

5th event „60 minutes, 3 topics“
as part of the Norddeutsche Wasserstoffstrategie

Norway's capabilities, expertise and ongoing activities in hydrogen energy

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Outline

- About NORWEP
- Norway – an energy nation
- Norwegian ambition in hydrogen energy
- Norwegian competence in hydrogen & derivatives
- Ongoing project examples
- Selected projects in pipeline
- Stimulation & motivation for cooperation



About NORWEP

- NORWEP is an independent non-profit foundation.
- 25 FTE and 25 local country advisors.
- Established to strengthen Norwegian international business activities and export.
- Comprising more than 330 partners/company members from the Norwegian offshore, energy and maritime industries.
- Providing market reports, databases and project intelligence to our partners.
- Mapping competence, technology and competitiveness of Norwegian suppliers and match with international demand.
- Arranging more than 100 events per annum.

Founders

Organisations

- Energy Norway
- Federation of Norwegian Industries
- Norwegian Oil and Gas Association
- Norwegian Shipowners' Association
- The Norwegian Confederation of Trade Unions

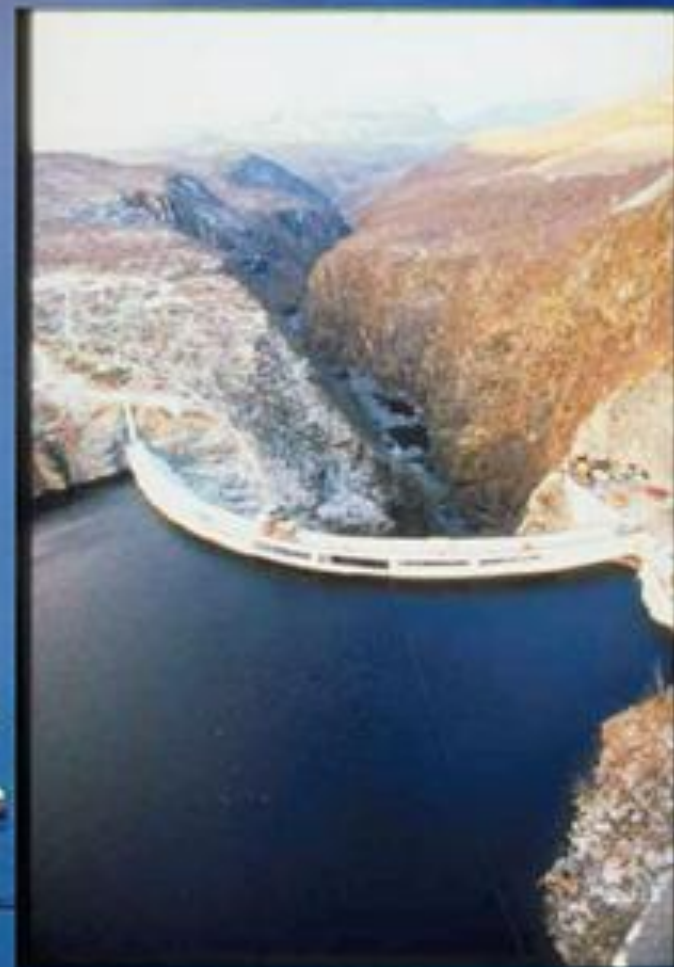
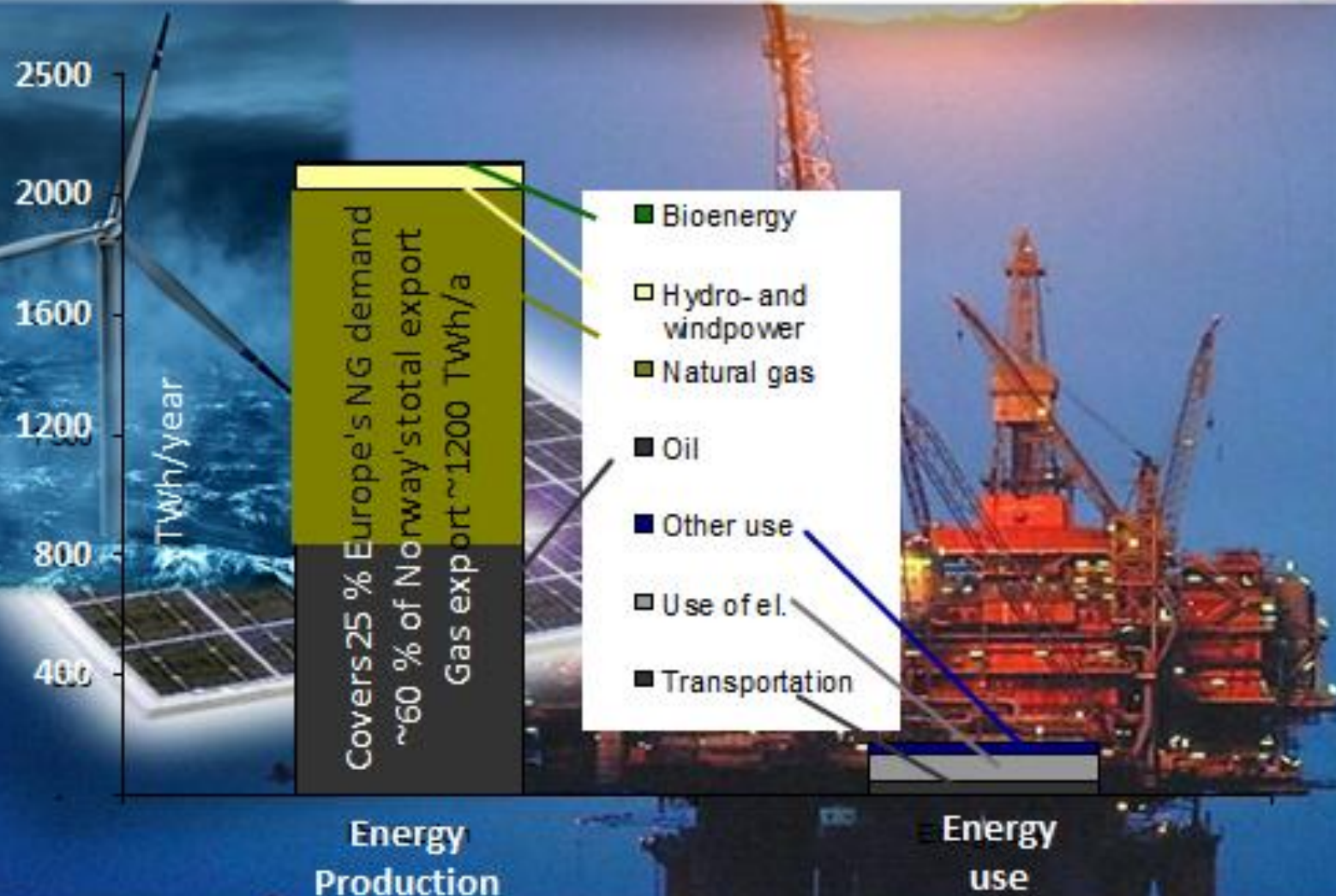
Norwegian Government

- Ministry of Petroleum and Energy
- Ministry of Trade and Industry
- Ministry of Foreign Affairs

Industry

- Equinor
- Statkraft

Norway - an energy nation.....

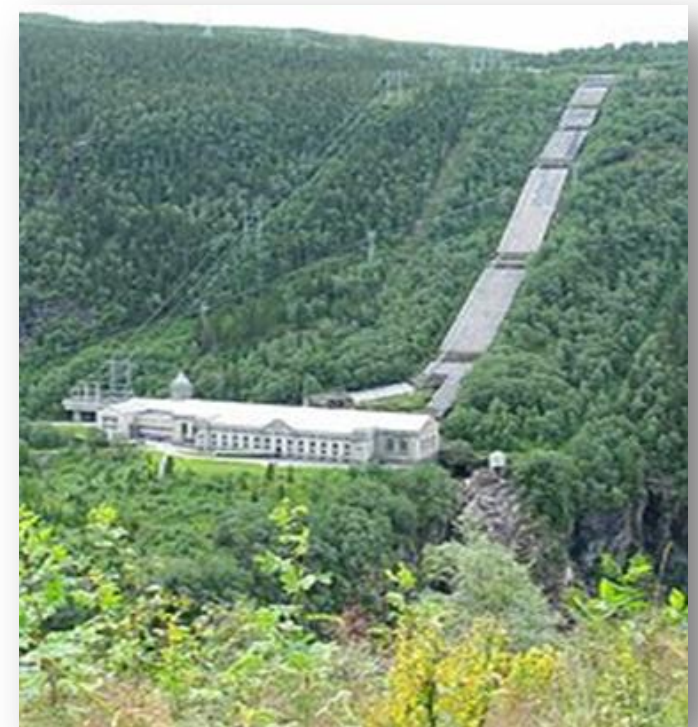




Norway's ammonia and hydrogen history

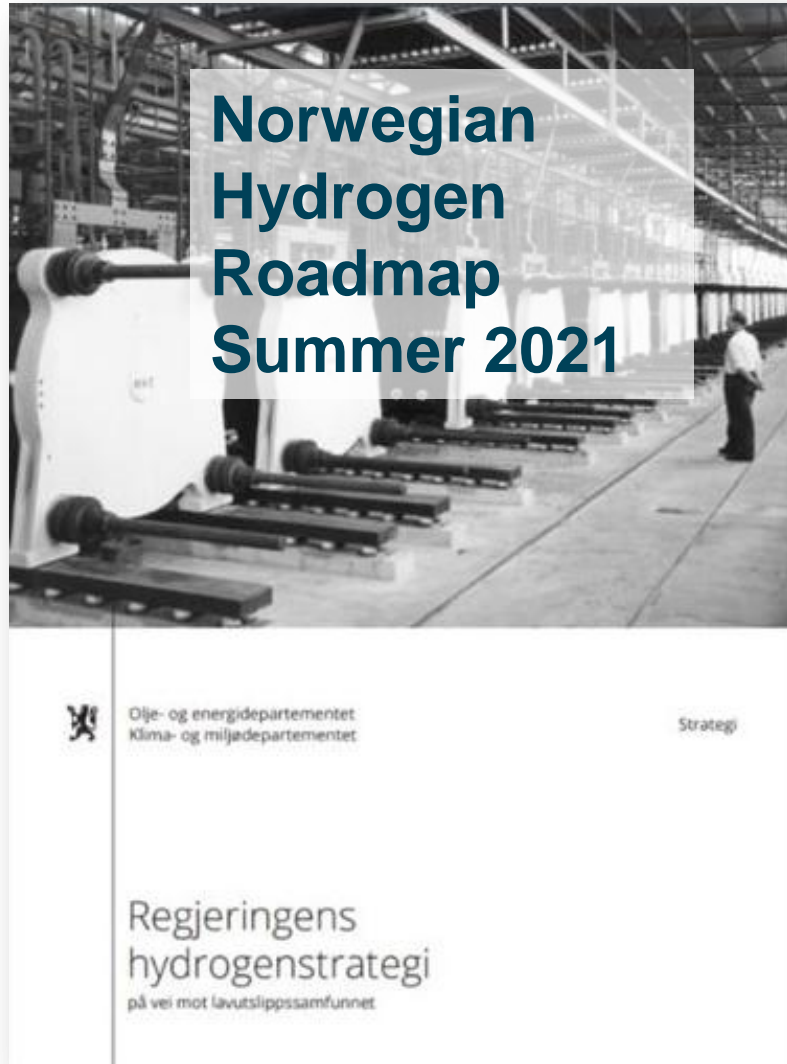
Norsk Hydro (Yara)

- First fertilizer production 1905 - Notodden
- Ammonia produced from green H₂ (electrolysers) 1929 – Notodden & Rjukan





Norwegian ambition in hydrogen energy



Norwegian Hydrogen Roadmap Summer 2021

1. Safe use and production of hydrogen with low emissions
 - Hydrogen with low emissions - from production to consumption
 - Safety and regulations
2. Hydrogen in Norway
 - Transportation (maritime, onshore, infrastructure)
 - Industry
 - Power sector
 - National R&D
3. Norway & Hydrogen Internationally
 - European ambitions
 - International cooperation



- Collaboration agreement on energy, climate policy and industrial transformation between Germany¹ and Norway² (March 2022)
- Joint project proposals announced (e.g. feasibility study for H₂-pipeline by 2030), in line with the EU's RePowerEU plan

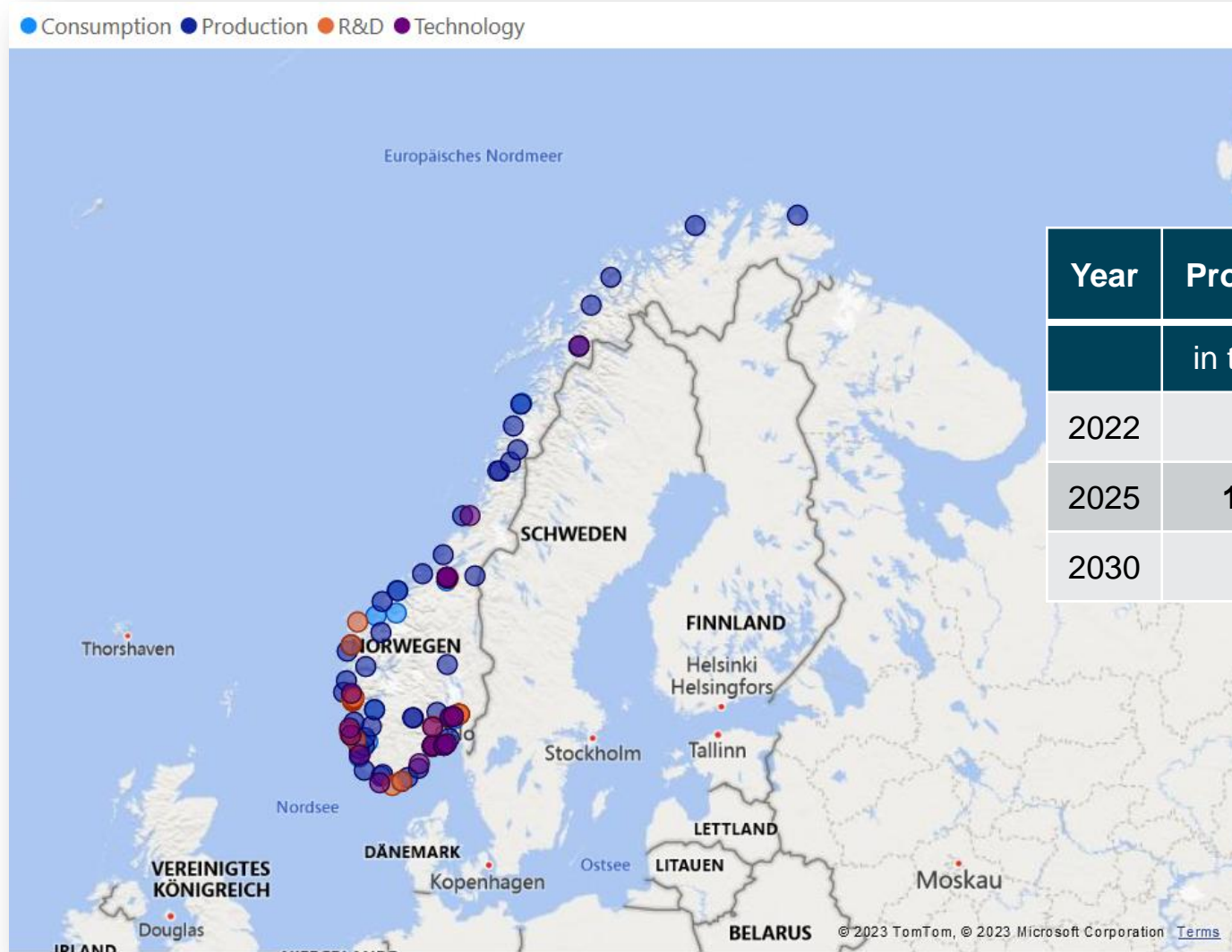
¹ **Robert Habeck**, Minister for Economic Affairs and Climate Protection, Germany

² **Jonas Gahr Støre**, Prime Minister; **Jan Christian Vestre**, Minister of Trade & Industry; **Terje Aasland**, Minister of Petroleum & Energy



The Norwegian Hydrogen Landscape

Available as interactive map with all project details in separate list on NHF website!



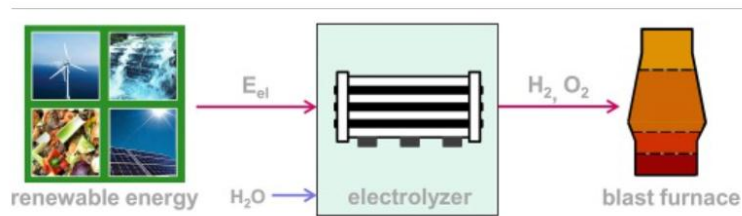
Year	Projects	Planned production capacity [MW]			Jobs in H ₂ ²
		REN	Low-CO ₂	Total	
2022					815
2025	126	797	20	817	
2030		9,457	5,425	9,457	5,800

¹ incl. production, consumption, R&D and technology scale-up
² Menon Economics, Verden av den norske hydrogenneringen: Status og fremdriftsutisikter, 16.11.2022

Source: Norwegian Hydrogen Forum 2023, <https://www.hydrogen.no/faktabank/det-norske-hydrogenlandskapet>

Examples for ongoing projects 1/2

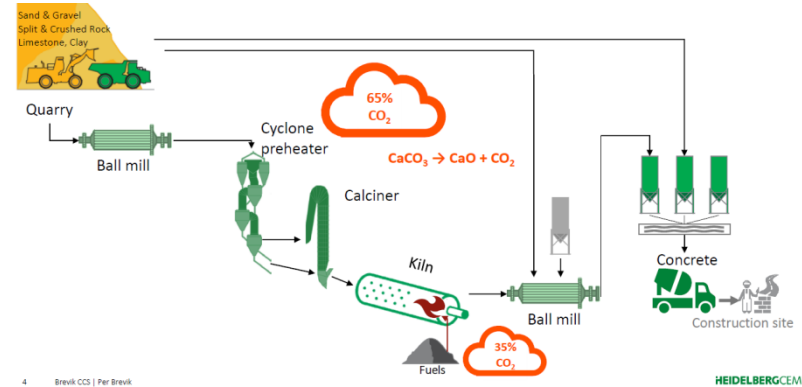
Steel production (H₂ as reducing agent)



TiZir Titanium & Iron (TTI/Tyssedal)

- Replace 85% of coal by H₂
- Reduced CO₂-emission by ca. 235 000 ton/year

Brevik/Heidelberg Cement (cement production)



- ### CCUS plant to reduce CO₂-emissions in Brevik cement plant
- 65 % of CO₂ emission from cement production process
 - 35% CO₂ emission from fuel

SKREI project Herøya (green ammonia production)



24 MW electrolysis demo plant

- one of the largest projects for green ammonia in the world (ca. 20,500 tonnes/year).
- Renewable energy to replace fossil fuels with CO₂ emissions reduction by ca. 41,000 tons/year.

Sources

Examples for ongoing projects 2/2

LH₂-Ferry in Rogaland H₂-Bulkship in Oslo Fjord H₂ test center Herøya



- First car-ferry in daily service from 2022
- Route „Hjelmeland-Nesvik-Ombo“ (Rv 13)
- Operator: Norled, hydrogen delivery from Germany: Linde
- Next project: Bodø-Moskenes, with Torghatten operating H₂-ferry from 2025



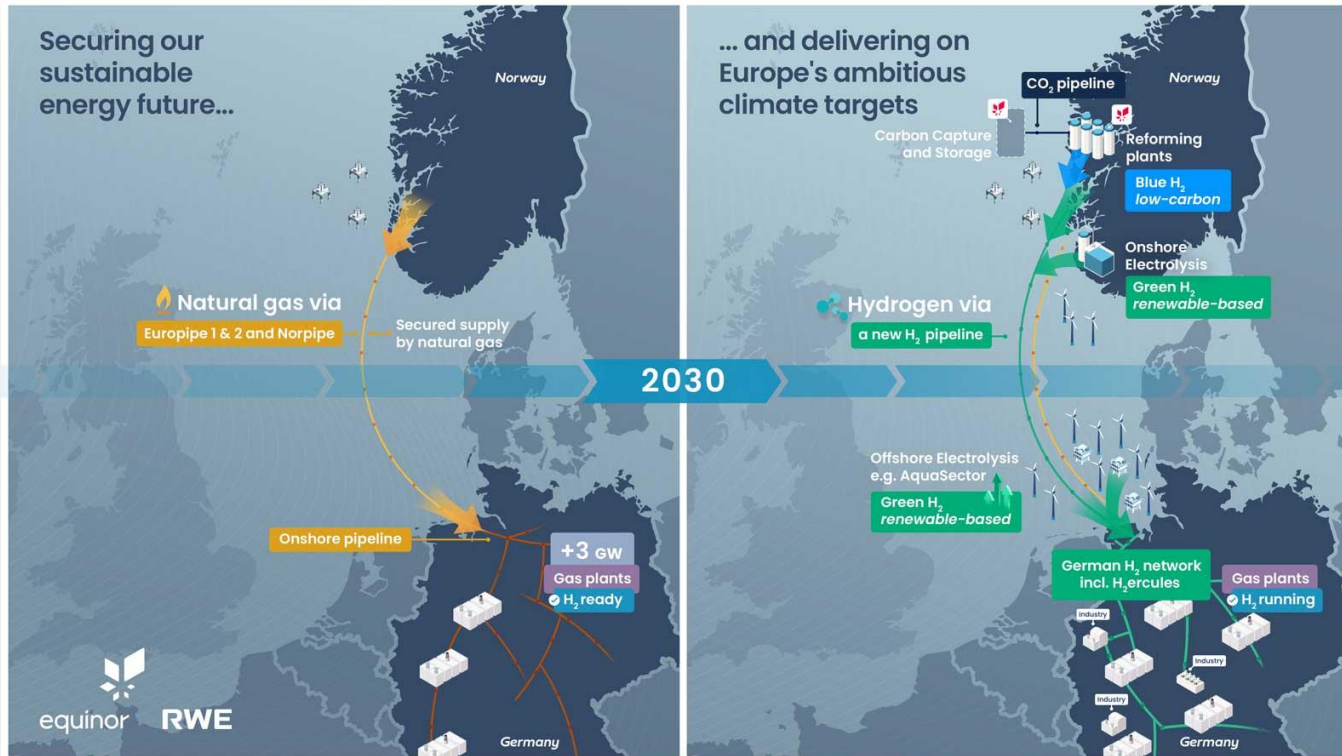
- H₂-bulkship in operation 2024: Heidelberg Cement & Felleskjøpet Agri
- Goods transport for grain & building material along Oslofjord
- Other ship types earmarked for speed~, feeder~, fishing~, service~ & fishfarming~ operation



- Test center for green energy & emission-free fuel in Seidr Energipark, Herøya
- H₂, NH₃ and battery testing: fuel cells, energy storage, charging infrastructure, distribution and user systems, energy management systems, equipment for burning

Selected projects in pipeline 1/3

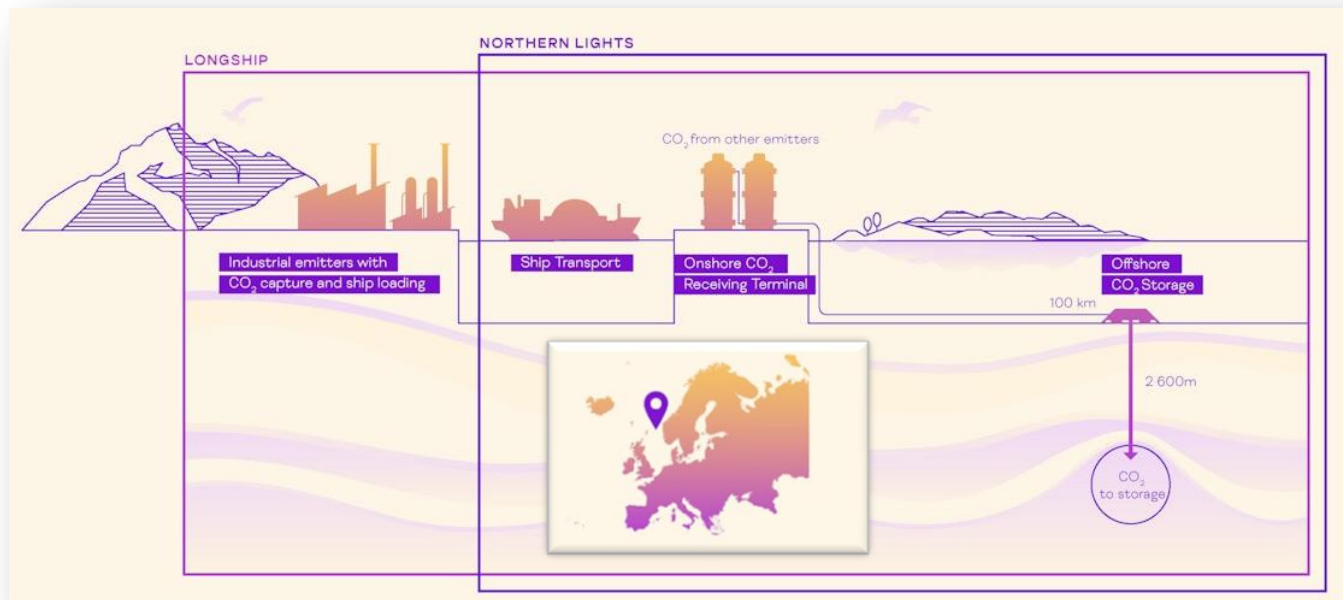
Hydrogen pipeline from Norway to Germany



- Green-H₂ production (e.g. offshore-wind: AquaSector 300 MW), transportation & end-use (combustion):
 - **Equinor** : source green- and blue- H₂ in Norway, transport to Germany via H₂-pipeline,
 - **RWE**: burn H₂ in H₂-ready, gas-fired power plants (ca. 3 GW) for electricity production.
- Assessment of pipeline construction by Gassco, Equinor & 3rd parties.
- By 2038, export of ≤ 10 GW of piped blue-H₂ to Germany.

Selected projects in pipeline 2/3

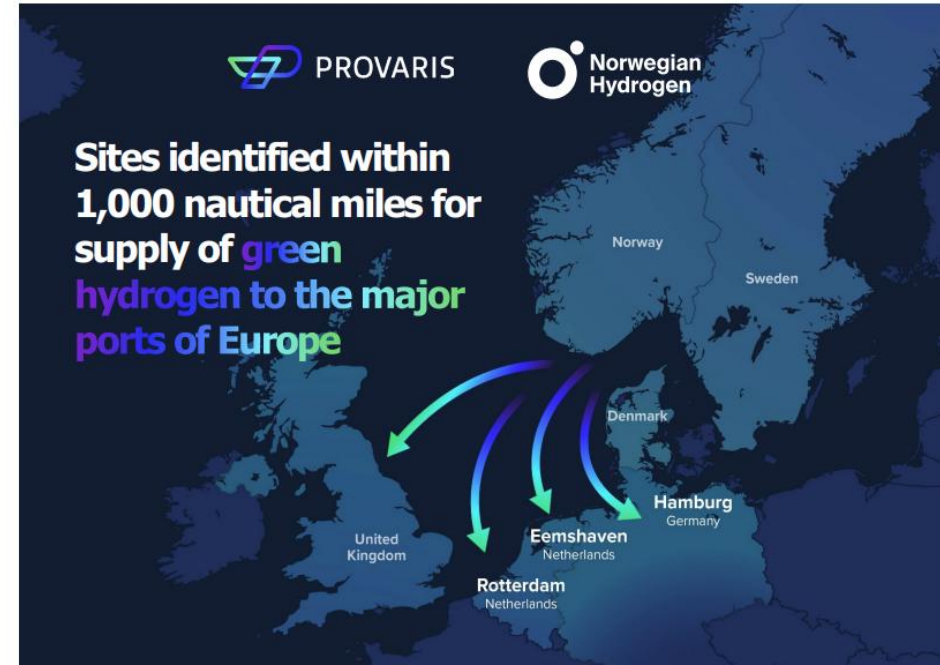
Northern Lights – Industrial decarbonisation, CO₂-storage for Europe



- First ever cross-border, open-source CO₂ transport and storage network.
- Transport of captured CO₂:
 - 2 dedicated CO₂ carriers to onshore terminal on Norwegian west coast
 - pipeline to a North Sea offshore subsurface storage location.
- **Phase I:** completed by mid-2024, capacity 1.5 Mt_{CO2}/yr.
- **Phase II:** Capacity expansion by 3.5 Mt_{CO2}/yr; receiving terminal, offshore pipeline (110 km), umbilical to offshore template for additional volumes.
- Partnership between Equinor, Shell and Total; key component of Longship, the Norwegian Government's full-scale CCS project.

Selected projects in pipeline 3/3

Compression provides low-cost, simple, energy-efficient supply chain for regional hydrogen markets

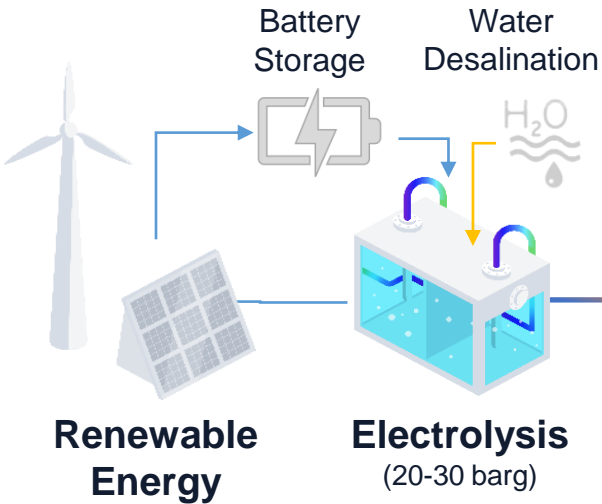


Production of Hydrogen



Hydrogen Shipping and Storage

Production of Green Hydrogen



Compressed H₂ Supply Chain



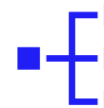
Source: <https://www.provaris.energy/>



Compression of H₂ established for 50 years (proven)



Does not require a base-load renewable energy supply to be efficient



Flexible solutions for loading and unloading in gaseous form



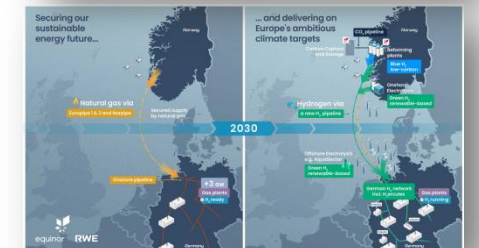
Commercial at low volumes and scales with market supply/demand

Stimulation and motivation for cooperation

Projects building on joint Norwegian-German interests

- **Ammonia:** Production and import of blue- and green-NH₃ in the port of Rostock between partners:
 - *VNG, ONTRAS, City & Port of Rostock – Yara Clean Ammonia*
- **Blue-H₂:** Production of 8.6 TWh_{H₂}/yr for e.g. industry in NRW by 2030, with CO₂-transport infrastructure
 - *OGE, TES – Equinor*
- **Green-H₂ (and Blue-H₂):** Production, transportation & combustion of blue- and green-H₂, transport to Germany by H₂-pipeline (110 km) and burning in H₂-ready, gas-fired power plants (≤ 10 GW) by 2038.
 - *RWE – Equinor, Gassco*
- **Technology cooperation:** Norwegian Hydrogen joins QUANTRON's Clean Transportation Alliance for 5 year strategic collaboration to deploy H₂-powered heavy-duty trucks in the Nordics (Norway, Iceland, Sweden, Finland, Denmark).
 - *QUANTRON – Norwegian Hydrogen*

Sources: <https://www.yara.com/news-and-media/news/archive/2023/yara-and-vng-with-commitment-for-cooperation-in-ammonia/>;
<https://oge.net/en/press-releases/2019/equinor-and-open-grid-europe-present-joint-h2morrow-project-to-support-deep-decarbonization-of-german-industry>; <https://www.rwe.com/en/research-and-development/project-plans/hydrogen-pipeline-in-the-north-sea/>;
<https://url.avanan.click/v2/>;
<https://www.norwegianhydrogen.com/news/norwegian-hydrogen-closes-deal-with-billion-nok-potential>



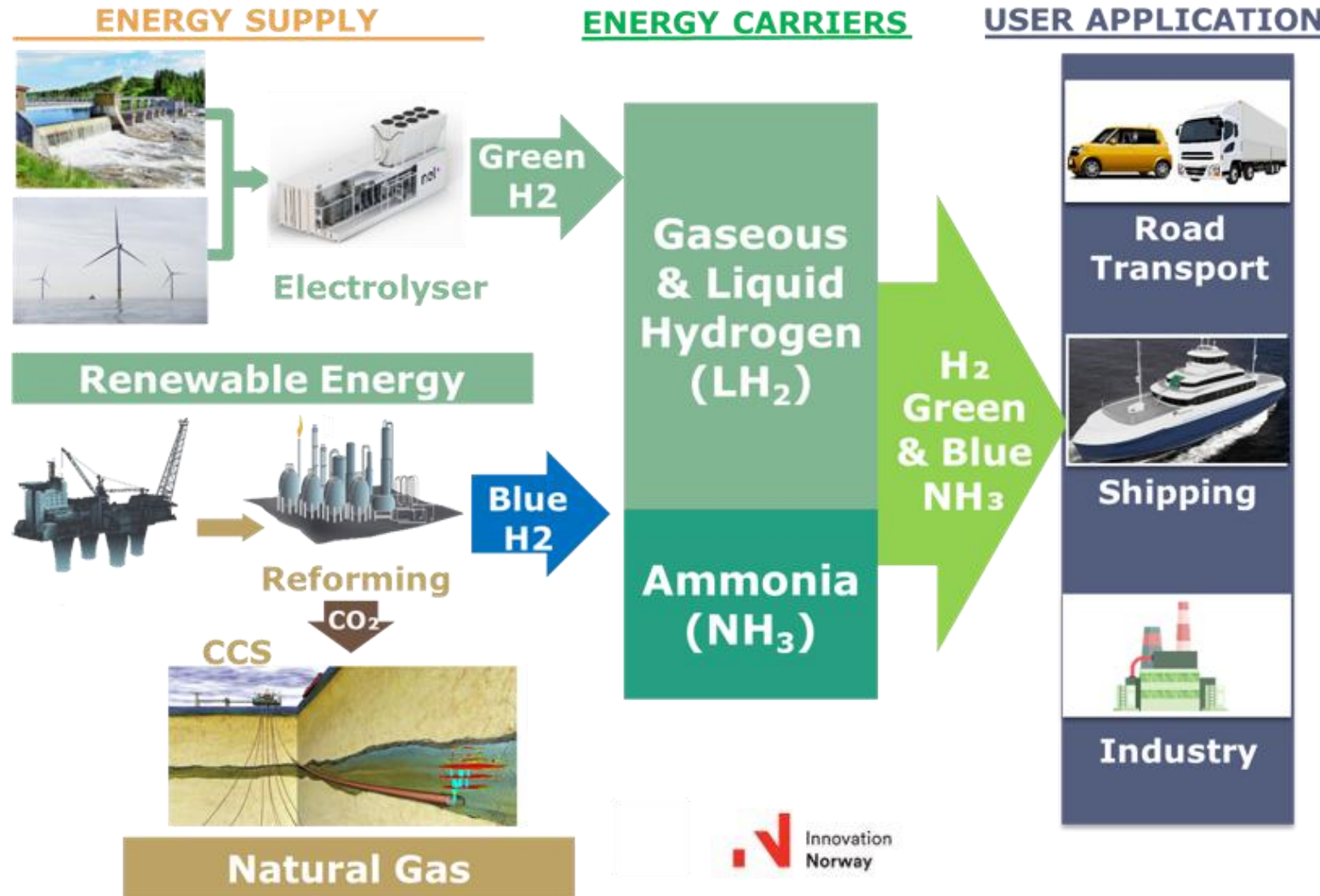
Thank you!



Norwegian
Energy Partners



Norway - developing a comprehensive H₂ value chain



Norway has wide expertise & competence from its historical energy system characteristics:

- energy production,
- energy infrastructure and
- energy end-use

Past expertise spans fossil (oil, natural gas) and renewable energy (hydropower, PV), enabling hydrogen energy

Now, also on- and offshore wind and blue/green-H₂ energy extend portfolio



Norwegian competence in hydrogen and its derivatives

(selected companies in production & export, technology & services)

Production

- **Equinor** – Clean H₂ with CCS, Northern lights project
- **Reinertsen new energy/HYDROGEN Mem-Tech** – Production of H₂ with CCS
- **Seid; ZEG** – H₂ production
- **Siemens** – H₂ electrolysis, batteries and gas turbines
- **Statkraft** – Renewable solutions, energy management
- **NEL** – H₂ production, storage and refueling solutions

Transportation, distribution & storage

- **Moss Maritime** – Marine applications
- **Equinor**
- **UMOE Advanced Composites** - Storage
- **TechnipFMC** – Deep purple project (H₂ & wind)
- **Kongsberg** – Marine applications
- **Kongstein** - Engineering & consulting, propulsion solutions
- **LMG Marin** - Design, engineering & documentation
- Norwegian shipowners (**BW, Höegh, Golar** etc.) – Transportation of H₂
- Provaris – H₂ transport

End user & utilization

- **Equinor** – Green shipping/fuel on vessels
- **ABB** – hybrid power system, fuel cells
- **Yara** – Fertilizer production
- **Sevan SSP** – SSP hull. offshore wind, hydrogen
- **NORLED** - Vessels operating on H₂
- H₂ in the process industry
- **Bergen Engines**

Other companies: **DNV** and **Gexcon** (Risk management, safety, studies), **Aker Horizon, Aragon, Wilhelmsen, NOV, Stena** (Equipment for offshore loading, storage, conversion), **Multiconsult** and **Norconsult** (consulting) and **Academia/R&D**