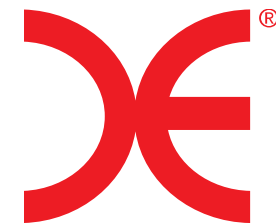
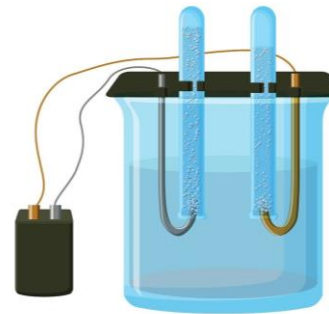

Hydrogen

Future Gas project

Final meeting, June 23 2020

Morten Stryg



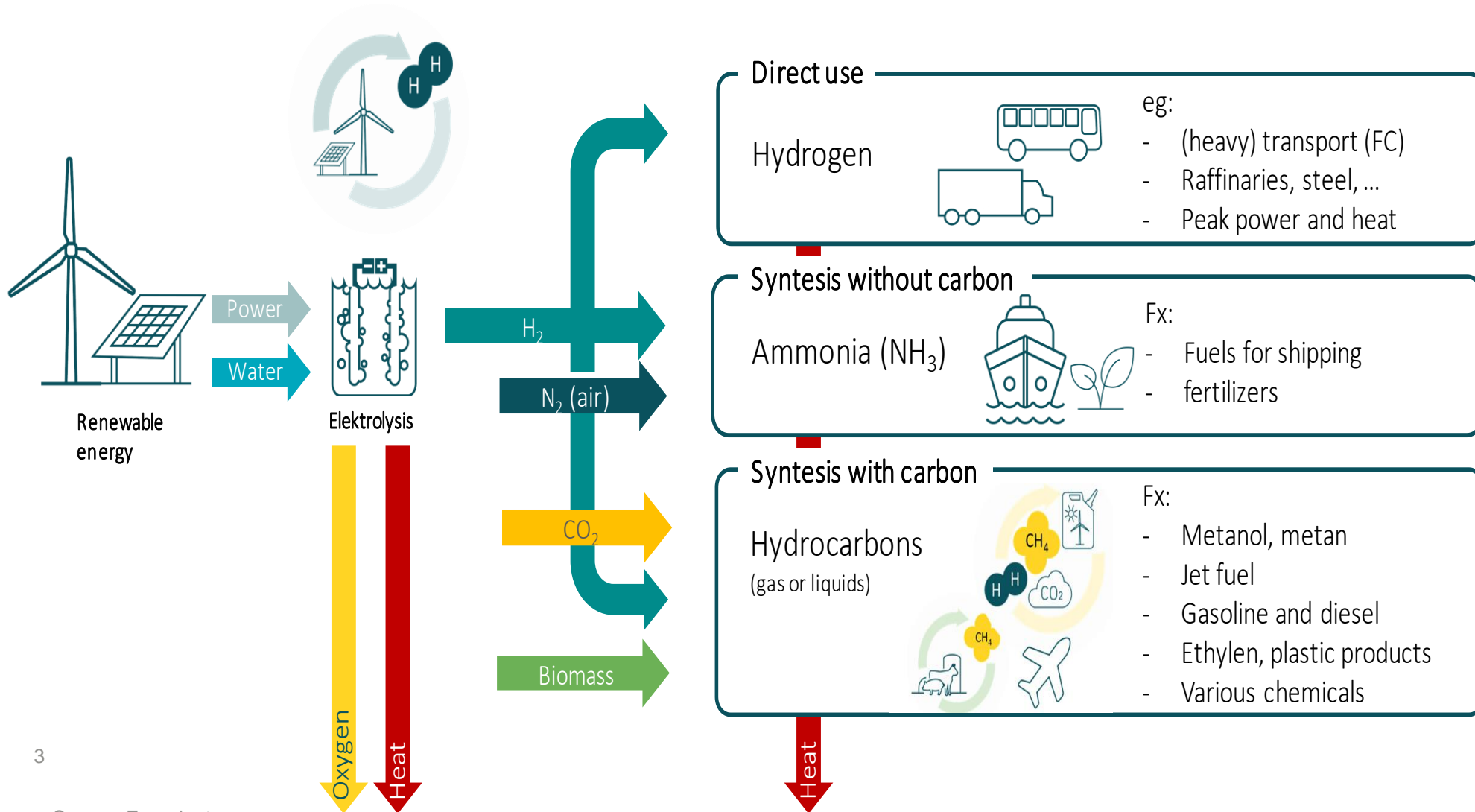
**DANSK
ENERGI**

Agenda



- Introduction to hydrogen and Power-to-X
- Status of hydrogen development
- Potential hydrogen demand in Denmark and renewables potentials
- Hydrogen production costs
- Perspective: Hydrogen infrastructure

Hydrogen is key to decarbonizing hard-to-abate sectors



Hydrogen status in Denmark



Hydrogen pilot projects announced in 2019

- In Copenhagen Ørsted and 7 industry partners announced a 2 MW plant including hydrogen storage.
- HySynergy announced a 20MWe electrolyser plant at the refinery in Fredericia.
- Green Lap Skive announced a 12 MWe electrolyser plant.



New industry partnerships announced in 2020

- Ørsted, SAS and Mærsk along with other partner announced ambitions of a large-scale hydrogen factory in Copenhagen with 1,3 GW electrolysis.
- Shell have plans of building a PtX factory with 1 GW electrolyser plant on their refinery in Fredericia.



New climate agreement June 2020

- At least 750 mio. DKK to new PtX projects in Denmark
- 5 GW energy island in the North and East Sea with possible hydrogen production

- SEAS-NVE, PFA, Pension Denmark and CIP have ambitions to build and run an energy island with up to 10 GW offshore wind and possible onsite hydrogen production.

1,3 GW elektrolyse
Ca. 7-10 TWh



Danske giganter i alliance om enorm brintfabrik i København

Lastbiler, skibe og fly vil inden for det næste årti blive forsynet med store mængder flydende grøn brint fra en fabrik ved Avedøre Holme syd for København. Sådan lyder den ambitiøse plan fra dansk erhvervslivs helt store spillere som blandt andre Ørsted, Mærsk, DSV, SAS og Københavns Lufthavn.

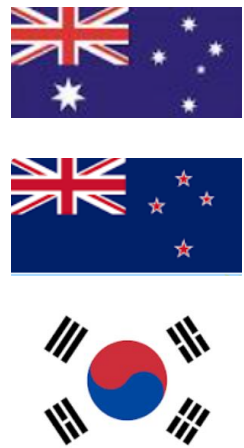
1 GW elektrolyse
Ca. 5-8 TWh



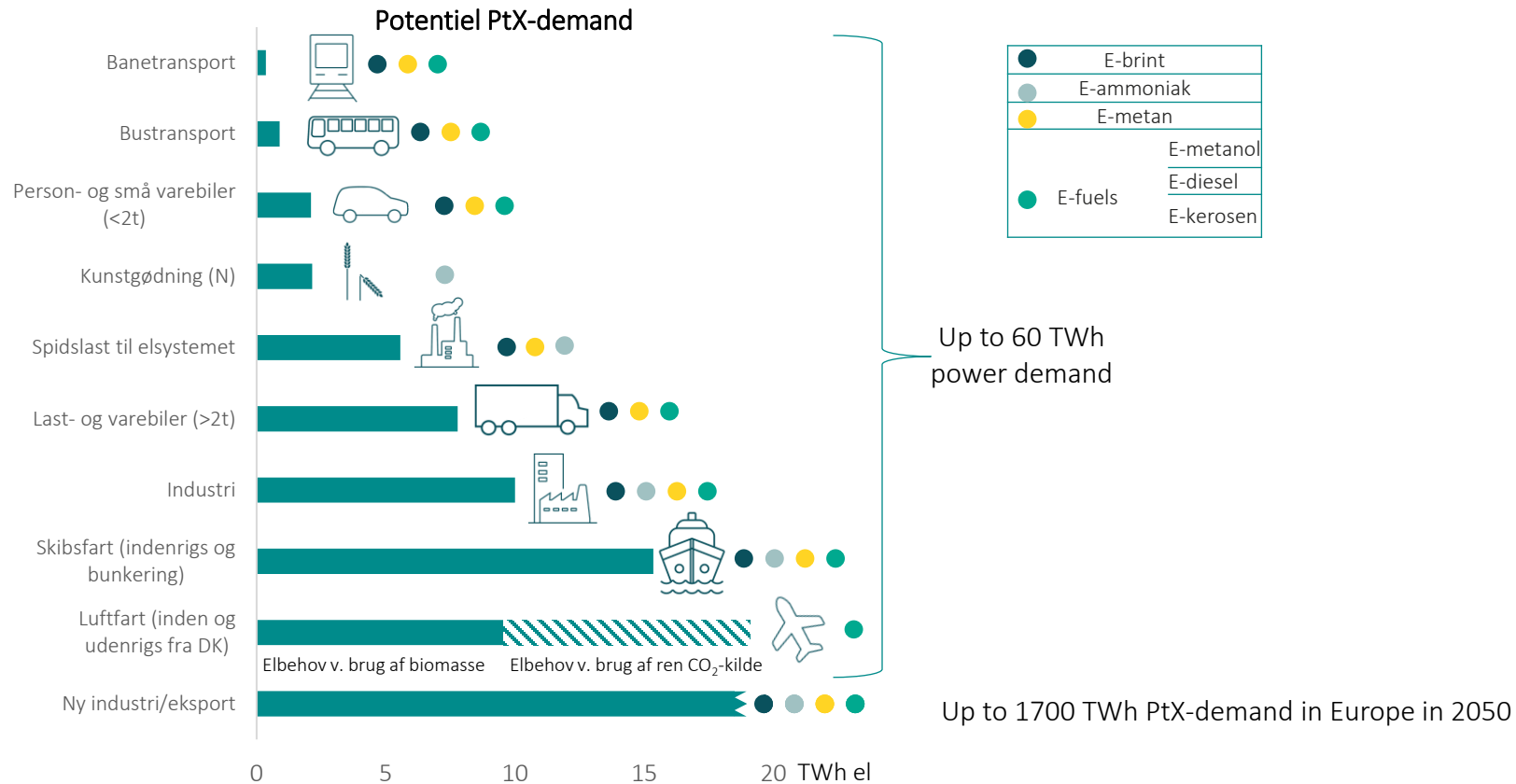
Shell vil opføre Europas største grønne brintfabrik i Danmark

Med ambitioner om et gigawattstort anlæg vil Everfuel i samarbejde med oliemastodonten opføre et P2X-anlæg ved raffinaderiet i Fredericia.

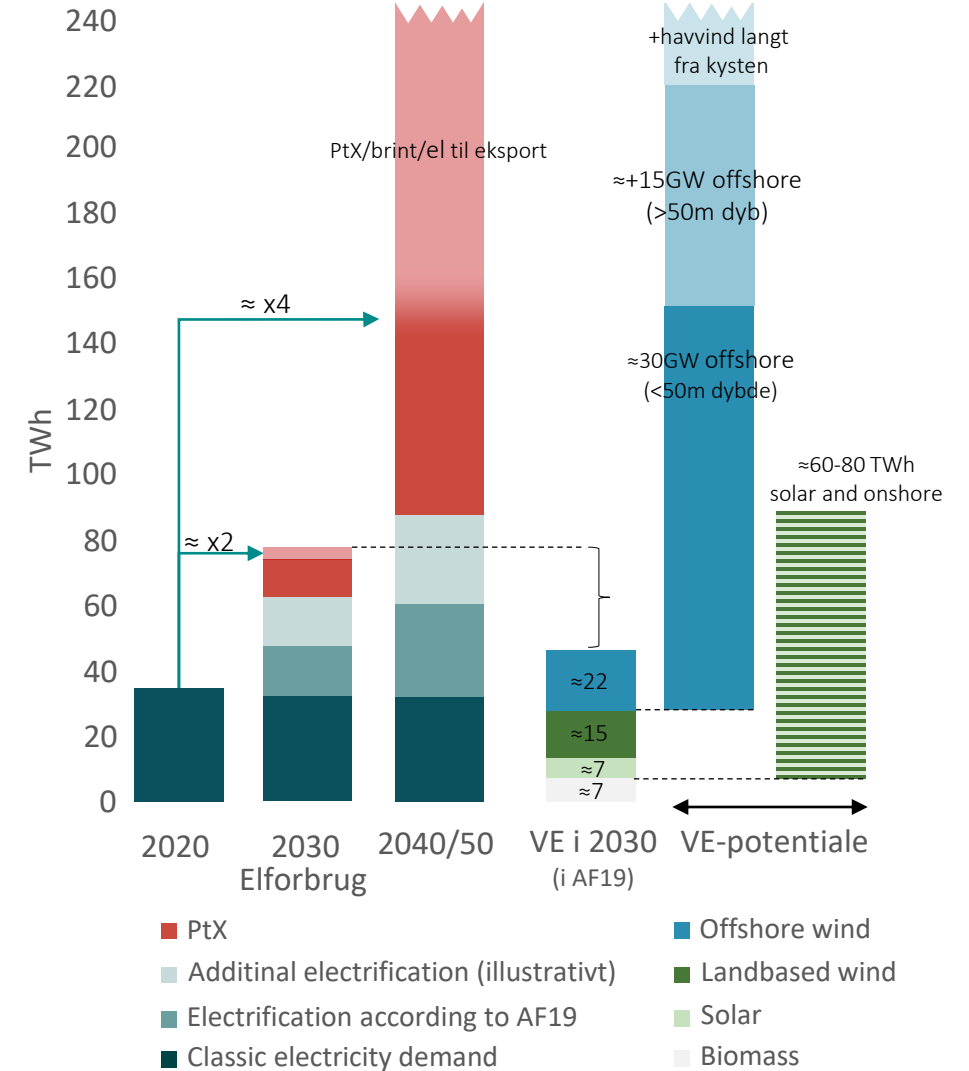
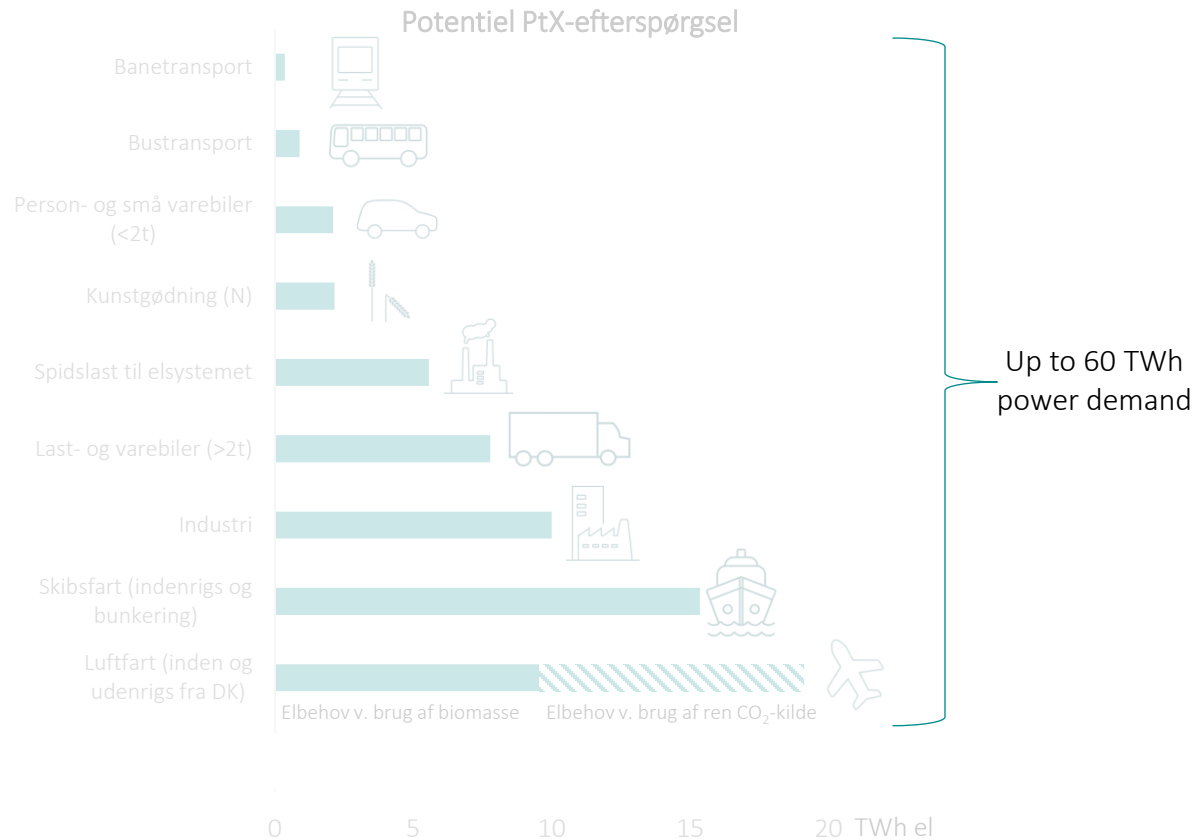
Recently published hydrogen strategies



Power demand for Power-to-X by end-use



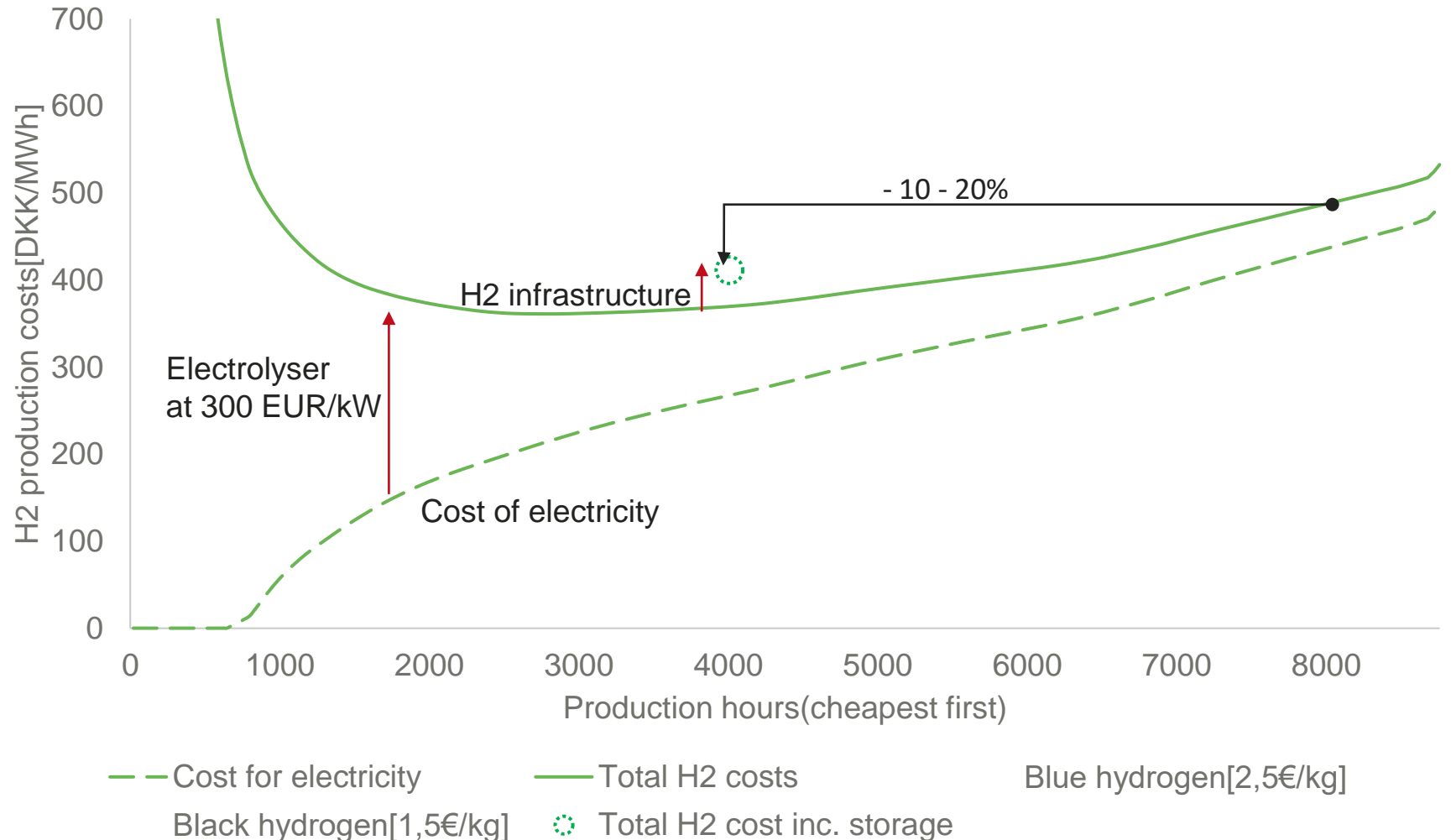
Renewable power potentials in Denmark



Hydrogen production costs

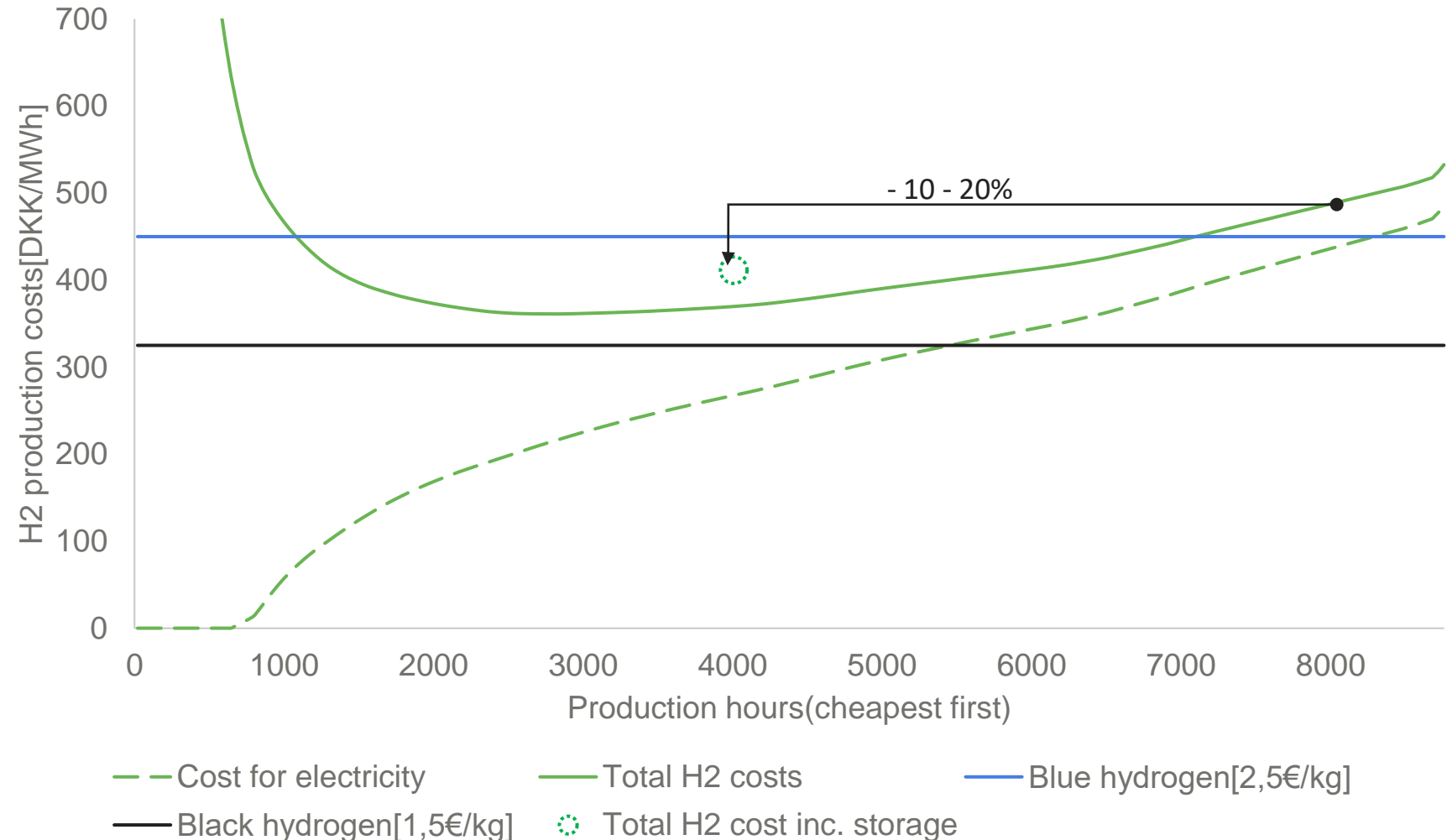


- Smart production of hydrogen is essential for reducing cost
- Optimal split between storage/infrastructure and hydrogen production capacity is dependent on costs and power system

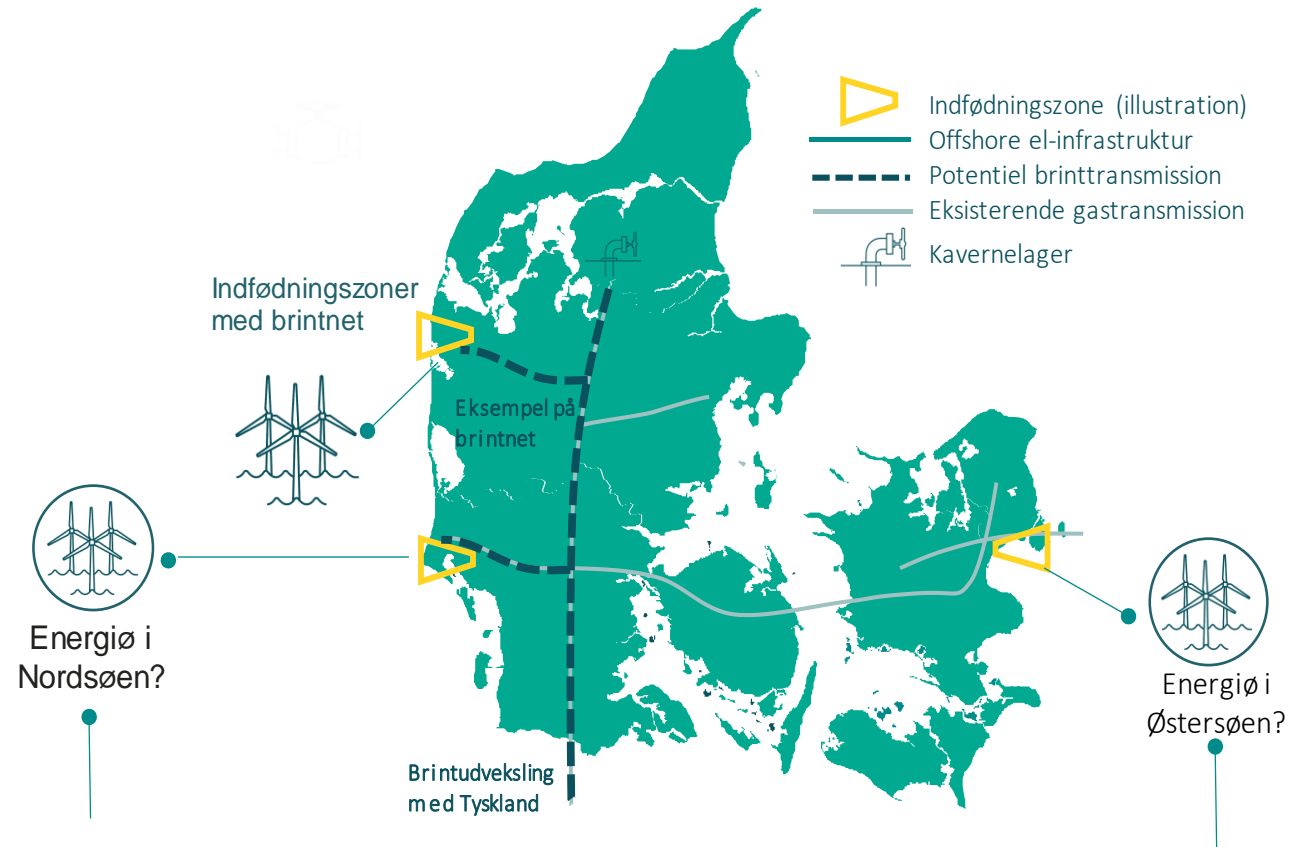
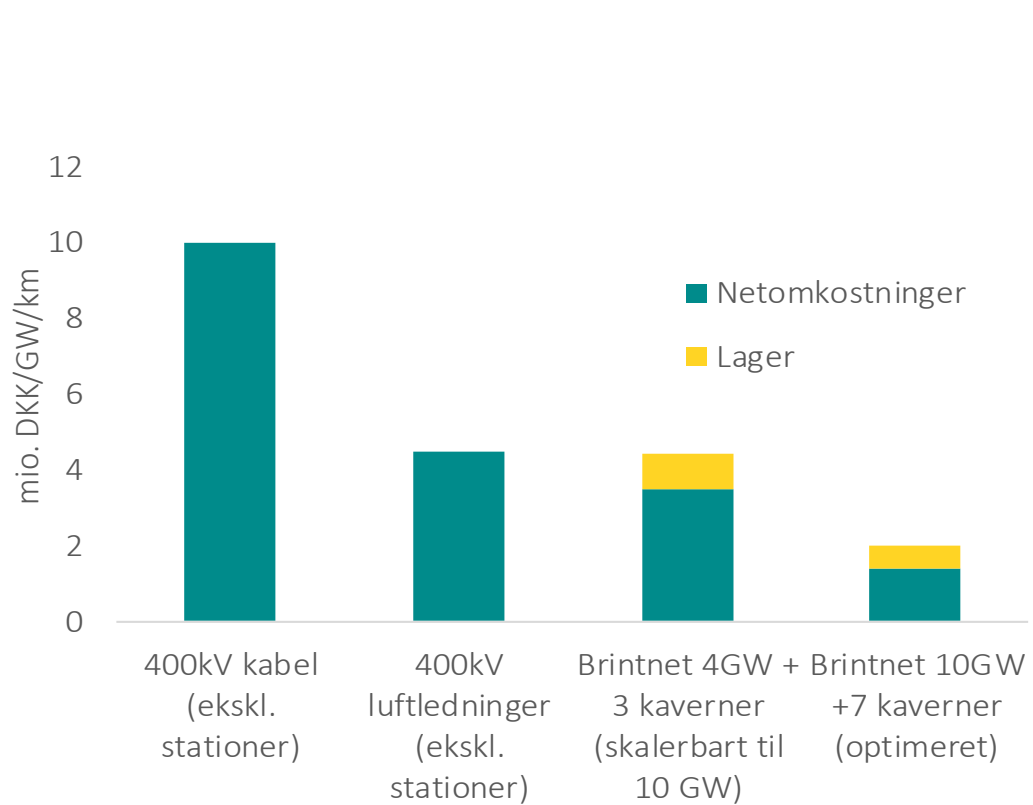


"Green" hydrogen produced in Danmark can compete with "blue" hydrogen in 2030

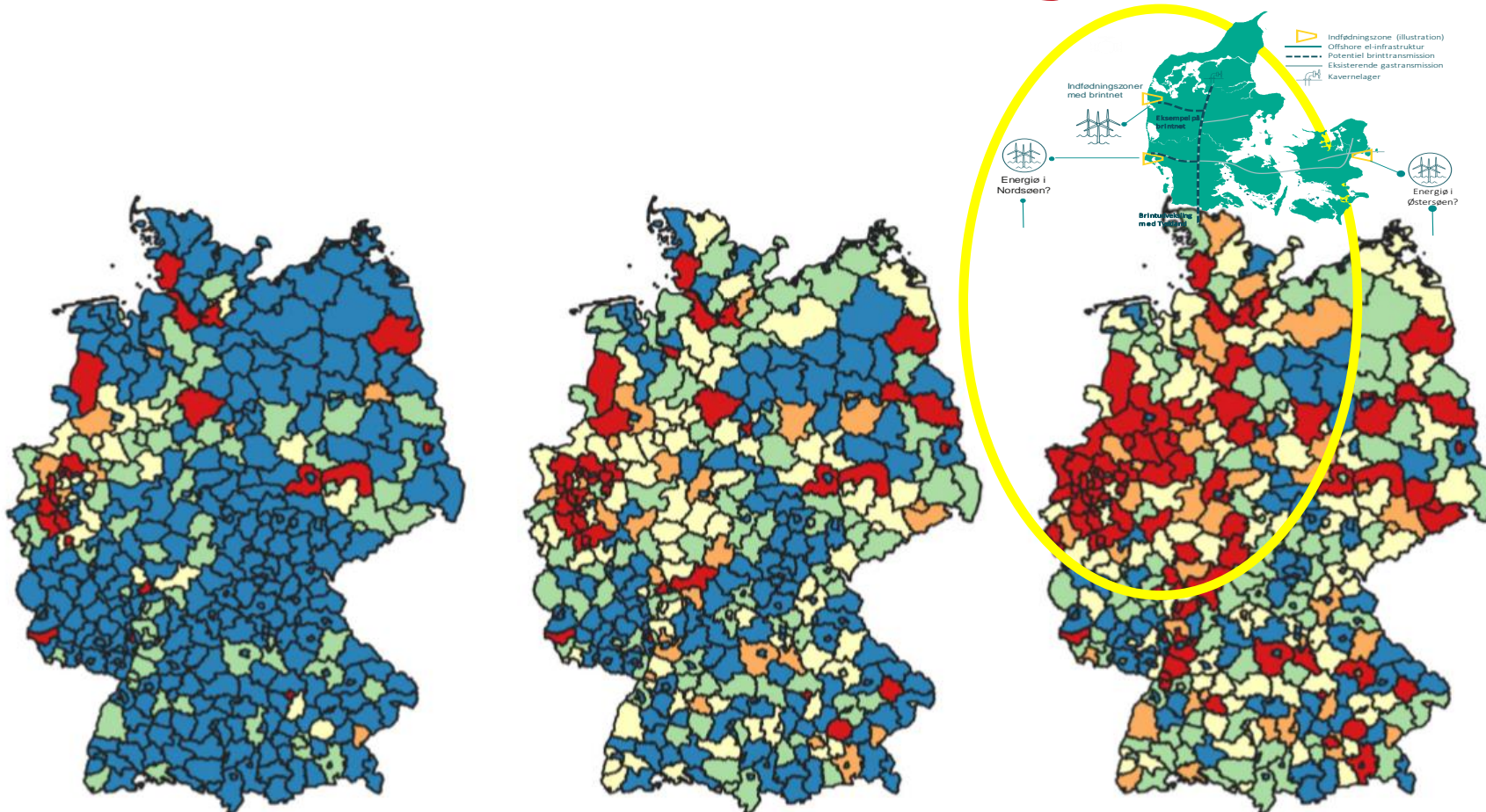
- Smart production of hydrogen is essential for reducing cost
- Optimal split between storage/infrastructure and hydrogen production capacity is dependent on costs and power system



The new infrastructure: Hydrogen and/or electric infrastructure



Hydrogen grids and increased demand could appear in Germany before 2030



Hydrogen grid:
 ~1000 km in 2030
 ~6000 km in 2050

1 Total hydrogen consumption in TWh

■ ≤0.1
 ■ 0.1-0.2
 ■ 0.2-0.4
 ■ 0.4-0.6
 ■ >0.6

Source: fnb-gas.de

