TRANSITION TIPPING POINTS:
ACHIEVING THE SECTORAL TRANSFORMATIONS NEEDED FOR 90% EMISSIONS REDUCTIONS BY 2040

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Starting question: 2040 emissions in line with Net Zero in 2050

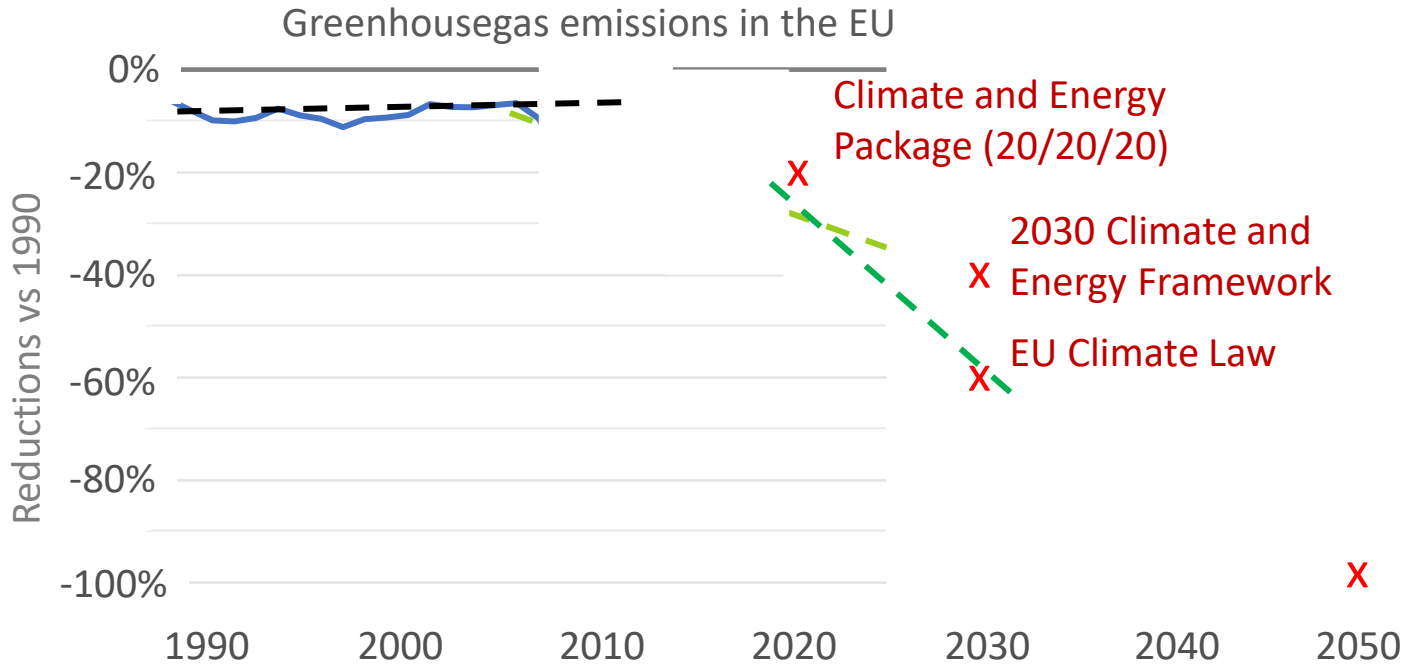
Objective:

- Dedicated EU transformation pathways that better account for
  - recent EU policies and other regional specificities for the EU
  - technological development over the last five years
  - short-term realism – “what is feasible until 2030”

- Main “NetZero” scenario: achieve climate neutrality by 2050 via a smooth carbon price path and other policies as deemed realistic

➔ What sectoral Transitions are needed, when do sectors “Tip” such that the transformation continues (mostly) by itself and only requires marginal increases of policies & Effort

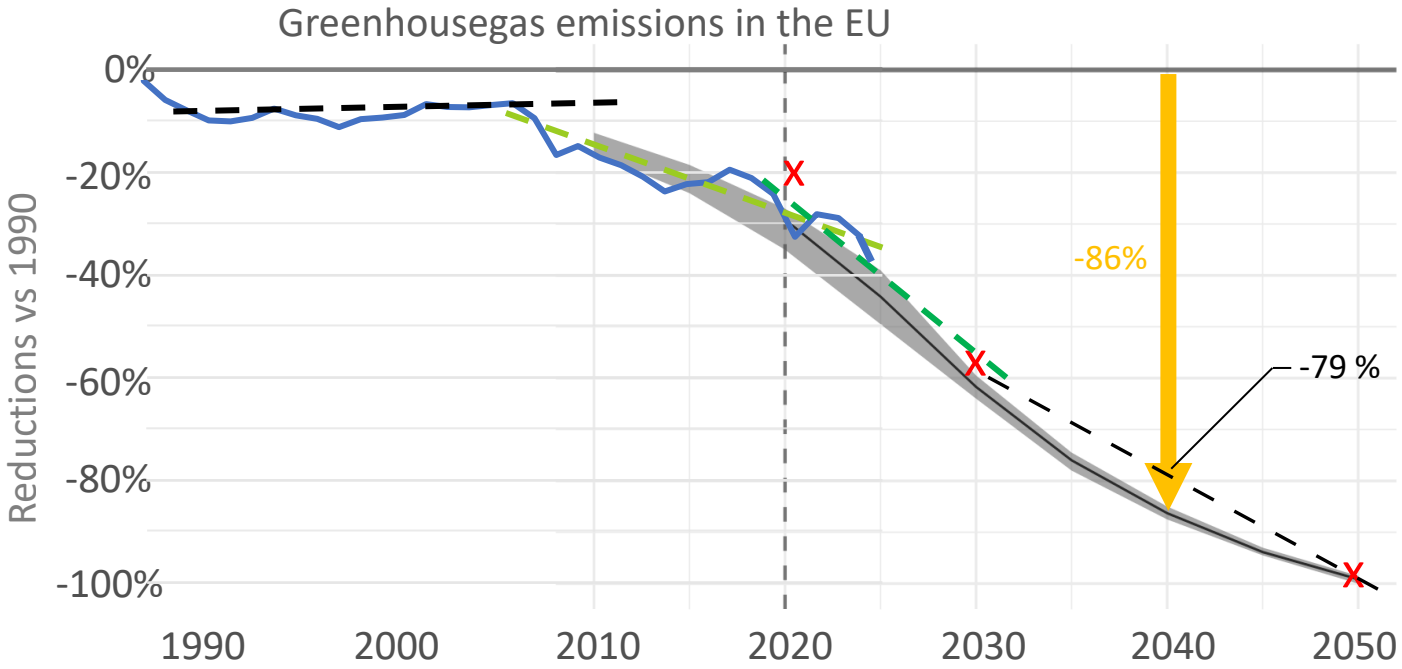
THE EU IS IN THE MIDDLE OF A COMPLETE TRANSFORMATION



- EU reached impressive emission reductions over the last 15 years (mostly industry & power)
- EU Green Deal requires (and brings) further acceleration

Source: EEA, ECEMF

How can the next Decades unfold?



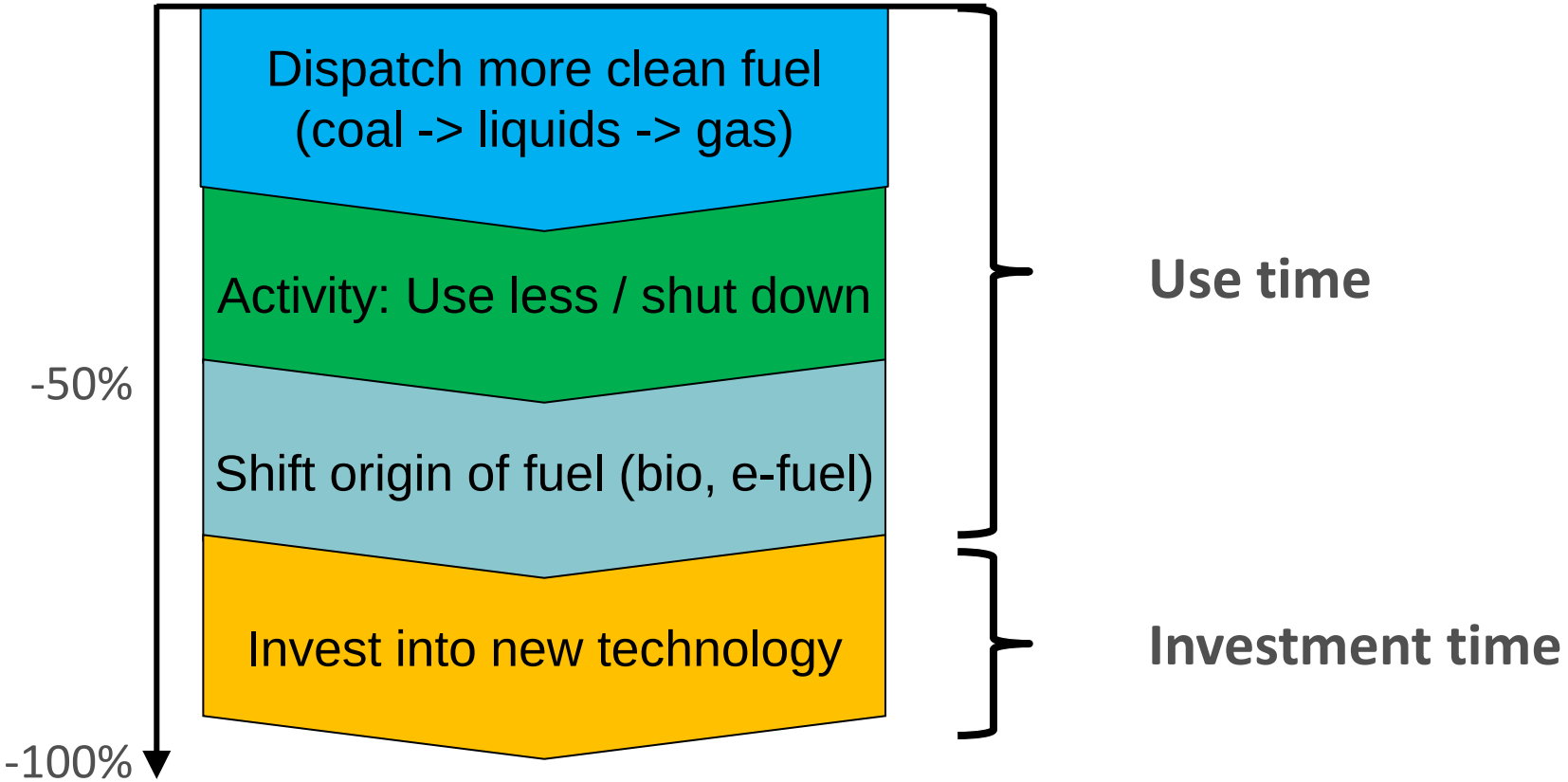
- Under all settings, the model manages to achieve Climate Neutrality by 2050
- We find 2040 GHG reductions of ~86% (84.. 89%) including bunkers
- This is more ambitious than the linear interpolation of 2030 and 2050

➔ Why? Can we understand the larger dynamics of the transformation?

Source: EEA, ECEMF

TRANSITION DYNAMICS ON THE EXAMPLE OF ROAD TRANSPORT

How to reduce emissions?



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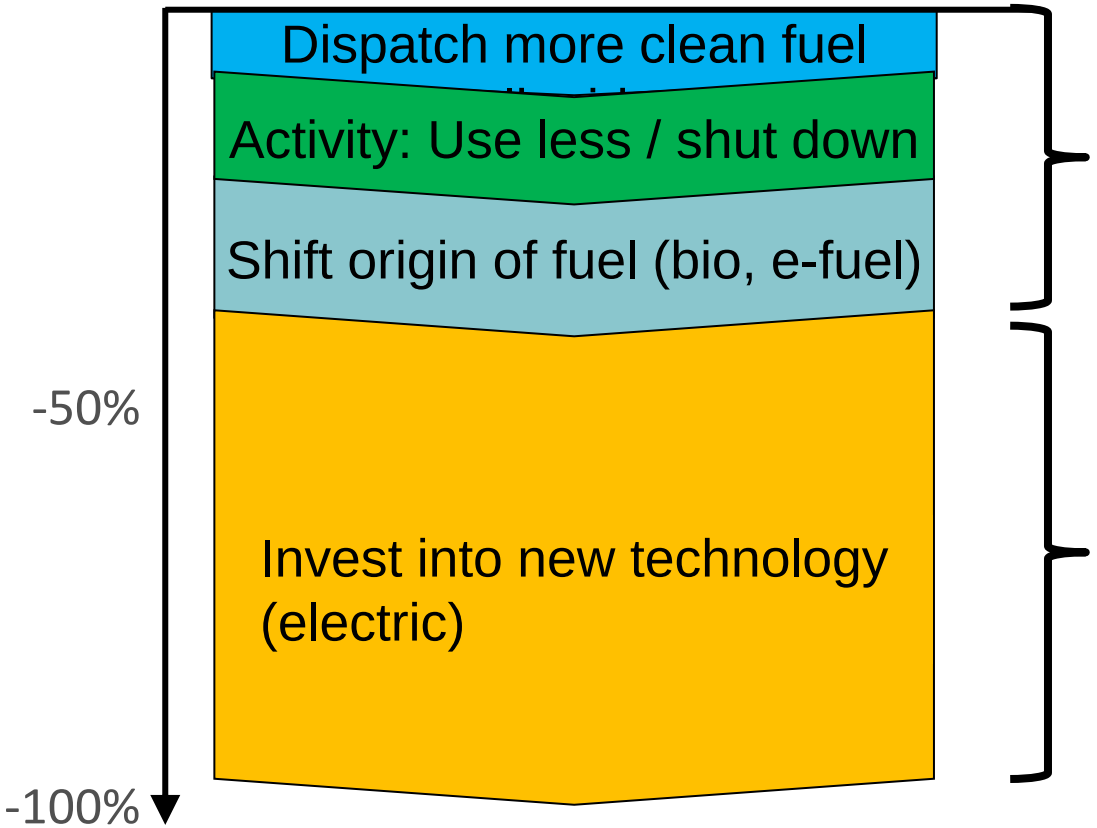


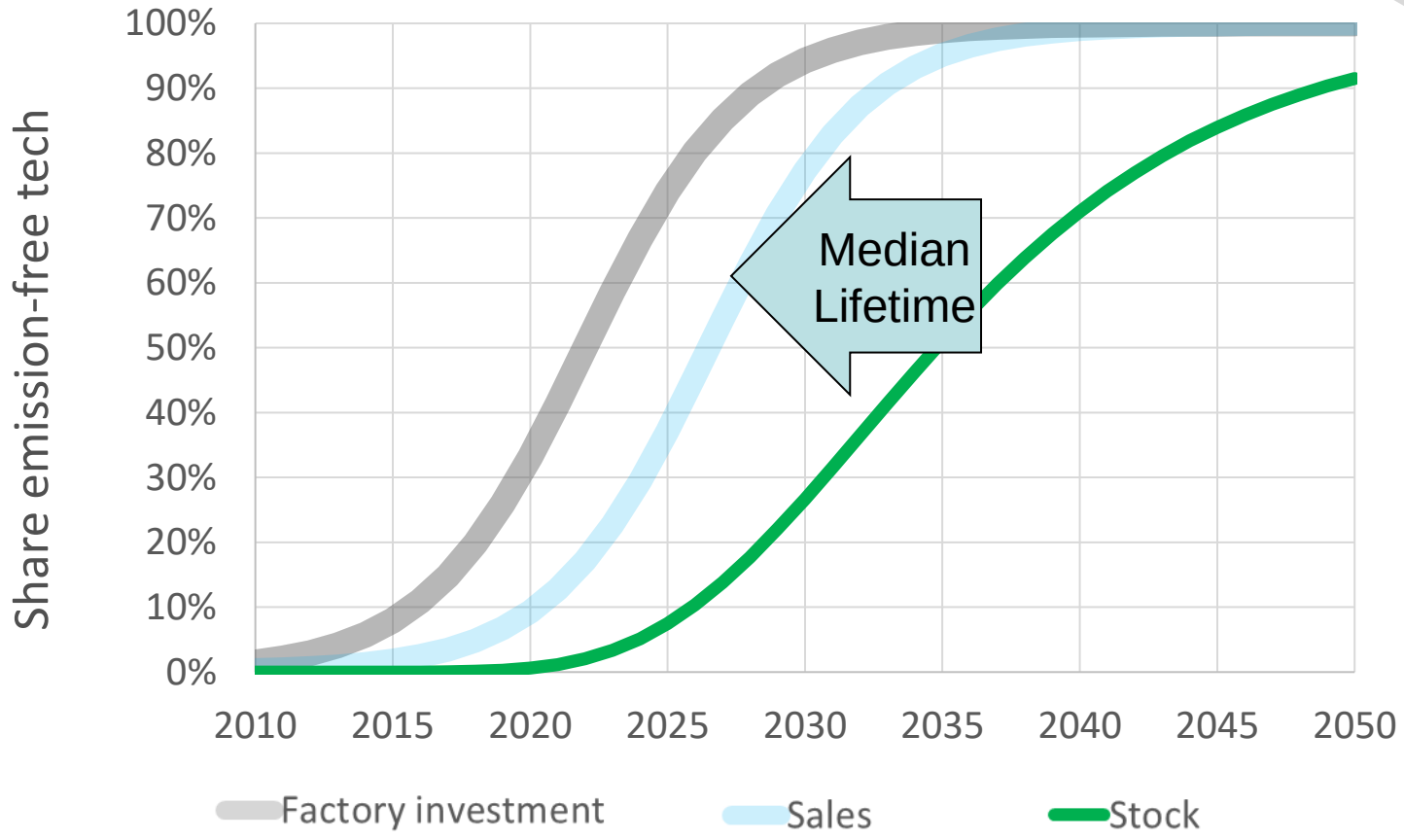
Use time

Investment time

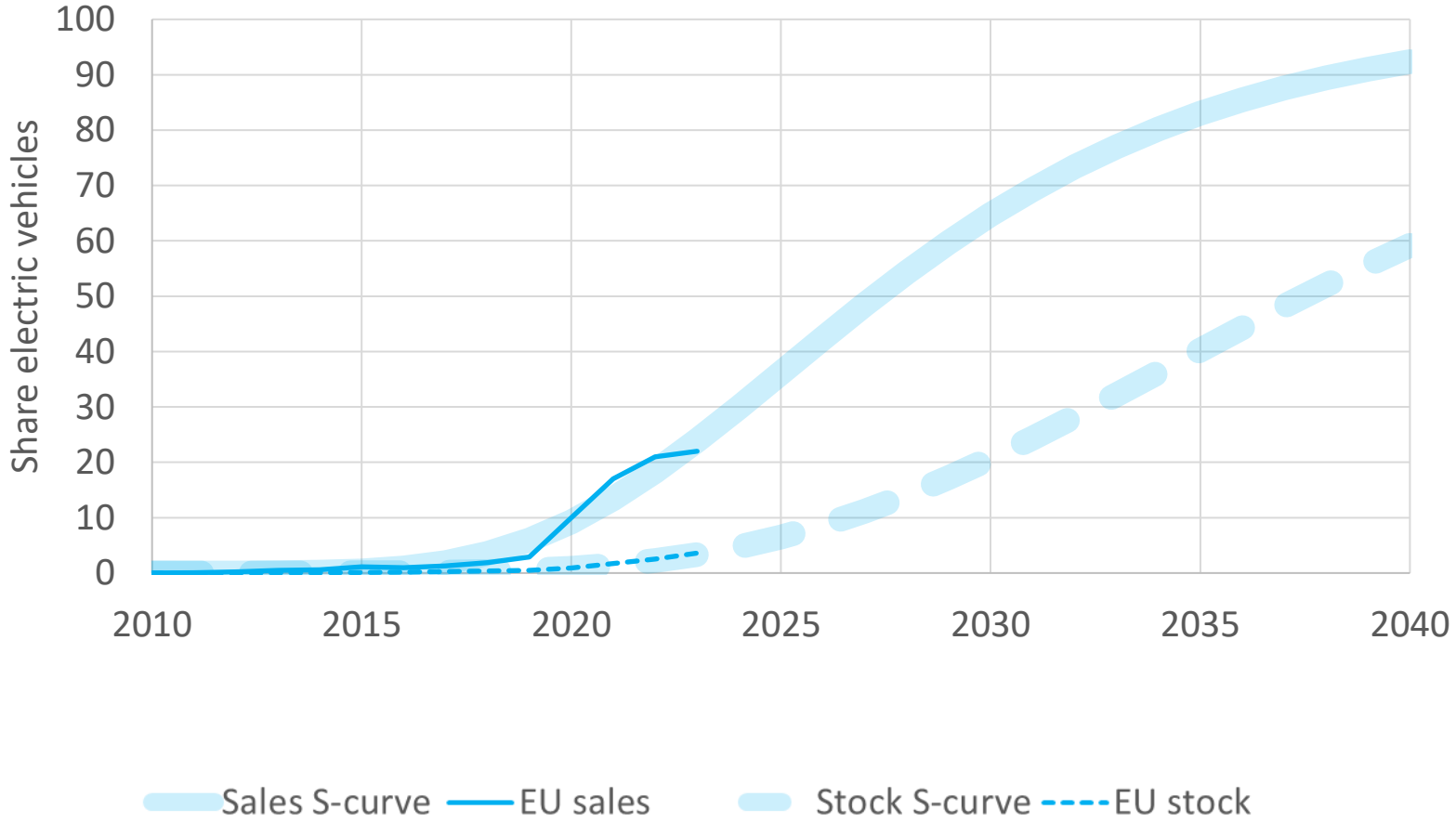
➔ **Investment dynamics**

Investment dynamics of a Demand Sector, eg Transport: Cars

Conceptual



Electric Vehicles: Historic Data and comparison to S-curves



Sources: IEA Global EV outlook 2024

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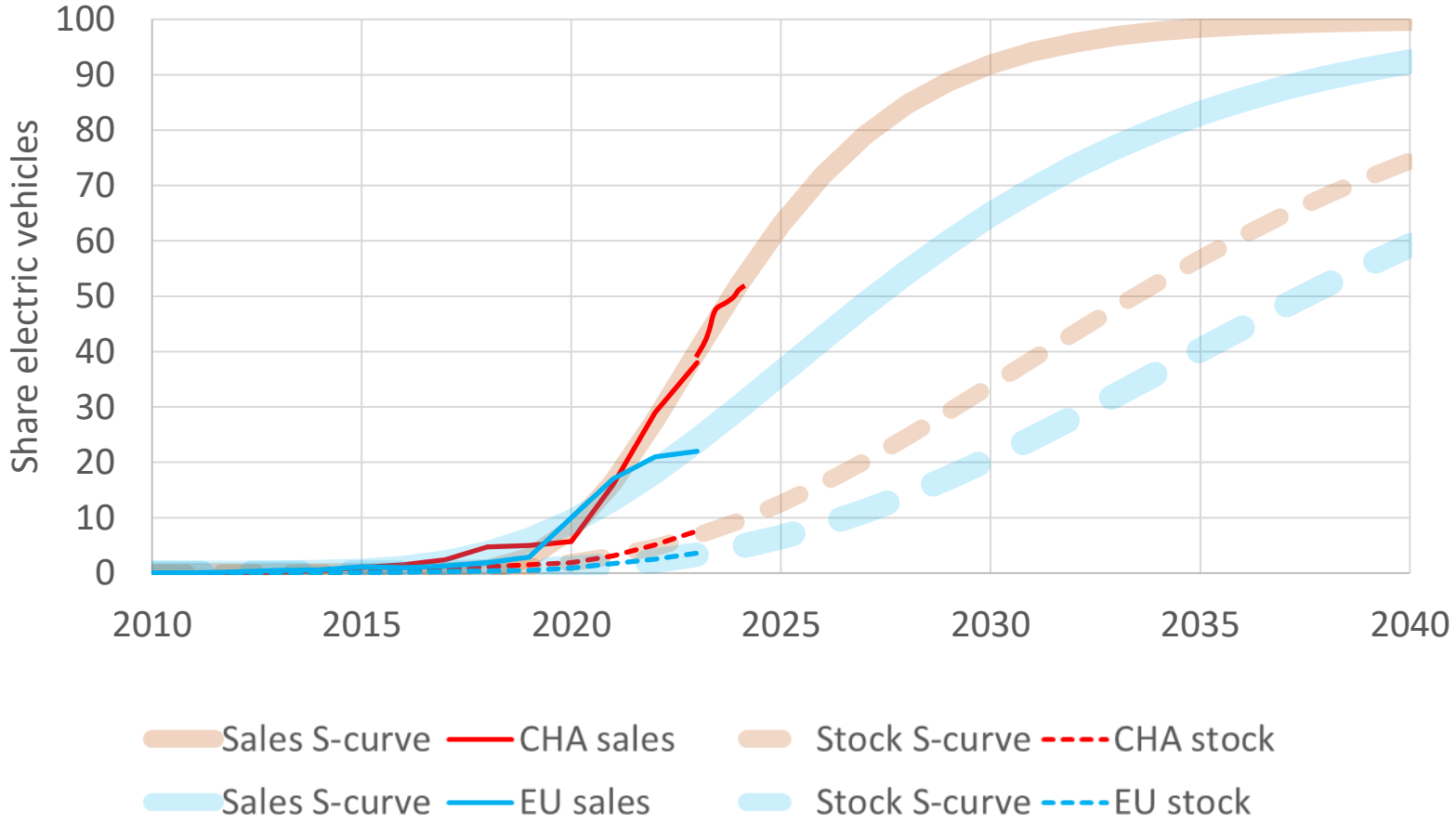

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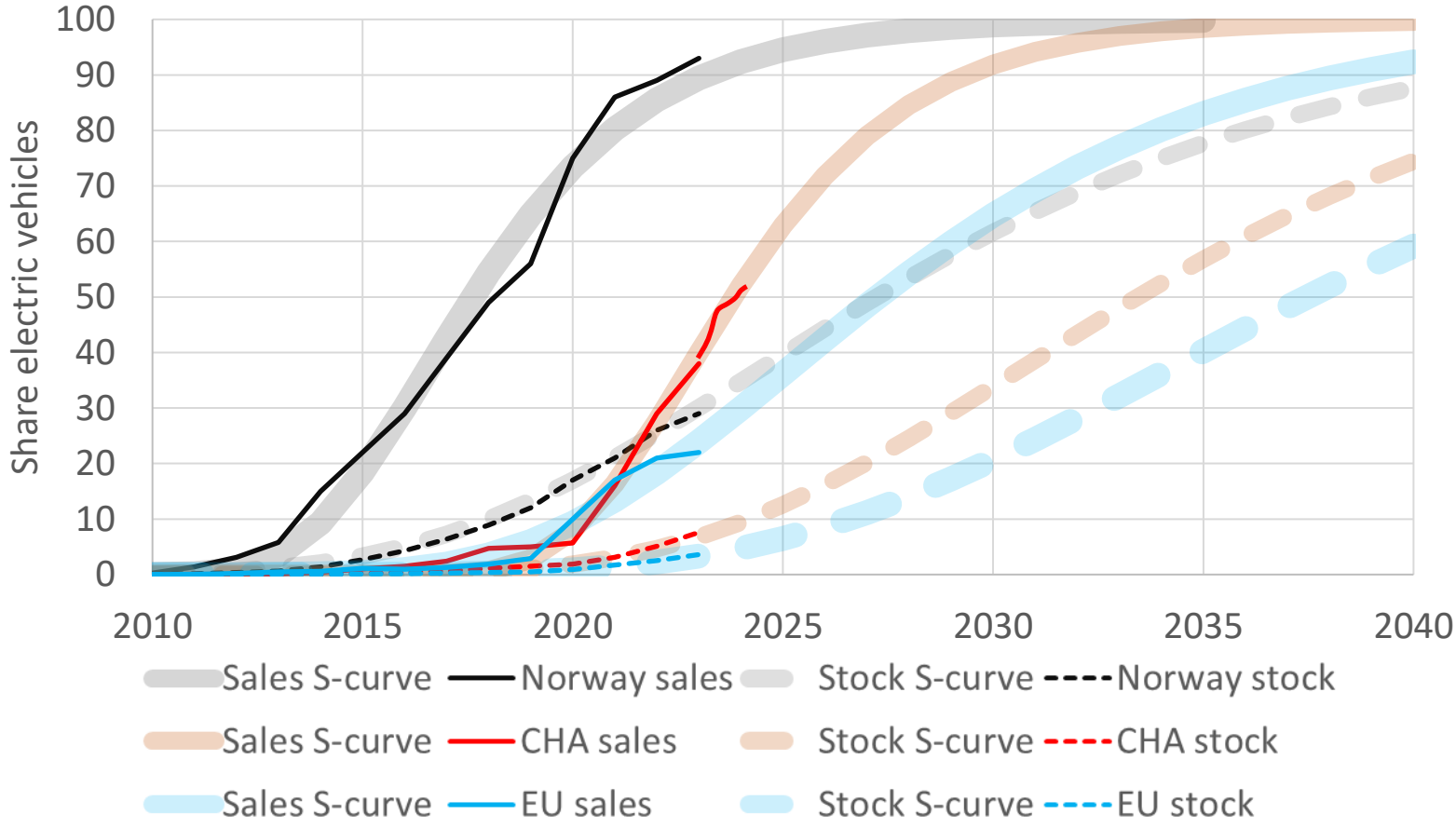

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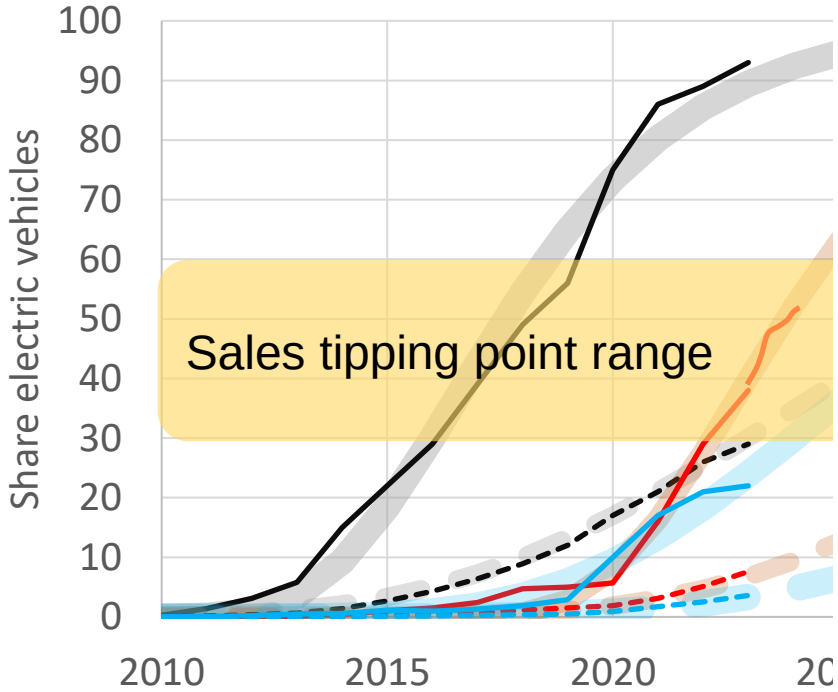


- New technologies face substantial barriers
  - Missing infrastructure
  - Missing knowledge about new technology
  - Limited model choice
  - Missing supply chain/craftspeople
  - Status-quo bias (Consumers, banks, vendors, ...)

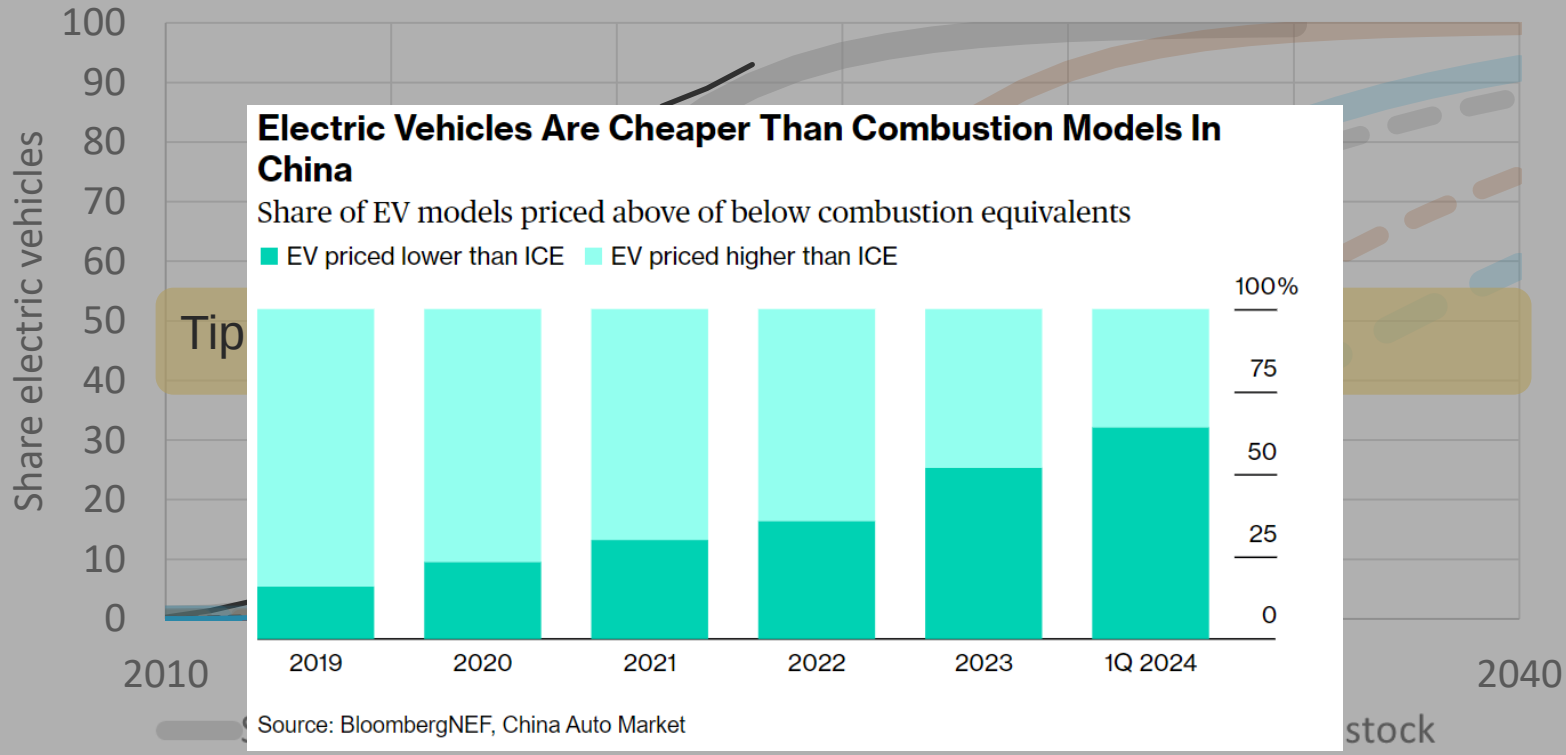
➔ Once new technologies have reached 30-60% of sales AGAINST these barriers, it is likely that a tipping point has been reached

- Barriers go down as knowledge spreads
- Learning reduces costs

  ➔ Transformation will speed up without further policy pushes

Sources: IEA Global EV outlook 2024

Electric Vehicles: Historic Data and comparison to S-curves



Electric Vehicles Are Cheaper Than Combustion Models In China

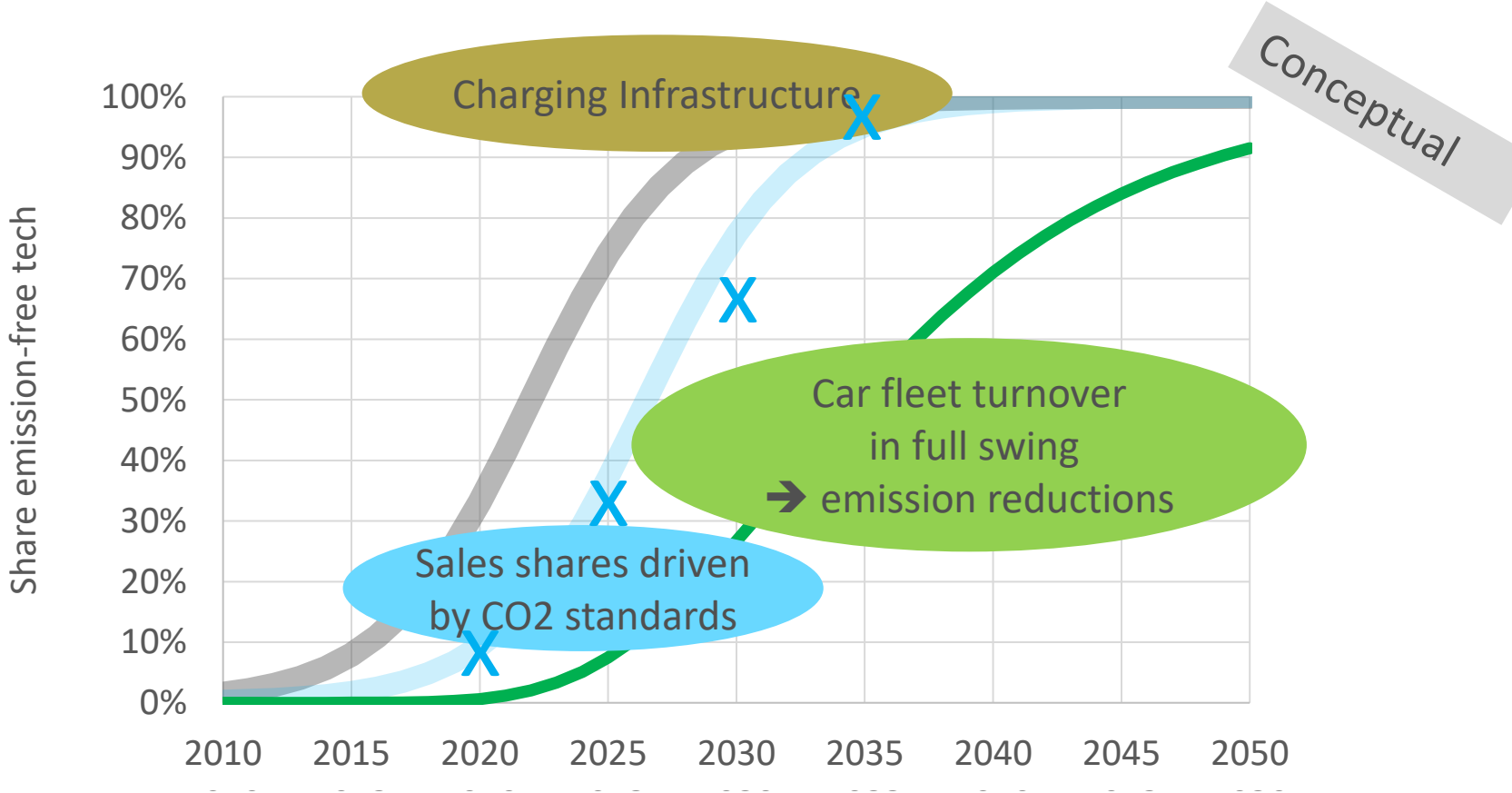
Share of EV models priced above of below combustion equivalents

EV priced lower than ICE EV priced higher than ICE

Source: BloombergNEF, China Auto Market

Sources: IEA Global EV outlook 2024

What are the building blocks of the Car Transformation over time?

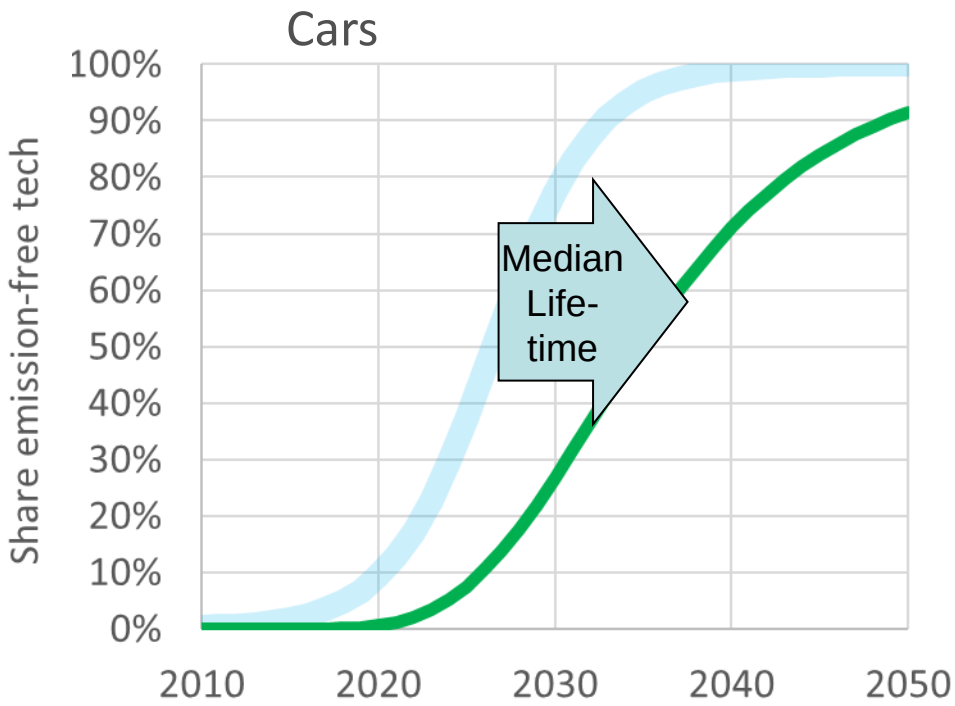


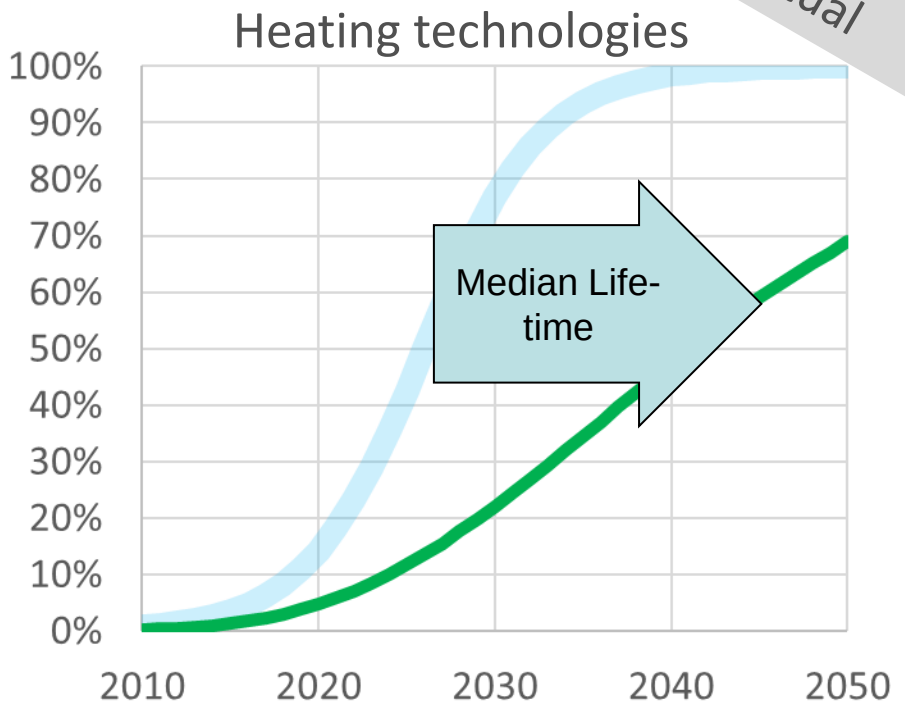
- Heavy-duty vehicle transition started 5-7 years later, but lifetime is 4-8 years shorter
  ➔ similar shares of emission-free vehicles in stock expected for 2050

A SHORT LOOK AT BUILDINGS

What about Investment dynamics in Buildings?

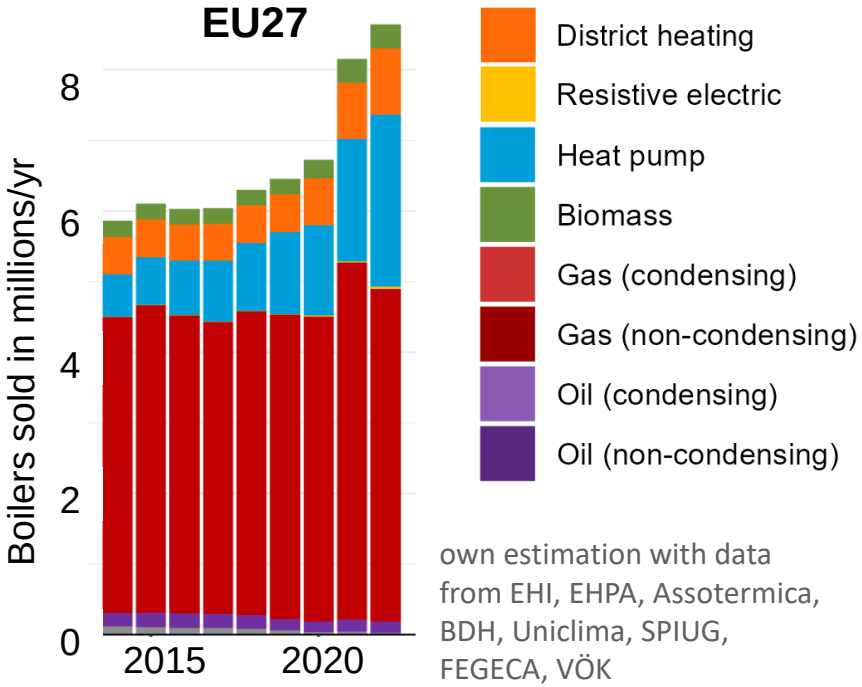
Conceptual



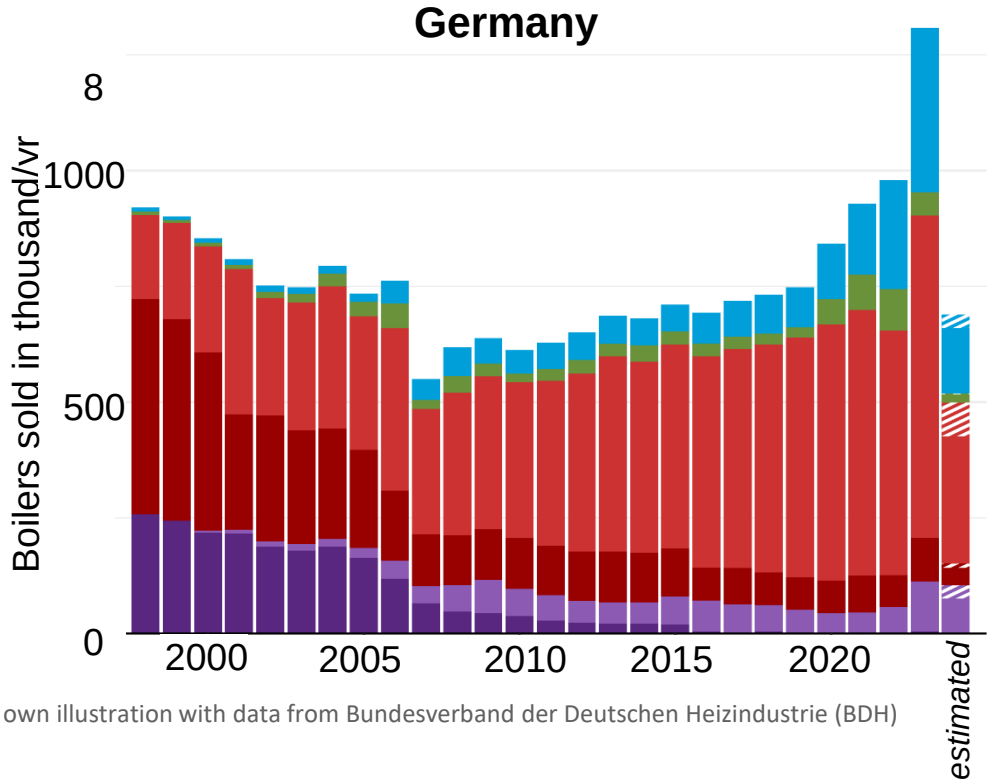


- Longer lifetimes of boilers ➔ later translation of clean sales shares into emission reductions
- Heating technologies strongly influenced by “status quo bias” ➔ sales shares of new technologies increase slower

SALES OF HEATING SYSTEMS



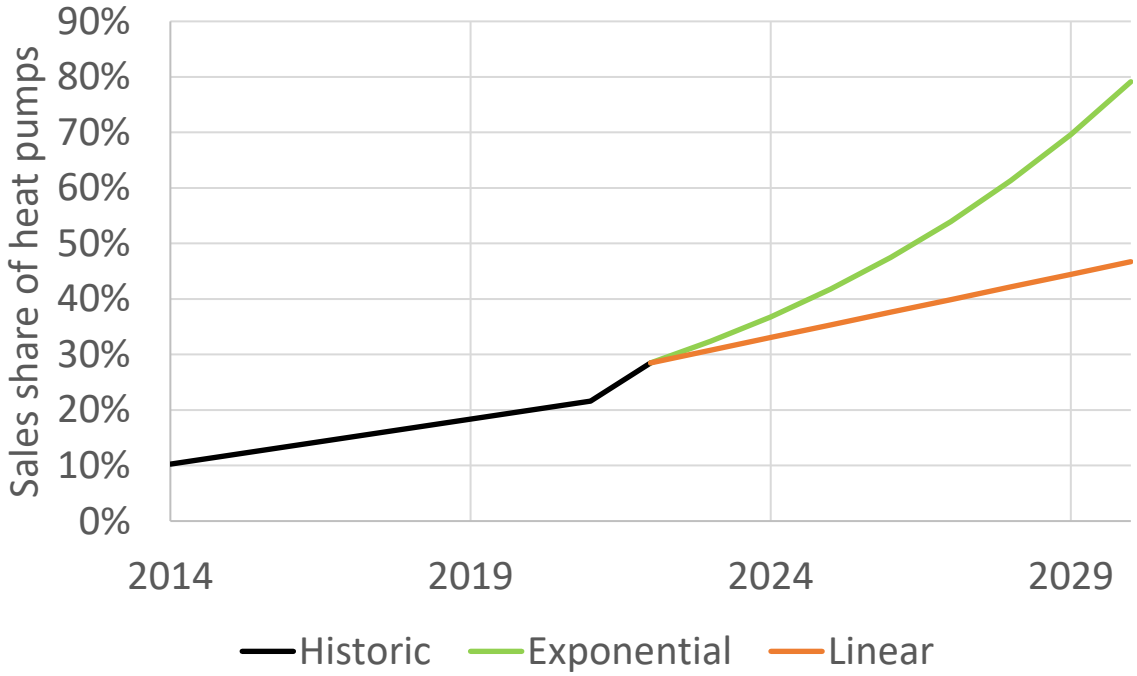
own estimation with data from EHI, EHPA, Assotermica, BDH, Uniclima, SPIUG, FEGECA, VÖK



own illustration with data from Bundesverband der Deutschen Heizindustrie (BDH)

- Medium growth of clean heating system shares over last decade, with energy crisis providing a boost in 2022/2023, but potential slowdown in 2024 (at least in Germany)

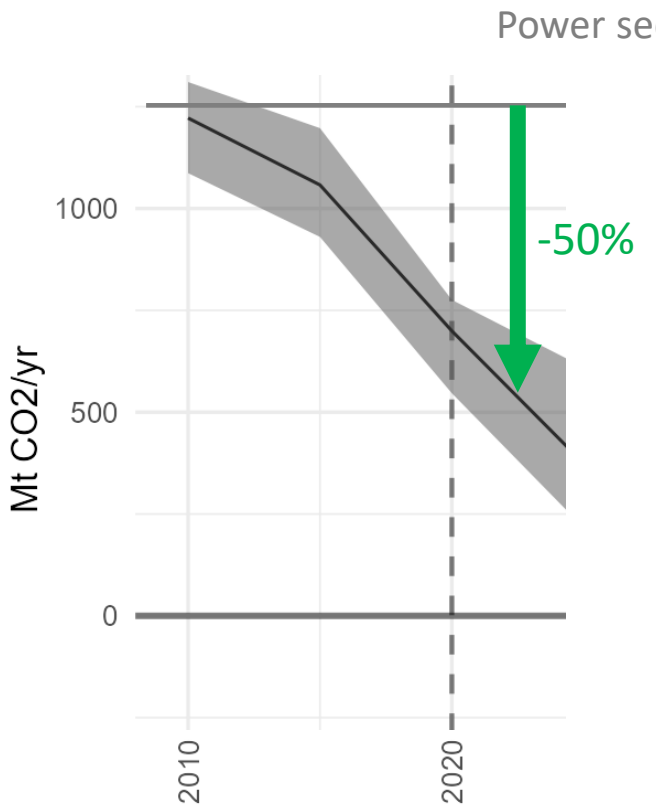
SALES OF HEATING SYSTEMS – HOW WILL IT CONTINUE?



- Future quite uncertain:
  - if growth continues exponentially, ~70-80% sales shares might be possible in 2030
  - if growth continues linearly, only ~50% sales shares

A SECTOR THAT HAS TIPPED:
POWER SECTOR TRANSFORMATION

DECARBONIZATION OF THE ELECTRICITY SECTOR IS ACHIEVED BEFORE 2040 ...

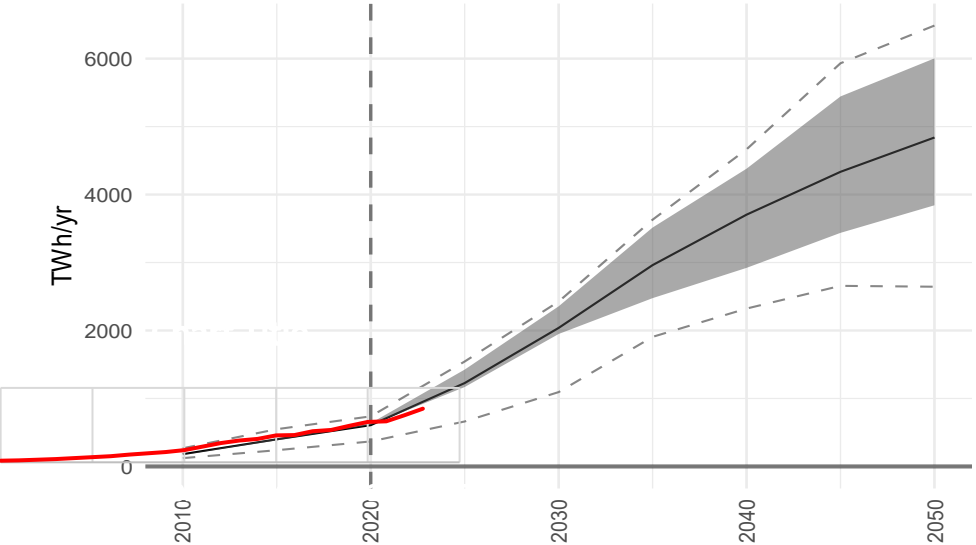


- Power sector emissions halved in 16 years since peak in 2007!
- The models see zero-emission electricity by 2040

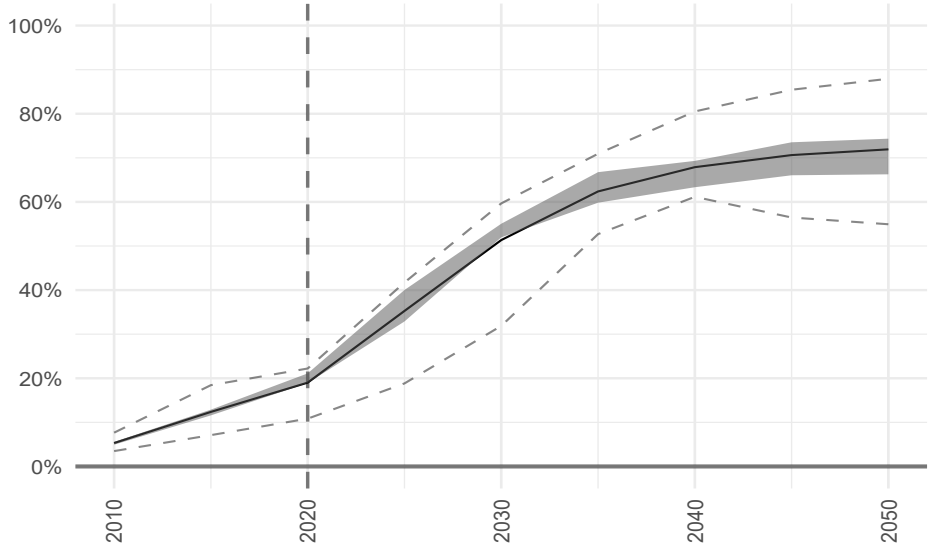
Source: EMBER, ECEMF scenarios

… MAINLY BASED ON THE RAPID EXPANSION OF WIND AND SOLAR POWER

Electricity generation from wind & PV



Share of PV & wind in electricity



- By 2040, solar power increases 9-fold vs 2020 to 1400 TWh/yr, wind 5-fold to 2200 TWh/y
- Wind and solar reach ~70% share of EU electricity generation in 2040

Source: ECEMF scenarios

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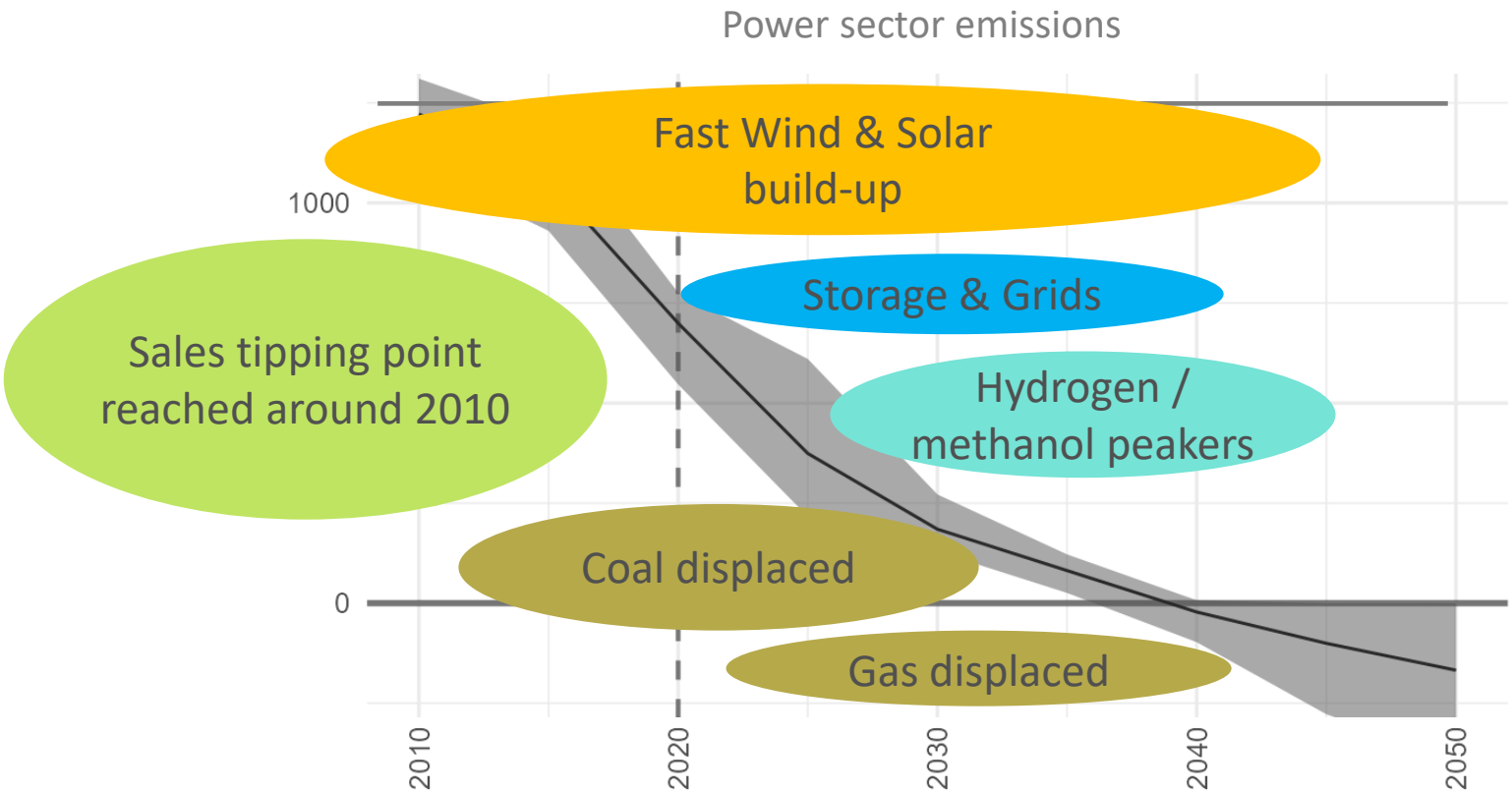

Source: EMBER, ECEMF scenarios

Main Takeaways

- The EU has achieved impressive emission reductions over the last 15 years
- Scenarios reaching GHG neutrality in the EU by 2050 show 2040 GHG emission reductions of 86% (84-89%) *including all bunkers* – **close to EC proposal**
- Achieving these reductions is **challenging** but seems **technically feasible**.
- **Decarbonization of the power sector before 2040** mainly based on rapid expansion of **wind & solar** (~70% of the EU's electricity generation by 2040)
- **Deep electrification** of the demand sectors, doubling the share of electricity in final energy to 45% by 2040
- **For this, investment dynamics are key:**
  - **Rapid increase of clean tech sales needed** in **transport & buildings** to start diffusion into the stock
  - **BEV tipping point** may be reached in 2025/2026 if **CO2 standards** are upheld

See also **Pietzcker et al, 2023: "Insights on EU2040 targets based on a model intercomparison exercise of EU Climate Neutrality Pathways". Zenodo. https://doi.org/10.5281/zenodo.8337668 and Rodrigues et al, 2024 (preprint): 2040 greenhouse gas reduction targets and energy transitions in line with the EU Green Deal**

Potentials for Learning between Transport & Buildings

Transport

Collect and provide data about transformation (sales, stock, ...)

Clear timeline for ramp-up of sales shares:
instrument on producer level analogous to CO2 emissions standards for cars (like the Clean Heat Market Mechanism in the UK) that mandates heat pump sales shares, eg
35% in 2027, 40% in 2027, 45% in 2028, 50% in 2029,
60% in 2030, ...

Less focus & resources for efficiency, more on heating ?!?

...

Buildings