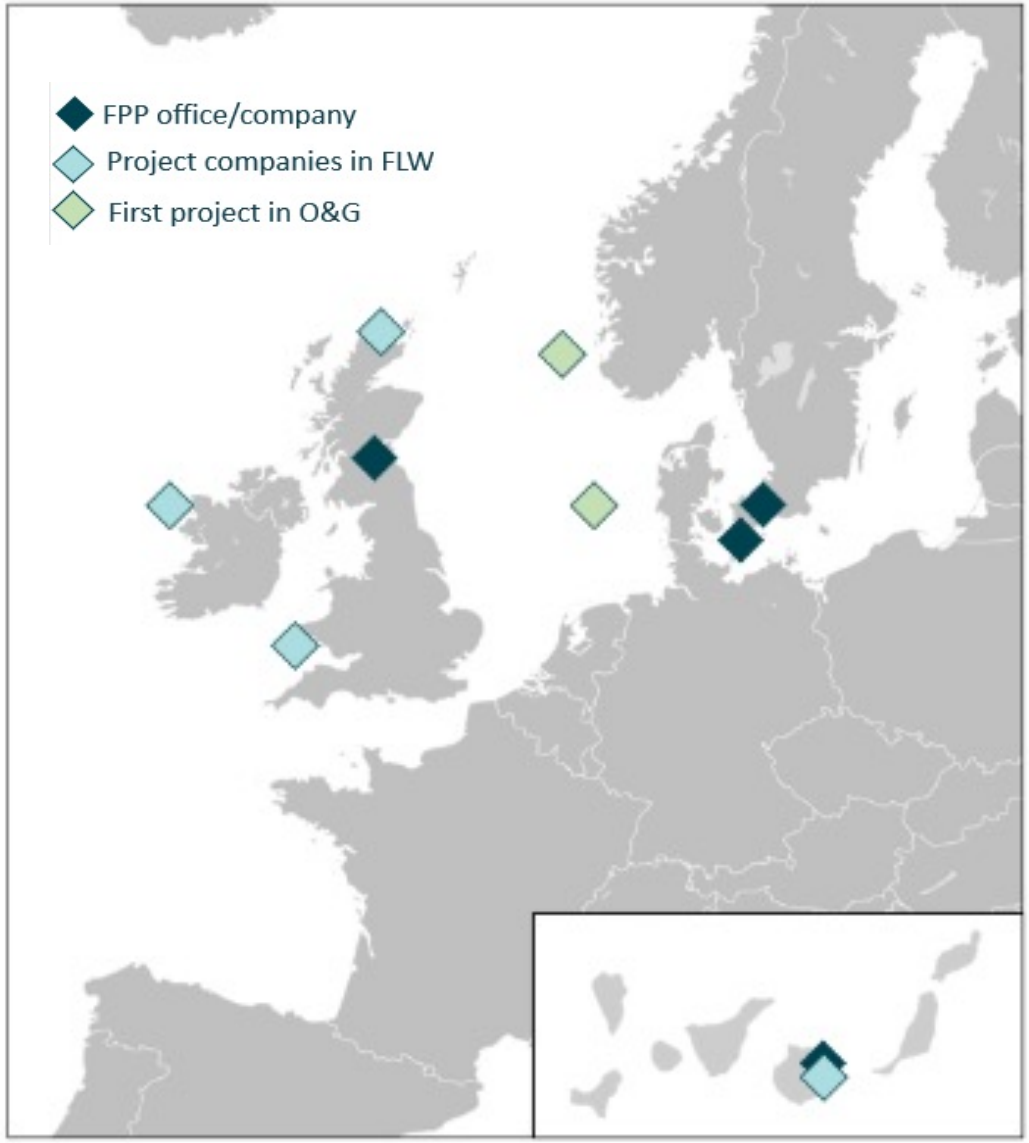
FLOATING POWER PLANT

Renewable energy driven integration of hydrogen in the (Danish) O&G sector

THE COMPANY BASICS



DEVELOPMENT PARTNERS

efront TECHNOLOGY
Marine Technology Development

FRITZ SCHUR ENERGY

Seasystems
A part of Scana

DTU Danmarks Tekniske Universitet

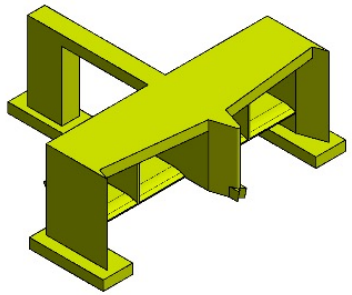
DEME

TechnipFMC

AALBORG UNIVERSITET

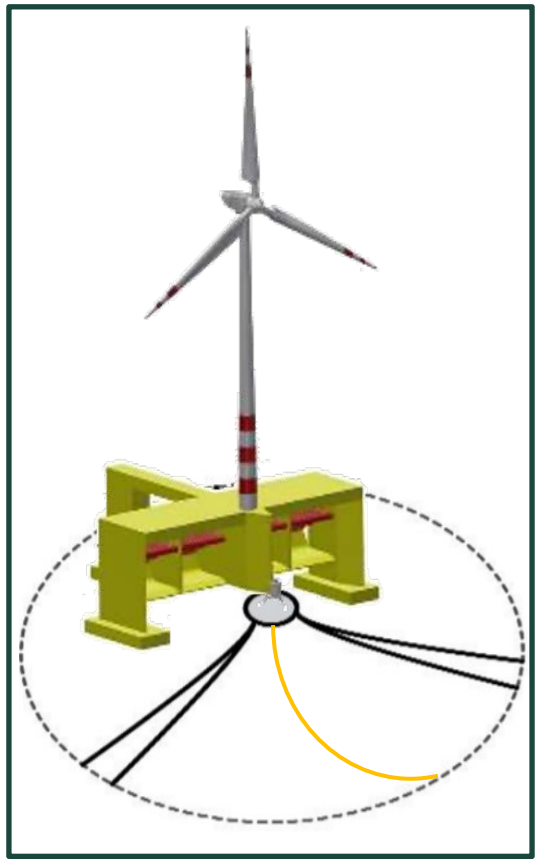
DNV·GL

THE TECHNOLOGY – KEY COMPONENTS

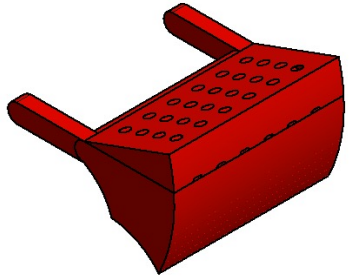


Semi-submersible platform

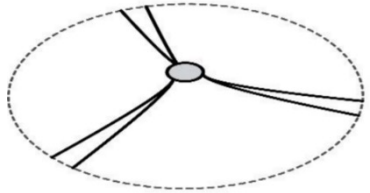
build via panels



4-15 MW wind turbine

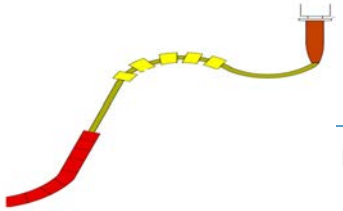


Unique, patented WEC and PTOs
1-4 MW wave power



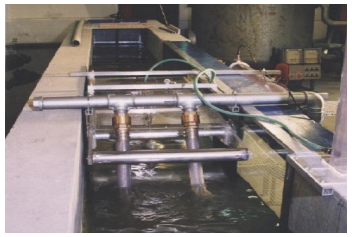
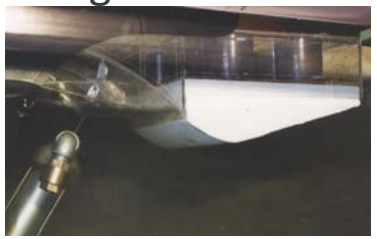
Disconnectable turret mooring

Subsea grid



Thorough Design Development – Driven by clients

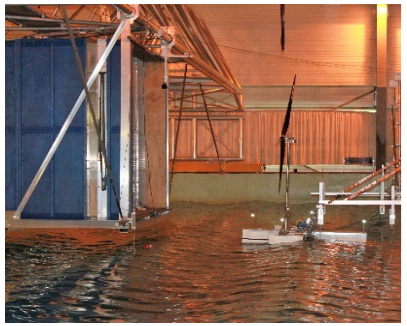
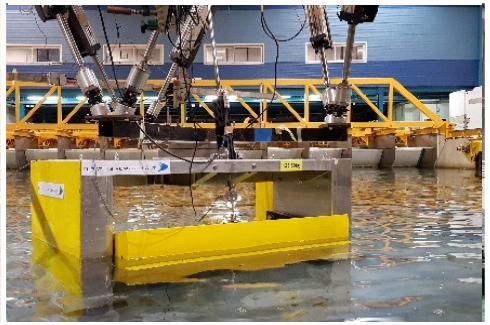
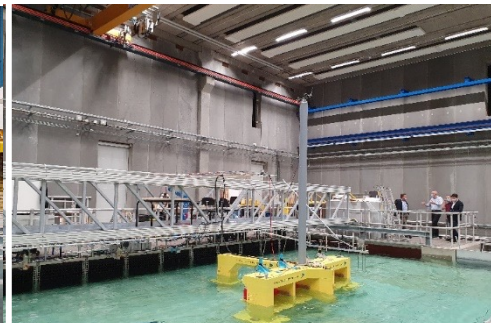
CONCEPT DEVELOPMENT – idea validation and patenting

PROOF OF CONCEPT – 4 offshore tests and dry testing




COMMERCIAL DESIGN & CERTFICATION BY LLOYDS + DNV GL

CLIENT DRIVEN DESIGN PROCESSES

DP ENERGY

FPP are co-owning and developing 3 SPVs with DP energy in Scotland, Wales and Ireland for utility scale floating wind farms based on FPPs technology

TOTAL DENMARK TechnipFMC

For Total Denmark, FPP and Technip FMC has developed baseload electrifications solutions enabled by hydrogen – "a gamechanger in power-to-x"

Lundin Energy Norway

For Lundin Norway, FPP and partners has developed solutions for supporting O&G production and electrification. Advisory support from Equinor and AKER BP.

Ørsted

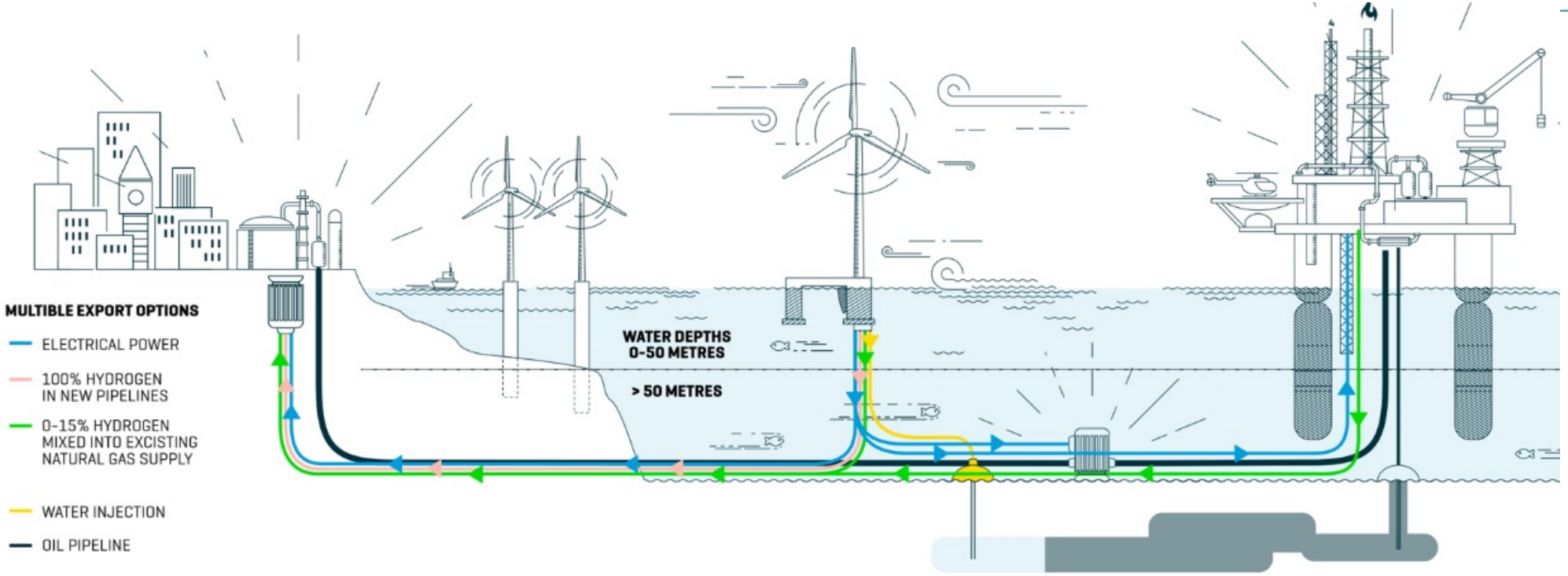
FPP's offshore testing has been with and grid connected via an Ørsted offshore wind farm - meeting grid codes, safety, insurance, O&M requirement, etc.

FLOATING POWER PLANT

DECARBONATION OF O&G

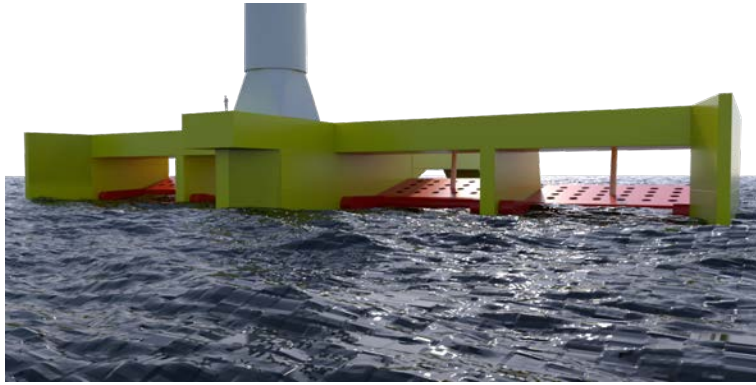
03/03/2022

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 FPP Platform has significant indoor area for auxiliary systems e.g. storage, power generation, process equipment, helipads etc.



O&G DESIGN PROJECT – LUNDIN

- ***Develop and adapt new designs and business concepts, for utilisation of renewables in combination with the extraction of hydrocarbons.***

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

Lundin Selection

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

Industry advisory board:

HYDROGEN CONCEPT – TOTAL DENMARK

Project goal

- **Provide "CONSTANT" renewable power for offshore oil and gas operations**

- Inject hydrogen into gas natural export (not included today)

FLOATING POWER PLANT

HYDROGEN VALLEY

ENERGY INNOVATION CLUSTER

DTU

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

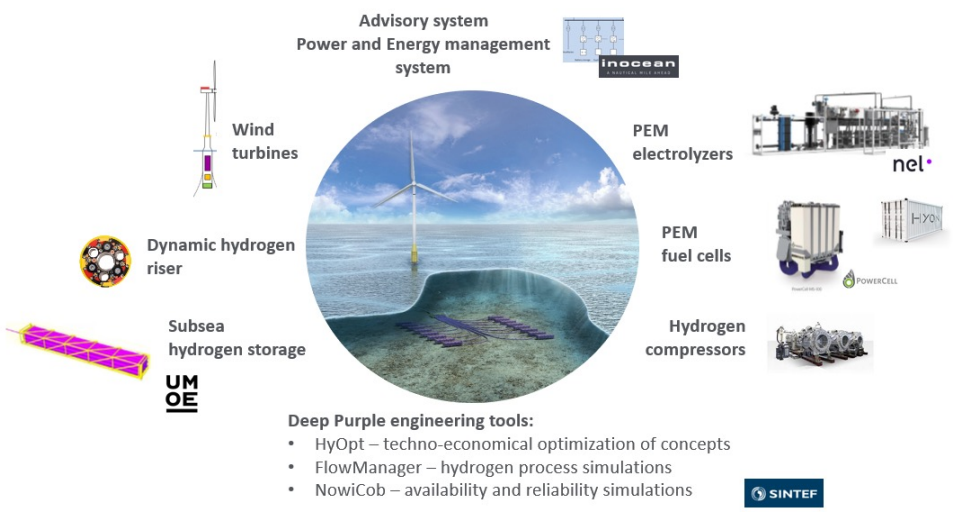
TOTAL DENMARK

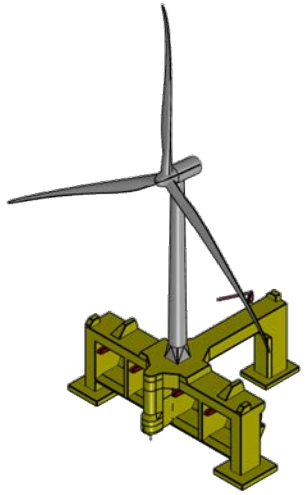
TechnipFMC

DGC

DTU Wind Energy

THE MAIN BUILDING BLOCK





TechnipFMC - Deep Purple

- **Key hydrogen equipment**
  - Desalination
  - Electrolysers to produce H_2
  - Storage systems
  - Fuel Cells for the conversion back to electricity

FPP - Platform

- 9,5 MW wind
- 2 MW wave
- House all hydrogen Equipment

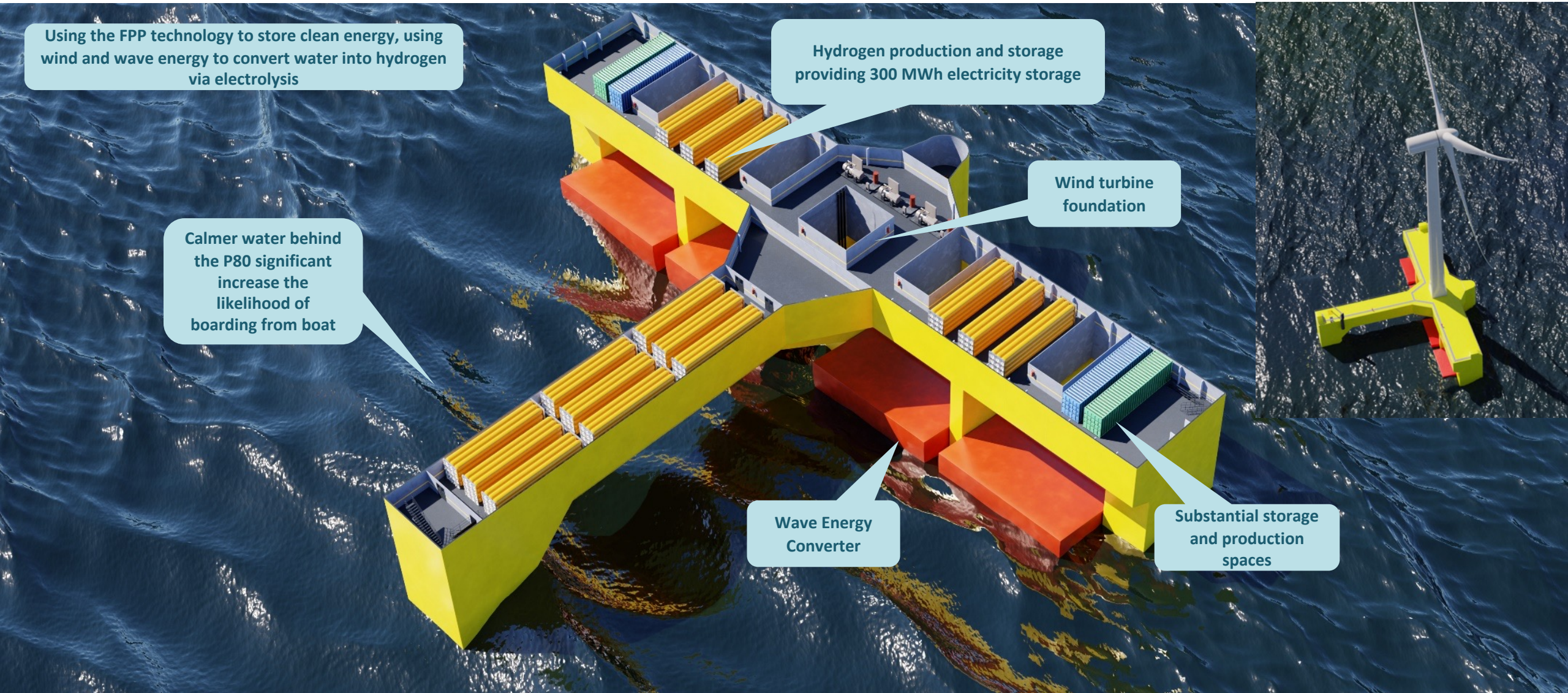
Harald - Offshore O&G platform

- 65.5m water depths
- 2018 production: 100 000 m3 oil & 500 000 000 m3 gas
- **Power generation**
  - All power currently generated from natural gas
  - 3 x 4.2 MW gas turbines installed
  - Power consumption: 4-5 MW

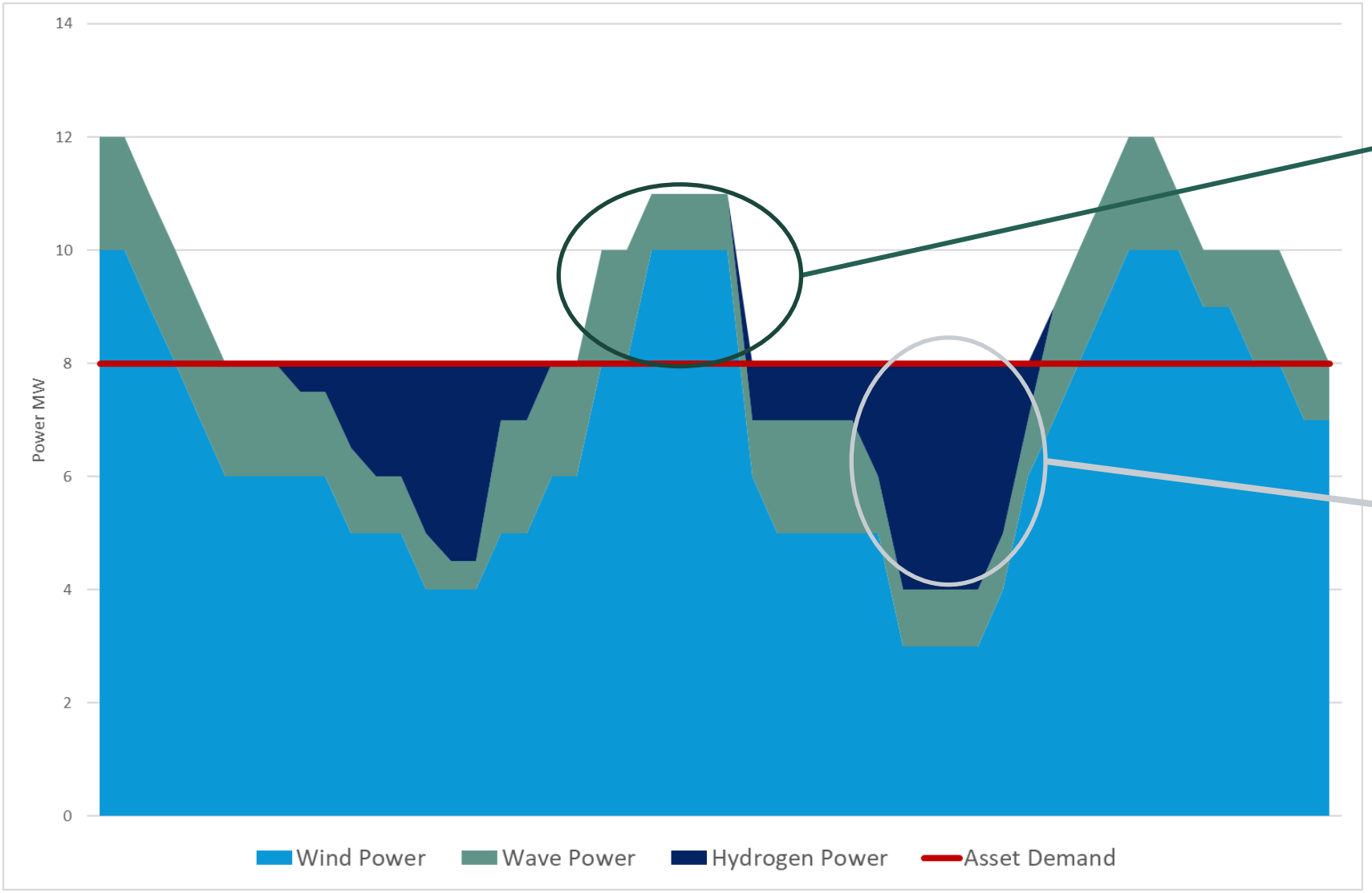
A GAME CHANGER IN POWER-2-X
PARTIAL OR BASELOAD POWER ENABLED BY HYDROGEN

TechnipFMC FLOATING POWER PLANT

Overview of the platform interior with substantial storage space and room for hydrogen production



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.

THE "ENERGY PROPOSITION"

1) Renewable power ONLY to Harald

- 9,5MW wind and 2MW wave
- Renewable energy
  = 56.1 GWh per year
- Harald power consumption
  = 34.9 GWh per year
- **Energy demand coverage**
  = 73%
- CO2 abatement is < 73% as backup power would be running
  (Idling gas generators)
- **~160 yearly generator start stops 161**
- Intermittency
  - 8.1 GWh are missing
  - **29.3 GWh are in excess**

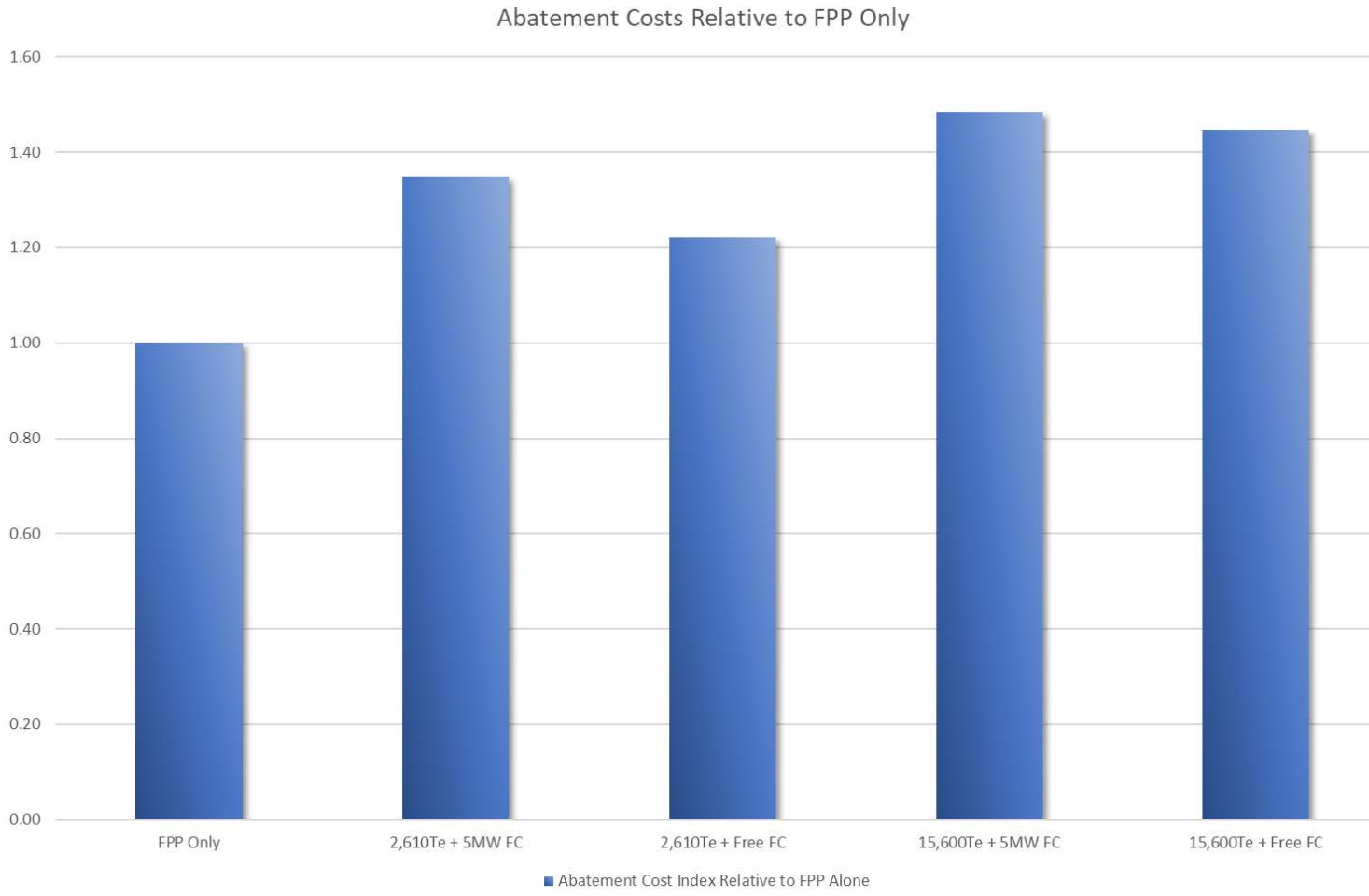
2) Renewable power to Harald - with hydrogen Back up on FPP

- Can increase energy coverage and abatement up to 90% with one platform for the 5MW demand
- Provides time to spin up generators
- Enables further CO2 reduction
  - Reduces need for idling/co-generation
- **Number of start and stops reduces from ~160 to ~30**
- Facilitates island mode capabilities
- ~ Same risk profile as current generation setup

- Can further support the energy transition…

RESULTS – CONCEPT SELECTION AND CO2 REDUCTION

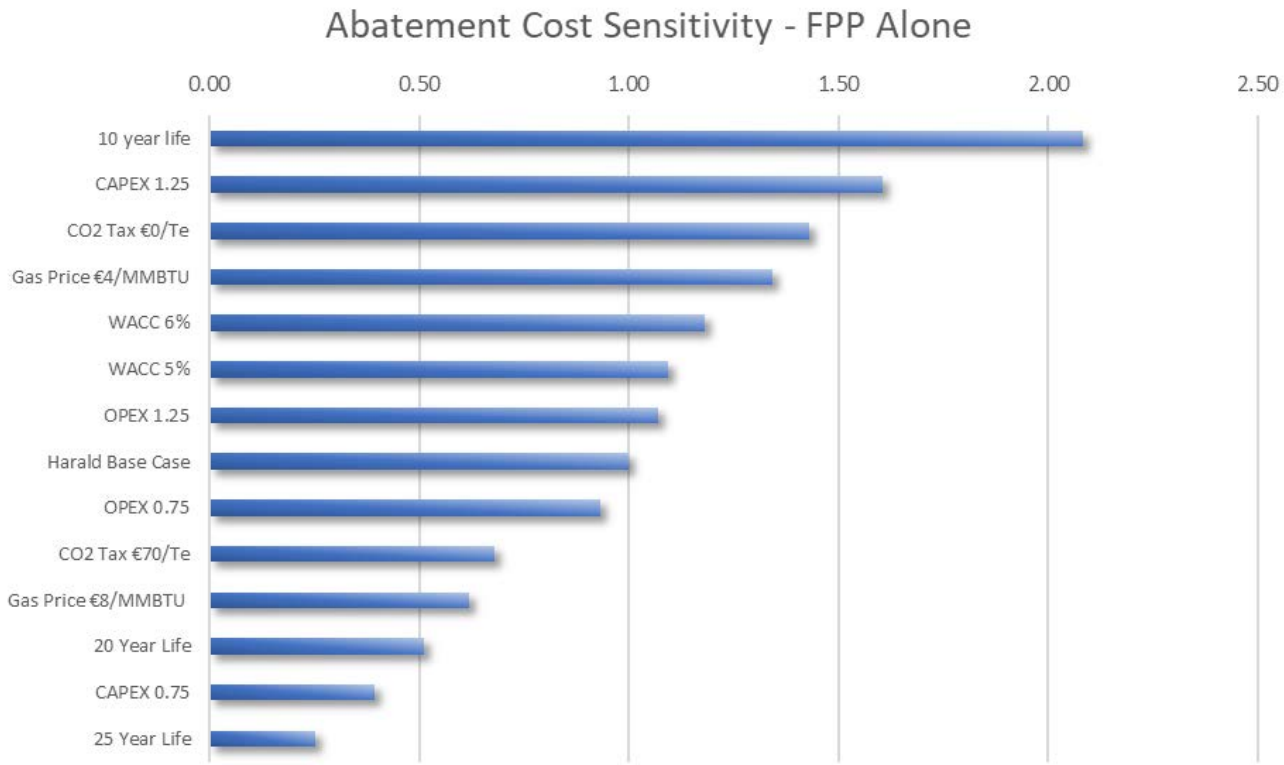
- **Renewable energy (FPP) only**
  - 10MW Wind and 2MW Wave
    - 73% CO2 Reduction
- **FPP with Hydrogen**
  - 2A: Low Storage and 5MW Fuel Cell
    - 79.5% CO2 reduction
  - 2B: Low Storage and “Free” Fuel Cell
    - 79% CO2 reduction
  - 2C: High storage and 5MW Fuel Cell
    - 87% CO2 reduction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



SENSITIVITY OF COST EFFECTIVENESS

- **Abatement Cost Highly Sensitive To**
  - Project Lifetime
  - Project size (single vs array)
  - 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



SAMPLE OF LESSONS LEARNED

Project objective concepts and main results:

1) Supplying offshore oil and gas facilities with renewable energy, reducing CO_2 emissions by 60-70%.

- The Floating wind and wave design (without hydrogen) can abate over 70% of CO2
- Combination of wind and wave improved power quality but does still not have baseload characteristic

2) Improving power baseload characteristics and increasing energy coverage / CO_2 reduction by integrating hydrogen as energy storage. Making the energy supply for offshore oil and gas facilities fossil-free in the long term.

- The integration of hydrogen significantly improves power quality (baseload) thus simplifying the electrification of off grid assets, e.g. O&G platforms, subsea infrastructure, islands, fish farms, etc.
- 300 MWh storage is the key enabler
- With one platform Harald can obtain an 87% coverage with a significant improvement in baseload characteristics due to the large storage and a 5 MW fuel cell

3) Adding up to 15% hydrogen from renewable energy to the natural gas produced, thereby reducing the carbon footprint of Danish North Sea production.

- 2% injection of hydrogen in the natural gas is a realistic short term goal.
- Higher concentrations need further R&D
- Key stepping stone in hydrogen energy transition

Other key learnings

- The concept is relevant for waters over 50 meters water depth
- Significantly reduces risk profile from an operator perspective
- Sensitive to project lifetime as it is renewables (high CAPEX, low OPEX)
- Different business model may be needed, e.g. moving platforms around
- Is cost competitive in correct project setup
  - Each project is different
- Demand side control is key for cost effectively increasing power coverage
- Regulations will be a challenge and needs further development and standardisation for large scale role out

FLOATING POWER PLANT

WHAT IS COMING NEXT

03/03/2022

DEPLOYMENT AND COMMERCIAL SCALE DEMONSTRATION - CANARIAS (PLOCAN)

FLOATING POWER PLANT

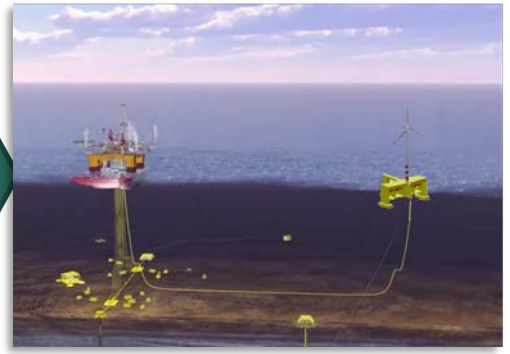
- **Deployment at PLOCAN test site in Gran Canaria**
  - 70-100 m depth, medium wind and wave ressource
  - Deployment of P-Plocan
    - 4,25-MW Wind and 1MW Wave
    - Expanded with hydrogen
      - 1,25 MW electrolysis, 100MWh storage, 2,2 MW fuel cell
  - Deployment H2 2024

- **Setup**
  - FPP Canarias S.L. registered an fully operational
  - Spot market tariff, working on being increased
    - Revenue 10-14m€
  - R&D Tax credit
    - 17.6 m€ certified (14m€ monetised)
    - 9 m€ not certified (7m€ monetisedI
  - Resell value after 10 year ~4-10m€

- **Site Development**
  - Lease (option agreement for 10 years) secured
  - Grid connection available
  - Existing consents and licenses
    - Compliance measures under development

MARKET DEVELOPMENT – A STEEPING STONE PROCESS

Electrification of O&G production
- FPP in process with +15 operators/projects
- Market of 3-5 GW by 2030
- No subsidy needed
- Need: ”constant” renewable power



- **Projects in 15-300 MW range**
- **Limited competition**
- **No competitive lease process, direct client engagement**
- **Significant developer opportunity**
- **Need for “fixed consortium/partner group” with fixed contracts and warranty setup**

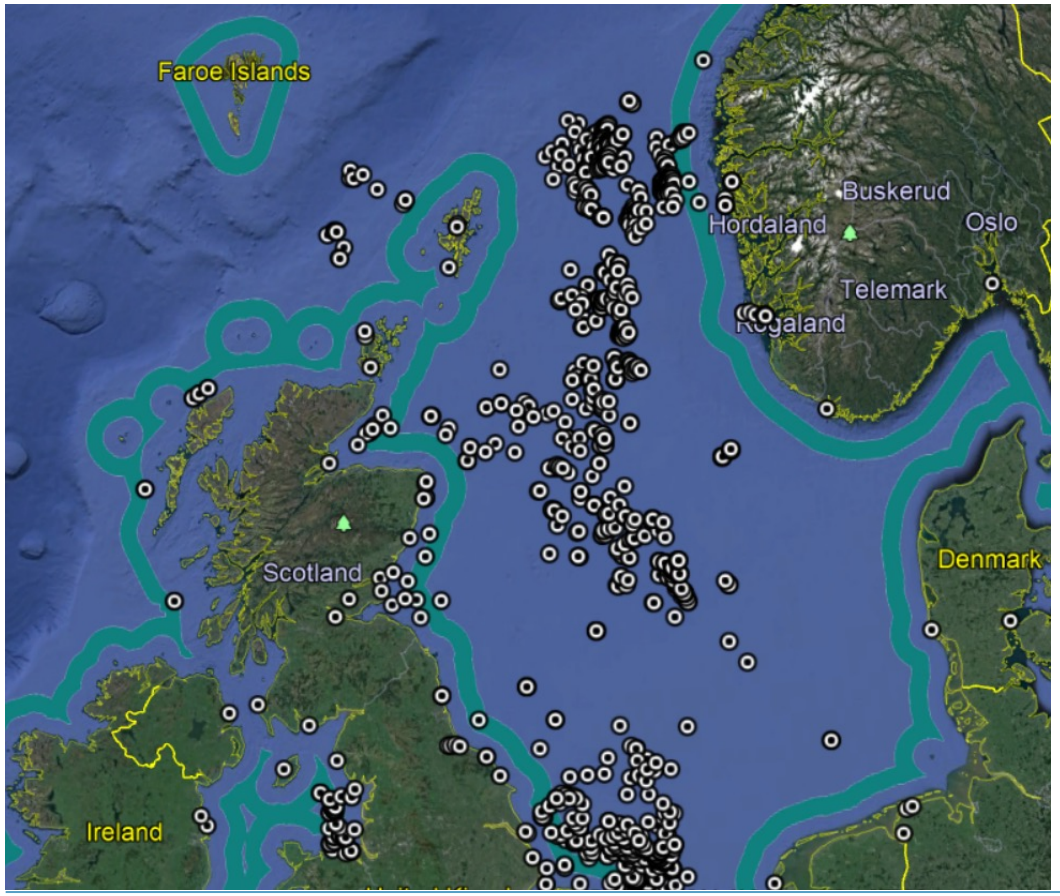
Renewable power to remote Islands
- FPP in development of first 2 projects
- Market of 2-3GW by 2030, >15 GW by 2050
- No new / extra funds needed, but a change in legislation to move diesel/gas payment to renewable power with demand coverage
- Need “Demand driven” renewable power

Green hydrogen production
- FPP in first stages of design with EPC
- Market of 1-3 GW by 2030
- Needs volume and series production to get cost down of green hydrogen
- New pricing structure/demand needed for green hydrogen

POWER TO X ("PTX") MARKET – O&G SEGMENT

Constant renewable power offshore – FPP or Cable

FPP is the main alternative to a cable from shore for reliable, low or zero intermittency renewable energy offshore



Dots show surface facilities

- 0-12 NM (before green band) best service via cable from shore
- 12-24 NM (green band) needs more detailed analyses
- Over 24 NM are likely to benefit from FPP's solution

RAPIDLY GROWING MARKET

- **First commercial design contract secured for UK O&G operator**
- **Engaged with +15 operators/projects for electrification**
- **January 2021 – Scotwind announced - 25 GW offshore wind**
  - Will include hydrogen
- **Innovation and Targeted Oil and Gas (INTOG) offshore wind leasing process announced**
  - Opening for bids ~ June 2022
  - Awards Q2/Q3 2023
- **EU**
  - New strategy approved in the Europa-Parlamentet har to minimum 5 doubles EU offshore wind by 2030
    - By 2050 300 GW offhshore wind and a further 40 GW from oter ocean sources as wave and tidal power
  - ”Fit for 55 package”– 40 GW elektrolyses capacity in EU by 2030…
- **Etc.**

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THANKS

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