Co-generation in an energy system perspective – what can we expect from the future?

HTC/KME Conference 2019

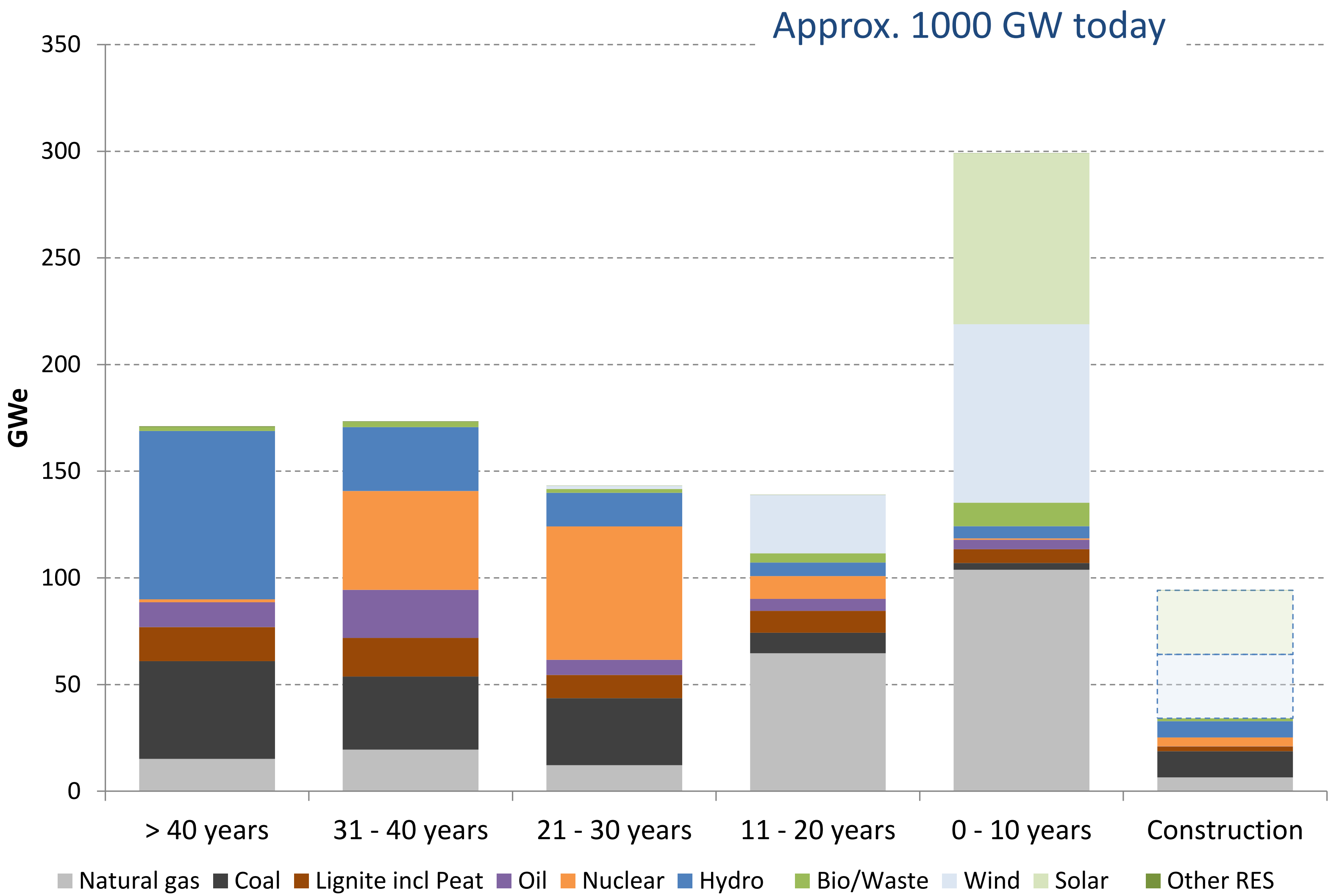
Gothenburg, 12 March

My presentation:

- Electricity generation in the future: Europe & Sweden – more variable generation, less thermal
- Electricity prices
- Increased value of co-generation for flexibility
- Value of co-generation from a local perspective
- Future district heating demand
- Policy measures influence the competitiveness of co-generation

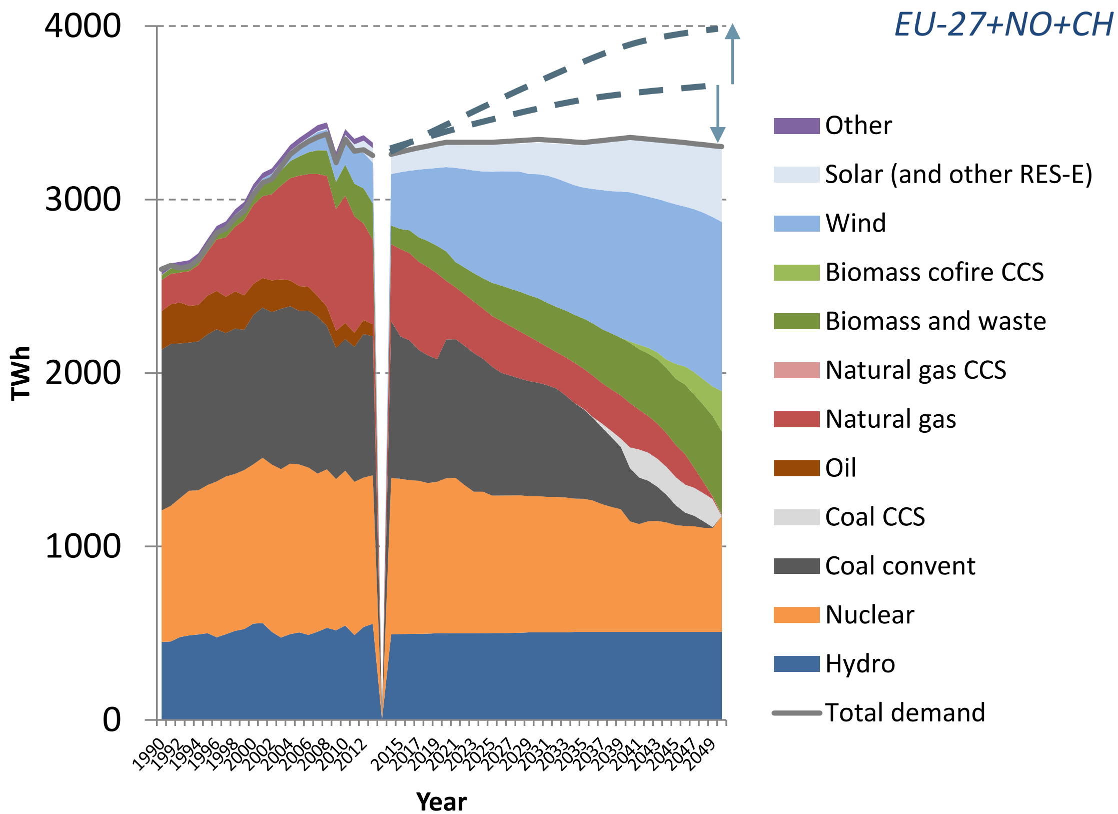
European electricity-generation capacity

- Existing and under construction



Source: Chalmers PP Db, beginning of 2015

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



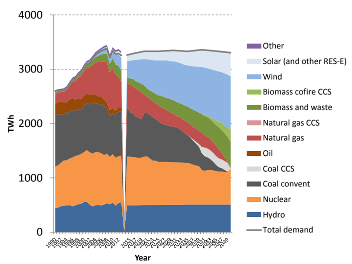
RES-E share from 30% (2013) to 50-70% in 2050

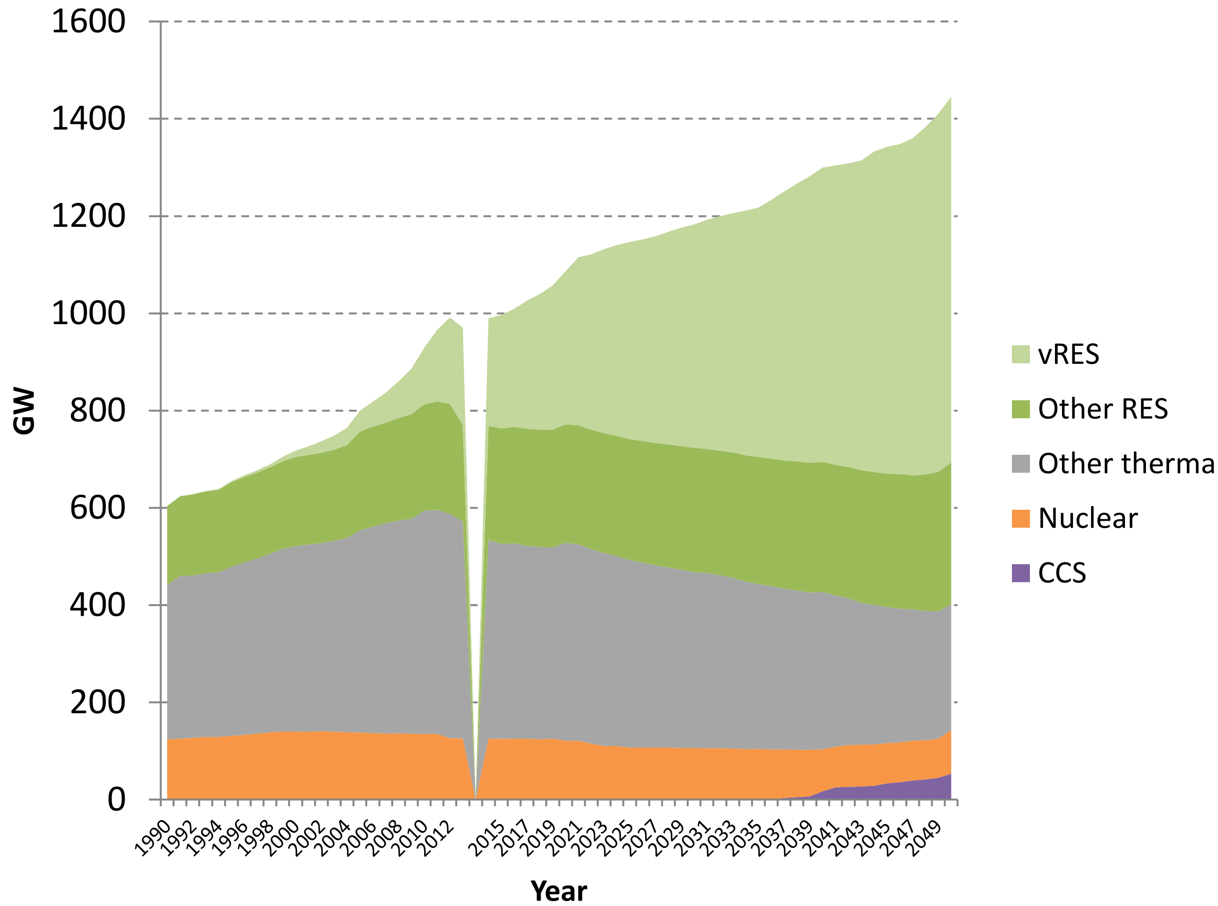
A question of: how much, pace, regional distribution and competition with other technologies

Main drivers: energy and climate policies and technological development

Large uncertainties for CCS and nuclear

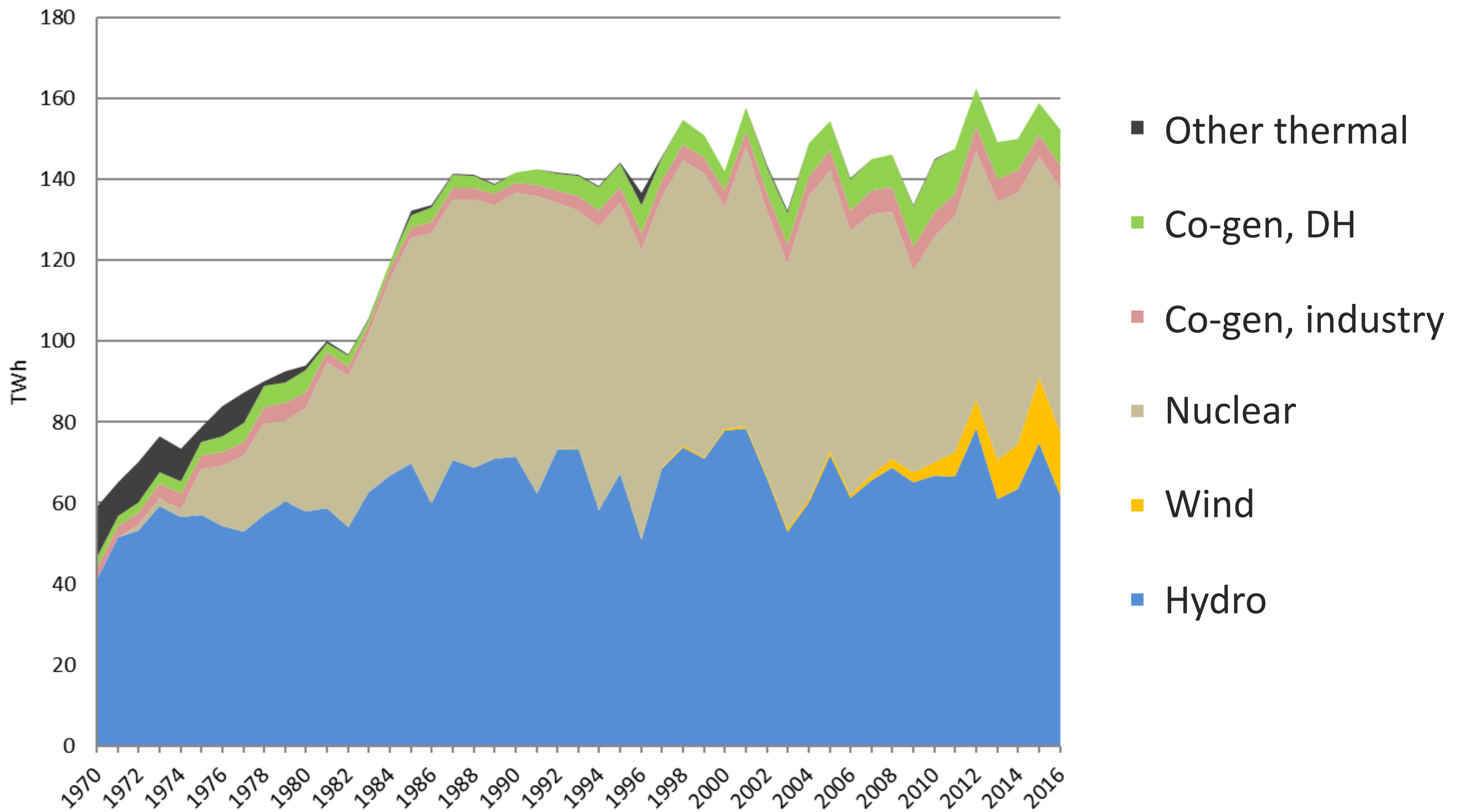
Significant expansion in RES-E -> substantial growth in capacity



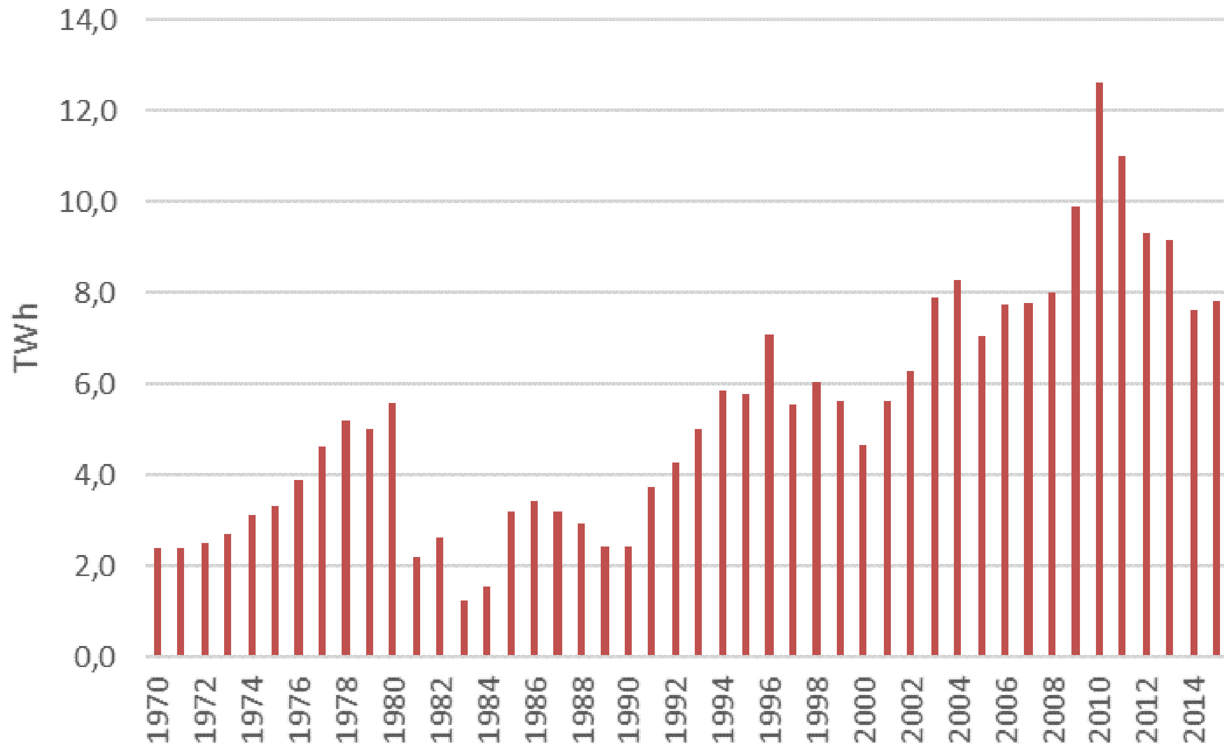


Growth in gross demand between 2013 and 2050: ~0-50% depending on scenario
-> growth in installed capacity: ~50-100% depending on scenario

Swedish electricity generation

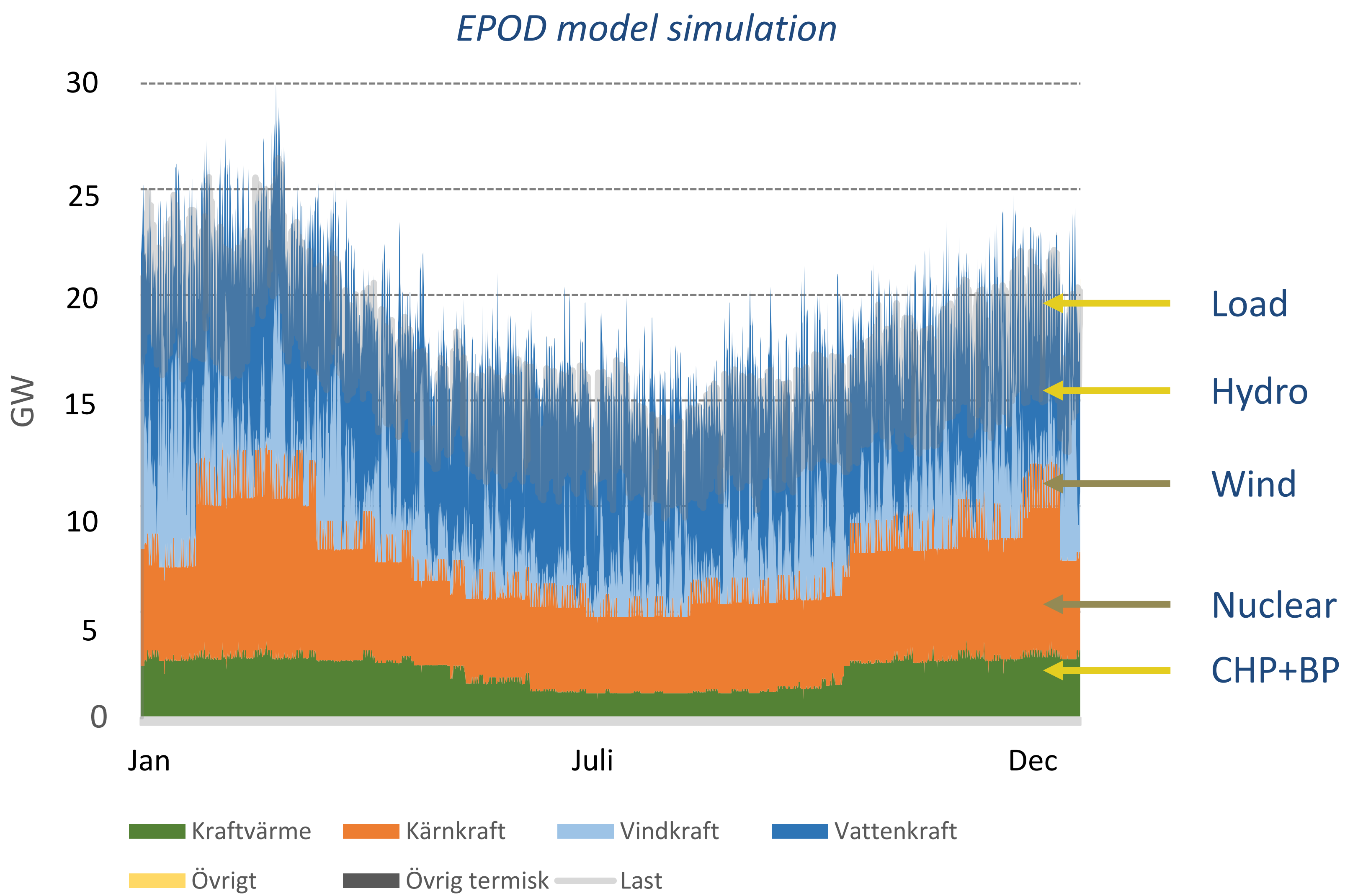


Electricity generation from co-generation i Swedish district heating systems



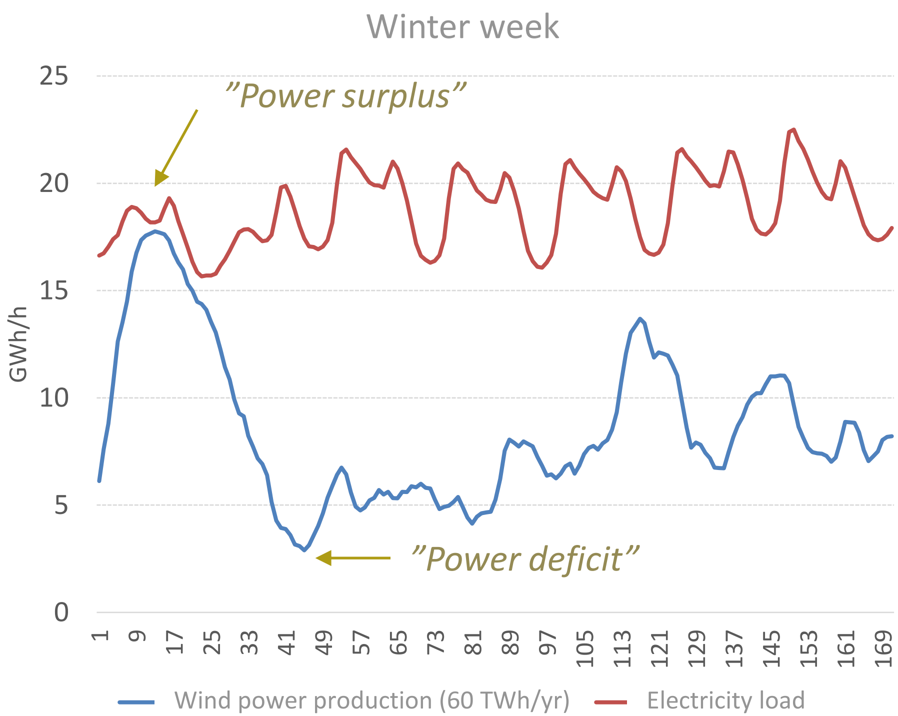
Large variations between different years. Examples of important influencing factors are heating demand (warm/cold) and electricity price.

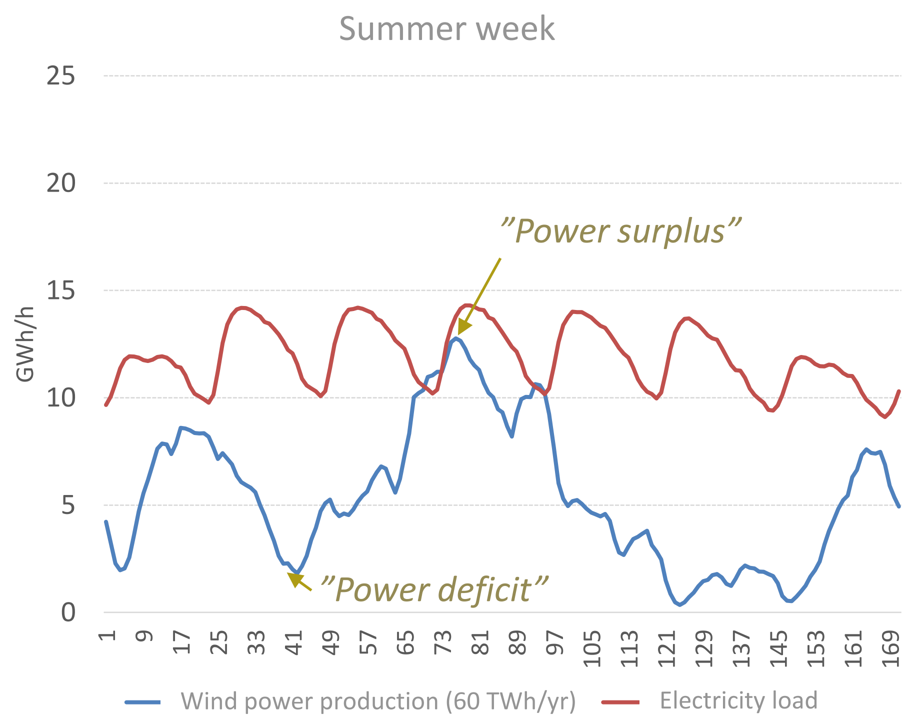
Swedish electricity production ”2025”:
~30 TWh wind power, all nuclear assumed available



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

<u>Example</u>: 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 and/or increase demand
”Deficit”: high prices -> increase other generation and/or import and/or reduce demand
<u>Net</u> load will ”design” the system!!!

More wind and less nuclear – the impact on the electricity-price duration curve

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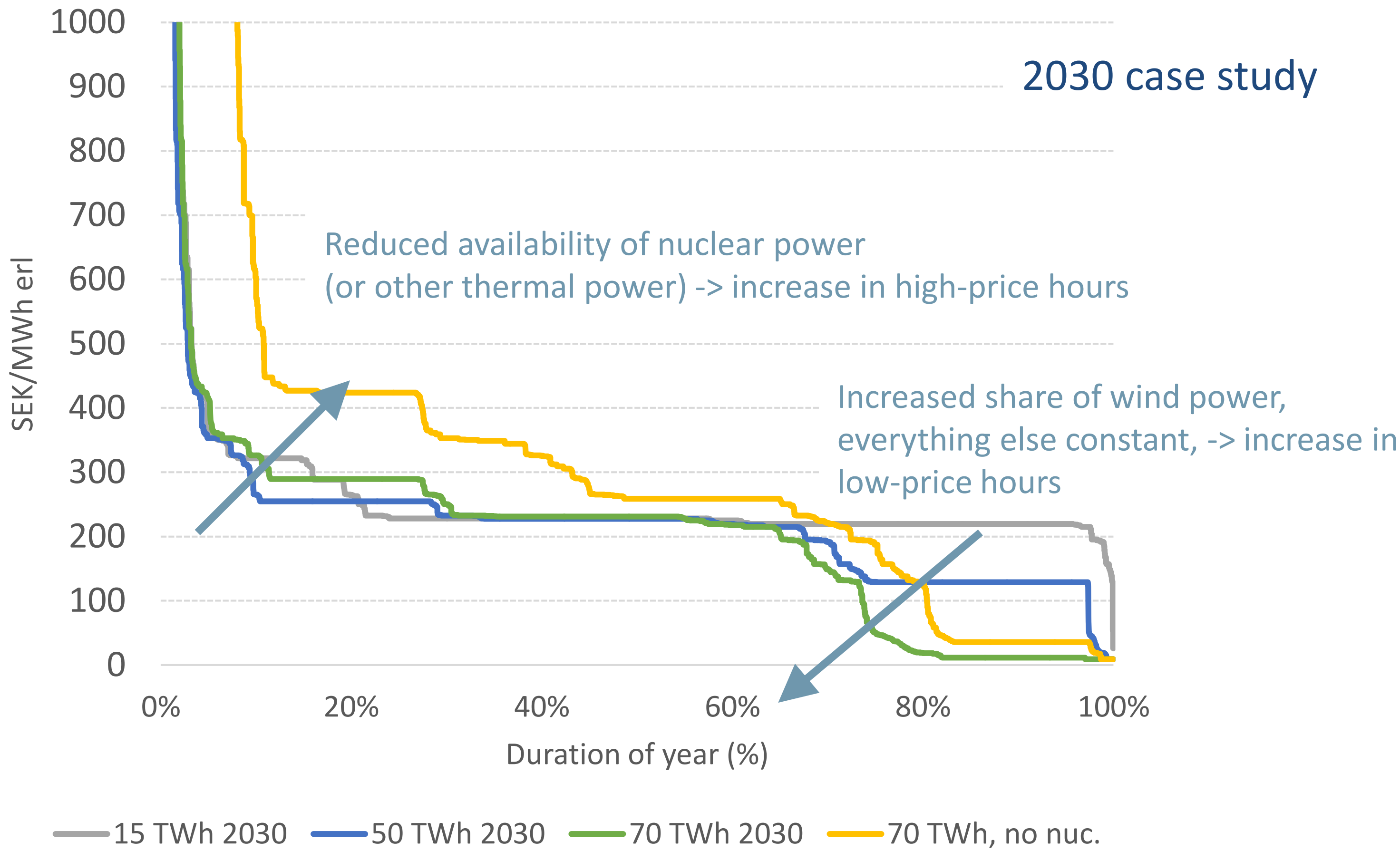

- More wind and less nuclear generate a steeper profile of the price duration curve over the year.
- Hydro and increased interconnector capacity dampen impacts!

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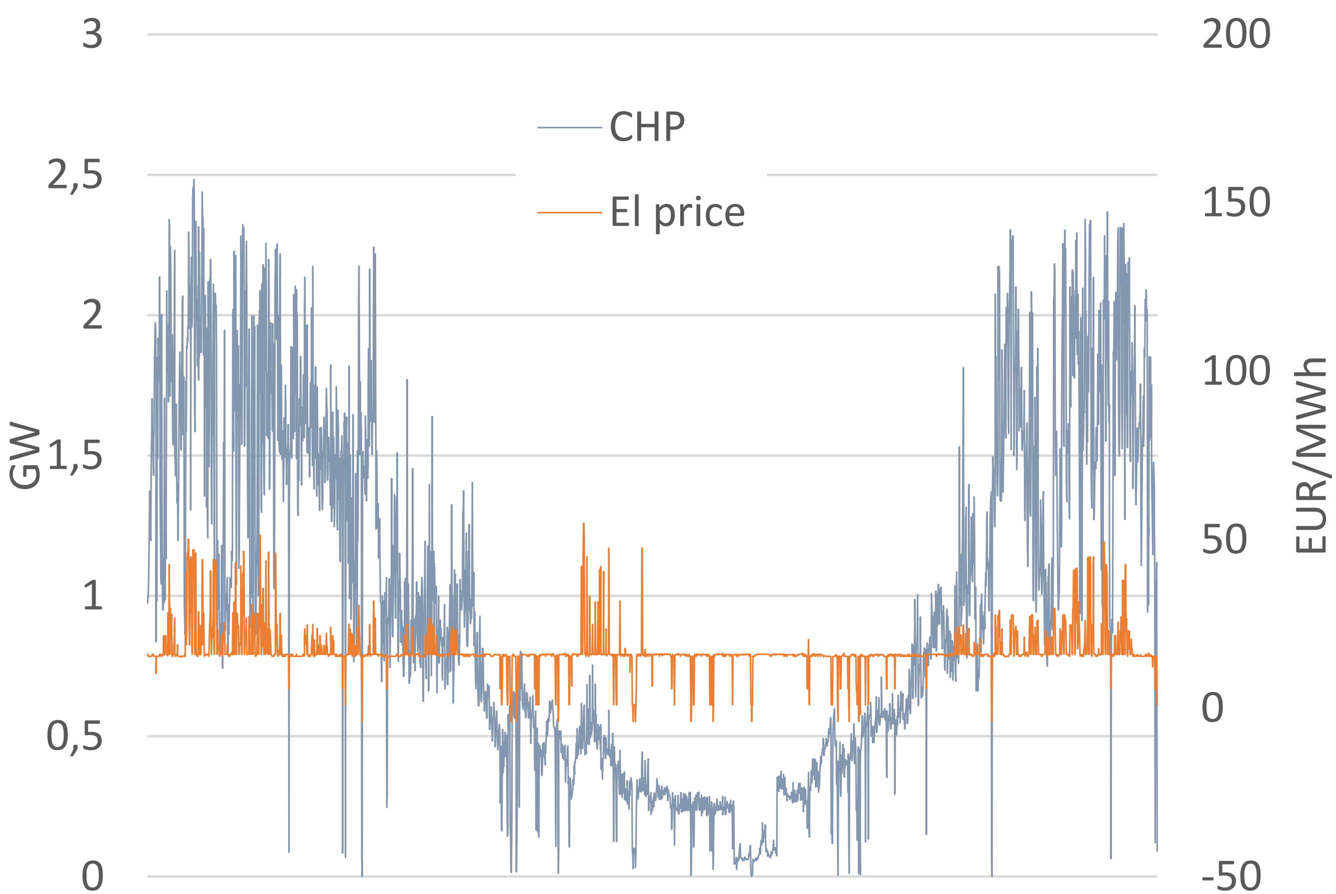
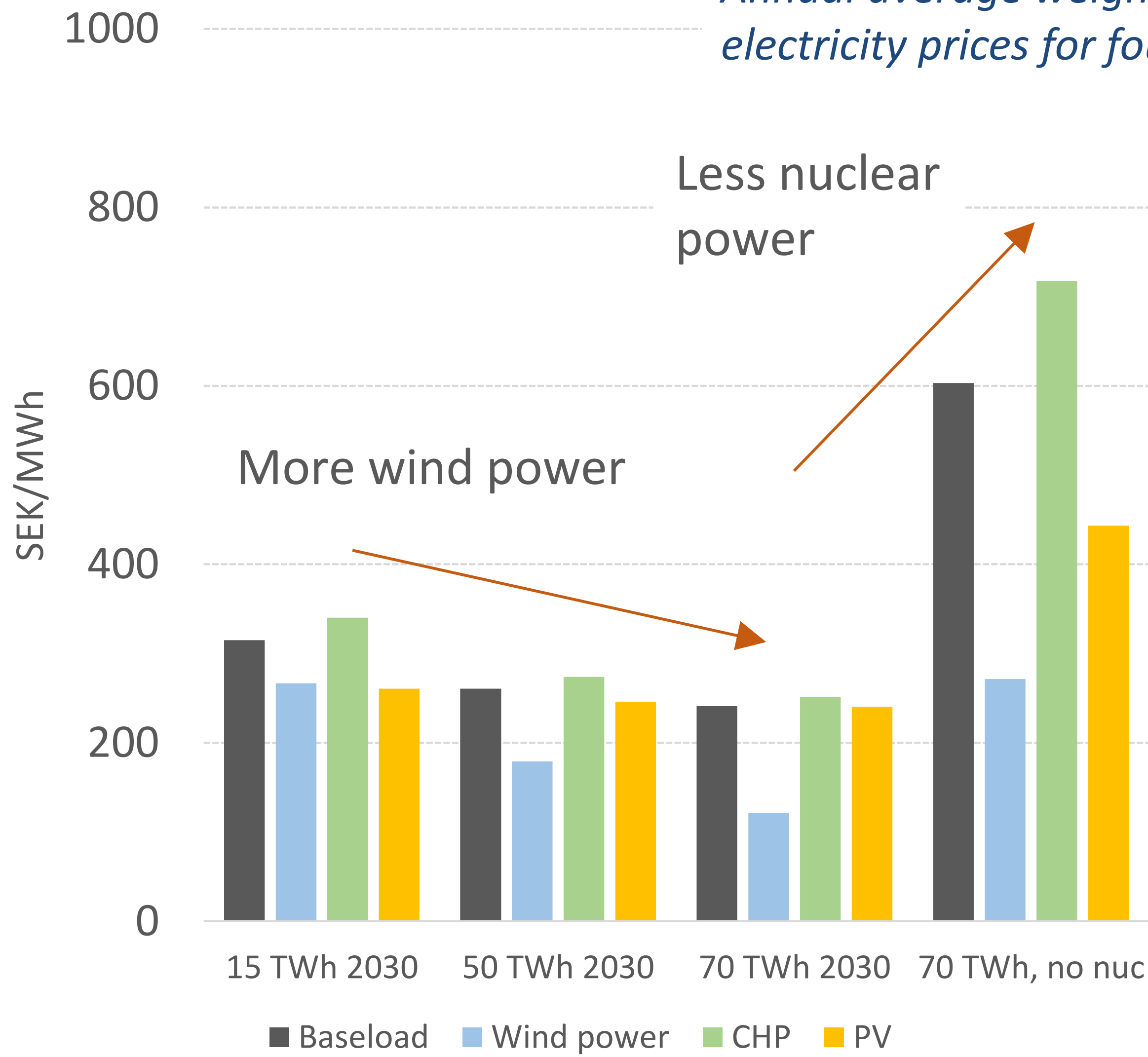
Co-generated electricity generation in Sweden, model year 2030



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

Eight future electricity system challenges (identified by the NEPP-projektet):

Challenges when high wind and solar generation coincide with low demand

1. Mechanical inertia
2. Balance regulation
3. Surplus situations
4. Ability to transmit electricity

Challenge when low wind and solar generation coincide with high demand

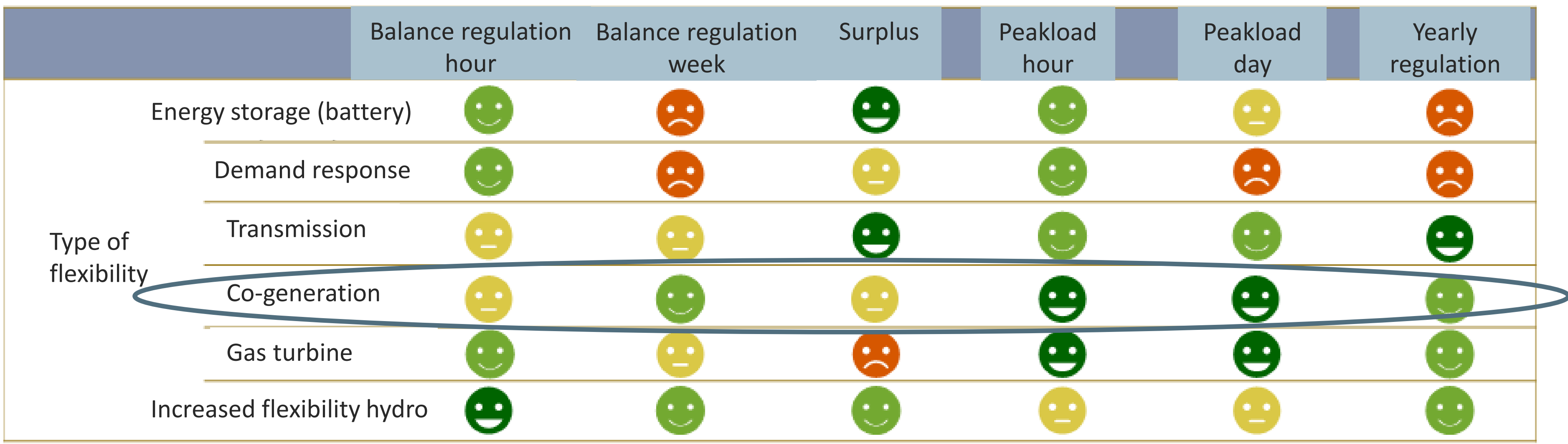
5. Available peak load capacity

General challenges to maintain balance

6. Increased demand for flexibility in dispatchable generation and demand
7. Adjustment of accountability and market mechanisms
8. Yearly regulation

NEPP: North European Energy Perspectives Project, www.nepp.se

Electricity system
– future flexibility challenges

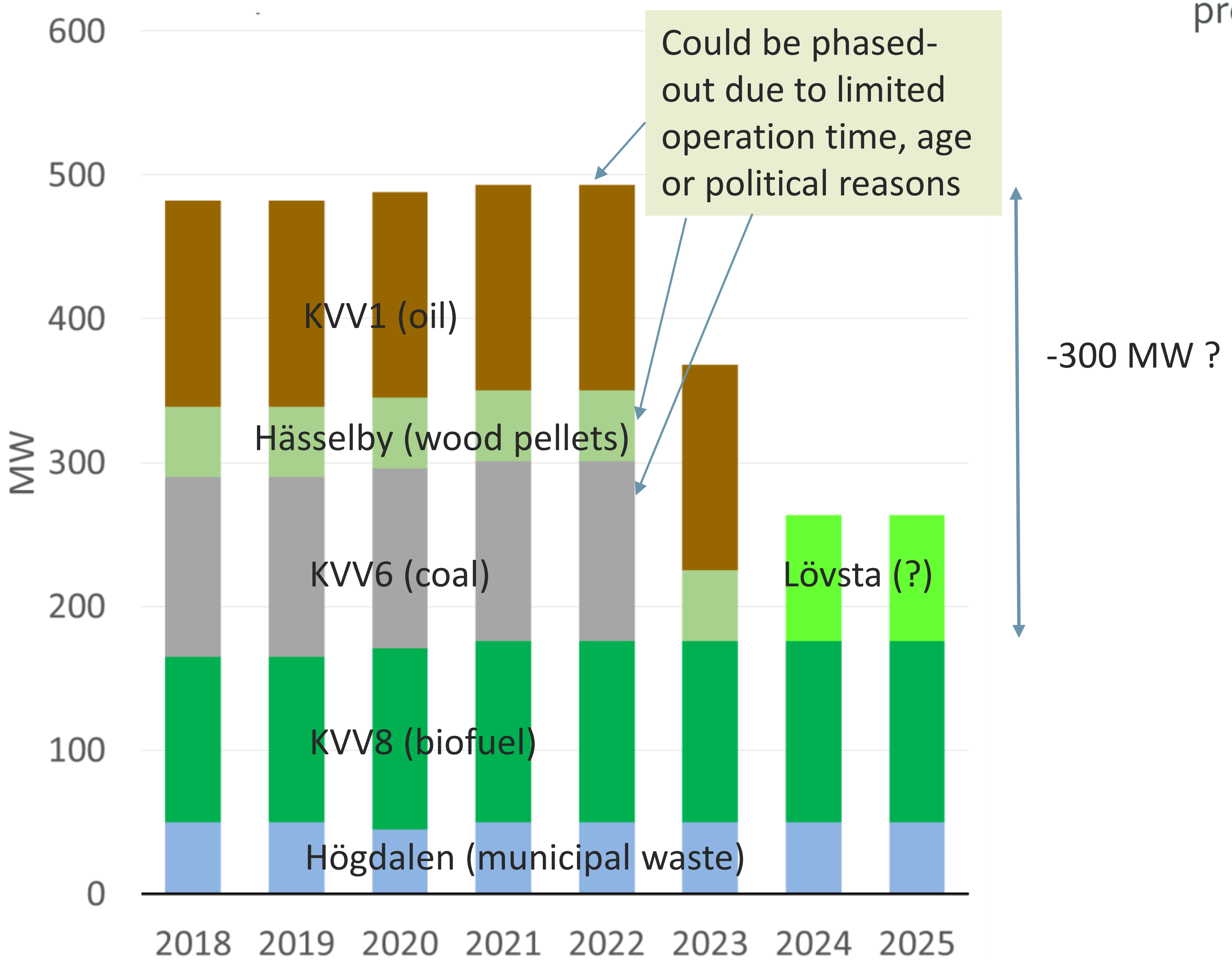


Schematic, and partly subjective, assessment of different measures´ ability to meet different flexibility challenges

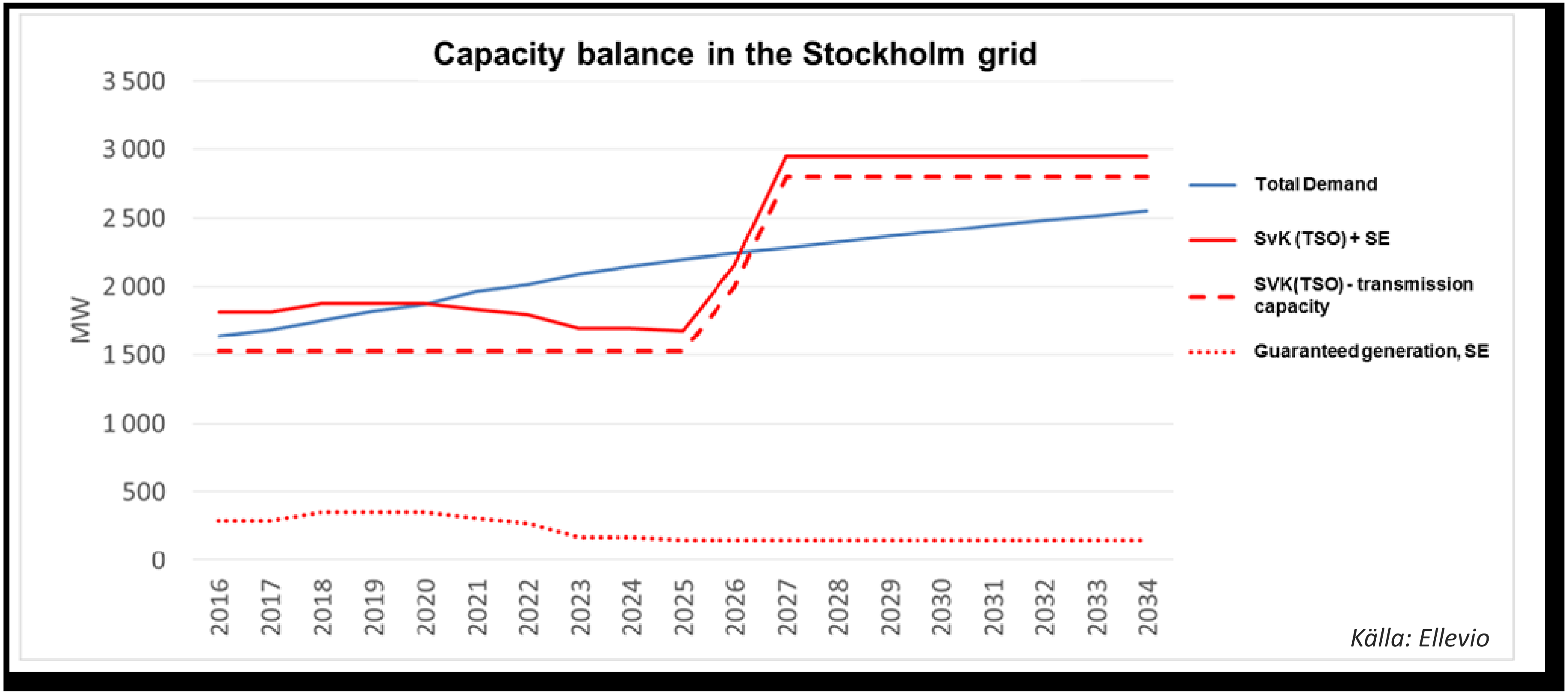
Local electricity grid ”bottle necks”

- Challenges for the electricity system – two different reasons
  1. The general electricity system´s need for flexibility due to more variable generation and phase-out of thermal generation
  2. Local/regional ”bottle necks” in electricity transmission and distribution grids in combination with increasing electricity demand
     - Difficult to obtain permits to build transmission lines / cables in cities
     - New applications for electricity (electric cars, data centers, …) and urbanization
     - Could stop or slow down city development

Electricity generation capacity in Stockholm

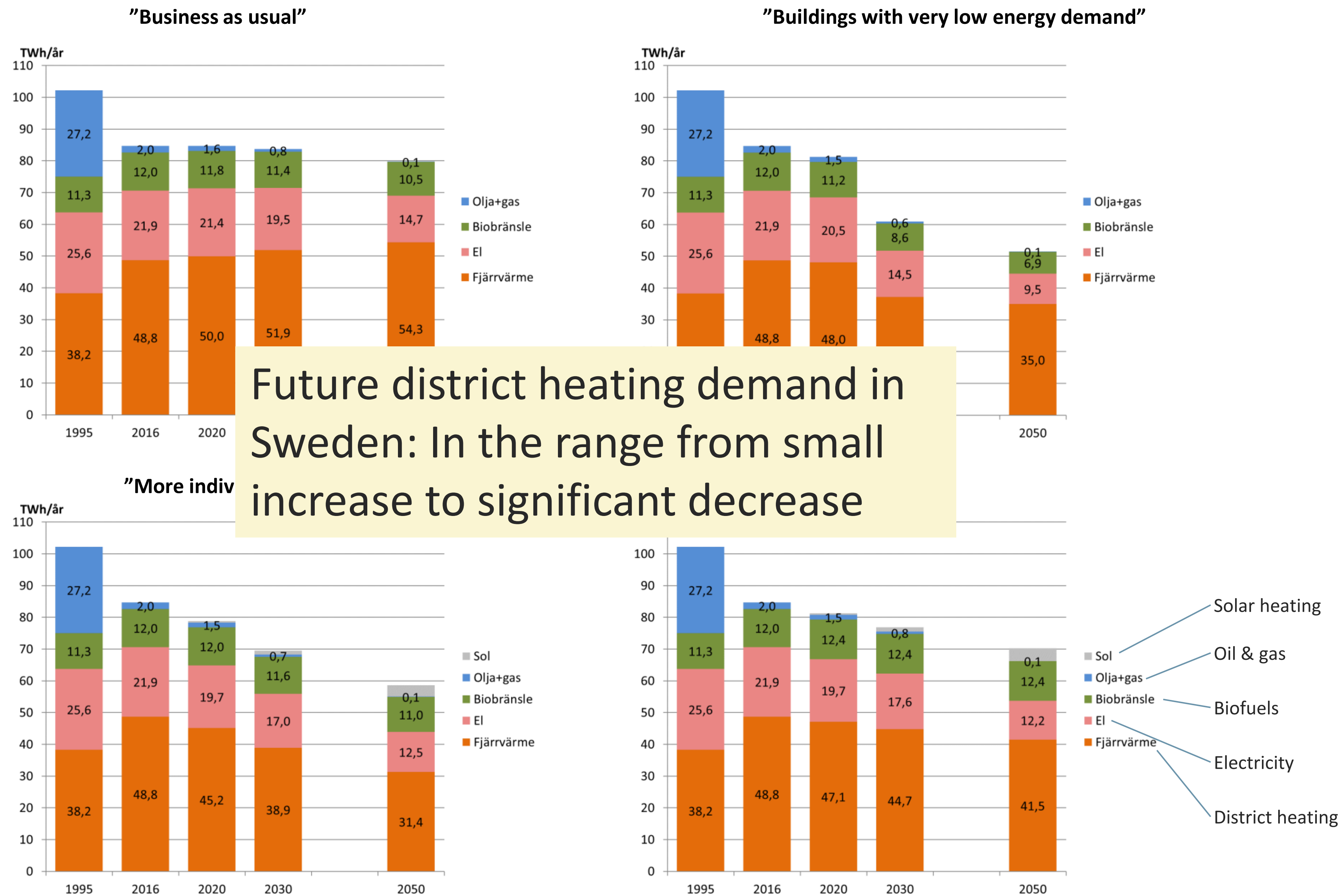


Source: Stockholm Exergi



Co-generation improves the local capacity situation in the case of grid ”bottle necks”. It could also strengthen security of supply.

Energy use for heating of Swedish buildings, four scenarios



Future district heating demand in Sweden: In the range from small increase to significant decrease

Policy measures influence co-generation competitiveness

- Co-generation is an energy efficient technology and is therefore often encouraged by policy instruments
  - Especially when renewable fuels are used
- Policy instruments can, however, also be counter productive
  - Competing technologies receive more support or support not related to actual benefit
  - Increasing demand for biomass increase fuel price
  - Unfavourable policy instruments introduced (e.g. NO_X-tax, waste incineration tax, …)
  - In Sweden co-generation is presently not an obvious choice for new investments

Summary

- More variable electricity generation and phase-out of thermal generation
- Net electricity load will vary more (size, speed, less predictable)
- Co-generation will be a valuable alternative for dispatchable electricity generation
- Development of district heating demand and other available heat production alternatives important
- Flexible operation important (load change, electricity-to-heat ratio, condensing possibility, …)
- Co-generation can contribute locally in case of grid ”bottle necks”
- Policy instruments influence profitability (positive or negative …)

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