Fraunhofer-Institution for Energy Infrastructures and Geotechnologies IEG

Integrated Infrastructure Planning and 2050 Climate Neutrality: Deriving future-proof European Energy Infrastructure

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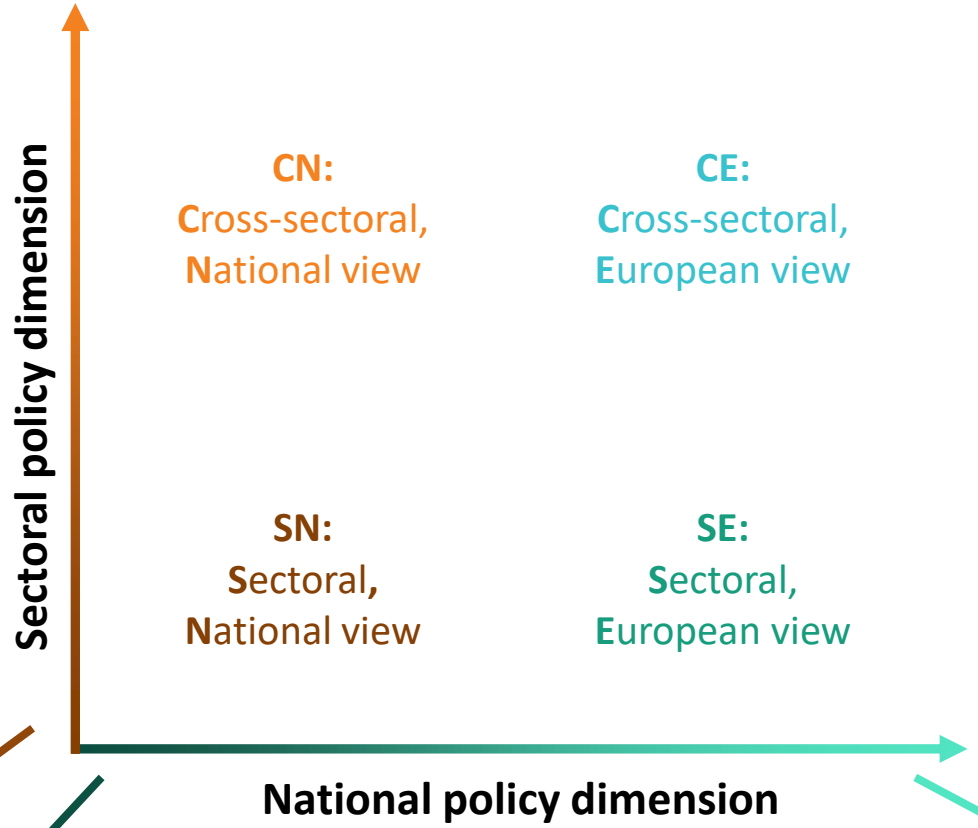
The European Energy System Model

Scenario Design

Cross-sectoral optimisation:
Free grid expansion with TYNDP projects under construction as lower bound

vs.

Sectoral optimisation:
Fixed grid expansion until 2040 to existing grid plans (TYNDP, H_2 infrastructure map, German H_2 core network)



National self-sufficiency targets:

- Electricity (min: 80% in 2030, 100% in 2050, max: 110% in all year)
- H_2 (min: 70%, max 110% in all years)

vs.

European optimisation with no national restrictions

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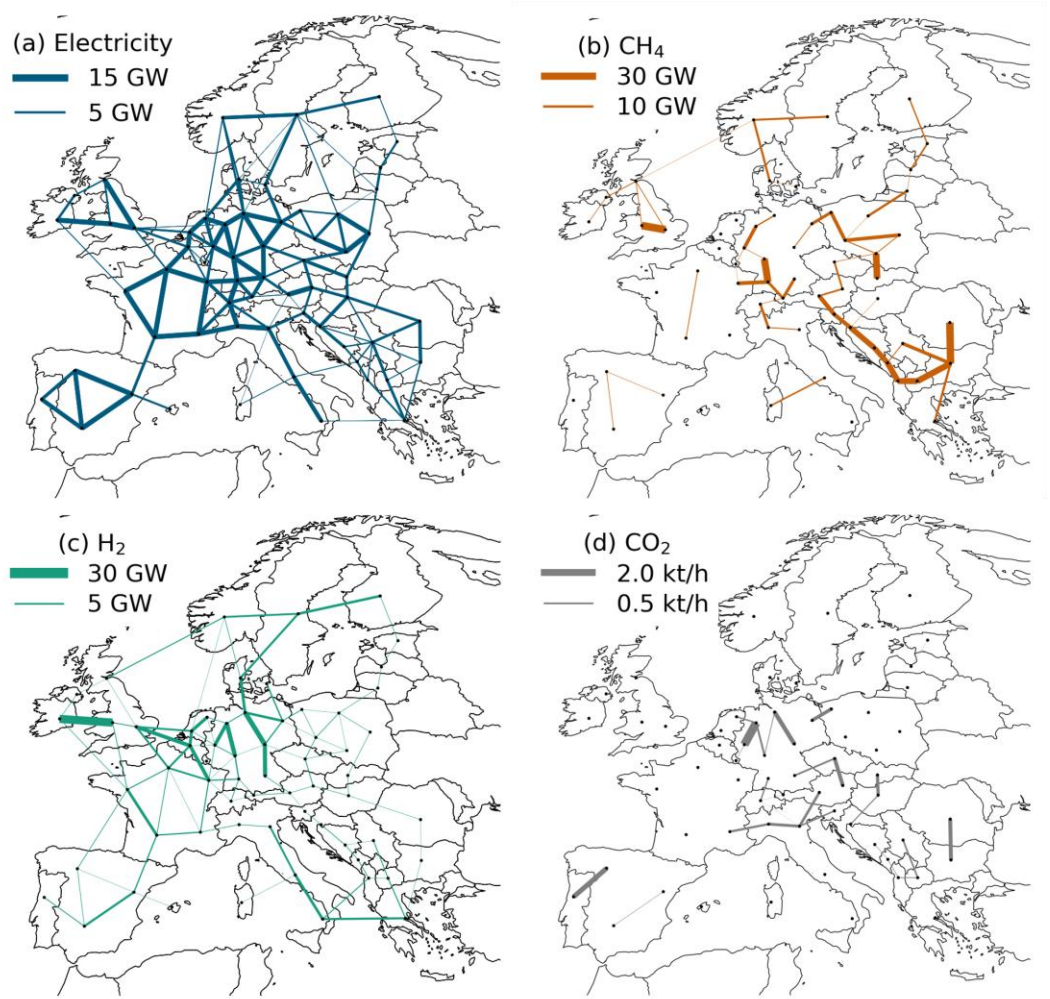
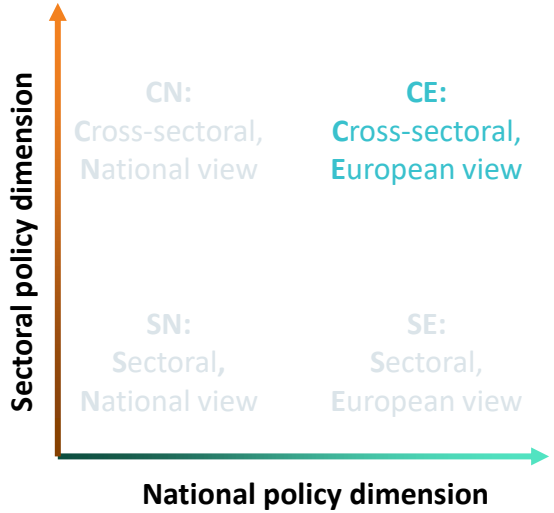
European Infrastructure in 2050

Optimal Transport Networks



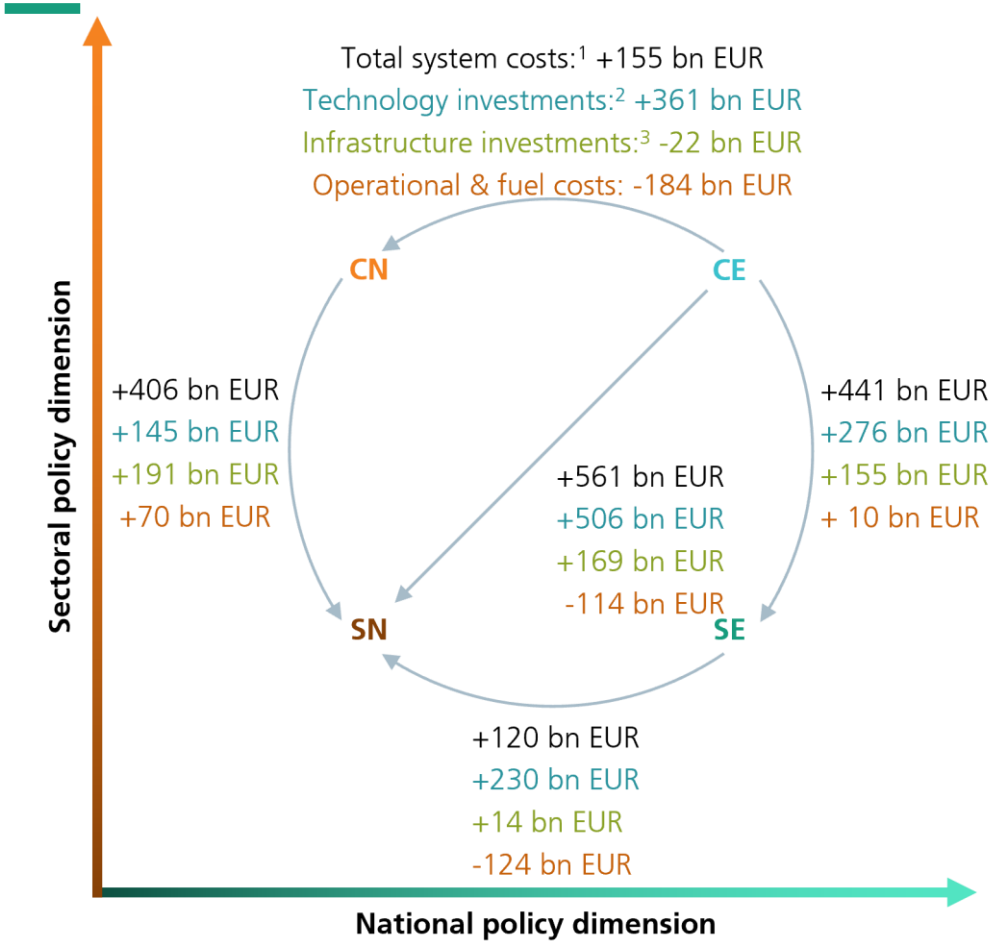


- **Massive expansion** of **electricity transmission grids across the EU.**
- **Significant hydrogen transport grid** to supply industrial demand centres.

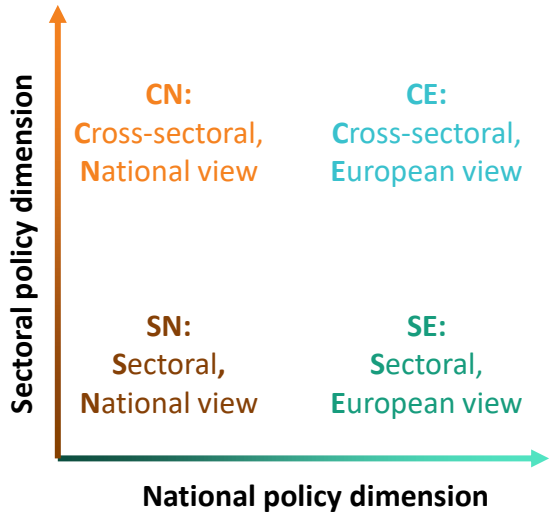
- **Strong decrease of gas grid capacity utilisation**.
- **Local CO_2 transport systems emerge** to connect point sources and storage / use.

Benefits of Integrated Infrastructure Planning

Cumulative System Costs



[1]Capital, operational and fuel costs
[2]Power generation, heat generation, storage and transformation technologies (e.g. H_2 electrolysis)
[3]Electricity, hydrogen, methane and CO_2 network

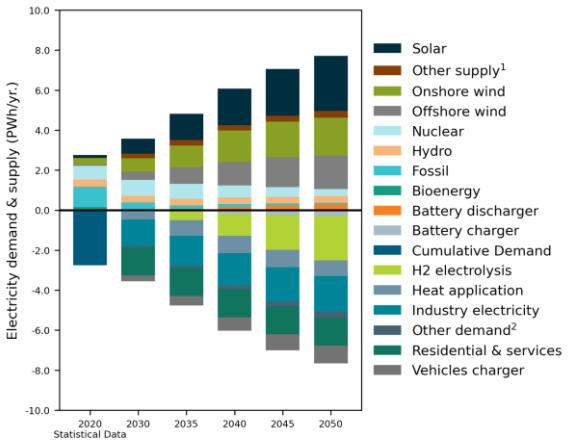


Total system costs of about 560 bn € can be saved until 2050 due to European and sectoral integration.

Avoided **investments in generation assets** followed by **avoided infrastructure investments** and **avoided operational and fuel costs** drive these **cost savings**.

Evolution of Energy Infrastructures Under Climate Neutrality Targets

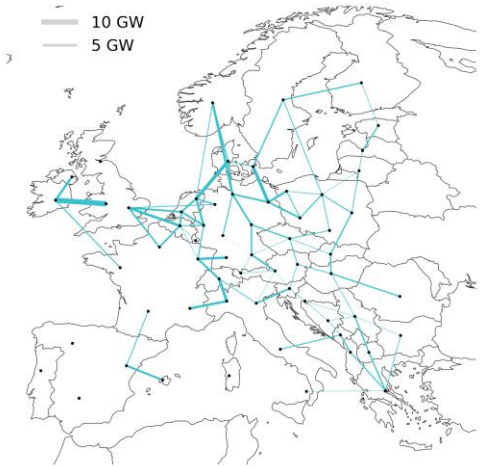
Benefits of Integrated Infrastructure Planning



[1] Other supply: Import, CHP, H2 fuel cell, H2 turbine, Home battery discharger, Vehicle-to-grid
[2] Other demand: Export, Agriculture electricity, DAC, Home battery charger, Methanol production, PHS

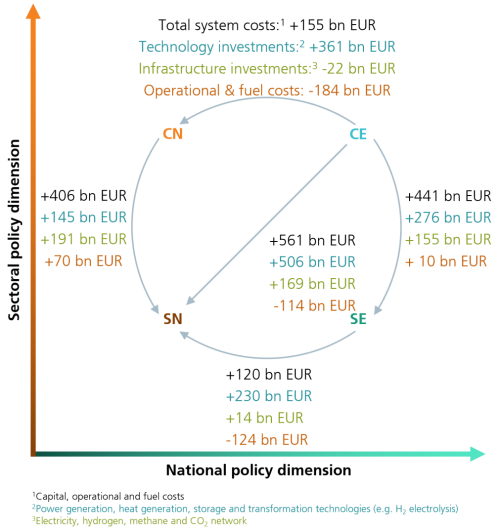
Energy demand development

- Electrification across sectors
- European hydrogen production requires increased electricity demand
- Large demand for basic industry and synthetic fuels dominates hydrogen demand



Infrastructure development

- European integration decreases capacity of generation and conversion assets
- Integrated scenarios lead to increased electricity interconnection capacity
- Cross-sectoral integration leads to reduced hydrogen transport capacity and increased hydrogen storage capacity



Investment needs

- 561 bn Eur savings by fully integrated planning
- Infrastructure investments reduced by 169 bn Eur in fully integrated scenario