Power2X Subgroup

Workshop Webinar
27th of May

Tampen Floating Wind Project Source – Equinor

Agenda

- 10.30 – Introduction – Jeya Calder and Paul O'Brien, HIE
- 10.35 – Integrating Energy Vectors- Wind, Wave and Hydrogen – **Chris McConville, Floating Power Plant**
- 10.50 - Hydrogen Innovation Call – **Emma Swiergon, OGTC**
- 11.05 – BEIS Hydrogen Suppy2 call – **John Sinclair, Bilfinger**
- 11.10 – Discussion forum
- 11.30 - End of webinar

INDUSTRIAL STRATEGY CLUSTER

DeepWind
North of Scotland Offshore Wind Cluster

INDUSTRIAL STRATEGY CLUSTER

Chris McConville

FLOATING POWER PLANT

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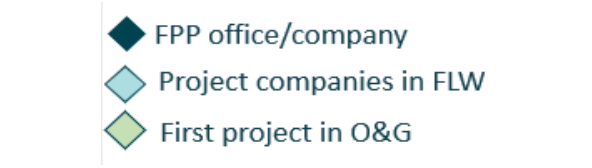
FLOATING POWER PLANT A/S

INTRODUCTION

27/05/2021

WE DEVELOP IN PARTNERSHIPS (IN THE PUBLIC DOMAIN)

- Integrate knowledge and experiences
- Prepare value chain for ramp up
- Reduce capital expenditure



David Nickols
Carsten Sonne-Schmidt
Claus Sivager
Kim Pajor
Nicolaj Holm Vang
Hans Vestergaard
Jens Tommerup

Graham Brown (Ltd)

CEO:
Anders Køhler

Head of R&D:
Sarah Thomas

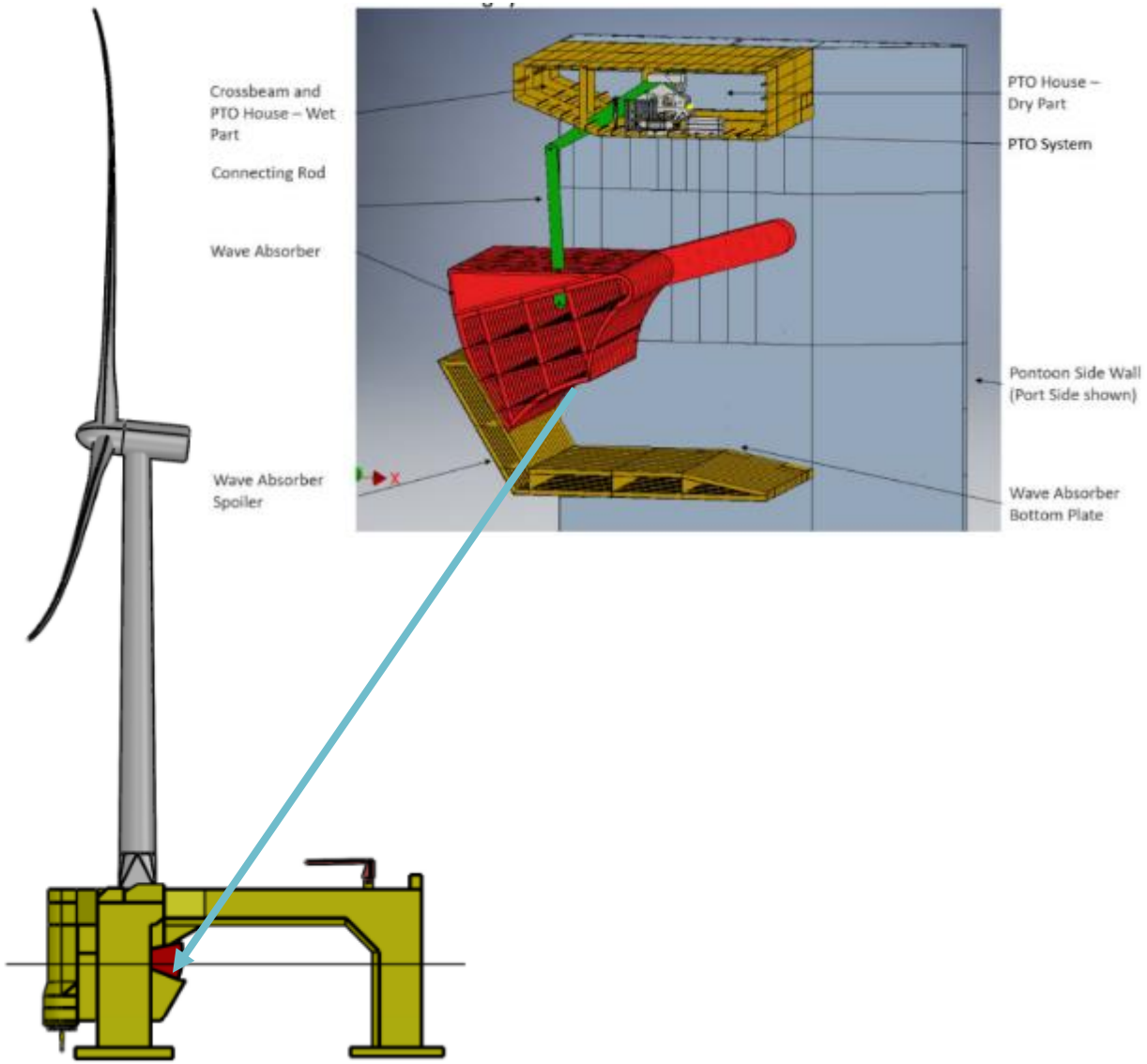
General Manager:
Chris McConville

Naval Architect:
Pablo Cena

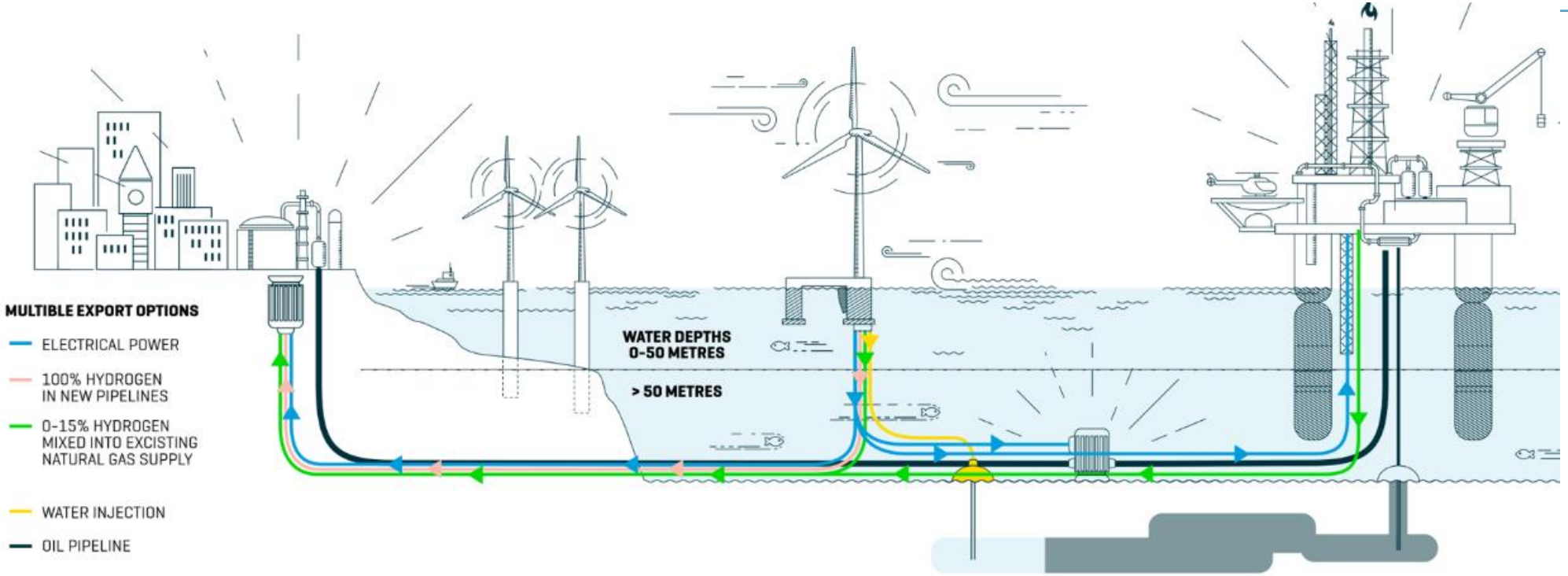
Lead Electrical and Control Engineer:
Nis Ebsen

SYSTEM OVERVIEW

- **Platform**
  - Generic design for 15m Hs sites
  - Panel based semi submersible
  - Makes use of harbour effect for transfer
- **Turret Mooring System**
  - Allows vaning into wave direction (WTG yaws independently)
  - Multi point catenary mooring system
  - Disconnectable if required
- **Wind Turbine Generator (WTG)**
  - Turbine agnostic
  - Currently designed for 10MW
  - Working towards 12MW and 14MW in future
- **Wave Energy Convertor**
  - 4 off, from 500kW to 1MW each
  - Wave energy converted to motion by absorber
  - Mechanical motion converted to electrical power via oil hydraulic Power Take Off (PTO) system

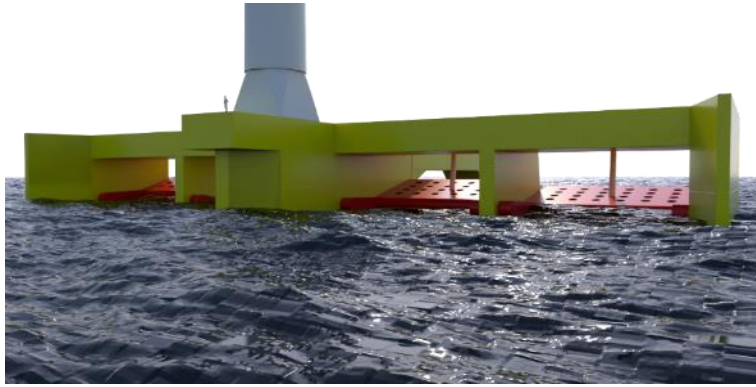


FPP'S MULTIPLE O&G MARKET APPLICATIONS (O&G MARKET)



FPP's unique value proposition towards the Oil and Gas market

- **Greater power capacity** and a **reduced cost of energy**
- A more **consistent and predictable power output** as waves lag wind, continuing to produce power when a floating wind turbine alone would have stopped
- **Increased safety, both from the lee/harbour effect provided** and by removing equipment from asset.
- Technology is **built up of High TRL subsystems** and standard components from O&G/Offshore Wind
- The technology **is designed for exploitation of high energy sites**.
- **Space for auxiliaries**, the P80 has significant indoor area for auxiliary systems e.g. storage, power generation, process equipment, helipads etc.



EUDP O&G APPLICATIONS

- Project awarded funding by Danish EUDP
- Partners

Lundin Norway
Aalborg Universitet
eUDP Energiteknologisk udvikling og demonstration
APL | NOV Completion & Production Solutions
semco maritime
efront TECHNOLOGY
DNV·GL

- Two stage project
  - 3 concepts (with several variations) developed
  - Single concept progressed through FEED for a specific project application

Generic Concepts -> Feb 2020
Development and design of
3 generic O&G concepts for
- Intermittent power
- Baseload Power
- EOR

Concept Selection

Specific project -> Nov 2020
Execution of light Front End Engineering Design (FEED) study for one out of the 3 concepts for a specific site

Industry advisory board:

equinor
AkerBP
SEALAND PROJECTS
DTU Centre for Oil and Gas - DTU The Danish Hydrocarbon Research and Technology Centre
MAERSK DECOM
The Oil & Gas Technology Centre

HYDROGEN CONCEPT - TOTAL

- **Project 1/2-2020 to 31/12 2020**
- **Concept**
  - Renewable power for platform
  - Use excess energy to produce hydrogen
  - Use hydrogen as energy storage (via fuel cells) or mix into natural gas line
- **Wider Application**
  - Consistent renewable power for offshore oil and gas operations
  - Hydrogen economy

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HYDROGEN VALLEY

ENERGY INNOVATION CLUSTER

DTU

Centre for Oil and Gas - DTU
The Danish Hydrocarbon Research and Technology Centre

TOTAL DENMARK

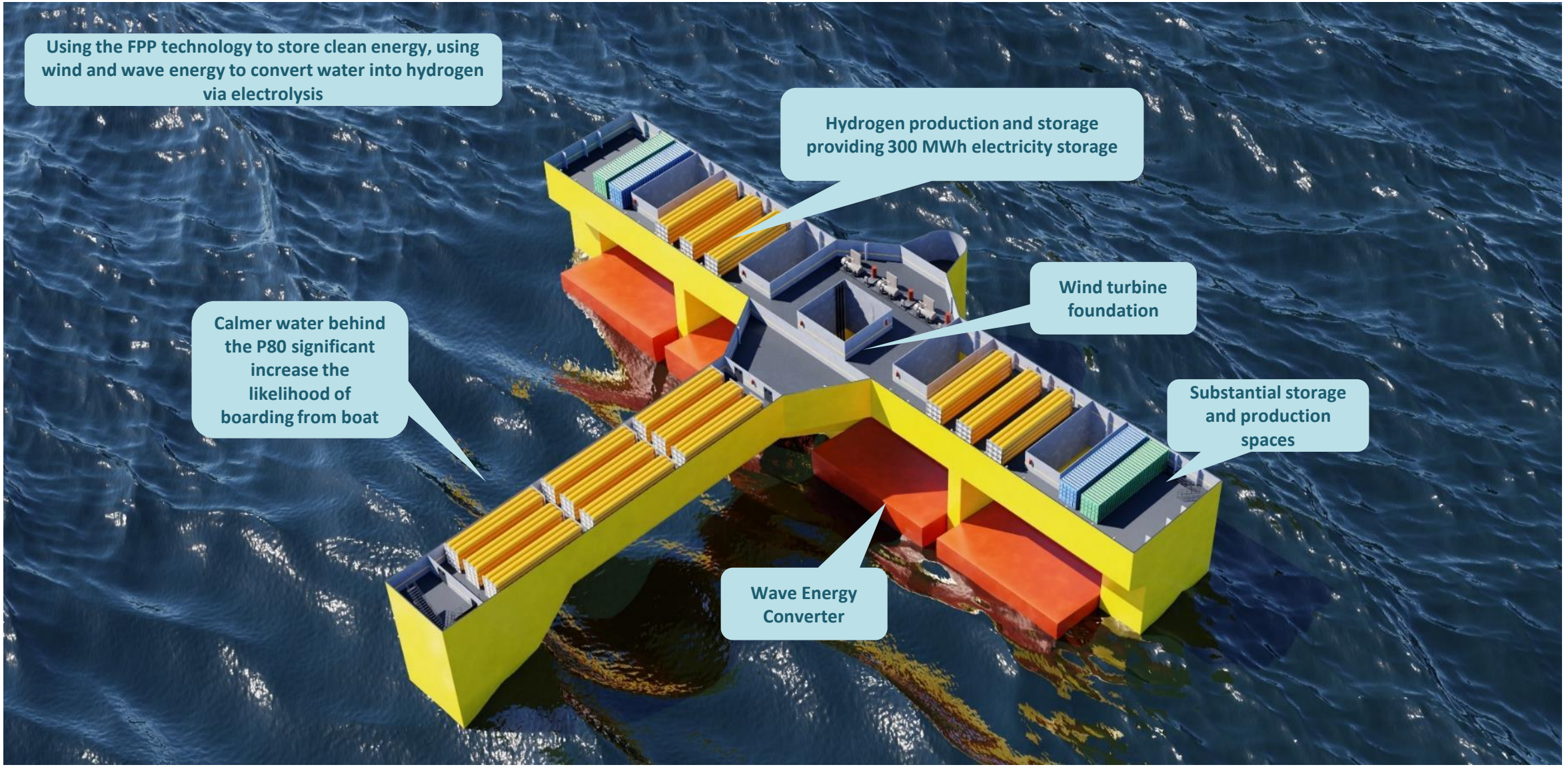
TechnipFMC

DGC

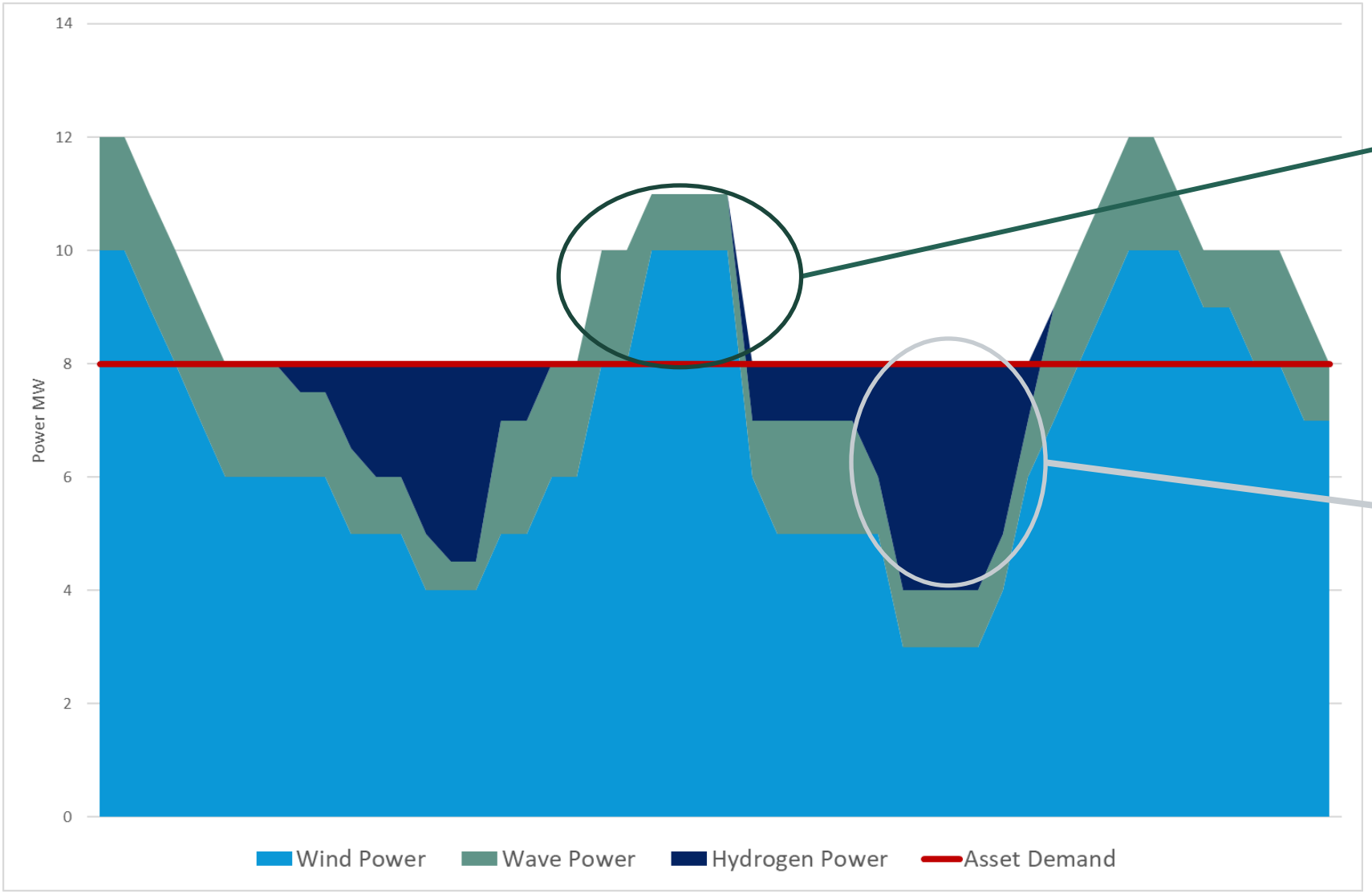
DTU Wind Energy

A GAMECHANGER IN P2X – BASELOAD POWER ENABLED BY HYDROGEN

TechnipFMC FLOATING POWER PLANT



HYDROGEN "BATTERY" PRINCIPLE

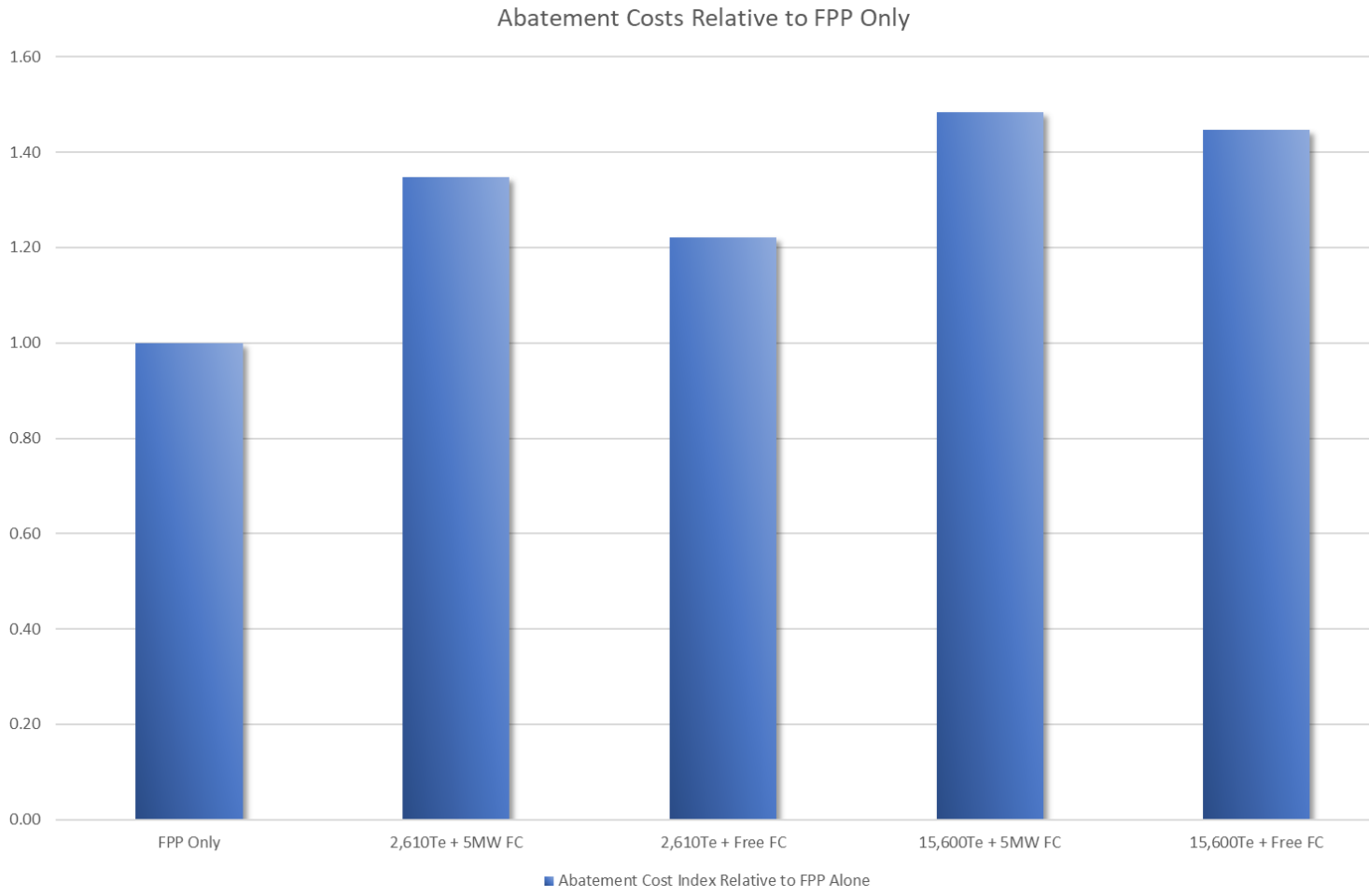


The excess wind and wave power is used to produce hydrogen from seawater which is stored on board

The stored hydrogen is then used in fuel cells on board the platform to produce power when there is insufficient wind and wave resource. This provides complete demand coverage.

RESULTS – CONCEPT SELECTION AND CO2 REDUCTION

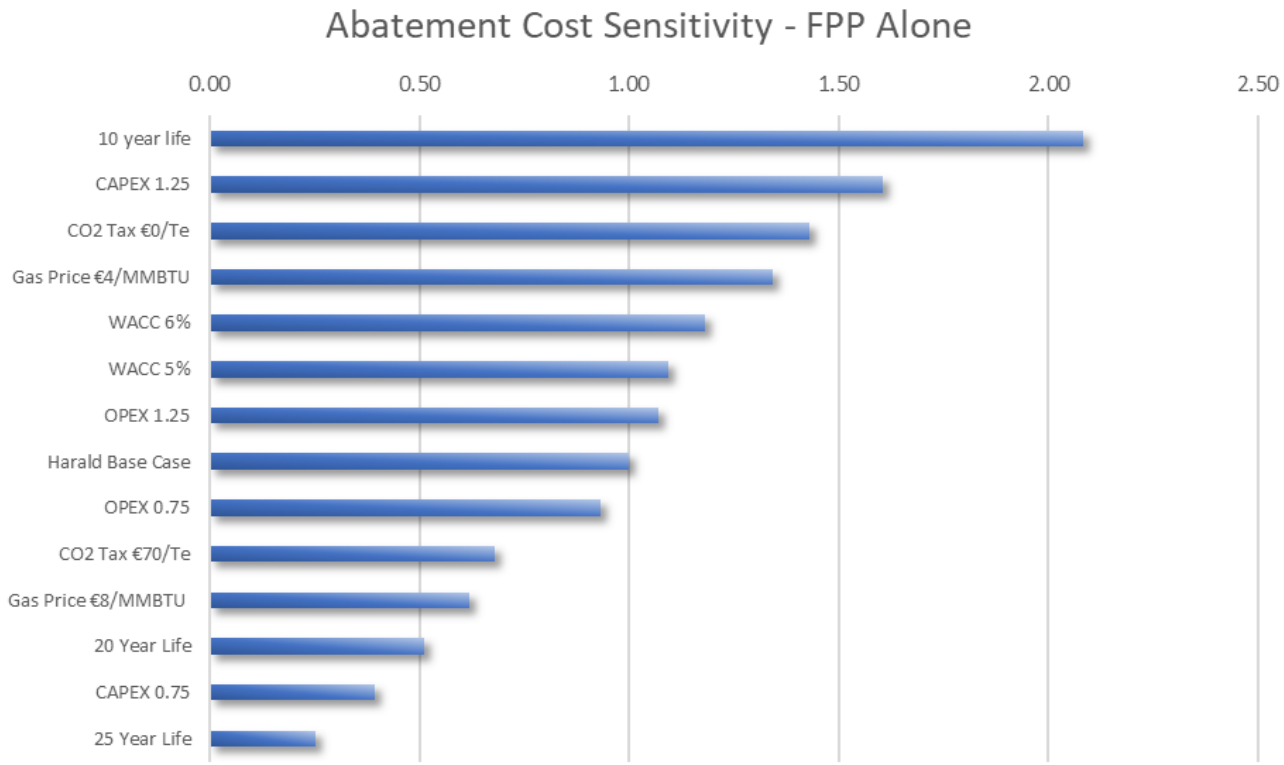
- **Concept 1: Renewable/FPP only**
  - 10MW Wind and 2MW Wave
    - 73% CO2 Reduction
- **Concept 2: FPP with Hydrogen**
  - 2A: Low Storage and 5MW Fuel Cell
    - 79.5% CO2 reduction
  - 2B: Low Storage and “Free” Fuel Cell
    - 79% CO2 reduction
  - 2C: High storage and 5MW Fuel Cell
    - 87% CO2 reduction
  - 2D: High Storage and “Free” Fuel Cell
    - 86% CO2 reduction



SENSITIVITY OF COST EFFECTIVENESS

- **Abatement Cost Highly Sensitive To**
  - Project Lifetime
  - CAPEX
  - Cost of alternative (gas price and CO_2 tax)
  - True for all scenarios

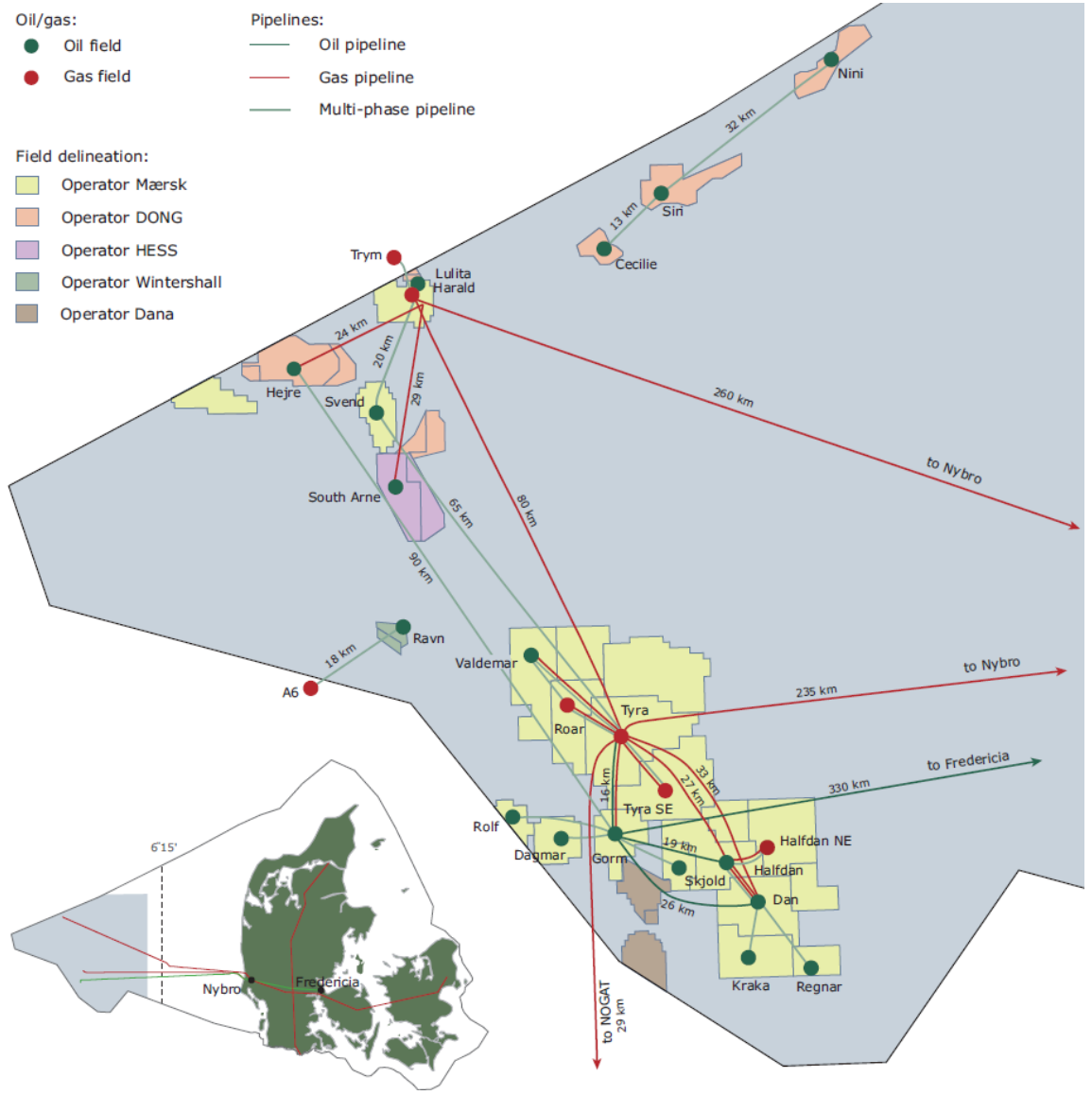
- **Important to consider**
  - CAPEX will reduce with technology maturity
    - Cost baseline is first one ever built
    - 25% is a conservative estimate
  - Cost of alternative likely to increase (especially CO_2 taxes)
  - Using over long life field, or in multiple shorter fields, improves cost effectiveness
    - Renewable + hydrogen system has a 25 year design life
  - Main alternative is cable to shore



NATURAL GAS NETWORK DECARBONISATION

- **Future application**
  - Blending hydrogen with natural gas
  - May pave way for piping hydrogen back to shore for future hydrogen economy

- **Research by DGC indicates**
  - 2% looks feasible in the shorter term, main challenges are:
    - Rules, DNO and TNO rules
      - Germany has plans to inject
    - Long term pipe impact
    - Should be coupled with electrification via renewables
    - Can support the energy transition process
  - Up to 15% requires R&D
  - Over 15% will require pipe/system upgrades (dedicated system maybe)



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THANKS

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Emma Swiergon

Technology Driving Transition

OGTC

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Technology
Driving
Transition

Track Record

1230+ technologies screened

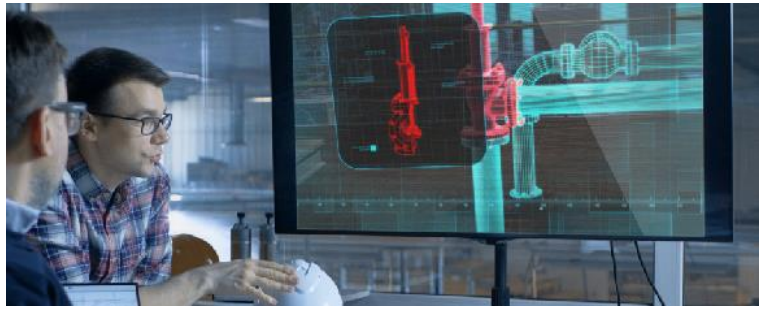
260 projects

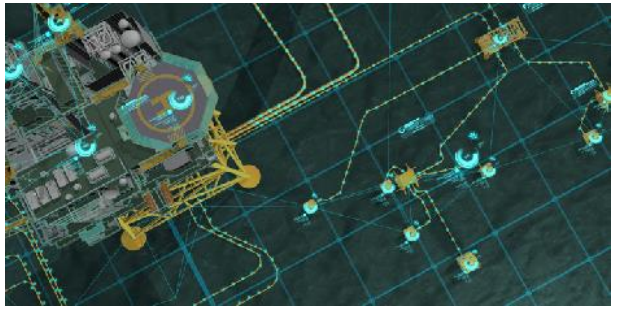
100+ field trials complete, planned or underway

20 technologies commercialised

£163m invested with industry

£100m leveraged from industry partners





ESI Draft Roadmap

Renewables & Energy Storage	Offshore Renewables	**Cost competitive floating offshore wind solutions** Reduce the cost of floating offshore wind from £175/MWh (2020) to £50/MWh in 2030
	Energy Storage	**Economical large and inter-seasonal energy storage options** Reduce the cost of large scale storage from £250MWh (2020) to <£200/MWh in 2030
	Network Infrastructure	**Foundations of an integrated UKCS power grid are in place** Three power from shore or offshore power hubs are operational
Hydrogen & other clean fuels	Hydrogen Production	**Cost competitive green and blue hydrogen production** Blue £1.8/kg (2020) to £1.5/kg in 2030 Green £3.5/kg (2020) to £2.0/kg in 2030
	Transportation & Storage	**Affordable hydrogen transportation and storage solutions** Two major trunk lines repurposed for hydrogen transportation; 2TWh/y hydrogen exported to Europe by sea
	Alt. Fuel Production	**Carbon based synthetic fuels with a low-carbon footprint are approaching commercialisation** Synfuel production cost reduces from £1.1/ltr (2020) to £0.8/ltr in 2030
CCUS	Capture inc. negative emissions	**Modularised CCS deployed offshore on UKCS; UKCS leading the way on DSC** Modular CCS deployed on 5 installations; Seawater capture demonstrated at TRL 8; Onshore CO_2 capture costs reduced by 15%
	Utilisation	**Commercial utilisation options available** Three operational carbon utilisation plants
	Transportation & Storage	**Offshore UKCS CCS infrastructure established; UKCS importing CO2** 30MT/yr CO_2 stored on UKCS 5MT/yr CO_2 imported from outside UK

OGTC Hydrogen Portfolio and R&D

- TechX
- Alt Fuel Gas Turbines
- ORION
- Marine Projects
- Net Zero R&D Programme

World-leading accelerator programme providing a flow of hydrogen-focused start ups

Cohort 4 2022

Building the home of net zero cleantech

TechX Accelerating Innovation

Challenging the status quo

Partnering to build a thriving ecosystem

Aligning TechX with the industry's net zero technology requirements

Growing new companies

Flexing across education, infrastructure and funding

TEAM SUPERCRITICAL

Matt Bird

Chief Executive Officer

Luke Tan

Chief Product Officer

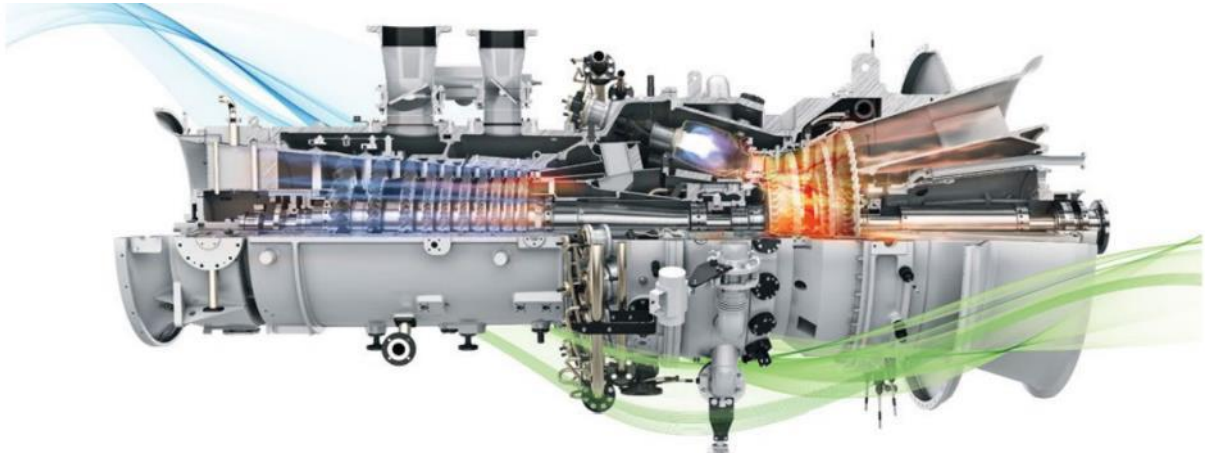
Mike Russ

Chief Technology Officer

Gael Gobaille-Shaw

Chief Scientist

Securing carbon neutral gas solution for offshore power generation



Project aims to develop gas turbine technology that can operate on a low carbon alternative to natural gas, providing a low carbon solution for decarbonising both offshore operations and existing onshore industrial processes and electricity generation plant without extensive modifications.

Clean fuels

- Carbon free replacement for well gas / diesel back up
- 100% H_2 burns 'hotter and faster' than CH_4
- NH_3/H_2 blend has some similar characteristics to CH4
- 70:30 by volume works well in unmodified reciprocating engine
- So far untested in gas turbines

Production

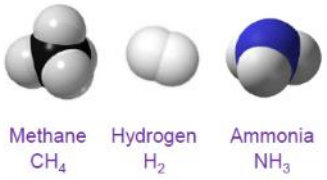
- Hydrogen from water by electrolysis
- Converted to ammonia by Haber-Bosch process
- Stored as liquid (-33°C / 10-15Bar)

Logistics

- Liquid NH_3 taken offshore by barge
- Barge tethered to stand off platform
- Fuel supply via fixed pipe to main platform
- Cracking and blending to ideal mix for equipment

Generation

- Existing generation modified for alternative fuel
- Emissions managed within limits



Methane CH_4 Hydrogen H_2 Ammonia NH_3

image from c-job.com

Safety case

Key Benefits

- Supply chain anchoring in NE Scotland
- Hydrogen market growth
- Technology and skills export & transfer
- Decarbonisation - 2.5 Mt/yr CO2 abated – assuming 25% UKCS uptake from 2025
- Job security ~440 full time jobs sustained

Shetland ideally located to exploit oil & gas skills & infrastructure, renewable energy, ports & transportation routes

Enable

Enable offshore oil and gas sector transition to net zero by electrification, utilising initially onshore wind, sustaining thousands of jobs and security of supply

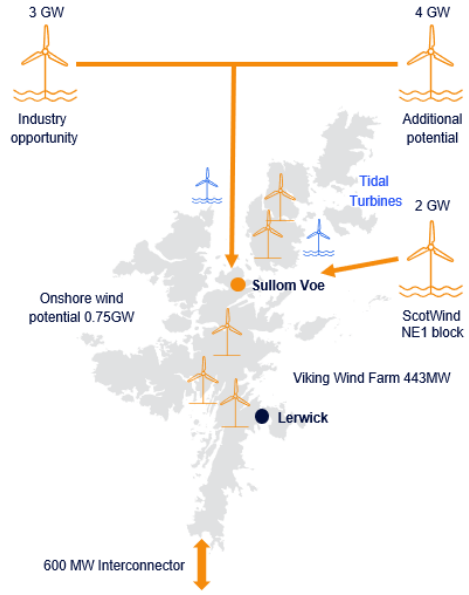
Transform

Transform Shetland's current dependency on fossil fuels to affordable renewable energy to address fuel poverty and improve community wealth

Create

Create on Shetland a green hydrogen export business at industrial scale by harnessing offshore wind power and creating new jobs

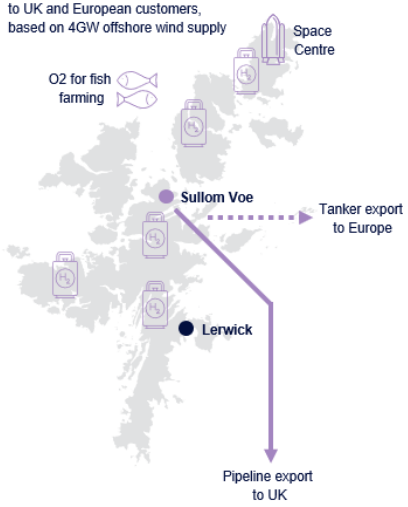
Wind



Hydrogen

60,000 tonnes p.a usage on Shetland for transportation power and heating, with energy from onshore wind & tidal

350,000 tonnes p.a. export capability to UK and European customers, based on 4GW offshore wind supply

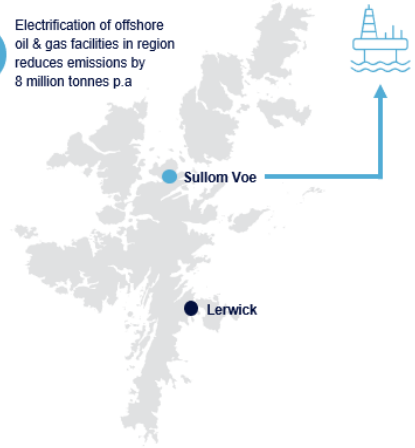


CO2

Blue hydrogen plant emissions transported via EOSPS pipeline to Magnus ca 20,000 tonnes p.a

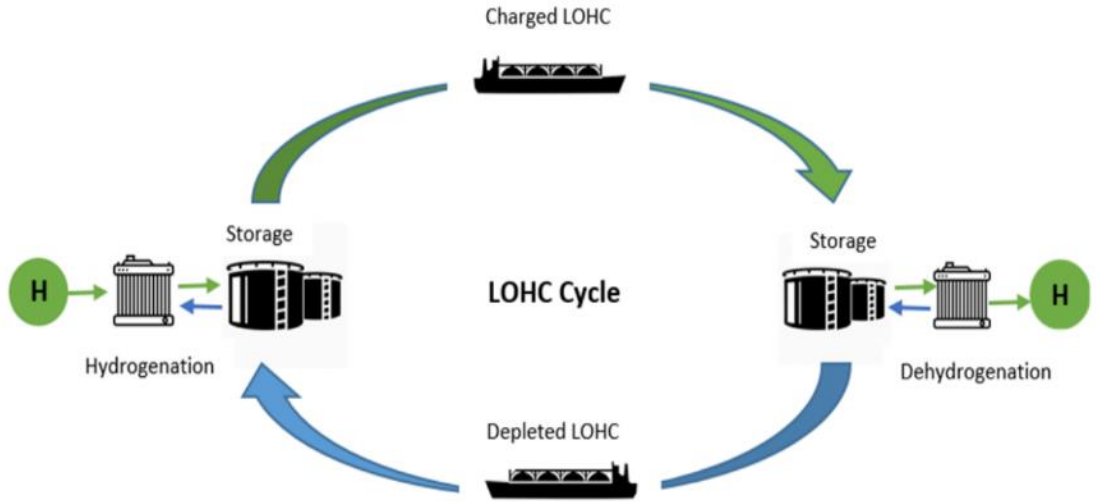
Shetland use of wind & hydrogen power reduces emissions by 650,000 tonnes p.a

Electrification of offshore oil & gas facilities in region reduces emissions by 8 million tonnes p.a



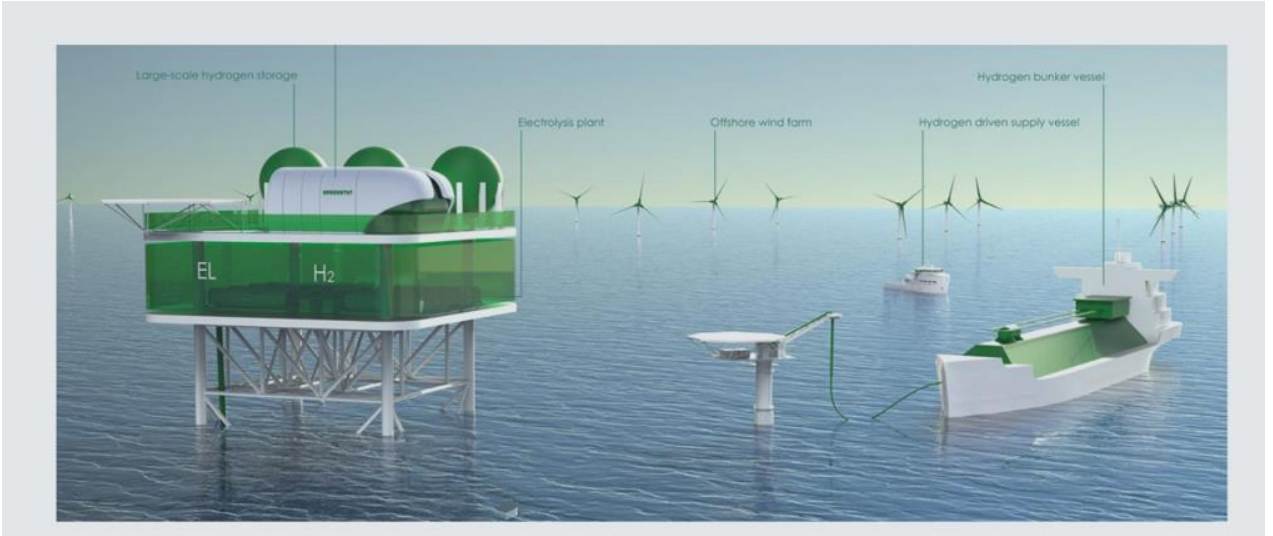
Assessing Marine options for transport, storage, and bunkering of Hydrogen

Marine bulk transport of hydrogen using Liquid Organic Hydrogen Carriers (LOHC)



LOHC Production, Transport and Usage, ERM

Hydrogen and the marine sector – hydrogen enabled ports



Artists impression of the Greenstat offshore wind farm hydrogen production and vessel bunkering. Image: Greenstat

Collaboration with Scottish universities to channel early TRL (1-4) hydrogen technologies

Scottish Funding Council
Comhairle Maoineachaidh na h-Alba

The Net Zero R&D Programme: Hydrogen Innovation

Optimising the Production of Blue Hydrogen

innovation in low carbon hydrogen production with carbon capture and storage. The main innovation gap here involves the separation of H_2 or CO_2 to improve yield and carbon capture.

Bulk Hydrogen Transportation

enable effective transportation of renewable energy to utilisation and storage locations. Technology challenges include effective hydrogen carriers (incl. Liquid Organic Hydrogen Carriers - LOHC) and pipeline repurposing.

Long-term Hydrogen Storage

enable intermittent renewable electricity to become a round-the-clock resource on the way to an eventual carbon free grid. This may include identification of potential storage sites across the UK and underground storage.

Hydrogen/Hydrogen Carrier Utilisation

applications include power generation for offshore platforms and/or as a transportation fuel for the marine sector

Technology
Driving
Transition

INDUSTRIAL STRATEGY CLUSTER

John Sinclair

AkerSolutions

DeepWind
North of Scotland Offshore Wind Cluster

BEIS Hydrogen Supply Call 2 - Background

The BEIS **£60 million Low Carbon Hydrogen Supply2 Competition** call was launched on Monday the 24th of May.

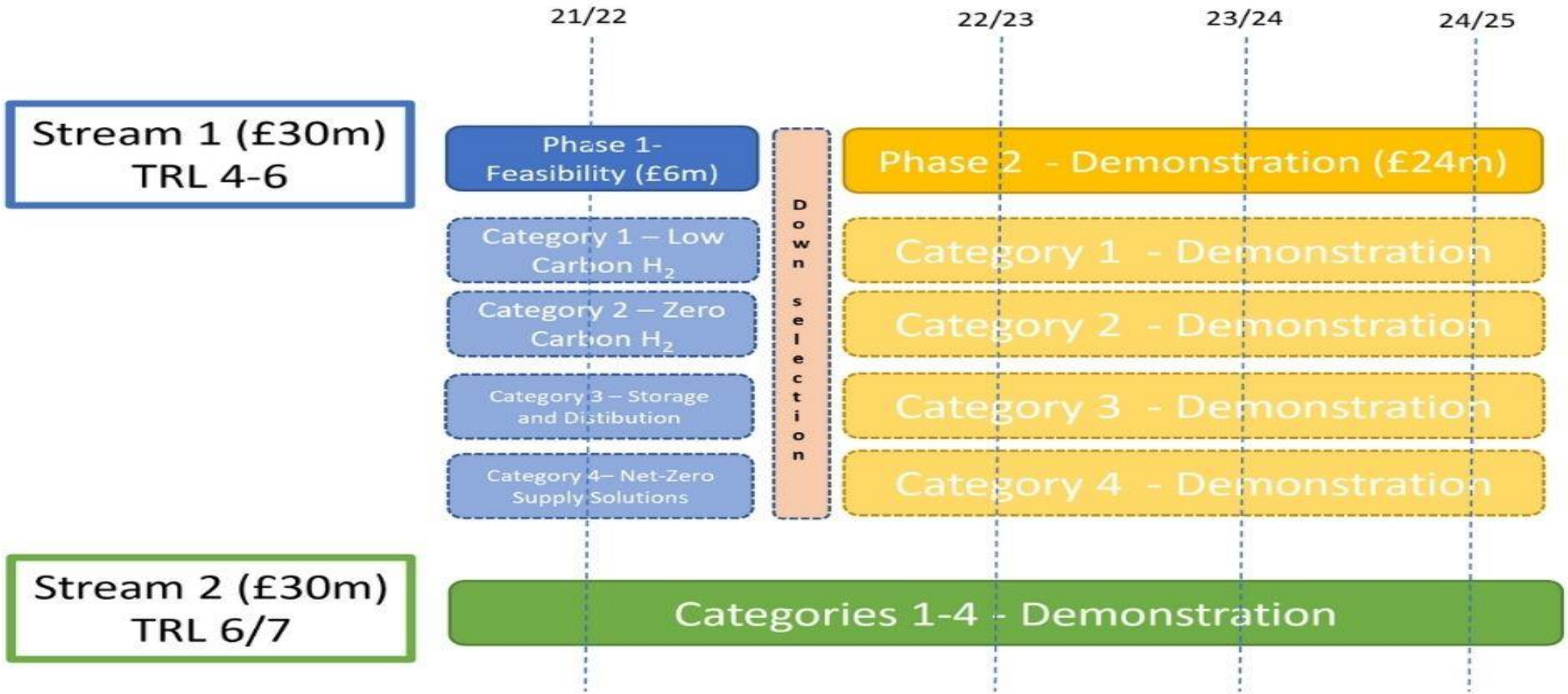
The aims of the call is to catalyse innovation in the supply of hydrogen, reducing the costs, bringing new solutions to the market, and ensuring that the **UK continues to develop world leading hydrogen technologies for a future hydrogen economy.**

The competition will be delivered via two streams.

Stream 1 will be for market entry projects and is expected to run over two phases

Stream 2 will be for more mature projects that can proceed quickly and play into the Governments agenda to scale-up hydrogen use, as well as potentially providing a pipeline of projects for the **£240 million Net Zero Hydrogen Fund.**

BEIS Hydrogen Supply Call 2 - Programme Overview



Stream 1: Phase 1 – Feasibility (TRL 4 to 6) and Phase 2 - Demonstration

Phase 1 - Up to £300,000 per project for feasibility studies that will inform Phase 2 projects. (£6m funding pot)

- **Category 1: low carbon hydrogen production** - This category will support projects that will have some residual direct emissions even when coupled with Carbon Capture Utilisation and Storage (CCUS).
- **Category 2: zero carbon hydrogen production** - This category will support projects that do not directly produce emissions.
- **Category 3: hydrogen storage and transport** - This category will support the development of novel hydrogen storage and transport/distribution solutions (including import/export).
- **Category 4: net zero hydrogen supply solutions** - This category will support solutions aiming to decarbonise the wider energy system.

Phase 2 - Selected from Phase 1 studies and will support demonstrations with up to **£6 million per project**. (£24m funding pot)

Stream 2 - Demonstration (up to £30 million, TRL level: 6 and 7)

Stream 2 is expected to be run over a single phase as outlined below.

It is proposed that Stream 2 supports projects across all four of the Stream 1 categories that are closer to market. This could support demonstration of projects with up to **£10m per project** available to demonstrate the hydrogen supply opportunities. This includes build, trial, decommissioning and knowledge dissemination.

Incubation support will be available for successful small and medium sized enterprise (SME) awardees who are the lead partner in receipt of funding.

BEIS Hydrogen Supply Call 2 – Expression of Interest

You need to complete the Low Carbon Hydrogen Supply Competition 2 EOI form to express your interest at: **https://www.gov.uk/government/publications/low-carbon-hydrogen-supply-2-competition/low-carbon-hydrogen-supply-2-expression-of-interest**

A virtual **Stakeholder Engagement Day** is proposed to be held on **8 June 2021.** To secure a place you need to select this option in the EOI form. EOI and attendee details must be provided by **12 noon on 7 June 2021**.

Note: Stream 1 - Only successful Phase 1 applicants will proceed to the demonstration opportunity in Phase 2

Discussion Forum