Hyper – idea and concept

The Role of Large Scale Hydrogen, *Brussels*, *December 10, 2019*

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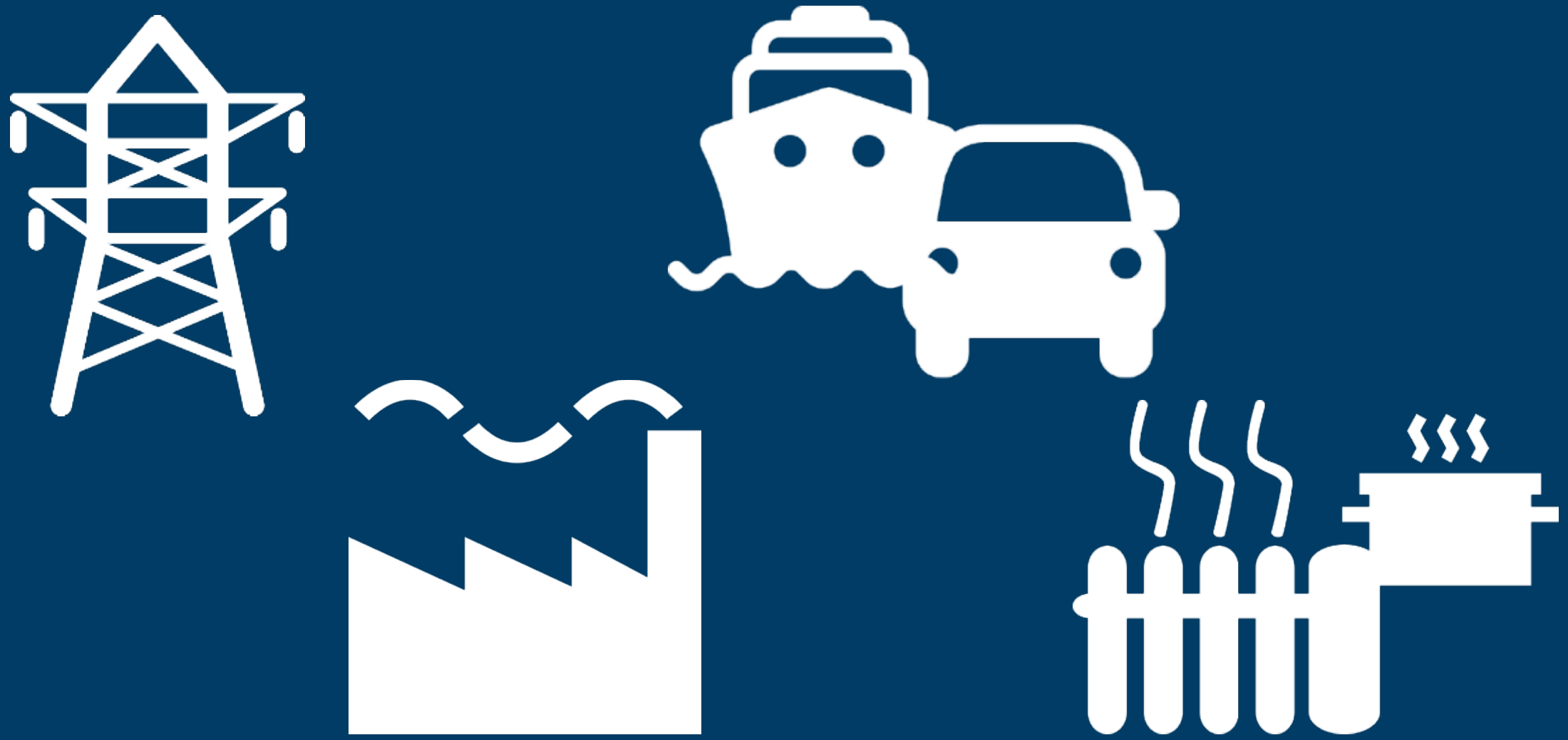
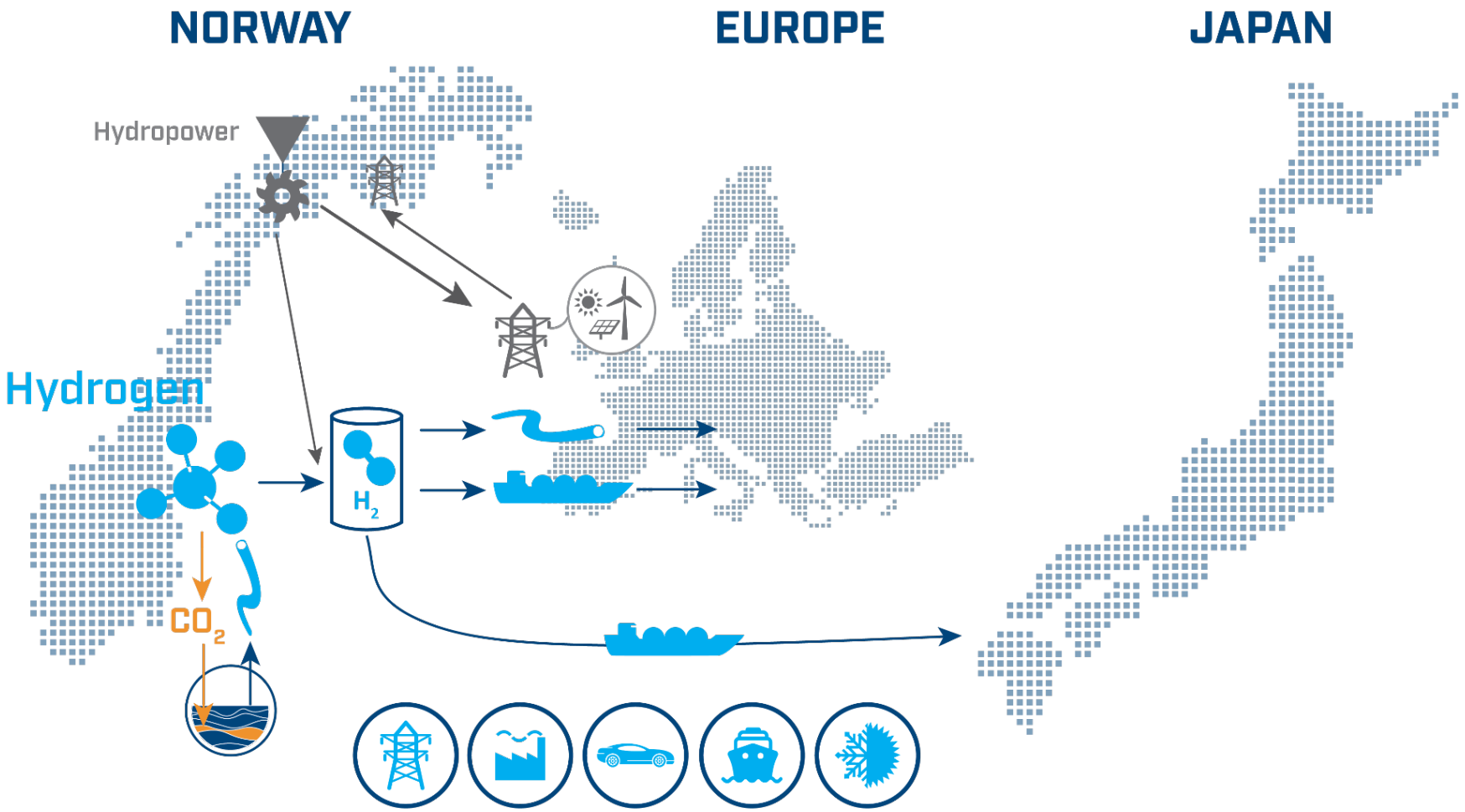


Hyper project idea, large scale hydrogen production for export



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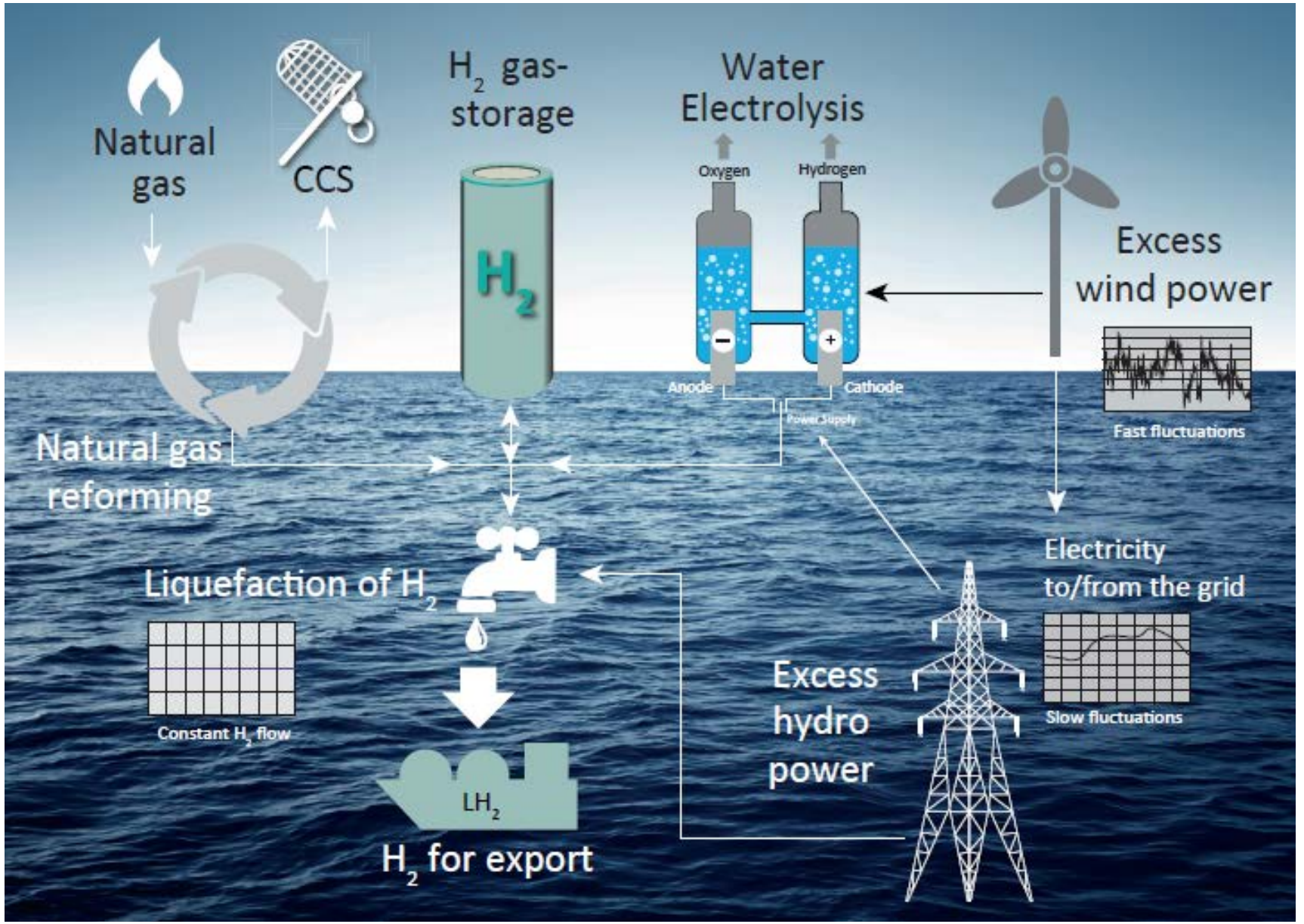
The Hyper concept



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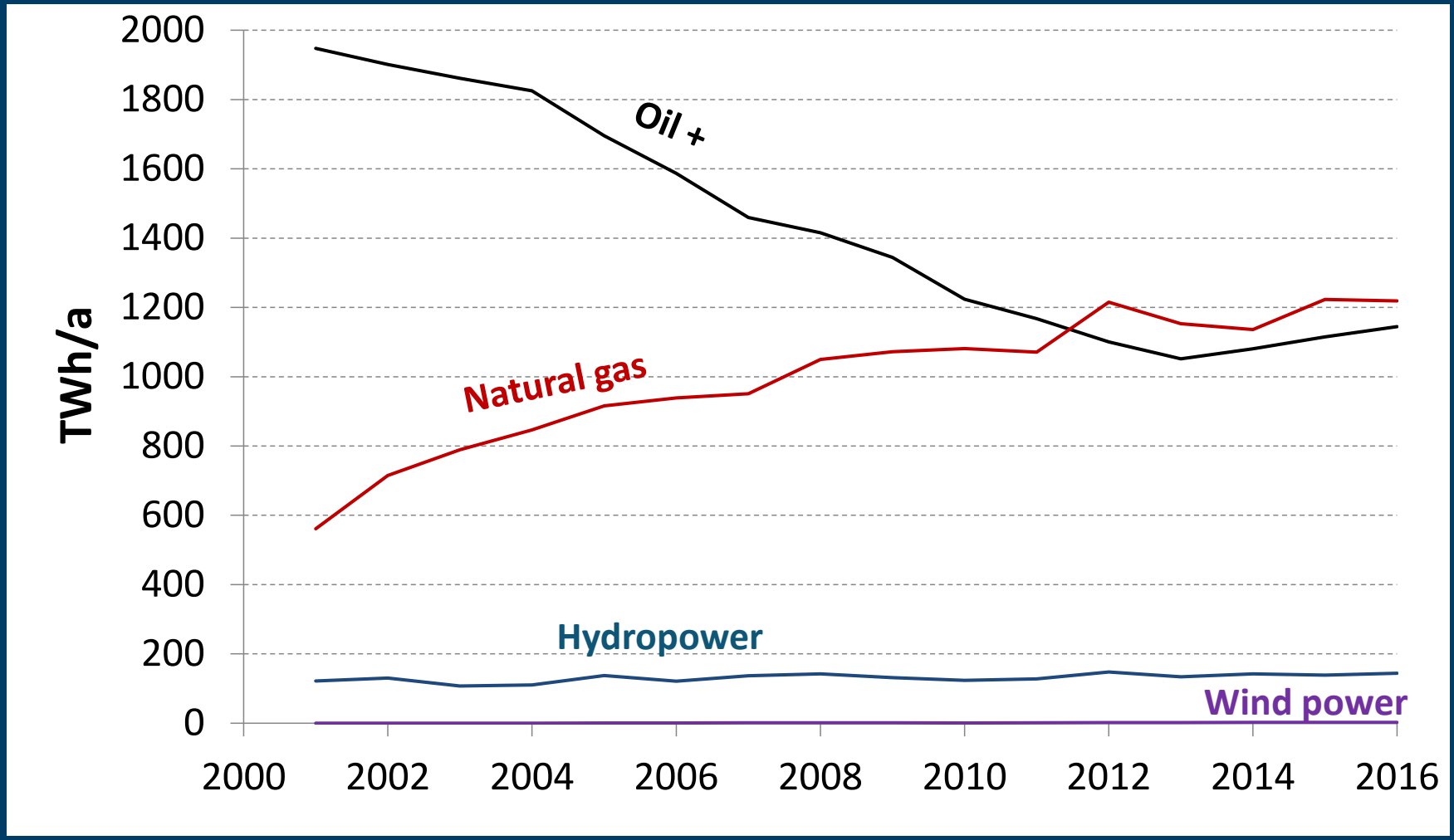
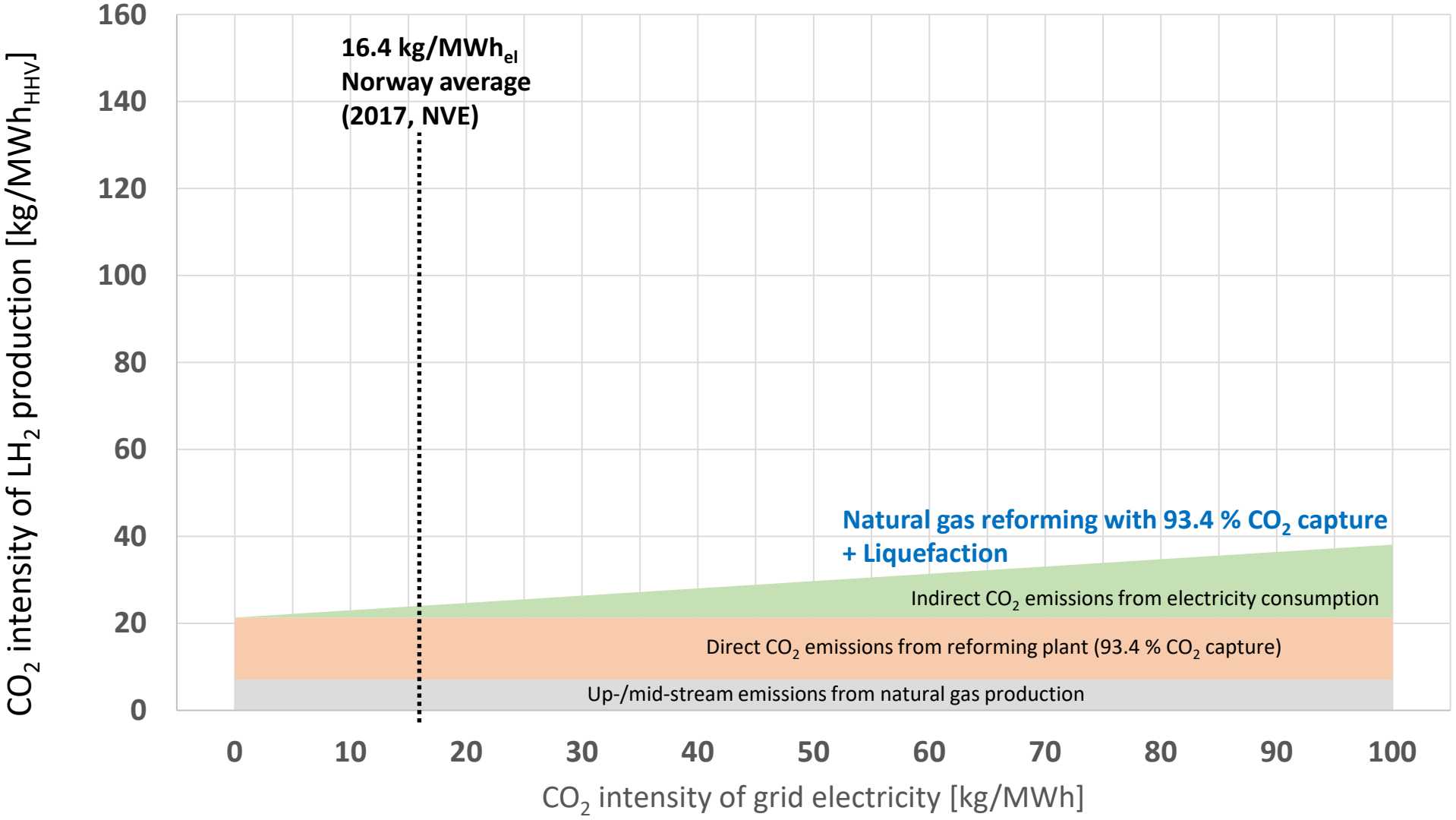
Primary energy sources in Norway



Data source: Statistics Norway, Norsk Petroleum

CO_2 intensity of liquid hydrogen product



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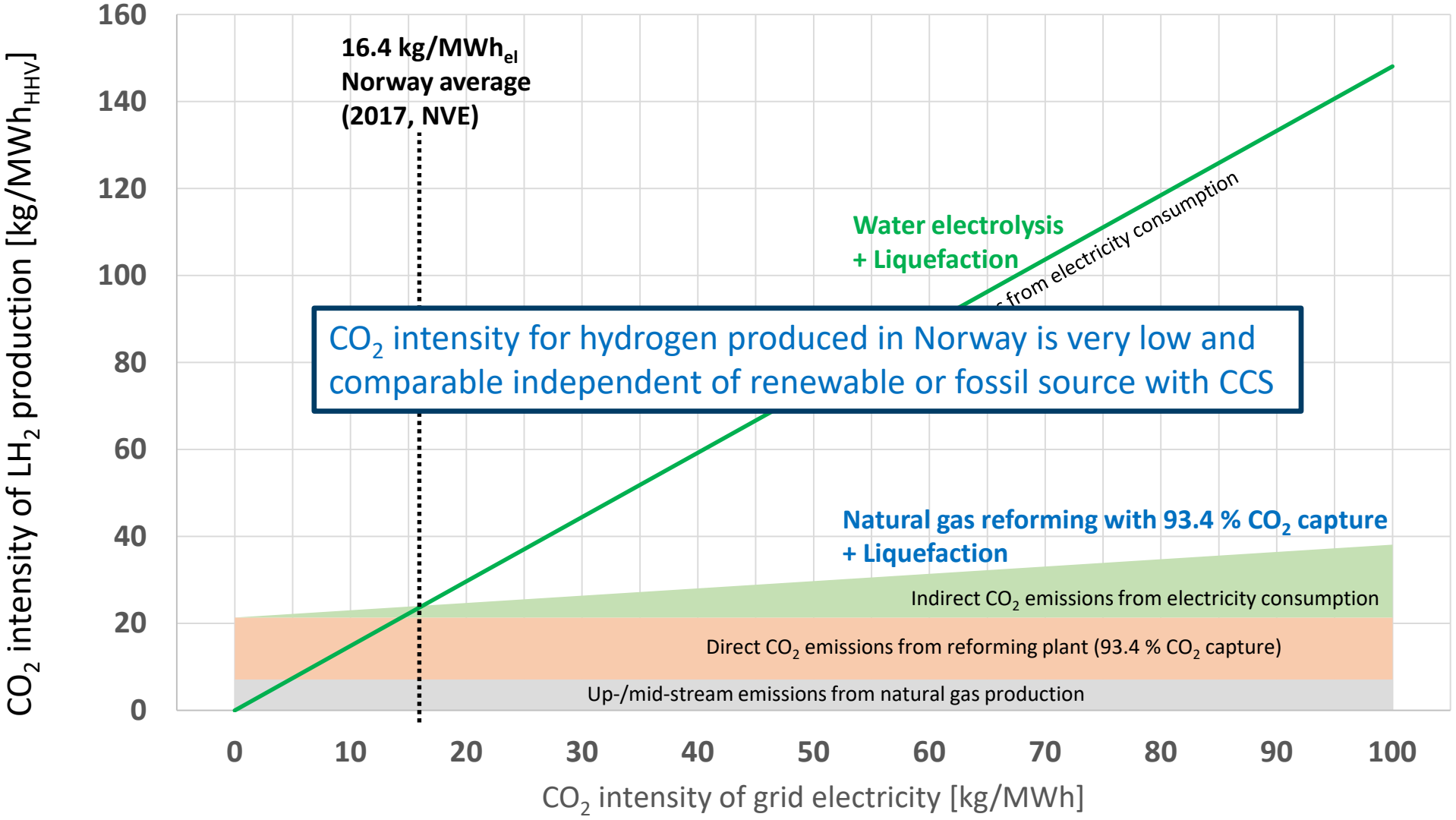
CO_2 intensity of liquid hydrogen product



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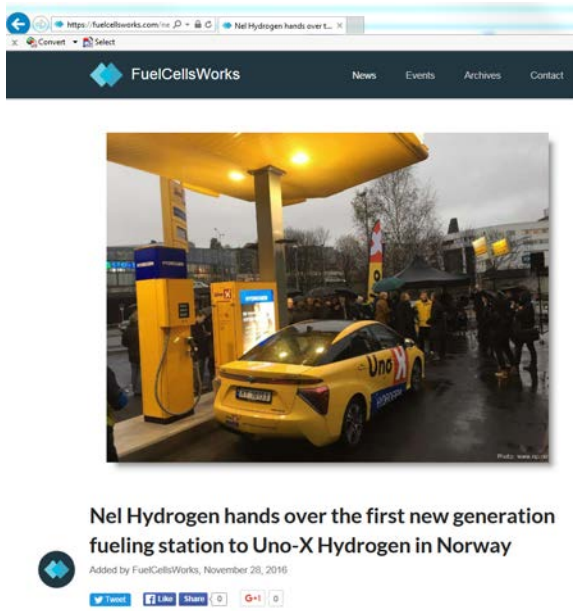
Examples of **scale** of production

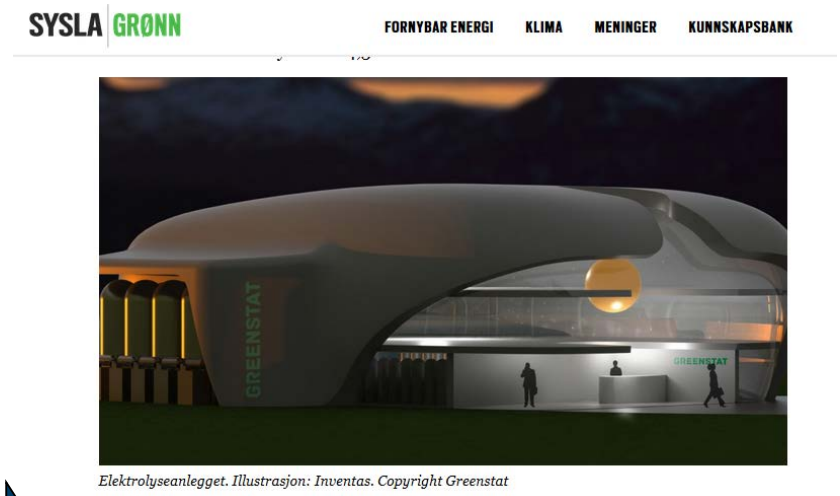
Hydrogen fuelling station



0.2–1 ton/d
(≈ 0.4–2 MW)

x 10 – x 100

Domestic use in industry (Tizir, Tyssedal)



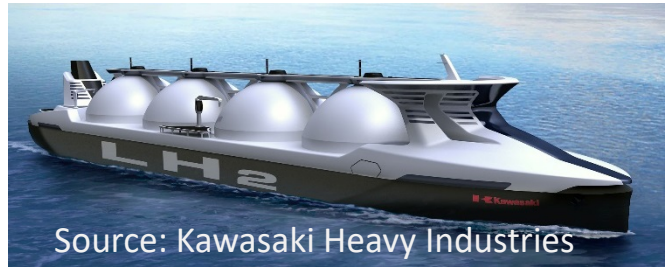
Elektrolyseanlegget. Illustrasjon: Inventas. Copyright Greenstat

30 ton/d
(≈ 50 MW)

x 15 – x 25

Scale of the Hyper project

Production, liquefaction of LH_2 for long-distance bulk transport



Source: Kawasaki Heavy Industries

500 ton/d
(> 1000 MW)

x 500–2500

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In perspective: 500 ton liquid hydrogen per day

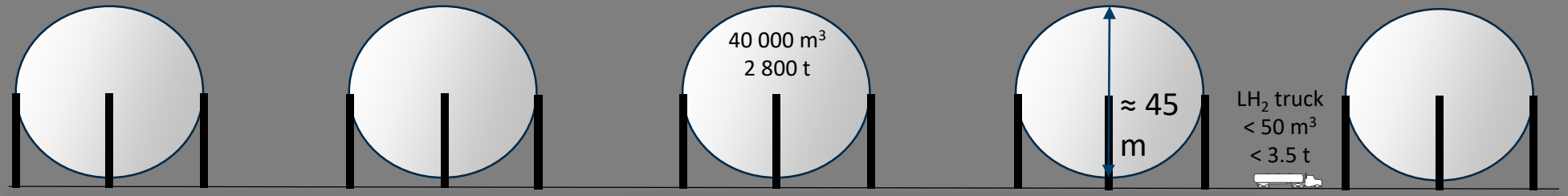
- **820 MW_{HHV}** hydrogen energy flux
- **7 TWh per year** of hydrogen energy output
- Decabonised fossil route (NG with CCS):
  - < 1 % of annual domestic natural gas production
- Green route (electricity as sole primary energy source):
  - > 1200 MW electric power
  - ≈ 10 TWh_{el} annually (about 7 % of annual domestic power generation)

Source: Kawasaki Heavy Industries

Scale and duty requirements – production volume rate and storage

Prospective LH_2 carrier
4 x 40 000 m^3
11 000 t

- Envisioned production volume: **500 tons per day**
  - Required volume for one 160 000 m^3 ship loading every 3 weeks (16 calls annually)
  - Comparison, Snøhvit LNG plant: 60–70 calls per year
- Energy flux in the hydrogen product stream:
  - 5.8 kg/s * 142 MJ_{HHV}/kg ≈ **820 MW_{HHV}**
- Corresponds to about **7 TWh per year** of energy output
- Theoretical minimum storage volume: 160 000 m3. Sketch below indicates size of 5 aligned 40 000 m3 spherical LH2 storage tanks (200 000 m3)



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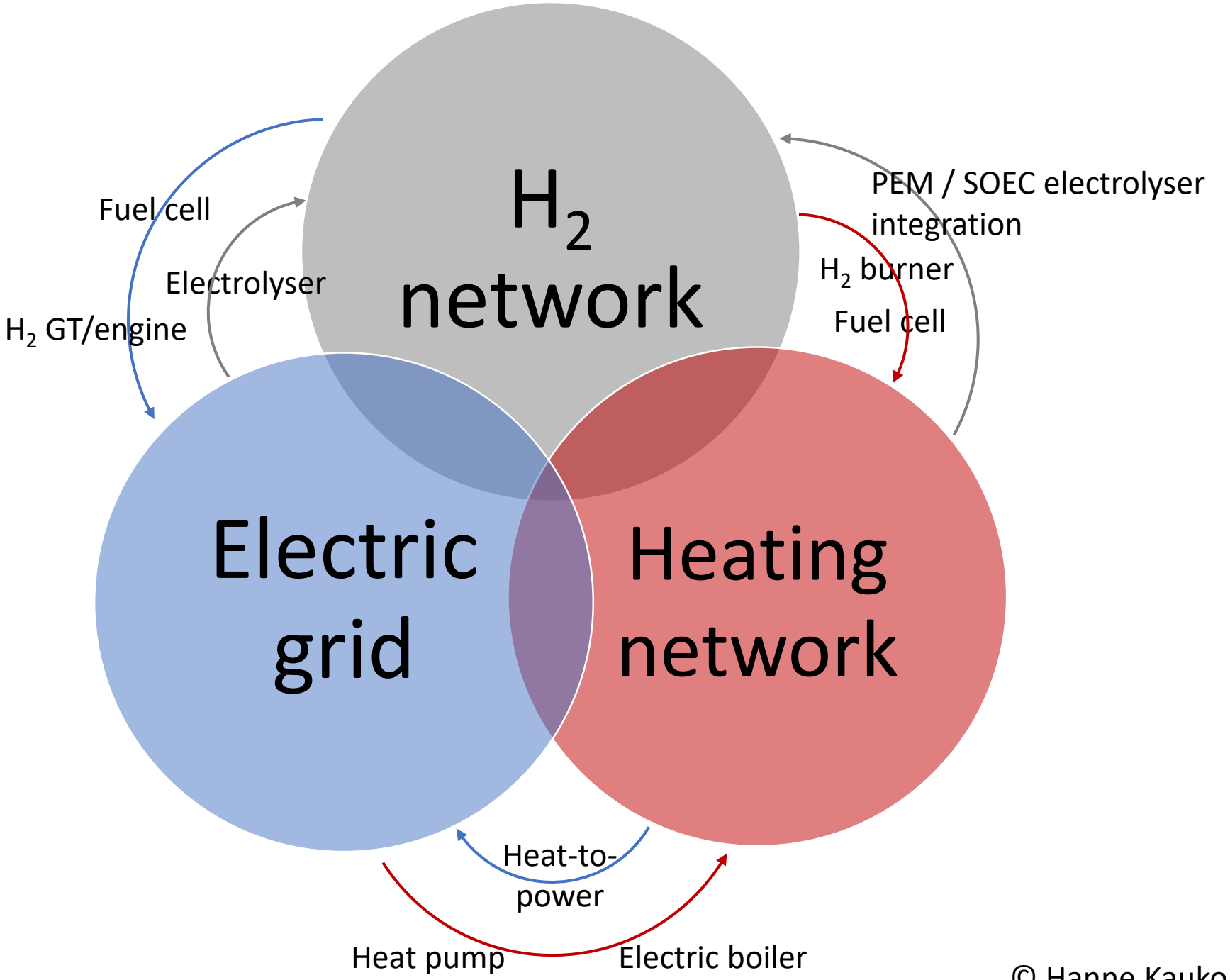
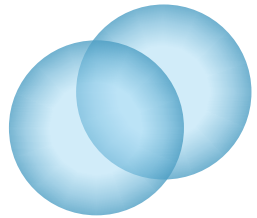


Summary



- Norway has a large potential for hydrogen export
  - Mid-term: Low-emission hydrogen in the GW range could be made from natural gas with CCS
  - Long-term: Increasing potential from renewable power
- Both sources can give very low net CO_2 emissions
- Hydrogen from fossil and renewable sources can be exported through common infrastructure
- Hydrogen production and export from Norway may be an emerging option of interest for:
  - valorisation of domestic energy resources
  - realising new industrial-scale CO_2 capture and storage projects
  - contributing to reductions in global CO_2 emissions within power, heating, transport and industries
- Let us find the optimal balance between the options available to obtain a *quick, secure* and *affordable* transition

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Teknologi for et bedre samfunn