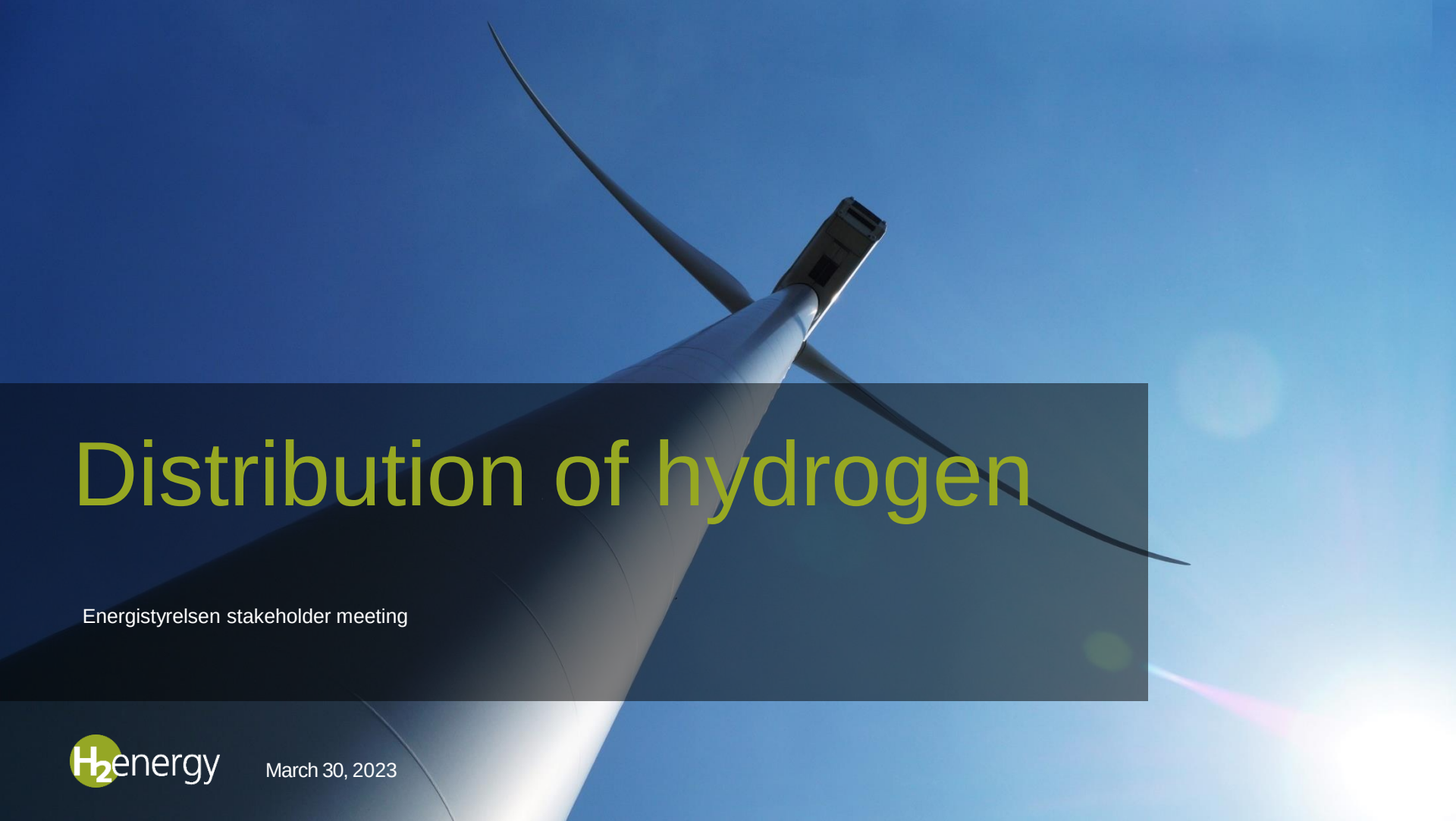

Distribution of hydrogen

Energistyrelsen stakeholder meeting

H2energy

March 30, 2023

H2 Energy – an integrated global hydrogen player

	UPSTREAM	MIDSTREAM	DOWNSTREAM	OFF-TAKE
PORTFOLIO	 Hydrospider			 Hyundai HM
PROJECTS	  Spedla Milford	OGE/H2E Rodeo Refinery Jet/H2 Midstream	PHILLIPS 66 H2energy JV Jet/H2	  DFDS Prinoth
TECHNOLOGIES	Engineering CH Engineering HUN Engineering DK	  Carbon cylinder Glass fiber cylinder		 Kvyreen

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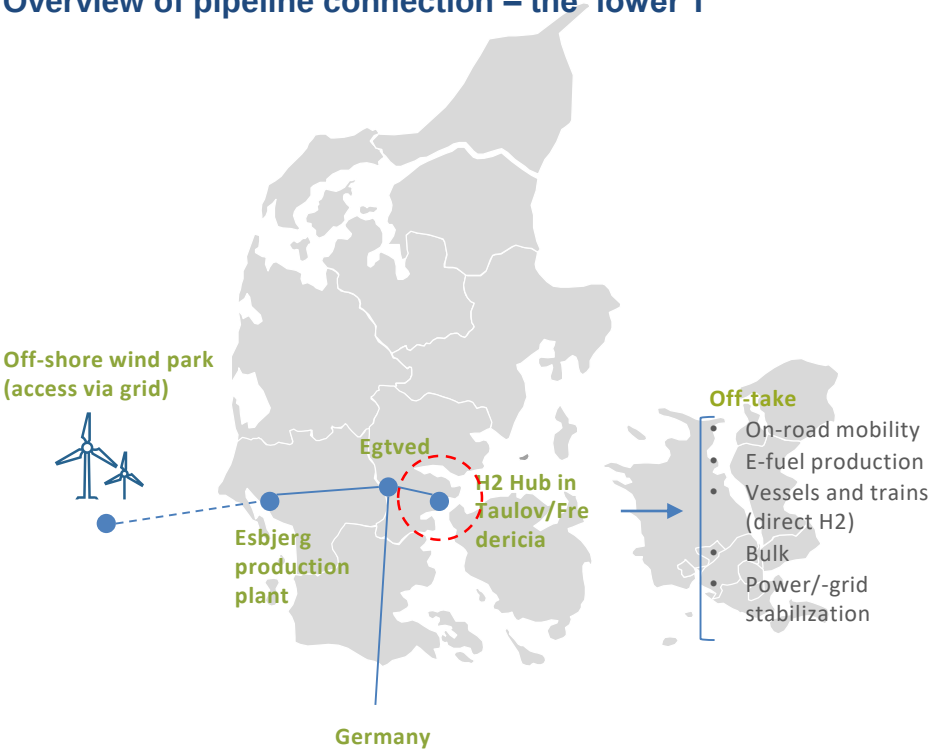
We will establish a GW hydrogen production plant in Esbjerg – connection to pipeline is crucial. By Dec-23 H2E has invested about 28-30mln Euro in DK maturing the project towards FID. Without certainty of the pipelines.

Esbjerg GW H2 production plant

Company:	H2 Energy Europe (50/50 JV with Trafigura)
Technology:	1 GW PEM electrolyser
Production:	- 90'000 tons of H2/year - Thermal power for district heating - Replacing 1.1 m tons CO2 emission
Distribution:	- Pipeline via Egtved to Taulov/Fredericia - Taulov as a H2 Hub

Overview of pipeline connection – the 'lower T'



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Certainty on hydrogen pipelines means everything. Pace is equally important as competition is fierce. Historic Danish opportunity!

Pipelines to be ready in 2026-2027

- First regional pipeline from Esbjerg to Fredericia should be ready in 2026-2027. The ´triangle´ area holds potential for production of sustainable aviation fuels and is a trucking centre in Denmark.
- ´Lower T´ connection to Germany can with benefit (and should) be pushed forward to 2027.
- Energinet and Gasunie announced by 2030 in Sept-22. We just moved it 2yrs ahead… is 1 more feasible?

Germany: Certainty and Inspiration

- ´We can take all Danish hydrogen production´ - according to a number of German influential people.
- Has committed to have 1,800km of hydrogen pipelines in 2027 – in Denmark we don't even have first regional pipeline scheduled. Why is that so when Germany is standing ready with demand?
- Built an LNG terminal in 12mths – everything is possible - ´if we want it´ - do we want hydrogen success?

Denmark can win the hydrogen race

- Denmark has cost competitiveness on delivery of hydrogen into Germany (see next slide)
- We should focus on what we are best and most competitive at = hydrogen in pipelines
- Denmark will not be price competitive for producing shipping fuels the first 5 years – electricity price is too high.

Action is needed

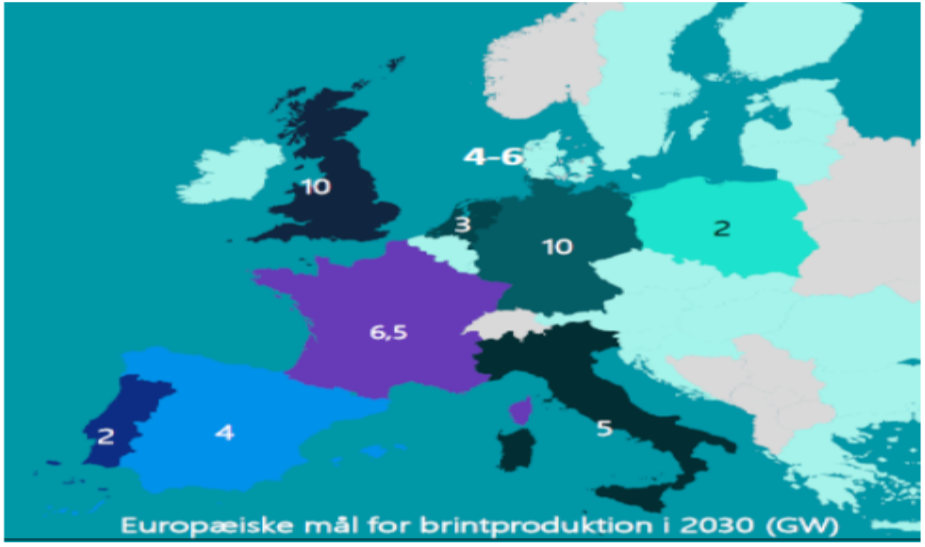
- There is NOTHING to lose by moving now. Biggest challenge is determining diameter of the pipelines and market signals before this decision (as FEED study progress) will be firm enough.
- There is a huge German market to be tapped into. The sooner we can deliver the stronger we are positioned = increased chances of FID in early stage challenging market.

Hydrogen demand likely to outstrip supply – what is the risk for Denmark by moving immediately ahead on pipeline implementation?

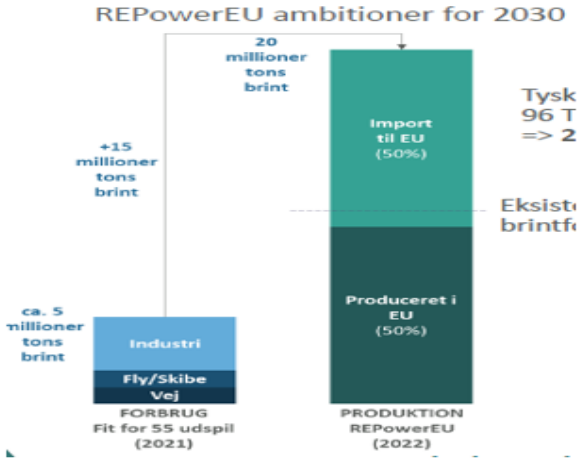
REPowerEU increasing ambitions for hydrogen from approx. 40 to 100 GW production by 2030.

There is likely to be a significant hydrogen production capacity shortage as the economy moves forward

National target for electrolyser capacity in 2030 = 48.5 GW



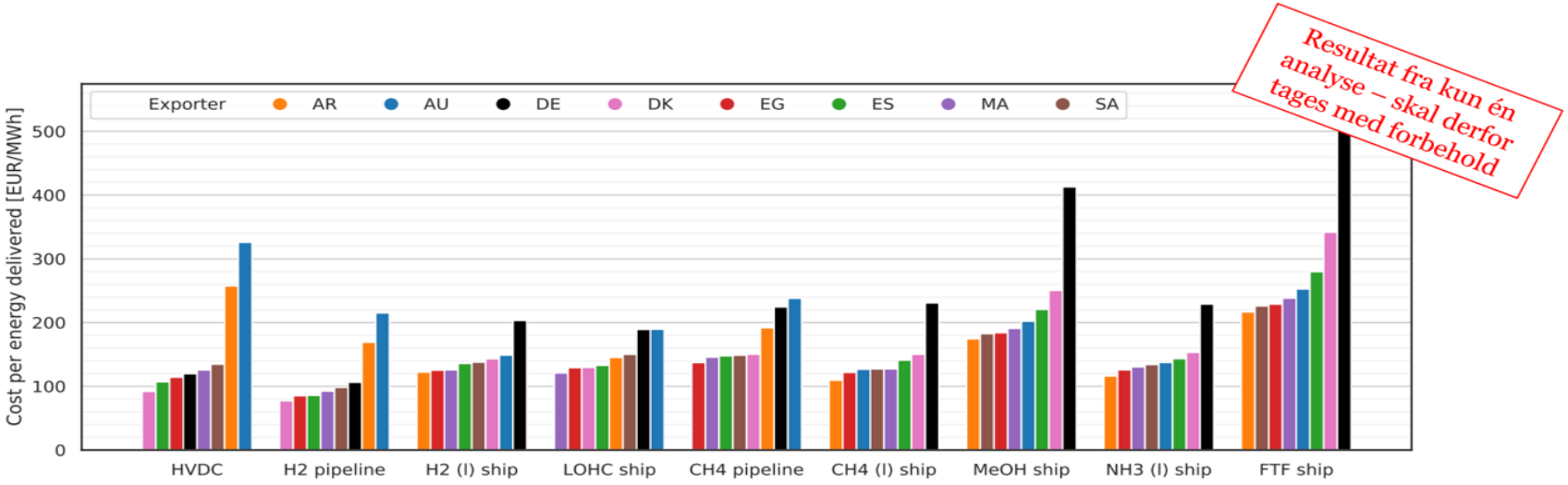
Germany in 2030 demanding 76-96 TWh hydrogen import => 20-30 GW electrolyser capacity



We are competitive on hydrogen in pipelines – and that is what we should be doing.

Klimarådet.

Vigtigt med fokus på konkurrencen fra andre markeder



Resultat fra kun én analyse – skal derfor tages med forbehold

Omkostninger ved leverance af forskellige produkter til Tyskland i 2030

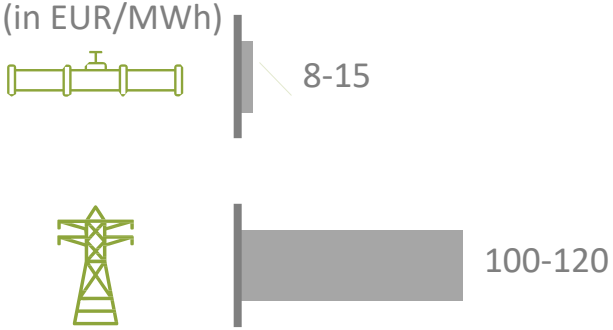
The importance of hydrogen infrastructure for the business case of GW-scale hydrogen production

Security of supply and demand	• creating a large single market for green hydrogen across Europe, which is needed to ensure offtake of large-scale production especially during the market ramp-up • linking renewables-rich geographies with key demand centers for green hydrogen
Flexibility	• Creating a variety of off-take opportunities (instead of reliance on one single offtaker, which is often the case for small-scale production)
Economies of scale	• Ensuring profitability of long-distance hydrogen logistics, which would not be competitive via road transport
Green transition	• Decreasing the CO2 abatement cost and hence contributing to the business case in the light of European decarbonization goals

Hydrogen offers the most efficient form for energy transmission

Full cost comparison of energy transmission infrastructure

(in EUR/MWh)



Gas-infrastructure 8-12 times less expensive for transmission

Advantages of gas vs. electrons

- Higher energy transmission capacity of pipelines vs. electricity grid (MW per line)
- Storage function
- Infrastructure mostly underground
- Lower lands use and footprint
- Lower exposure to weather variance, natural hazards
- Faster permitting processes
- Political acceptance
- Faster/immediate ramp-up possible

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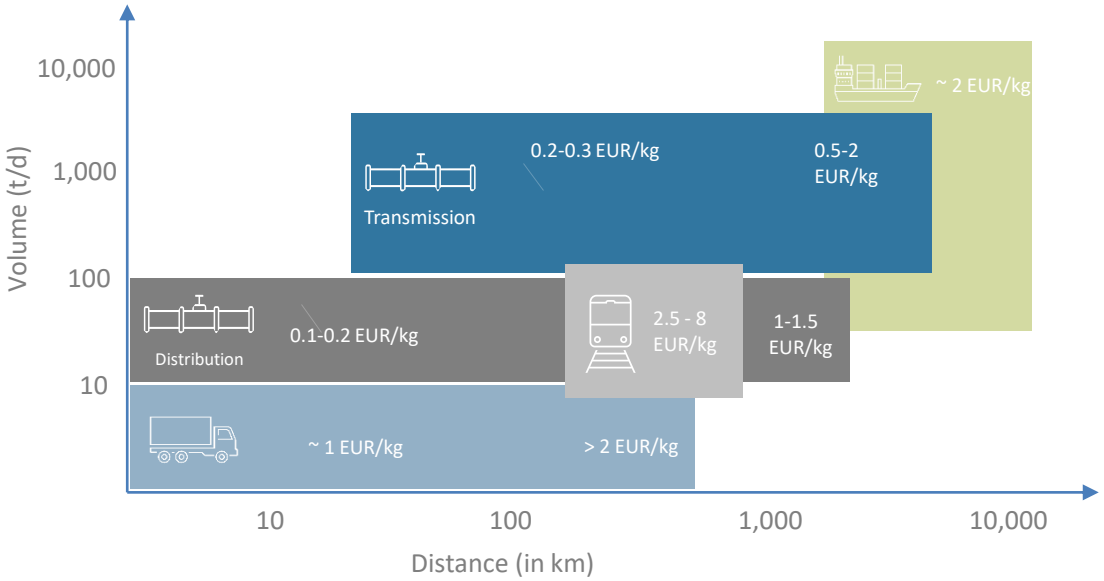
Source: H2 Energy, various research papers

Pipelines are instrumental for large-volume and long-distance transport of hydrogen within Europe

Estimated hydrogen transport cost based on distance and volume



Small volumes and short distances
- Trucks are most attractive (e.g. local or last-mile transport)

With increasing distance and volume
- Pipelines are most cost-effective route moving from distribution pipelines (i.e. small diameter) to transmission pipelines
- Rail as sustainable alternative if no pipeline available, yet least cost-competitive

Very long distances (e.g. across oceans)
- Ships are most attractive (e.g. with LOHC or ammonia)

Source: H2 Energy, industry consultations, IRENA

Challenges for establishing (cross-border) infrastructure and an international market

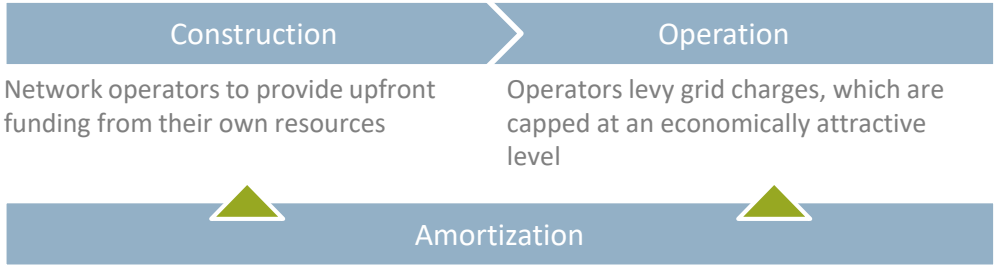
Factors contributing to a chicken-egg problem

- Uncertain **capacity utilization** of infrastructure
- **Ramp-up of H2 production volumes and demand unclear**
  - Uncertainty where demand will come from (e.g. which sectors, sites)
  - Uncertain financing conditions for pipeline operators and transportation cost for users
- Uncertainty on **technical requirements** for pipelines (e.g. H2 quality, purification, pressure level)
- Timeline for **phase-out of NG use** and ramp-up of hydrogen use
- High **number of stakeholders involved** (international and local grid operators, producers, policy makers, end users, etc.)
- **International coordination and dependencies** for an interconnected transmission system

Food for thought: financing hydrogen infrastructure - the “DENA model” to ensure risk distribution

Financing H2 pipelines through the “DENA model”

Basic idea: The state secures the investment through an amortization account - assuring the network operators that the investment will be profitable in the long term.



- Grid charges are paid by a small number of initial users – likely not sufficient to cover grid development costs
- Creation of an amortization account, from which construction costs are deducted and network charges added
- Initial financial gap likely to decrease over time as users of grid increase
- The state secures the amortization of the pipelines in the event that the hydrogen ramp-up is delayed

Advantages of the model

- **Acceleration:** speed up the expansion of the hydrogen network infrastructure
- **Distribution of risk and opportunity:** Safeguarding of amortization risks and opportunities for different players (grid operators, users and government)
- **Compatibility** with the ideas discussed at national and European level regarding unbundling, ownership and regulation
- **Climate:** Planning of the hydrogen network infrastructure compatible with climate protection goals

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Source: DENA (Deutsche Energie Agentur) 2022: https://www.dena.de/fileadmin/dena/Dokumente/Pdf/2022-08-H2-Netzinfrastruktur_Diskursbeitrag.pdf

Thank you!

Hohlstrasse 188 | 8004 Zürich | Switzerland

What is H2 Energy working towards?
- The green transition of the heavy transport sector

The heavy transport sector is responsible for 29% of Denmark's CO2 emissions. The sector is difficult to electrify and therefore holds great potential for hydrogen to transform all heavy transport and make it more climate friendly.

H2 Energy's hydrogen plant is just one of many important steps towards a greener transport sector in Denmark. The hydrogen plant's capacity makes it possible to cover more than 1/3 of all Danish lorries' fuel needs, which corresponds to more than 10,000 lorries.

To establish a hydrogen ecosystem, H2 Energy has partnered with Hyundai to manufacture hydrogen lorries under the name "Hyundai Hydrogen Mobility." However, before it is possible to replace conventional diesel lorries, a nationwide network of hydrogen filling stations needs to be built.

H2 Energy is therefore also working with Phillips 66 to set up hydrogen filling stations in Denmark, Austria and Germany. This makes it easy to get from A to B using hydrogen as fuel.

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H2 Energy PtX production site in Esbjerg

2021-2023
Pre-FID

2023
FID

2023-2025
Construction

2025
Go-live/COD

Value Chain Project ‘Spedla’ – Esbjerg and Taulov ecosystem