



Outline

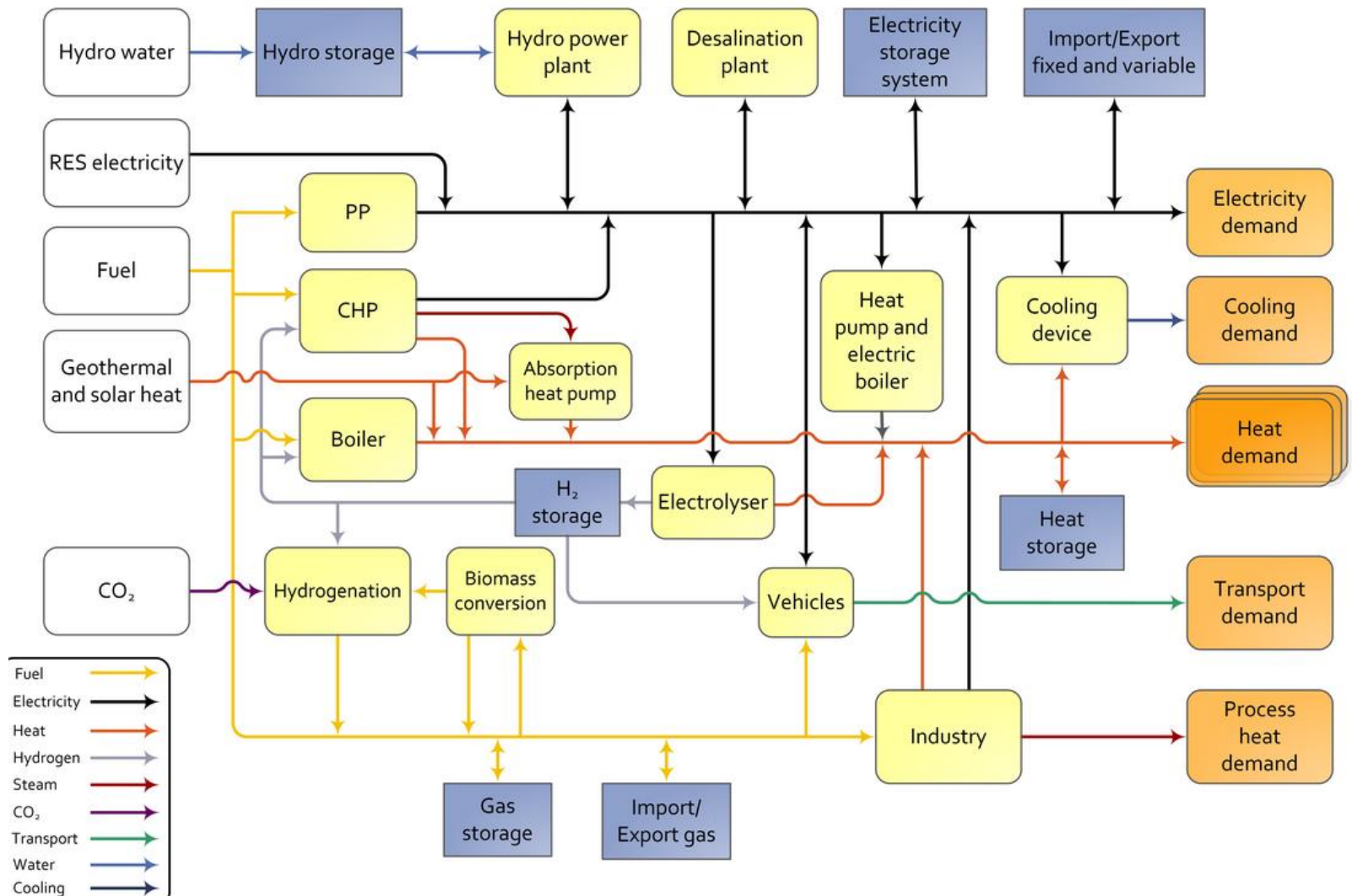
- ➔ The EnergyPlan
- ➔ Example: DK

The EnergyPlan

Techno-economic model

- Evaluates the energy system **operation** (incl. heating and cooling, electricity, transport and industry)
- Based on **hourly data**:
 - installed capacities and energy resources and production
 - demands
 - costs
 - lifetime...
- Evaluation on a **yearly basis**: interdependencies rather than projections!
Timeline achieved by repeating simulation with changing assumptions

The EnergyPlan



The EnergyPlan

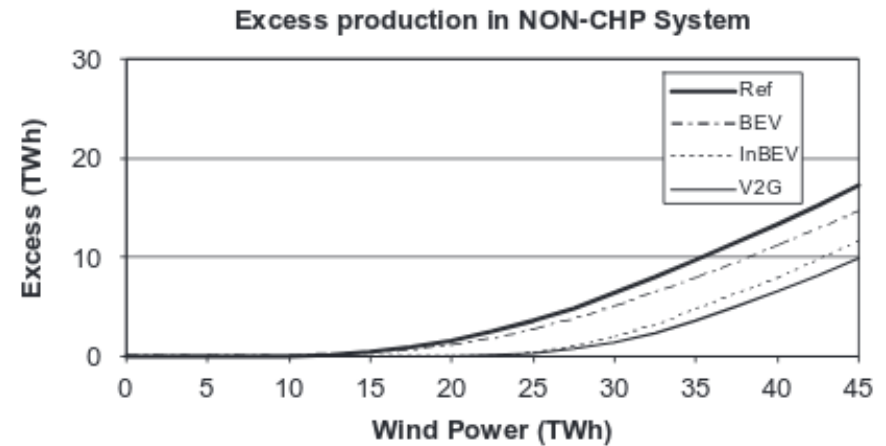
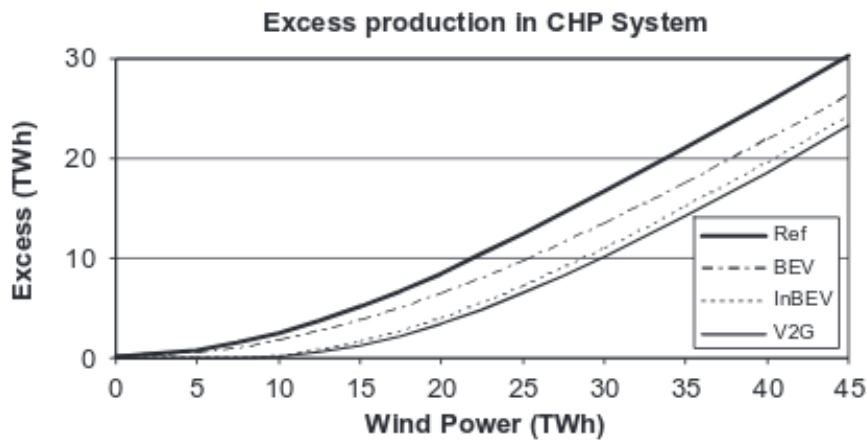
Example: DK

Scenario Assumptions

- Wind energy penetration for electricity generation ranging from 0 – 100%
- 10 KW connection for charging: speed and flexibility
- Four types of vehicle fleets:
 - REF: ICE fleet
 - BEV: Battery Electric Vehicles with night charge
 - InBEV: Intelligent Battery Electric Vehicles (excess RE power compensation)
 - V2G: Vehicle to Grid cars
 - V2G+: V2G with 3xlarger battery
- 20300 km/(a*vehicle) [GER: ca. 14.500 km/(a*vehicle)]
- Average consumption of 14 km/l gasoline → 14250 l/(a*vehicle)
- 1.872.631 vehicles [GER: ca. 63.700.000 vehicles] → 25.5TWh/a

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Example: DK



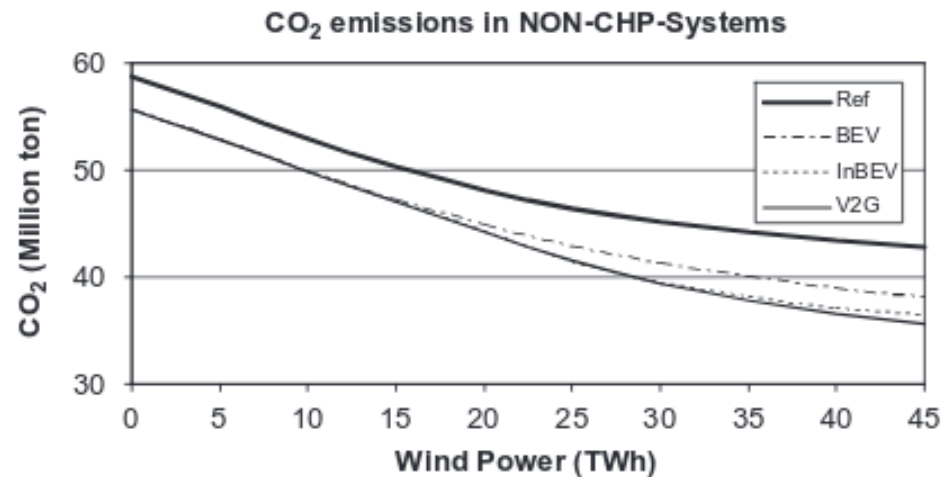
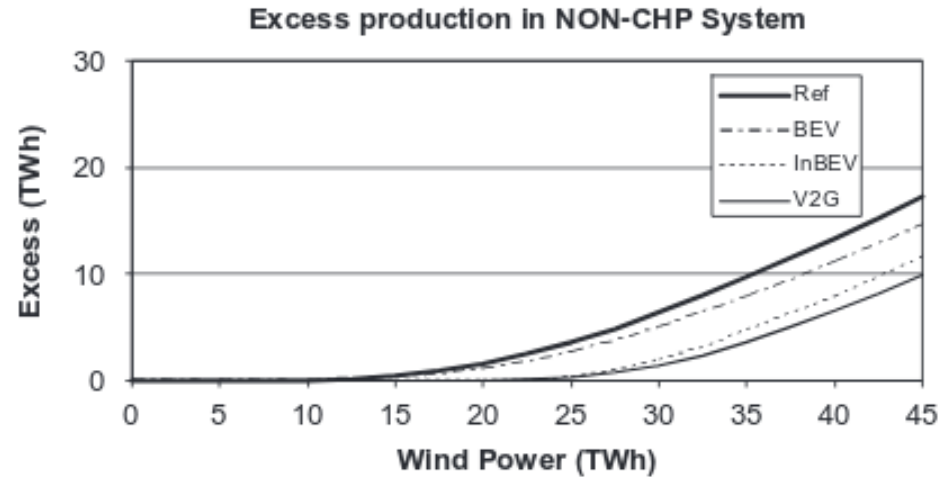
Source: Lund, Kempton, 2008

- Excess increases with increasing RE share:
 - @ 10% wind production (ca 5TWh/a) excess is negligible!
 - @ 50% wind production (ca 22 TWh/a) excess is 25% of the production!
- Electric vehicles help reducing the excess production from fluctuating RE sources (e.g. wind), specially with V2G approaches!

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Example: DK

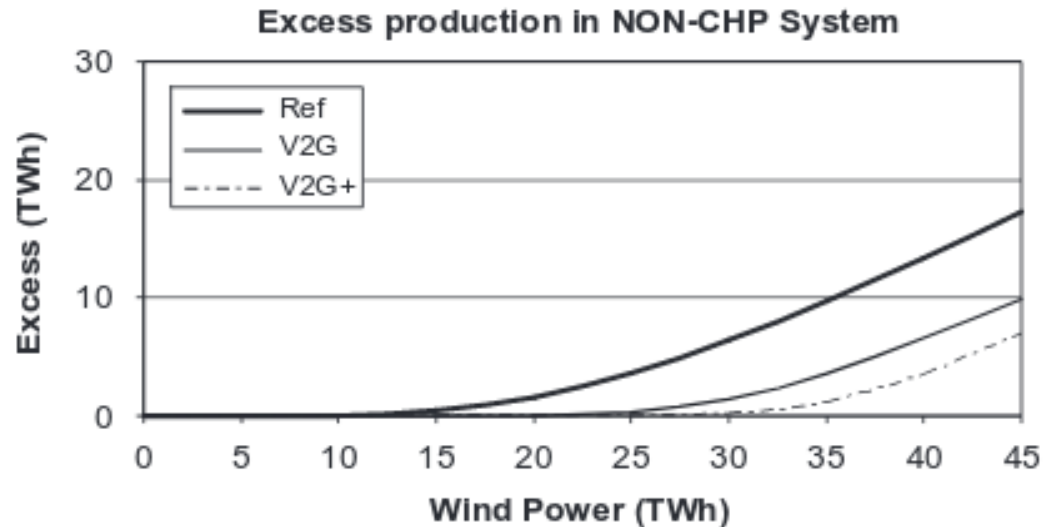
- At 0 Twh/a wind power
→ CO₂ reductions are due
to increased efficiency of
E-vehicles
- RE in GER:
ca. 220TWh in 2017



Source: Lund, Kempton, 2008

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Example: DK



Source: Lund, Kempton, 2008

- V2G = Battery capacity of 30 kWh/vehicle
- V2G+ = Battery capacity of 90 kWh/vehicle
→ significant reduction in the excess production and CO₂ emissions

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Example: DK

Critical remarks:

- Electricity demand DK, 2020 = 41TWh/a;
Electricity demand DK, 2020 + including electric vehicles = 45 TWh/a!!
- Additional RE production in GER: ca. 100TWh/a (Römer, 2018)

References

Lund, Kempton, 2008. Integration of renewable energy into the transport and electricity sectors through V2G. *Energy Policy* 36 (2008) pp. 3578–3587.

Römer, 2018. Die Verkehrswende –Einblicke in die Mobilität der Zukunft. KfW Research, Focus Volkswirtschaft.
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