Low carbon – Equinor R&T

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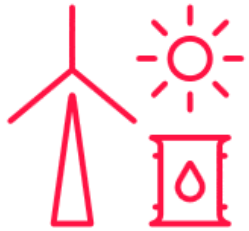
equinor

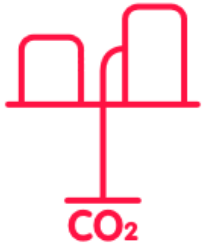
Context: Climate change

- **We believe a low CO_2 footprint is a competitive advantage, providing us with attractive business opportunities in a transition to a lower emission economy.**
- Equinor acknowledges the Intergovernmental Panel on Climate Change's (IPCC's) scientific consensus of the influence human activities have on climate change. Equinor aims to be a part of a global energy transformation and continue to turn natural resources into energy for people and progress for society.

- Our strategy focuses on three main areas. We are building a high value and low carbon oil and gas portfolio, we are building a material industrial position in renewable energy and low carbon solutions, and we embed climate risk and performance into our decision-making.
- Our Climate Roadmap explains how we plan to achieve our goals and how we will develop our business, in support of the ambitions set out in the Paris climate agreement.



By 2020 we expect up to **25%** of research funds to be devoted to new energy solutions & energy efficiency.



Aiming to achieve annual CO_2 emission reductions of **3 million tonnes by 2030** compared to 2017.

By 2030 new energy has the potential to constitute around **15-20%** of investments/annual capex.

CLIMATE ROADMAP

Creating a low carbon advantage

Methane emissions in the gas value chain is below **0.3% of gas delivered** to the market for Norwegian gas to Europe

We aim to reduce emissions with **3 million tonnes/year** accumulated from 2017 to 2030

We aim to reduce our carbon intensity to **8kg CO2/boe** by 2030

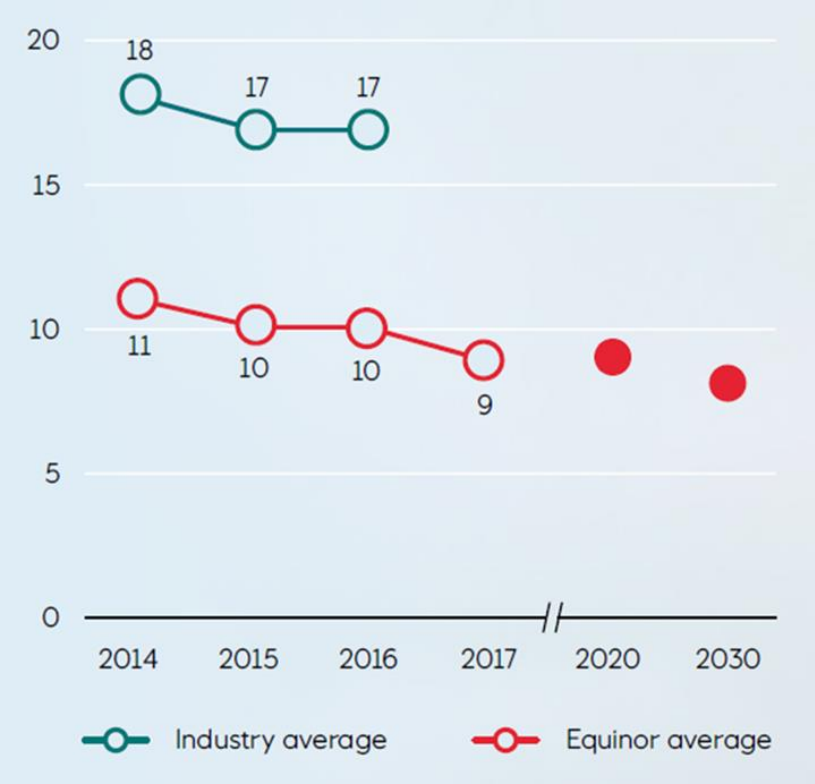
We expect **15-20% of our investments** to be in new energy solutions by 2030

We expect low carbon R&D to account for **25% of research funds** in 2020

All investment decisions are evaluated against our **climate ambition**

Context

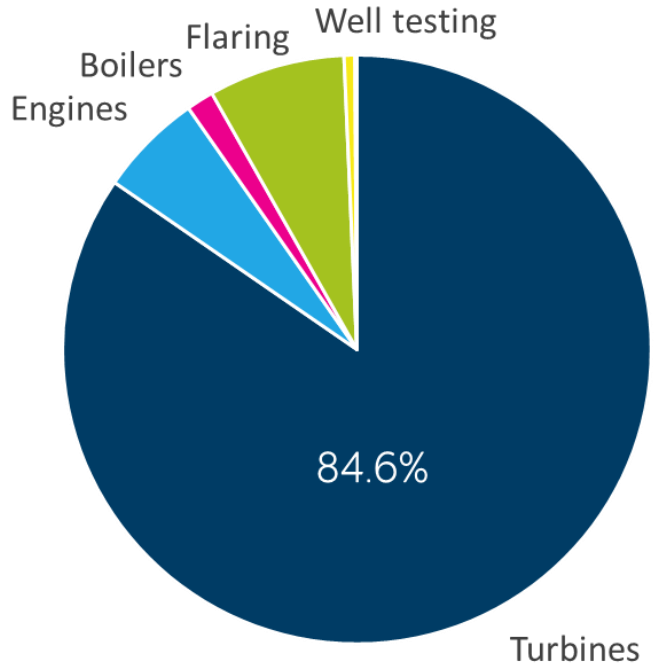
- **Equinor goal 2030: 8 kg CO_2/boe**



Upstream CO_2 intensity, kg CO_2/boe

Source : IOGP/Equinor

- Gas turbines accounted for **85%** of the Norwegian CO_2-emissions from petroleum activities (2017)



Source: Norwegian Petroleum Directorate


DELIVERING CLIMATE IMPROVEMENTS ON NORWEGIAN CONTINENTAL SHELF
800.000
tonnes CO_2 reduction/year
• Target established in 2008
• Reached in 2016
1.200.000
tonnes CO_2 reduction/year
• Increased target by 50% to 2020
• On track to deliver target already in 2018 – two years ahead of plan
2.000.000
tonnes CO_2 reduction/year
• New step up: another 2 million tonnes yearly CO_2 reductions by 2030
• Ambitious target – new ideas and solutions needed

Corporate Technology strategy

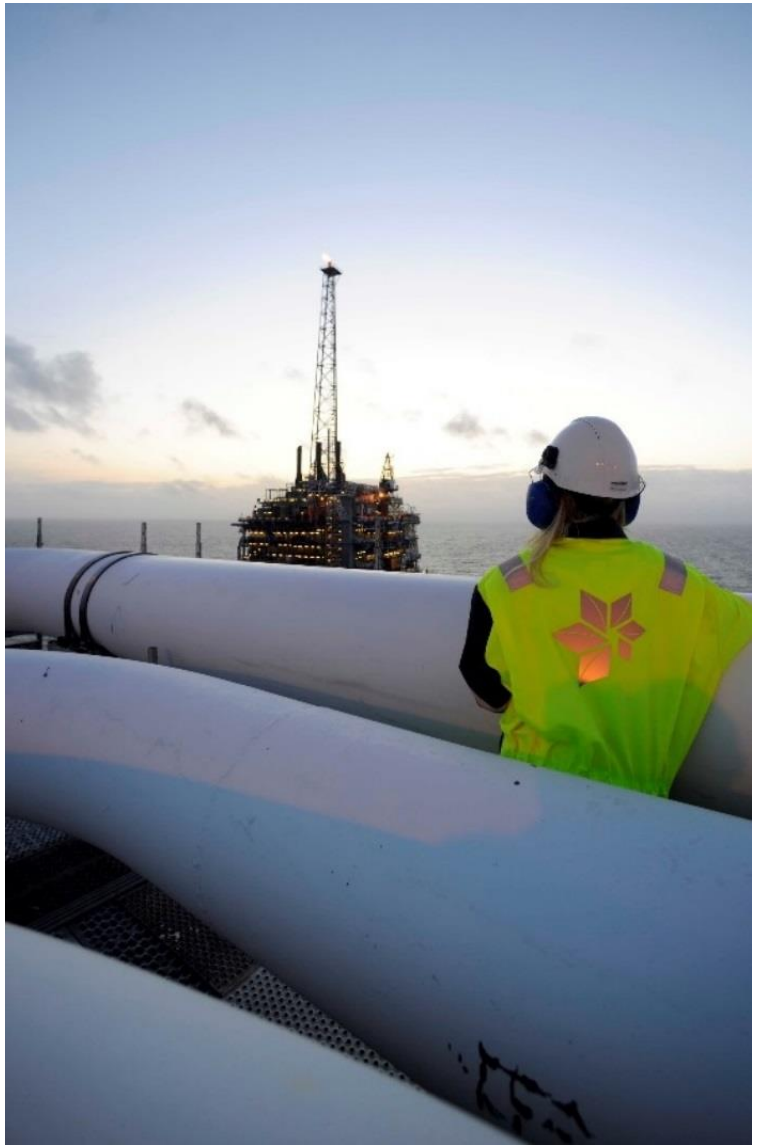
- Low carbon and Renewables solutions as focus areas

Low carbon solutions for oil & gas

Reduce emissions and decarbonize processes and products

Value chain perspective reducing emissions from reservoir to market:

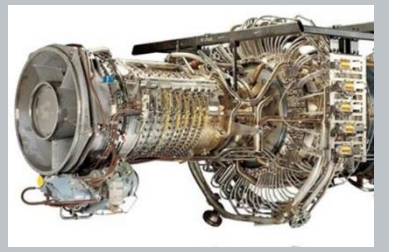
- Energy efficient field development and operation
- Low carbon power and heat supply
- Value chains with carbon capture, utilization and storage



Some examples

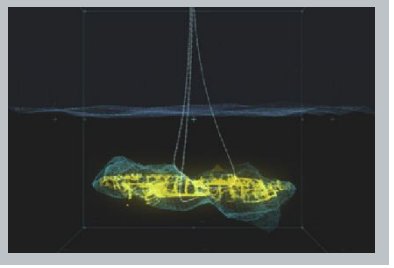
Energy efficient subsea processing

Maximise power generation efficiency



Optimise electrification

Hydrogen from natural gas with CCUS

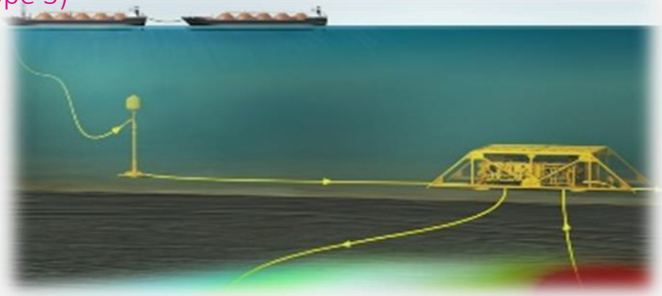


R&T FVC 2018-2020 R&D portfolio focus

Cost competitive offshore wind

Main focus: Technologies to **increase income** and **reduce opex/capex**.

Low Carbon Gas Solutions for our own facilities (scope 1) and technologies to support investments in CO_2 and H_2 Value Chains (scope 3)

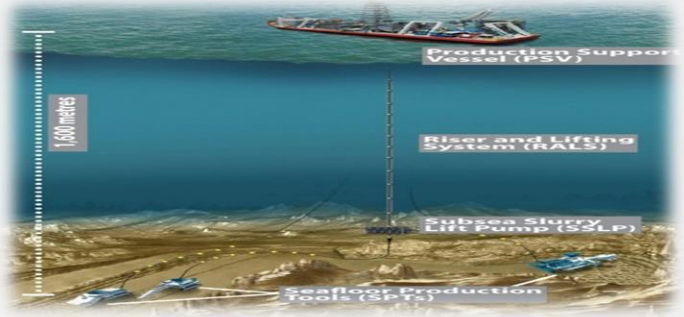


Main focus: Technologies to secure **safe operations**, **reduce capex** and secure **public acceptance**.

Tools and technologies to unlock opportunities in Solar, Geothermal and Energy storage

Main focus: Develop in-house **tools** and **competence** to support first investments & identification of technology **game changers**

Identify and mature emerging new value chains

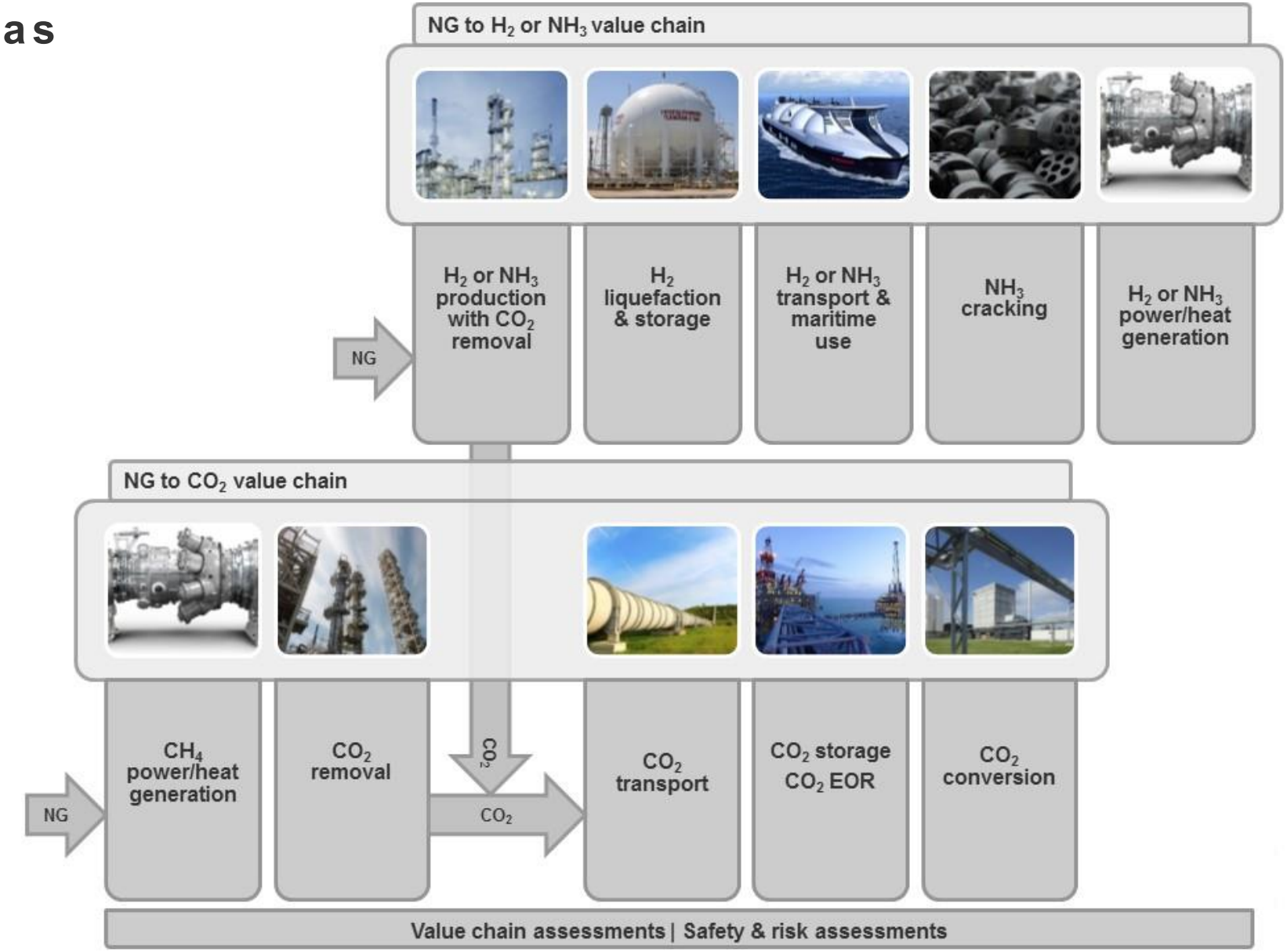


Main focus: **Understand** and **de-risk** new emerging value chains and industry step outs

H_2 and CO_2 Value Chains
Technology Focus Areas

- Clean hydrogen and ammonia value chains are dependent on a sustainable carbon dioxide value chain

- Equinor has extensive experience in the capture and storage of CO_2 - an enabler for clean H_2



Equinor’s approach Clean (Blue) Hydrogen

Infrastructure Dimension

- Build on the massive existing natural gas network
- Produce hydrogen at large scale from natural gas
- Capture the CO2 in the process and send it to permanent offshore storage

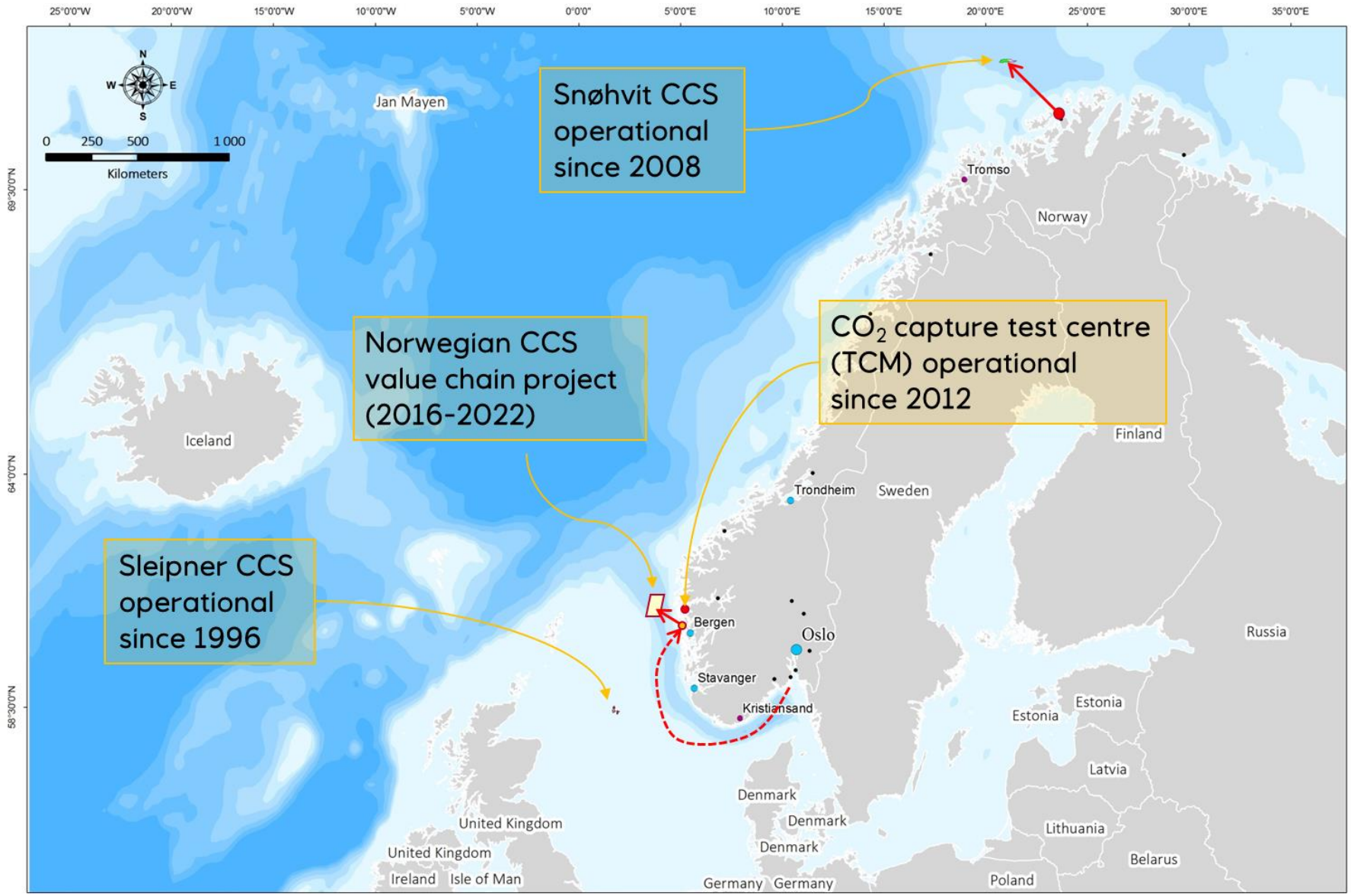
Commercial Dimension

- Identify markets suitable for switching to hydrogen
- Partner with large customers who are pioneers in pursuing low carbon solutions
- Develop real, tangible and sizable projects
- Approach authorities to design suitable financial support solutions

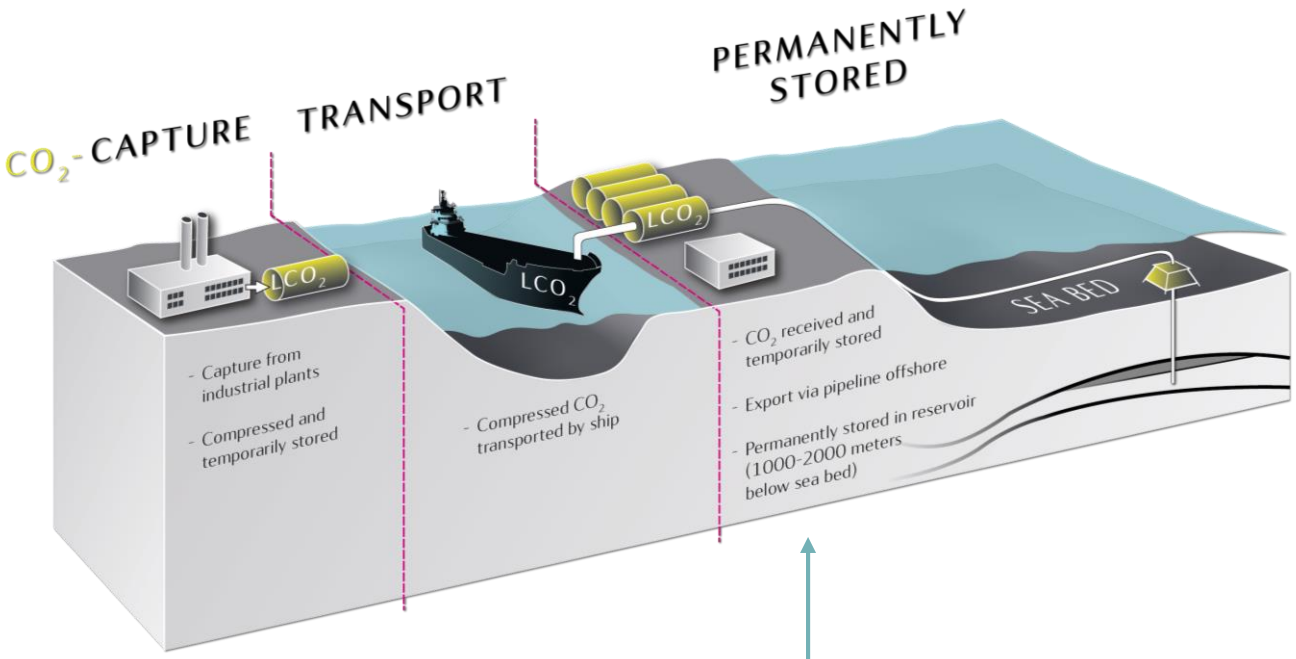
Hydrogen Council · Hydrogen Europe · NUON · gasunie · Northern Gas Networks · VIKING CRUISES · Open Grid Europe The Gas Wheel

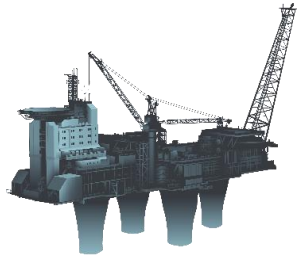
Norway CCS: Building on experience

- 22 years of operations
- Building confidence in CCS
- > 22 Mt CO_2 stored
- New full-scale CCS project being developed

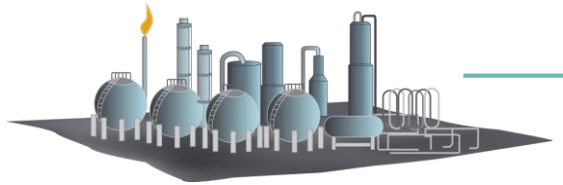


CCS as enabler for hydrogen production





Natural Gas



CO_2

H_2

H_2

Clean Hydrogen

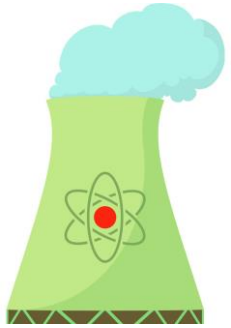
- for power generation
- for heat
- for maritime transport

Demand for Clean and Flexible Power Expected to go up

Baseload

Coal

Phase Out



Nuclear

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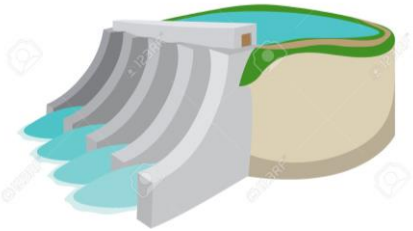
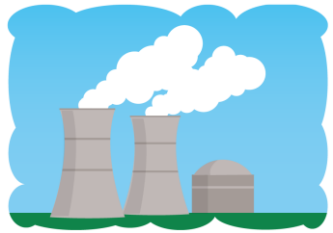
Flexible



Hydro

Limited Growth



Gas –> Clean Hydrogen

Strong Growth

Balance
Supply
&
Demand

Intermittent

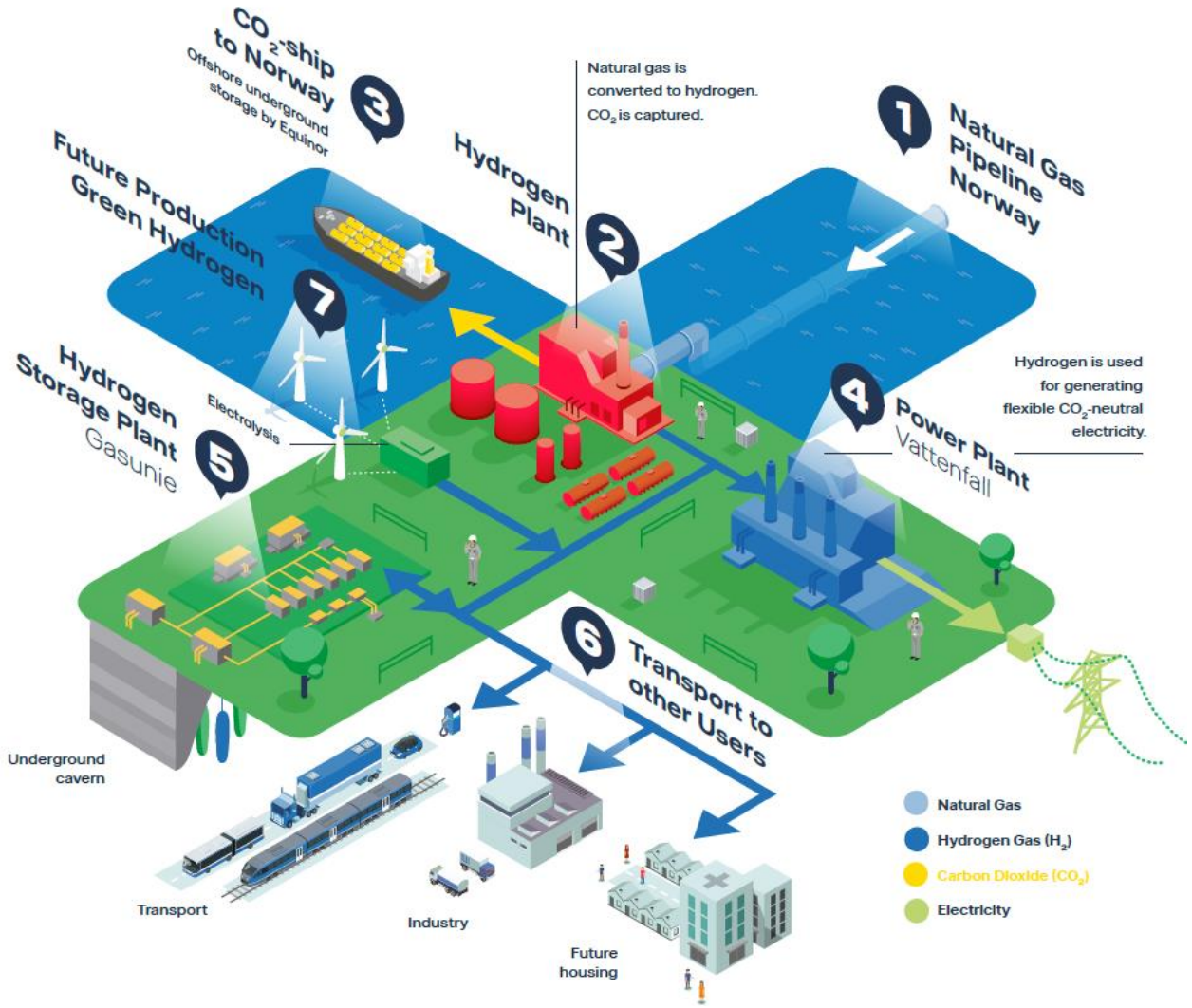
Wind

Strong Growth

Solar

Strong Growth

H2M – Magnum, Netherlands



- Energy: 8-12 TWh
- CO2 emissions reduction of 1,3 Mton/year (per CCGT)
- Utilise existing gas power plants and gas infrastructure
- Switch fuel from natural gas to clean H2
- Clean, flexible electricity as back-up for solar and wind
- Launch large-scale H2 economy

- Partners: NUON & gasunie

H21 North of England

- System approach to decarbonise residential heating and distributed gas use– fuel switch from natural gas to hydrogen
- Large-Scale: 12.5% of UK population , ~85 TWh
- 17-18 Mtons CO2 reduction per year
- Continued use of existing infrastructure
- SoS: copes with seasonal (winter) peak demand
- Offshore CO2 storage in either UK or Norway
- Facilitating unlimited system coupling between gas and electricity
- Launch date: November 23rd, 2018 (London)

Key messages and take-away

- Decarbonising the energy sector towards 2050 is a major challenge
- Renewable solutions are perfect for the carbon-light sectors
- Heavy industry, heat and flexible power generation require large-scale solutions on which we need to start working today
- Hydrogen from natural gas with permanent offshore storage of CO_2 offers:

Low cost	Gas reforming is the most cost effective hydrogen pathway
Low technical risk	Proven technology in H_2 production and CO_2 storage
A clean value chain	The CO_2 is returned to permanent offshore storage
Large scale	The industry has demonstrated a track-record of mega projects

- Hydrogen from natural gas with CCS will establish a robust hydrogen infrastructure that green hydrogen can utilise

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