

# "Hydrogen som en del av løsningen i nullutslippssamfunnet

- *Hvilke prosjekter er på gang?"*

*«Optimalisering og realisering av H<sub>2</sub>-produksjon og -distribusjon basert på innestengt småkraft»*

*Dialogkonferanse, Ålesund 27/9 2019*

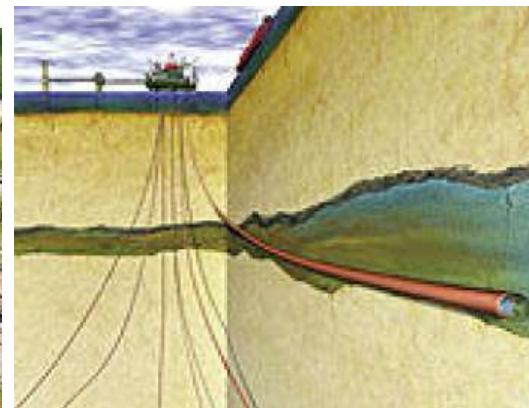


**Steffen Møller-Holst**  
Markedsdirektør

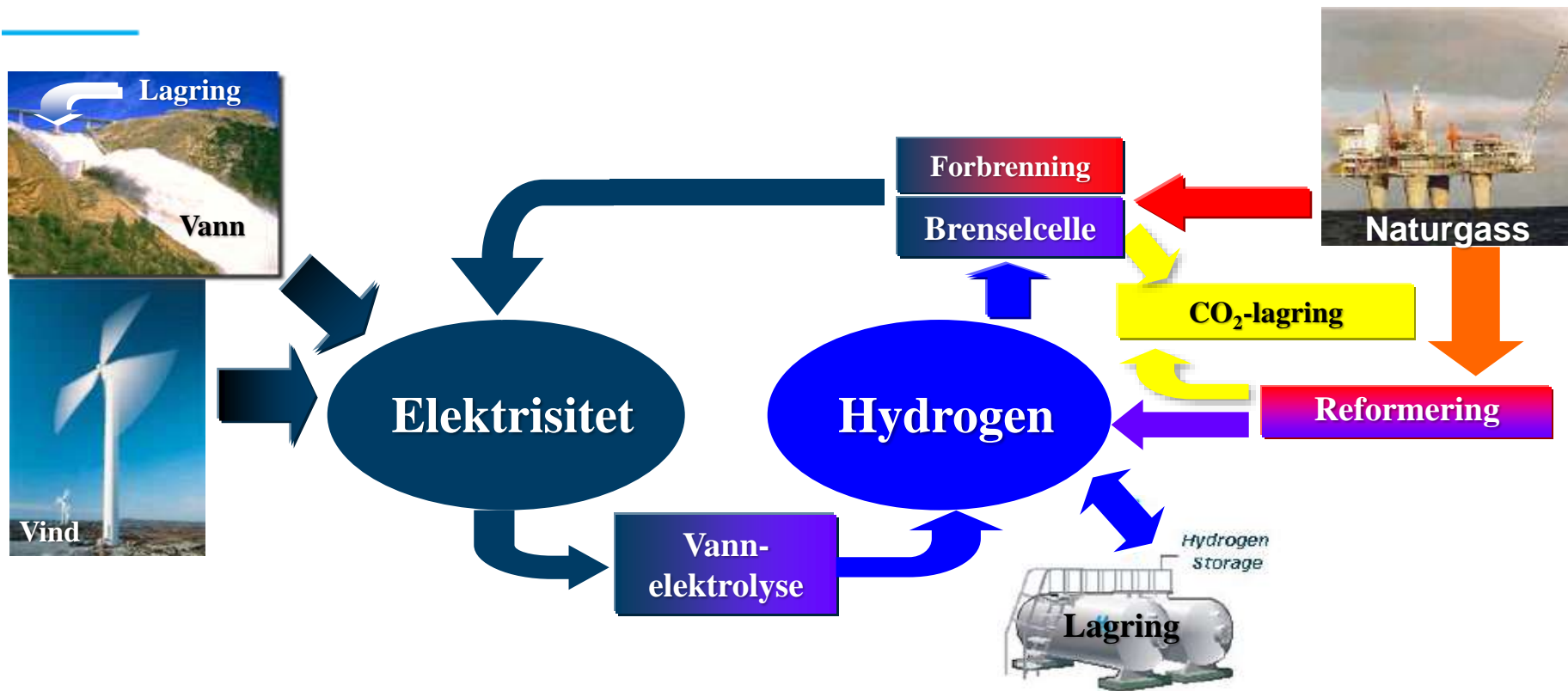


**Styreleder**  
NORSK HYDROGENFORUM  
**hydrogen.no**

Chairman  
Transport 

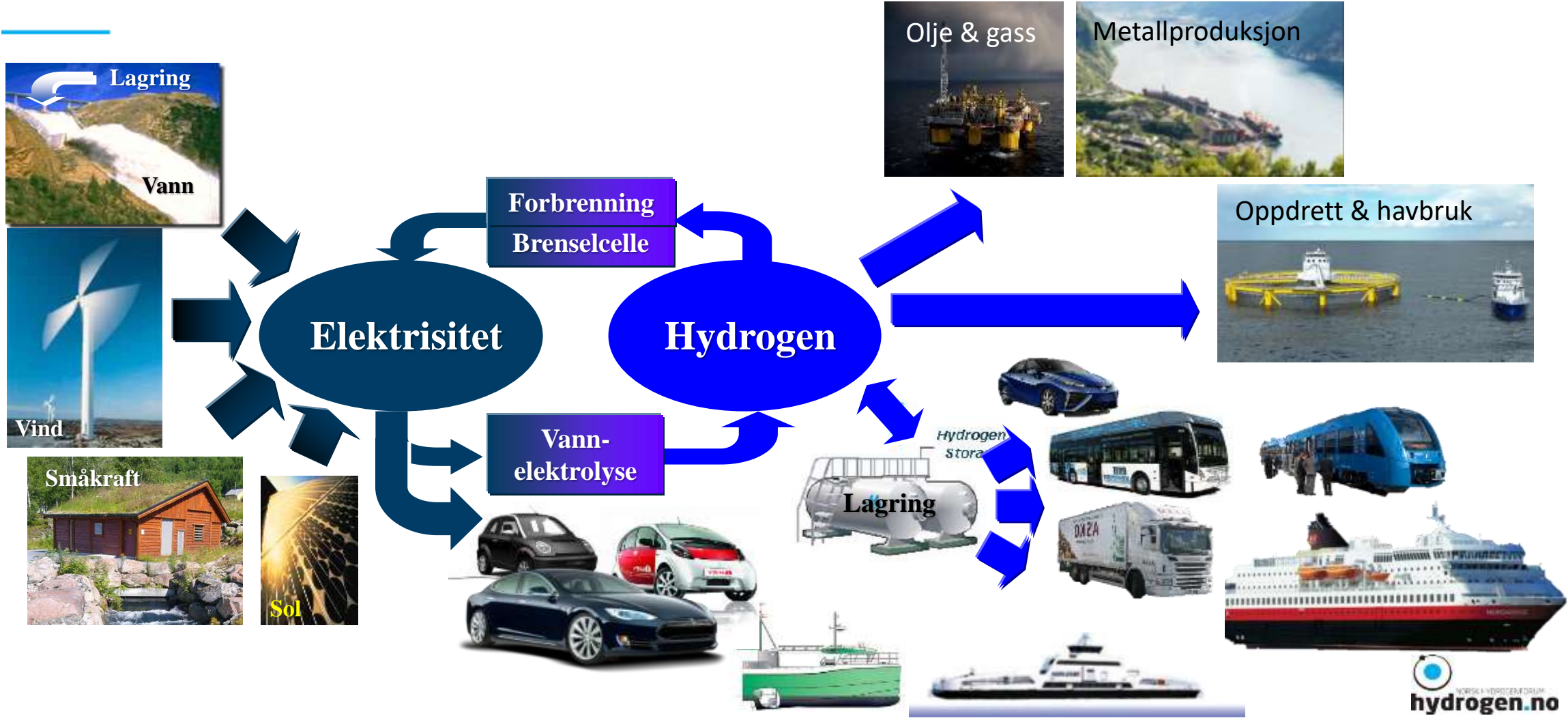


# Hydrogen som energibærer

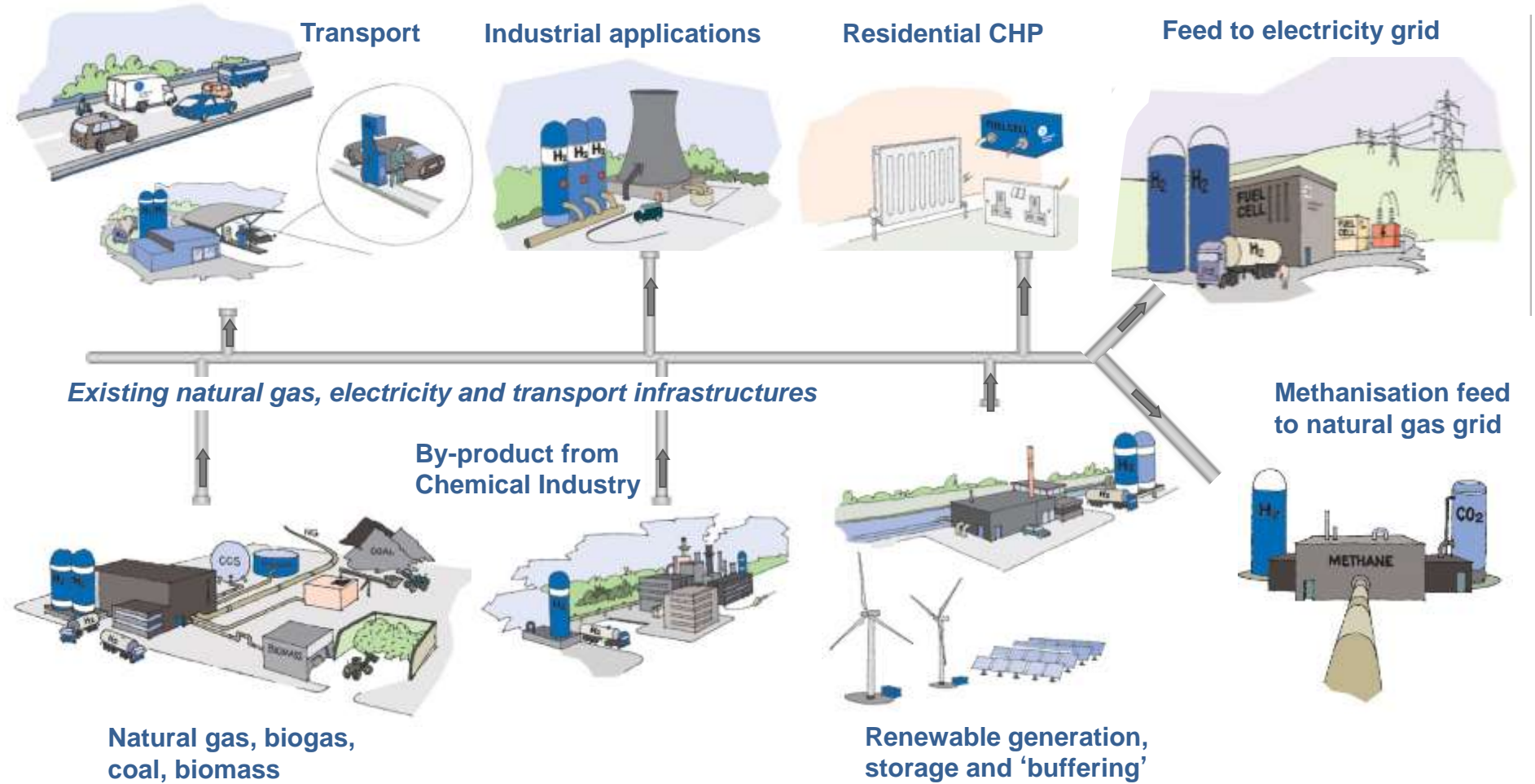




# Hydrogen som energibærer



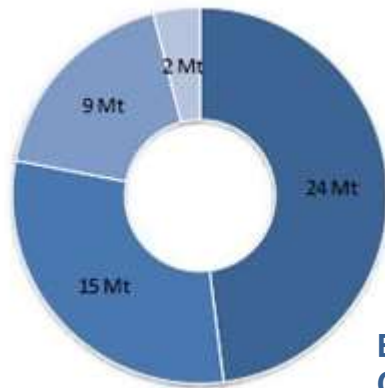
# Kilder og Anvendelser



# Kilder og Anvendelser

- Global H<sub>2</sub>-produksjon (>60 Mtonn/år)

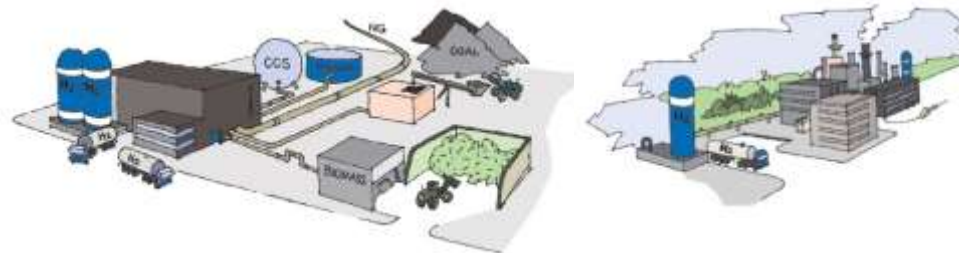
- Naturgass
- Olje
- Kull
- Elektrolyse



## Industrial applications



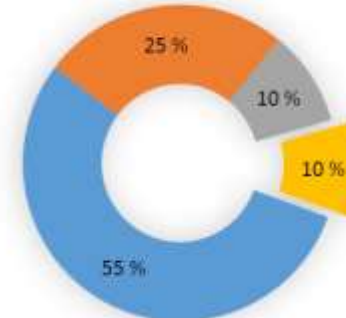
## By-product from Chemical Industry



Natural gas, biogas, coal, biomass



## Globalt hydrogenforbruk

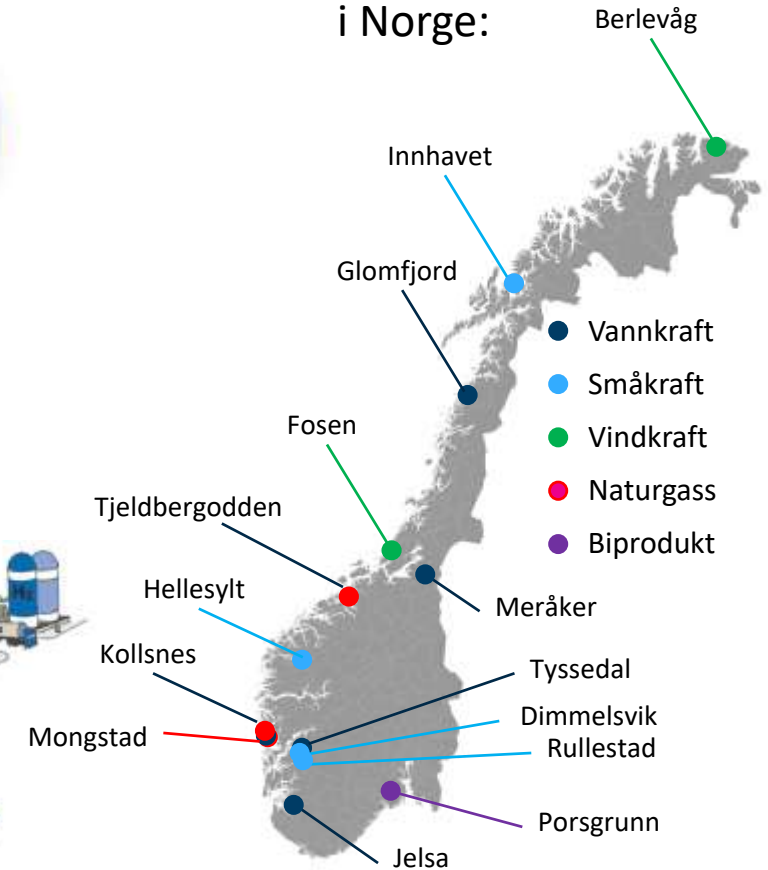


- Amoniakk
- Raffinerier
- Metanol
- Annet



Renewable generation, storage and 'buffering'

## Initiativer for H<sub>2</sub>-produksjon i Norge:





# Sterkt økende politisk engasjement



**H<sub>2</sub>EM 2019**  
Hydrogen Energy  
Ministerial Meeting

25/9 2019



# Industri-engasjement\_Hydrogen Council

## The Hydrogen Council Members:



## Originally 13 founding members (Davos):

- Investment 1,4 B€/a in H<sub>2</sub>-technologies
- Pledges 10,7 B€ next 5 years

## Press release:

September 7<sup>th</sup> 2017:

11 new members

(including  Statoil )

Collectively representing

- total revenues of 1.3 trillion
- and > 2 million employees
- 2018:

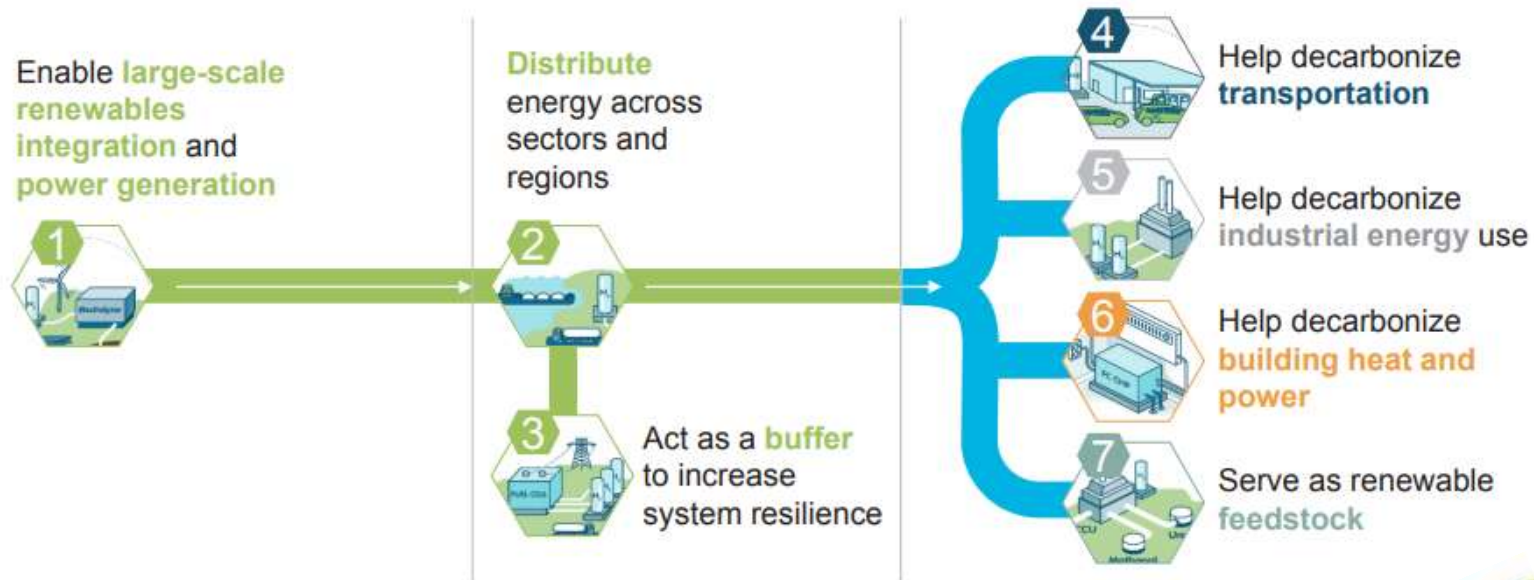




# Hydrogen Council, "Hydrogen - Scaling Up"

Exhibit 3: Hydrogen can play 7 roles in the energy transition

Enable the renewable energy system → Decarbonize end uses



SOURCE: Hydrogen Council

Hydrogen Council, November 2017





# Climate Neutral Europe 2050

## Detailed assessment supported by scenario analysis

	Electrification (ELEC)	Hydrogen (H2)	Power-to-X (P2X)	Energy Efficiency (EE)	Circular Economy (CIRC)	Combination (COMBO)	1.5°C Technical (1.5TECH)	1.5°C Sustainable Lifestyles (1.5LIFE)
<b>Main Drivers</b>	Electrification in all sectors	Hydrogen in industry, transport and buildings	E-fuels in industry, transport and buildings	Pursuing deep energy efficiency in all sectors	Increased resource and material efficiency	Cost-efficient combination of options from 2°C scenarios	Based on COMBO with more BECCS, CCS	Based on COMBO and CIRC with lifestyle changes
<b>GHG target in 2050</b>		-80% GHG (excluding sinks) ["well below 2°C" ambition]				-90% GHG (incl. sinks)	-100% GHG (incl. sinks) ["1.5°C" ambition]	
<b>Major Common Assumptions</b>	<ul style="list-style-type: none"> <li>Higher energy efficiency post-2030</li> <li>Deployment of sustainable, advanced biofuels</li> <li>Moderate circular economy measures</li> <li>Digitisation</li> </ul>				<ul style="list-style-type: none"> <li>Market coordination for infrastructure deployment</li> <li>BECCS present only post-2050 in 2°C scenarios</li> <li>Significant learning by doing for low carbon technologies</li> <li>Significant improvements in the efficiency of the transport system.</li> </ul>			
<b>Power sector</b>	Power is nearly decarbonised by 2050. Strong penetration of RES facilitated by system optimization (demand-side response, storage, interconnections, role of prosumers). Nuclear still plays a role in the power sector and CCS deployment faces limitations.							
<b>Industry</b>	Electrification of processes	Use of H2 in targeted applications	Use of e-gas in targeted applications	Reducing energy demand via Energy Efficiency	Higher recycling rates, material substitution, circular measures	Combination of most Cost-efficient options from "well below 2°C" scenarios with targeted application (excluding CIRC)	COMBO but stronger	CIRC+COMBO but stronger
<b>Buildings</b>	Increased deployment of heat pumps	Deployment of H2 for heating	Deployment of e-gas for heating	Increased renovation rates and depth	Sustainable buildings			CIRC+COMBO but stronger
<b>Transport sector</b>	Faster electrification for all transport modes	H2 deployment for HDVs and some for LDVs	E-fuels deployment for all modes	Increased modal shift	Mobility as a service			<ul style="list-style-type: none"> <li>CIRC+COMBO but stronger</li> <li>Alternatives to air travel</li> </ul>
<b>Other Drivers</b>		H2 in gas distribution grid	E-gas in gas distribution grid			Limited enhancement natural sink	<ul style="list-style-type: none"> <li>Dietary changes</li> <li>Enhancement natural sink</li> </ul>	

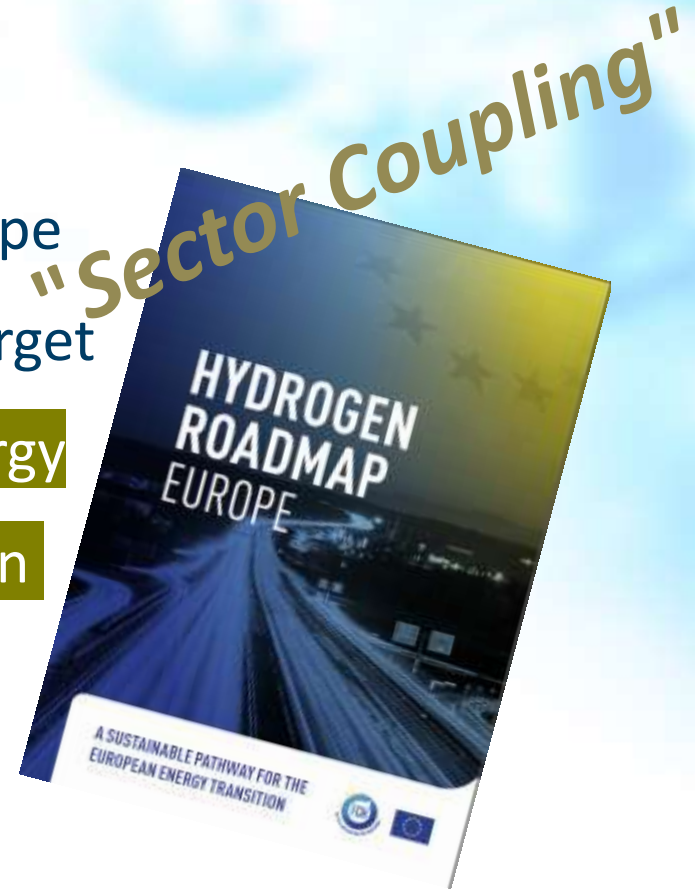


Brussels, November 2018

# Increasing focus on Hydrogen in Europe

## Hydrogen Roadmap Europe:

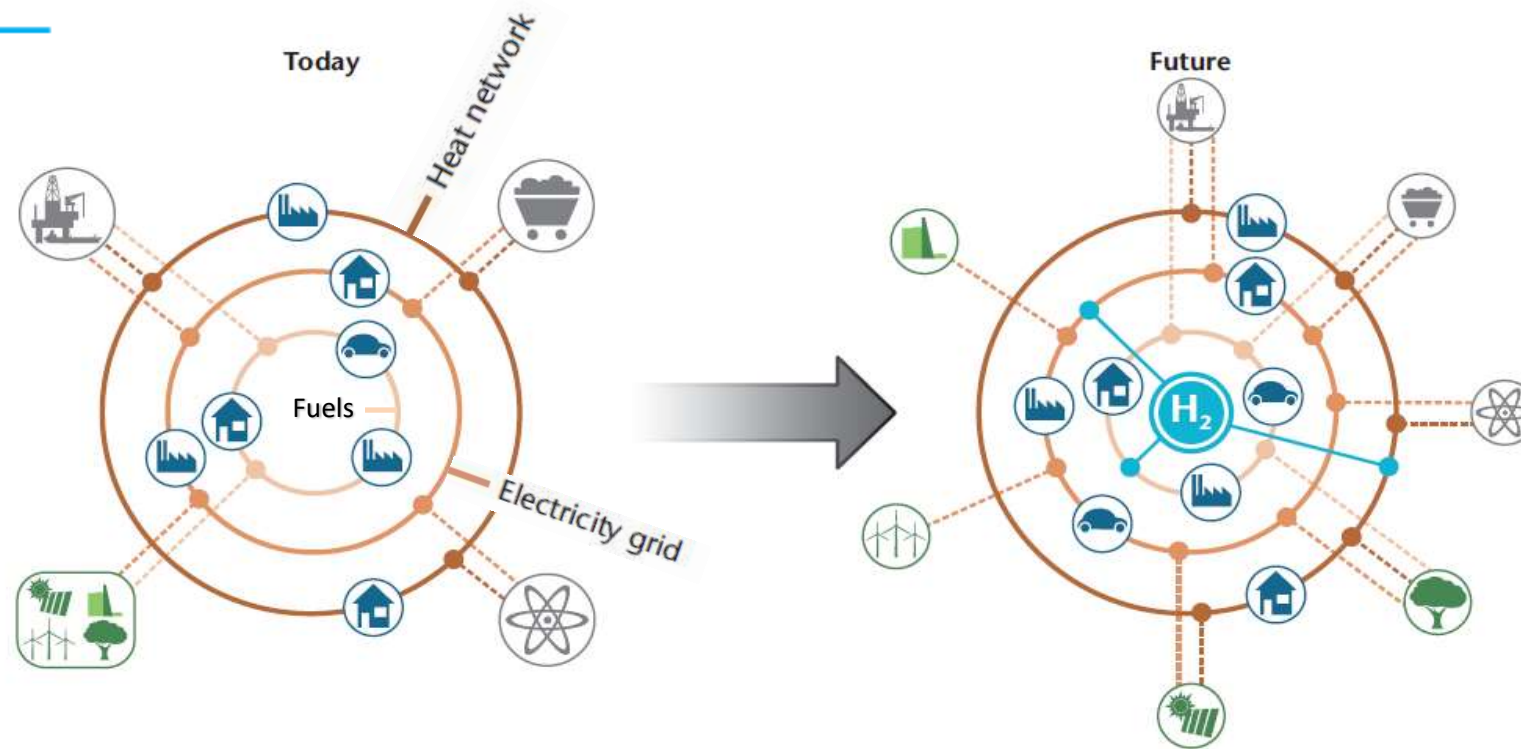
- Hydrogen is required to achieve the energy transition in Europe
- Hydrogen may close up to ~ 50 % of the gap towards a 2°C target
- Points at import of H<sub>2</sub> from regions with abundant wind energy
- Concludes that the most cost optimal decarbonization solution include both water electrolysis and reforming of natural gas
- Asks for immediate and concerted action to establish a masterplan for decarbonization for the European Union



*Brussels, February 2019*



# Hydrogens rolle og funksjon



"Sector Coupling"



**KEY POINT:** Hydrogen can link different energy sectors and energy T&D networks and thus increase the operational flexibility of future low-carbon energy systems.

# Områder der Norge vil kunne spille en nøkkelrolle innen hydrogenteknologi

Storskala H<sub>2</sub>-produsent fra fornybare kilder & NG<sup>m</sup>/CCS



Eksportør av H<sub>2</sub> & H<sub>2</sub>-teknologier



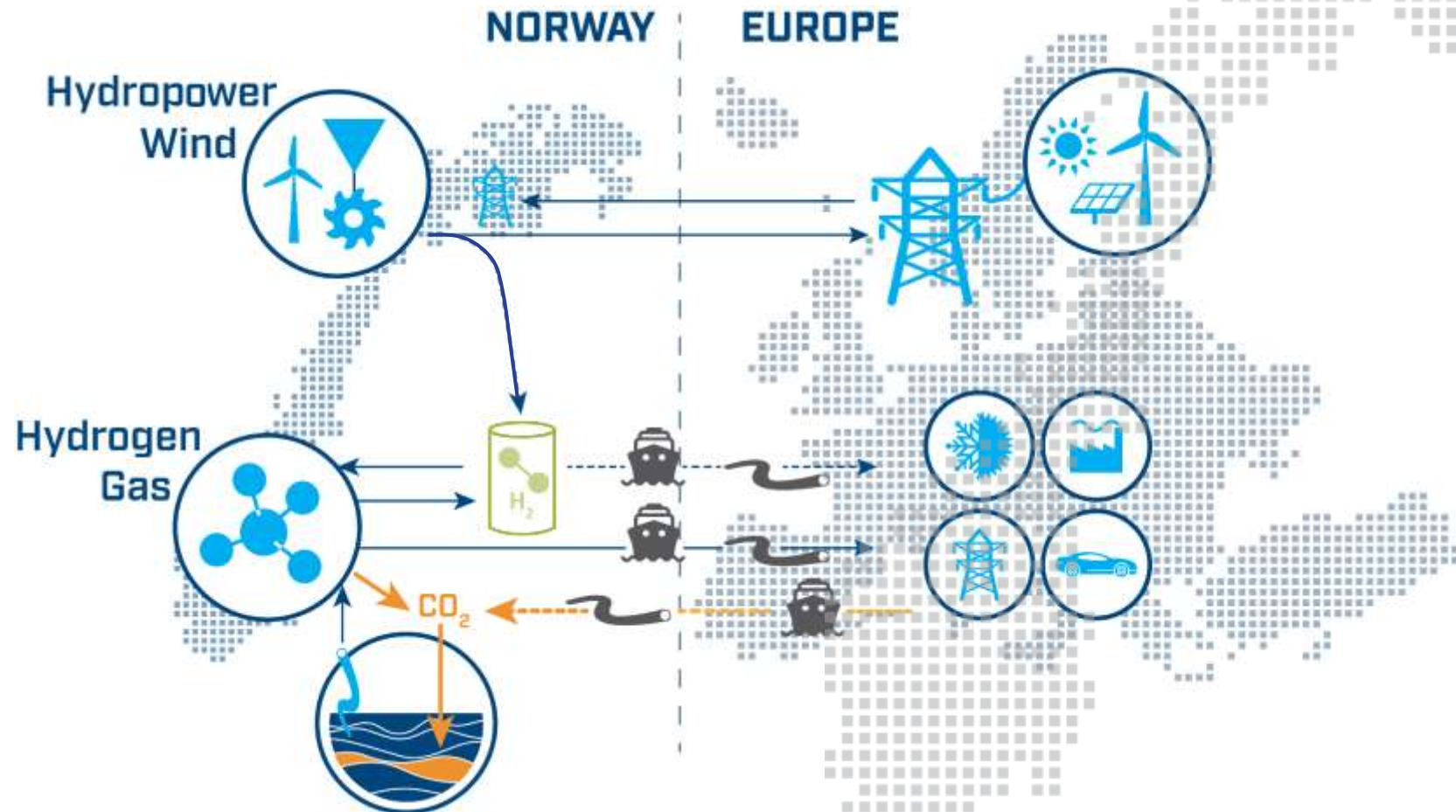
Tidligbruker av H<sub>2</sub> i transport & industri







# Norge, fremtidig energiekspport

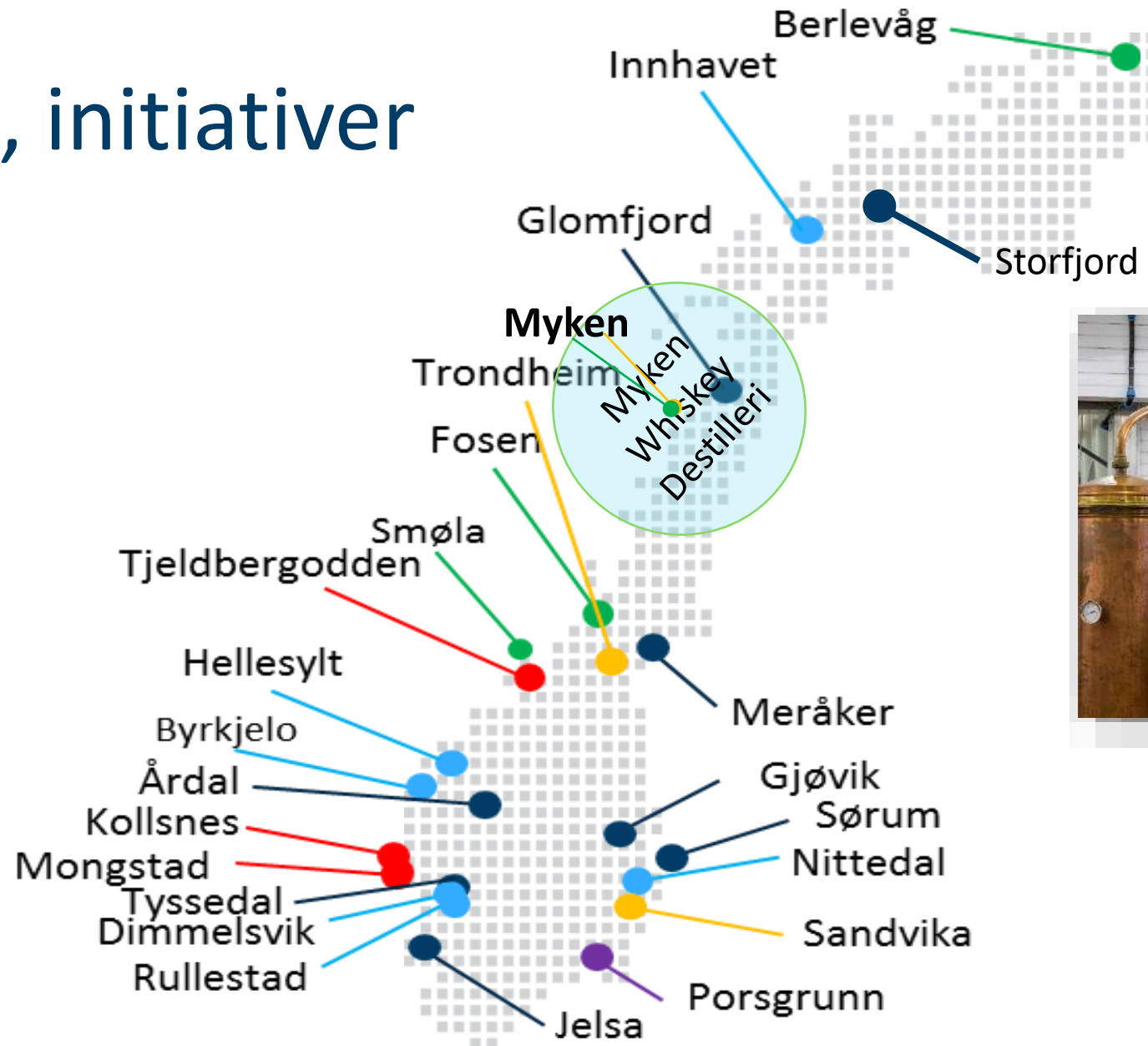




# H<sub>2</sub>-produksjon, initiativer

## Energy sources:

- Hydro power
- Run-off rivers
- Wind power
- Natural gas
- Byprodukt
- Solar power





# H<sub>2</sub>-produksjon, Myken

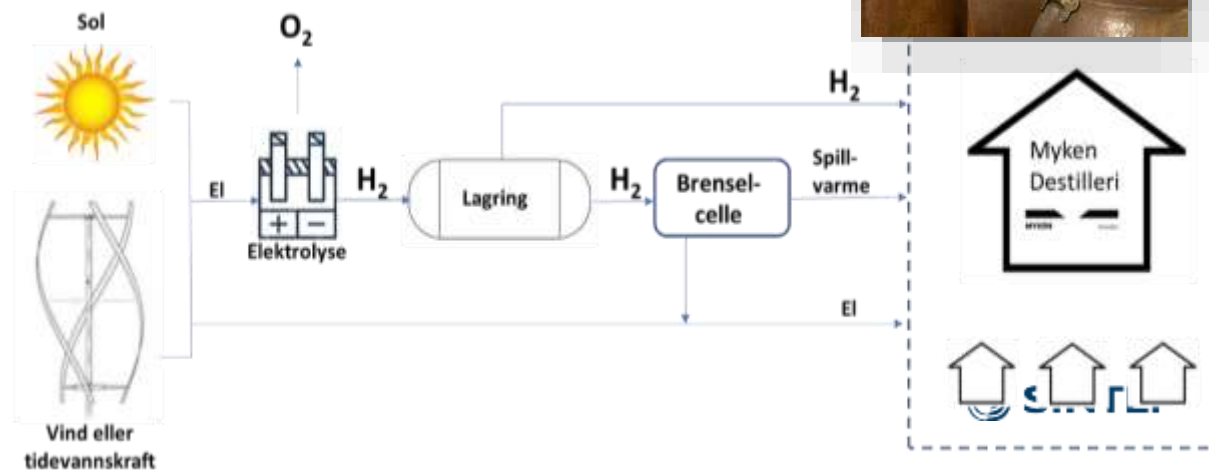


Foto: Kenneth Didriksen



- Øygruppe og fiskevær i Rødøy kommune (Nordland)
- 9 faste innbyggere (32 km fra fastland)
- Forsynes i dag med strøm gjennom sjøkabel (anno 1965).
- Dagens reserveløsning: Diesellaggregat (utslipp + støy)
- Største strømkunde: Myken Destilleri (anvender propangass i destilleringen)

**ENOVA**





# H<sub>2</sub>- og O<sub>2</sub>-produksjon, Innhavet

## Energy sources:

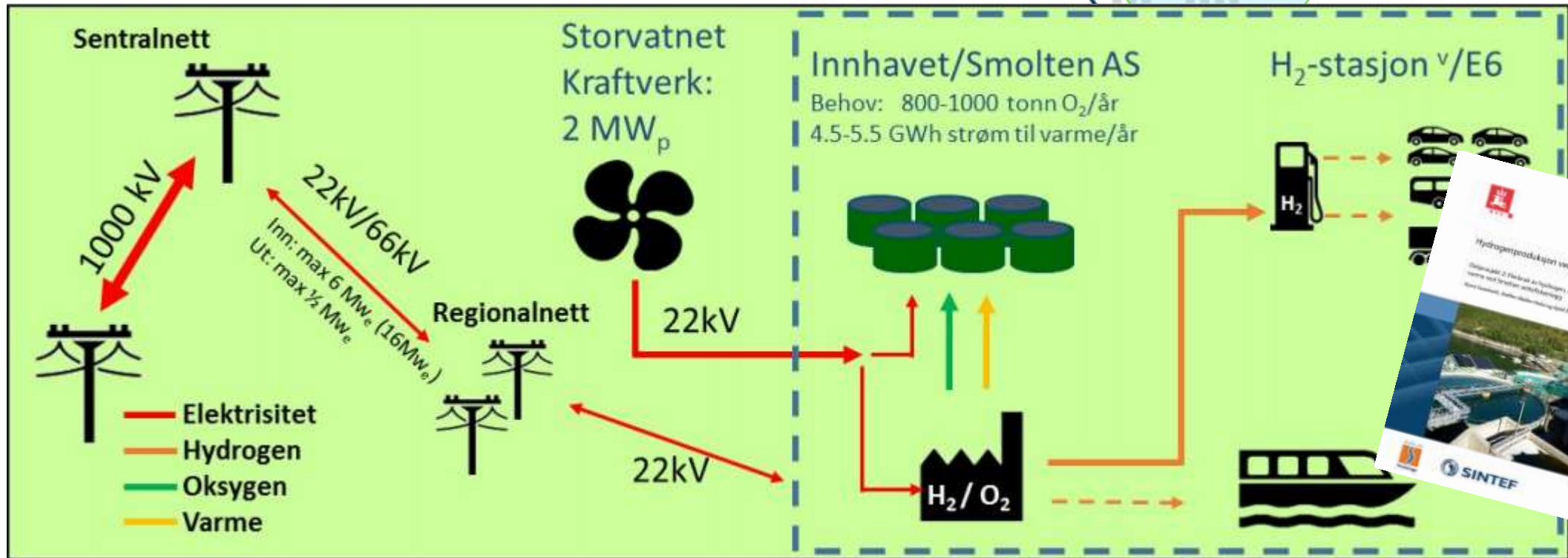
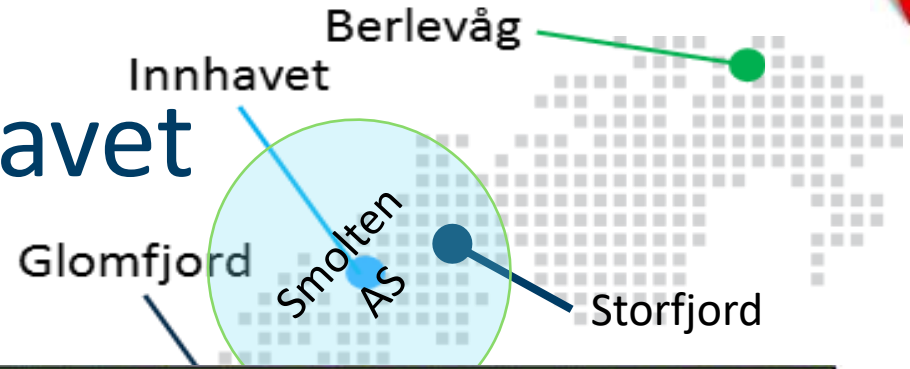
- Hydro power
- Run-off rivers
- Wind power
- Natural gas
- Byprodukt
- Solar power







# H<sub>2</sub>- og O<sub>2</sub>-produksjon, Innhavet



Rullestad

Jelsa

Porsgrunn

One of SINTEF's 28 EU-projects under the FCH JU-program

# Wind → 1000 kg H<sub>2</sub>/day

- Electrolyser (2,5 MW) installed in Berlevåg in 2020
- Directly connected to Raggovidda wind park (avoiding grid tariff)
- Electrolyser exhibit fast response
  - Stabilize grid voltage and frequency
- EU (FCHJU) -project:
  - Total budget 7 M€ (70 % public support),
  - Start January 2018, duration 4 years

Berlevåg

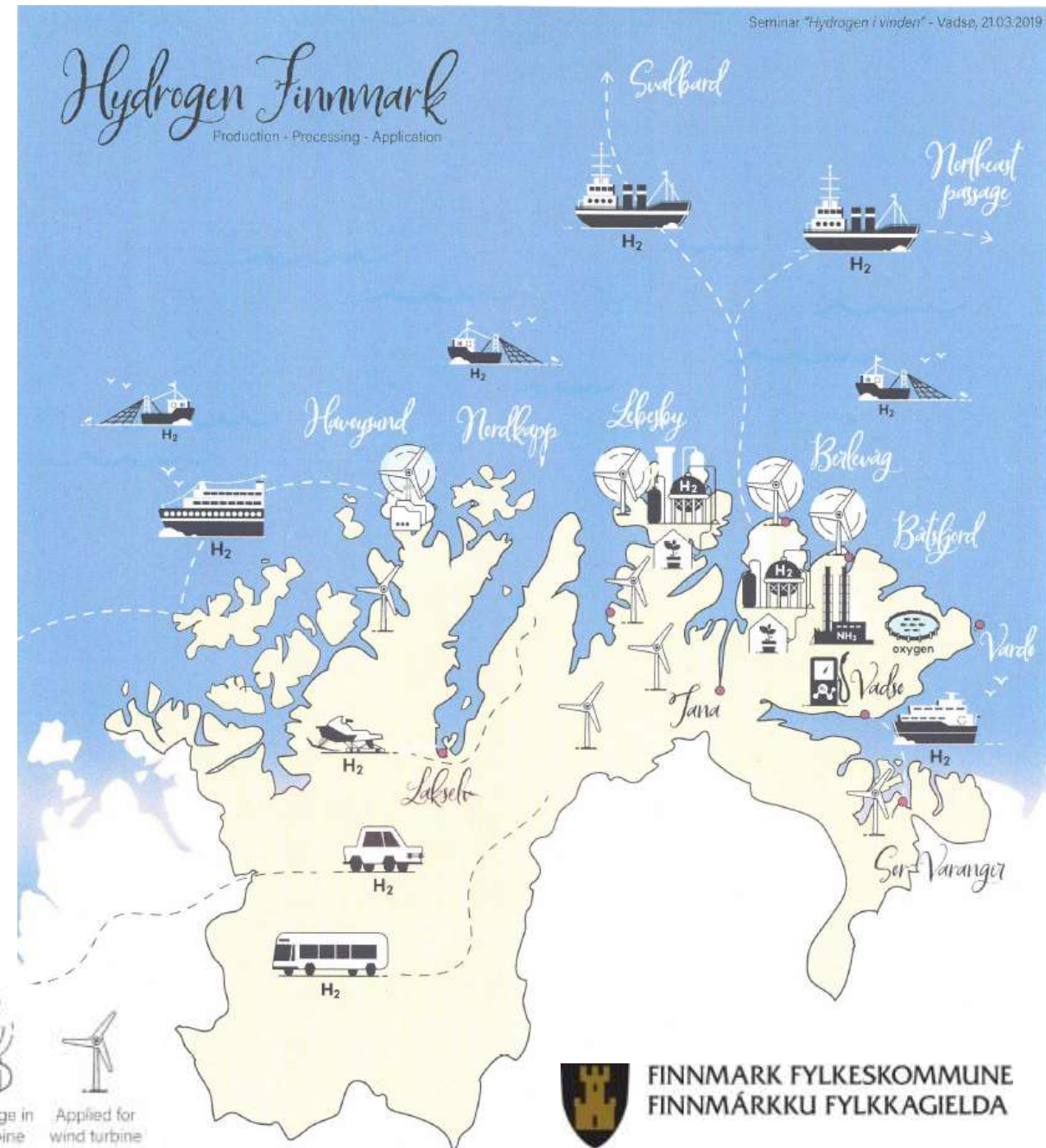
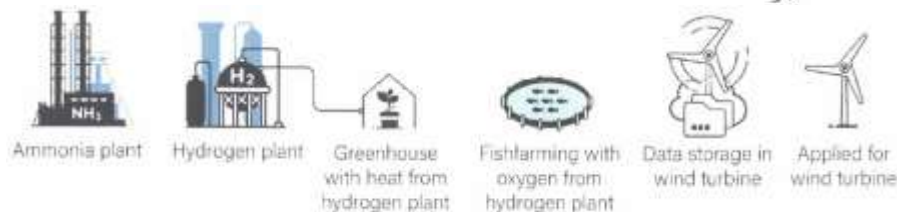
2 GW  
innestengt  
vindkraft





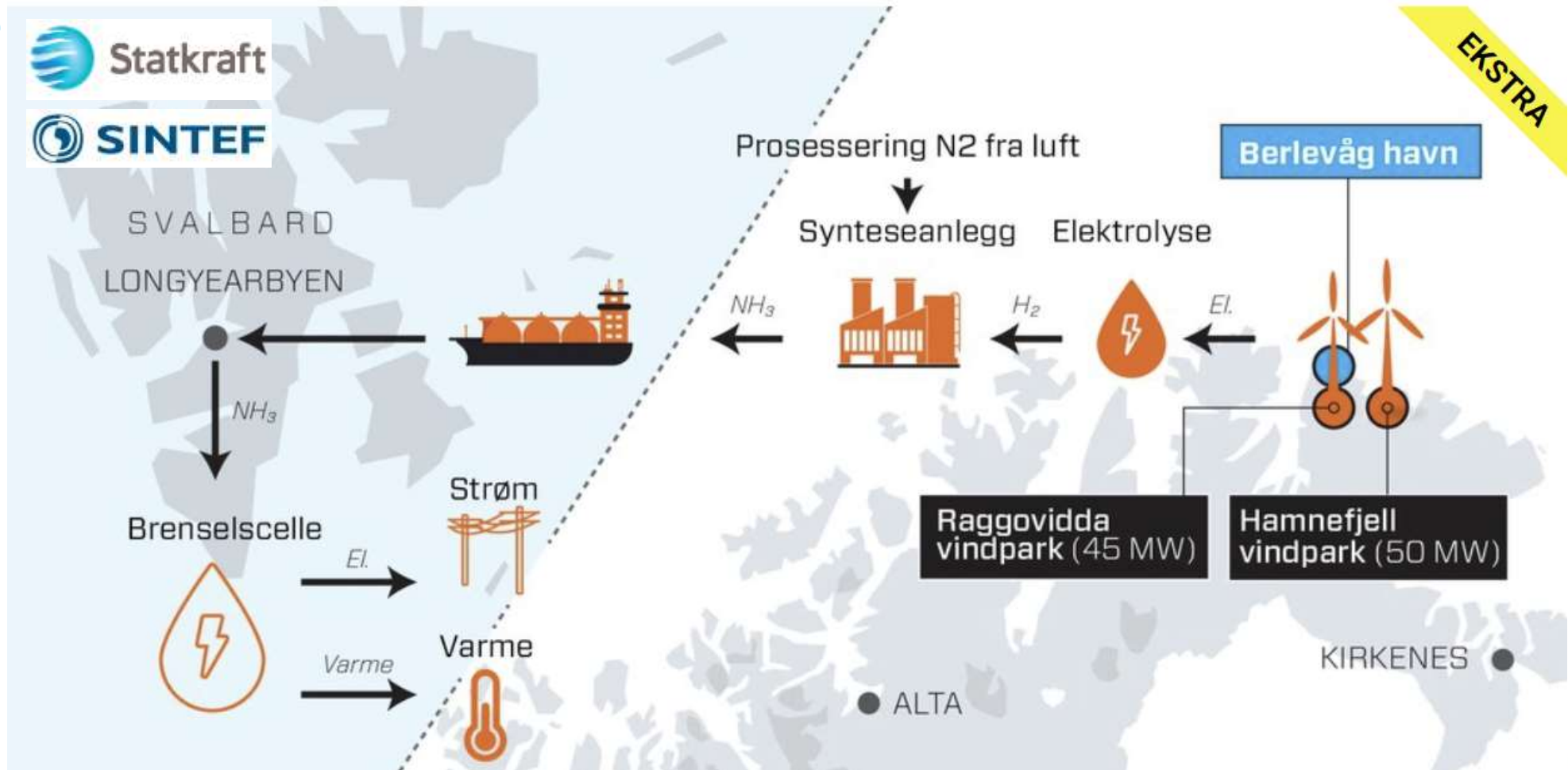
# Innestengt vindkraft

- Pilot-prosjekt: 2,5 MW → 1 tonn H<sub>2</sub>/dag
- Konsesjoner 225MW → 50 tonn H<sub>2</sub>/dag
- Vindpotensial 2 GW → 500 tonn H<sub>2</sub>/dag
- Drivstoff til ½ mill. personbiler
- Anvendelser i regionen:
  - Person-, vare- og lastebiler, Snøscootere
  - Fiskebåter, Trålere, Hurtigruten,
  - Oppdrettsanlegg (O<sub>2</sub>&varme), Industri (NH<sub>3</sub>?)

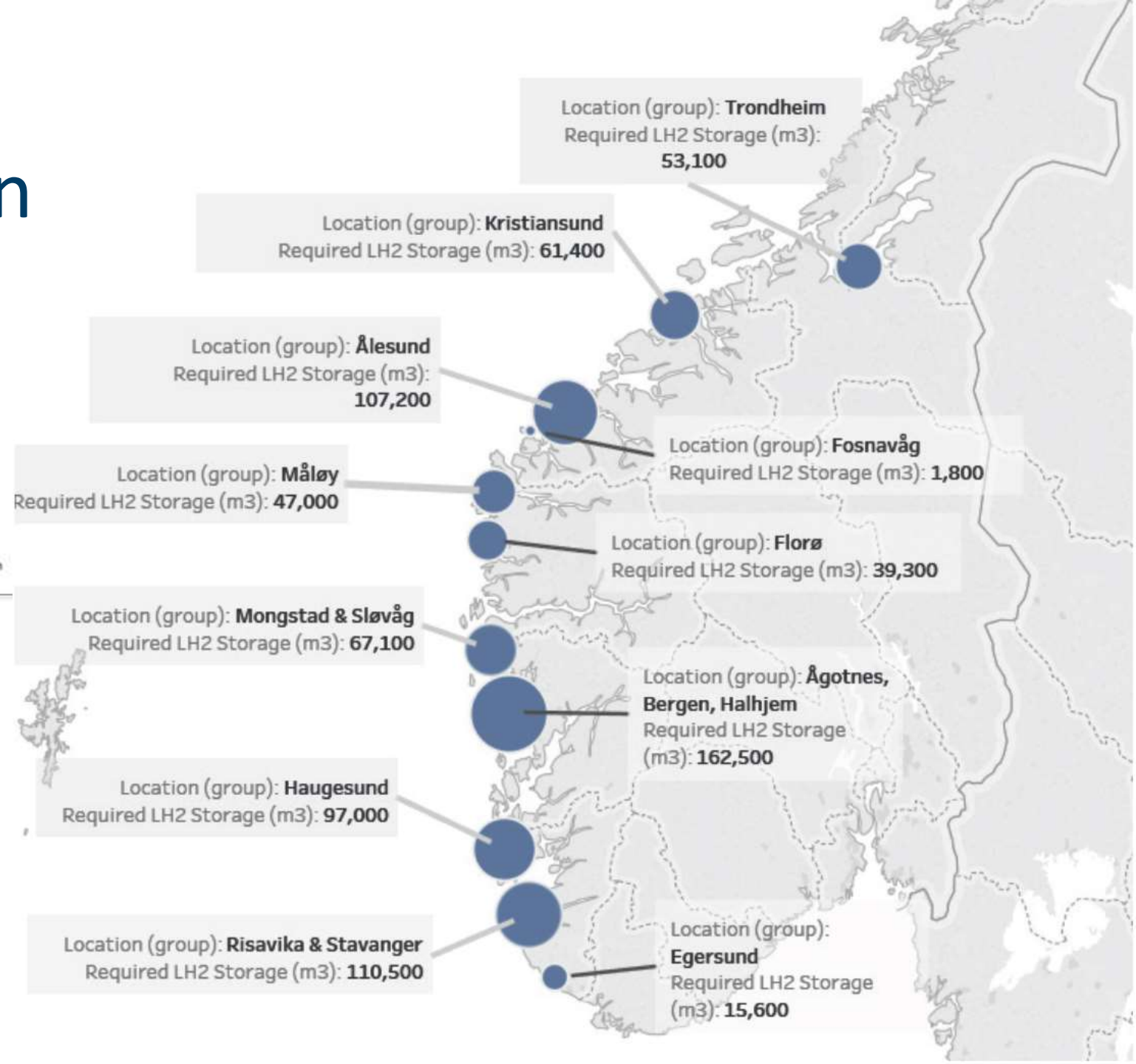
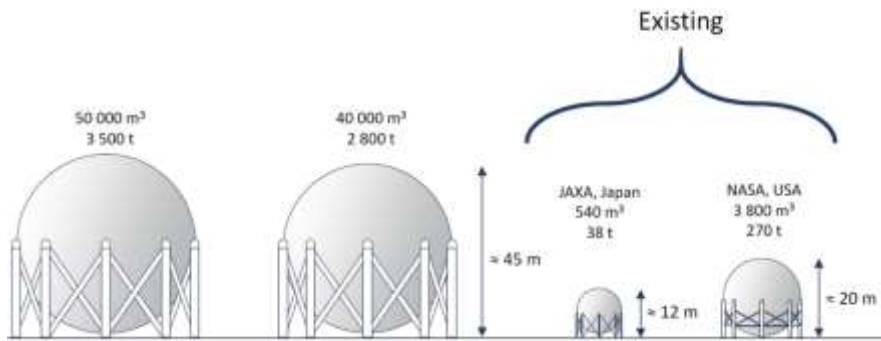




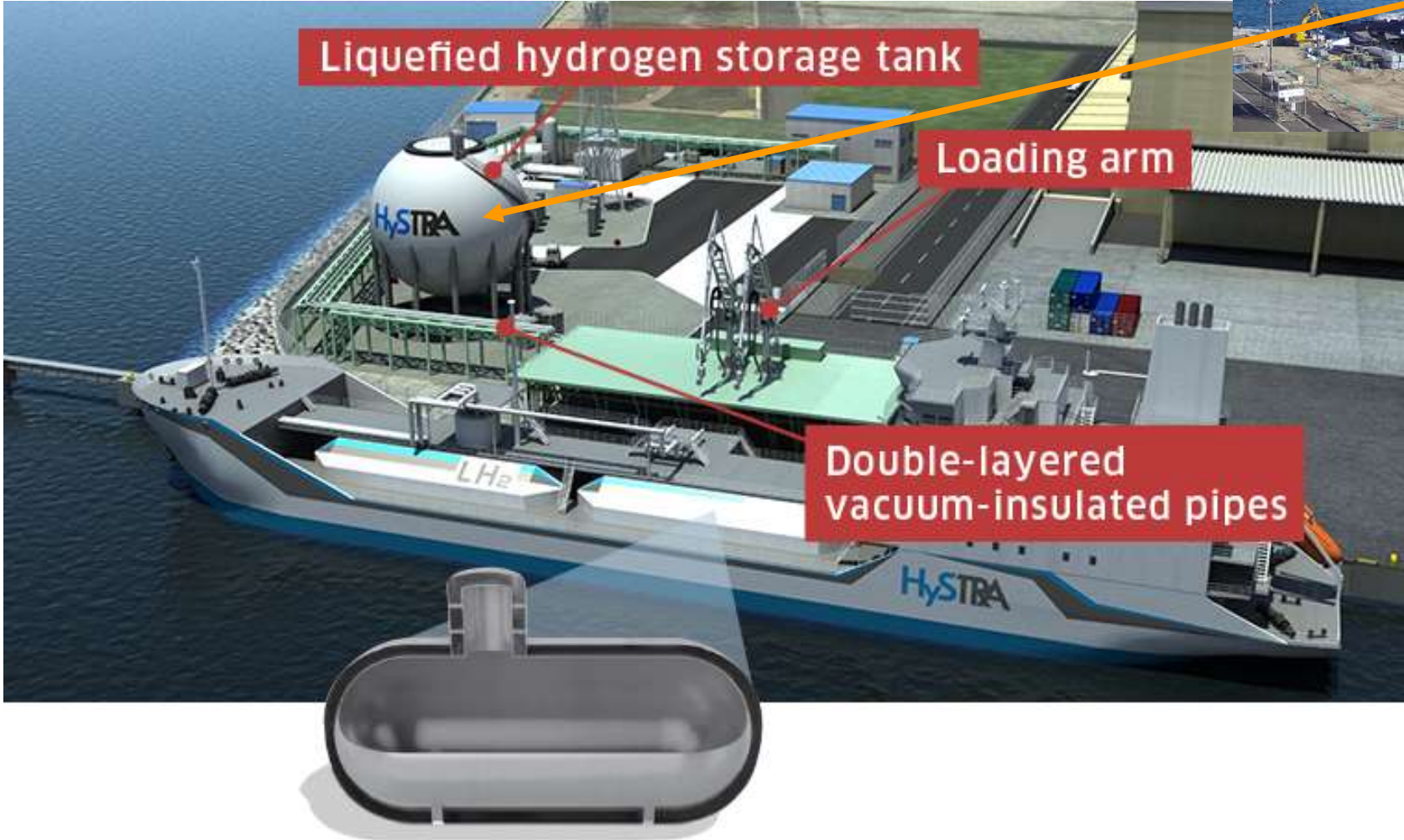
# Innestengt vindkraft → 0-utslipp på Svalbard?



# Flytende hydrogen



# Flytende hydrogen







# Utslipp fra transport & H<sub>2</sub> initiativer i Norge



Passenger vehicles, 5,3 mill tonnes

CO<sub>2</sub>

Vans and heavy duty vehicles 4,5 mill tonnes

CO<sub>2</sub>



H<sub>2</sub>-delivery trucks in 2019 →



Domestic maritime and fishing, 2.9 mill tonnes

Other mobile sources 2.3 mill tonnes



Domestic air traffic 1,3 million tonnes

Motor bikes and scooters 0,1 million tonnes

Railroads, 0,1 million tonnes



100 passenger trains 2018-2021



0-emission passenger trains in Norway?

Raumabanen



5,6 MW H<sub>2</sub>/FC freight train in Norway by 2025?



*San Francisco 10.-11.September 2019*



# International Workshop, H2@Ports

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- >100 delegates, Japan, Europe, North America (host US DoE/DoT)
- Steffen Møller-Holst (SINTEF) (re)presented Norway
- Workshop objectives:
  - *address barriers to industry commercialization,*
  - *identify needed research to accelerate technology development and*
  - *explore opportunities for cooperation and collaboration on H<sub>2</sub> maritime areas of interest.*
- Panel discussions following each session
- High focus on regulatory barriers for H<sub>2</sub> and Fuel Cells
- Norway was pointed at as a front runner in maritime applications



San Francisco 10.-11.September 2019



# International Workshop, H2@Ports



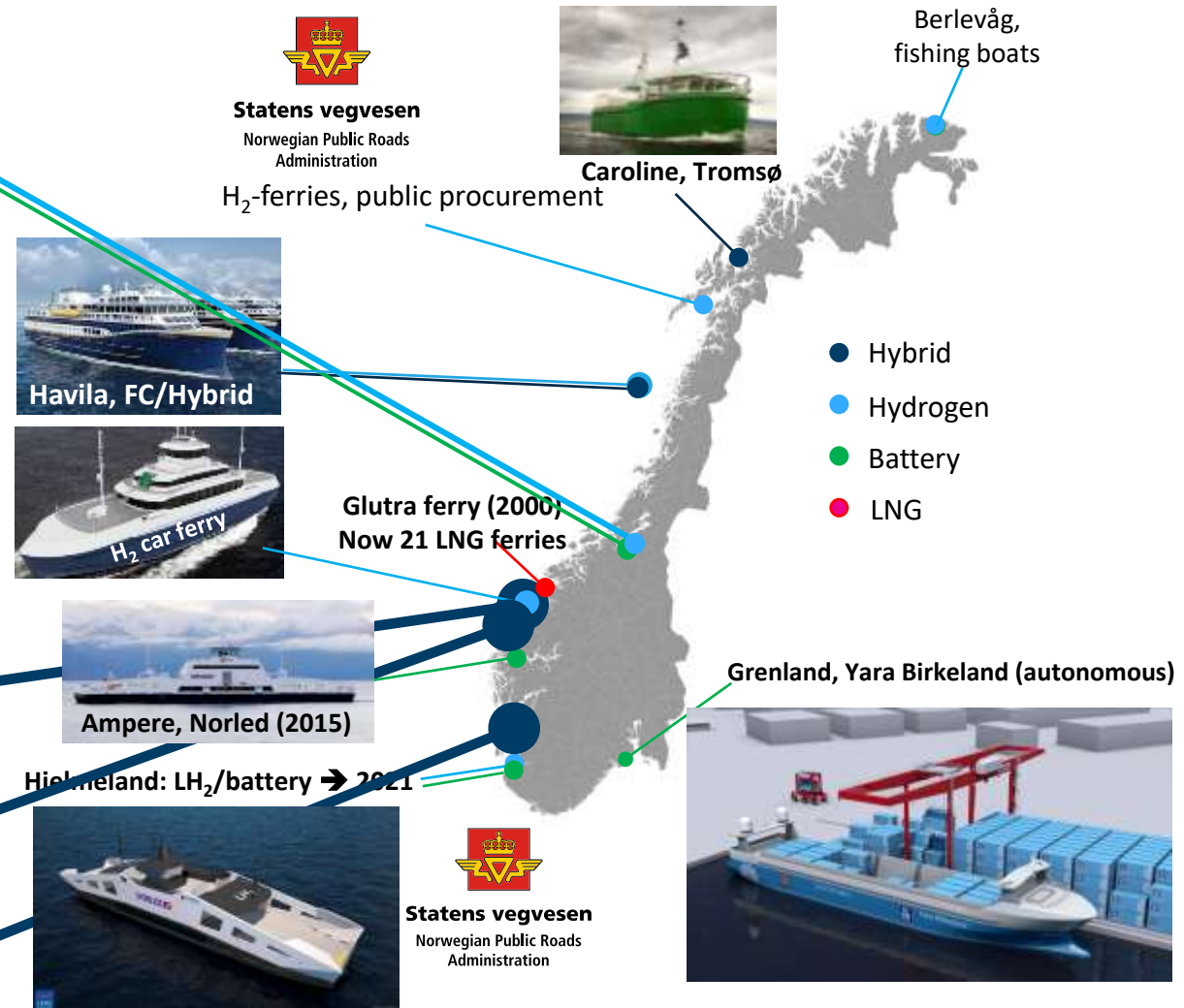


San Francisco 10.-11.September 2019



# GHG emission reduction, maritime initiatives

Trondheim Sept 3<sup>rd</sup>, 0-emission High speed passenger boat concepts





# Hydrogen use in industry

18


**Offshore**



**50 B€ export of oil & gas annually**

**Metal production**

Replacing coal with H<sub>2</sub> in titanium production (electrochemical cells)



**GREENSTAT SKL TIZIT**

**Fish farming**



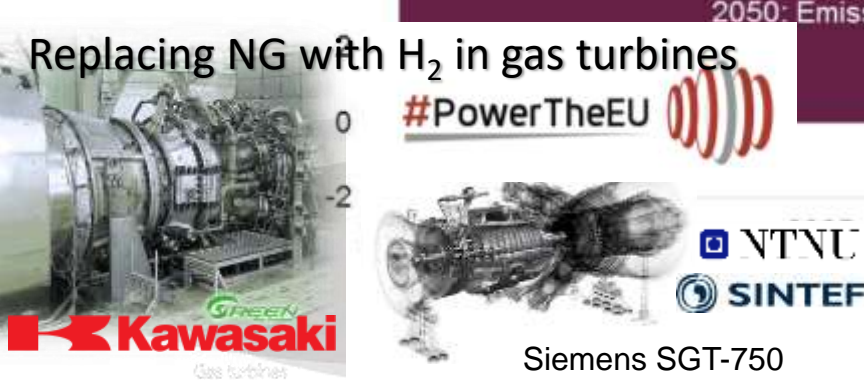
Source: SALMAR / Ocean Farming

H<sub>2</sub> / O<sub>2</sub> / heat



Replacing NG with H<sub>2</sub> in gas turbines

#PowerTheEU



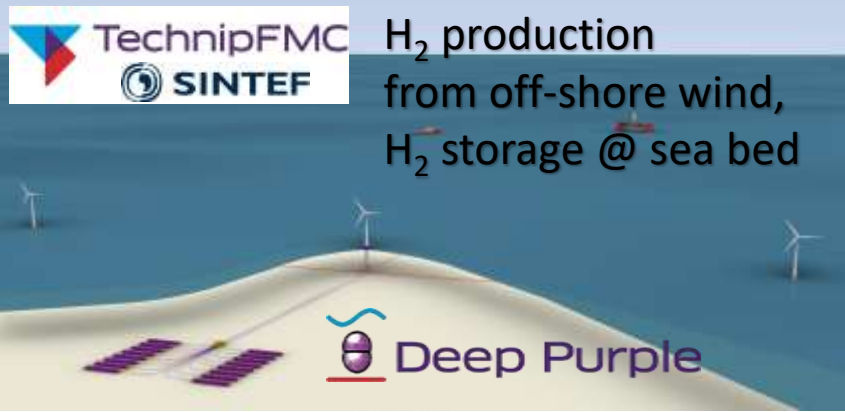
**Kawasaki** Green Gas turbines

**NTNU SINTEF**

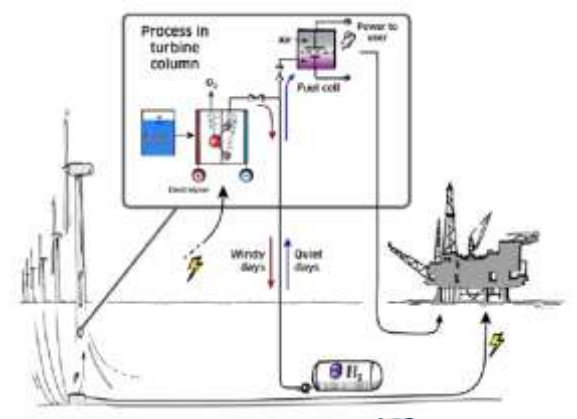
Siemens SGT-750

**TechnipFMC SINTEF**

H<sub>2</sub> production from off-shore wind, H<sub>2</sub> storage @ sea bed



**Deep Purple**







# Verdiskaping i norsk industri

Sunnmørsposten Nyheter Sport Kultur Debatt Les e-avis Bli abonnent MENY

## Hexagon kapret milliardavtale med bilprodusent

Hexagon Composites skal leveres til en verdi på 1 milliard kroner i aksje



HEXAGON  
PURUS



1 mai bestilte det amerikanske ølkonsernet Anheuser-Busch 800 inntekter på fire milliarder kroner. Foto: Pressebilde Nikola

Nyheter Børs

## Nel inngår milliarddeal med Nikola Motor - stiger på Oslo Børs

Hydrogenselskapet Nel kan få inntekter på fire milliarder kroner for utstyr til ladestasjoner i USA.





# Norges bransjeforening for aktører med engasjement innen H<sub>2</sub>-teknologi



[www.hydrogen.no](http://www.hydrogen.no)

Norsk Hydrogenforum har ca. 60 medlemmer fra industri og akademia:





# Oppsummering

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- Hydrogen vil spille en sentral rolle for å realisere et bærekraftig energisystem
  - Stabiliserende effekt på nettet når andelen uregulerbar kraft øker, gir mulighet for utnyttelse av innestengt kraft
- Det satses stort på hydrogen internasjonalt og ikke minst i Europa (industri, FCH JU)
- Norge kan oppnå betydelig verdiskaping og klimegevinster fordi Norge har
  - Svært god tilgang på energikilder egnet for videreforedling i form av hydrogenproduksjon & eksport
  - Internasjonal ledende industri innen H<sub>2</sub>-produksjon, H<sub>2</sub>-lagring / sikkerhet og høykompetente FoU-miljøer
  - Inntatt en ledende rolle innen implementering av 0-utslippstransport, attraktivt tidligmarked for H<sub>2</sub>-kjøretøyer
  - Offentlige støtteordninger med fokus på H<sub>2</sub> / CCS / flåter / maritime & industrielle anvendelser, videreutvikles
- Nord-Vestlandet er i posisjon til å bidra → *Regional og nasjonal verdiskaping!*



Takk for  
oppmerksomheten!

NORSK HYDROGENFORUM  
**hydrogen.no**