



CATAPULT
Offshore Renewable Energy

The Co-development of Wind and Hydrogen

A UK Perspective

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Introduction to the Offshore Renewable Energy Catapult

- A leading technology innovation and research centre for offshore renewable energy
- Research and innovation, testing and validation, analysis & insights, policy & strategy



[Levenmouth Demonstration Turbine](#)



[Testing & Validation - ORE \(catapult.org.uk\)](https://catapult.org.uk)

Trend setting developments in UK

- UK Government Ten Point Plan
 - Offshore wind and hydrogen are points 1 and 2
- ScotWind/Crown Estate Leasing Rounds
 - General problem of lots of new capacity with limited electrical network
- UK Hydrogen Strategy
 - Focus on low carbon hydrogen
- British Energy Security Strategy
 - Increases ambition for offshore wind and hydrogen
- Pilot projects on offshore green hydrogen production
 - ERM Dolphyn and Vattenfall Hydrogen Turbine 1
- First Hydrogen Business Model/Net Zero Hydrogen Fund Electrolytic Allocation Round
- Looks like offshore wind and hydrogen will be pillars of the UK's energy future



How can ORE Catapult enable this?

- Hydrogen is a big space – where does it overlap with ORE Catapult’s vision?
 - As a means of integrating offshore renewable energy into the wider energy system
 - Ambition to be a champion of green hydrogen
- Potential areas of focus:
- Detailed technical capability
 - How can electrolyzers be best integrated with wind turbines? Developed models to consider:
 - Maximising efficiency, response times, energy storage to balance power and demand, with ambitions for further work
 - What are the characteristics of cables compared to pipelines?
 - Ancillary services and advanced control
 - Testing and demonstration, building on Blyth facilities and Levenmouth Demonstration Turbine

How can ORE Catapult enable this?

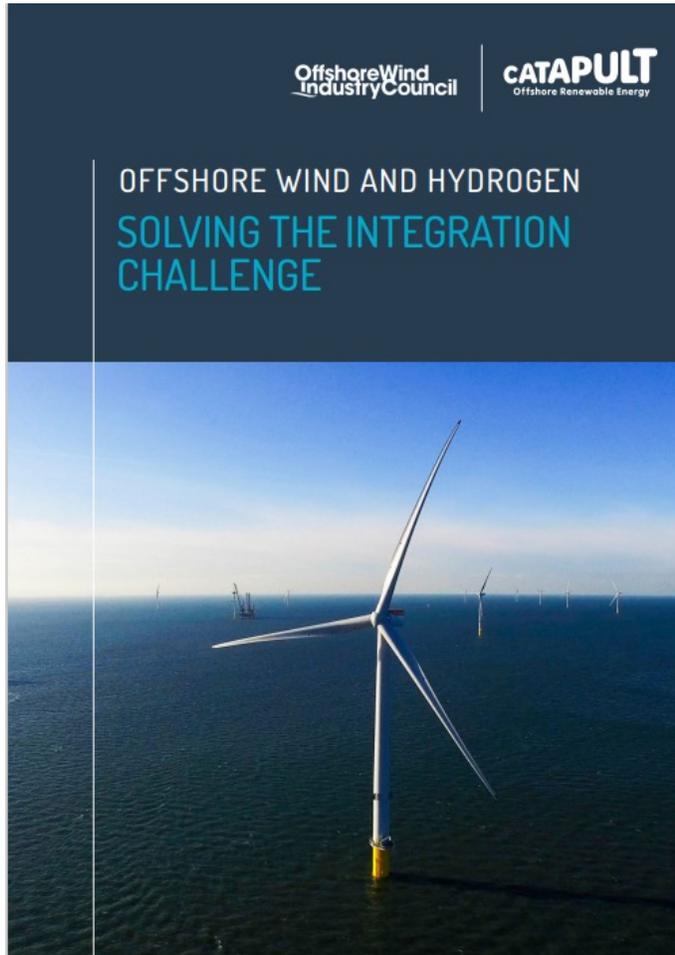
- Project economics and techno-economics
 - When does it make sense to include hydrogen in an offshore renewable energy project?
Cost per kg?
 - [Solving the Integration Challenge report](#)
- Energy systems
 - With lots of new wind farms coming online, which should be dedicated to hydrogen production?
- Policy
 - Inform key decision makers with analysis/information

Summary of Offshore Wind Hydrogen Projects



2020 Report on offshore wind and hydrogen

- Solving the Integration Challenge
- Cumulative GVA of £320 bn and 120,000 new jobs by 2050



KEY FINDINGS

OSW OPPORTUNITY



There is sufficient offshore wind for UK energy needs, plus substantial energy export exports; to exploit this the UK will need to coordinate infrastructure and markets, with neighbours in Europe.

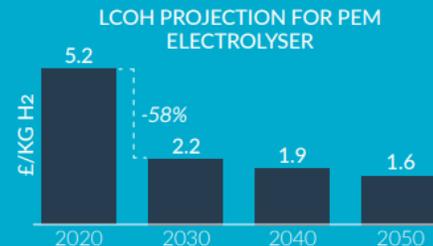
ENERGY SYSTEM

The UK energy system requires 130TWhr to over 200TWhr hydrogen in 2050, to integrate 75GW, or more of offshore wind.



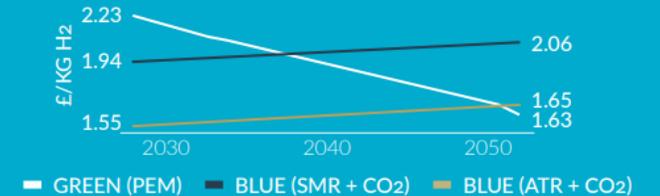
COST REDUCTION

Most of the cost reduction for green hydrogen from offshore wind occurs by 2030, by which point it can meet a significant part of energy demand.



GREEN AND BLUE HYDROGEN

Green hydrogen from offshore wind costs less than blue hydrogen by 2050*, although factors including more rapid adoption of electrolyzers, swings in natural gas prices, leakage of natural gas, or cheaper blue hydrogen generation technologies, could change this picture.



*Hydrogen production from natural gas with CCS might not be a necessary part of a net-zero UK energy economy in 2050.

Milford Haven: Energy Kingdom

- The project explored the potential of renewable electricity and hydrogen to meet future energy needs of a port with major existing hydrocarbon infrastructure



RWE Pembroke
Power Station
2200MW Combined
Cycle Gas Turbine

Valero Pembroke Refinery
270,000 bpd, 10.5m
barrels storage

Valero Pembrokeshire
Oil Terminal
8.7mb petroleum products
storage facility

Dragon LNG
Liquefied Natural
Gas terminal

South Hook LNG
Liquefied Natural
Gas Terminal

Puma
1.4m m3
storage facility

4,000 jobs (40% of total local employment around the Port)



Project partners

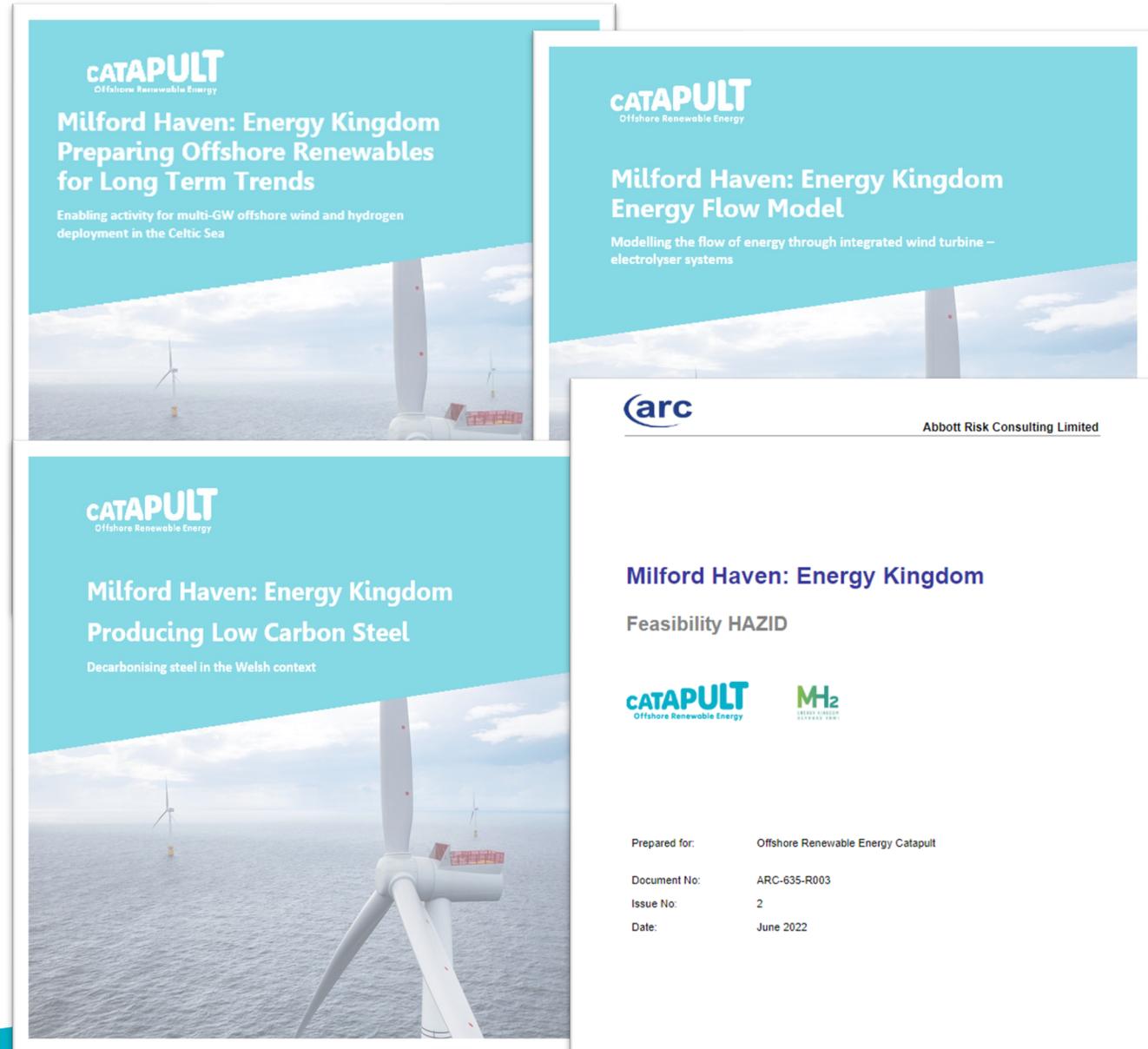


Electrolyser and refueller providers



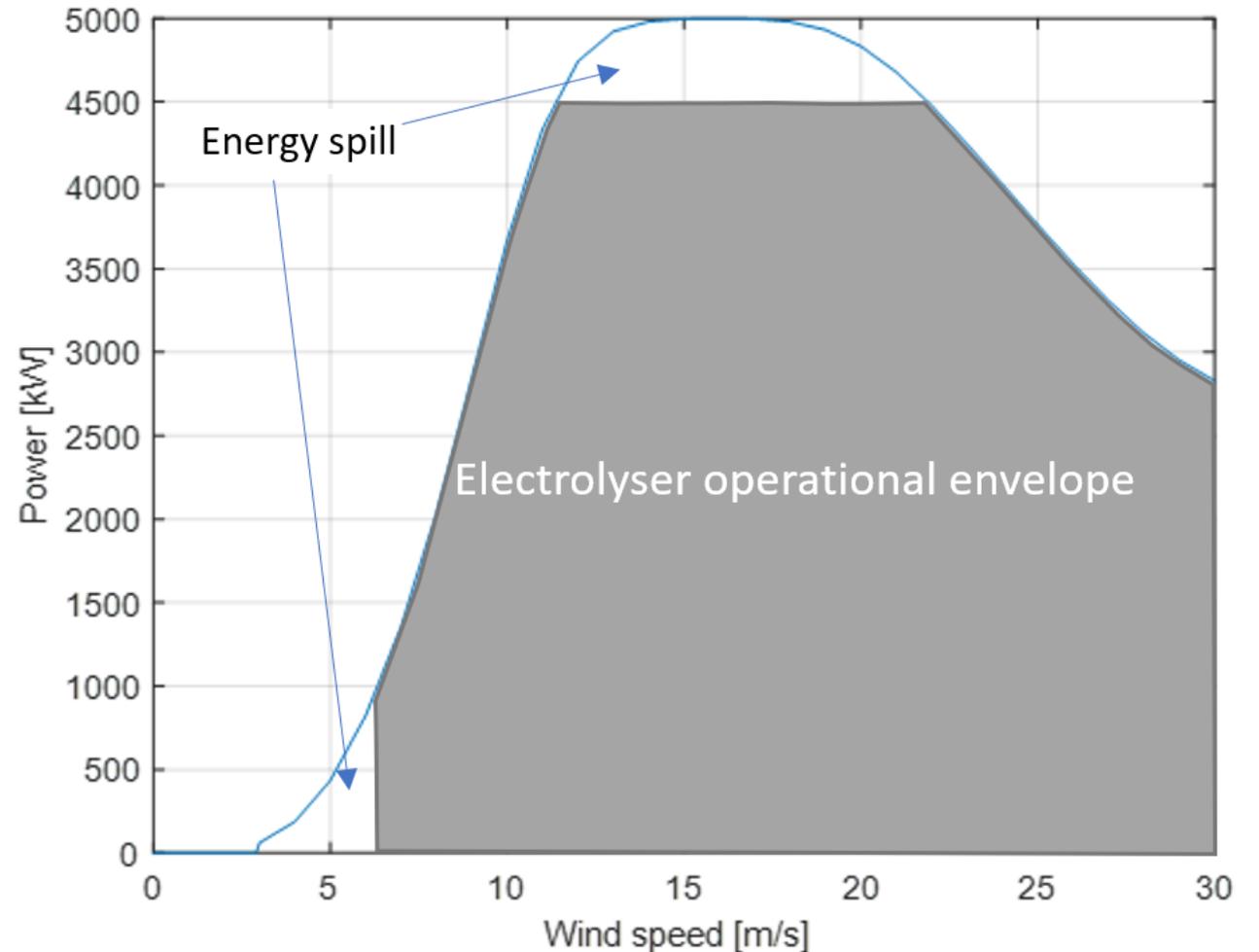
MH:EK - Preparing offshore renewables for long term trends

- ORE Catapult has produced a suite of 4 reports, which we aim to release soon
- Overarching report
 - Theme 1 – Technology development
 - Theme 2 – Energy system techno-economics including long term energy planning in Wales using our modelling tool
 - Theme 3 – Demonstration project proposals
 - Theme 4 – Considering Milford Haven in the context of a global green hydrogen market
- Modelling the flow of energy through integrated wind turbine – electrolyser systems
- Decarbonising steel production in Wales
- Identifying hazards of producing hydrogen from offshore wind



MH:EK Deep Dive: Energy spill

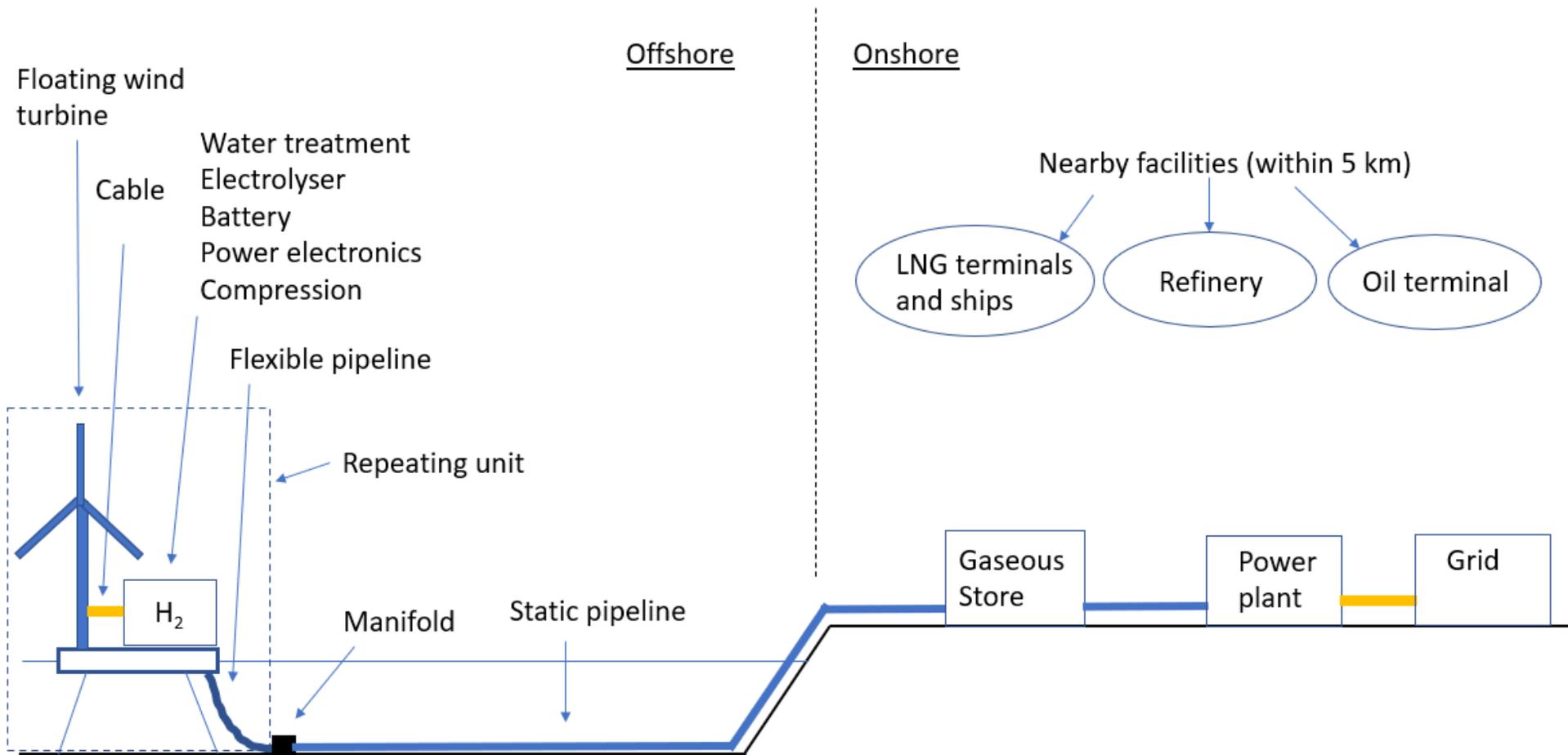
- The wind turbine may produce some power that the electrolyser cannot use
- Example – 5 MW wind turbine integrated with electrolyzer that has:
 - Capacity of only 4.5 MW, for economic reasons
 - Minimum load factor of 20% (0.9 MW), for safety reasons
- How much is spilled?
 - Between about 4 – 14%
- Could be it used to meet standby power losses?
 - Yes
- Also quantified storage capacity required



[Siemens Gamesa SG 5.0-132 - 5,00 MW - Wind turbine \(wind-turbine-models.com\)](http://wind-turbine-models.com)

MH:EK Deep Dive: Safety study

- What could go wrong?
- Three scenarios
 - Decentralised offshore electrolysis (below)
 - Centralised onshore electrolysis
 - Centralised offshore electrolysis, where hydrogen is shipped onshore



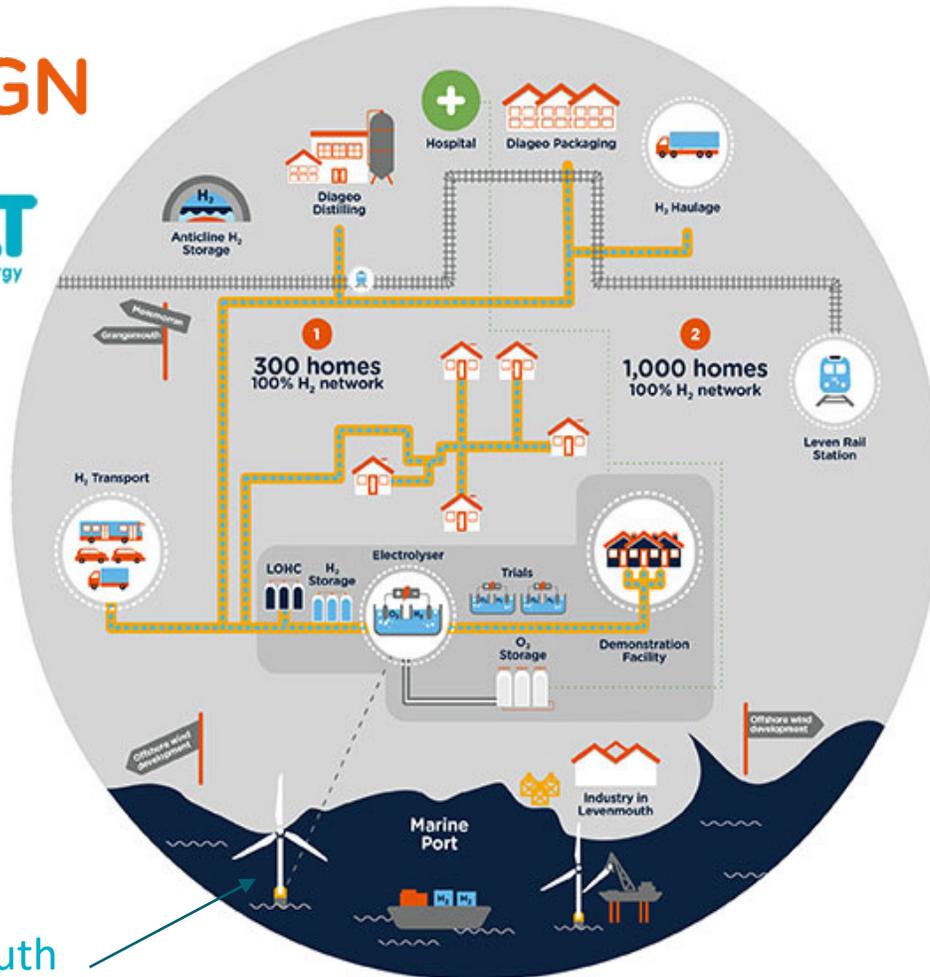
CLUE Project

- Contributing the use of our 7 MW demonstration turbine into demonstrating federated control of generation and demand, incorporating renewables, batteries and hydrogen across multiple sites.
- Ambitions to link this to MW scale hydrogen production through the H100 project.



H100 Fife Project

The first 100% H2 to homes, zero carbon network in the world.

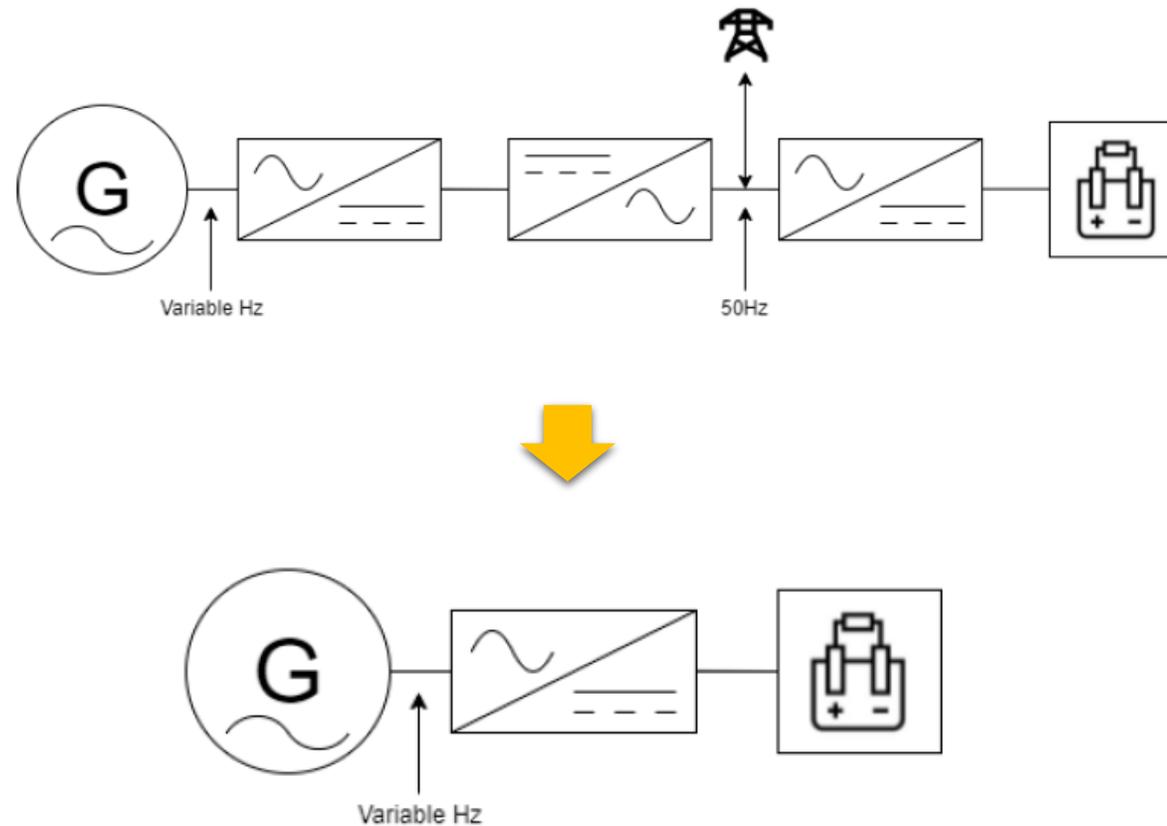


Levenmouth
Demonstration
Turbine (LDT);

Source: Scottish Gas Network (SGN) H100 Fife

- Development of a world-first 100% hydrogen gas network in Levenmouth that will **bring renewable hydrogen into homes** in 2022.
- Green Hydrogen **gas produced** from offshore wind using an electrolyser installed at **ORE Catapult's Levenmouth Demonstration Turbine**
- In the project's **first phase**, the network will connect around **300 local homes to hydrogen** and **second stage** would be a new network with around **1000/2000 homes**.
- Undertake studies that measure the technical, social and commercial performance of the hydrogen network

- Supporting manufacturer Dynex in a feasibility study for an optimised power converter for integrated wind turbine – electrolyser devices





GLASGOW

BLYTH

LEVENMOUTH

GRIMSBY

ABERDEEN

CHINA

LOWESTOFT

PEMBROKESHIRE

CORNWALL