Hydrogen in the future energy system

Preliminary results

Future Gas workshop - 11th september 2018

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Agenda

- Hydrogen demand in the future energy system

- 2050 Socioeconomic energy system analysis
  - RE-fuel and RE-gas costs
  - Hydrogen demand in Base and High Gas price scenarios

- Price-flexible hydrogen demand analysis
  - Operation of electrolyser and hydrogen storage
  - Supply and demand price of hydrogen

- Discussion

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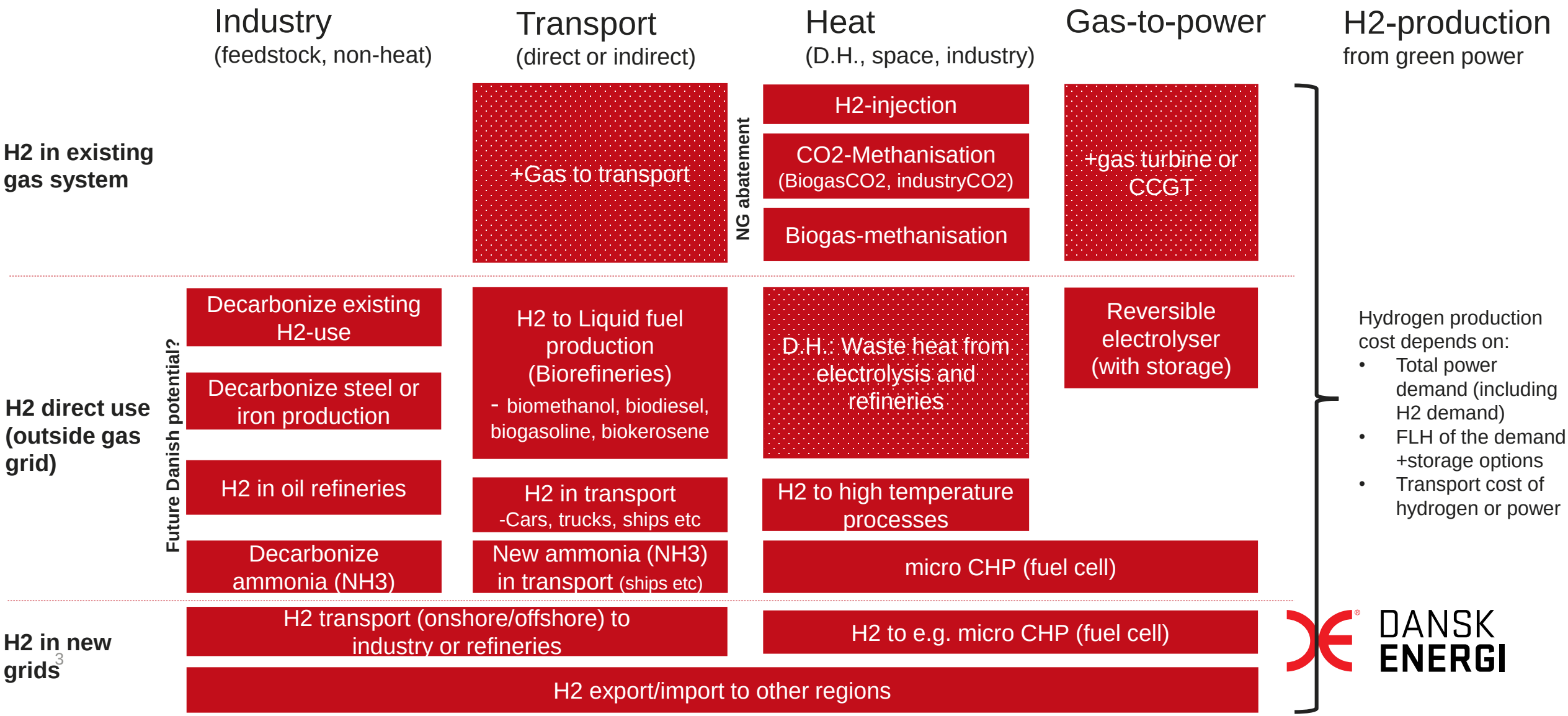
Hydrogen demand in the future energy system



Hydrogen production cost depends on:

- Total power demand (including H2 demand)
- FLH of the demand +storage options
- Transport cost of hydrogen or power

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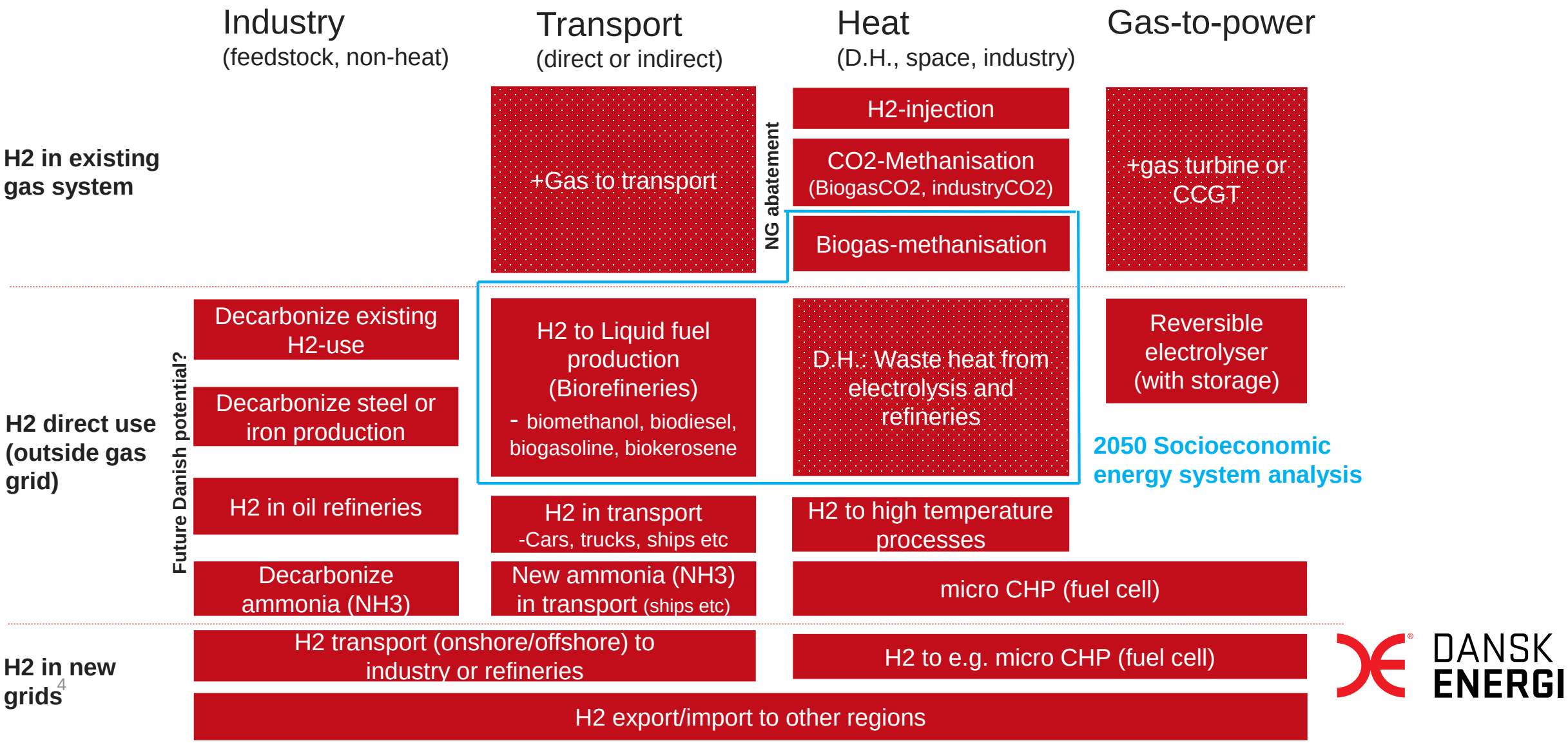
Hydrogen demand in the future energy system



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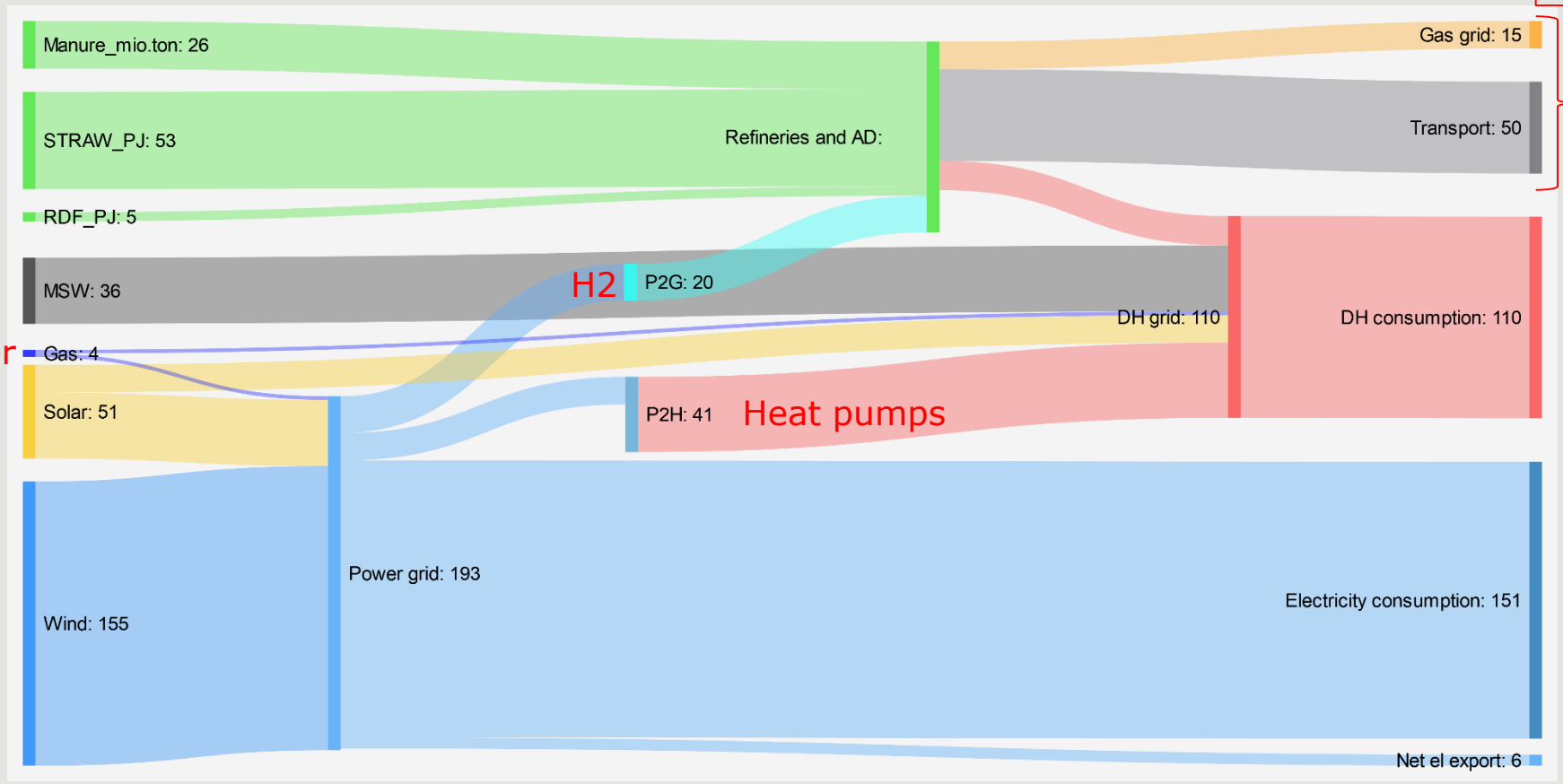
Energy flows distric heating, power and transport (DK 2050) Base scenario

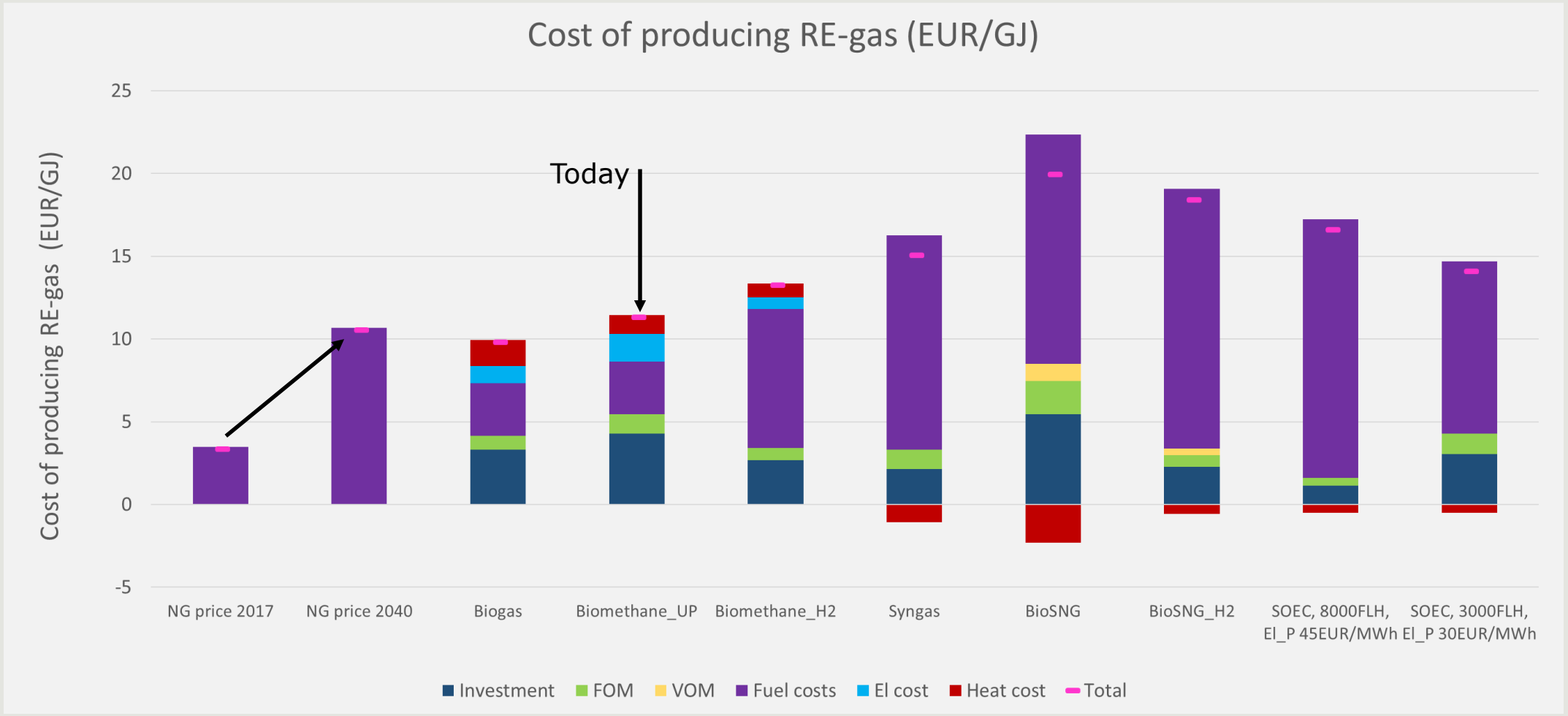
Not in analysis yet

+Gas-to-transport
+Industry heat
+Residential heating

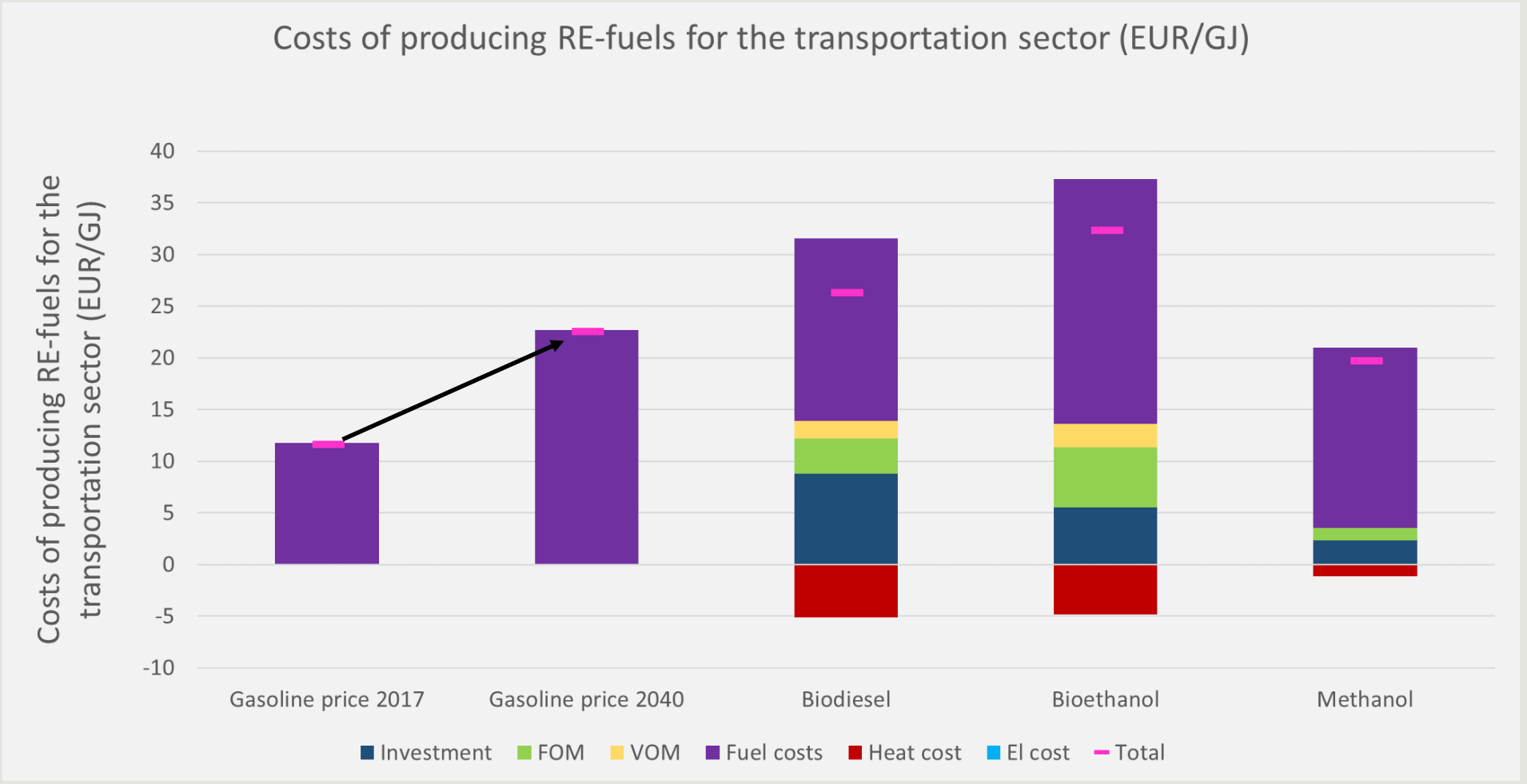
Unit: PJ (except manure (in mio. tons))



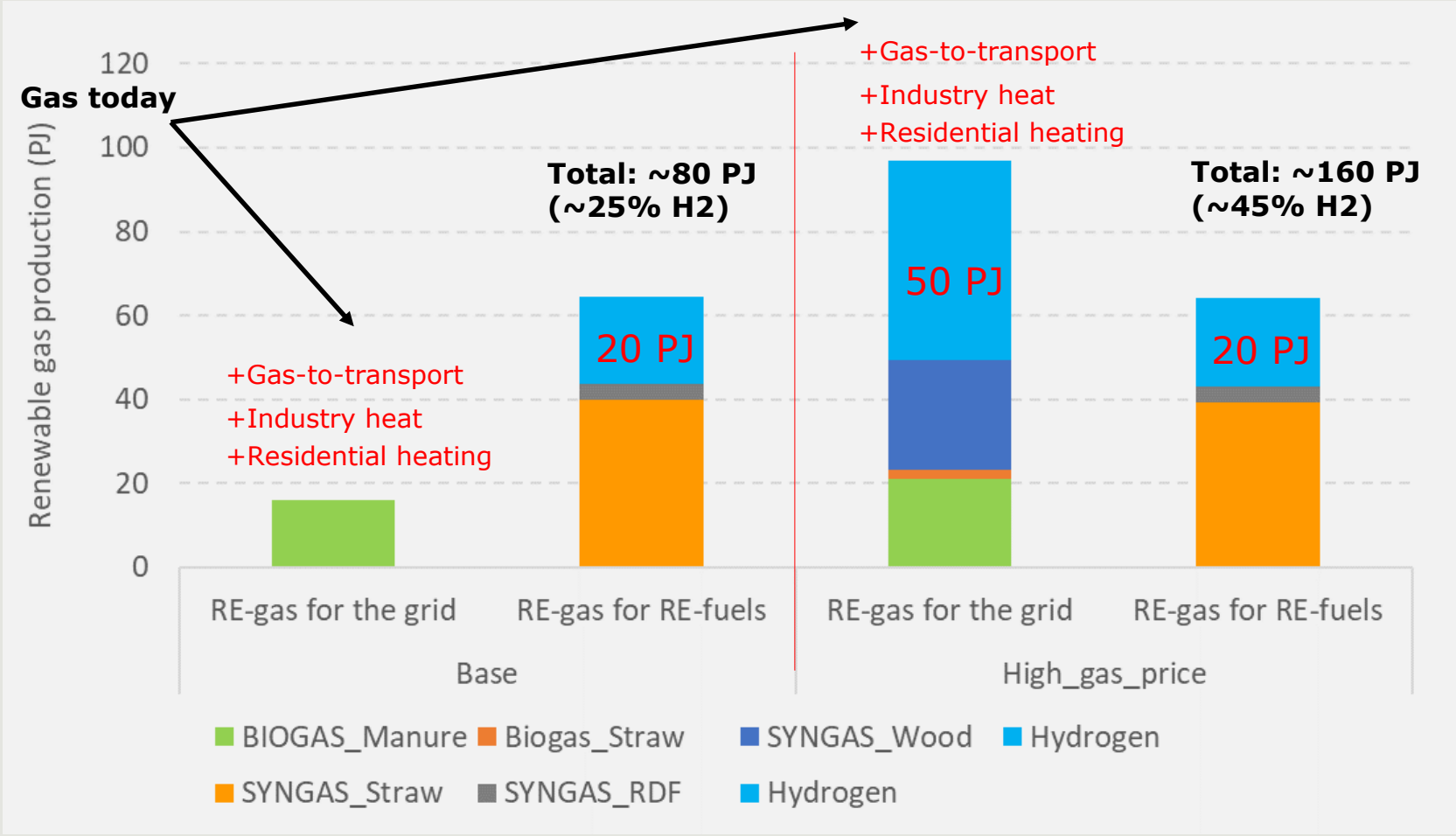
Socioeconomic costs of RE-gas (DK 2050) – Base scenario



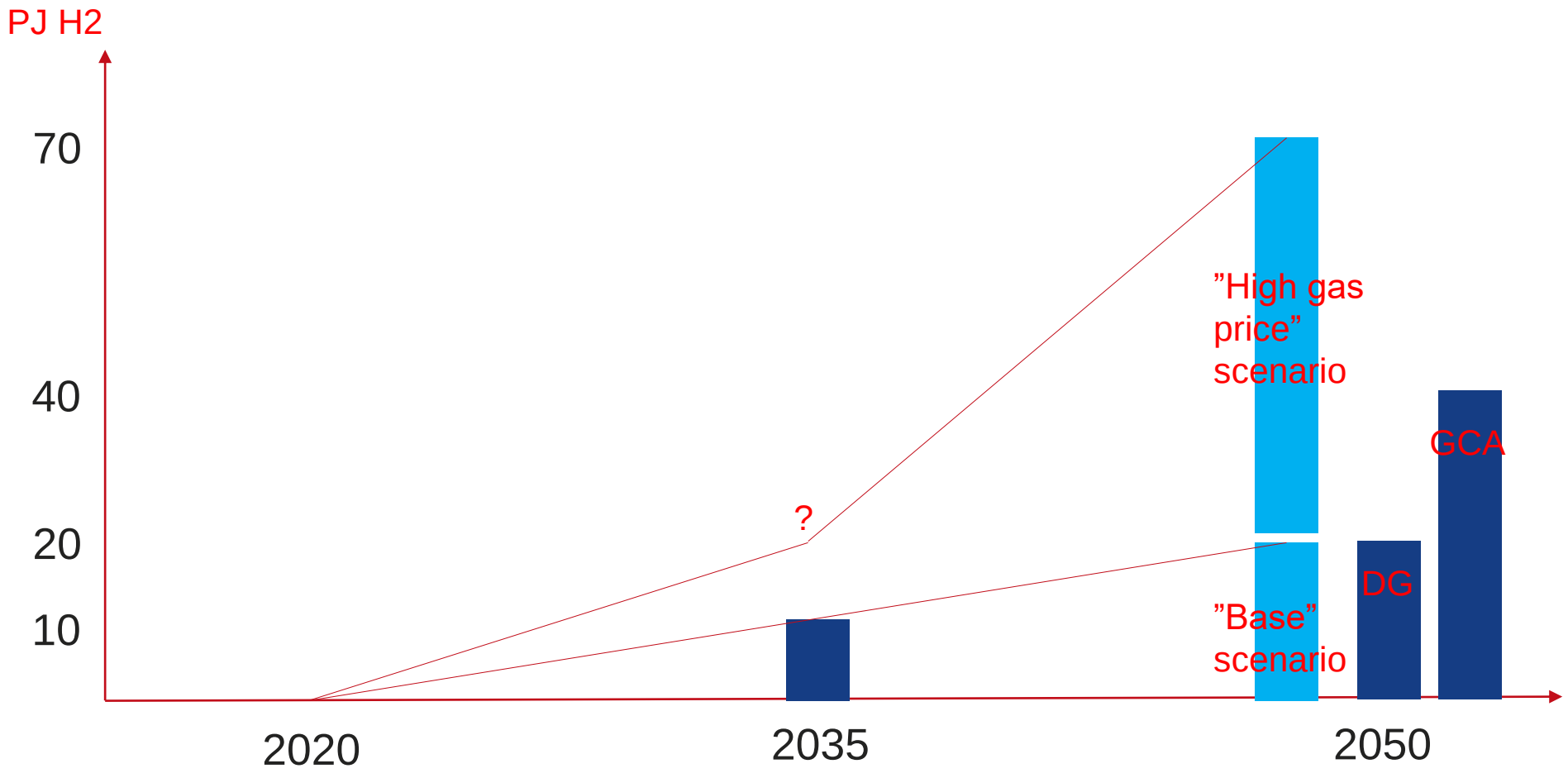
Socioeconomic costs of RE-fuels (DK 2050) – Base scenario



Renewable gas and fuel production (Denmark 2050)



Danish hydrogen demand: 20-70 PJ in 2050?

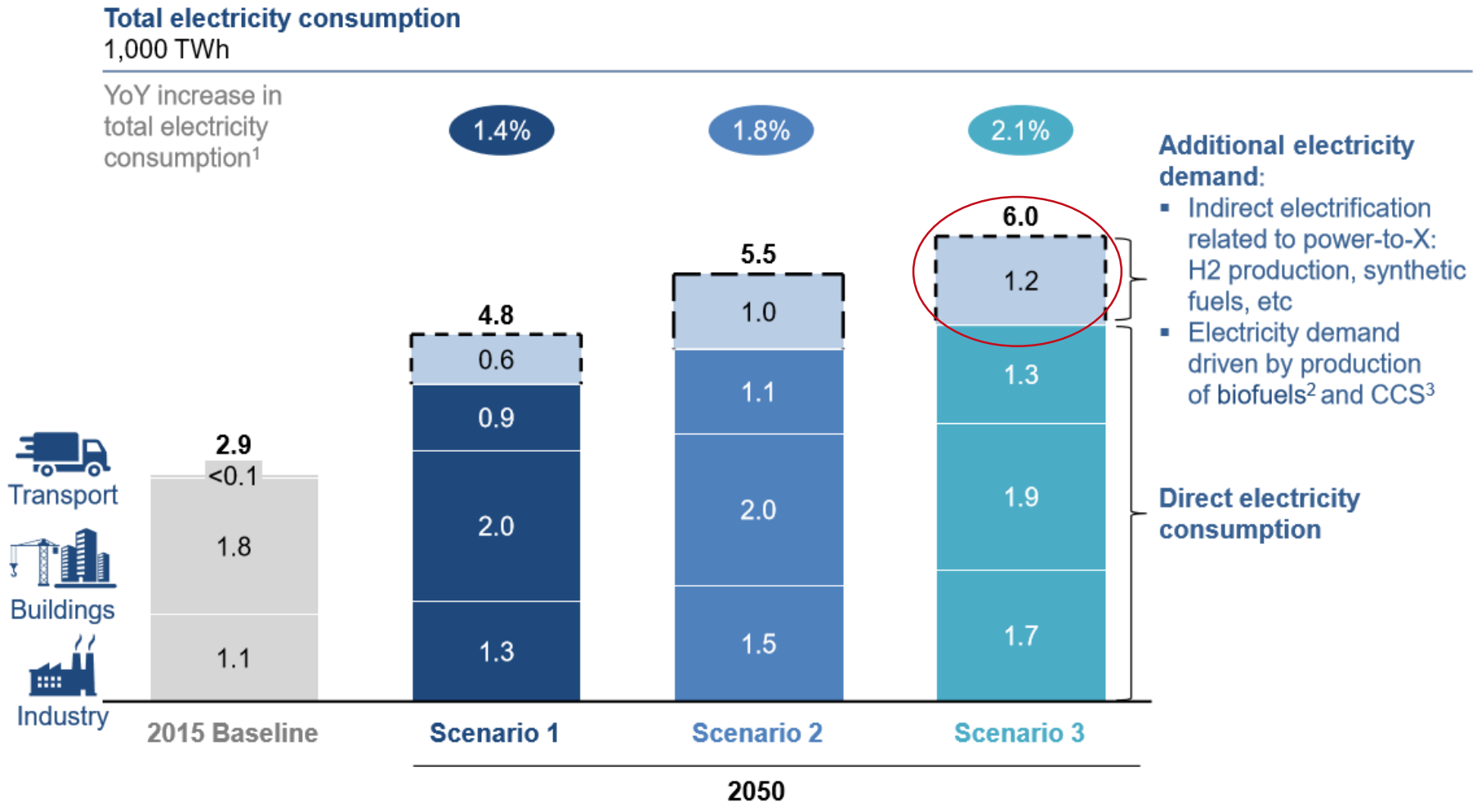


Large uncertancy regarding final demand

Biomass restriction and CO2+fuel prices have significant influence

Kilde: Energinet (2018), ”Systemperspektiv 2035” (dark blue) – Future Gas preliminary calculations (light blue)

EU hydrogen demand: 2000-3000 PJ in 2050?



Up to 3100 TWh electrification towards 2050 in Europe

Indirect electrification including H2 could make up to 1200 TWh power = ~4300 PJ power = 2000-3000 PJ hydrogen?

Kilde: Eurelectric 2018, ”Decarbonization pathways European economy”

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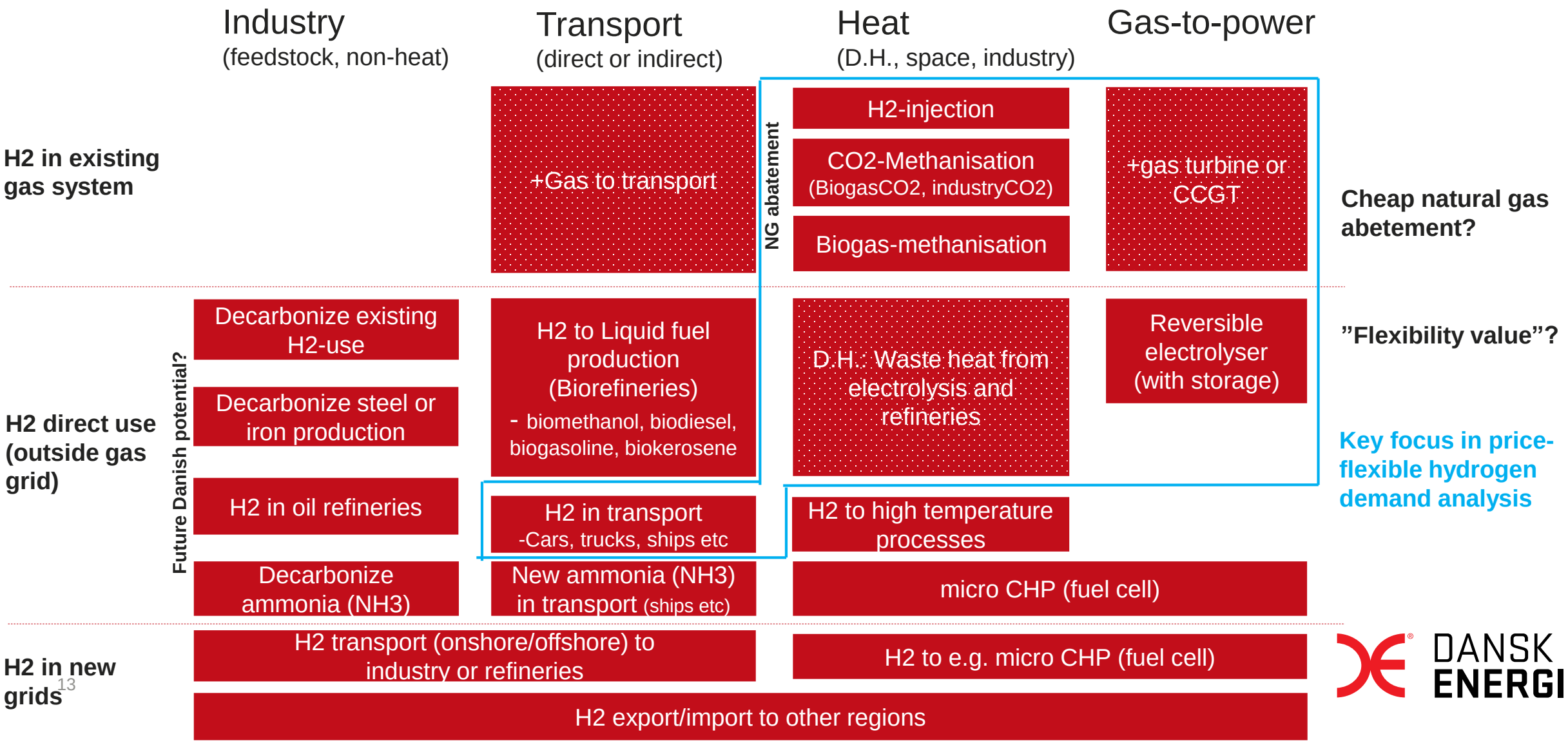
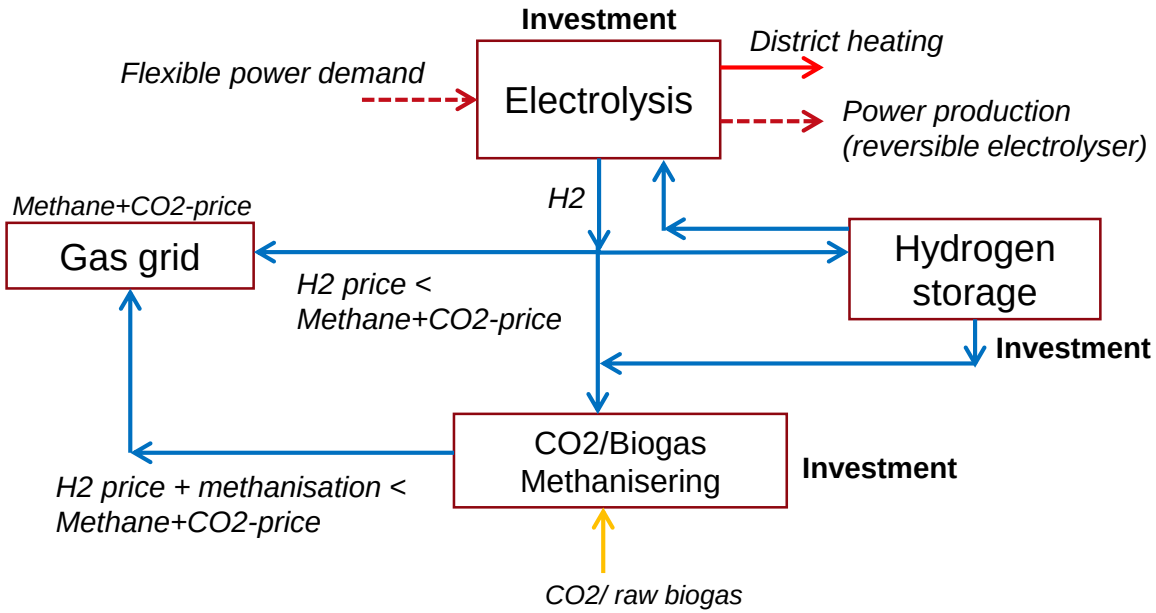
Hydrogen demand in the future energy system

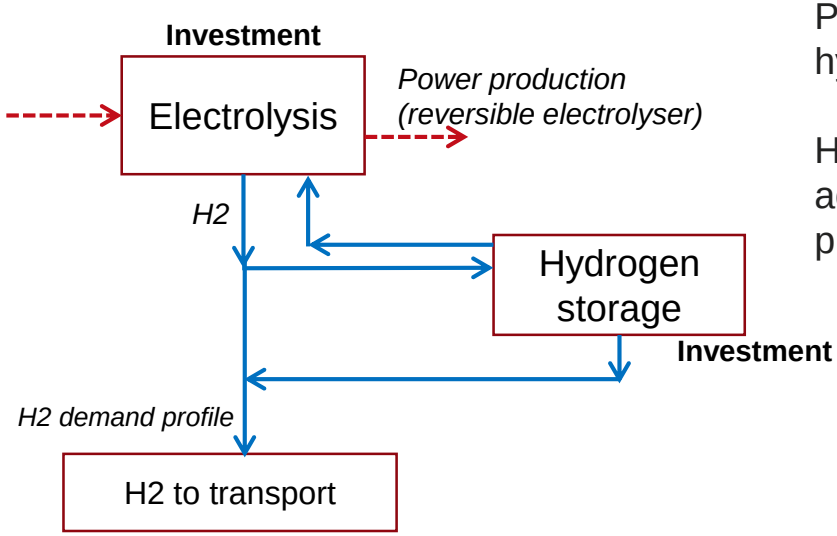


Modeling of hydrogen demand and supply

Power-to-gas (and gas-to-power)



H2 to transport



Price flexible hydrogen demand

Hydrogen demand according to demand profile (with storage)

Minimization of the total investment and operation costs in the Balmorel model area (North west Europe)

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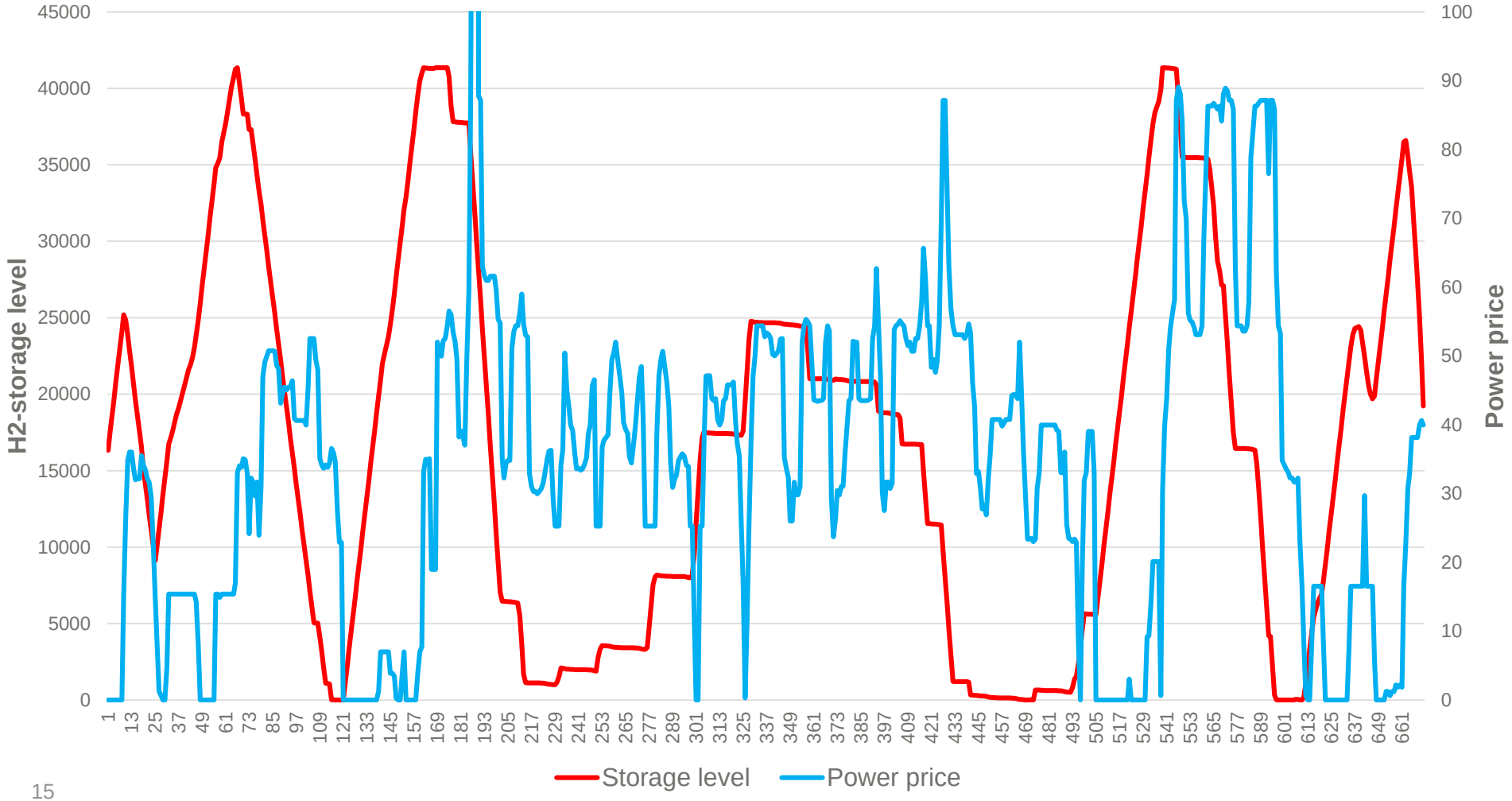
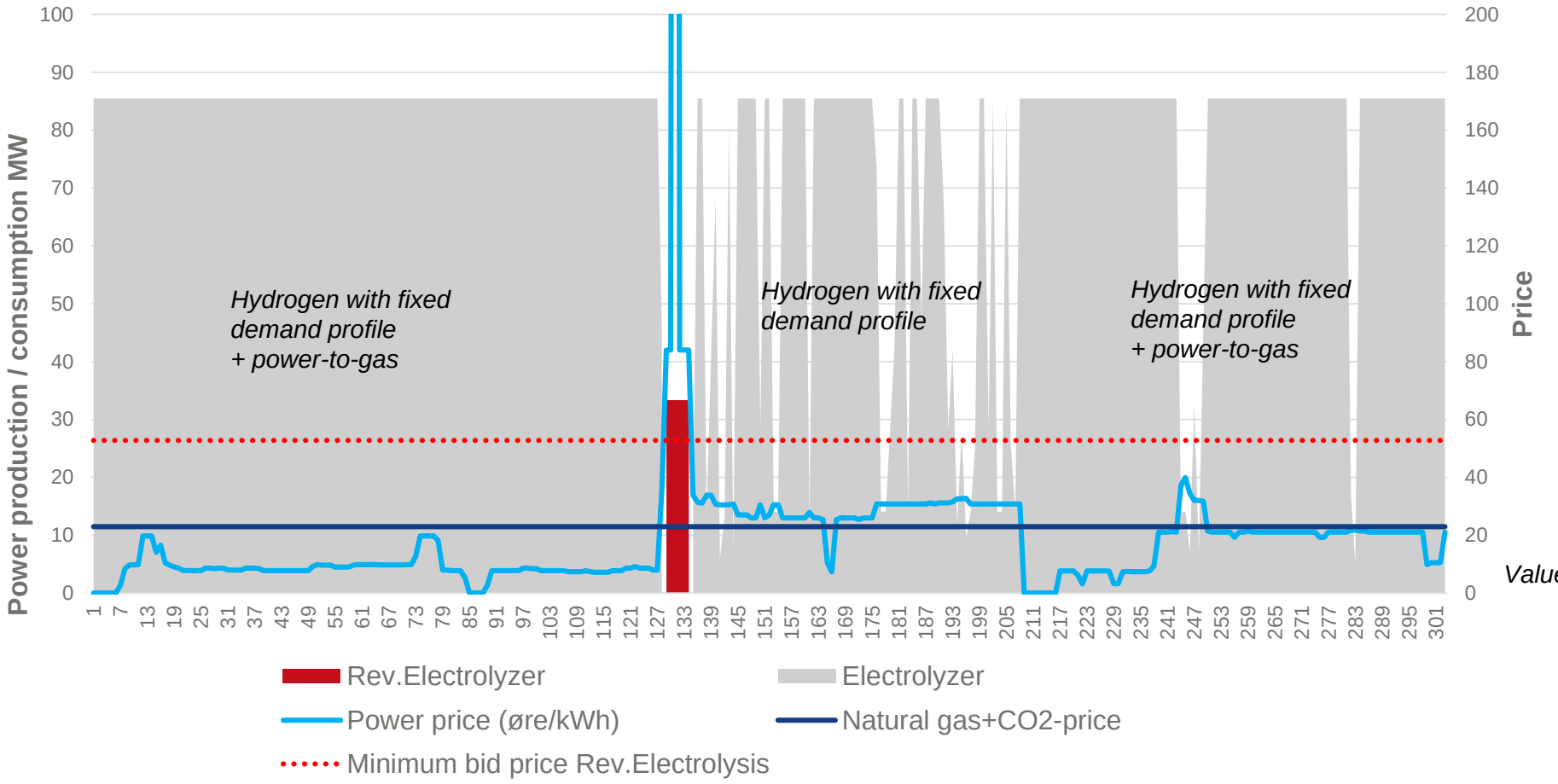
Operation of hydrogen storage



H2 production at low power prices

Storage optimized with yearly forecast horizon

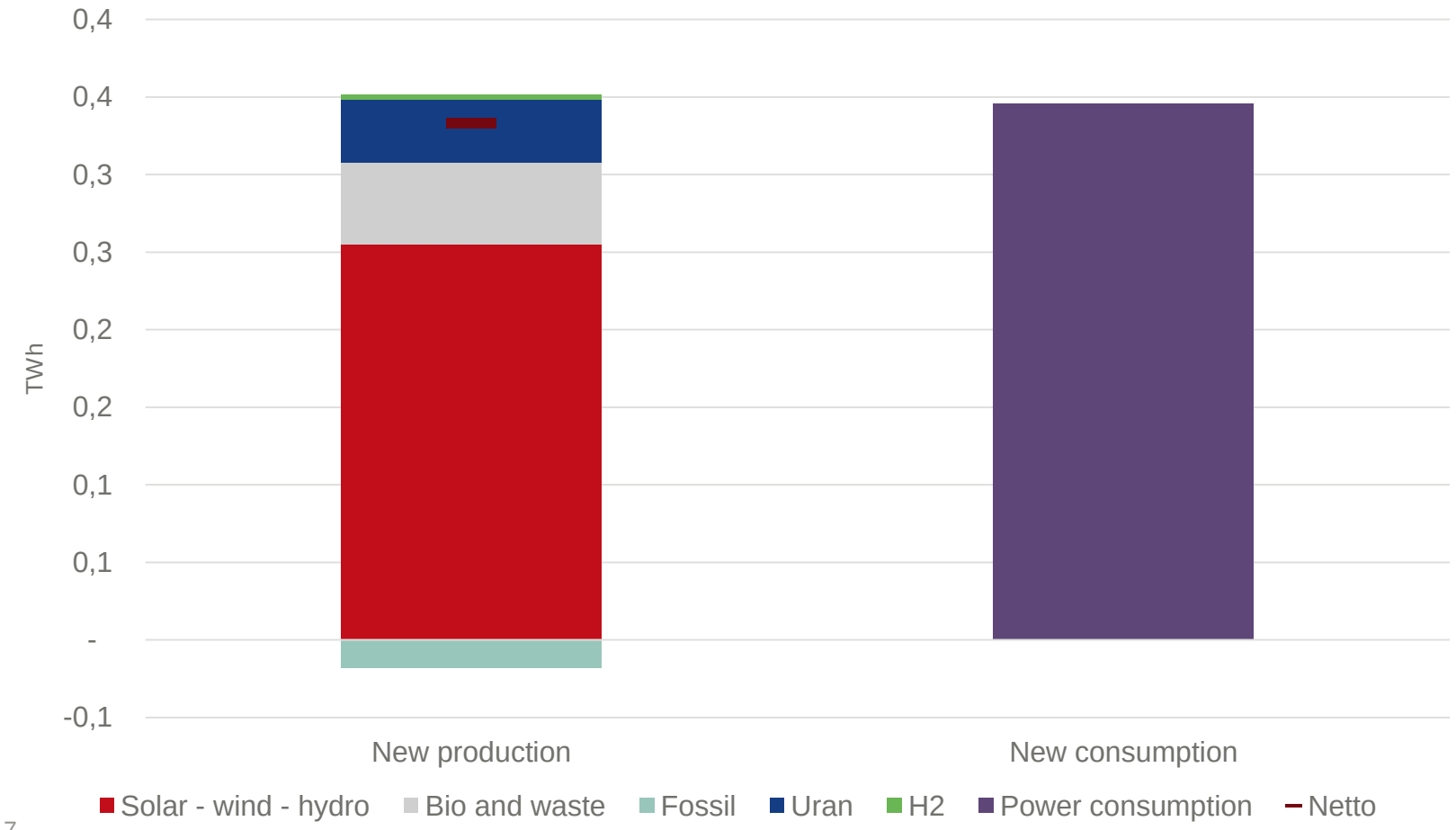
Operation of electrolyser



Reversible electrolyser oprates only at high power prices

Value of power-to-gas

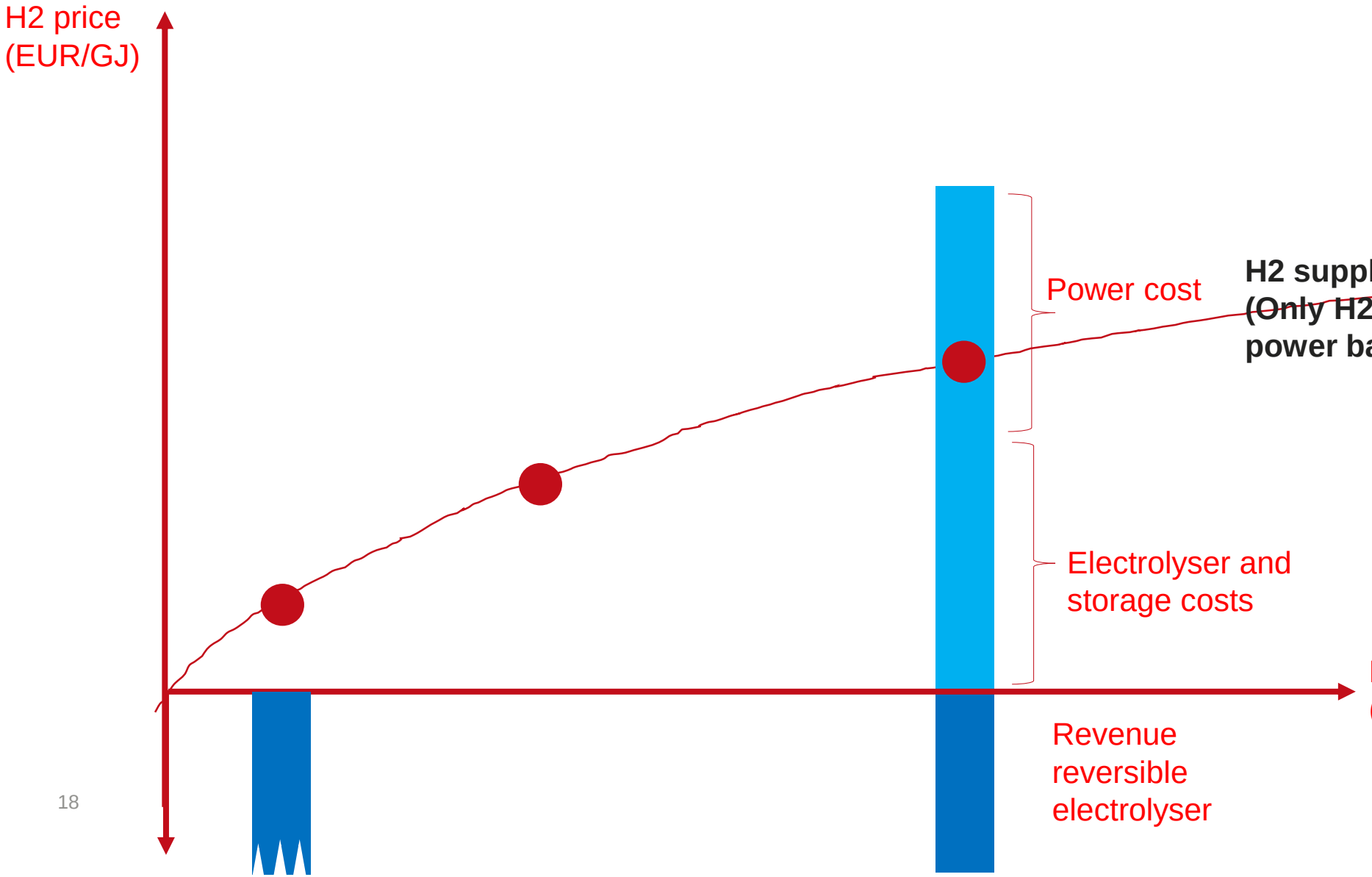
New hydrogen demand produced by new green power



100% RE in hydrogen production

However, new power production will depend on power market development

Supply price of hydrogen



Hydrogen price increases with higher demand

Power-to-gas with low Full load hours (2000-3000 h/year) => electrolyser costs has significant influence

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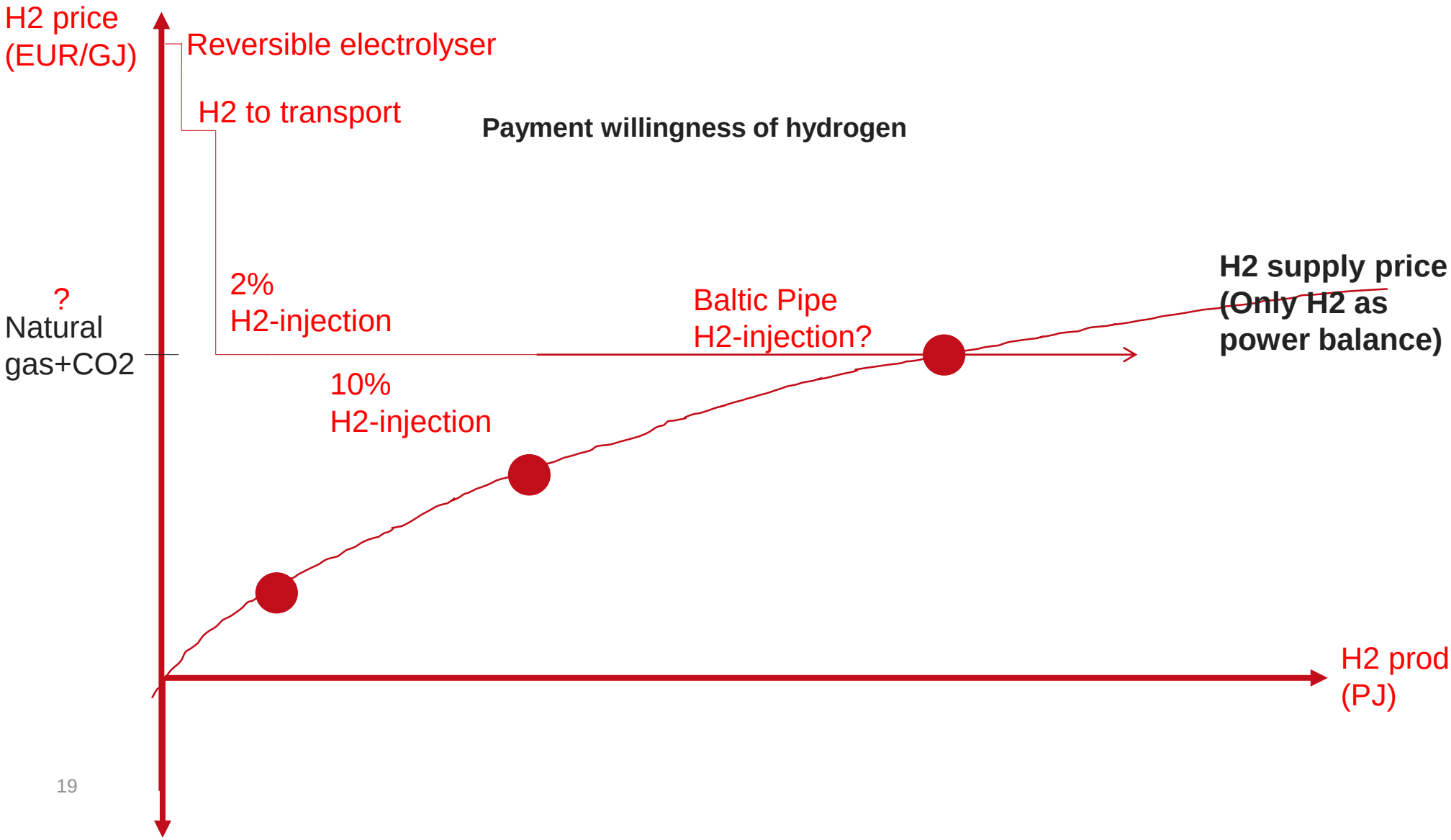
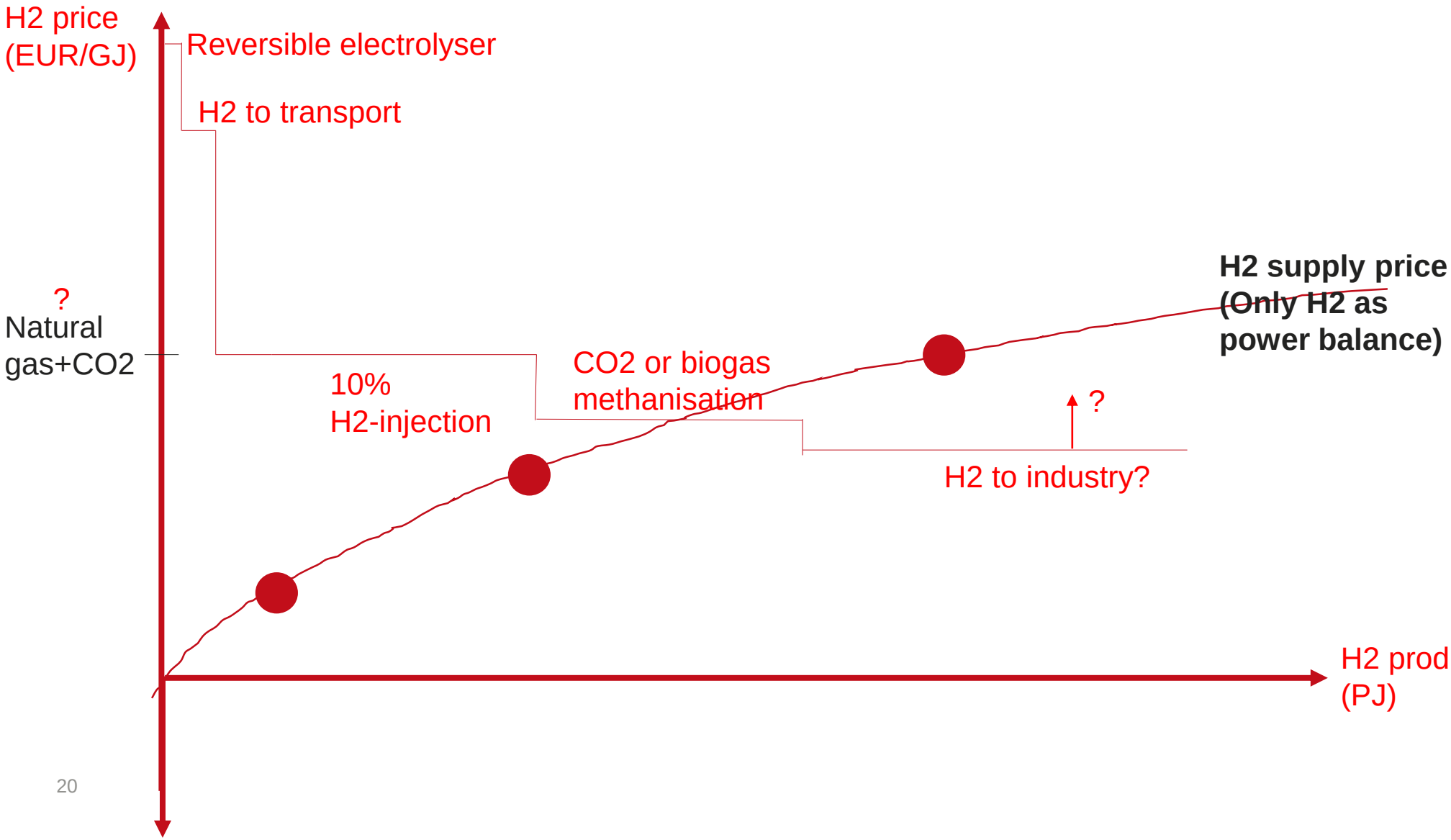
Demand price of hydrogen



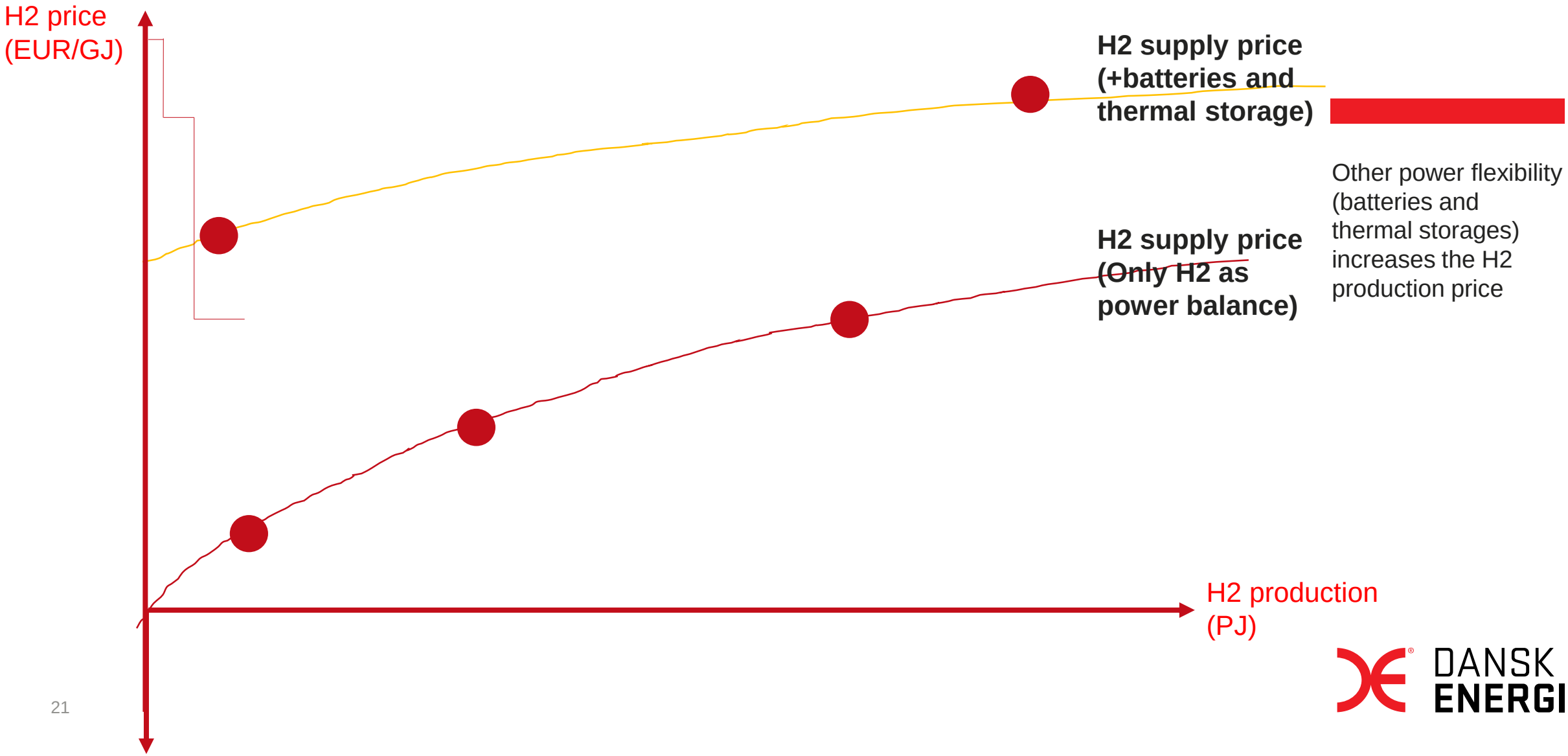
H2 injection option could have high influence – especially with high natural gas+CO2-prices

Demand price of hydrogen

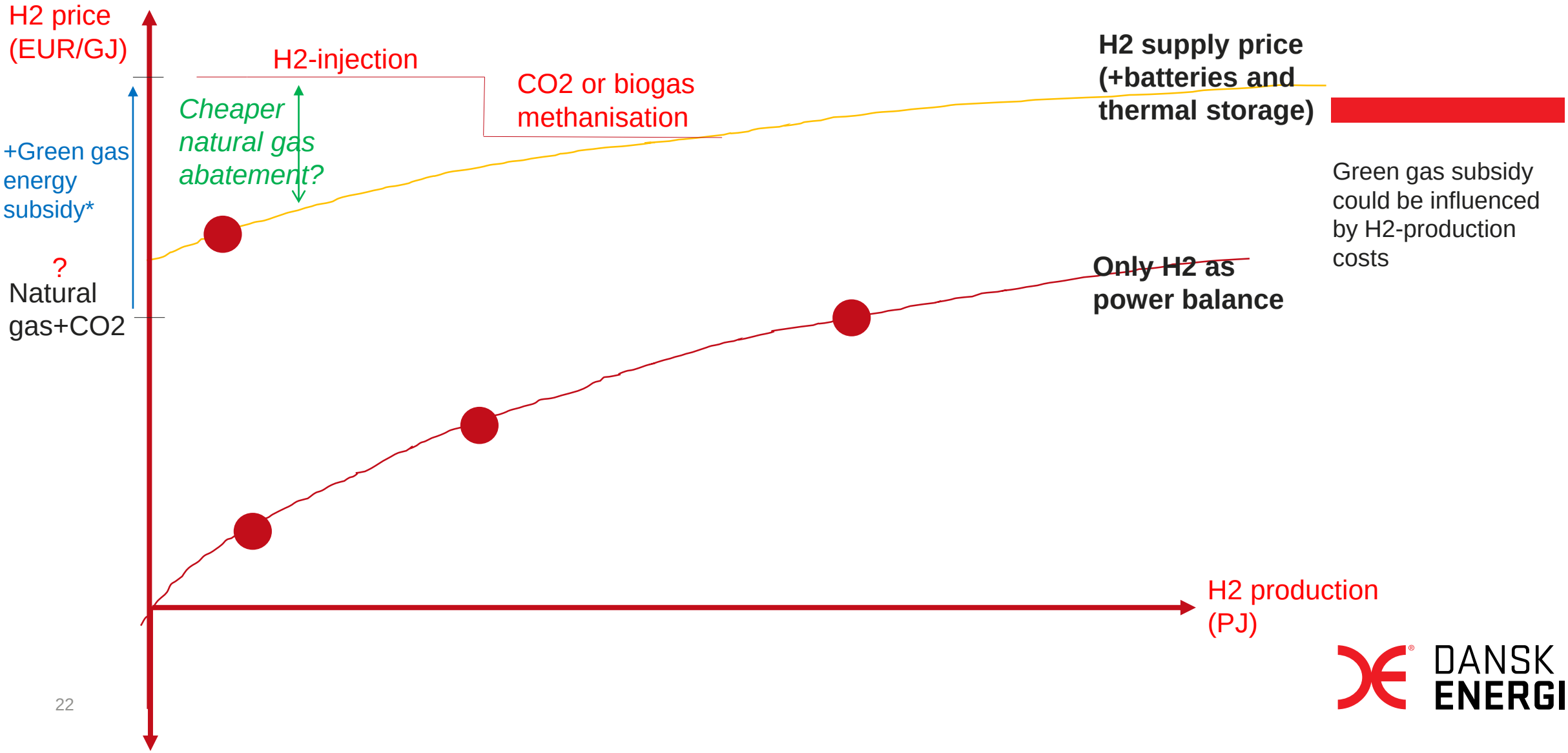


Power to gas with low Full load hours => electrolyser costs has high influence

Supply price of hydrogen – with other flex



Supply and demand of hydrogen



*) Green gas energy subsidy = Biogas subsidy – environmental benifits

Discussion

- Some questions:
  - Key hydrogen demand to include in analysis (Future Gas)?
    - H2 demand prices?
  - Key technology costs? (electrolyser, wind/PV production, hydrogen storages…)
    - H2 supply prices?
  - Economic framework to support flexible hydrogen demand (and storage)
    - Support schemes? RE-gas and RE-fuel?
    - tarif and taxes?

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Tak for opmærksomheden

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