

**EUROPEAN
CLIMATE + ENERGY
MODELLING
FORUM**

Charting the path to climate neutrality in the EU: Insights from a model comparison exercise

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ECEMF model intercomparison: How to achieve Climate Neutrality in the EU



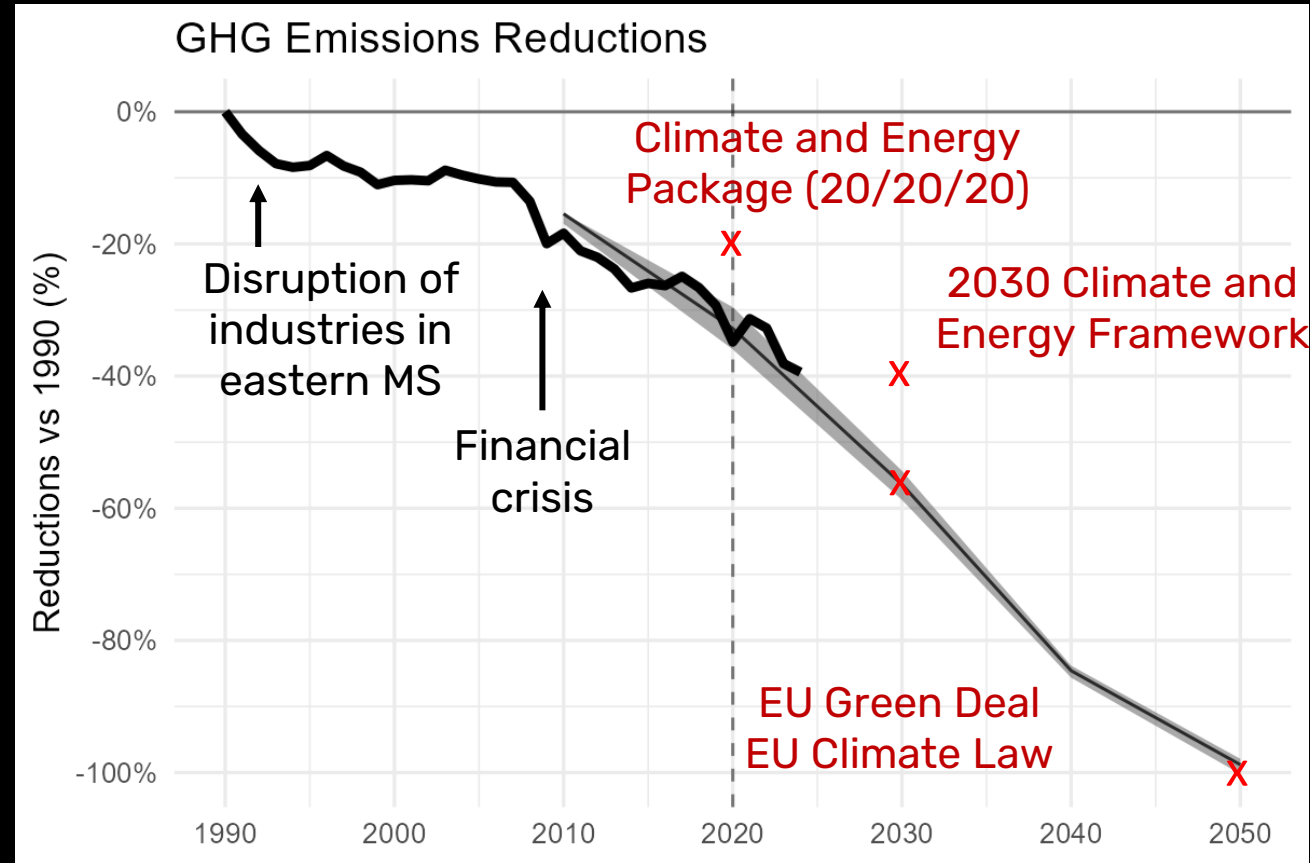
- Aim: Provide a solid knowledge base for policy makers and businesses by determining robust strategies and identifying upcoming milestones and bottlenecks
- Approach: Develop dedicated EU transformation pathways that go beyond previous integrated assessment scenarios (IPCC AR6 database) and that better account for the fundamental changes of the last five years
 - recent EU policies
 - rapid technological development
 - short-term realism – “what is feasible until 2030”

Approach



- 6 full-system models (IMAGE, PRIMES, PROMETHEUS, REMIND, TIAM-ECN, WITCH)
- 3 power sector/supply-side models (Euro-Calliope, LIMES, MEESA, OSEMBE)
- Implementation: The modelling teams were tasked to calculate cost-efficient pathways towards climate neutrality with updated model versions

The EU is in the middle of a complete transformation – and has achieved more than a third!



Source: UNFCCC

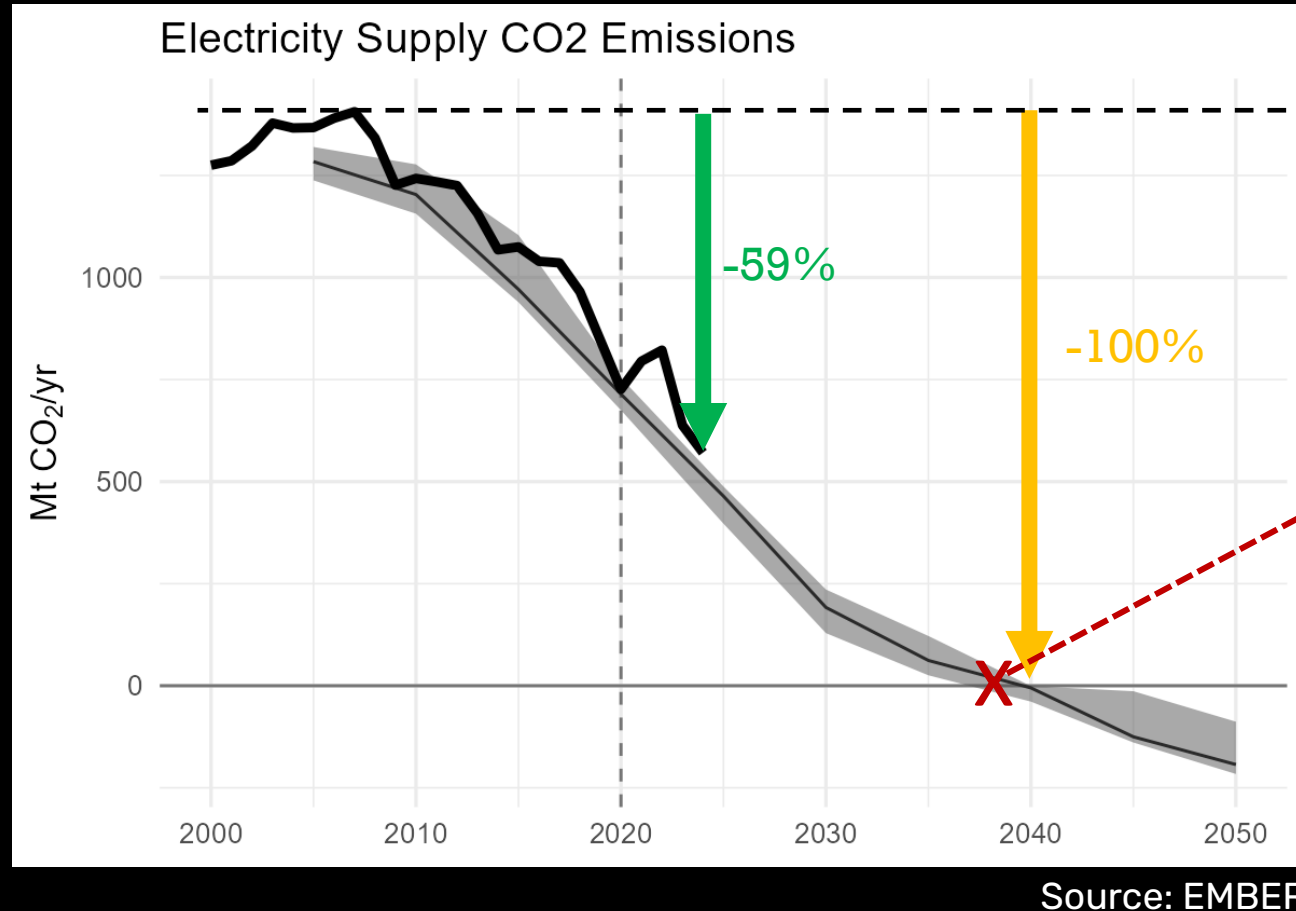
- All models manage to achieve climate neutrality by 2050

Robust aspects of pathways to climate neutrality



The core strategy: **Direct electrification using renewables-based electricity**

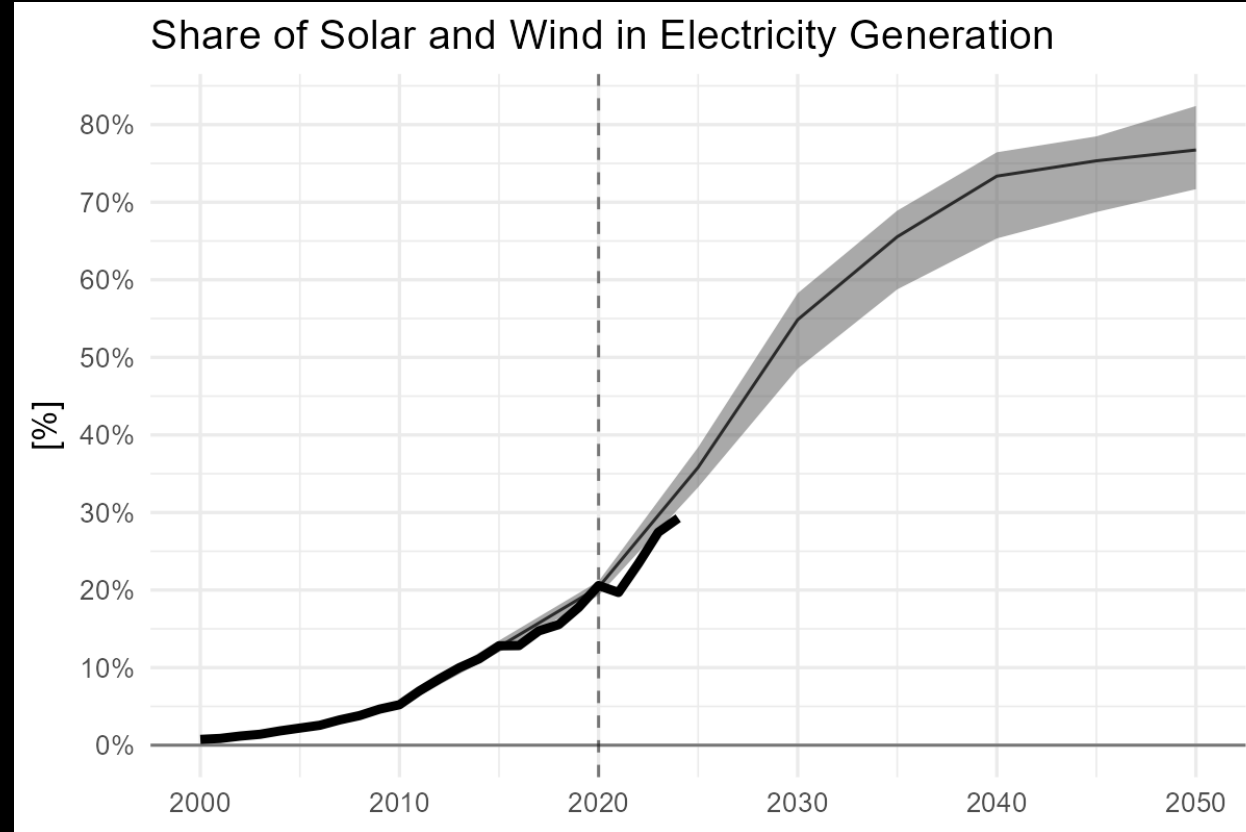
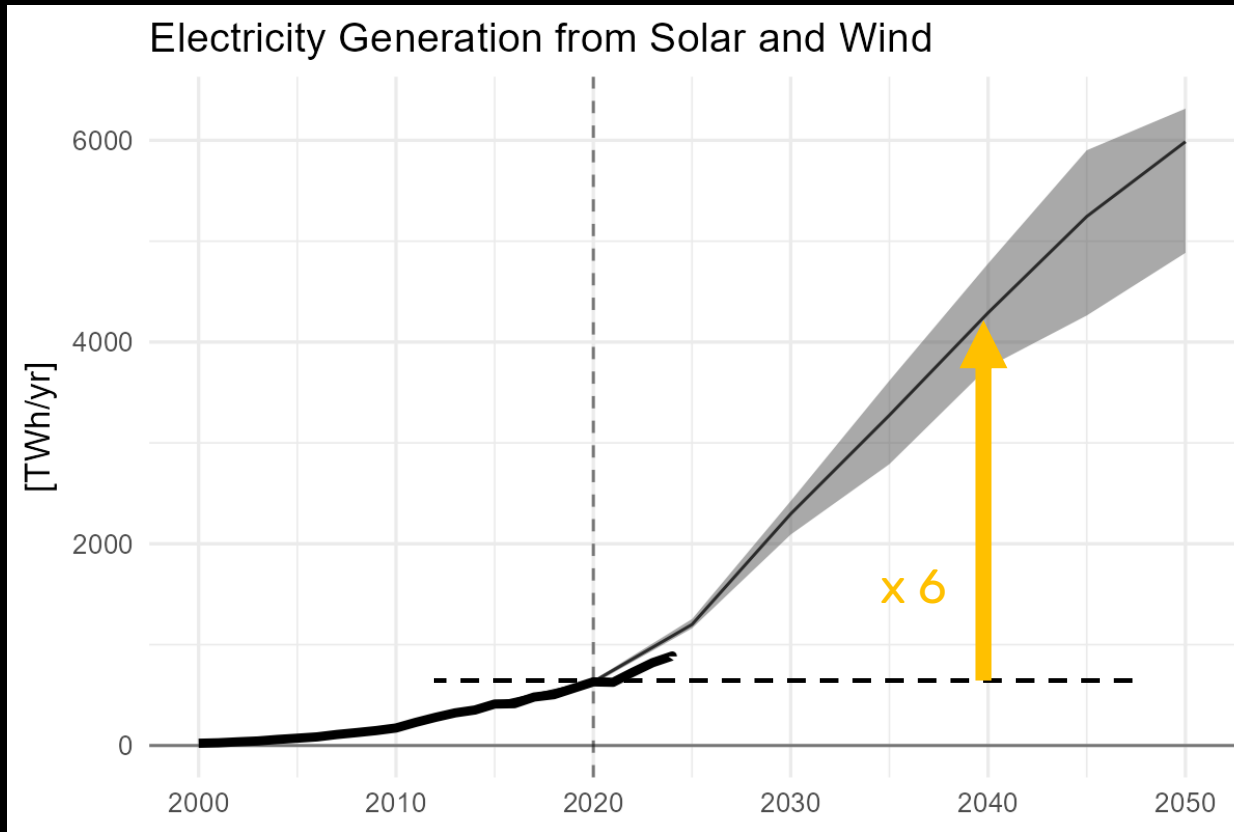
The electricity sector continues the successful transformation story and decarbonizes before 2040 ...



First new EPR2 nuclear power plant will become operational in France - if completed without delays

- Since their peak in 2007, electricity sector emissions were reduced by more than 50%
- All models see close-to-zero emissions for EU27&UK by 2040, most see net negative emissions

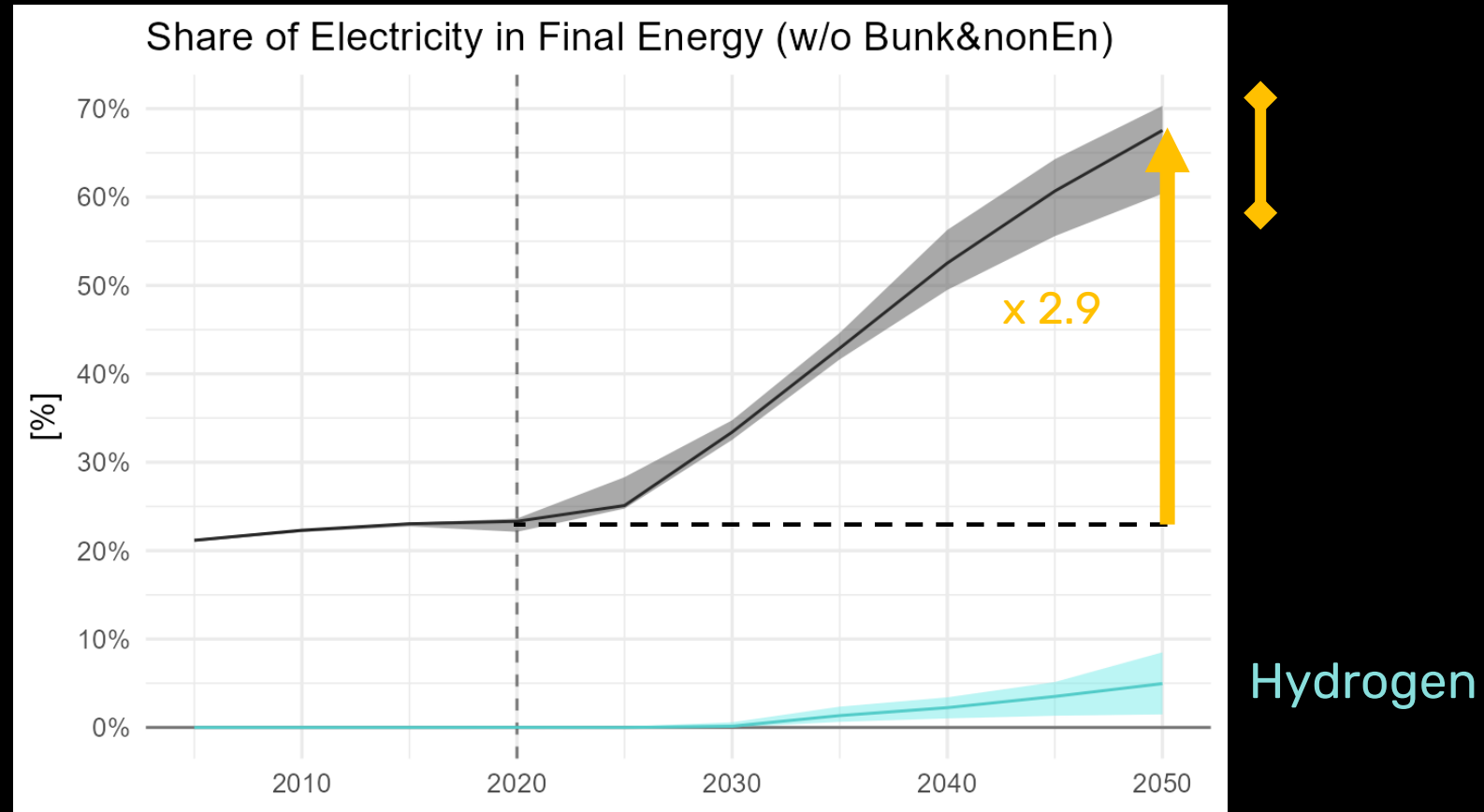
... mainly via the rapid expansion of wind & solar power



Source: EMBER

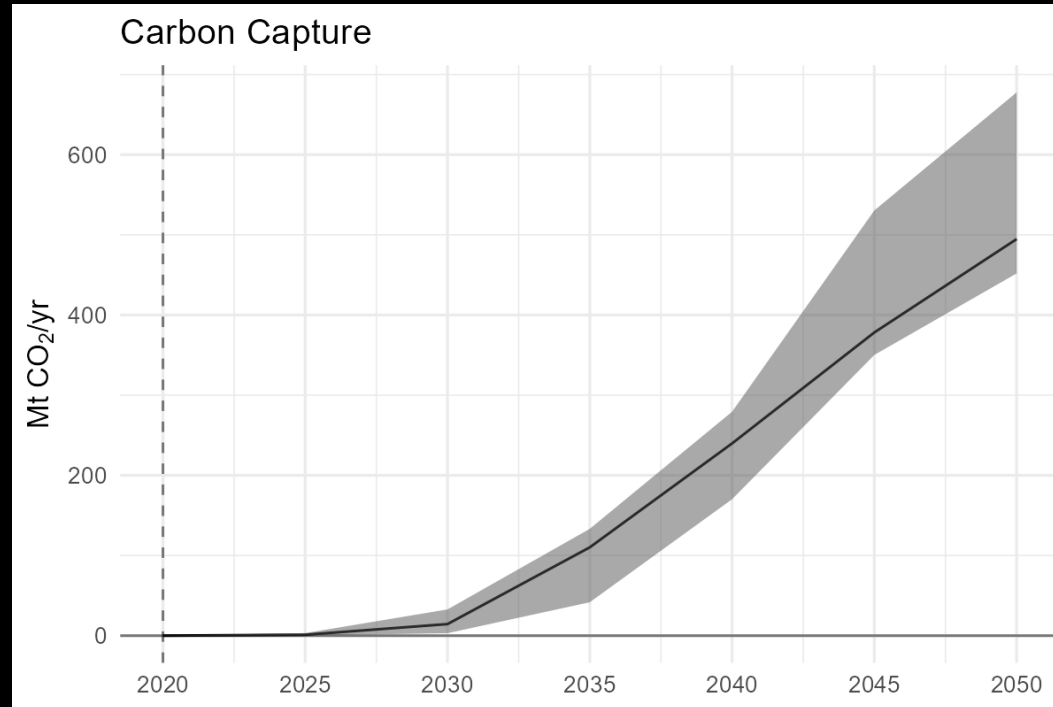
- Roughly 6-fold increase of wind and solar power from 2020 - 2040. This is mostly in line with recent deployment acceleration due to REPowerEU & subsequent national regulatory changes
- Wind and solar become the main pillar of the EU electricity system, supplying 70% by 2040
- Substantial flexibility investments (grid, storage, DSM) required

Direct electrification is the cornerstone of climate neutrality



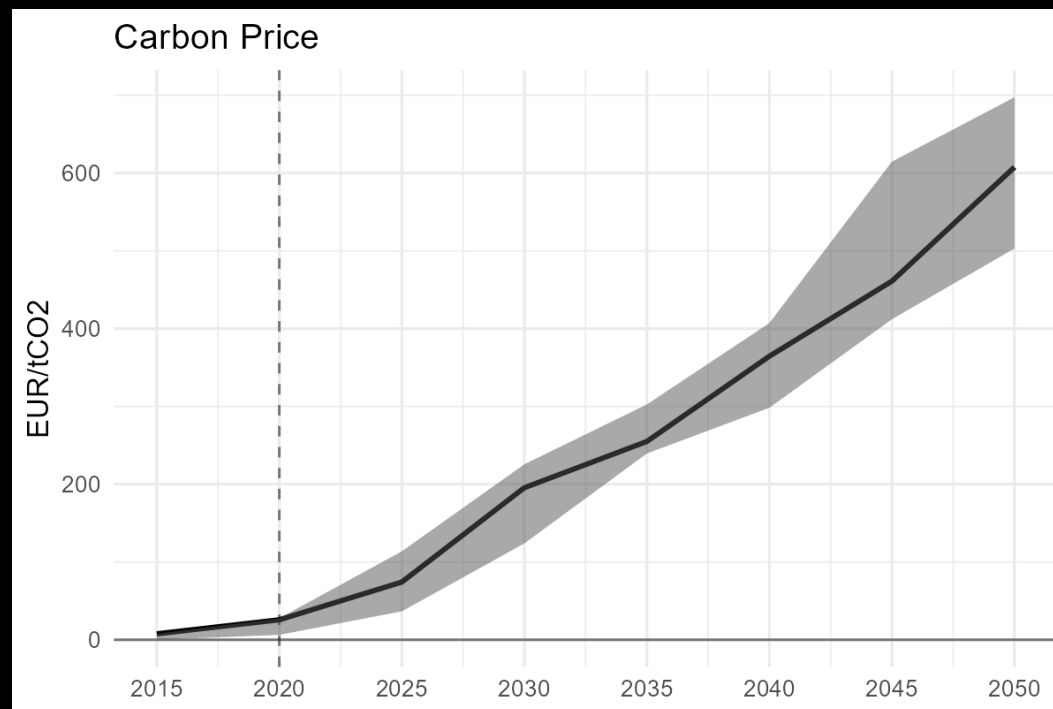
- Electricity becomes **the main energy carrier**, more than doubling its share compared to 2020, so that it provides 60-70% of final energy by 2050
- Electricity shares align with ranges determined by sectoral models
- Hydrogen also sees a strong increase, but at a much lower total level, reaching ~5% by 2050

Carbon Capture scaleup



- Models show 200-300 MtCO₂/yr carbon capture by 2040, increasing to 450-700 MtCO₂ in 2050
- The captured carbon is mostly from biomass, with two models seeing a relevant contribution from DACCS in 2050

Carbon Prices



- Required carbon prices in 2040 in the range of 250-400 EUR/tCO₂, increasing to 500-700 EUR/tCO₂ in 2050

Summary

The EU is in the middle of a deep transformation

Findings from the model intercomparison exercise:

- All models manage to show a feasible path towards climate neutrality by mid-century
- The core emission reduction strategy: electrify using renewables-based electricity
- Decarbonization of the electricity sector by 2040, mainly via solar & wind deployment
- Electricity becomes the main energy carrier, providing 60–70% of final energy demand in 2050
- Hydrogen increases after 2030, but only to a limited level (2–10% of final energy)
- Carbon capture is scaled to 200–300 MtCO₂/yr in 2040 – mostly biomass, some DACCS
- Carbon prices in 2040 reach 250–400 EUR/tCO₂