Increase in renewables and the electricity system

Selected findings from ongoing research in the NEPP project, the Pathways program and Fjärrsyn

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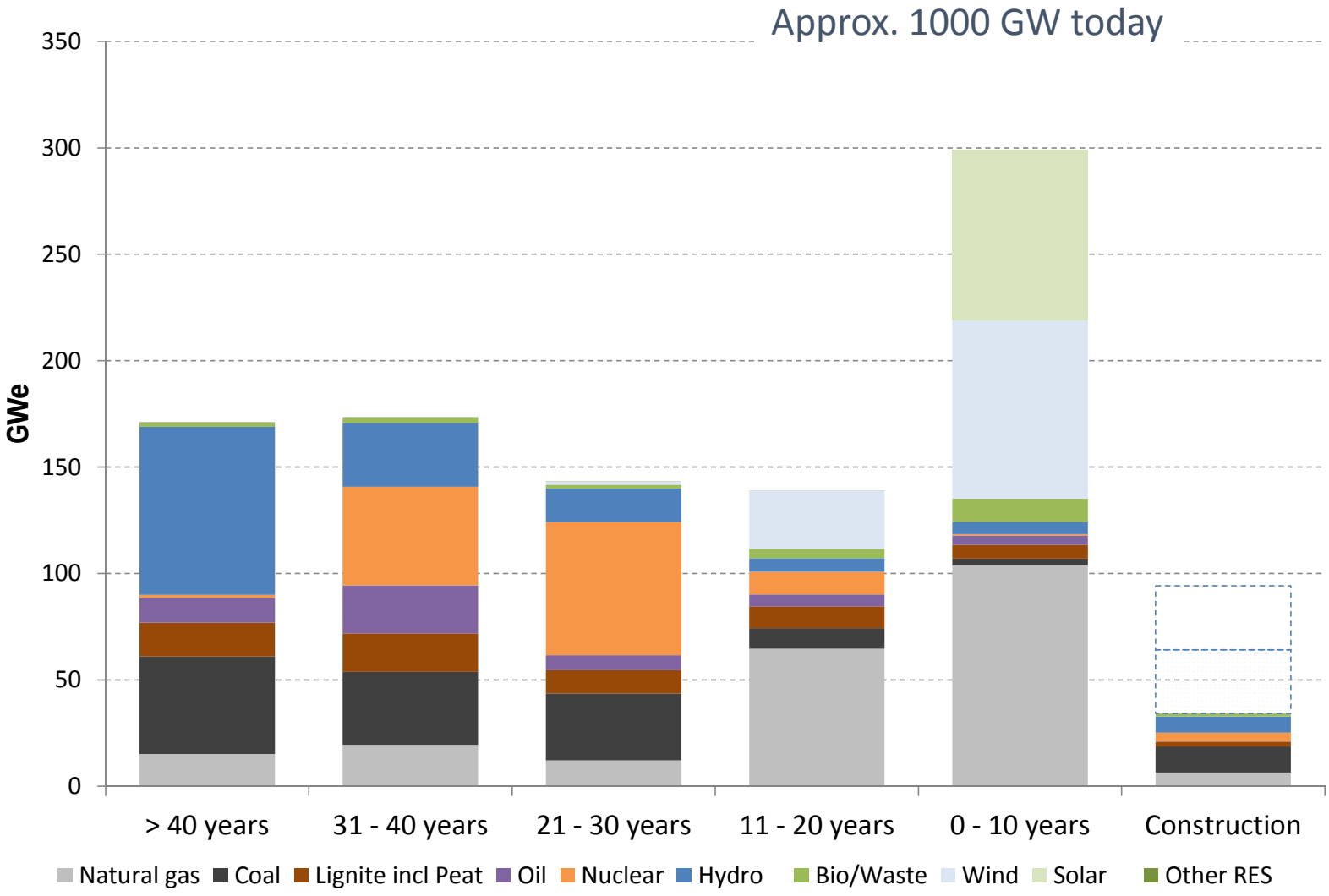
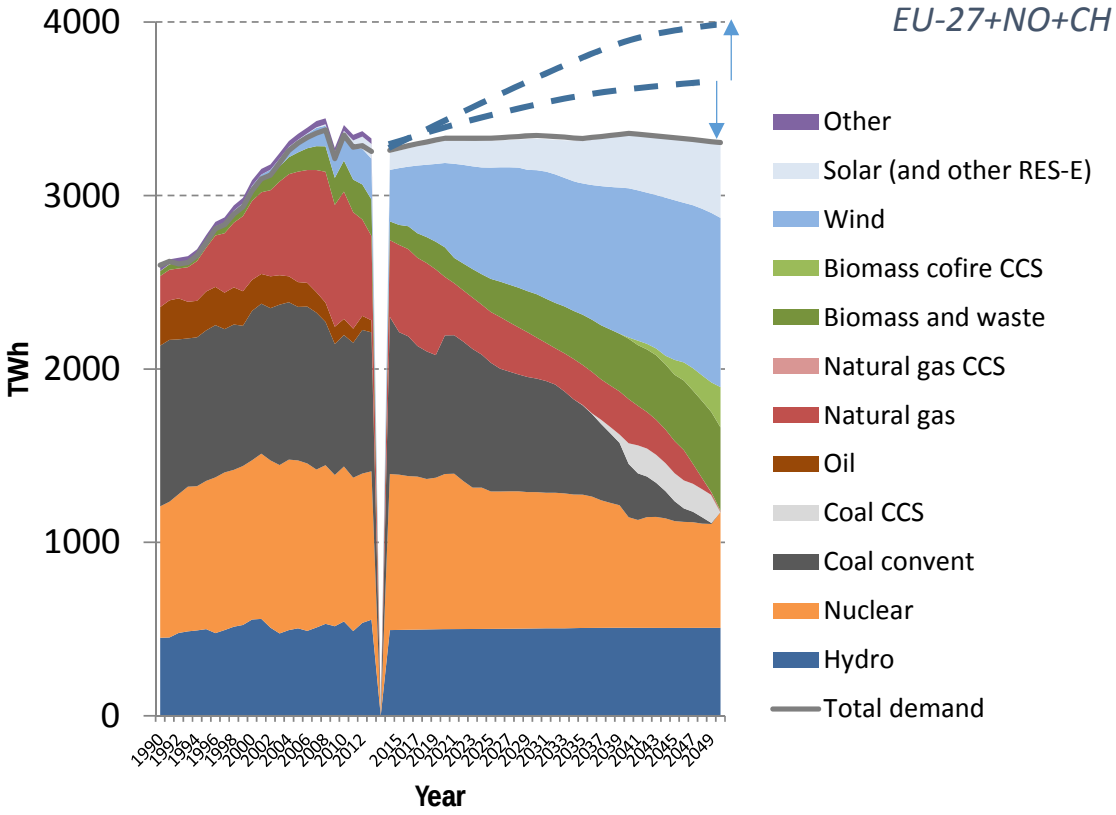
European electricity-generation capacity

- Existing and under construction



Source: Chalmers PP Db, beginning of 2015

Regardless (almost) of scenario assumptions: Renewable electricity generation will increase substantially!

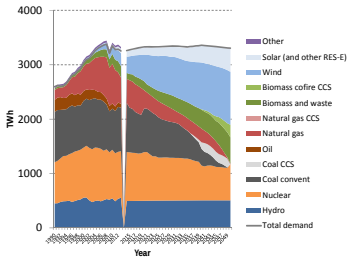


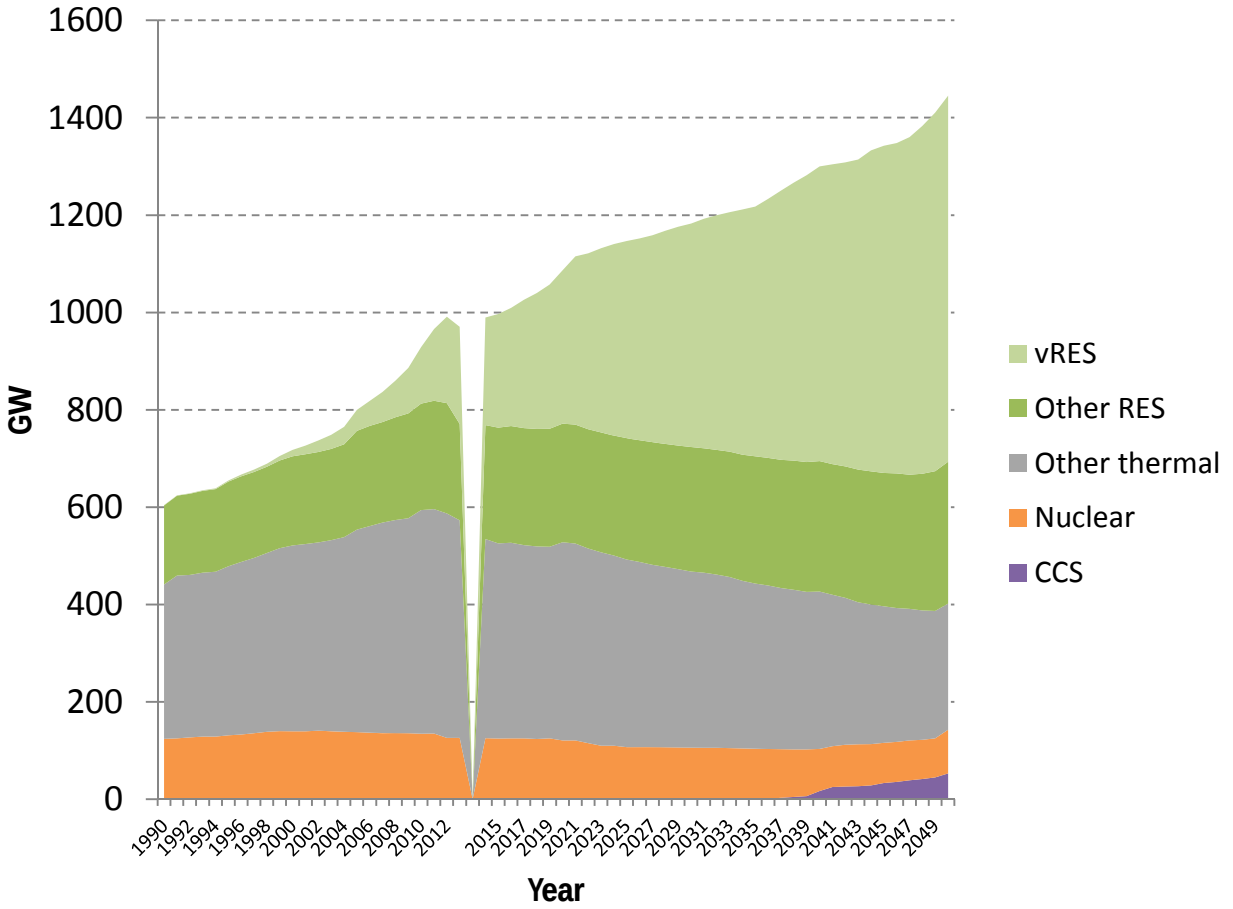
RES-E share from 30% (2013) to 50-70% in 2050

A question of: how much, pace, regional distribution and competition with other technologies

Main drivers: energy and climate policies and technological development

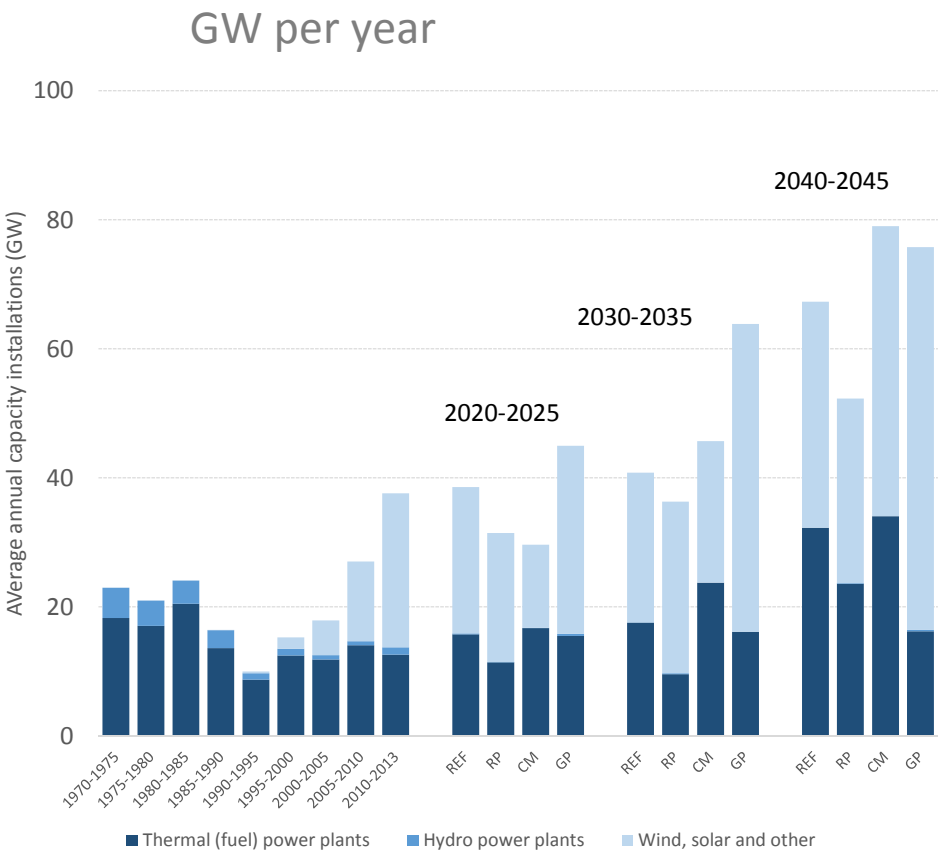
Significant expansion in RES-E -> substantial growth in capacity

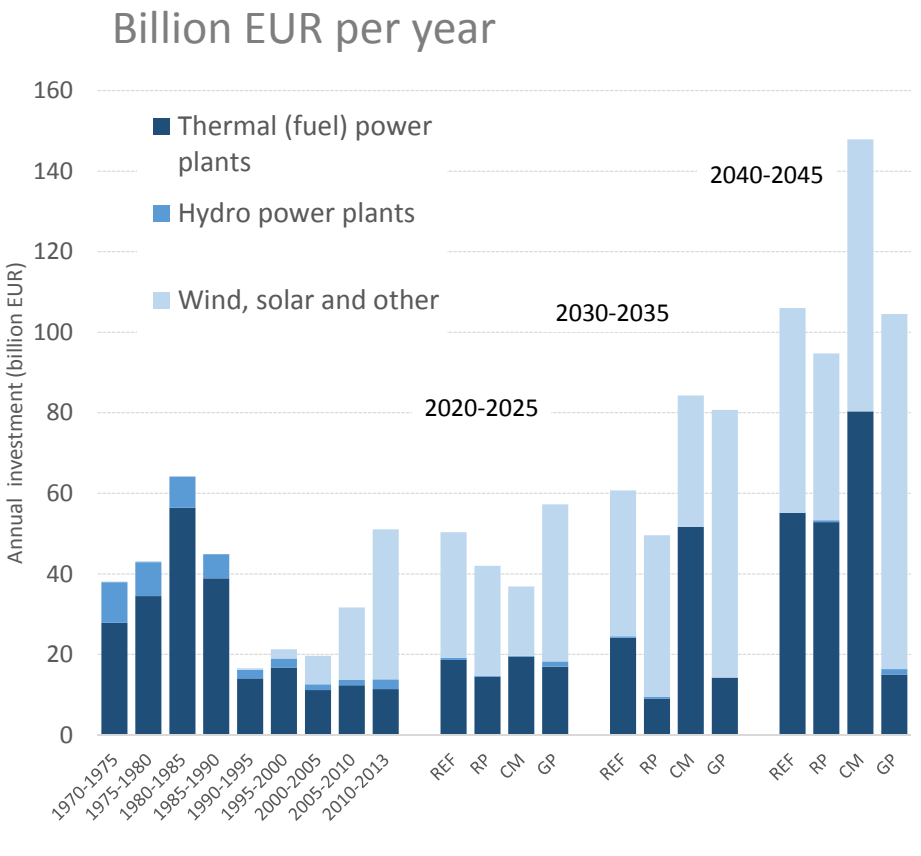




Growth in gross demand between 2013 and 2050: ~0-50% depending on scenario
-> growth in installed capacity: ~50-100% depending on scenario

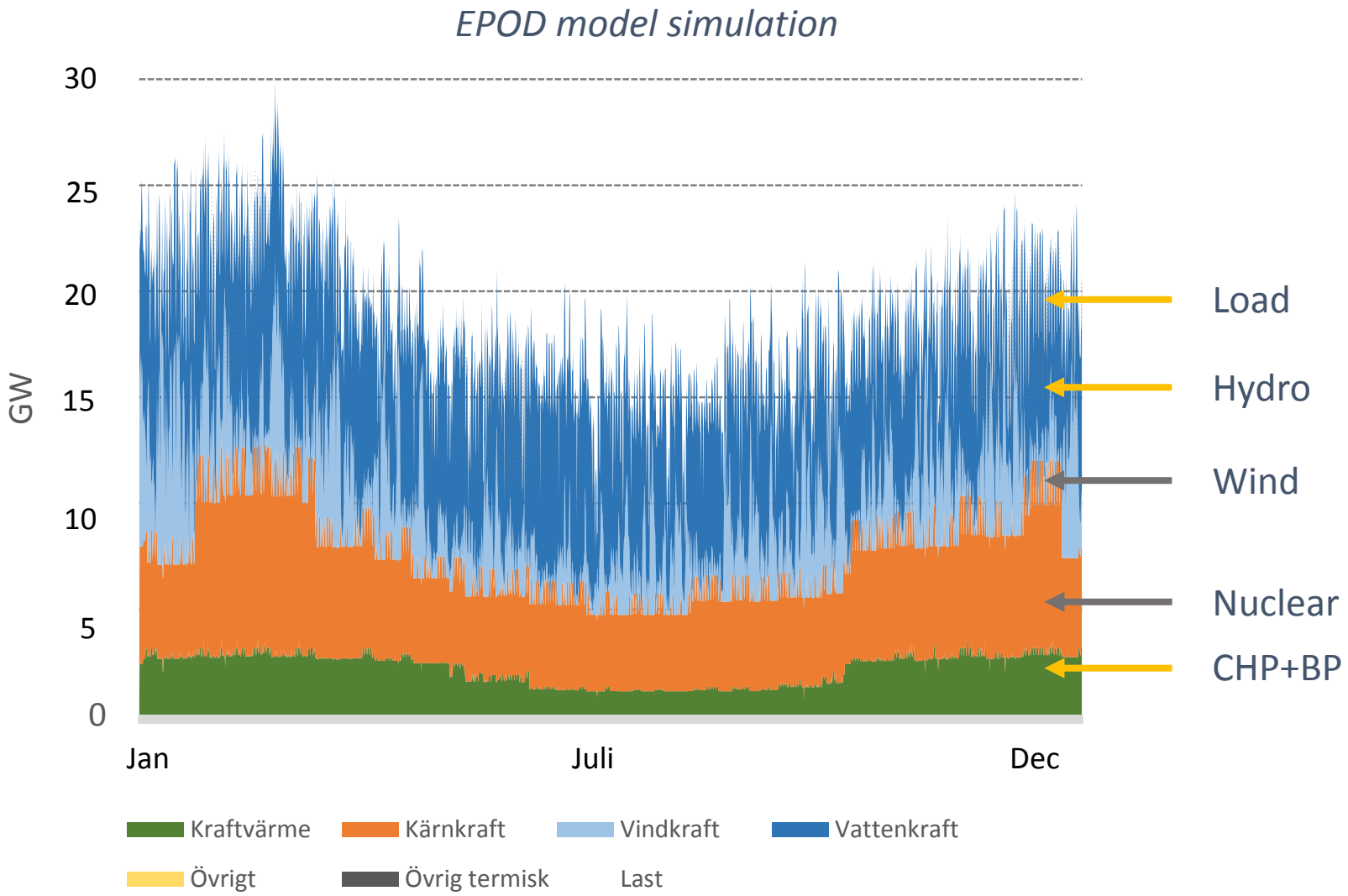
Dramatic increase in annual investments to reach the goals



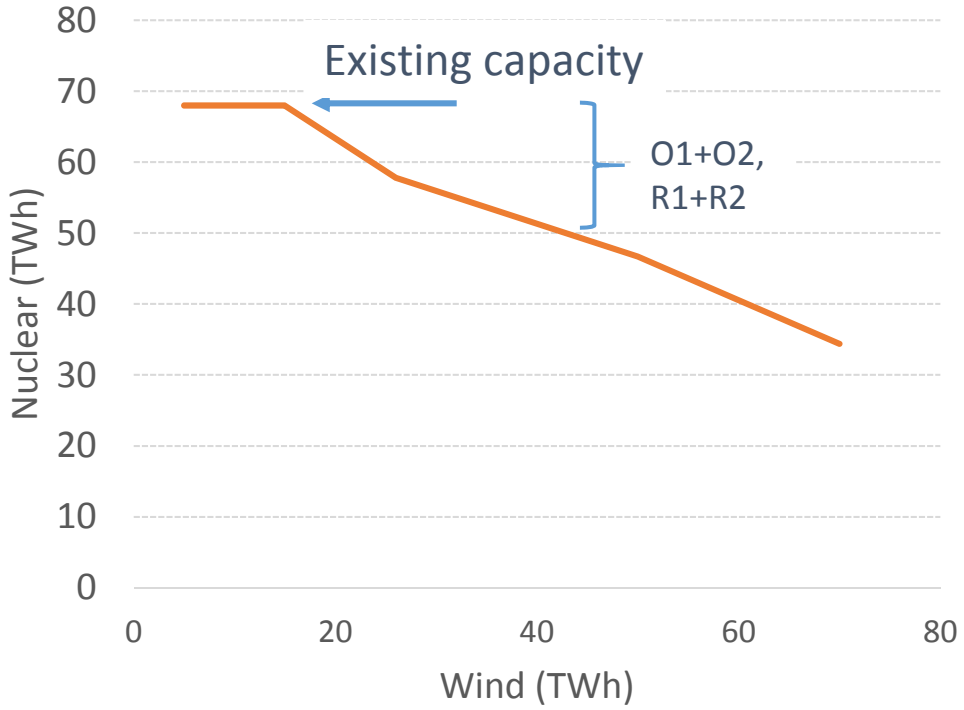


In addition: huge investments in grid infrastructure. European interconnector capacity 2-5 times existing capacity by 2050 depending on scenario
-> IEA estimates grid infrastructure to~1/3 of total supply investments until 2040

Swedish electricity production ”2025”:
~30 TWh wind power, all nuclear assumed available



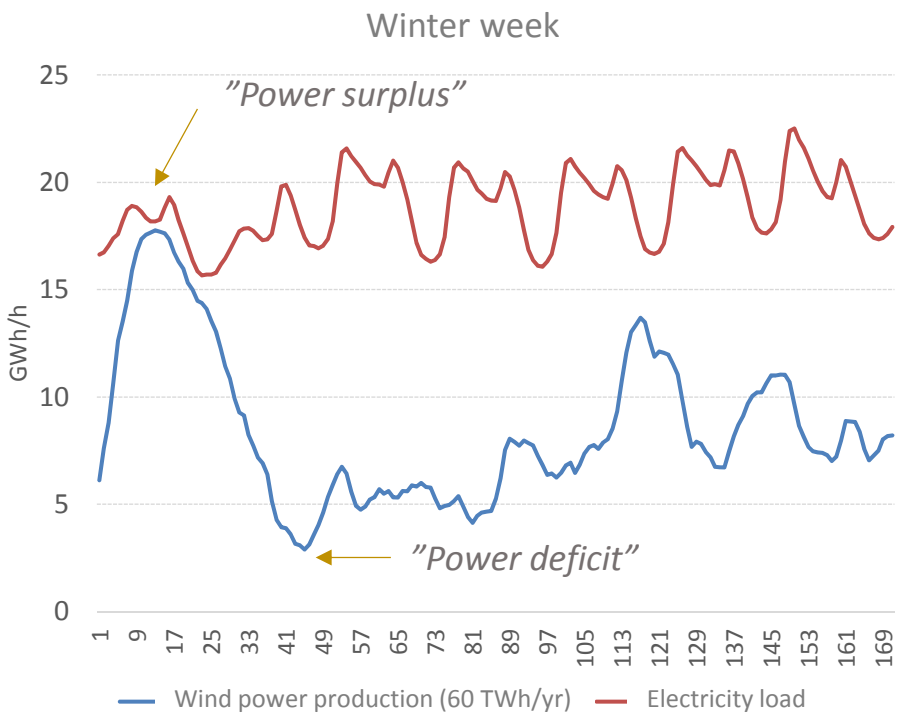
System impact of increasing volumes of wind power (case study Sweden)

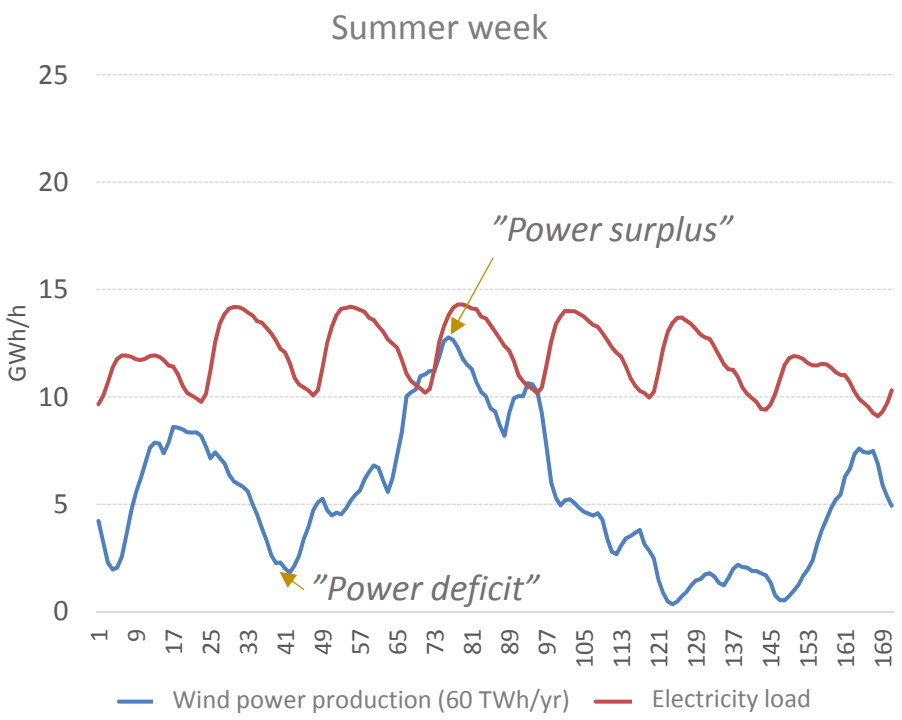


- Reduced utilization of nuclear (cf figure)
- Limited impact on CHP and BP
- Hydro power dispatched more ”offensive” (more often closer to max and min)
- Net export increases

Large amounts of vRES –>
”power surplus” and ”power deficit” during all seasons

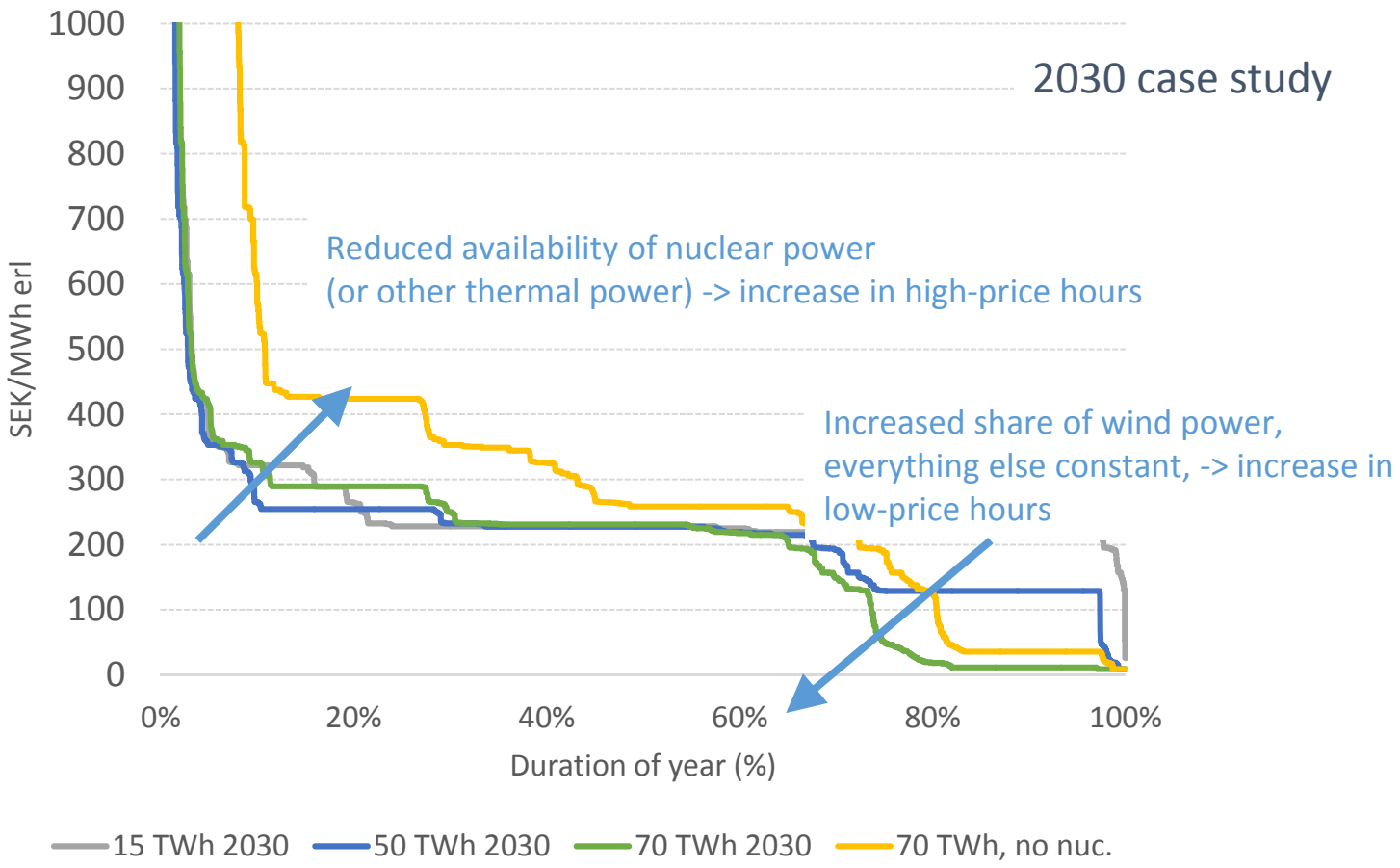
Example: 65 TWh hydro power, 15 TWh CHP and 60 TWh wind power in Swe. In total 140 TWh





”Surplus”: low prices -> reduce other generation and/or export
”Deficit”: high prices -> increase other generation and/or import
Net load will ”design” the system!!!

More wind and less nuclear – the impact on the electricity-price duration curve (price area SE3)



- More wind and less nuclear generates a steeper profile of the price duration curve over the year.
- Hydro and increased interconnector capacity dampens impacts!

More wind and less nuclear – further observations from model simulations..

- Low-price hours will become an ”all-year phenomena” (today primarily a ”summer phenomena” and coincides with large wind-power output

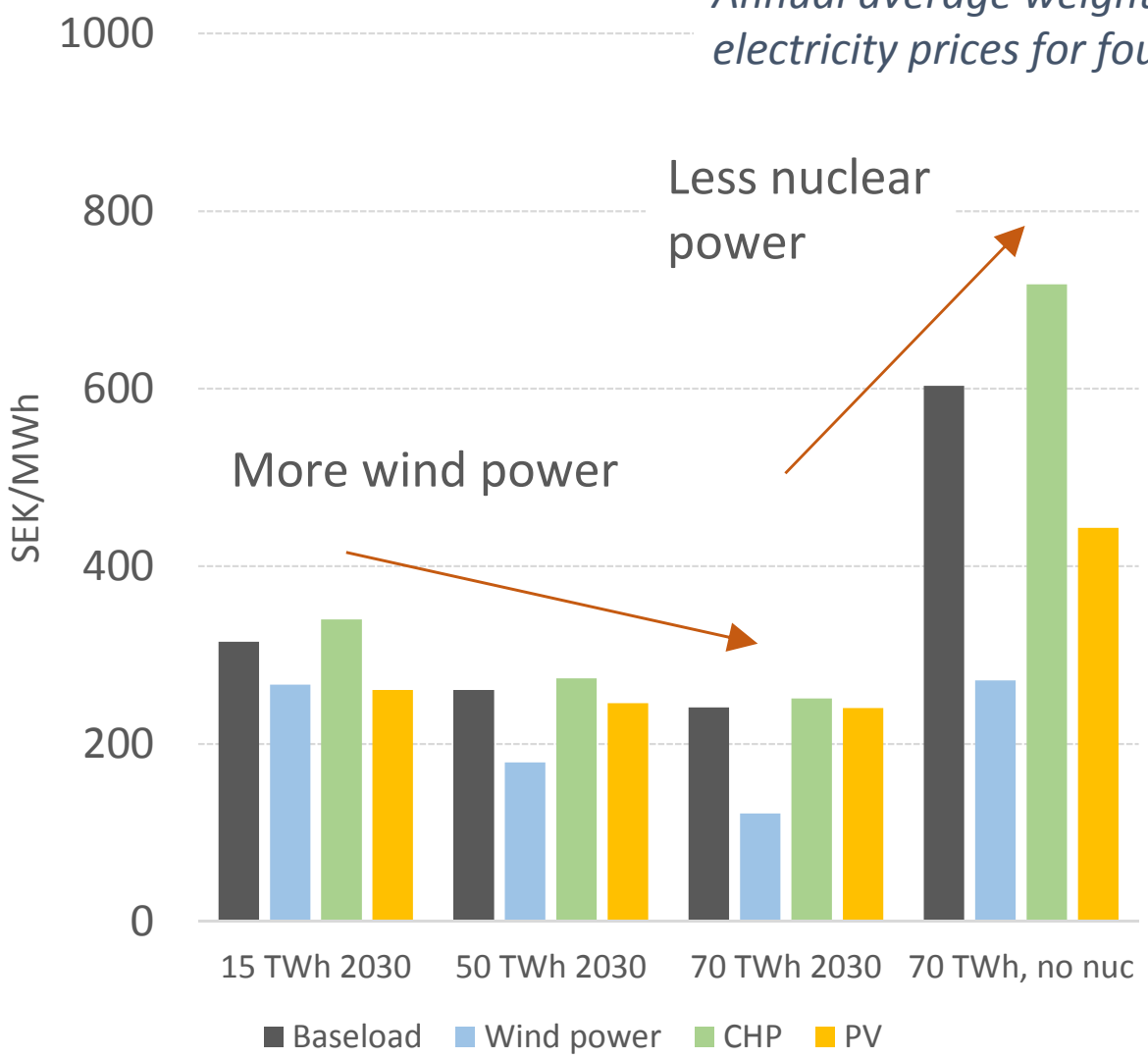
- High-price hours will primarily remain as a winter phenomena but occurance will increase during other periods:
  - Induced by scarcity (typically winter especially if thermal is
  - phased out)
  - Induced by increased cycling costs

- Low-price periods are relatively long in duration due to windy conditions (typically days) -> limited potential for DSM as a DSM cycle typically occurs within a day or two

- High-price periods generally more scattered and single -> more feasible for DSM

Income from electricity market depends on production profile – 2030 case study

Annual average weighted (against production profile) electricity prices for four types of generators



(Baseload,CHP and PV are "price takers" while wind increasingly sets the price)

cf. Energy Brainpool study for Germany 2020:
- 75% for wind
- 85% for PV

of annual average price