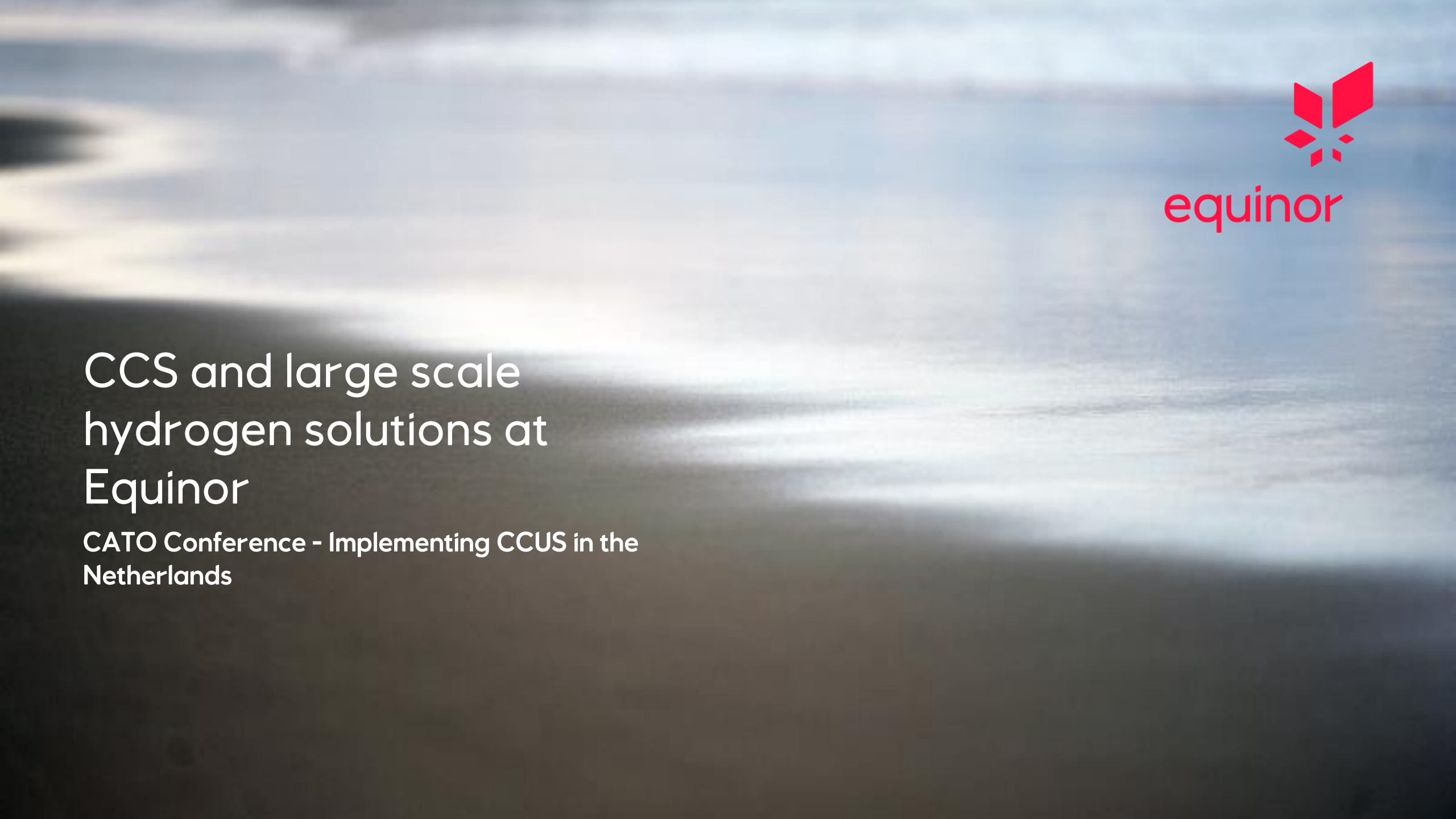


CCS and large scale hydrogen solutions at Equinor

CATO Conference - Implementing CCUS in the Netherlands

Decarbonising Energy Systems

Easy ⟵ **complexity to decarbonise** ⟶ **Hard**

Transport

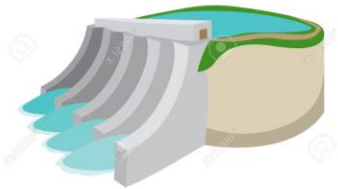
Battery (mostly) plus Hydrogen for Heavy Duty

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 Back-Up Power for Large Scale Intermittency

Industry

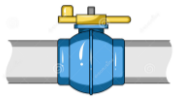
Light Industry powered by Renewable

Heavy Industry powered by Hydrogen from Natural Gas + CCS

CCS for Industry without other Alternatives

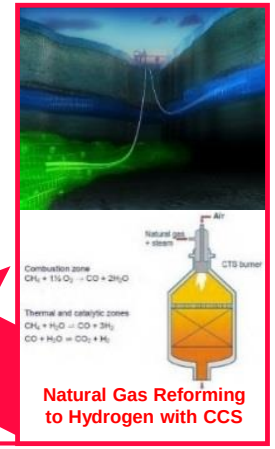
Heat

Heat Pumps For Efficient Use of Electricity in Homes



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

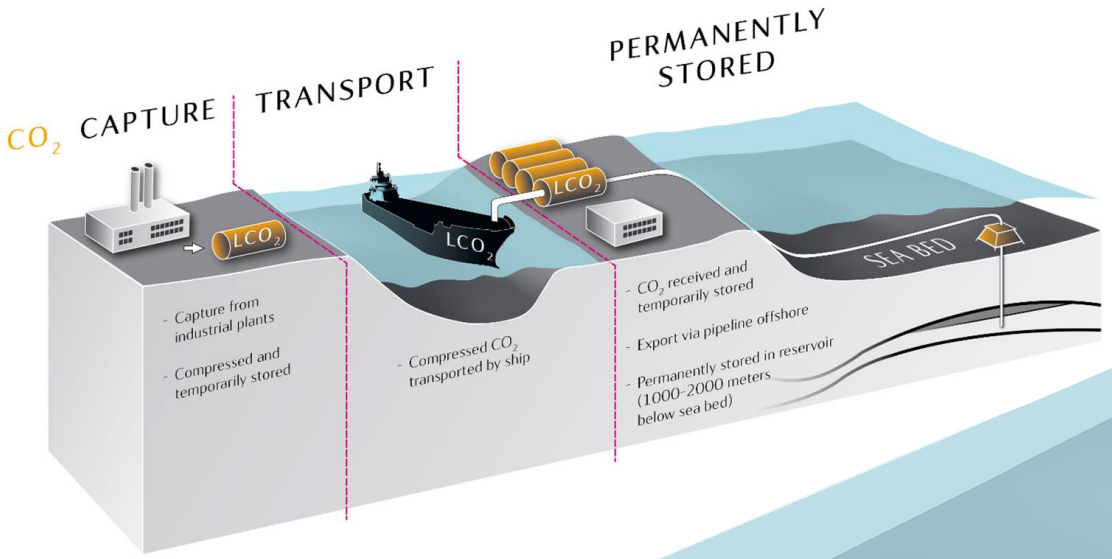
Hydrogen for Large Scale Seasonal Storage

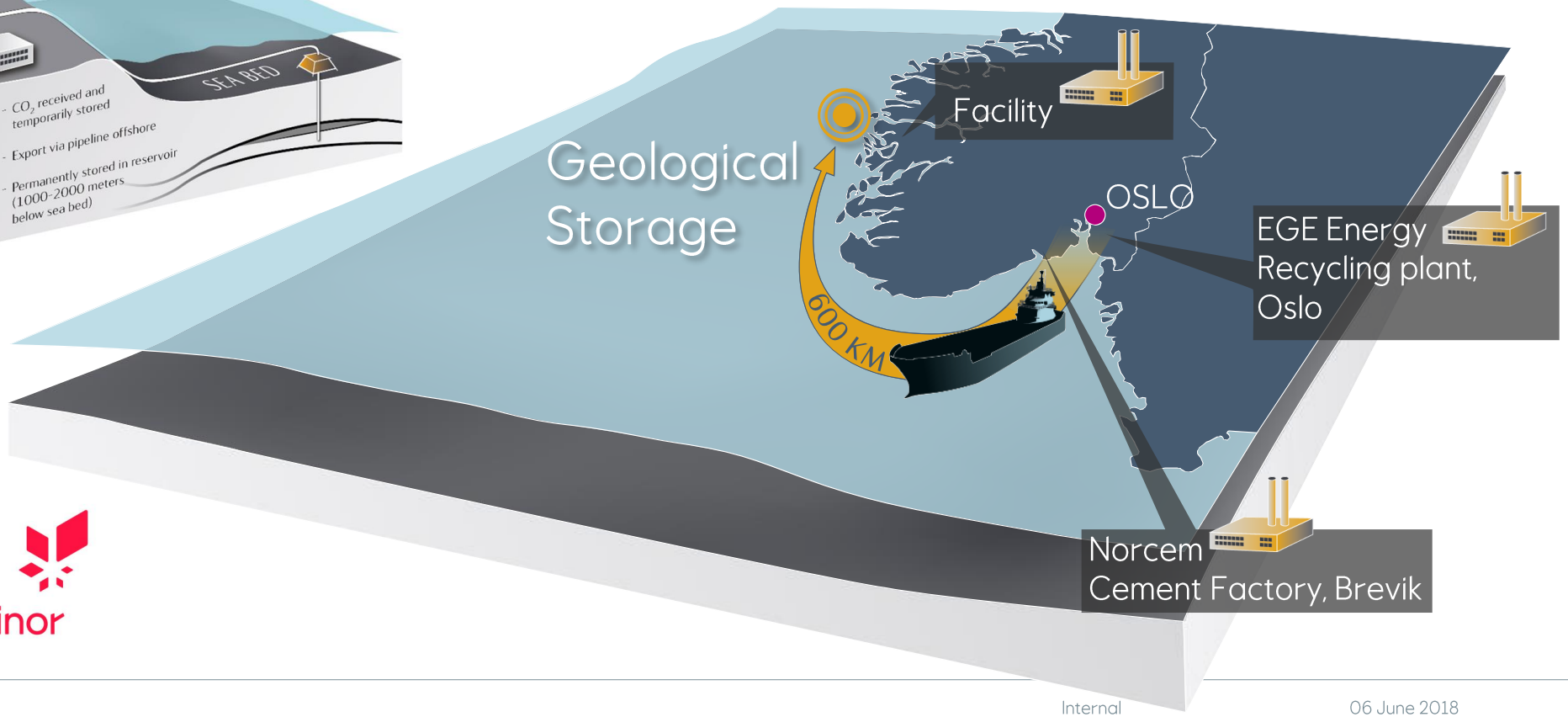


Natural Gas Reforming to Hydrogen with CCS

Multiple technologies to address the challenge

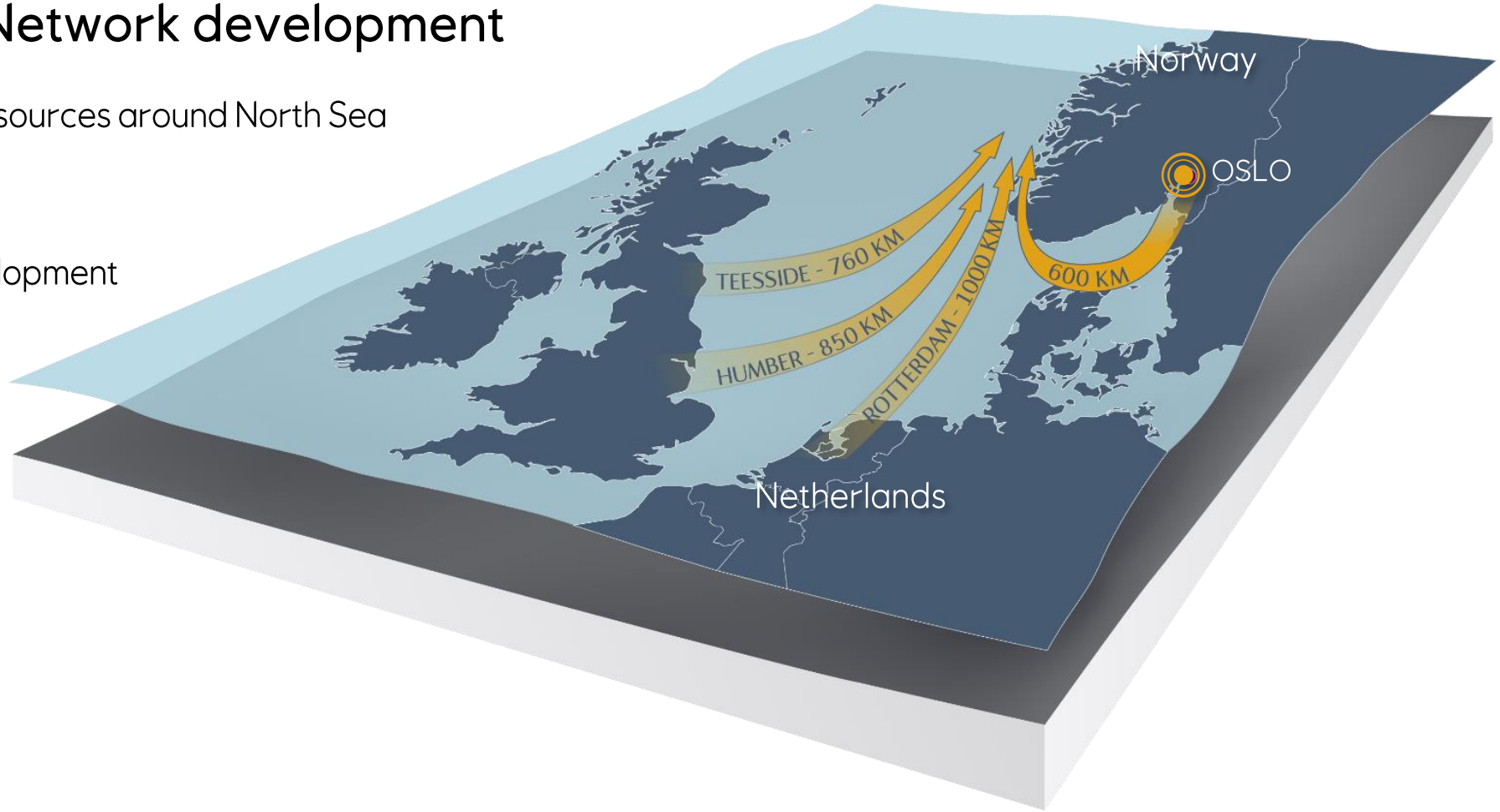
The Northern Lights Project
Transport and storage of industrial CO_2 on NCS





European Storage Network development

- Potential to store from other sources around North Sea
- Flexible due to ship solution
- Stepwise infrastructure development
- Creating Hubs and Clusters



Project of Common Interest

CO_2 cross border transport connections

a) Emission sources in the Teesside industrial cluster; and/or

b) The Eemshaven area in the Netherlands

and a storage site on the Norwegian Continental Shelf (NCS)

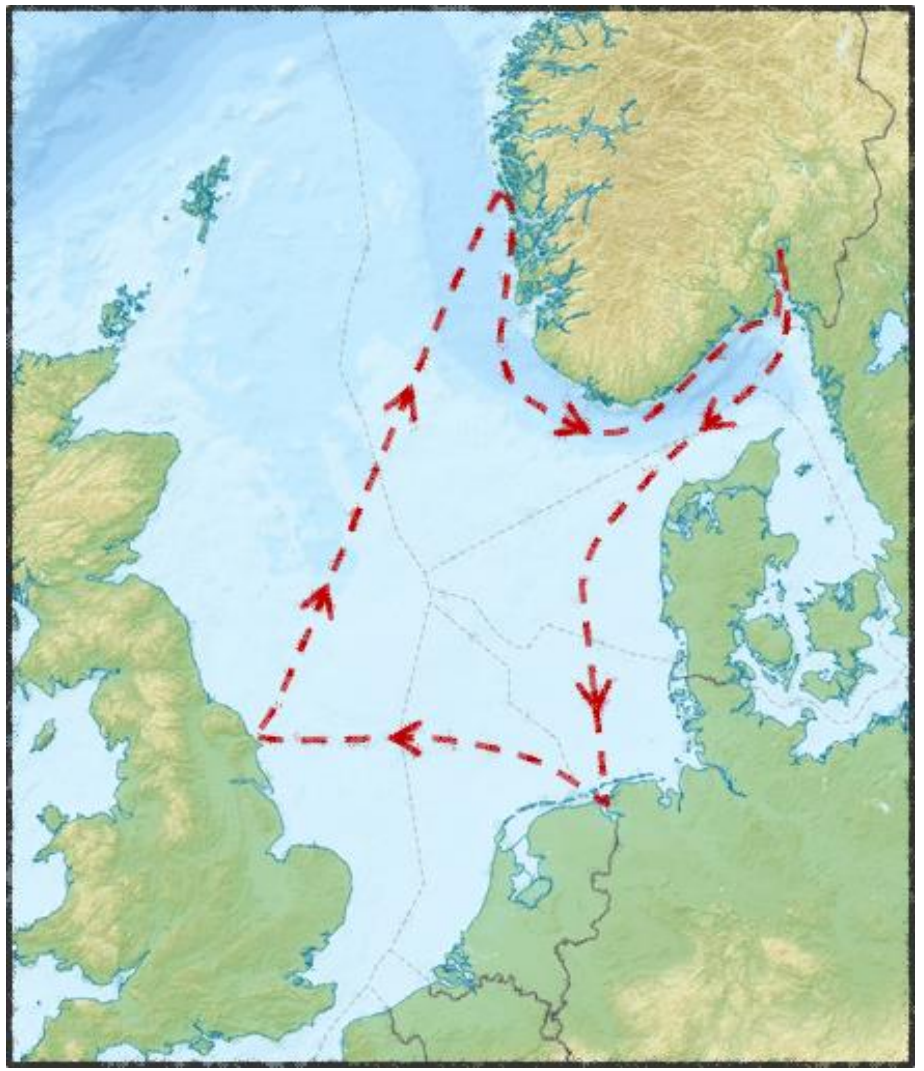
Norway: Equinor (project promoter)

UK: Tees Valley Combined Authority

NL: Vattenfall/Nuon – Gasunie

Build on existing CCS projects (current and past)

- Norwegian CCS project
- Teesside Collective
- Hydrogen 2 Market



Equinor Hydrogen Portfolio

Power Generation

- Utilize existing gas power-plants
- Switch fuel from gas to hydrogen
- Clean baseload electricity
- Clean back-up for solar and wind
- Launch large-scale H2 economy
- Enables H2 to transport later

Heat

- Large energy sector in UK
- Difficult (and expensive) to de-carbonize with electricity
- Utilize existing gas network
- Synergies with industry/power gen
- Enables H2 to transport later

Maritime

- Battery solutions not available
- Compressed or Liquefied H2
- Utilize existing gas processing plants to provide low cost H2
- FC efficiency -> CO_2 reductions
- Centralize CO_2 emissions which provides CCS optionality

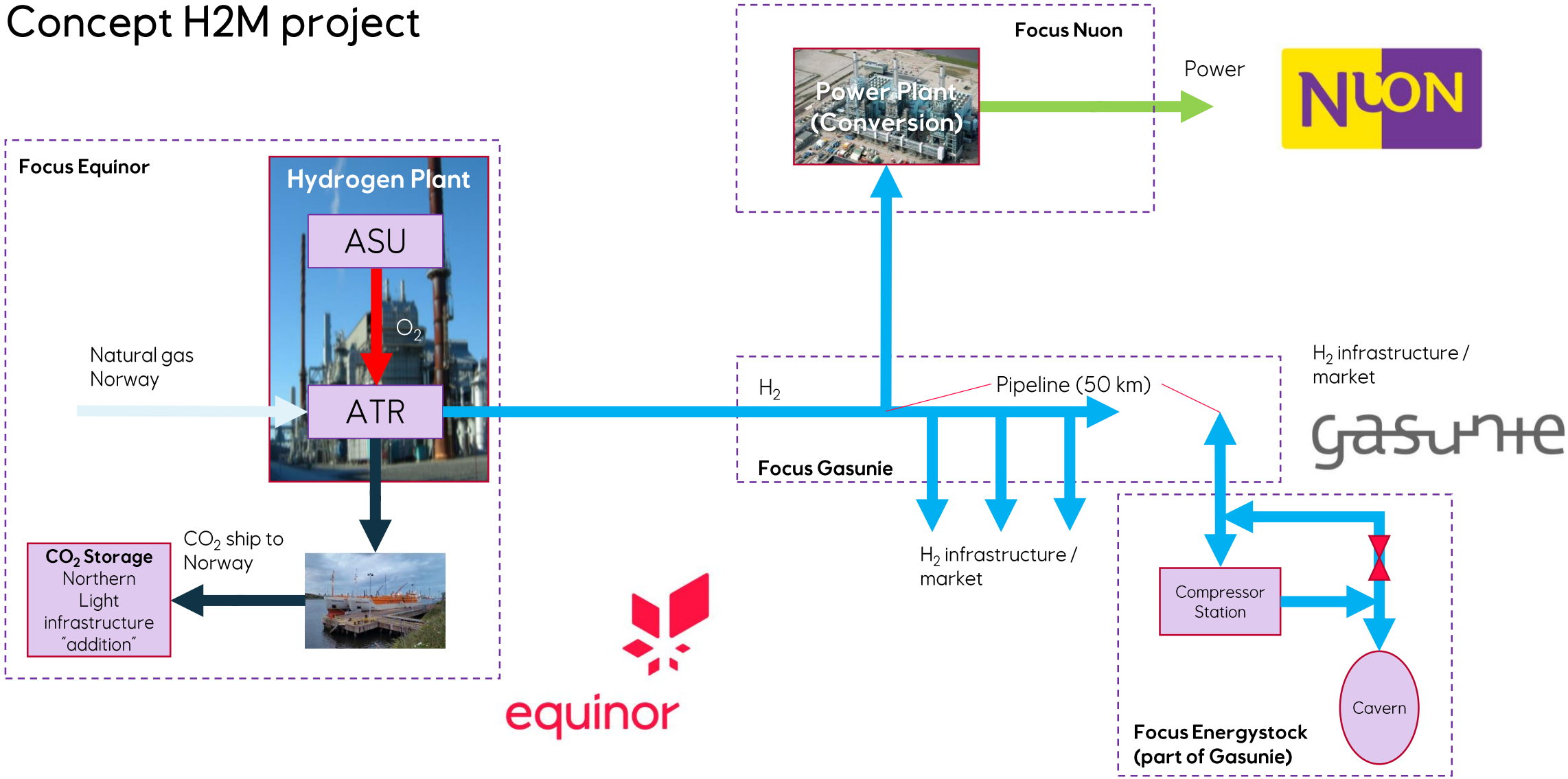
Perfect fit Offshore Wind and Hydrogen

= 10 sec backup

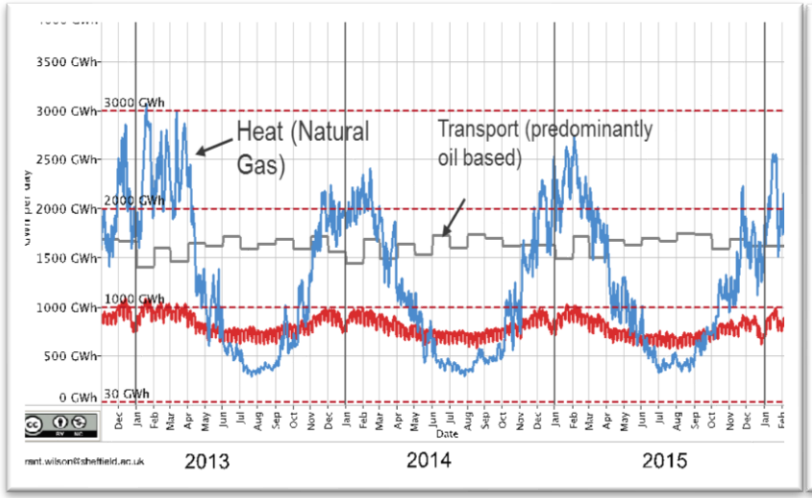
21.600 units (2,5 days backup)

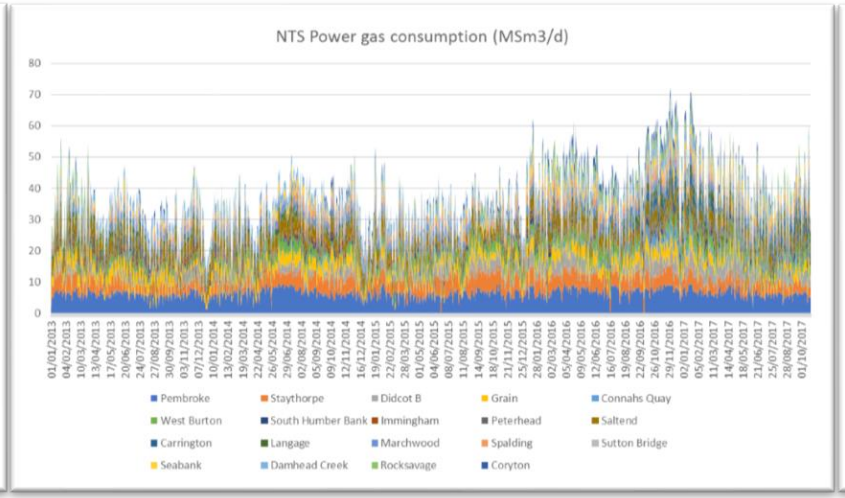
440 MW unlimited, clean backup

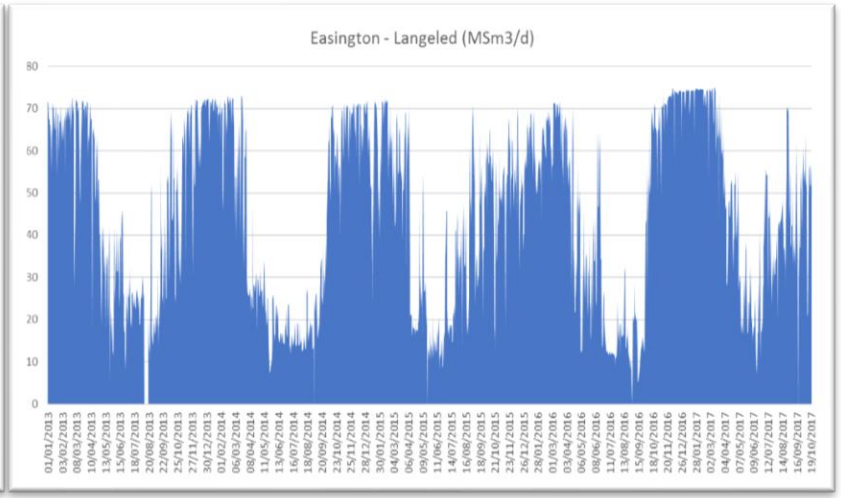
Concept H2M project



The Heat challenge a UK example – Huge Seasonal Variations (not unique)







UK Energy

- Gas dominated – 800 TWh
- CO_2 emission from gas = 160 MTPA
- Seasonal variations in heat only require 60-80 TWh storage/ flexible supply

Gas Power

- 20-25 GW installed capacity
- Majority swing producers
- Increase with phase out of coal

Norwegian Gas to UK

- The UK «energy storage»
- 40% of Norwegian gas export
- Norwegian total gas export= 1100 TWh

H21 – Equinor Clean Hydrogen Concept Development

Hydrogen Production and seasonal storage

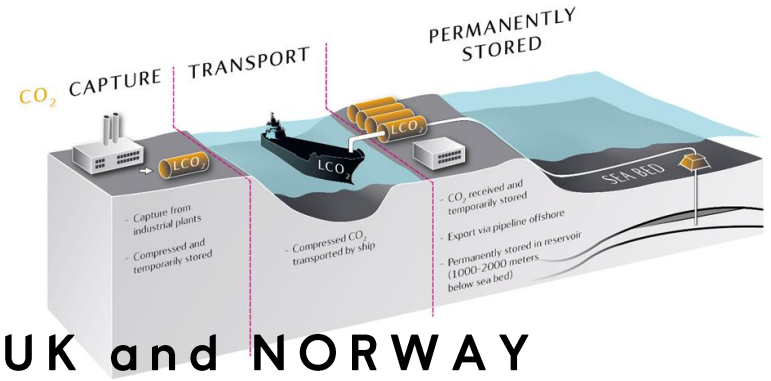
- Technology Evaluation
- Supplier and references
- Establish CAPEX estimates
- Efficiency and CO2 capture rate
- Risk evaluation
- Technology selection
- Ammonia storage and import

CO2 Transport and Storage

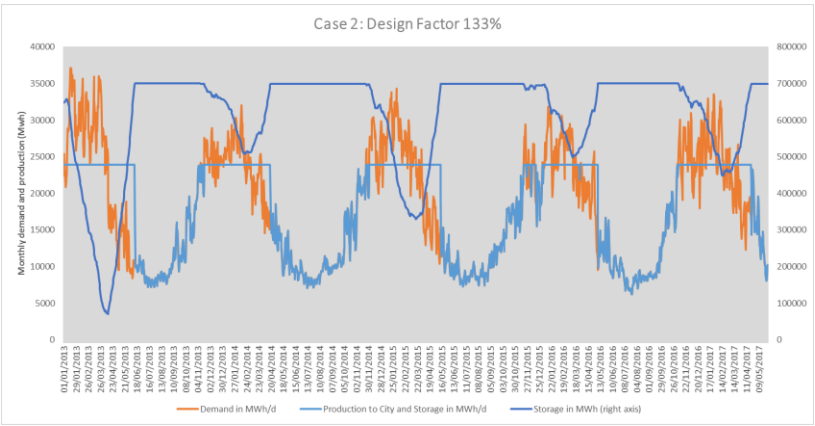
- Establish a transport and storage solution for 15 mtpa in 25 years
- Review potential for 75 mtpa in 50 years
- Mapping UK storage sites in SNS
- Detailed analysis of selected sites
- Up-scaling of Smeaheia area to 15 mtpa
- CO2 shipping and pipeline transport

System Design

- 10-15 GW facility design and CO2 transport and storage solution
- Hydrogen based power production
- Operation and redundancy
- Project schedule and investment cost
- GVA and Environmental performance
- Economic assessment

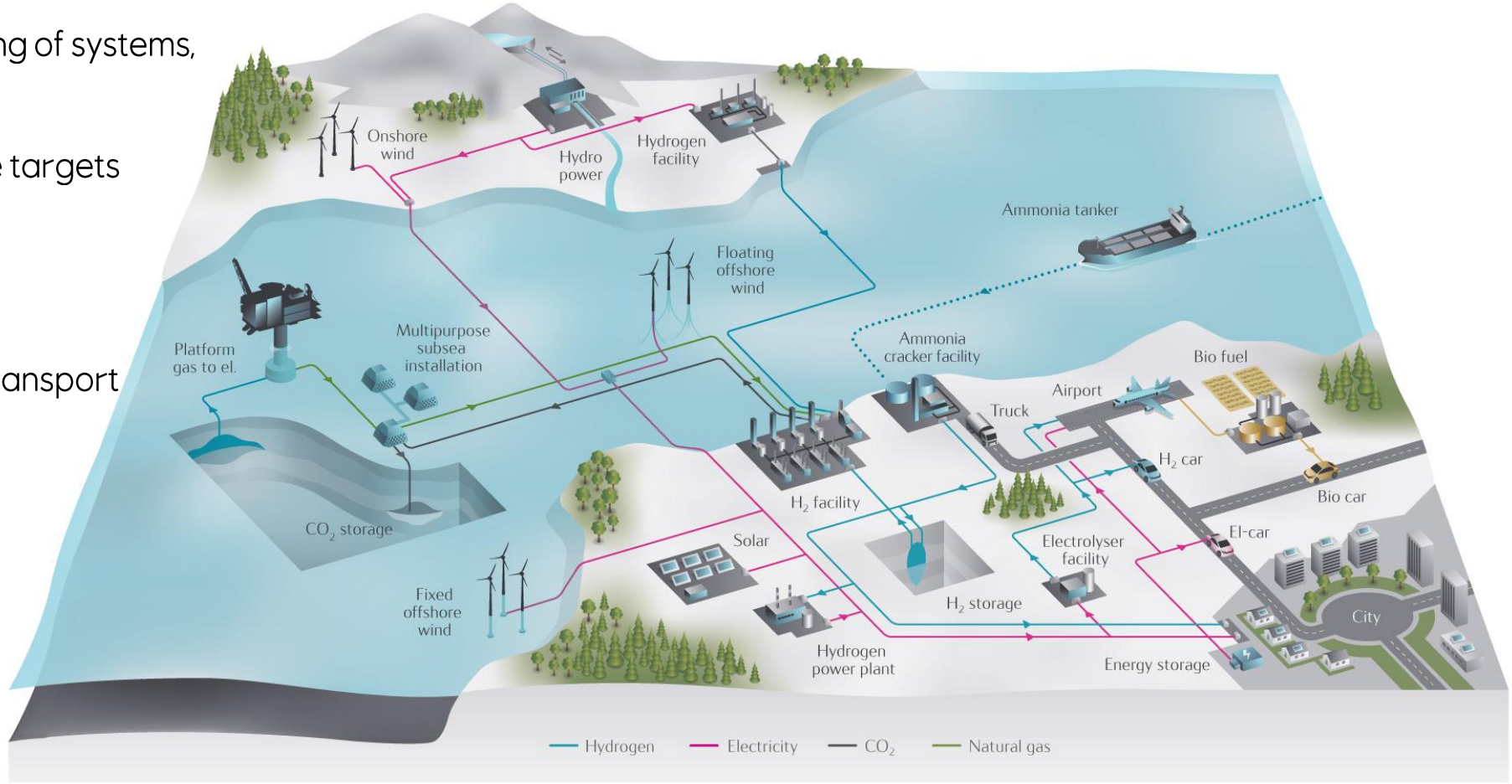


UK and NORWAY location



A vision of a low carbon energy future

- A low carbon society – decarbonising of systems, i.e. not only RES
- CCS – key technology 2050 climate targets
- Northern Lights
  - Ship flexibility
  - Stepping stone to European transport and storage network
- Hydrogen production with CCS
  - Large scale
  - Complementary to RES



CCS and large scale hydrogen solutions at Equinor

Lamberto Eldering, Business Developer Low Carbon Solutions