ENERGY SYSTEM SYNERGIES OF HYBRID ENERGY NETWORK TECHNOLOGIES

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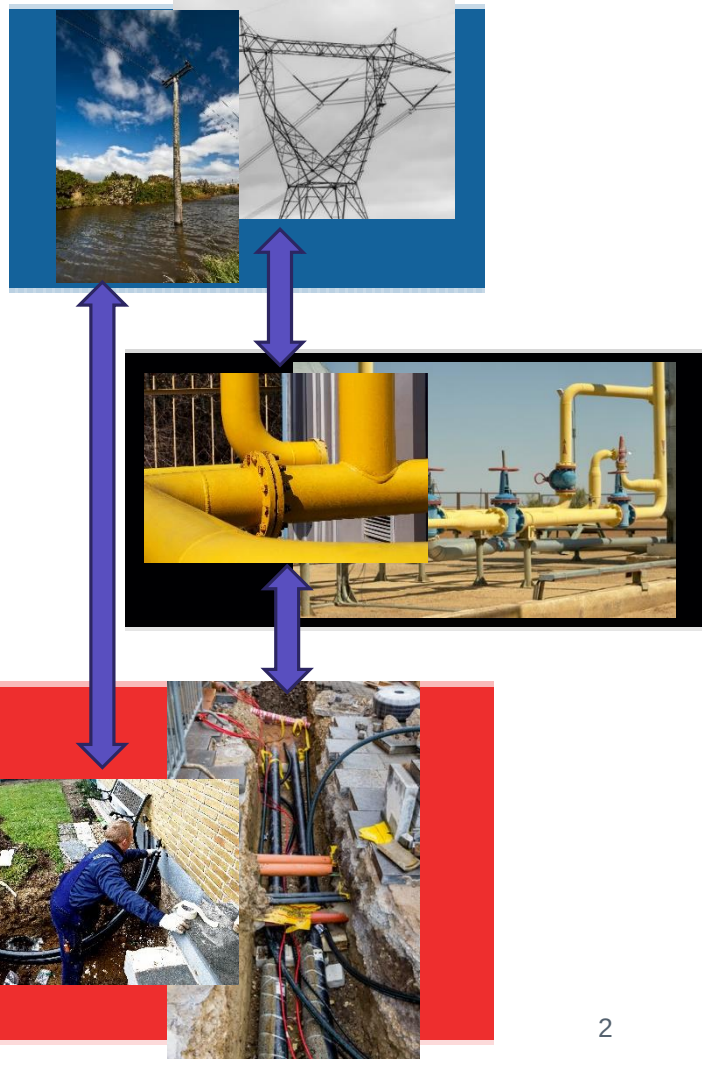
Networks

- Electricity
- Gas
- Heating and Cooling



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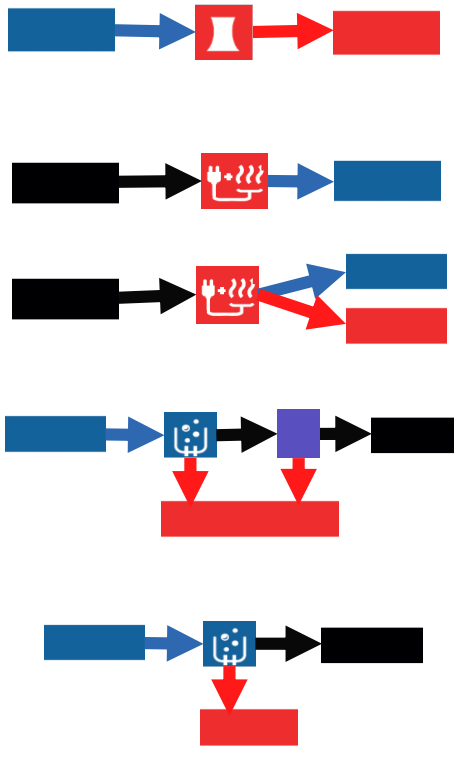
Technologies tested in national energy system scenarios

- Direct electrification of district heating:
  - Electric boilers and electric-driven heat pumps in district heating
- Thermal plant technologies:
  - No large-scale CHP plants
  - Large-scale CHP as combined cycle gas turbines
  - Large-scale CHP as simple cycle gas turbines
  - Large-scale CHP as biomass-fired
- Excess heat from electrofuels (incl. electrolysis)
  - 0%, 50% and 100% of potential identified in scenarios
- Electrolysis technology. Change all to (with 0%, 50% and 100% excess heat utilization):
  - Alkaline
  - PEM
  - SOEC



Six national energy system scenarios used

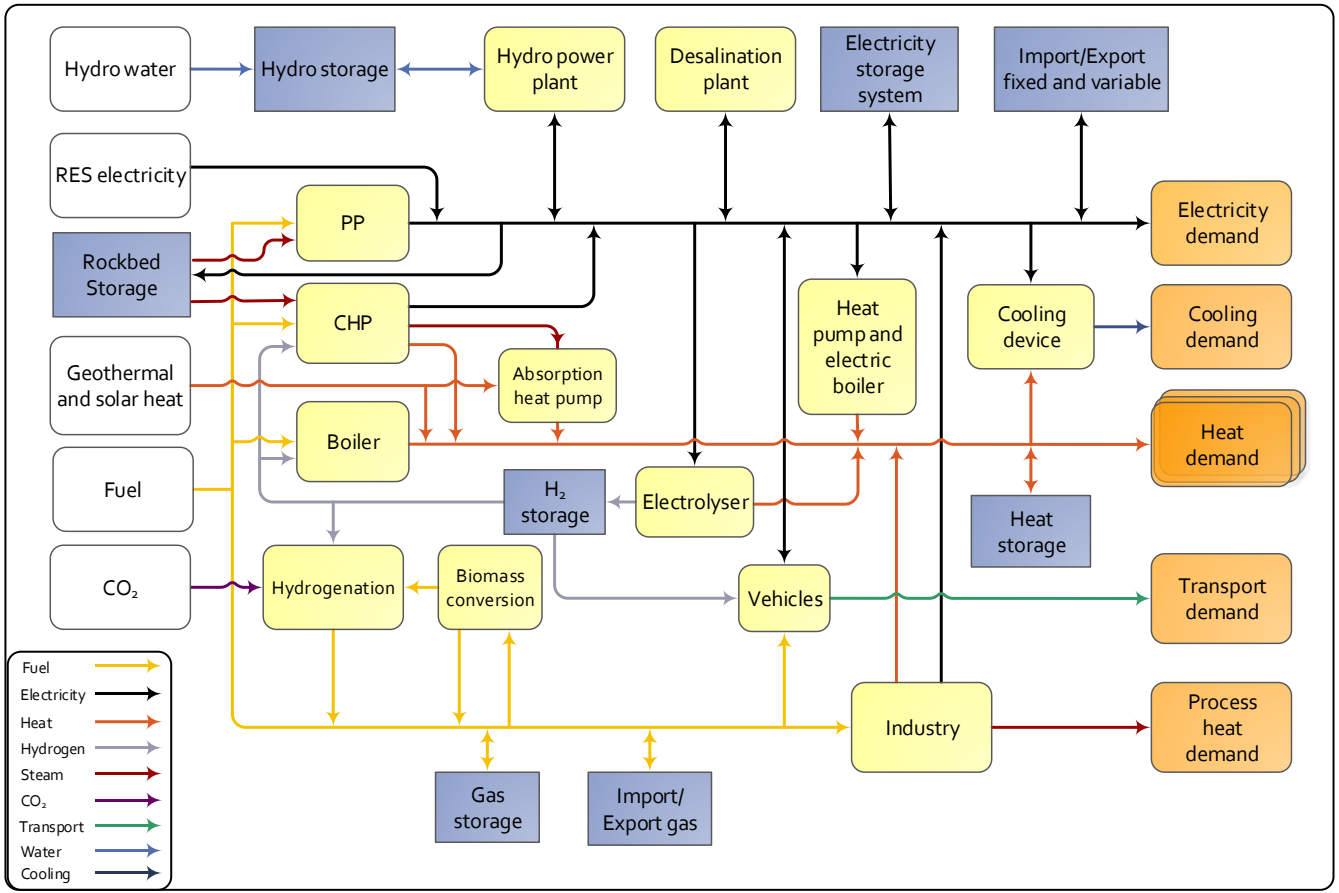
Two baseline scenarios:

- Baseline scenarios (2015) for the energy systems of Austria and Denmark.

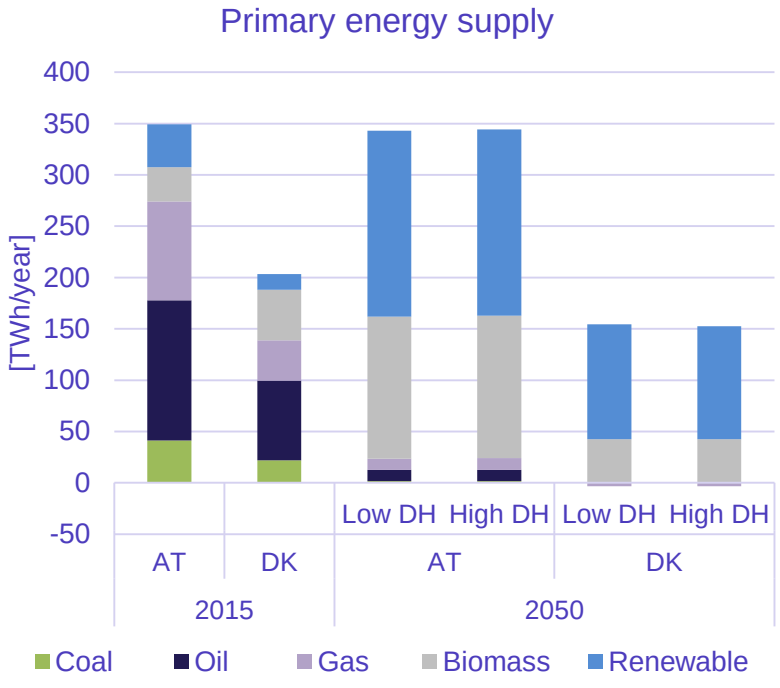
Four future scenarios:

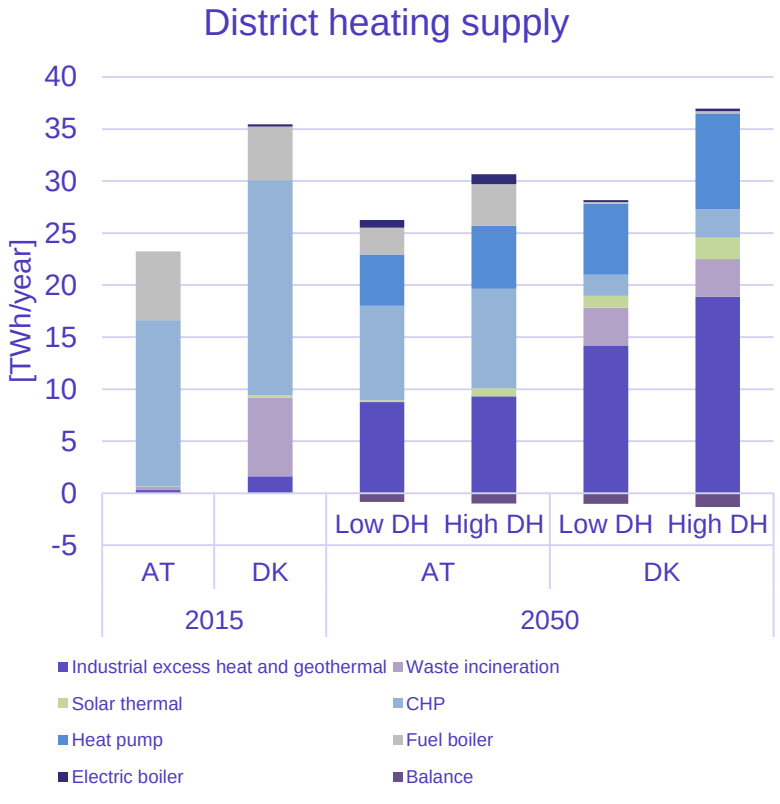
- Future scenarios with high shares of renewable energy for both Austria and Denmark. High district heating utilisation scenarios from:
  - Austria: ”Heat Roadmap Europe 4” (HRE4)
  - Denmark: ”IDAs Climate Response 2045”
- For each country two different future scenarios topologies are investigated:
  - A system with (relative) **low district heating utilisation** (developed based on high district heating utilisation scenarios)
  - A system with (relative) **high district heating utilisation**

Energy system simulation tool - EnergyPLAN v16



Primary energy supply of the entire energy system and district heating supply





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Simulation approach

- All scenarios are simulated without electricity transmission connections to other countries.

- Sufficient energy supply has been ensured by adjusting the marginal variable renewable electricity source, so that the yearly production of unusable electricity is unchanged*.
  - The marginal variable renewable electricity source is assumed to be photovoltaic for Austria and offshore wind power for Denmark.

- Gas exchange is maintained by adjusting the gas produced via CO_2 hydrogenation (also affects the electrolysis and H_2 storage capacities).

**In a real-world situation this production would either be exported or result in reduced production from variable renewables*

Direct electrification of district heating – conclusions

- Electric boilers' less efficient conversion of electricity to heat allows for larger integration of variable renewables without creating increased levels of unusable electricity production.

- Heat pumps have a larger potential to reduce the biomass consumption compared with electric boilers.
  - Only until the operation of the heat pumps is limited by the district heating demand.
  - The biomass reduction is especially in relation to reduced use of biomass-fired boilers.

- The costs of the energy system are mostly affected by the capacity of heat pumps, compared with the electric boilers.
  - For electric boilers, the effect on the costs is mostly related to the potential to integrate more variable renewables into the energy system.
  - However, the change in costs is relatively low compared with the total cost of the entire energy system, as this also includes costs for the transport sector, etc.

Thermal plant technologies – conclusions

- Having no large-scale CHP plants and instead large-scale power plants increases the energy system costs and biomass consumption of the energy system, as well as the demand for variable renewable electricity sources.

- Combined cycle gas turbines show lower energy system costs as well as lower need for installed variable renewable energy capacity compared with simple cycle gas turbines and biomass-fired thermal plants.

Excess heat from electrofuel production – conclusions

- The use of excess heat from electrofuel production reduces the costs of the energy system, the use of biomass and the need for variable renewables.

- For electrolysis the results show that having a higher electric efficiency is more important from an energy system perspective than being able to utilise larger amounts of excess heat from the electrolysis.
- Due to relative high electric efficiency of SOEC, SOEC shows the lowest energy system costs and lowest need for installation of variable renewables.

Thank you for listening

For more follow the IEA DHC Annex TS3: Hybrid Energy Networks

https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3

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