

European Gas Virtual 2021

Natural gas to blue hydrogen –
Pipeline Transportation to Market and Decarbonisation in Multiple Sectors

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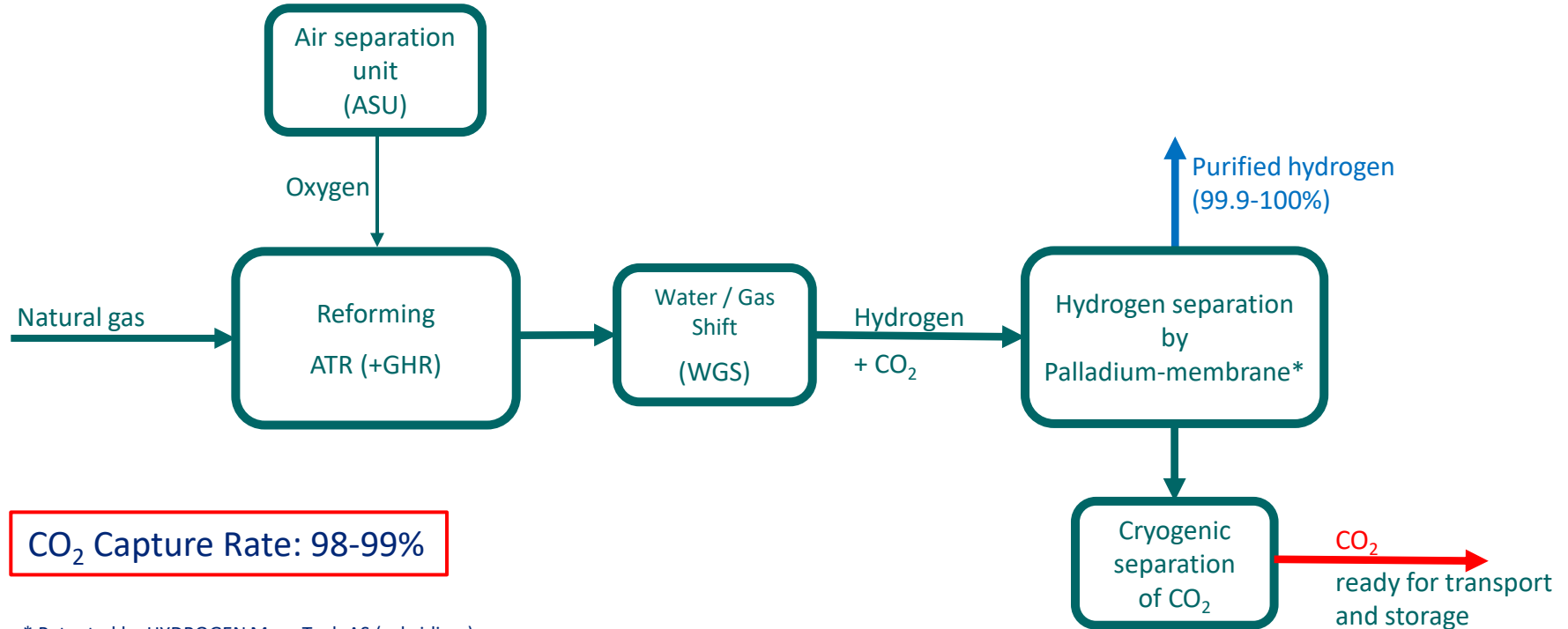
.... Developing Clean Energy Solutions

Large scale, emission-free production of hydrogen – HyPro-Zero™

Existing technology in a new combination!

Clean and affordable!

PATENT PENDING
By REINERTSEN New Energy AS



CO₂ Capture Rate: 98-99%

* Patented by HYDROGEN Mem-Tech AS (subsidiary)

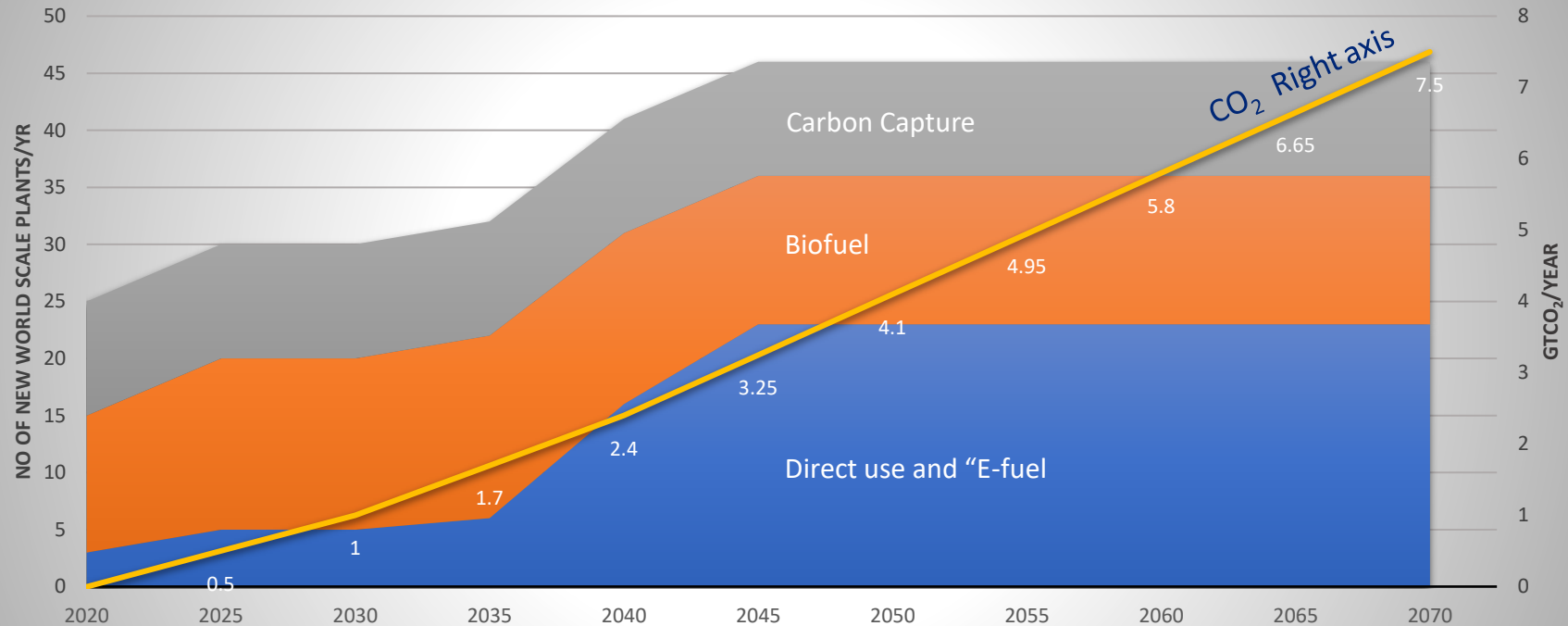
Competitive emission-free, blue hydrogen production

Hydrogen production cost (incl. CO ₂ capture)*:	1.2 €/kgH ₂
+ CO ₂ transport and storage cost:	0.3 - 0.5 €/kgH ₂
Total production cost**:	1.5 - 1.7 €/kgH₂

* Natural gas price assumption: 0.12 €/SM³

** Net cost, excl. financing, distribution of hydrogen etc.

Significant global demand for new blue hydrogen production plants - and associated CCUS capacity

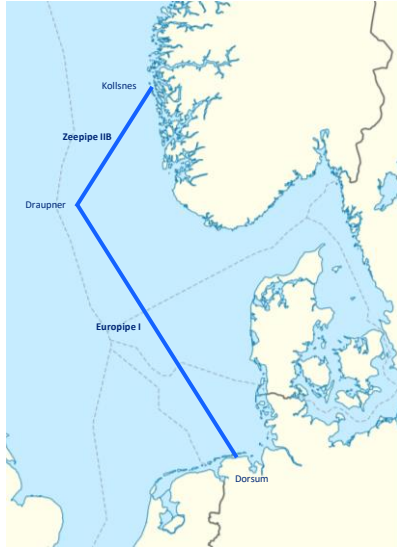


Data from:
IAE report; Energy Technology Perspective (Sept. 2020)
Concawe report; biofuel and "E-fuel" Sept. 2020

"World scale plant": 400.000 tH₂/year

Gas pipelines for efficient hydrogen transportation - Examples

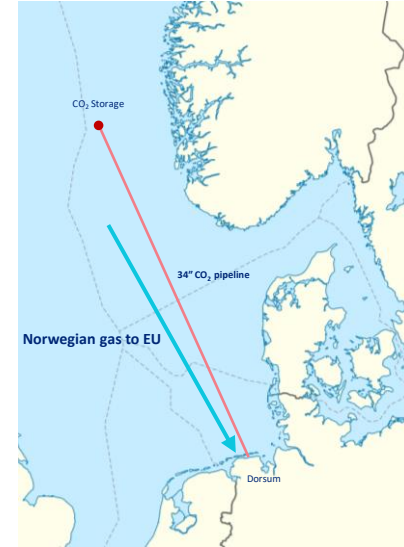
Existing gas pipeline converted to hydrogen service, 40"/924km



New hydrogen pipeline 42"/800km
(3.5 million ton H₂/year)



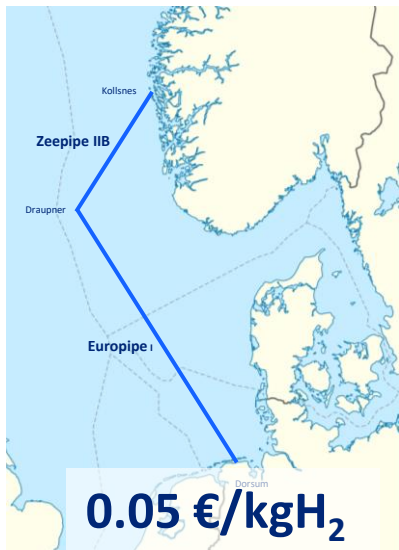
New pipeline for CO₂ return to Norway, 34"/800km



Gas pipelines for efficient hydrogen transportation – Examples

Cost of hydrogen transportation (€/kgH₂)*

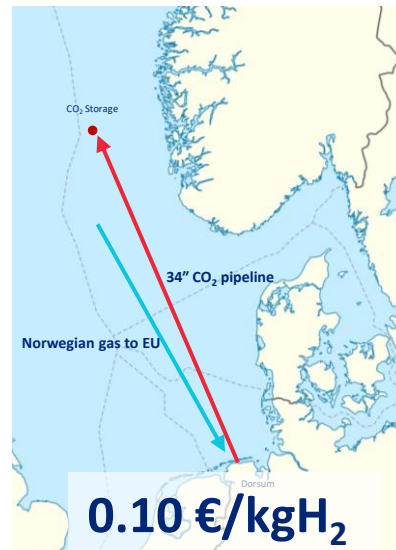
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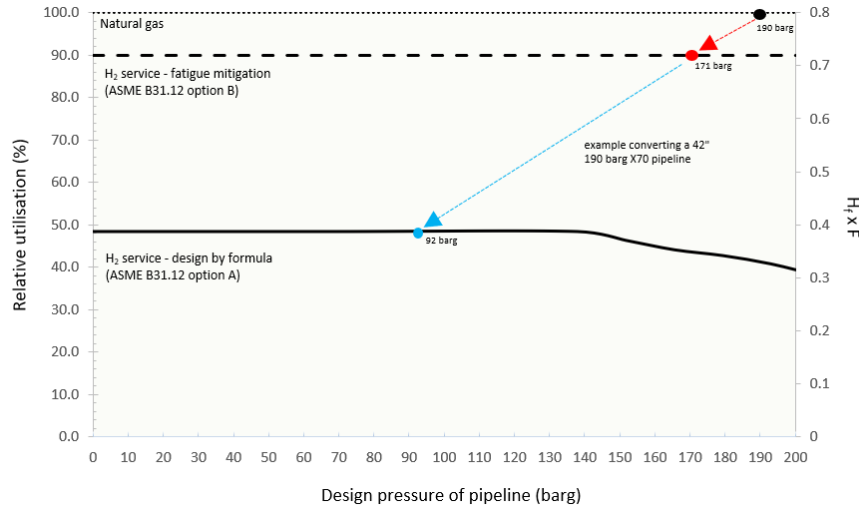
New pipeline for CO₂ return to Norway, 34"/800km



*Net cost, excl. financing etc.

Hydrogen Pipeline Design

Relative reduction of design pressure for existing pipeline when converting X70 steel grade pipeline from natural gas to H₂ service



Reduction of pressure in range 10 % (●) to 50% (●) compared to natural gas, 100% (●).

A target of 90% (●) utilization may be obtained by fatigue mitigation ¹⁾;

- Material qualification testing and documentation
- Reducing pipeline free spans by rock dumping

¹⁾ M. Hval and S.V. Gråberg: "Transportation of Hydrogen Gas From a Local Plant to Remote Markets via High Pressure Submarine Pipelines", OMAE 2017, paper 61355.

"Advanced engineering enables utilization of existing subsea pipelines with minor reduction of design pressure"

Large scale, competitive, blue hydrogen production and transportation

Hydrogen production cost (incl. CO₂ capture)*: 1.2 €/kgH₂

+ CO₂ transport and storage cost: 0.3-0.5 €/kgH₂

Total production cost: 1.5-1.7 €/kgH₂

+

Hydrogen transportation Norway – Germany/Netherlands: 0.08 €/kgH₂

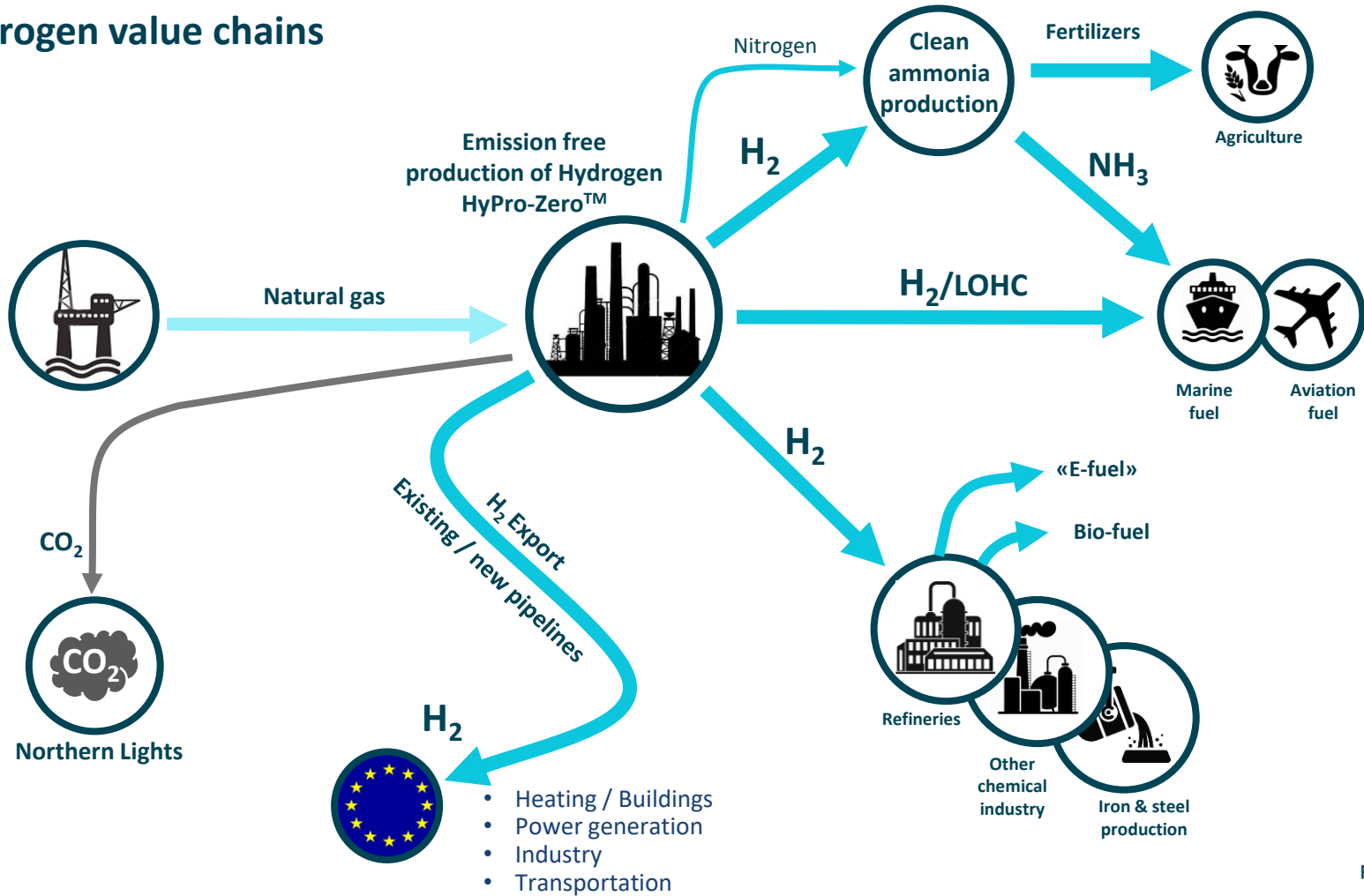
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Total production and transportation cost:** ~ 1.7 €/kgH₂

* Natural gas price assumption: 0.12 €/SM³

** Net cost, excl. financing, etc.

Hydrogen value chains



CO₂ abatement cost utilizing blue hydrogen (HyPro-Zero™)

- Emission-free production of hydrogen by efficient Carbon Capture at high pressure, from synthesis gas.
- CO₂ void-cost by use of blue hydrogen: **150-200 €/ton CO₂** (dependent of application)*

* Net costs, inclusive CCS, excl. financing etc.

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..... we make Zero happen!

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