

# subsea 7

## Road to COP28 – Offshore Renewables & New Energies

Make offshore green Hydrogen possible

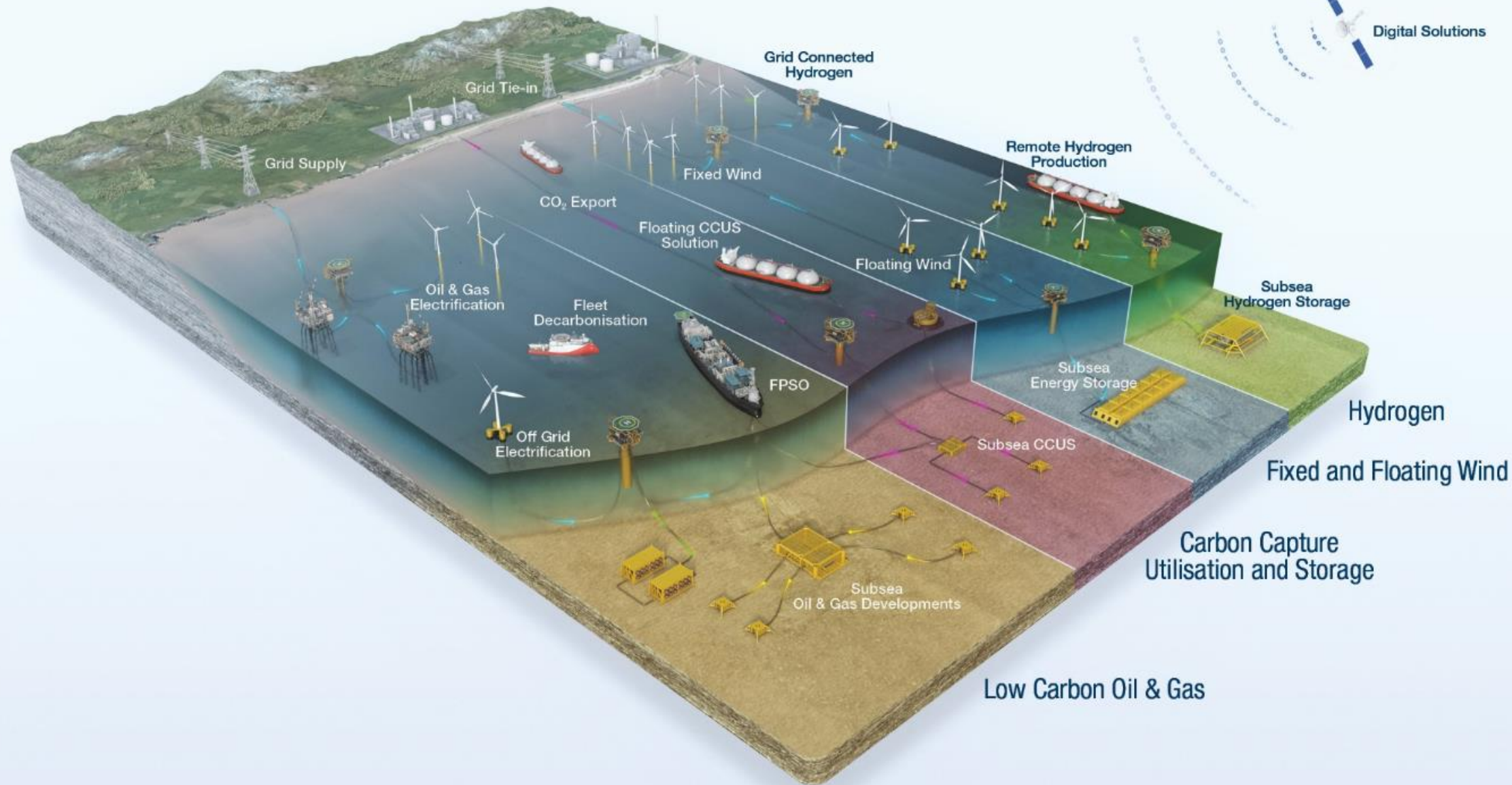
12th September 2023

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subsea 7



**MAKE  
POSSIBLE**

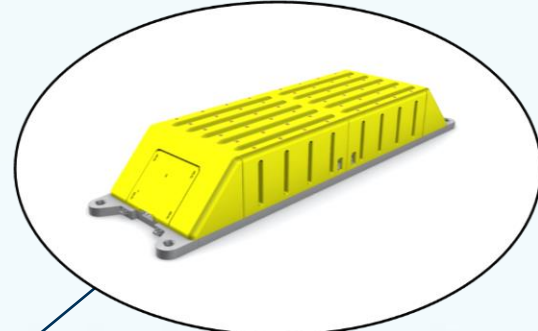




Large-scale H2 production solutions

- Offshore Hydrogen Ecosystem:**
- Offshore Wind
  - Green hydrogen production
  - Hydrogen transport technologies
  - Hydrogen storage

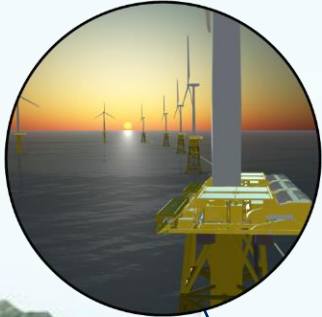
Digital Solutions



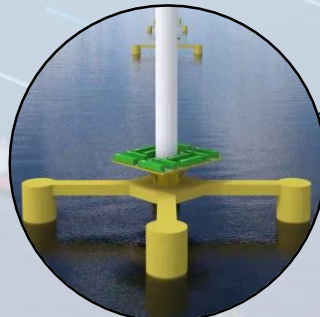
Subsea H2 storage module



Remote Hydrogen Production



Fixed Wind including integrated H2 production solutions



Floating Wind including integrated H2 production solutions



Infield H2 transportation solutions

Grid Connected Hydrogen

Subsea Hydrogen Storage

Hydrogen

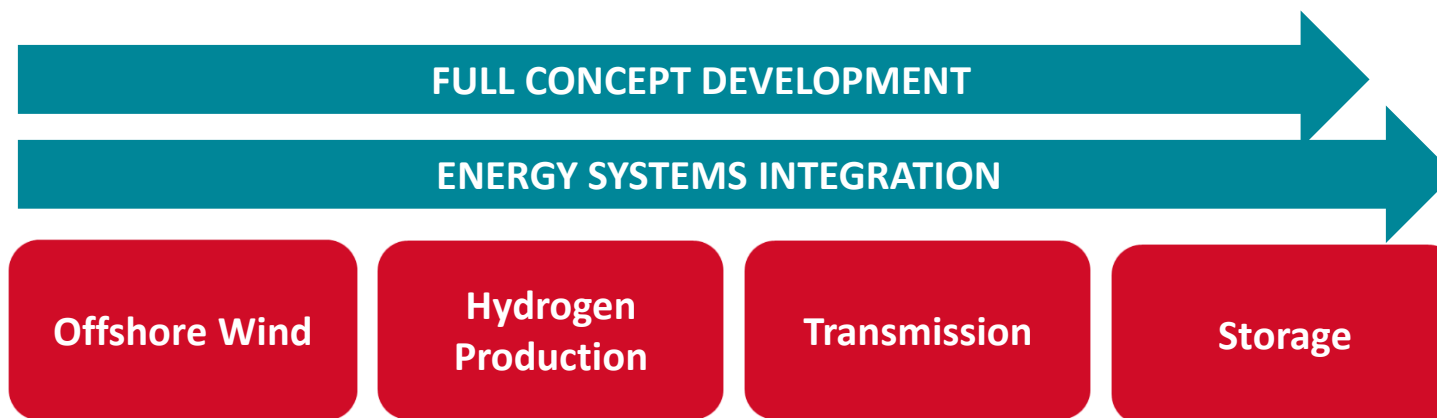
## Our Mission

# Support the development of renewable offshore hydrogen

- Large scale hydrogen Production
- O&G decarbonization

## What We Do

We bring together key building blocks of offshore wind-to-hydrogen to deliver reliable, optimised and integrated solutions

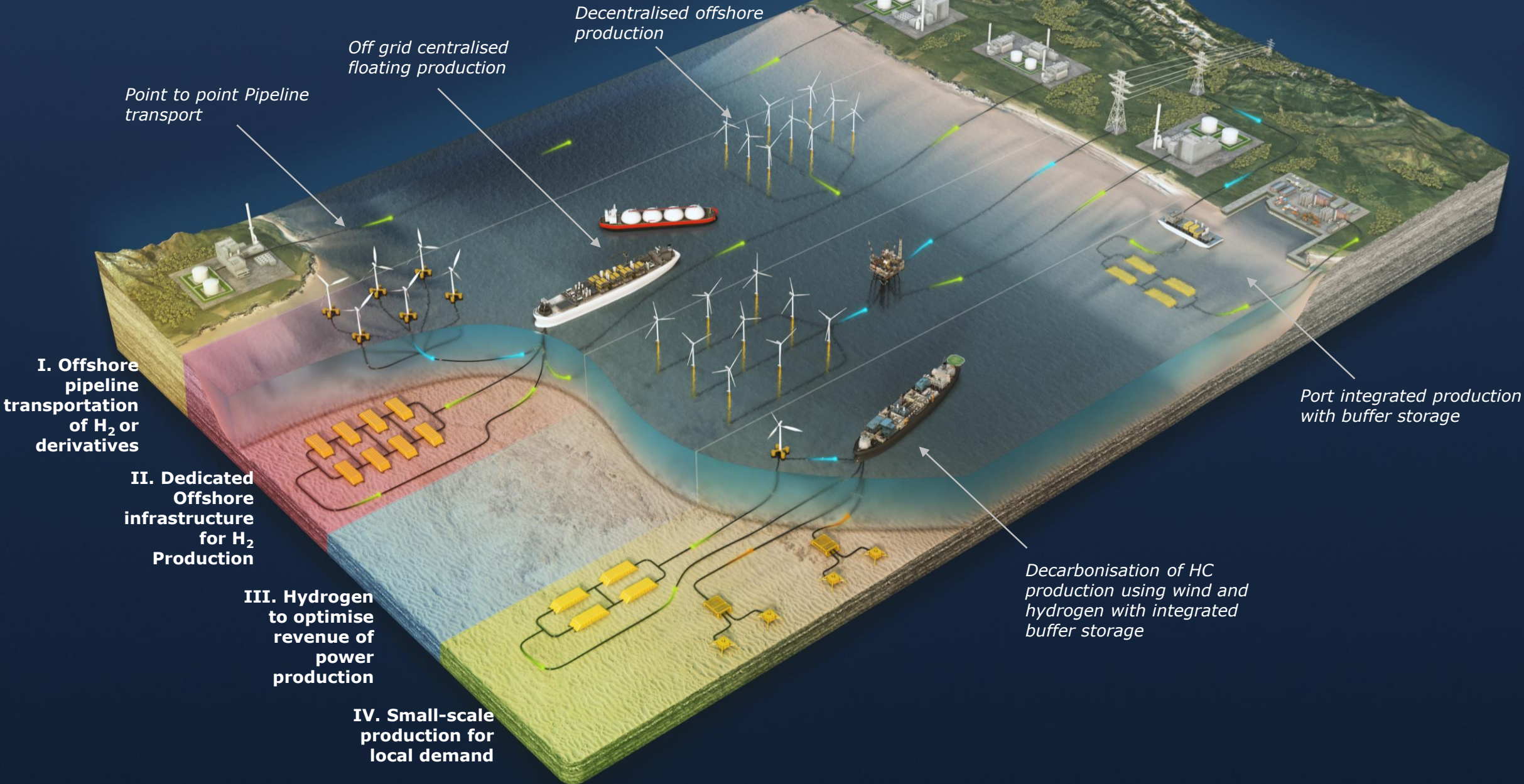


## Our Strengths

Delivery-oriented, 1000+ projects  
Market leader in offshore wind  
Market leader in O&G integrated projects  
Collaboration through Early engagement



# Offshore Hydrogen Archetypes



# Archetypes, clients and drivers

I



## H2 Archetype

Offshore pipeline transportation of hydrogen

## Architectures

Grid connected point-to-point pipelines and networks. New and repurposed infrastructure

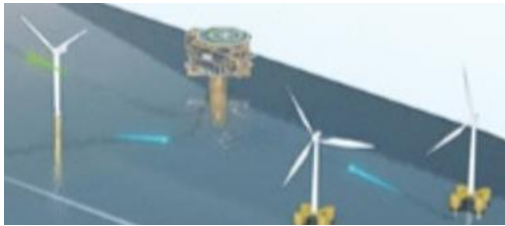
## Typical clients

Gas grid operators

## Needs, drivers

Pipeline systems for transportation of gas H<sub>2</sub> derivatives. Multi nation cooperation & investment

II



Dedicated offshore facilities to produce hydrogen

Off grid fixed, floating, centralised and decentralised systems with H<sub>2</sub> export by pipeline or tanker.

Power producers, Tech. gas providers, O&G clients

Offshore wind facilities optimised for hydrogen. Off-grid and independent

III



Hydrogen and electricity to optimise revenue or meet variable demand

Fixed and floating centralised and decentralised systems with H<sub>2</sub> and electrical export infrastructure. Possible grid connection

Power producers, Tech. gas producers

Offshore wind facilities, Pipelines and cables, electrical and gas infrastructure, Improved utilisation of plant i.e. H<sub>2</sub> to benefit from curtailed wind of market volatility

IV



Small-scale production for local demand

Small scale production for local consumption. fixed/ floating, centralised or decentralised. Possible modular and mobile systems to meet short term goals

Industry wanting a dedicated supply, Ports, transport, off grid customers

Local production driven by demand or resource opportunity, Also customers driven by decarbonisation



# Subsea7 ongoing work – Studies and business associations

## H2Shore - Hydrogen coastal storage and distribution



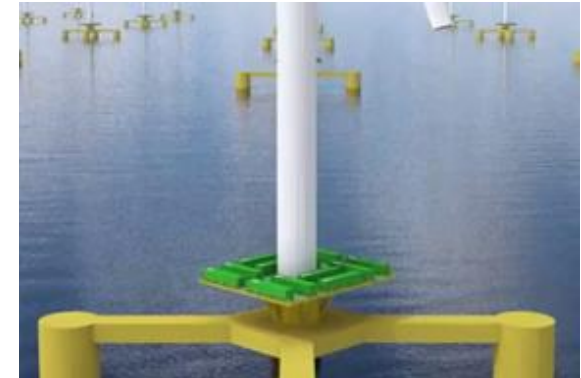
## Large Scale Floating Hydrogen Production Offshore Scotland



## Offshore Hydrogen Production Architectures



## Offshore Hydrogen Production



Collaboration with



Collaboration with



Collaboration with

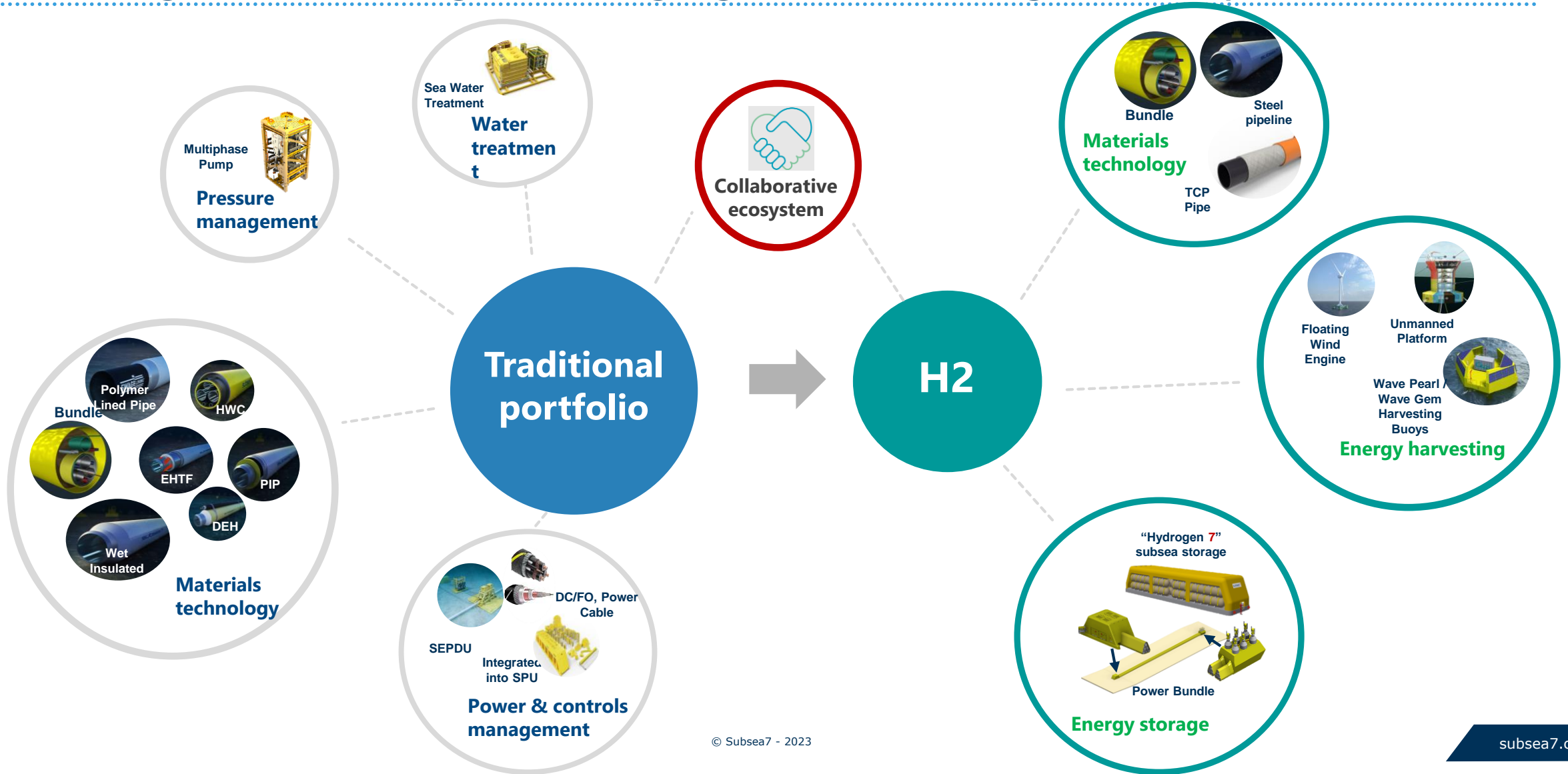


Collaboration with





# Reducing LCOH through leveraging our technologies ecosystem

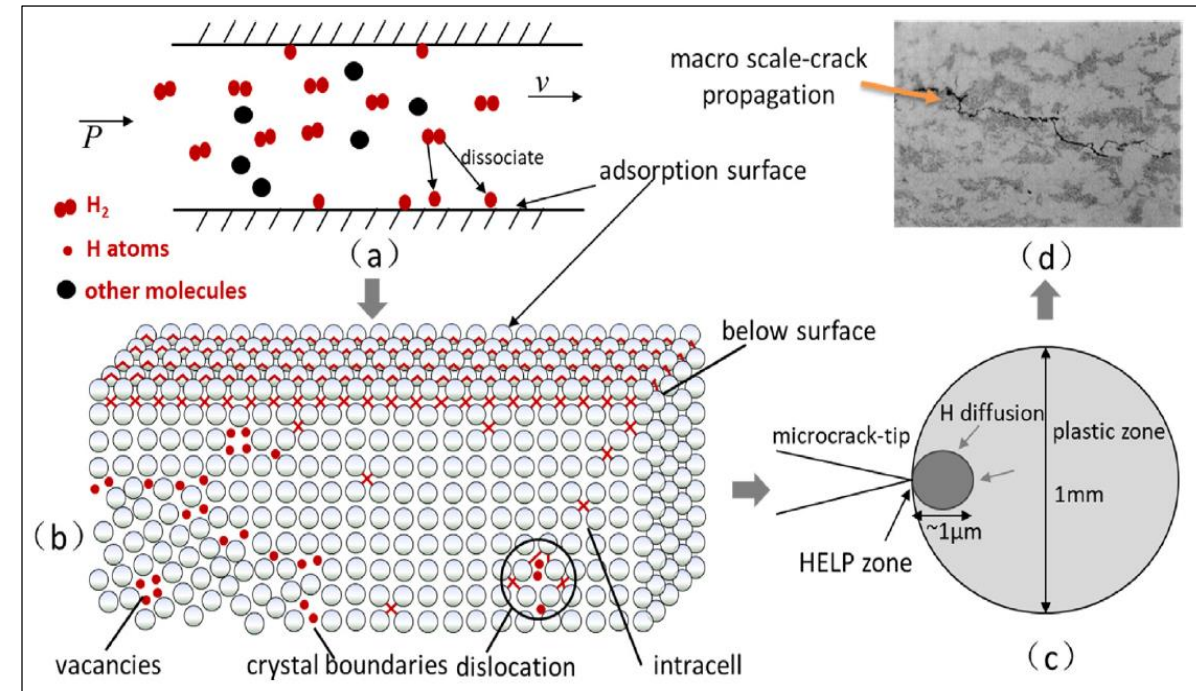


# H2 Pipelines and Challenges

- Hydrogen causes Hydrogen Embrittlement (HE)
- HE will degrade material properties
  - Increased FCGR → reduction in fatigue life
  - Reduction in fracture toughness and ductility
- Pipeline welds are more susceptible to HE due to presence of
  - different microstructure (e.g. non-metallic inclusions)
  - metallurgical defects
  - stress distribution

→ Various collaborative initiatives intend to tackle the subject, including:

- H2Pipe JIP by DNV
- Hydrogen Pipelines, by EPRG



**Physical process of H2 Embrittlement (HE):** from micro to macro; (a) H2 is dissociated into H atoms in the pipeline and adsorbed to the inner surface of the metals, (b) H atoms or regenerated H2 molecules degrade metal lattices, (c) H2 breaks the lattices and evolves into micro-crack propagation, (d) macroscopically visible cracks appear (taken from Wu, X. et al. (2022); "From the Perspective of New Technology of Blending Hydrogen into Natural Gas Pipelines Transmission: Mechanism, Experimental Study, and Suggestions for Further Work of Hydrogen Embrittlement in High-Strength Pipeline Steels")

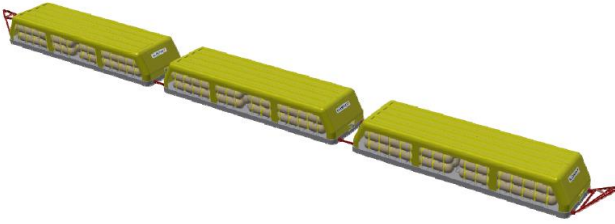
# PowBox-H™, a novel approach to offshore hydrogen storage: compact, modular and scalable subsea module

Patent pending

**Subsea storage of 15T of gaseous hydrogen at up to 350bars**  
Water depth **from 30m to 1500m**

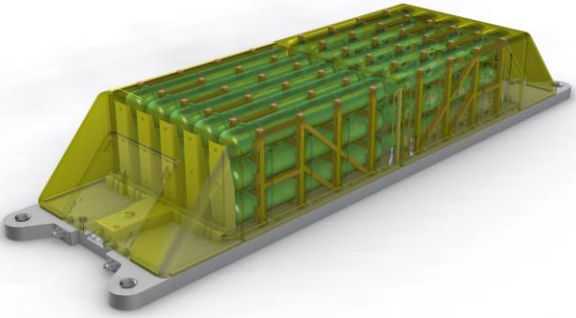


Storage capacity of each unit ~**500 MWh**  
Several units can be connected to build up a **larger capacity of several GWh**



**Very compact, easy to manufacture**, can be produced efficiently, **made of mature components**

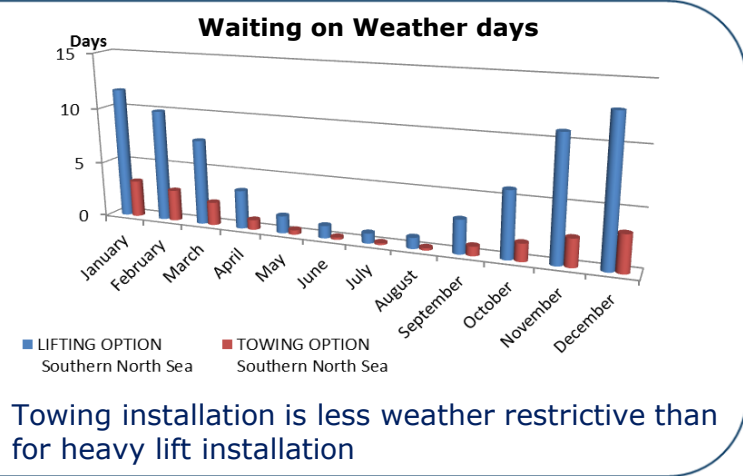
**Composite cylinder tanks** Type IV (PE liner, fiber wrapping) reducing the need for maintenance and corrosion protection



**Shore-based assembly and testing** of system at manufacturing site

**Floating structure towed to site** and submerged into position at seabed in a controlled manner thanks to its integrated ballast system

→ low installation cost, relocation possible



Use of field proven engineering principles from the subsea O&G industry, building on Subsea7's **towed pipeline bundle expertise** (>40 installed)

Light composite tanks combined with a structural foundation of concrete enable a **simple hydrostatic balancing of the structure** for towing and stability at seabed



**Qualification tests performed** at SINTEF Ocean in Norway and witnessed by DNV. Included towing and installation assessments, impact loads and overtrawlability testing



## Key messages

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- Offshore wind is a significant part of what we do and we are focused on the wider energy transition
- Developing field development solutions and technology development to enable Offshore Hydrogen production
- Collaboration and partnerships are essential to how we operate
- Through collaborative work, technology and system integration we contribute to cost effective solutions and lower LCOH to enable large scale offshore hydrogen

**THANK YOU**



**subsea 7**