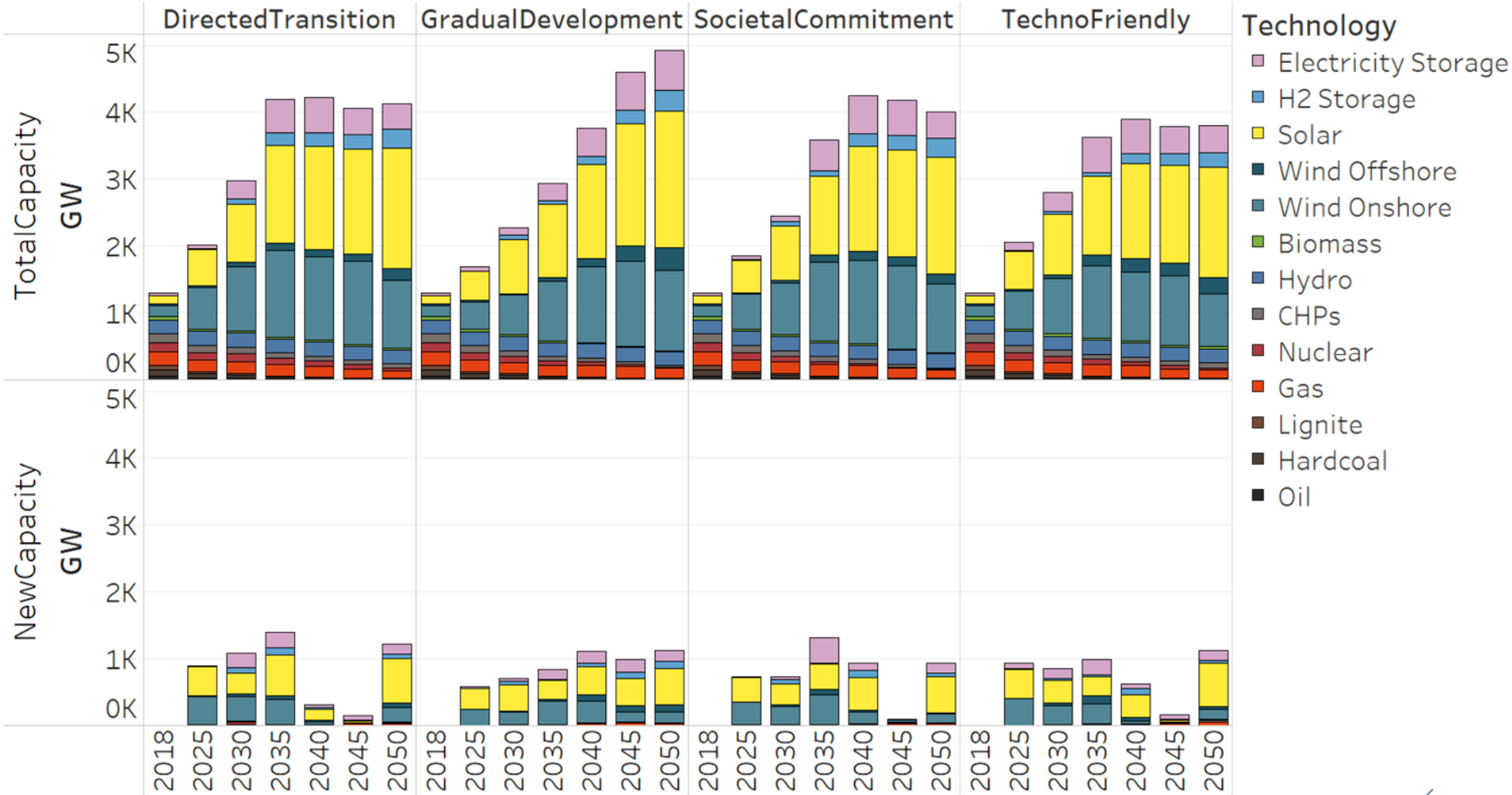
Emissions per sector (top) and per energy carrier (bottom)



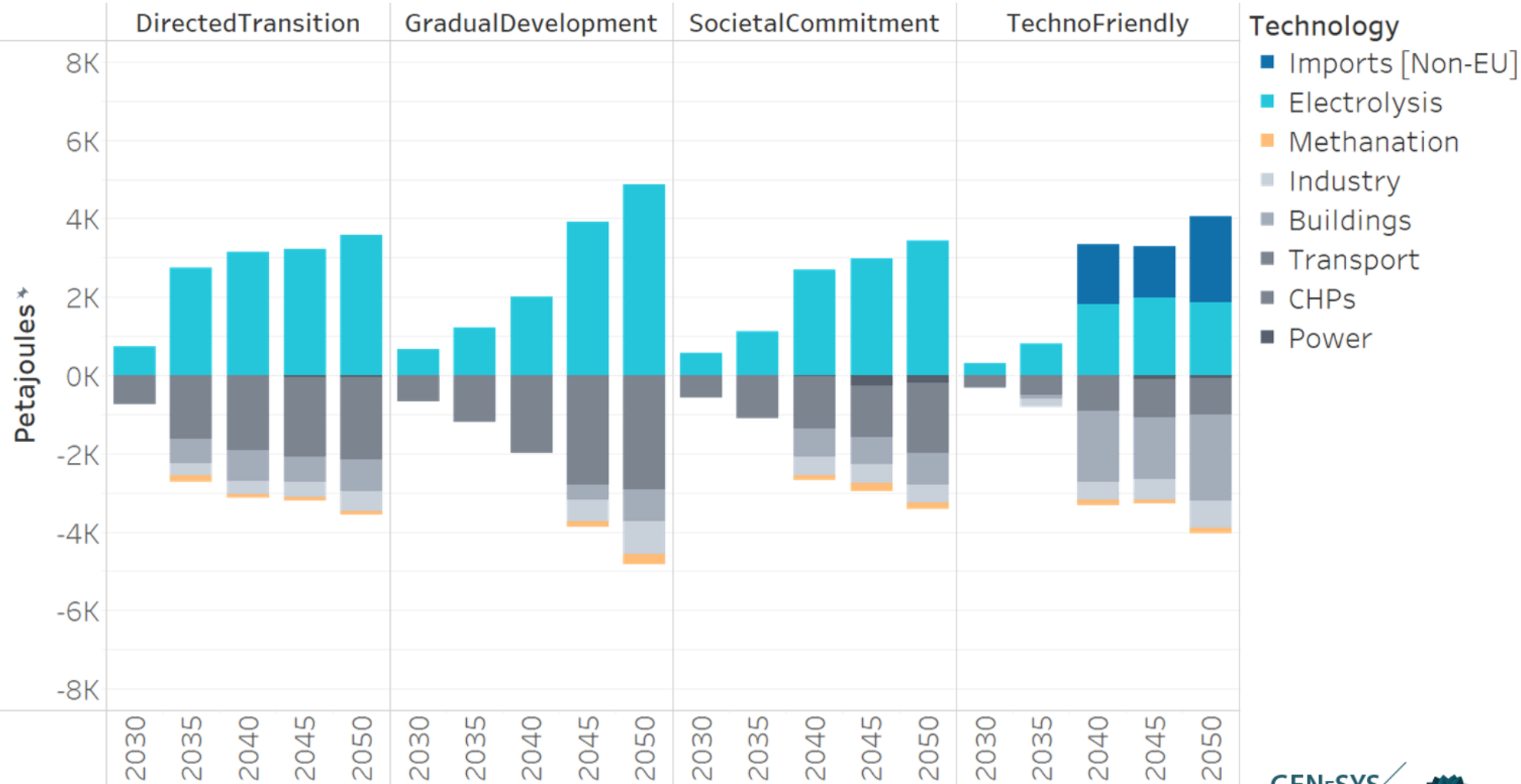
Results: Building heat



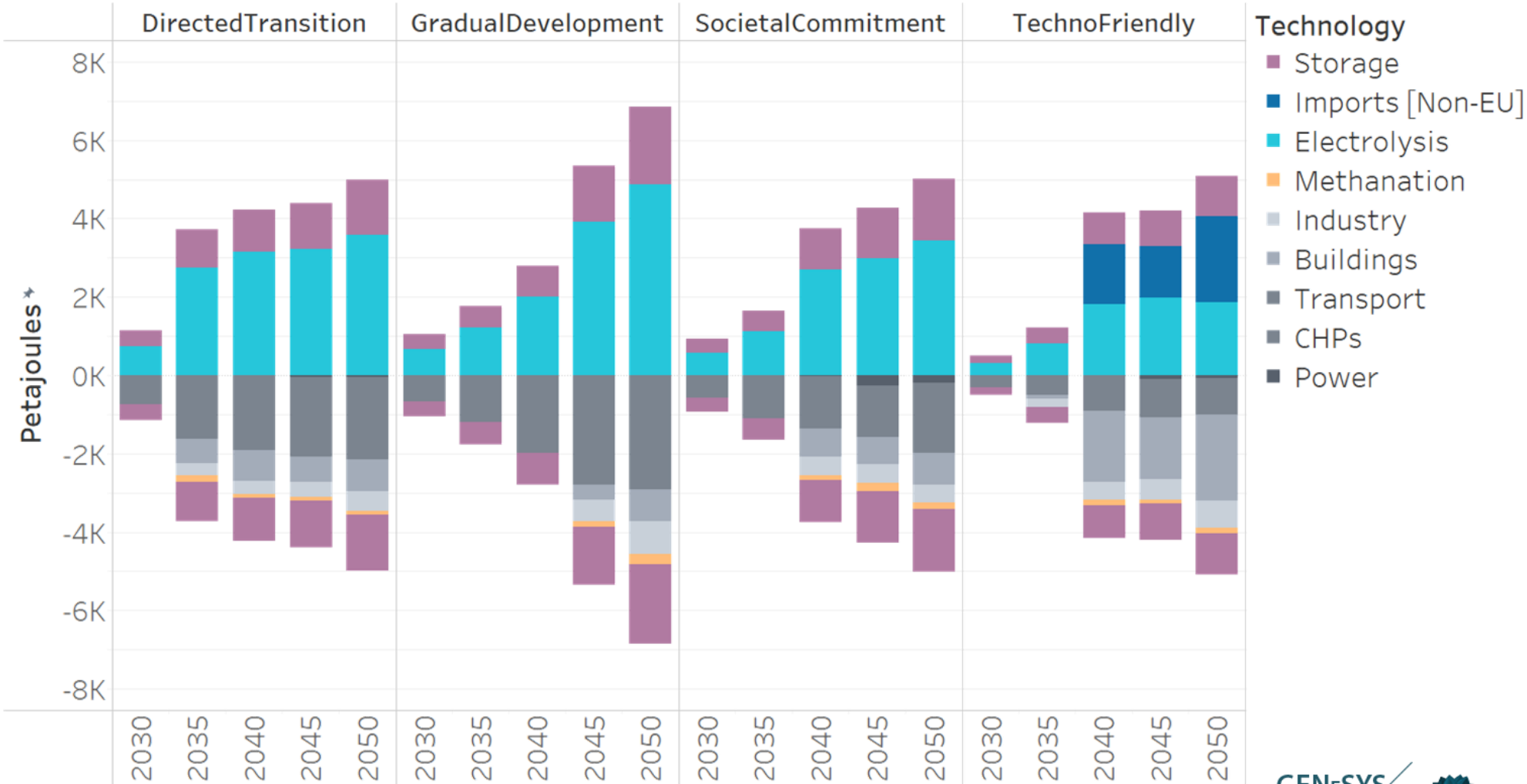
Results: Installed (power) capacity



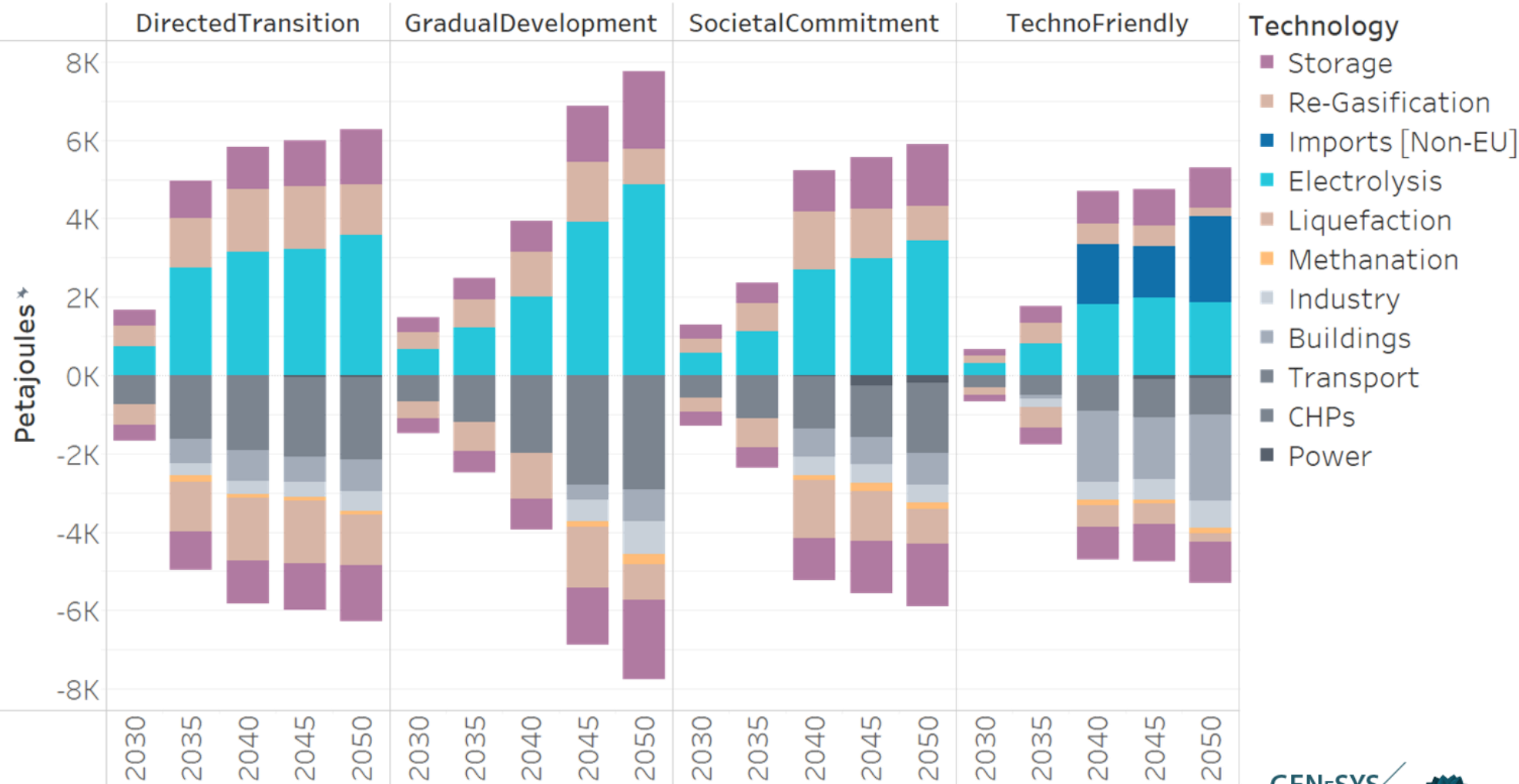
Pathway results – Hydrogen [excl. Storage & Liquefaction]



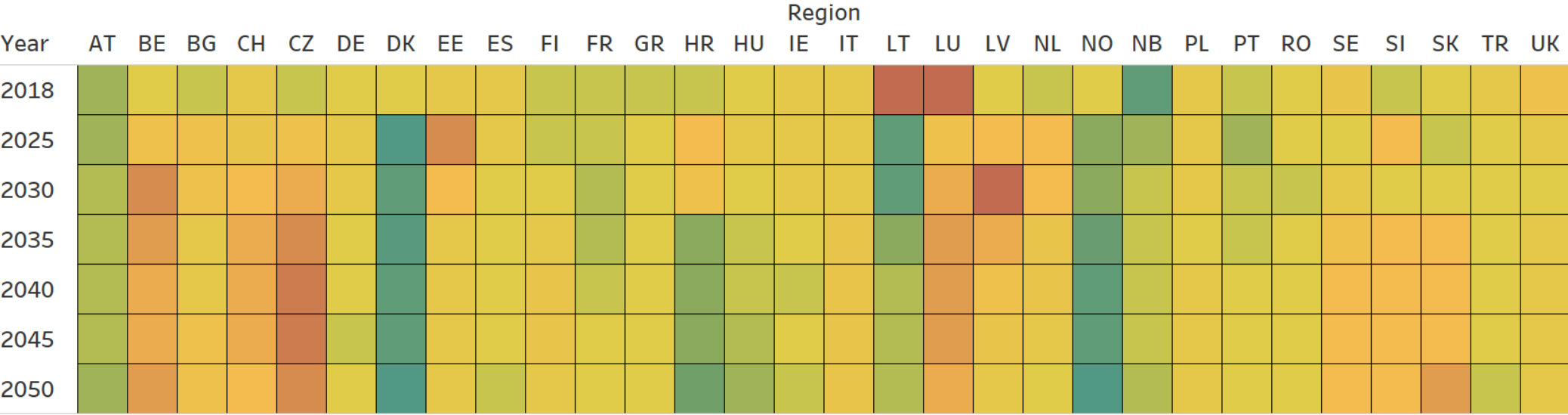
Pathway results – Hydrogen [incl. Storage]



Pathway results – Hydrogen [incl. Storage & Liquefaction]



Results: Country-level share of domestic electricity



Share of domestic electricity generation (below 1: net-importer | above 1: net-exporter)



Results: Electrification Rate

