



Equinor's vision for Hydrogen

Fuel Cell Hydrogen Joint Undertaking Stakeholder Forum

Henriette Undrum – New Energy Solutions

Decarbonising Energy Systems

Easy ← complexity to decarbonise → Hard



Transport



Battery (mostly) plus Hydrogen for Heavy Duty



Hydrogen Fuel-Cell Trains

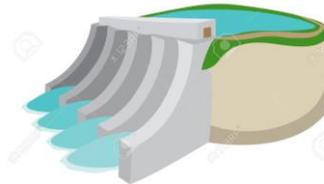


Liquid Hydrogen and Fuel-Cells for long haul Big Ships

Power



Large Battery Systems for Daily Swing (night-to-day)



Hydro-Power as Battery for Small Scale Intermittency



Hydrogen fired CCGTs Clean Back-Up Power for Large Scale Intermittency

Industry



Light Industry powered by Renewable



Heavy Industry powered by Hydrogen from Natural Gas + CCS



CCS for Industry without other Alternatives

Heat



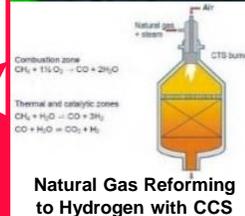
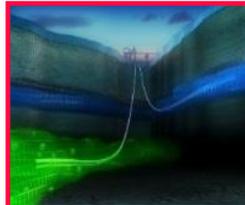
Heat Pumps For Efficient Use of Electricity in Homes



Hydrogen for Efficient Transfer of Energy from Production to End-Users



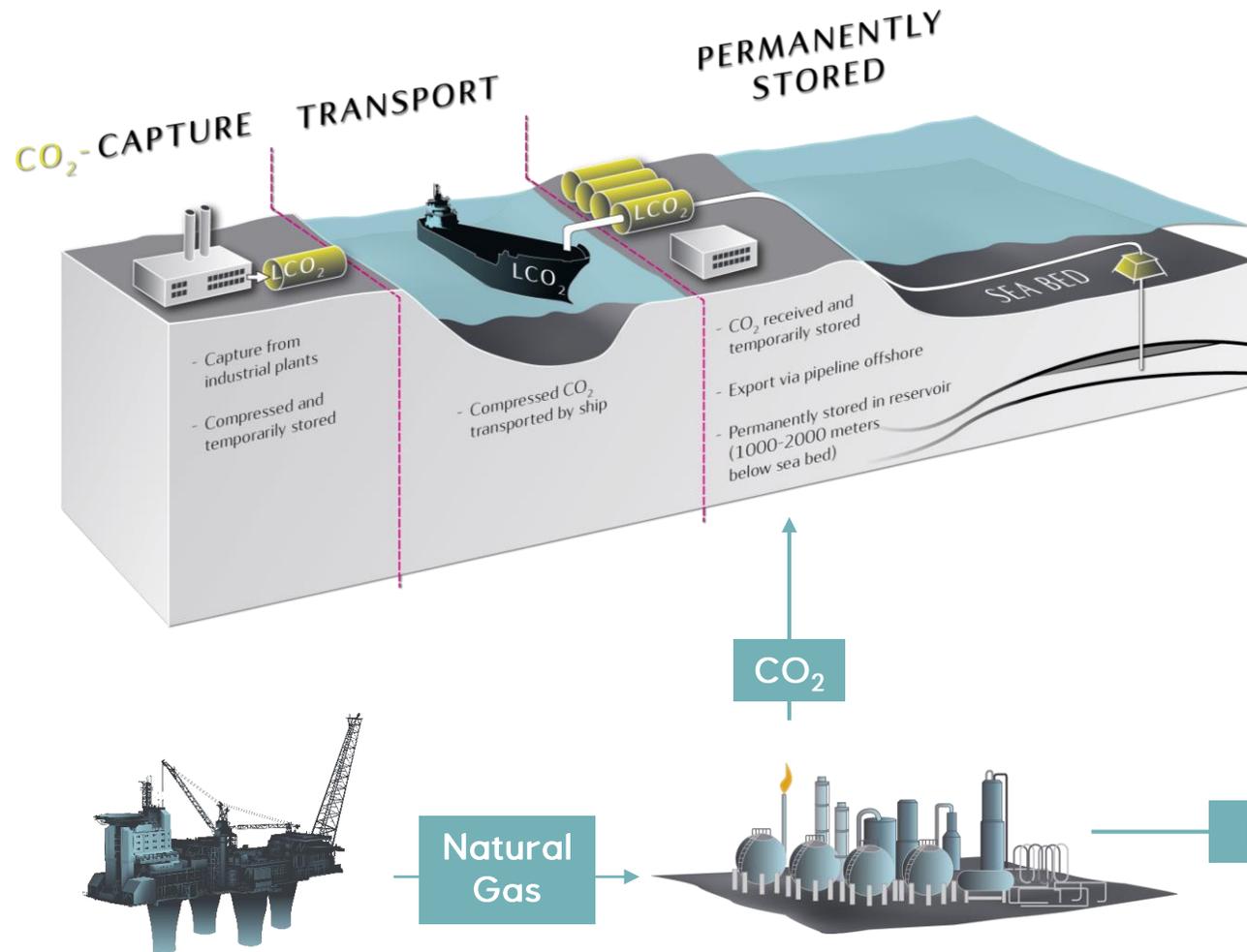
Hydrogen for Large Scale Seasonal Storage



Natural Gas Reforming to Hydrogen with CCS

Multiple technologies to address the challenge

CCS as enabler for hydrogen production



H₂

Clean Hydrogen



for power generation



for heat



for maritime transport

Equinor Hydrogen Portfolio

H2M - Magnum

- Energy: 8-12 TWh
- Utilise existing gas power plants
- Switch fuel from natural gas to clean H2
- Clean electricity
- Clean back-up for solar and wind
- Launch large-scale H2 economy
- **Partners: Nuon and Gasunie**



H21 North of England

- Energy: 75-85 TWh
- Domestic heating in UK
- Utilise existing gas network
- Synergies with industry/power generation
- Enables H2 to transport later
- **Partners: Northern Gas Network and Cadent**



New Projects

- Maritime transport – Norway
- Clean Hydrogen Pilot – Norway
- Ammonia to Power – Japan (6-7 TWh)
- Power and Industry – France
- Heat and power – Germany with OGE
- Hydrogen CCU – UK (80-90 TWh)
- Power and Industry – NL (12-20 TWh)



Clean hydrogen from natural gas with CCS

- Decarbonizing Europe towards 2050 is a major challenge.
- Renewable solutions are perfect for carbon-light/easy to electrify sectors.
- Heavy industry, heat and flexible power require large-scale solutions.
- Hydrogen from natural gas with permanent offshore storage of CO₂ offers:
 - **Low cost** – *Gas reforming is the most cost effective hydrogen pathway*
 - **Low technical risk** – *Proven technology in H₂ production and CO₂ storage*
 - **A clean value chain** – *The CO₂ is returned to permanent offshore storage*
 - **Large scale** – *The industry has demonstrated a track-record of mega projects*

H₂

Clean Hydrogen



for power generation



for heat



for maritime transport

Hydrogen from natural gas with CCS can happen fast and will establish a robust hydrogen infrastructure that green hydrogen can utilize later



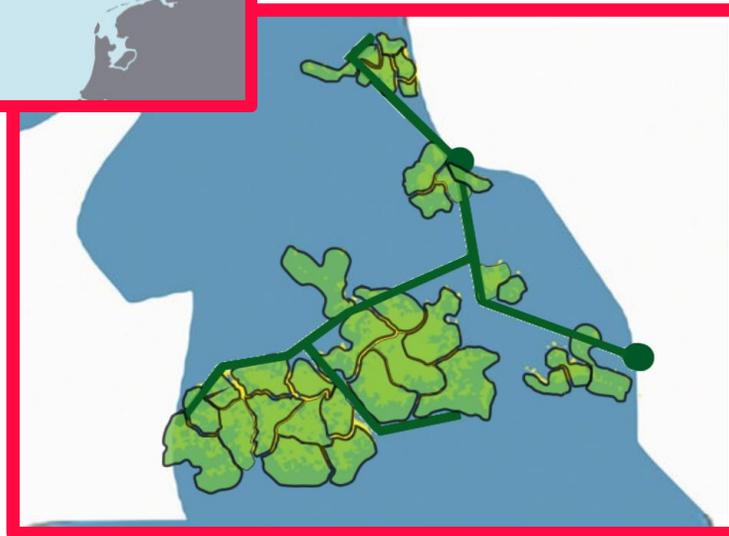
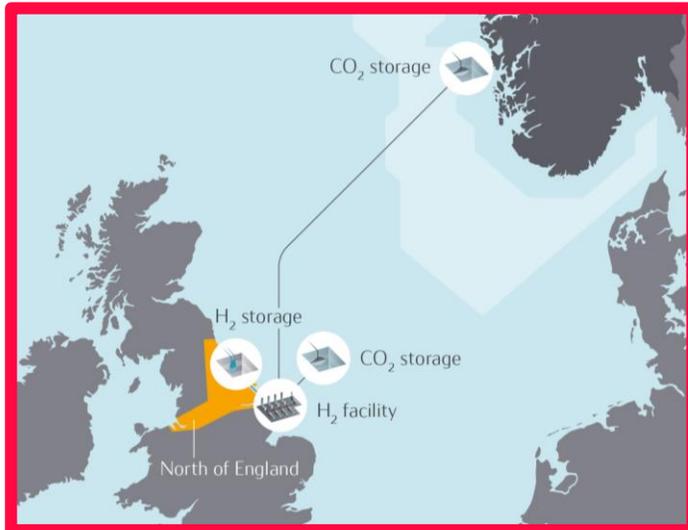
How to future-proof the FCH JU?

1. Private-public collaboration must be **technology neutral**, supporting all forms of clean hydrogen production and use
2. The undertaking should help **commercialize the hydrogen economy**. Greater focus must be put on scalable projects with a serious market potential.
3. Take a **broader value chain perspective** to include all potential hydrogen users – energy, heating and industrial sectors.
4. A broadened sector coupling scope would justify a **name switch to the Hydrogen Undertaking**
5. We recommend to **research and qualify technologies** through pilots for:
 - **Combustion of hydrogen** in industries, power plants, heating applications
 - Future proofing of the existing **natural gas infrastructure** for hydrogen

Do not include

H21 North of England Hydrogen Supply Concept

based on proven and referenced technology



Key Features

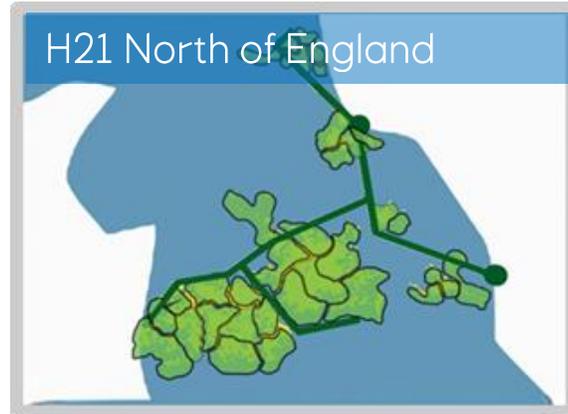
- Conversion between 2028 and 2035, 12.5% of UK population covered by one project.
- Design capacity of 85 TWh, Decarbonising heat using existing infrastructure.
- Production in UK based on reforming of natural gas and CCS (17-18 million tons CO2 per year avoided)
- Equivalent security of supply during peak winter (the beast from the east).
- Offshore CO2 storage in either UK or Norway
- Supporting decarbonization of transport with hydrogen fueling stations
- Supporting decarbonisation of electric decentralized and centralized generation.
- Facilitating unlimited system coupling between gas and electricity.

Energy Flexibility in Europe

Natural Gas currently provides Europe with more than 1500 TWh of flexible energy.
A proven resilient, robust system developed over more than 80 years

What is 1500 TWh ?

Circa 50 x



11,600,000 x



20,000,000,000 x



200 x

