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Early decarbonisation of the European energy system pays off

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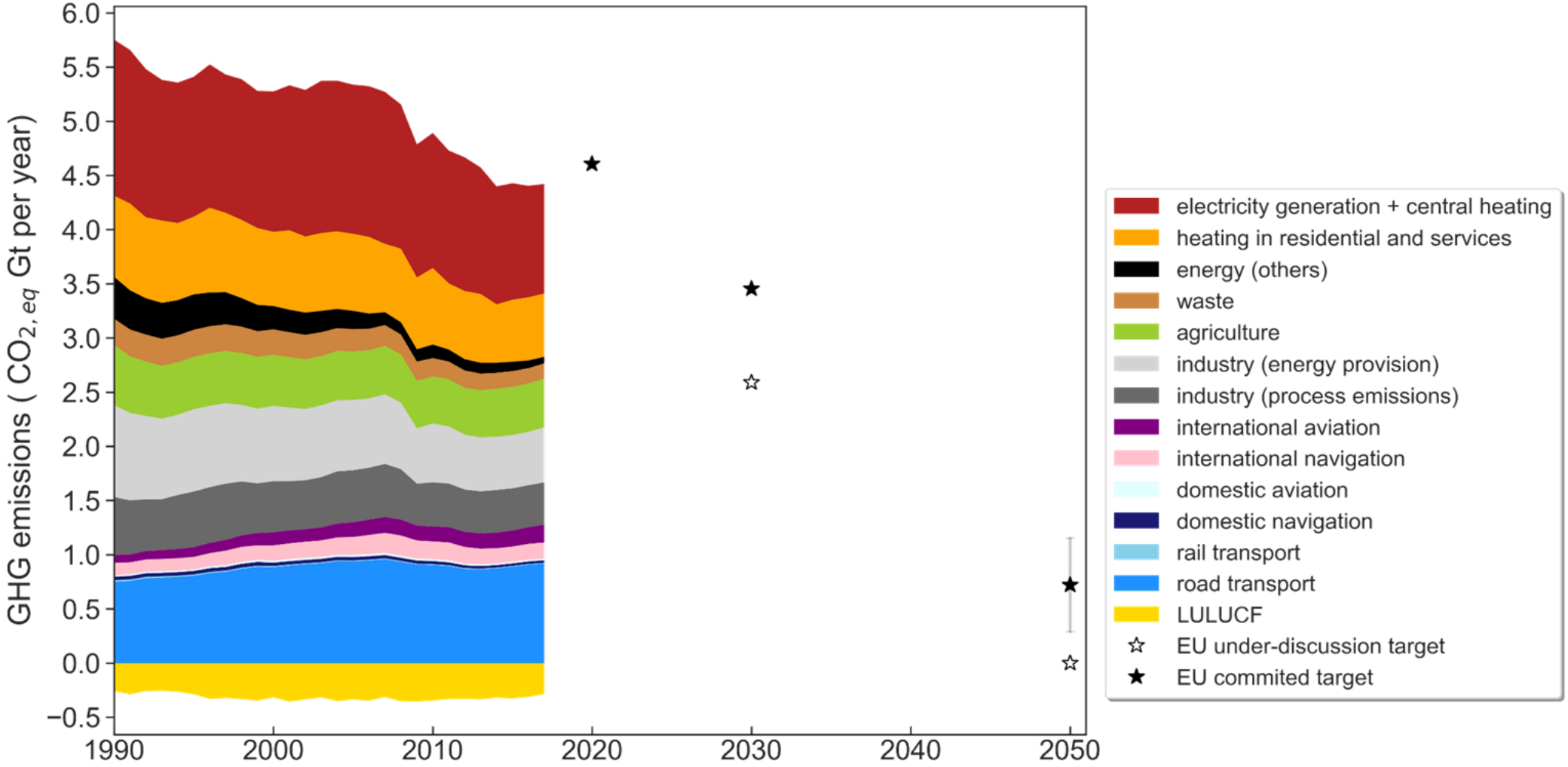
The challenge ahead



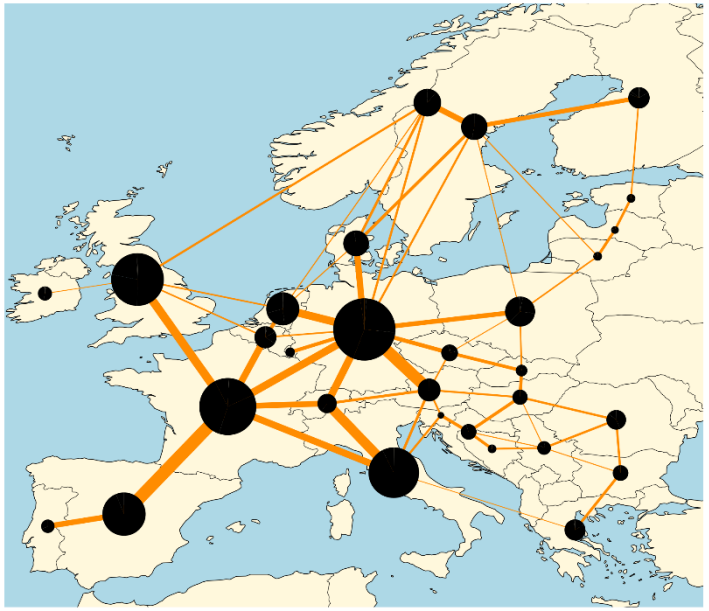
Methodology

$$\min \left(\sum_{n} \underset{costs}{generation} + \underset{costs}{storage} + \underset{costs}{transmission} + \sum_{n,t} \underset{costs}{variable} \right)$$

Subject to constraints :

$$generation + balance = demand$$

$$\sum emissions \leq CAP_{CO2}$$



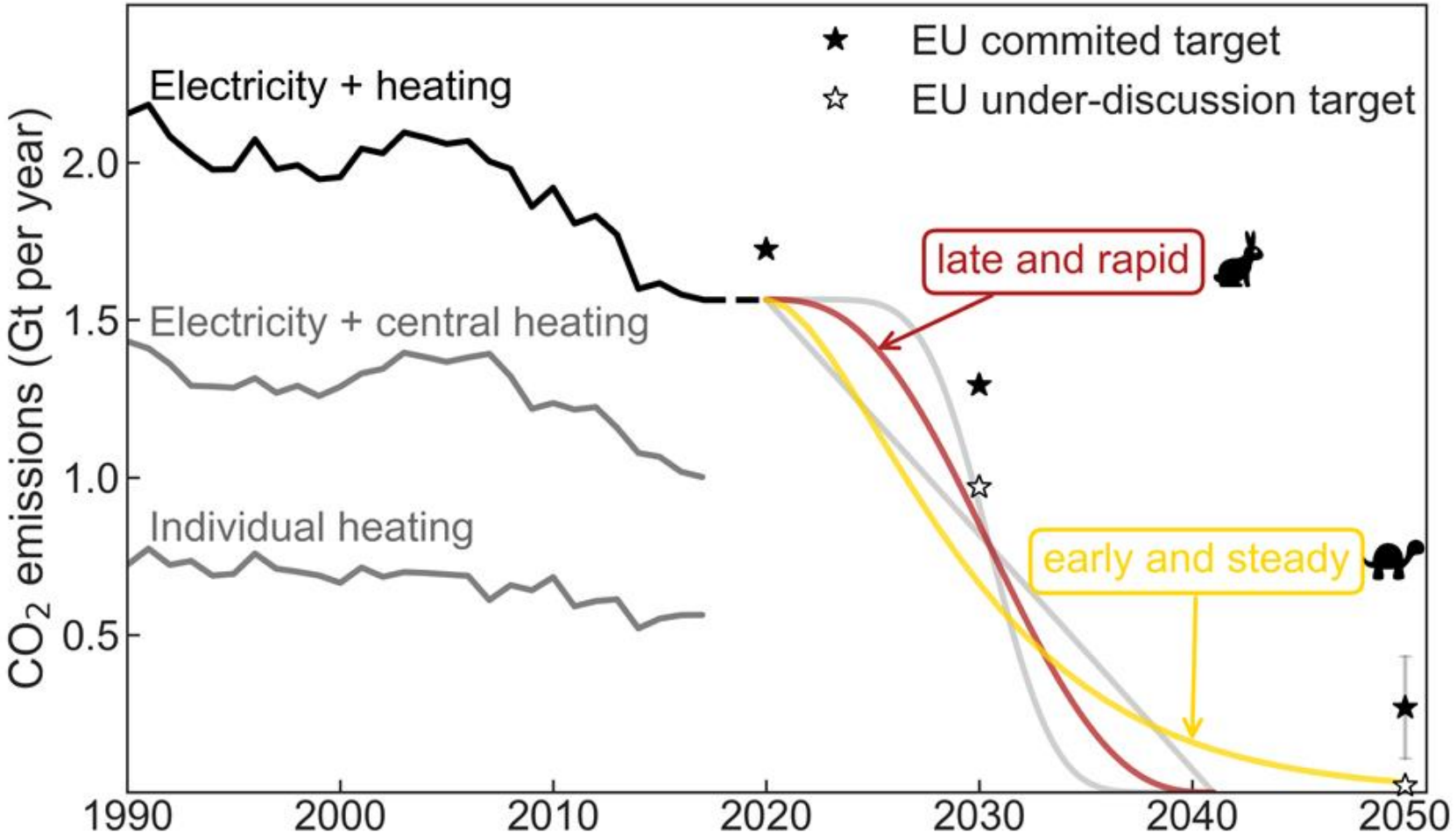
Strategies to balance renewables:

- Storage
- Reinforce interconnections
- Flexibility provided by sector coupling (electricity, heating and transport sectors)

open model : https://github.com/martavp/pypsa-eur-sec-30-path
+ open data : 10.5281/zenodo.4010644
+ open discussion : arXiv:2004.11009
ensures transparency and reproducibility

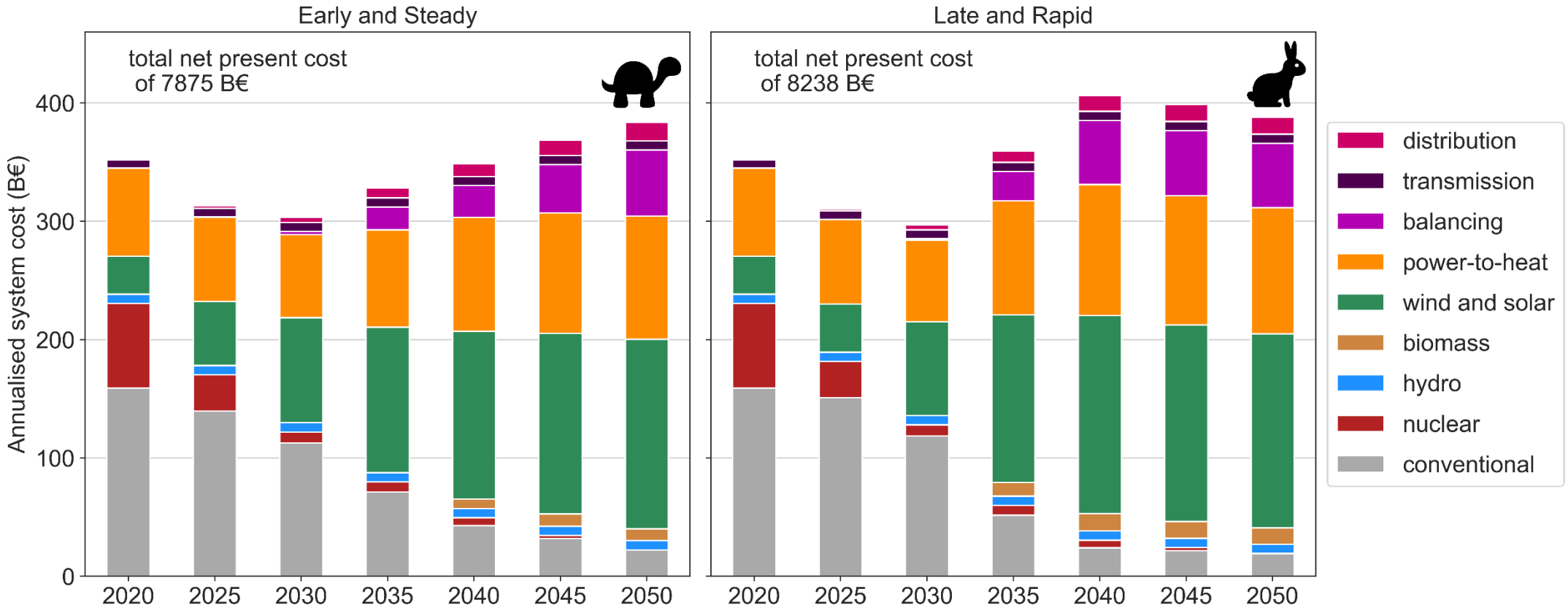
Transition paths with strict carbon budget

The cumulative carbon dioxide emissions from the European electricity and heating sector between 2020 and 2050 must remain below 21 Gt CO_2 to meet the Paris Agreement.



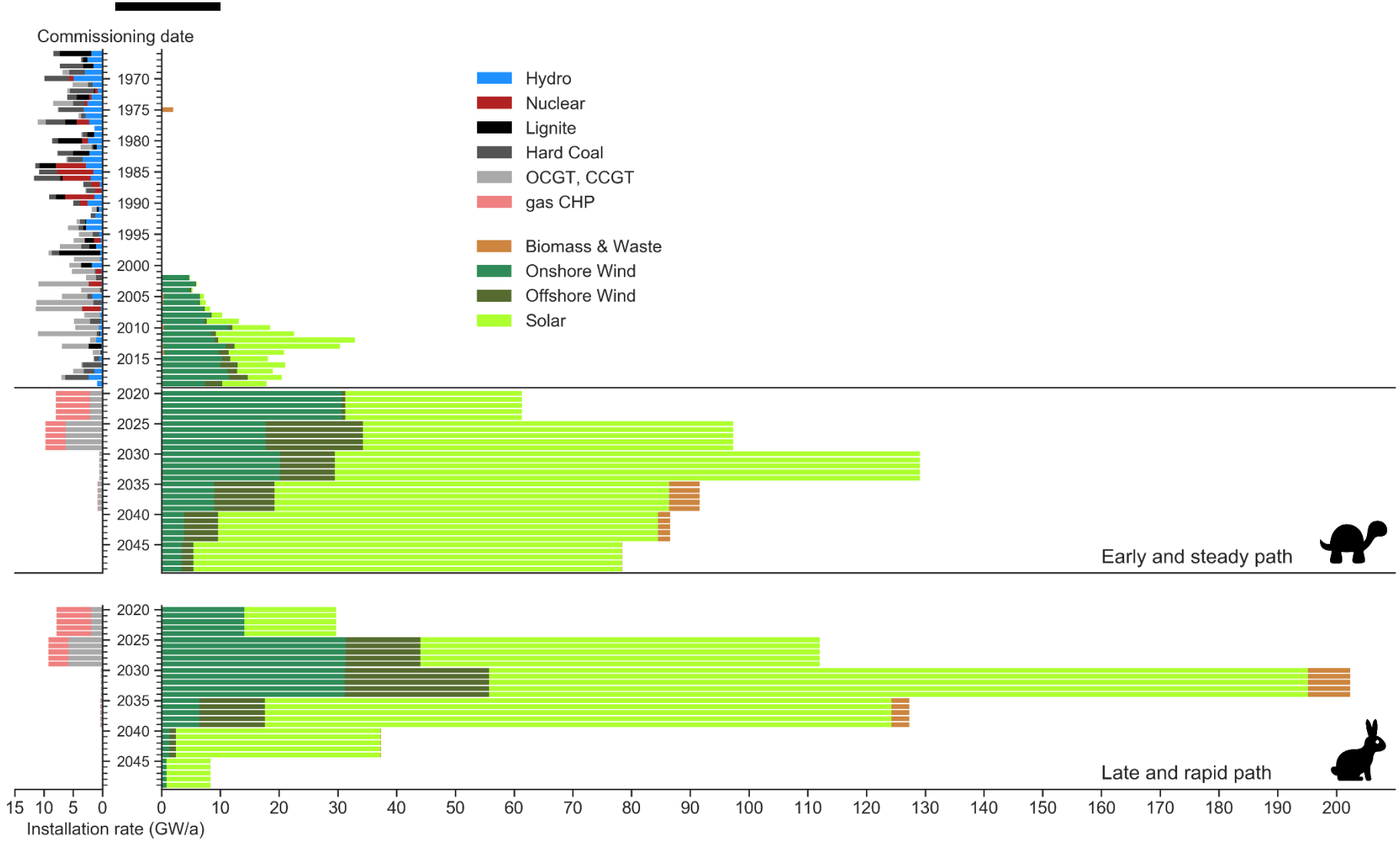
Results : Early and Steady vs Late and Rapid

The Early and Steady path is less expensive.



Victoria et al. 'Early decarbonisation of the European energy system pays off ' (2020), arXiv:2004.11009

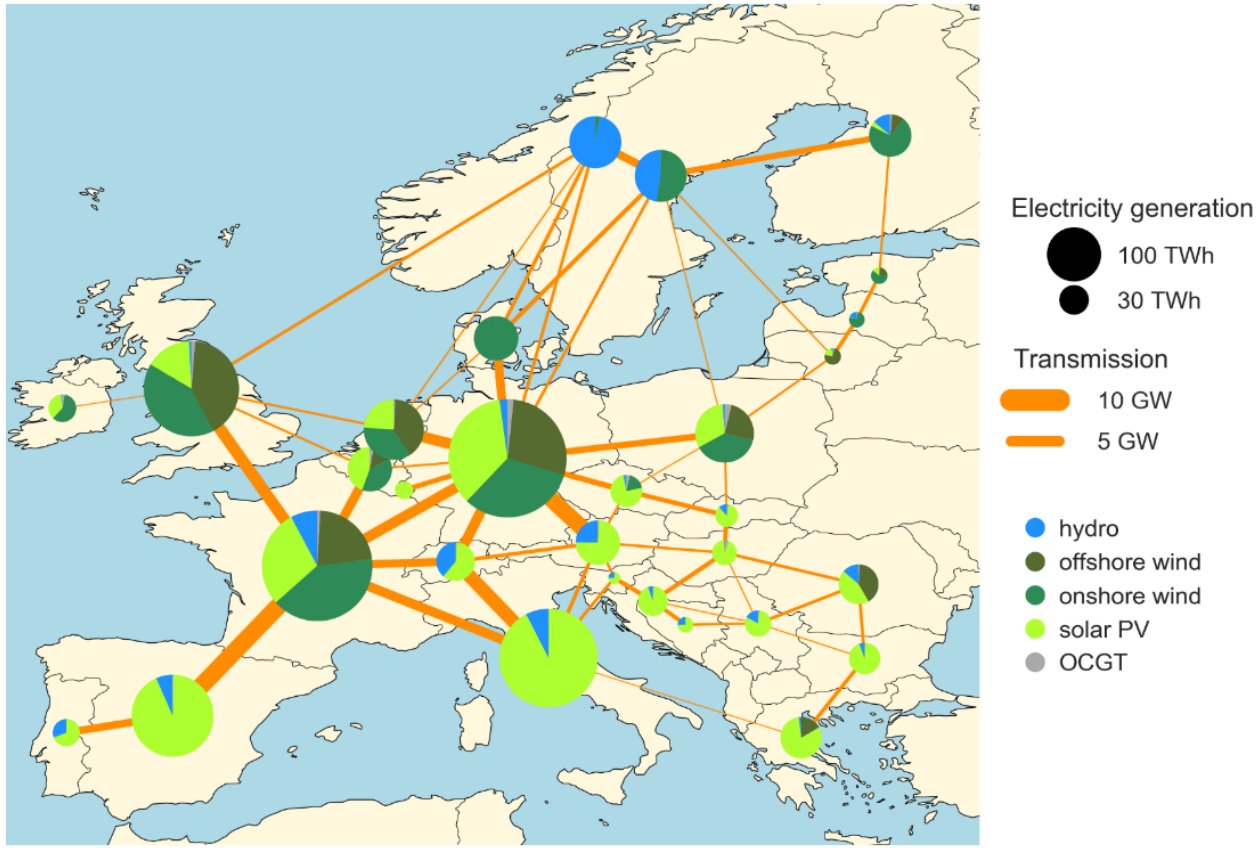
Results : Early and Steady vs Late and Rapid

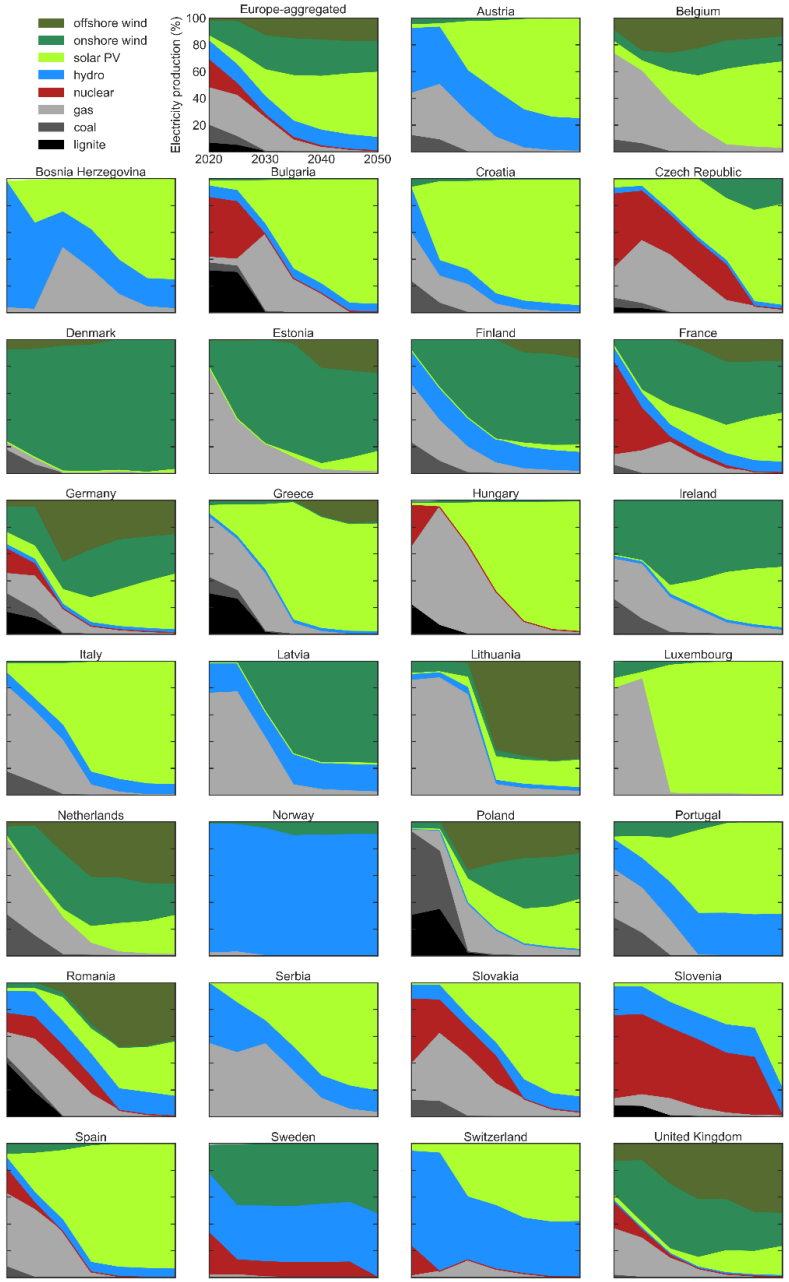


- Almost no new fuel-based electricity generation.
- Massive deployment of solar PV and wind, bioenergy play a small role
- Build rates similar to highest historical values.

Victoria et al. 'Early decarbonisation of the European energy system pays off ' (2020), arXiv:2004.11009

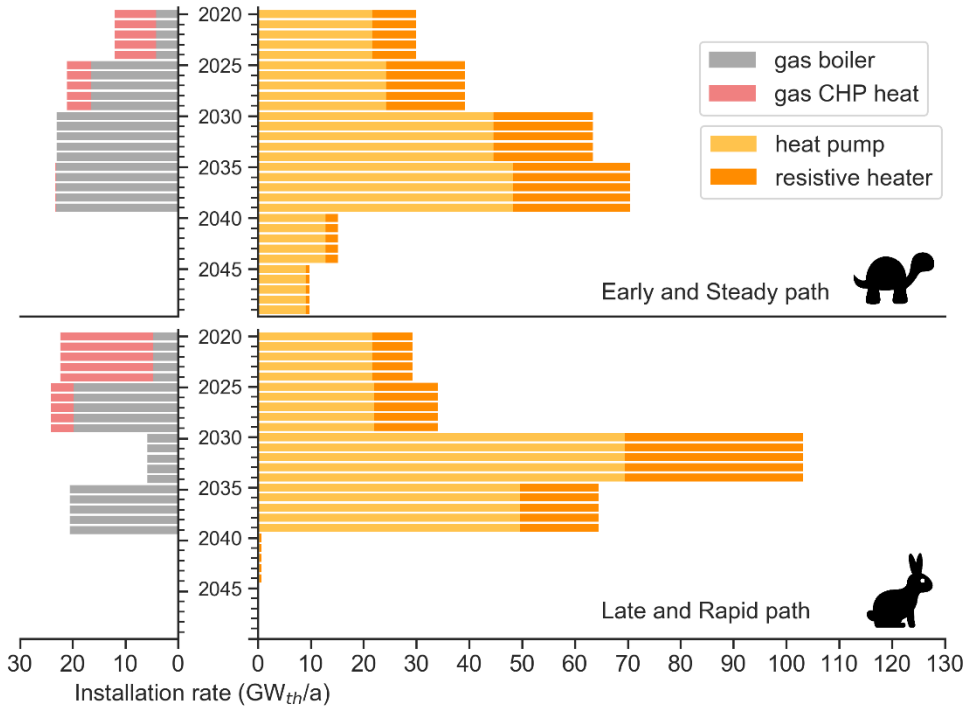
Results: Cooperation among countries and technologies



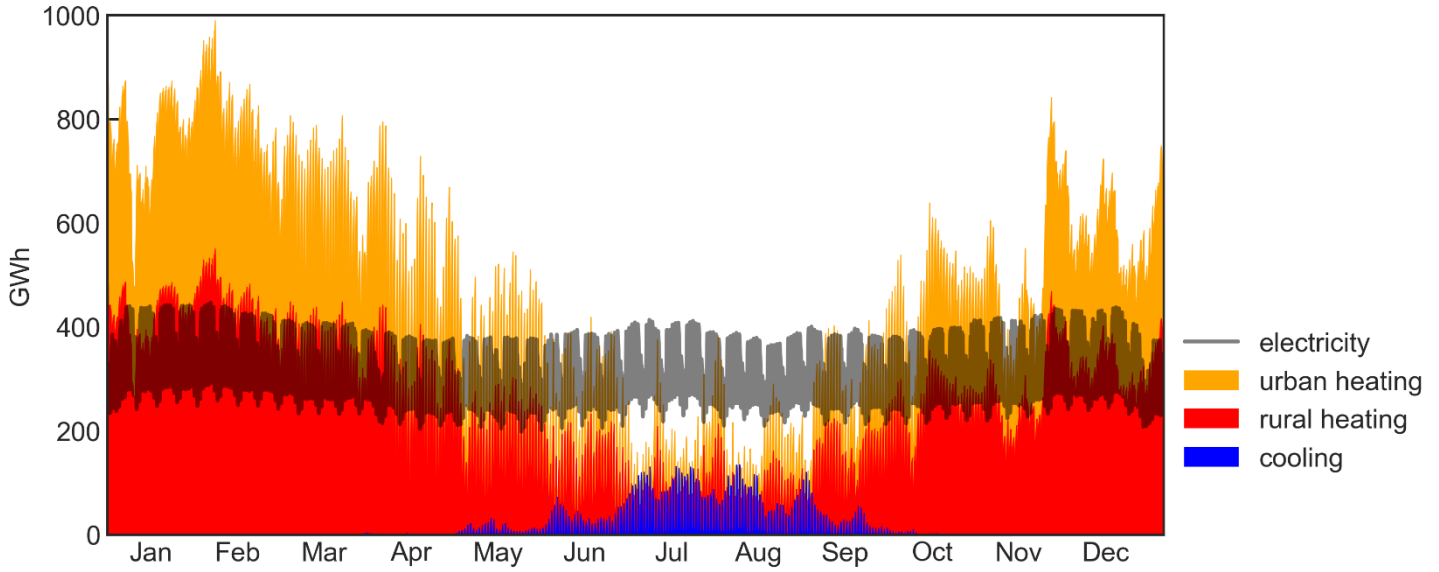


Results : Early and Steady vs Late and Rapid

The electricity sector gets quickly decarbonised in both paths and more notable differences appear in new conventional heating capacities

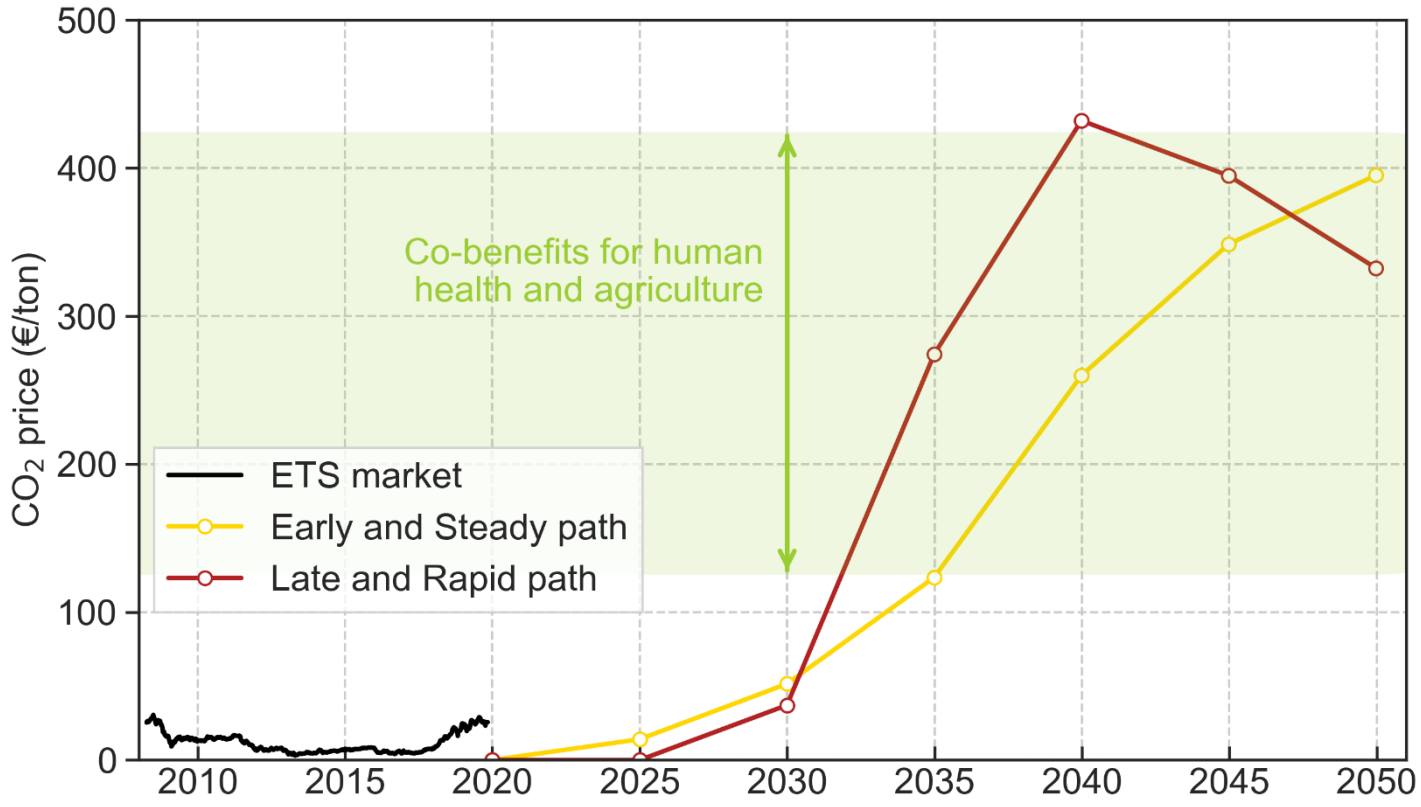


Large seasonal variation in heating demand makes decarbonization in this sector more difficult



Results : Early and Steady vs Late and Rapid

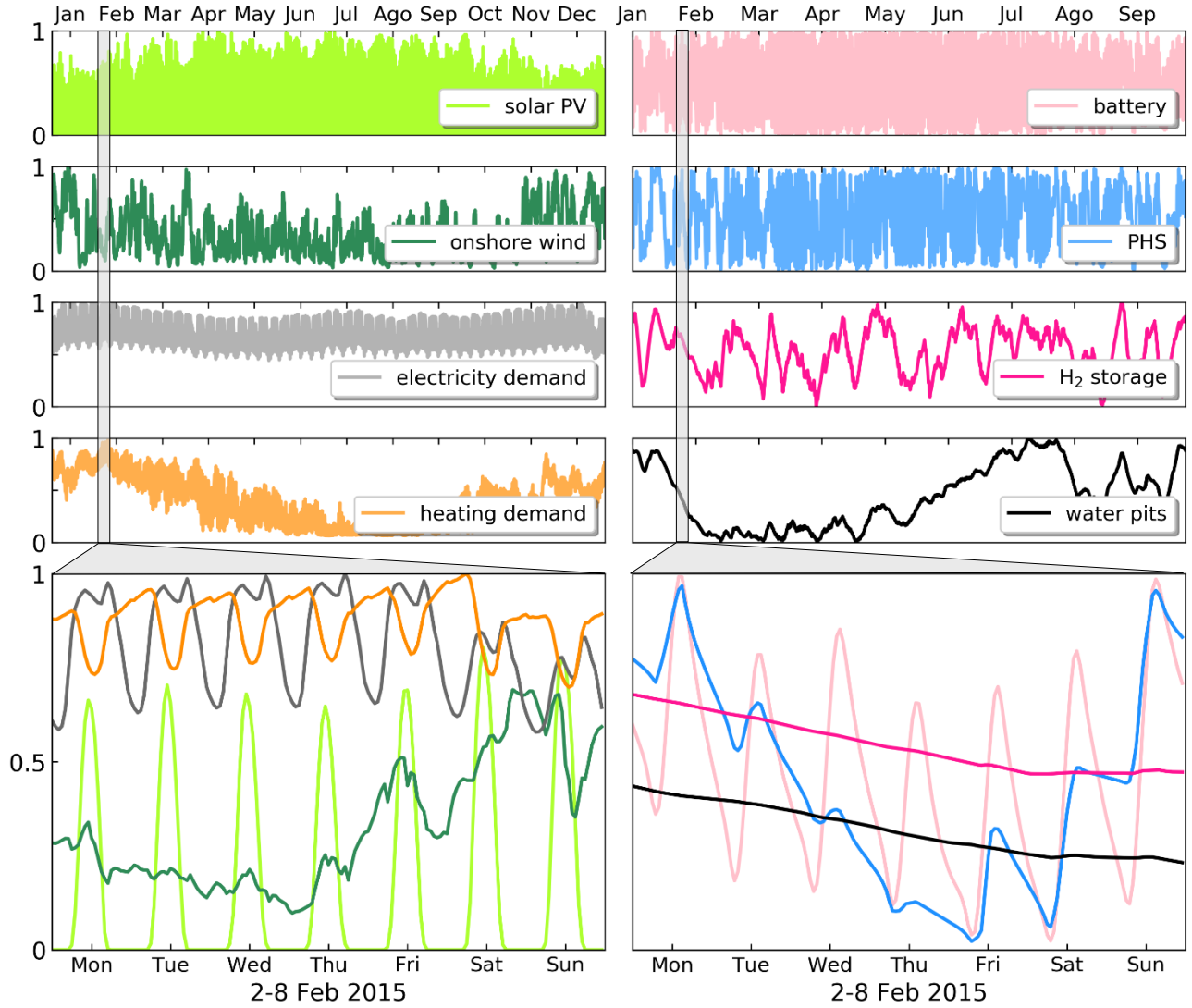
Gentle path incentivises more stable CO_2 prices.



Transition paths

Main features capture by hourly interrupted time stepping:

- solar and wind power generation smoothed by the grid and storage
- the role of long-term storage
- system operation during cold spells



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