SCCS

PhD Consortium (Autumn) 2024

Bringing academia and industry together

Repurposing Legacy Oil and Gas Assets for Green Hydrogen Production

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National Decommissioning Centre, University of Aberdeen

02/12/2024


The National Decommissioning Centre
North


The National Decommissioning Centre

NEWS & INSIGHTS | ARTICLE

Data for Net Zero: Developing analytics to unlock the energy transition

The DN4Z will be a truly different way of working, pioneering collaboration and breaking down barriers across the industry and allowing SMEs and providers of innovation technologies and solutions access to an integrated energy future.

Net Zero Technology Transition Programme

In August 2021, the Net Zero Technology Centre was awarded £16.5million from the **Scottish Government's Energy Transition Fund**. The award, match-funded by industry, will drive seven projects:

- Energy Hub
- Hydrogen Backbone Link
- Alternative Fuel Gas Turbines
- Offshore Low Touch Energy Robotics and Autonomous Systems (OLTER)
- Advancing Remote Operations
- Data for Net Zero (D4NZ)
- Offshore Energy Digital Architecture

The projects are designed to develop the skills, technologies, and infrastructure that Scotland needs to deliver an affordable green economic recovery.

We don't simply want to deliver net zero for the UK, we want to seize the full economic benefits of doing so in a global market with huge export potential – and maintain that advantage long into the future.

▲ Data for Net Zero

Challenge

Scottish Government
Riaghaltas na h-Alba
gov.scot

This cluster of projects is driven by the Scottish Government's commitment to achieve Net Zero emissions by 2045. To achieve this, all decommissioning activities will need to reduce emissions.

Project Aim

To assist the sector in reducing greenhouse gas emissions through deployment of new technologies, operation optimisation, basin wide decision making and co-action and reuse and repurposing of assets

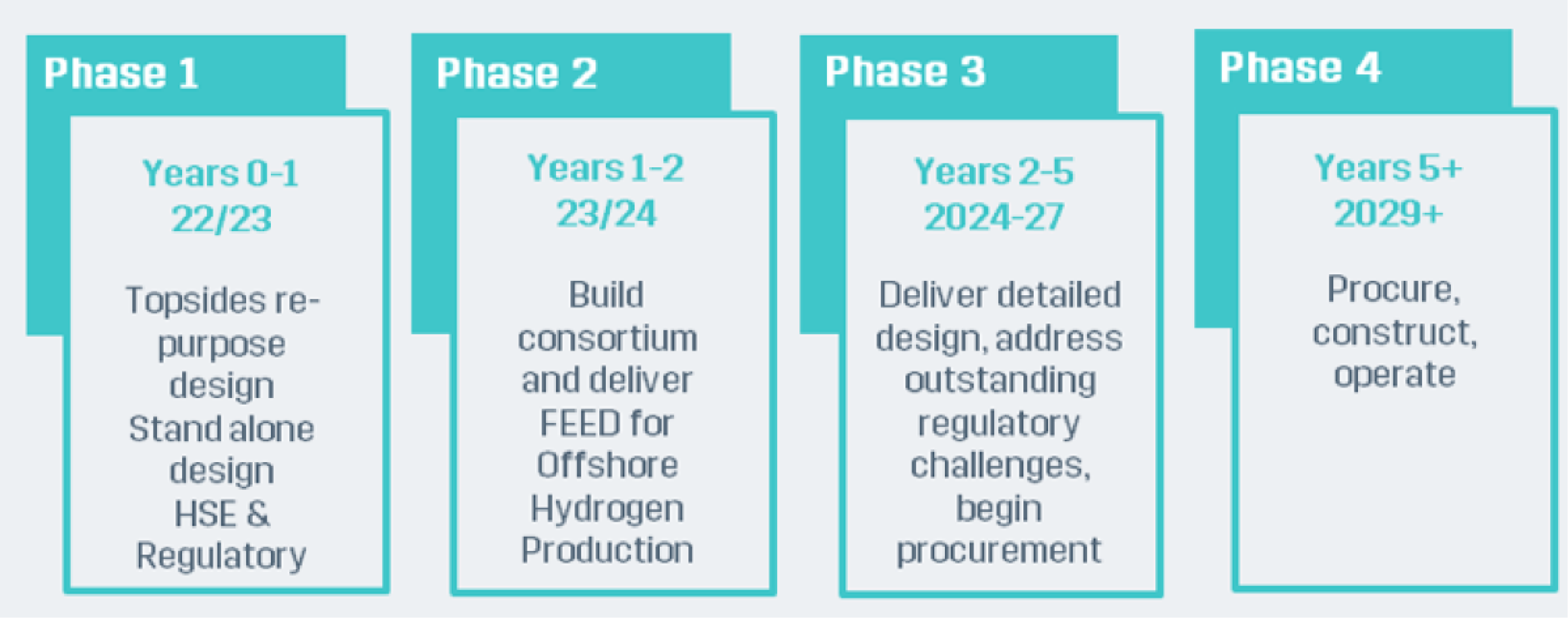
Project Outline

- **De-carbonising Decommissioning**
  - Optimisation of decommissioning techniques for emissions reduction
  - Modelling of new technologies and decommissioning scenarios
- **Decision Making in Late Life and Decommissioning**
  - Supporting of emissions reduction through co-action and campaign planning
  - Supporting the supply chain in decision making for investment and technologies
- **Infrastructure Re-Use**
  - Obtaining data from UKCS and building a digital copy of an exemplar region of the North Sea
  - Assessment of suitability for re-purposing of oil and gas legacy infrastructure to accelerate the progress of CCS and hydrogen production and storage
  - Modelling of opportunities for energy integration concepts

Status

The final scope of the areas identified is taking place

PHASES



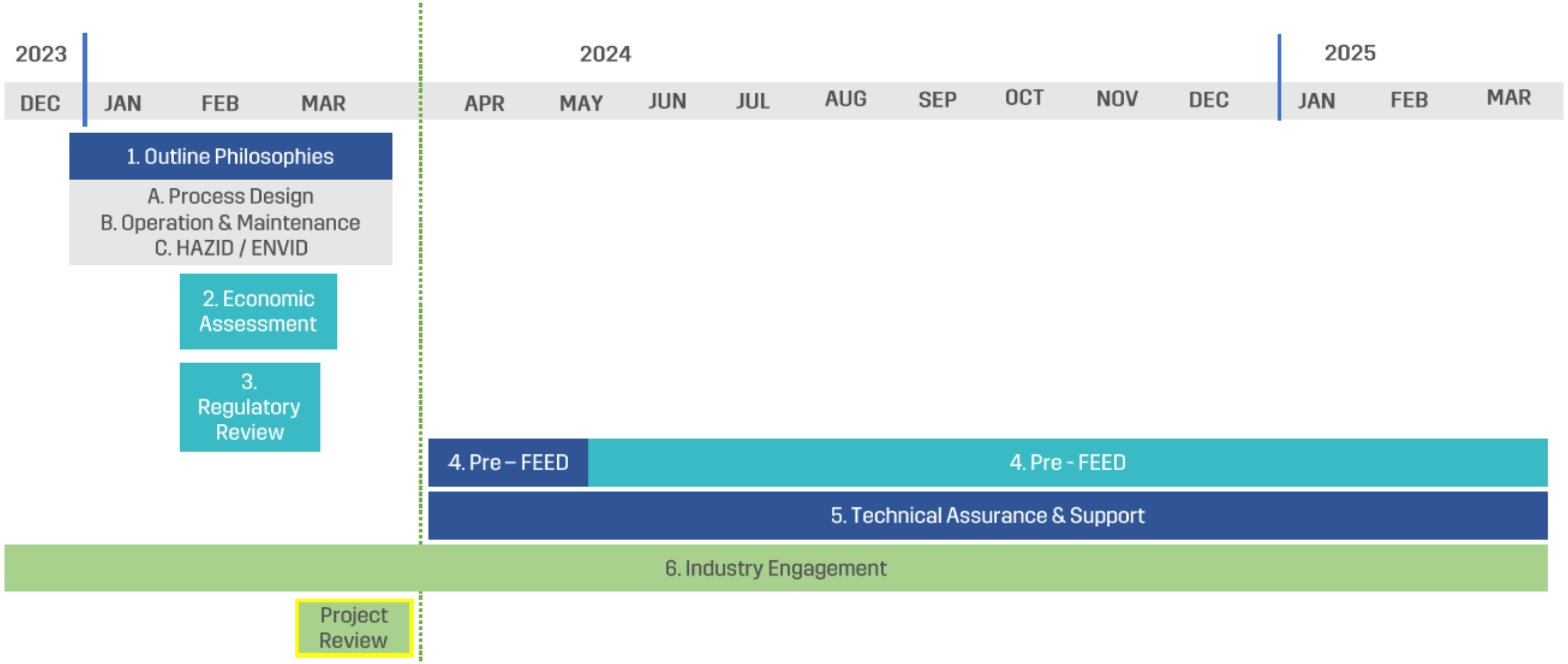
Phase 1
Years 0-1
22/23
Topsides re-purpose design
Stand alone design
HSE &
Regulatory
Phase 2
Years 1-2
23/24
Build consortium and deliver FEED for Offshore Hydrogen Production
Phase 3
Years 2-5
2024-27
Deliver detailed design, address outstanding regulatory challenges, begin procurement
Phase 4
Years 5+
2029+
Procure, construct, operate

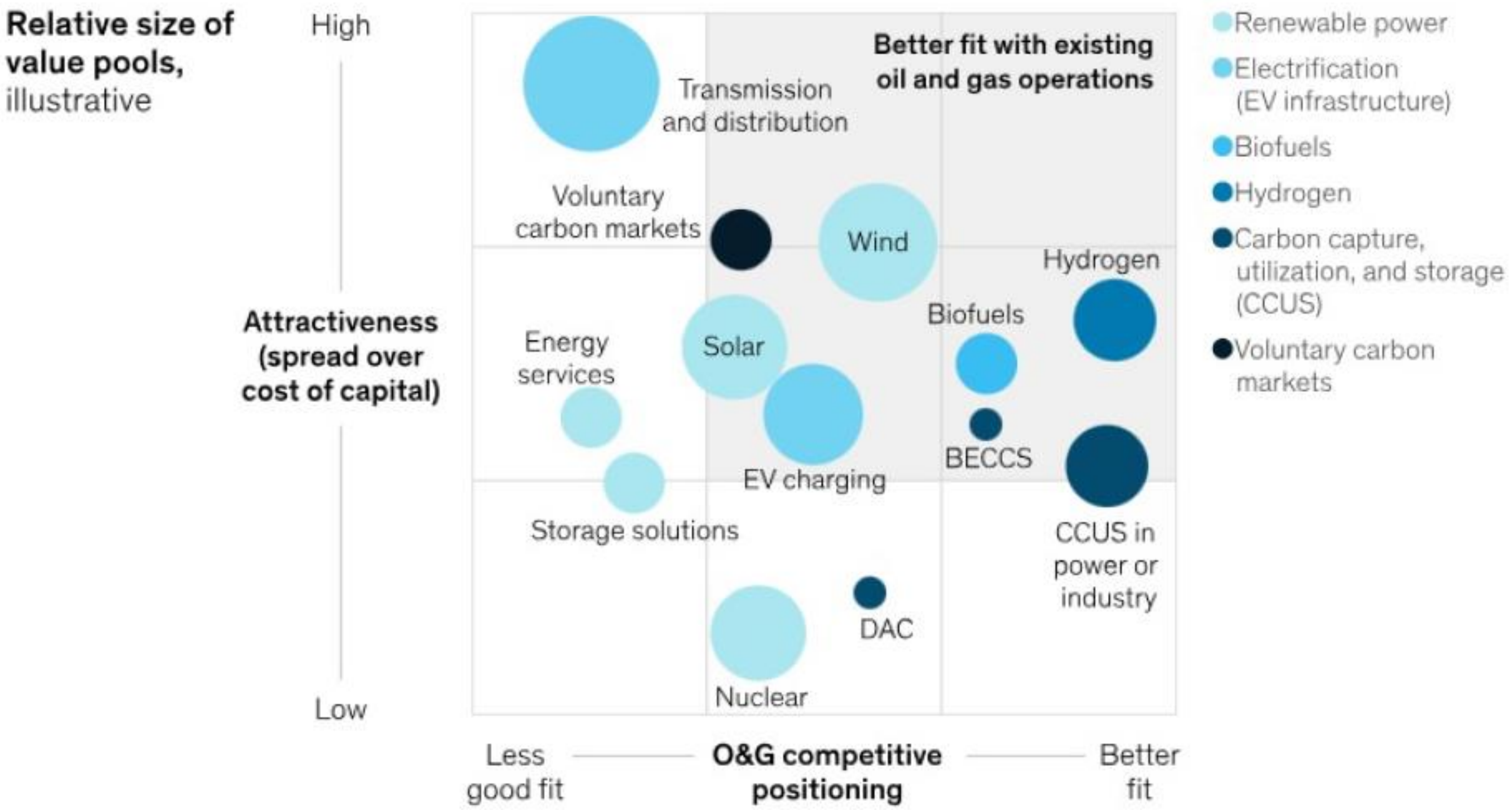
Techno-Economic Study of Repurposing an Offshore Oil Production Platform in UKCS for Green Hydrogen Production

OBJECTIVES

- Demonstrate that offshore green hydrogen production is feasible at a scale of 200MW to 1GW by repurposing legacy oil and gas assets.

- Outline what this sort of asset for offshore green hydrogen production could achieve within the UKCS and what the impact would be on the regional workforce, supporting a just transition.



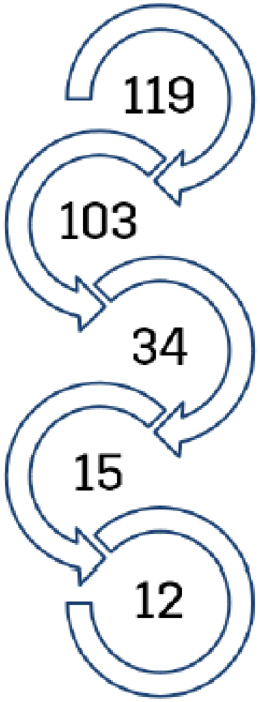


Different energy transition scenarios that fit with existing oil and gas operations

ASSET CRITERIA SELECTION

Step 1 – Facility Type Criteria: Fixed Facilities Only

Step 2 – Substructure Type Criteria: Gravity-Based Concrete or Large Steel Jacket
Asset Age & Life Extension Potential: 25-year H_2 design life, maximum 45-year jacket
Criteria: >2006 Steel Jacket

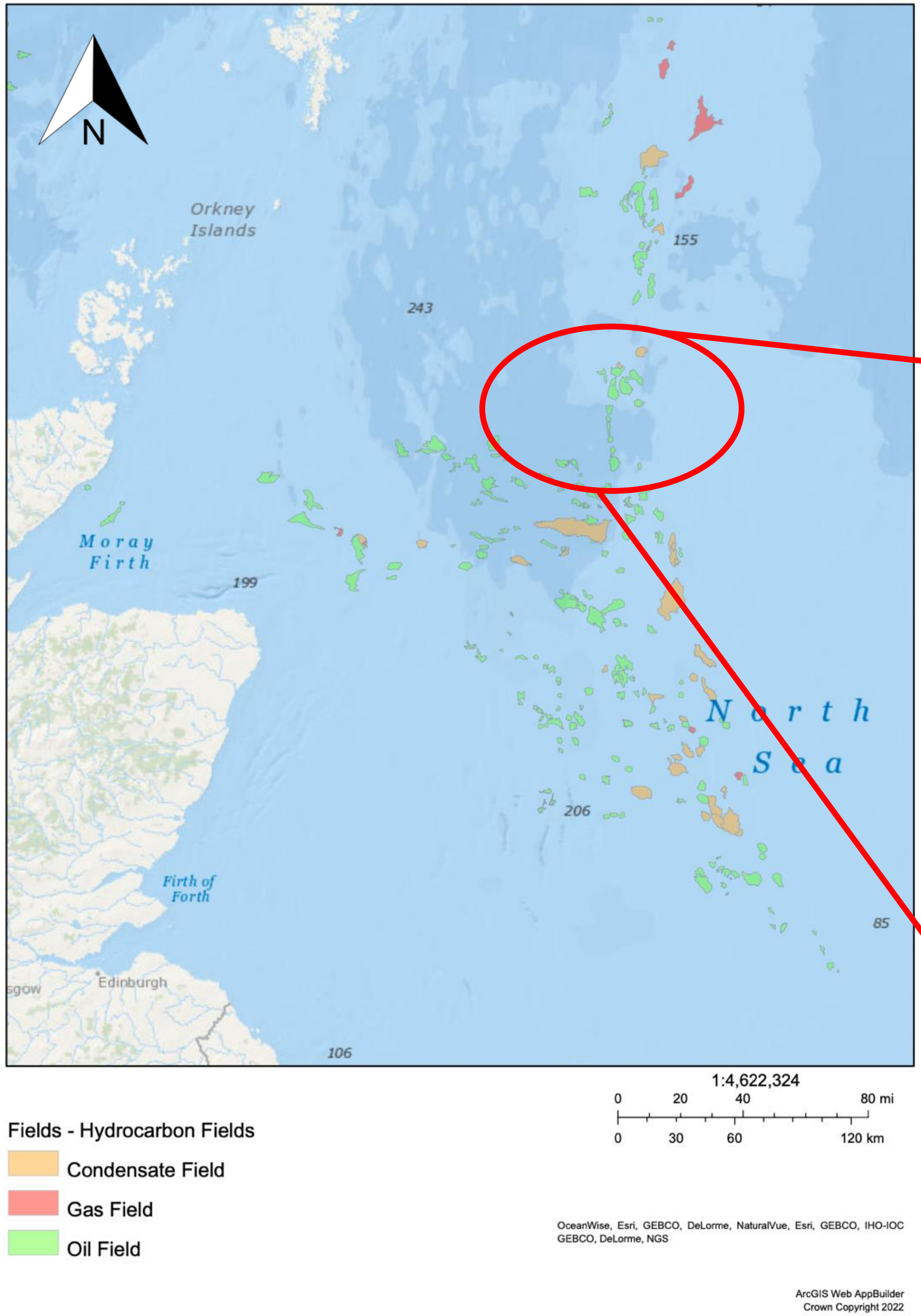


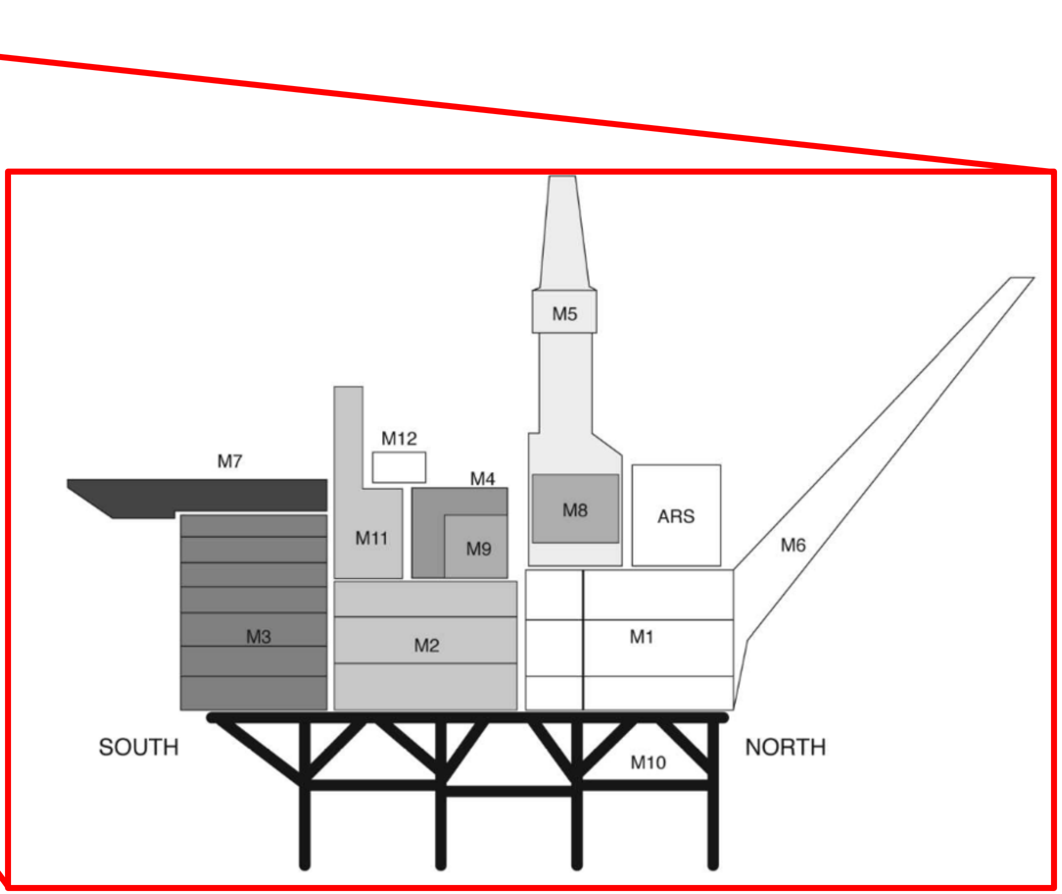
Step 3 – Asset Availability
Criteria: Estimated CoP Date < 2034
Criteria: No approved decommissioning plan for substructure

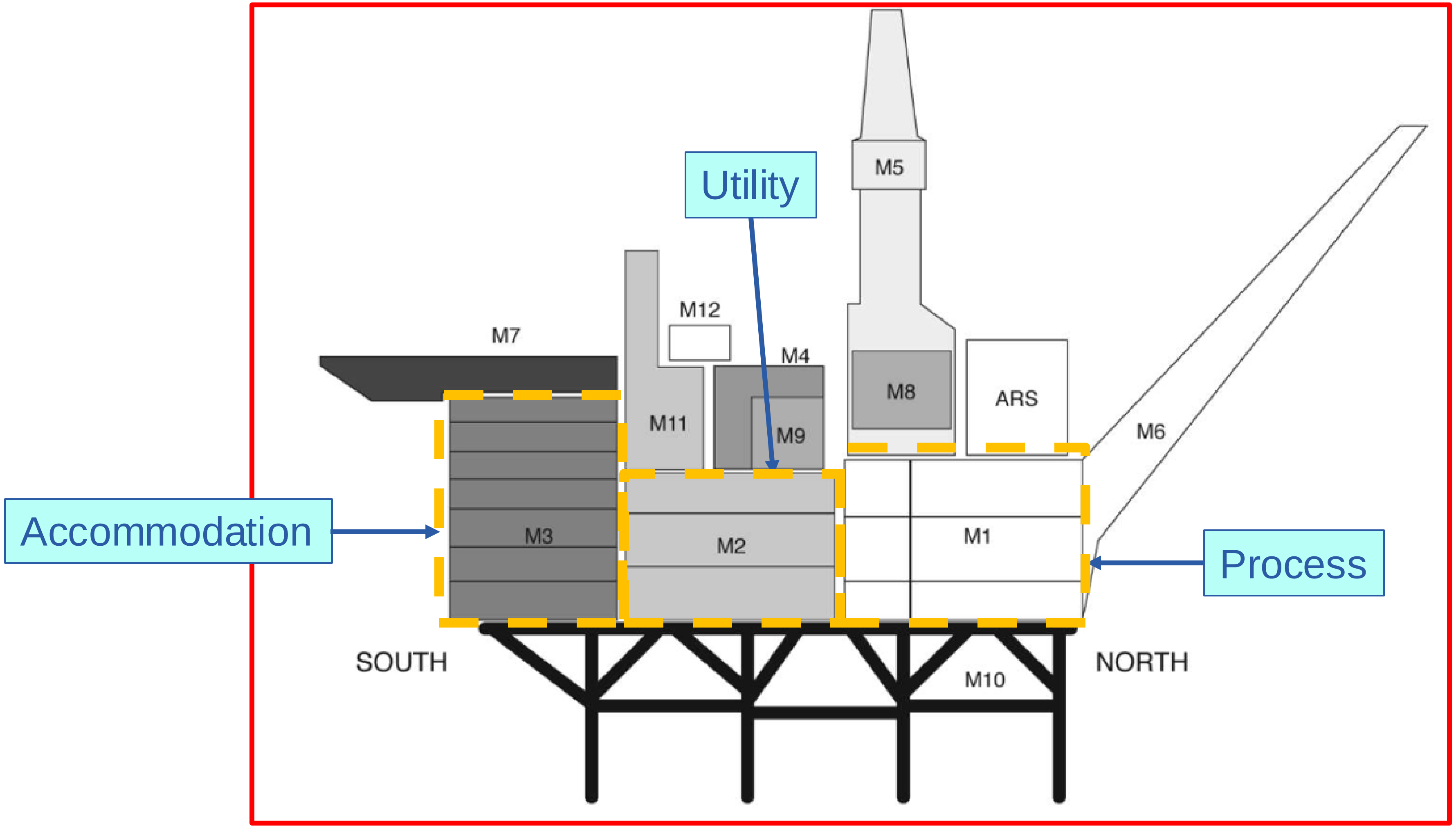
Step 4 – Topsides Weight
Criteria: < 5,000 tonnes not considered feasible for H2 production at this scale

Over 300 UKCS oil and gas assets were screened

OVERVIEW OF THE PLATFORM





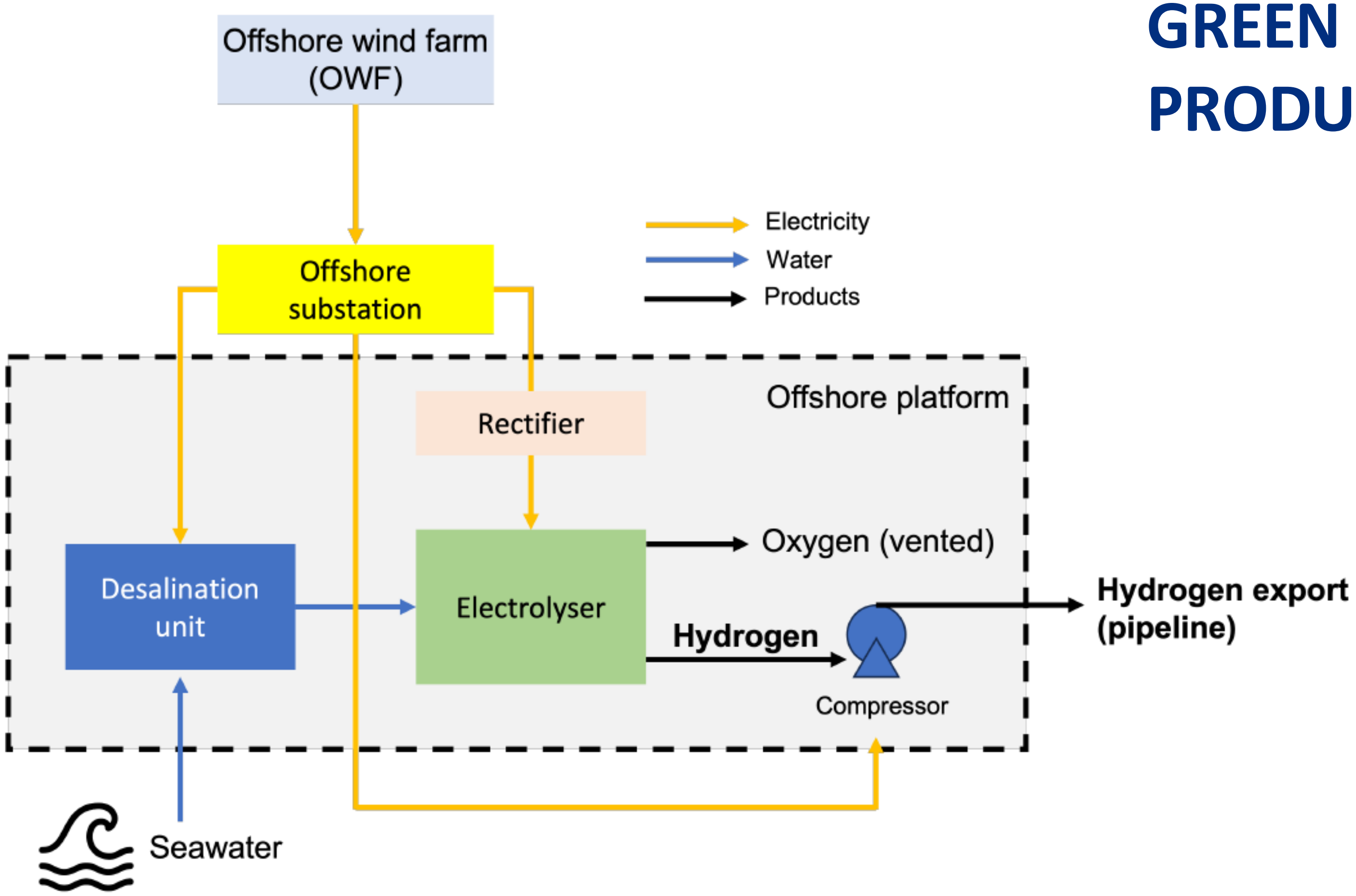

Utility
M5
M12
M7
M4
M8
ARS
M11
M9
M6
Accommodation
M3
M2
M1
Process
SOUTH
M10
NORTH

OVERVIEW OF THE OFFSHORE WIND FARMS

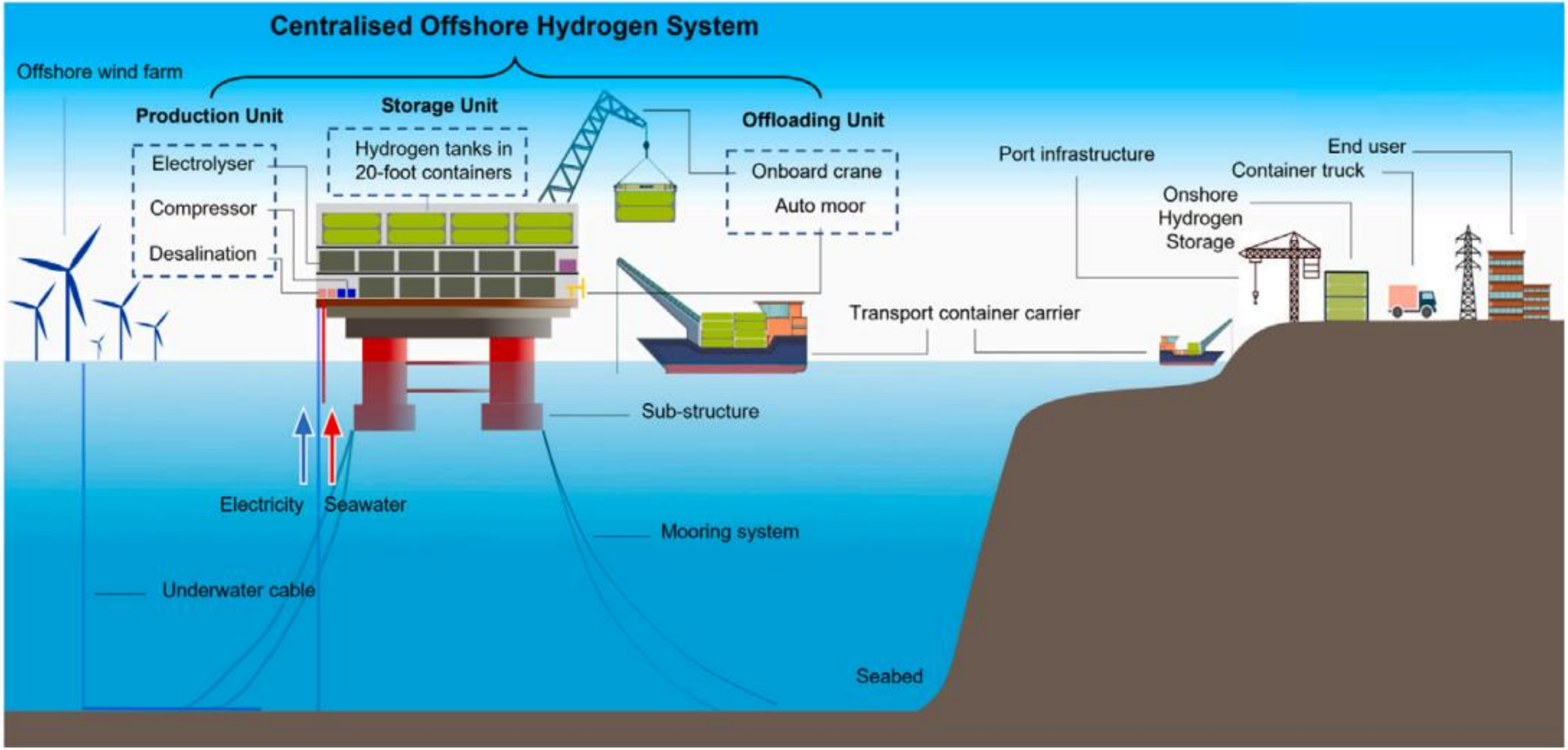
= ScotWind projects

= INTOG projects

GREEN HYDROGEN PRODUCTION UNIT



Block Flow Diagram showing the process for offshore green hydrogen production on a repurposed oil and gas platform. Electricity is supplied by a nearby offshore wind farm to a substation located on a separate platform. The rectifier converts AC from the wind farm to DC for the electrolysers and hydrogen storage equipment.

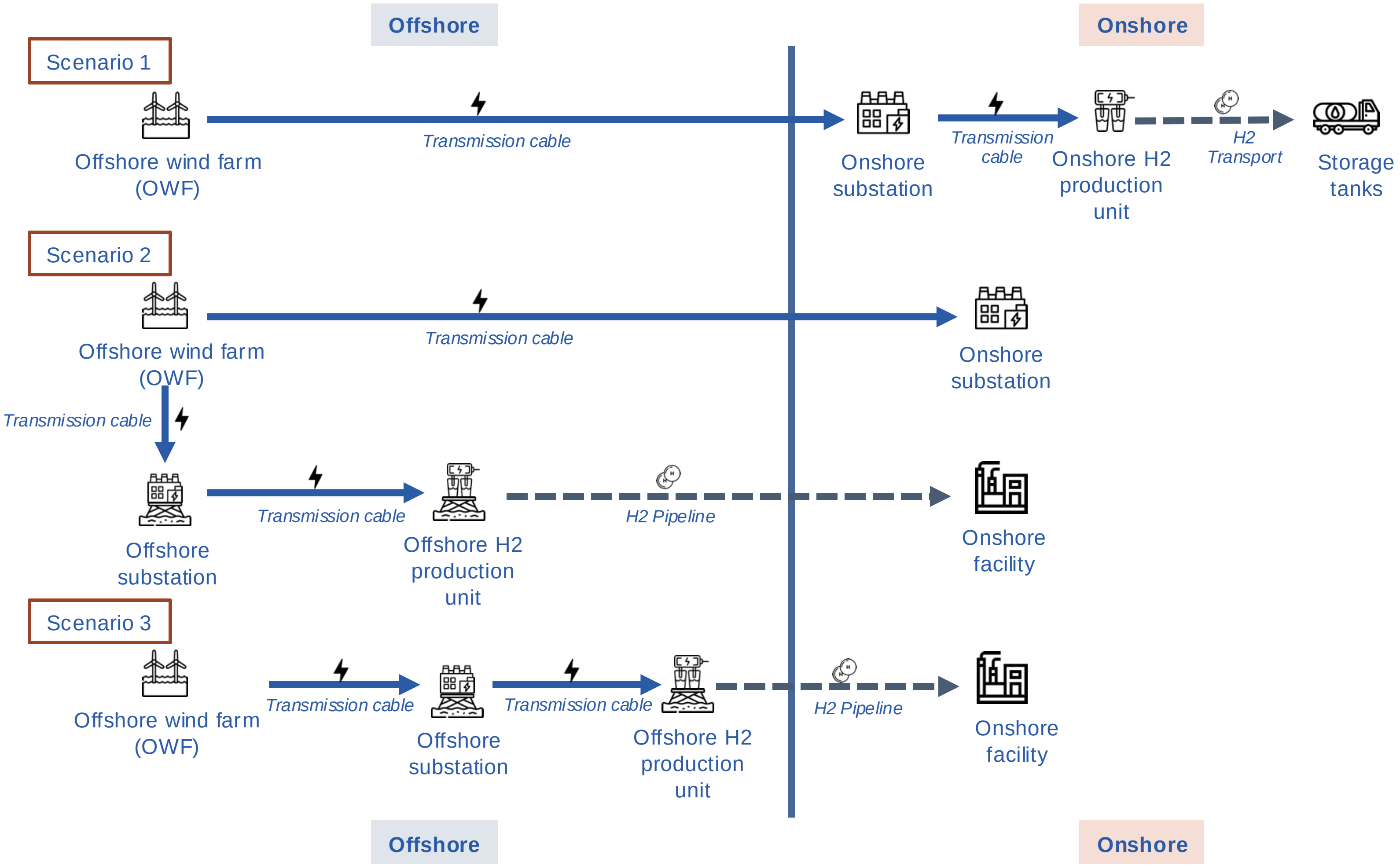

Centralised Offshore Hydrogen System
Offshore wind farm
Production Unit
Storage Unit
Offloading Unit
Electrolyser
Compressor
Desalination
Hydrogen tanks in 20-foot containers
Onboard crane
Auto moor
Port infrastructure
End user
Container truck
Onshore Hydrogen Storage
Transport container carrier
Sub-structure
Electricity
Seawater
Mooring system
Underwater cable
Seabed

SCENARIOS

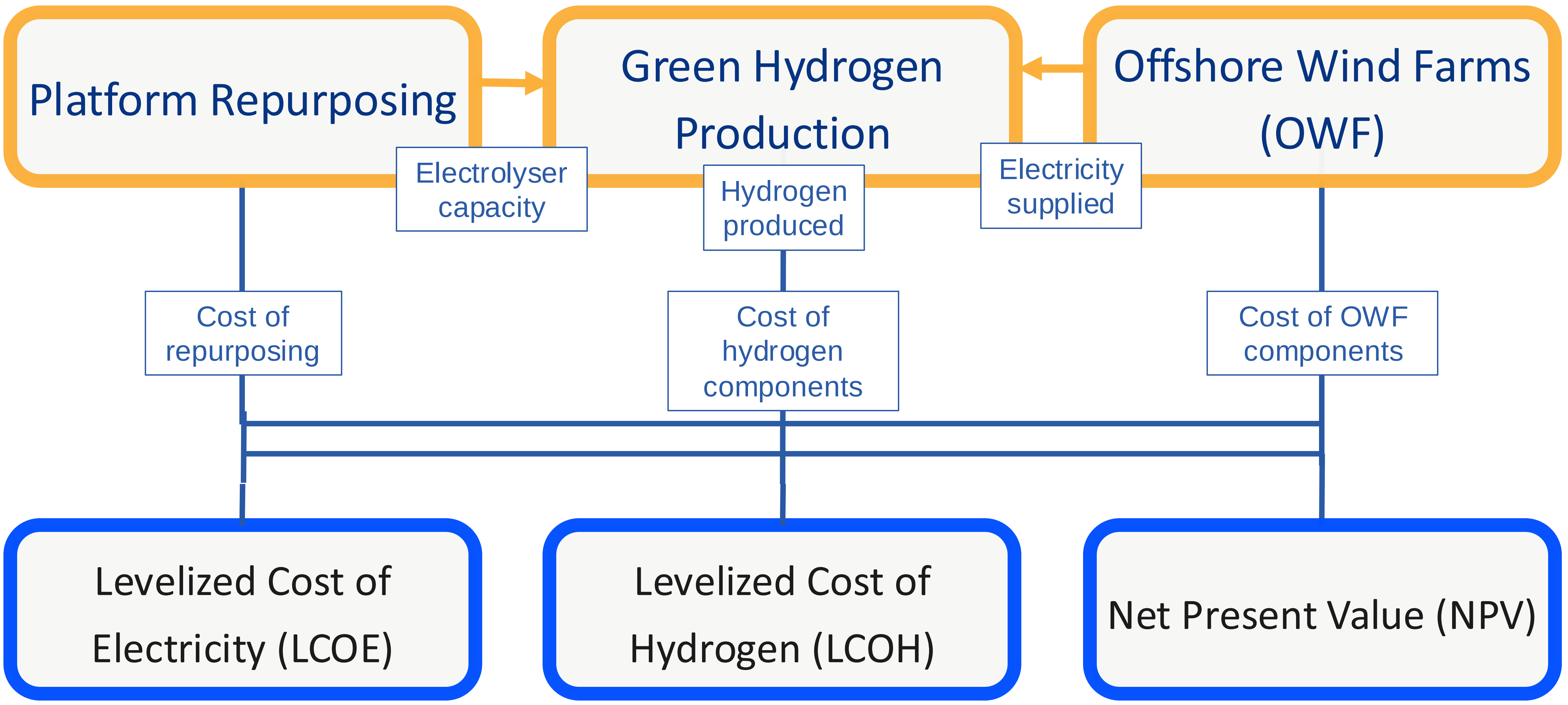
Scenario 1:
Onshore green hydrogen production, powered by offshore floating wind farm

Scenario 2:
Offshore green hydrogen production, powered by offshore fixed-bottom wind farm

Scenario 3:
Offshore green hydrogen production, powered by offshore floating wind farm



TECHNO-ECONOMIC STUDY



TECHNO-ECONOMIC CONSIDERATIONS

Levelized Cost of Electricity (LCOE)

Levelized Cost of Hydrogen (LCOH)

Net Present Value (NPV)

$$\text{LCOE/LCOH} = \sum_{t=0}^{T} \frac{\text{Total lifetime costs}}{\text{Total lifetime output}},$$

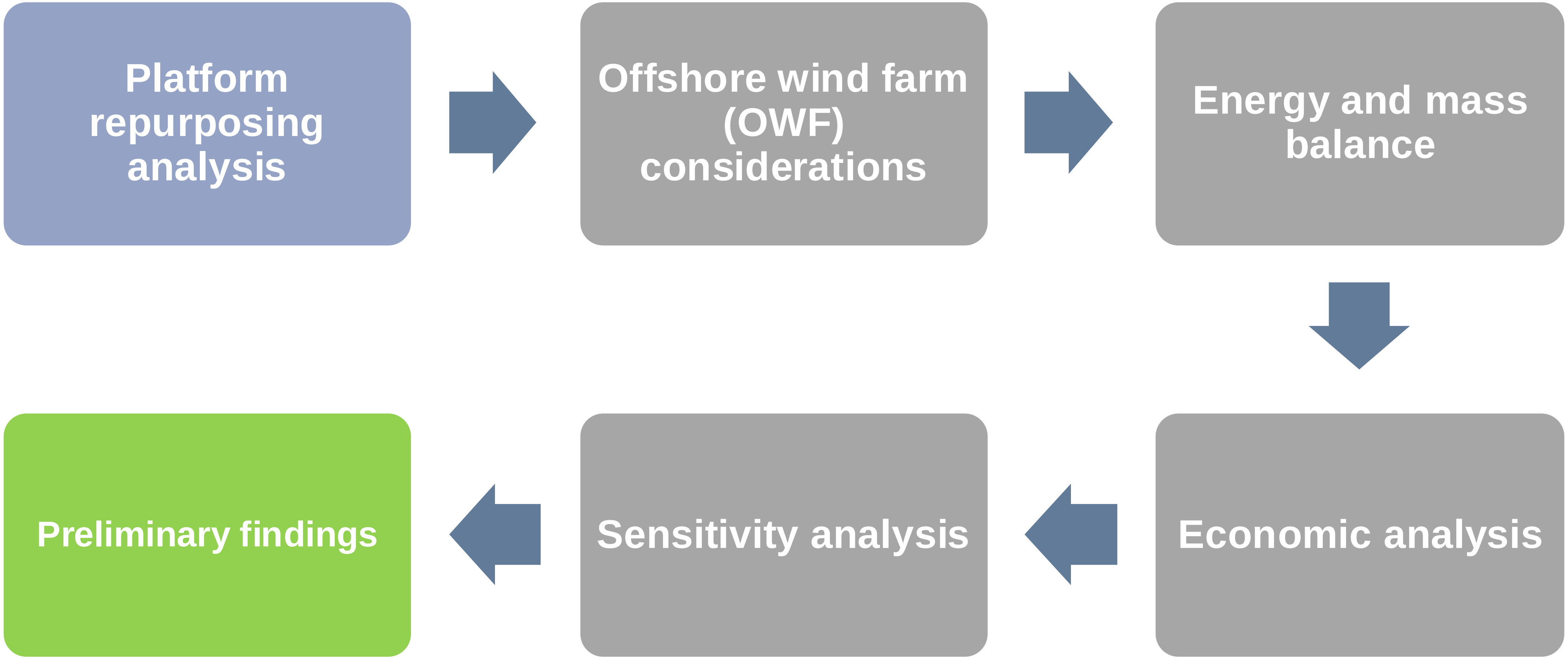
$$\text{Total lifetime costs} = \sum_{t=0}^{T} \frac{\text{CAPEX+OPEX+Replacement+Repurposing}}{(1+r)^t},$$

$$\text{Total lifetime output} = \sum_{t=0}^{T} \frac{\text{Total output produced}}{(1+r)^t},$$

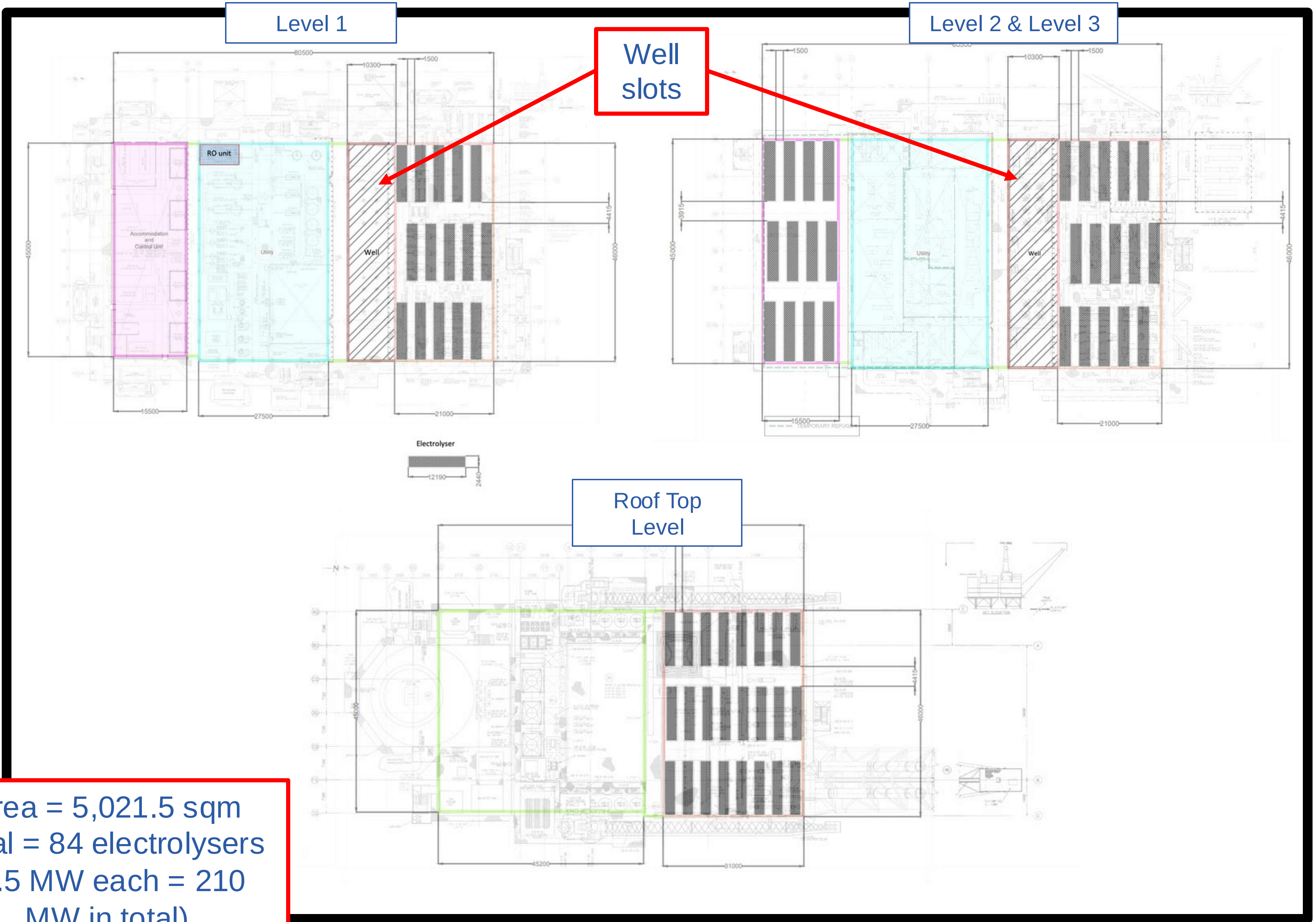
$$\text{DCF} = \frac{\text{Revenue}-\text{costs}}{(1+r)^t},$$

$$\text{NPV} = \sum_{t=0}^{T} \text{DCF}.$$

METHODOLOGY

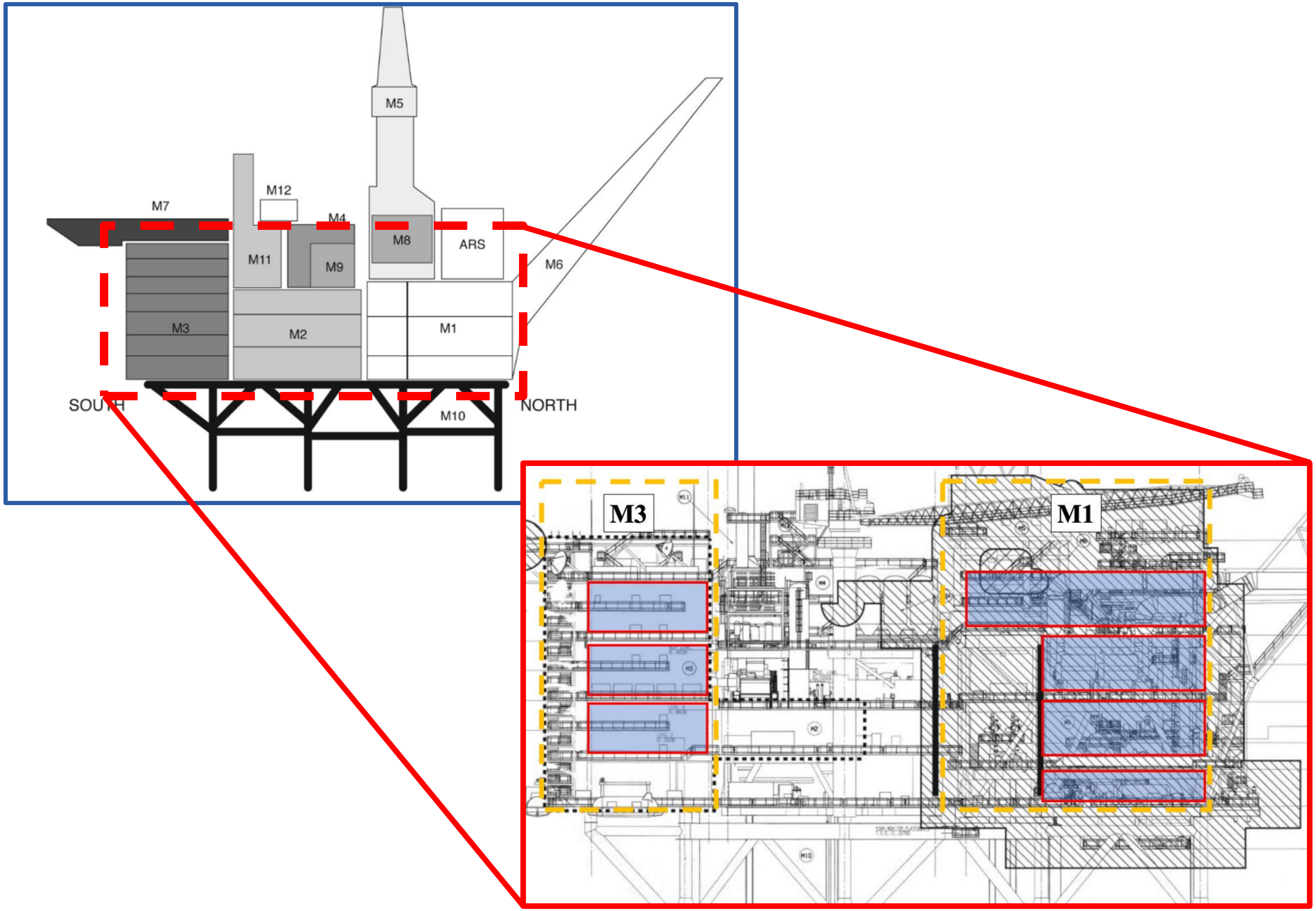


PROPOSED LAYOUT



Area = 5,021.5 sqm
Total = 84 electrolysers
(2.5 MW each = 210 MW in total)

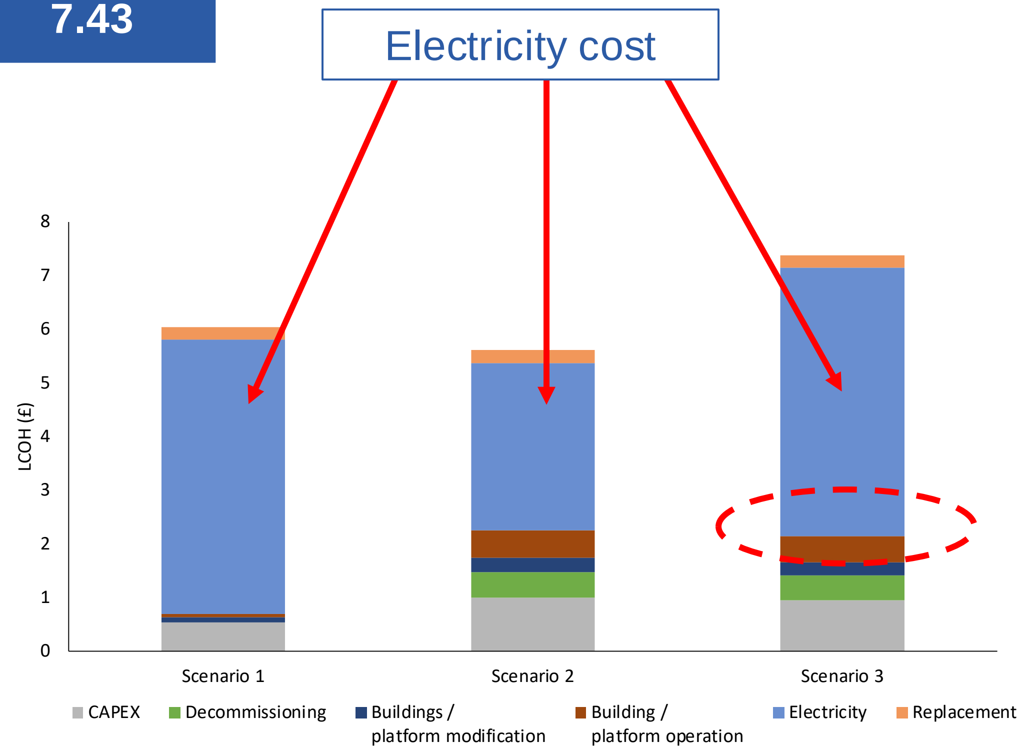
PROPOSED LAYOUT



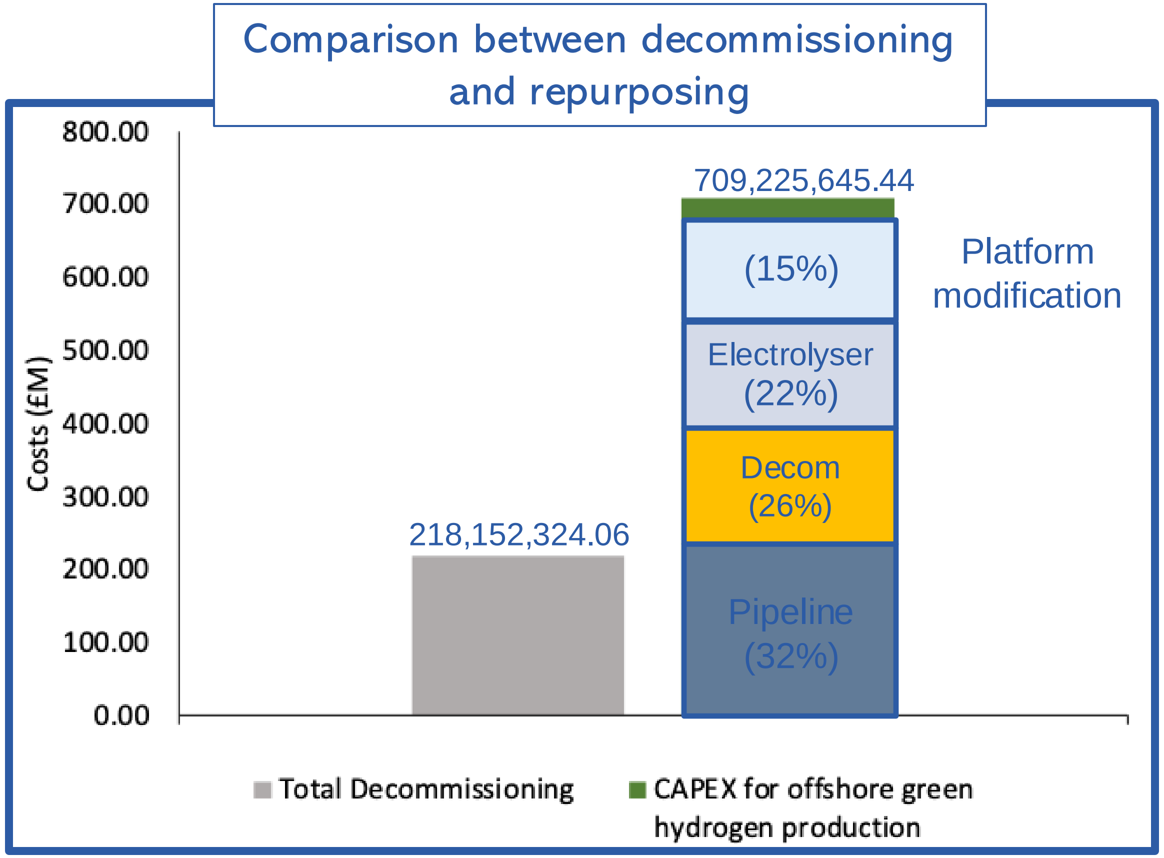
RESULTS

	H2 Produced (t/yr)	Electricity transmitted (GWh)	Transmission loss (%)	Excess power (GWh)
Scenario 1	32,830.40	5,581	8.22	3,661
Scenario 2	31,336.93	4,191	9.39	2,358
Scenario 3	32,793.17	5,410	11.04	3,492

	Scenario 1	Scenario 2	Scenario 3
LCOE (£/MWh)	85.25	51.66	84.24
LCOH (£/kg H2)	**6.20**	**5.74**	**7.43**

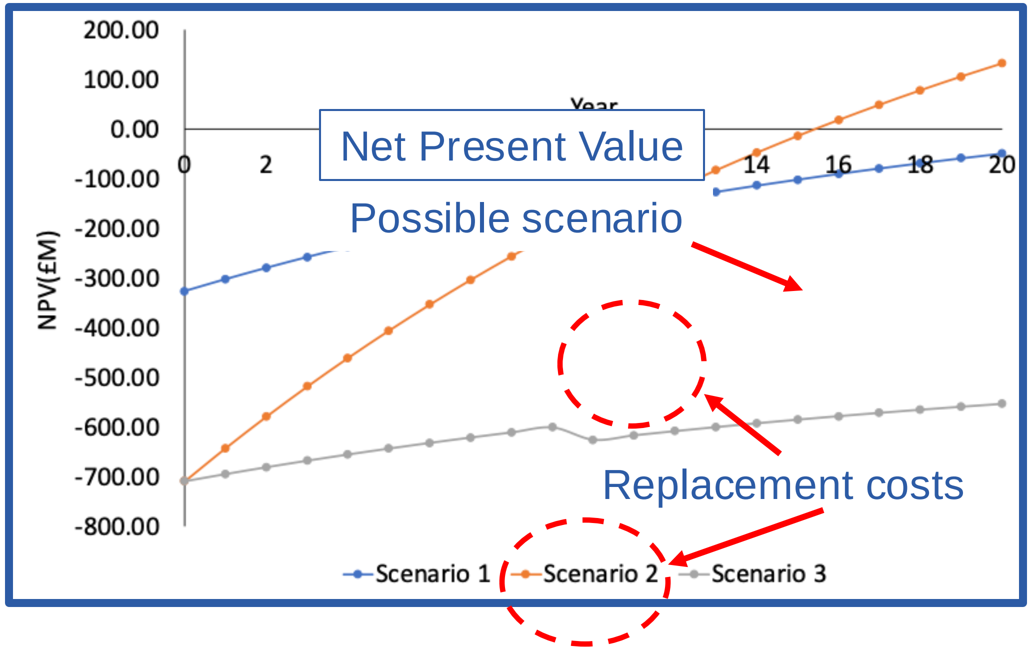


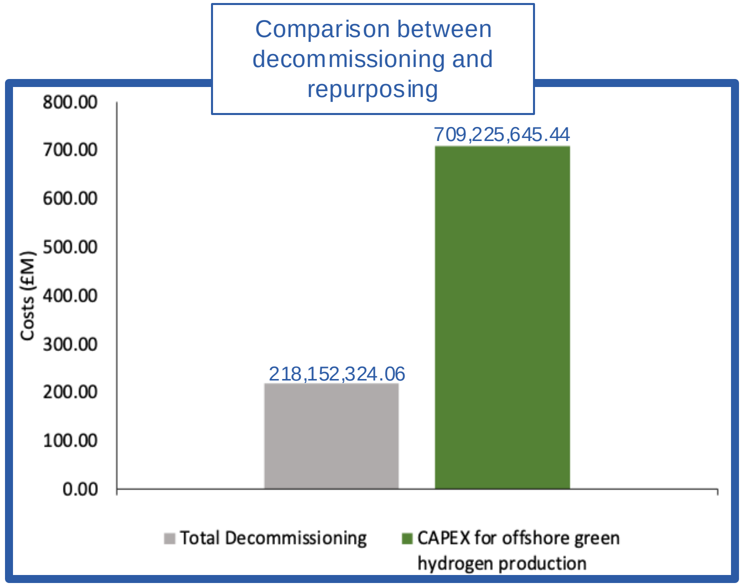
RESULTS



Sections	(%)	Total Decommissioning (£)	Partial Decommissioning (£)
Topside	30	50,701,896.84	21,380,832.94
Jacket	15	28,735,194.81	28,735,194.81
Well	45	116,900,000.00	116,900,000.00
Others	10	101,252,324.06	68,673,364.17
TOTAL	**100**	**218,152,324.06**	**185,573,364.17**

RESULTS





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TOTAL	**100**	**218,152,324.06**	**185,573,364.17**

- Green hydrogen selling price at £6.08
- Discount rate of 5%
- 20 years
- Scenario 2 gives positive NPV with PBP of 16 years

Key Outcomes – Transportation & Storage

National & international markets

Hydrogen Demand:

- UK: 80-140TWh in 2035
- Germany: 45-90TWh in 2030
- The Netherlands, Belgium, other EU countries also plan to utilise hydrogen

Hydrogen End-use:

- ➢ Industry
- ➢ Transportation
- ➢ Energy Storage
- ➢ Heating

Production & export locations

Opportunity to export from HOP2 facilities to:

- Offshore Hydrogen Backbone Link (HBL), onwards to European Hydrogen Backbone.
- Scottish import terminals – St Fergus, Sullom Voe, and Flotta. Onwards via onshore network (e.g. Project Union).

Hydrogen transportation

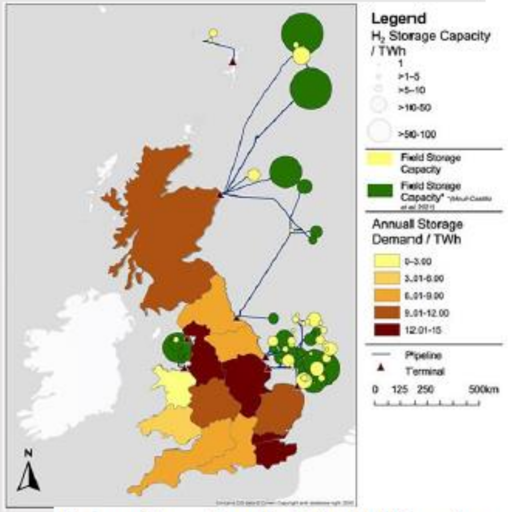
Transport by pipeline the most appropriate option for HOP2:

- 1 feasible reuse option
- New-build for tie-in to the HBL.

Hydrogen storage

Requirement for small/large-scale hydrogen storage, identified key opportunities:

- Depleted O&G reservoirs
- Salt caverns
- Line-packing



Hydrogen Storage Capacities in Depleted Reservoirs

Key Outcomes – Topsides Layout & Design

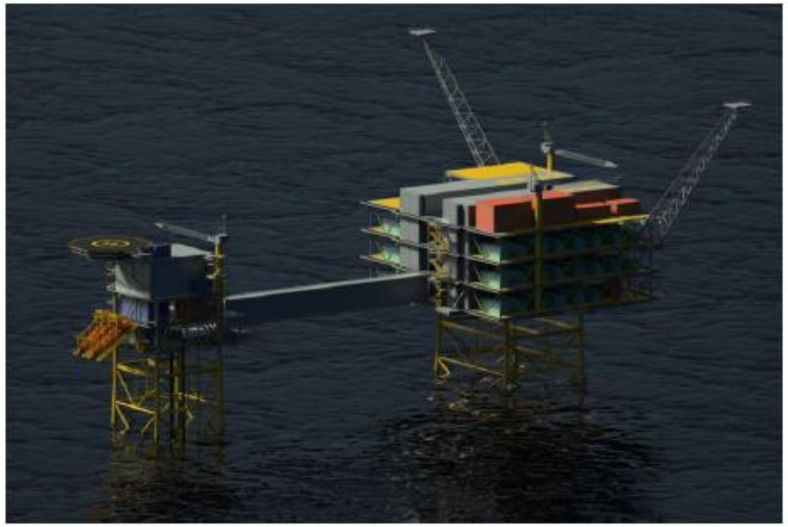
Option 1A (Single Large Platform)

- Central low-hazard zone between 2 electrolyser zones
- Living quarters on Level 2, upwind from hydrogen production facilities
- Weight: ~31,841 tonnes
- Challenges in weight and topside installation

Option 1C (Bridge-Linked)

- Living quarters on western platform; power facilities on central platform; oxygen vent on other. Electrolysers on both HP-A and HP-B.
- Requires detailed planning and safety considerations
- Weights: ~4,296 & 14,749 & 7,862 tonnes
- **Most feasible for repurposing an existing asset**

Option 2 (New Build)



- Designed to achieve most optimal layout
- 8 electrolyser arrays per level
- Separate living quarters
- Weights: ~4,296 & 30,150 tonnes
- High economic and environmental implications

Summary of Key Findings

- This study highlights the importance of considering various factors such as transmission systems, platform repurposing costs, and long-term financial implications when evaluating the viability of different scenarios for green hydrogen production.
- Through static energy and mass balance checks, we have determined that the case study platform can be reasonably repurposed for hydrogen production.
- Scenario 2 exhibited lowest LCOE of £51.66 and LCOH of £5.74/kg GH2.
- Lower electricity prices didn't always lead to lower LCOH (Scenario 3).
- Platform repurposing, CAPEX of electrolyser, and offshore hydrogen pipeline costs affected LCOH in Scenario 3.
- Scenario 2 showed potential financial benefits at £6.08/kg GH2 price.
- Results indicate promising potential for further investigation into platform repurposing, albeit with a payback period of 16 years. Extending the life of the platform has high associated costs that must be properly considered before executing the project.

SPE International
Society of Petroleum Engineers

SPE-220114-MS

Repurposing an Offshore Oil and Gas Platform for Green Hydrogen Production: A North Sea Case Study

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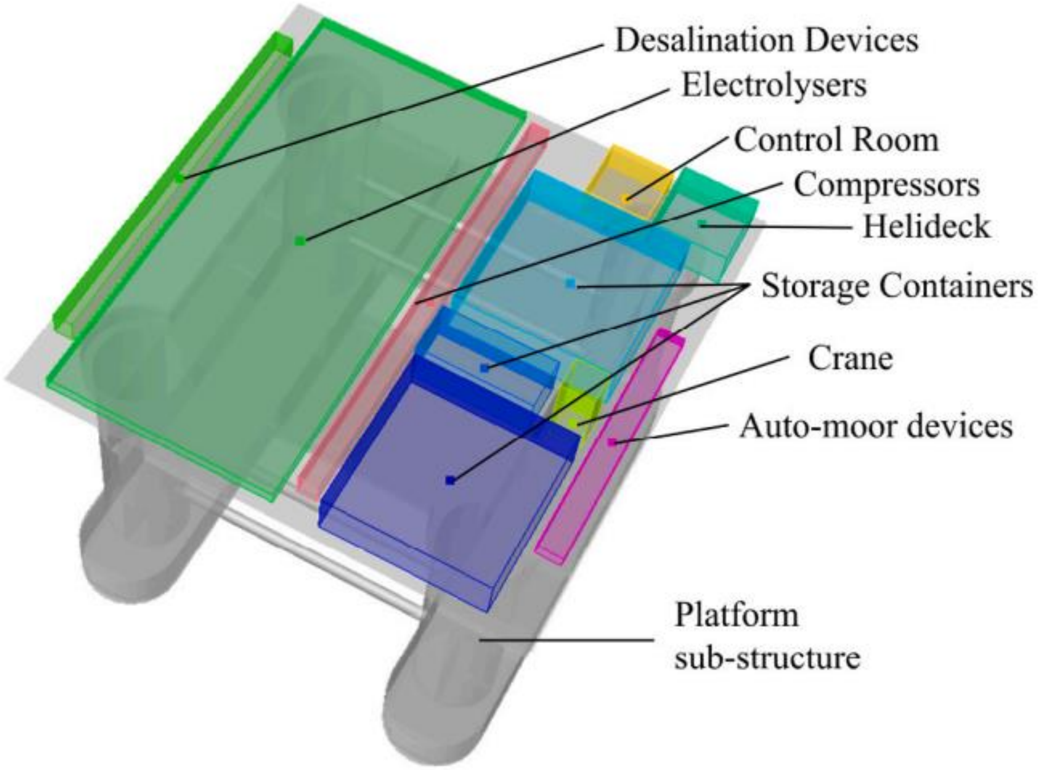
This paper was prepared for presentation at the SPE Europe Energy Conference and Exhibition held in Turin, Italy, 26 - 28 June 2024.

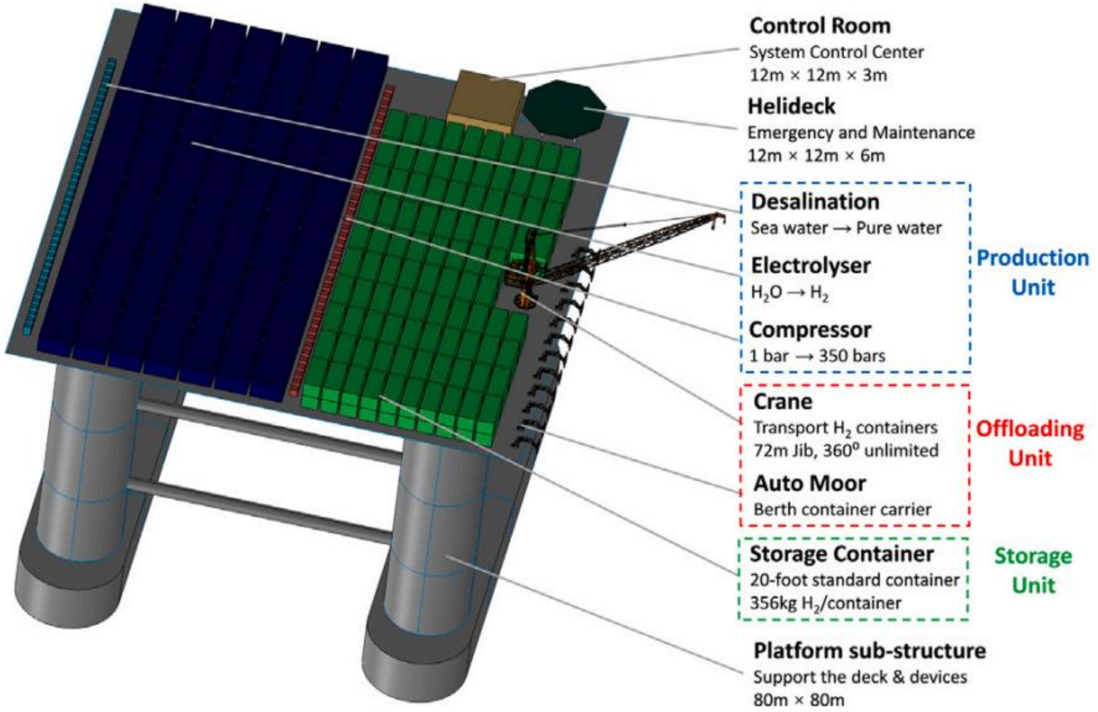
Abstract

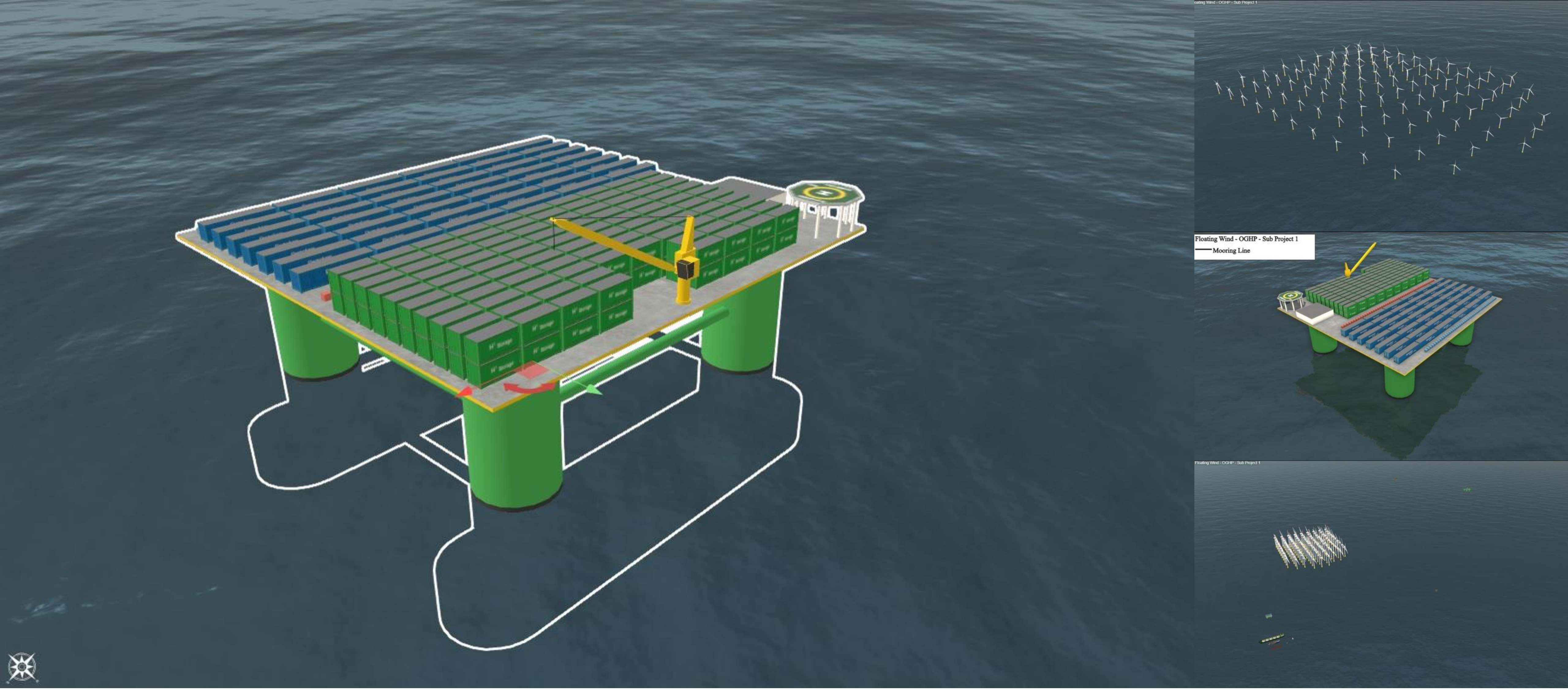
Over the next decade, 100 oil and gas platforms, 2,100 North Sea wells, and 7,500 km of pipeline on the UK Continental Shelf are forecast for decommissioning with costs estimated to be £59 billion by 2050. 10% of oil and gas expenditure in the UKCS went into decommissioning in 2021, and that figure rose to 14% in 2022 and is set to rise even further to 19% in 2031. The oil and gas industry aims to reduce these costs by repurposing some of the soon-to-be decommissioned assets for renewable energy generation. This paper presents the findings of a feasibility study conducted to identify opportunities and risks associated with repurposing an offshore oil and gas platform in the North Sea for green hydrogen production. Various technical scenarios were investigated for the case study platform and their profitability was determined using economic calculations. In addition, the results of the techno-economic models were compared with standard decommissioning costs for improved decision making and recommendation purposes. The results of the study highlight the importance of considering various factors such as transmission systems, platform repurposing costs, and long-term financial implications when evaluating the techno-economic viability of different scenarios for offshore hydrogen production. Despite the initial investment for repurposing being

Conference Paper

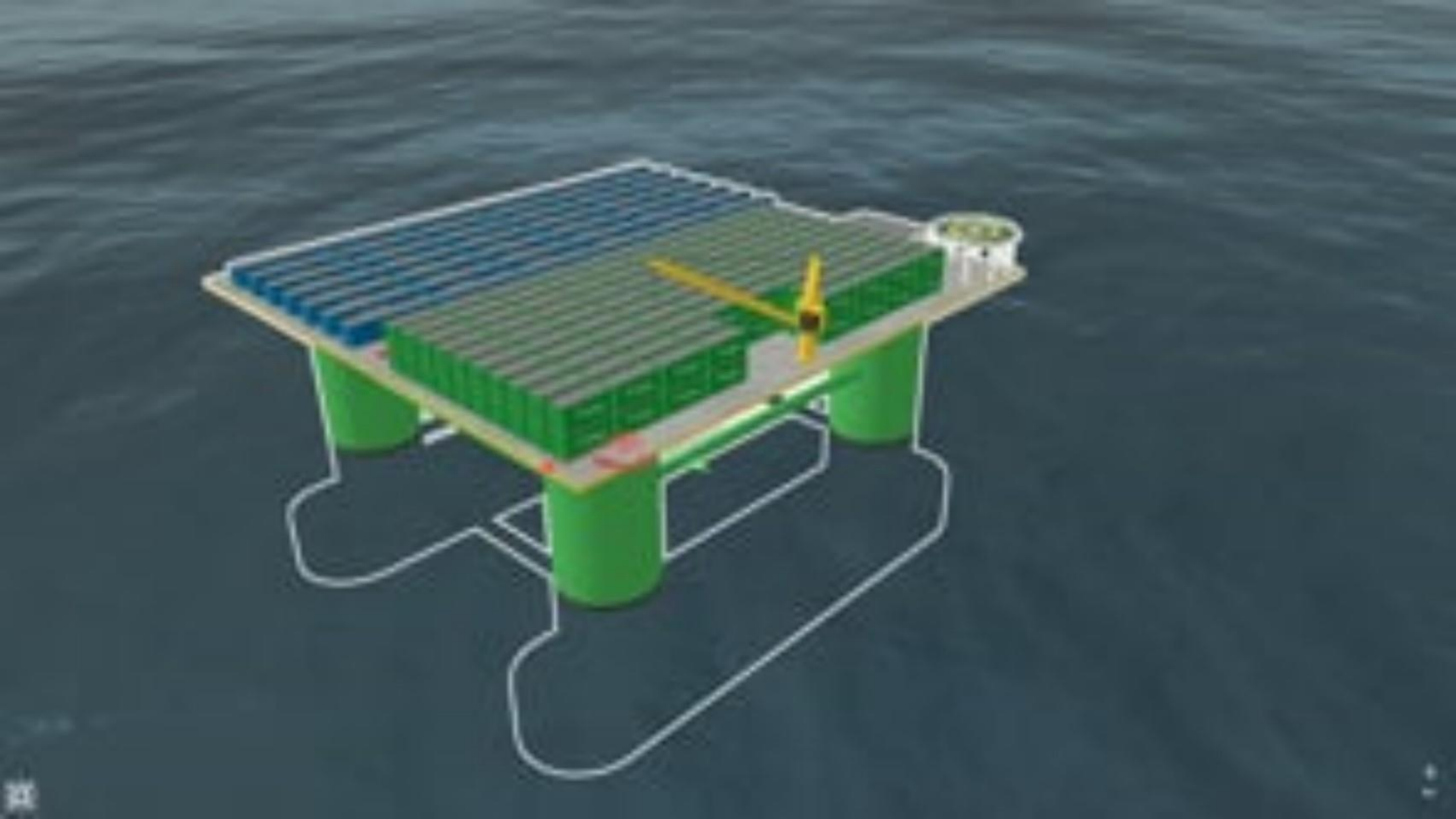
Conceptual Design - Centralised OGHP







Model of Conceptual OGHP Design



NEXT STEPS

- Implement further life extension studies.
- Assess the safety and reliability of offshore hydrogen production (i.e., advanced computational fluid dynamics and explosion risk analysis).
- Offshore cluster and infrastructure sharing (i.e., vertical stacking of electrolysers for platform space optimization).
- Investigate possibility of repurposing platform injection wells for CO_2 injection and sequestration.
- Visualization of various repurposing scenarios using the offshore marine simulator.

The National Decommissioning Centre

Innovation through Partnership

Net Zero Technology Centre

Technology Driving Transition

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Bringing academia and
industry together

Thank you

Any questions?