Energy storage showcase
BEIS perspective

Matthew Billson

Matthew.billson@beis.gov.uk

Deputy Director, Energy Innovation Strategy & Portfolio, BEIS

Co-lead £1bn+ Net Zero Innovation Portfolio
(Nuclear, Renewables, Smart, Built)

Department for
Business, Energy
& Industrial Strategy

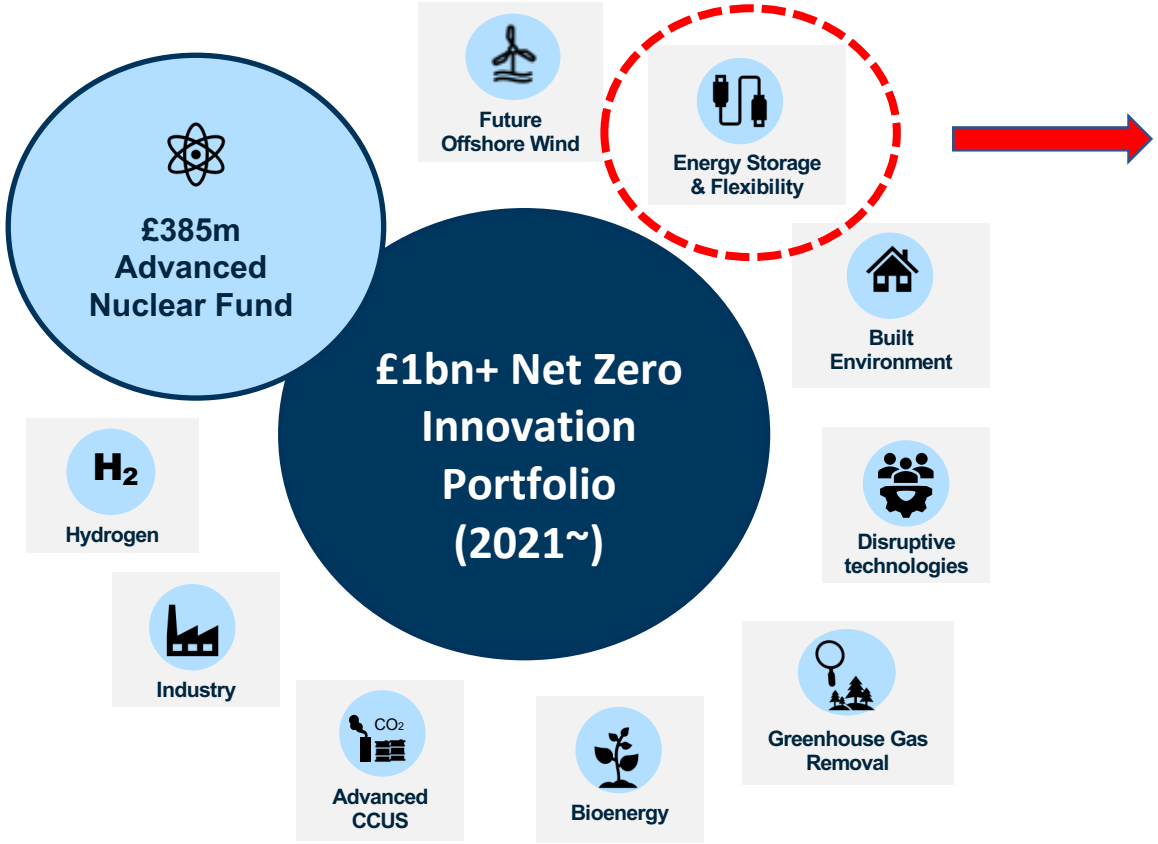
Context

2x – 3x

Market framework

Innovation support

£1bn+ BEIS Net Zero Innovation Portfolio (2021-25)



- **£68m Long Duration Energy Storage**
- **£65m Flexibility Innovation**
  - Vehicle-to-X
  - Automatic Asset Registration
  - Interoperable Demand Side Response

https://www.gov.uk/government/collections/net-zero-innovation-portfolio

Longer Duration Energy Storage and Storage at Scale Showcase:

Electricity Storage Policy Overview

Matt Aldridge
Head of Electricity Storage Policy
Department for Business, Energy & Industrial Strategy
HM Government

The transition to a smarter more flexible system…

Smart Systems and Flexibility Plan; Energy Digitalisation Strategy

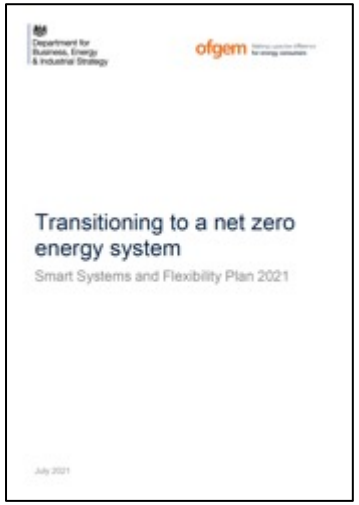
July 21

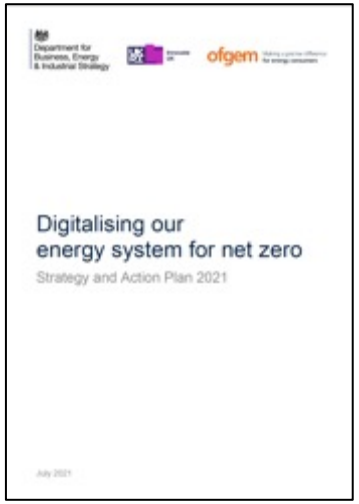
Net Zero Strategy

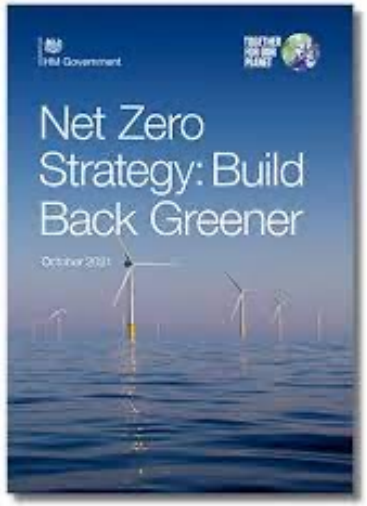
Nov 21

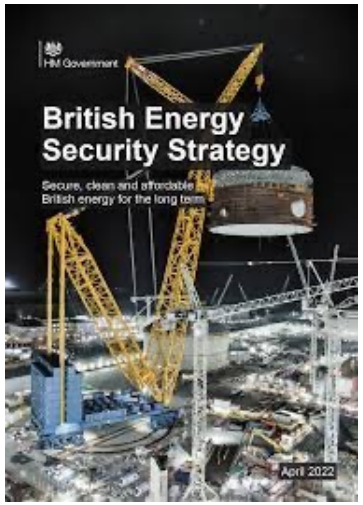
British Energy Security Strategy

Apr 22









Analysis: Low carbon flexibility is essential to meet net zero

We estimate that we will need around **30GW of low carbon flexible assets by 2030, which represents a three-fold increase on today's levels.**

By 2050, in our modelled scenarios, **around 30GW of combined short-term storage and flexible demand (DSR), and 27GW of interconnection could** .

- save up to **£10 billion per year by 2050** at 5g/kWh (high demand, no hydrogen scenario). by reducing the amount of generation and network needed to decarbonise
- reduce system costs between **£30-70bn from 2020 to 2050**.
- create up to **24,000 jobs**.

We assume around 15GW of storage (60GWh of storage capacity) and 15GW of DSR (but these are largely substitutable). We have **not explicitly modelled longer-duration storage**, or the role that flexibility could play in managing local network constraints. If these aspects were considered, it is likely that **additional flexibility** could lead to lower system costs.

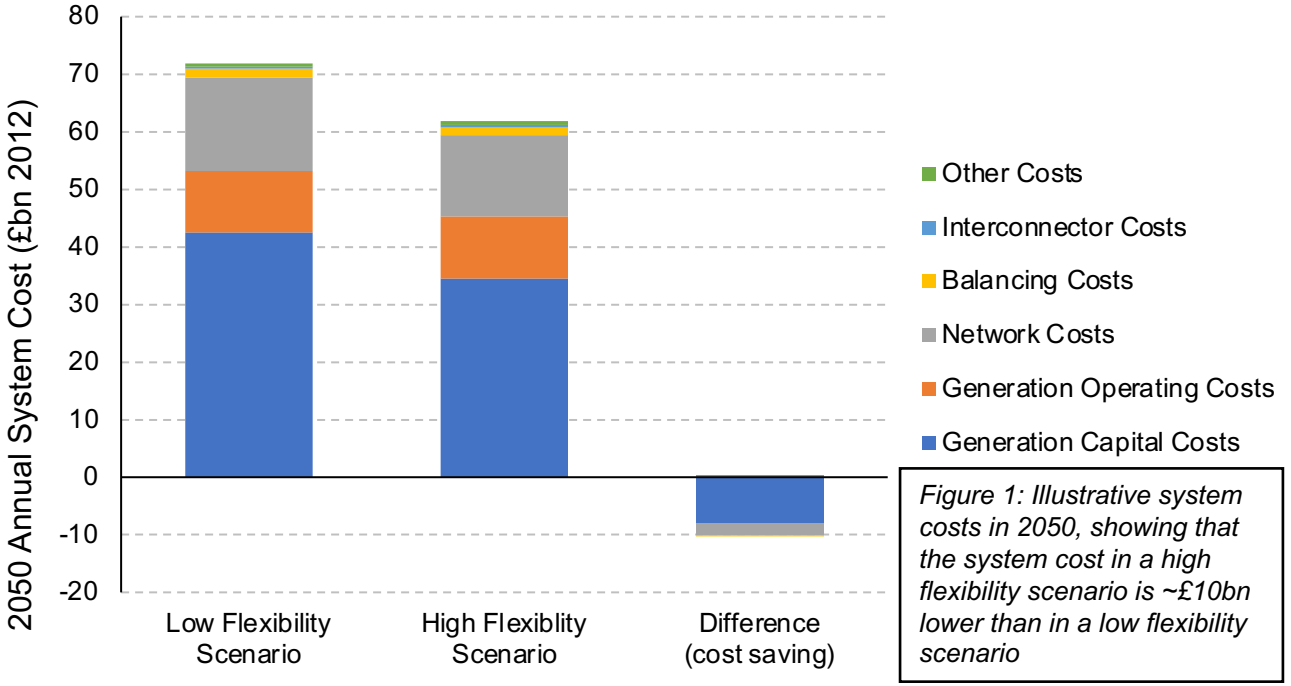


Figure 1: Illustrative system costs in 2050, showing that the system cost in a high flexibility scenario is ~£10bn lower than in a low flexibility scenario

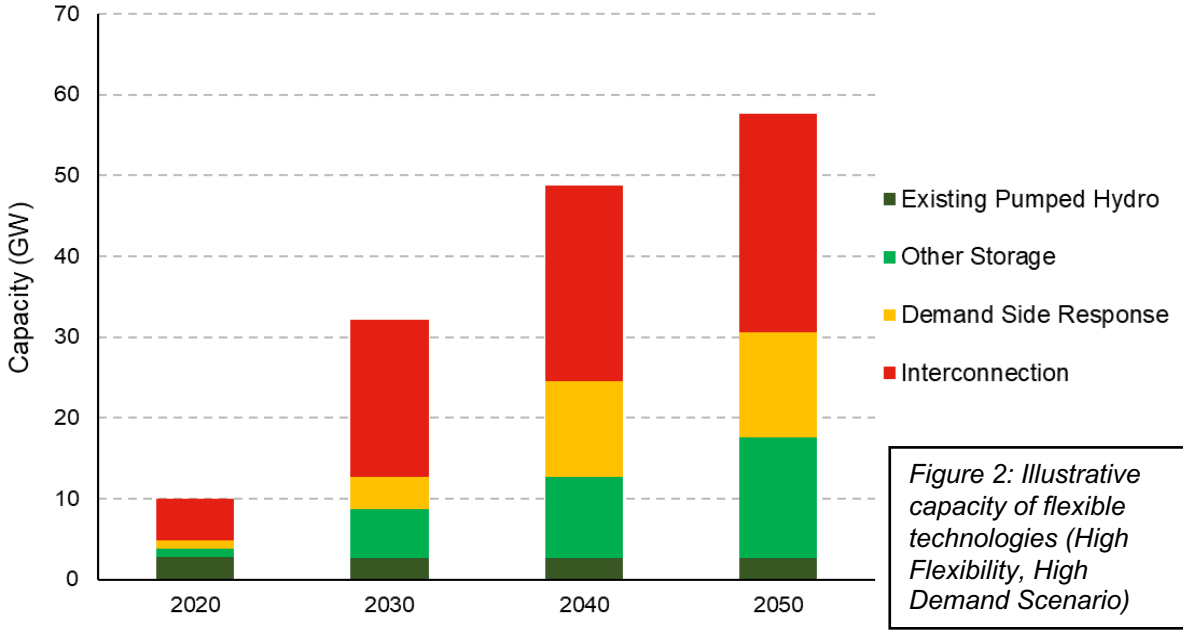


Figure 2: Illustrative capacity of flexible technologies (High Flexibility, High Demand Scenario)

Analysis: the role of flexibility in a net zero system

Updated analysis showing how much flexibility may be needed in a net zero system, and from what sources & technologies

Facilitating flexibility from consumers

Framework for driving participation and protecting consumers, through perspective of domestic, fuel poor, SME, I&C, local and public consumers. Support the deployment and uptake of smart, digital technologies. Regulatory approach to ensure cyber security and interoperability for smart appliances and flexibility providers. Includes enabling smart buildings and smart electric vehicles.

Removing barriers to flexibility on the grid

Identification and removal of specific regulatory barriers to smart technologies, including large-scale long-duration storage, domestic and small-scale storage. Includes interconnection policy to increase interconnector capacity, to enhance the role of interconnection as a flexibility asset internationally, and to ensure a consistent and scalable approach to interconnector operability.

Reforming markets to reward flexibility

Improving market design and coordination so that flexibility providers can secure revenues across multiple markets. Ensure flexibility is fairly rewarded, improve co-ordination and address carbon intensity of flexibility markets.

Digitalising the system

Set out joint strategic approach to digitalisation and opening up data across energy sector, to provide leadership and coordination, incentivise change, and develop innovative system-wide digital solutions and architecture.

Innovation, skills and monitoring

Set out how we will monitor how much flexibility is coming forward, assess whether this is in line with estimated system needs, and propose the indicators we'll use to know whether/how to adapt our approach.

Set out approach to innovation for both technologies and business models across each of the above smart systems themes

Policy and regulatory barriers

Delivering **Smart Plan actions and identifying additional barriers**

Continuing to deliver on Smart Systems and Flexibility Plan , we want to understand from stakeholders whether they are on track, how best these can be driven towards implementation and whether there are follow on actions?

- ❑ Planning guidance
- ❑ Definition of storage
- ❑ Business rates

- ❑ Connections
- ❑ Innovation

Facilitating the deployment of **domestic/small scale storage**

The 2021 Smart Plan have identified barriers to the deployment of storage at a domestic/small scale level.

- ❑ Health and Safety and asset registration
- ❑ Smart Export Guarantee
- ❑ Removal of final consumption levies
- ❑ VAT

Facilitating the deployment of **large-scale, longer-duration storage**

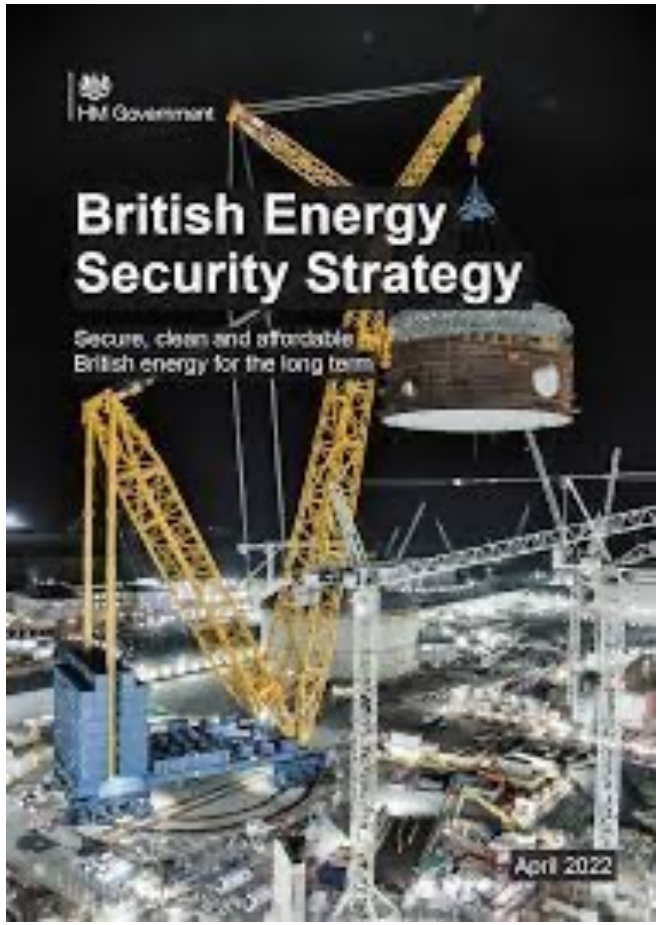
Stakeholders have identified that large-scale, longer duration storage may struggle to deploy due to high upfront costs.

- ❑ How challenges should be addressed in policy/regulatory frameworks
- ❑ Facilitating a level playing field
- ❑ Innovation needs for this type of storage

Long Duration Storage Policy

- ***'encouraging all forms of flexibility with sufficient large-scale, long-duration electricity storage to balance the overall system by developing appropriate policy to enable investment'***

- Call for Evidence
- Further analysis and energy system modelling
- Review of Electricity Market Arrangements (REMA), Capacity Market.



Glass Futures™

Glass Futures LoDES opportunities

with Aston Fuller, General Manager

THE GLOBAL CENTRE OF EXCELLENCE FOR GLASS
IN R&D, INNOVATION AND TRAINING

Glass As An Enabler

Construction

Pharmaceuticals

Defence and aerospace

Food and Drink

Optics and telecommunications

Power generation

Who We Are

We were built by the glass industry, for the glass industry to create the Global Centre of Excellence in St Helens, UK to make glass the low carbon material of choice.

Non-Profit, Membership Organisation

Research and Technology Organisation

Leading the global shift to sustainable manufacture

Glass Futures™

Our Mission

Support organizations Sustainability Journey

Demonstrate disruptive technologies

Generate new impactful ideas felt through the supply chain to the consumer

Our Vision

A sustainable future, enabled by glass.

Glass Futures Is Growing, Fast…

Guardian Glass
Siemens
eco Engineering Installations Ltd
Stoelzle Glass Group
NSG Group
Pilkington
Ardagh Group
University of Cambridge
University of Liverpool
Glass Technology Services
Experts in Glass
Stara Glass
encirc
The University Of Sheffield.
bormioli pharma
Estée Lauder
Diageo
Heineken
Rémy Cointreau
Sheffield Hallam University
RHI Magnesita
Pernod Ricard
University of Leeds
British Glass
SSRC Special Shapes Refractory Co.
Land Ametek Process & Analytical Instruments
Magma Combustion Engineering
vidrala
Calumite
良いものは、いつもガラスびん。 binkyo 日本ガラスびん協会
Society of Glass Technology
F.I.C. (UK) Limited

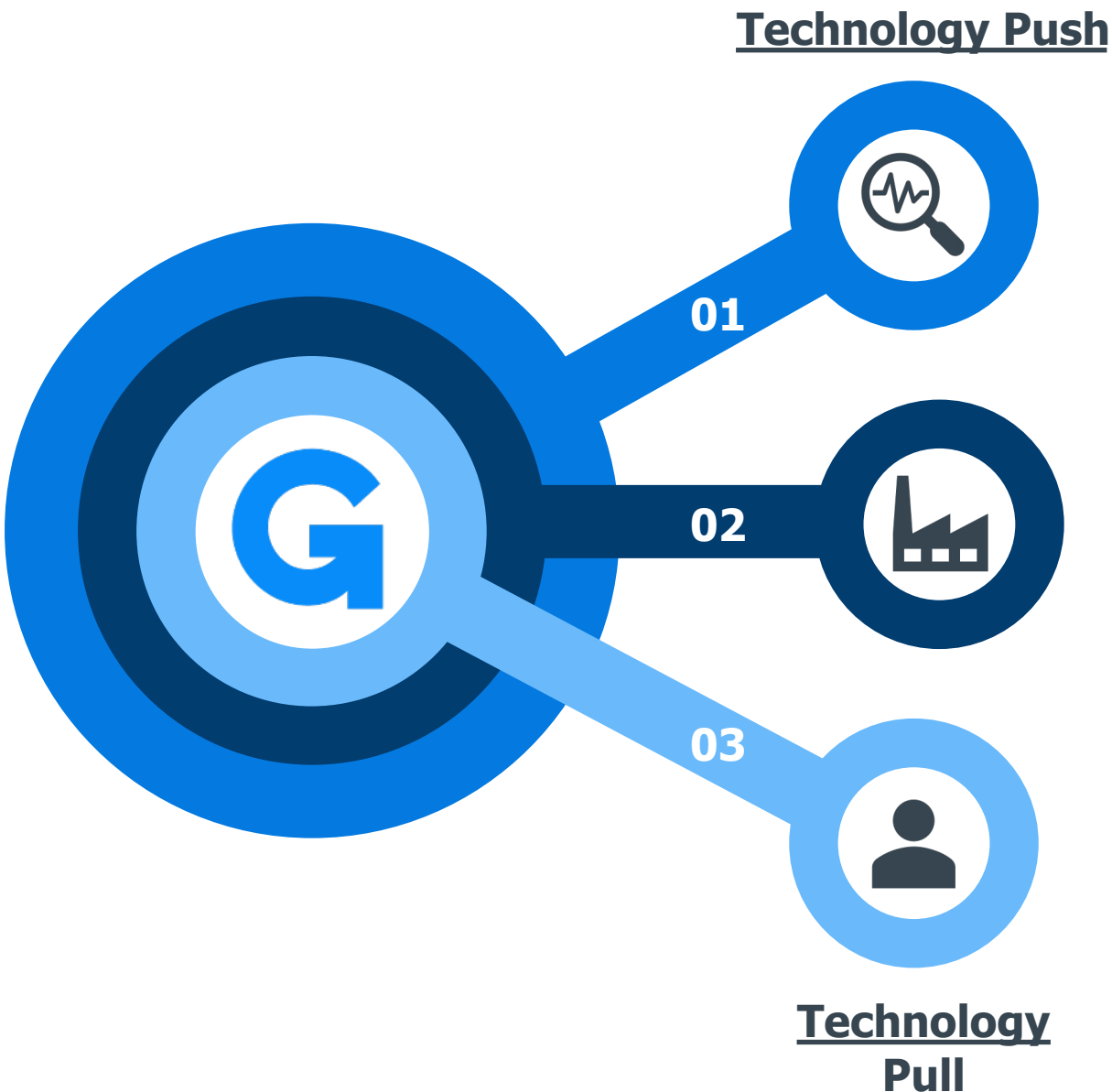
What We Do

Glass is **under threat** as a material. Whilst being **infinitely recyclable**, manufacturing is still **carbon intensive**. We need new solutions for **different regions across the world.**

"Insanity is doing the same thing over and over again and expecting different results"
Albert Einstein

Glass Futures™

Collaborating To Accelerate Global Change



01 Academia and Research Organisations

Provides industry with solutions but lacks resources to scale technology

02 Industry and Supply Chain

Shared costs and resources to speed up rate of development

03 End Users

Needs faster, more efficient route to success

Bridging The Technology Readiness Level (TRL) Gap

Technology Solution

- Fundamental research
- Solution focused
- Poor commercial awareness

Test and Development

- 24/7 20yrs+ commercial operations
- Risk Averse
- Solution support

Commercial Scale

- Market demand
- Requires full scale solutions
- Risk Averse

1 tonne p/d — **30 tonne p/d** — **100 tonne p/d**

1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9

Academia | **Major Technology Block** | **Industry**

Glass Futures

Key Technology Themes

Circular economy enablers – Driving towards very high recycled content, not just from cullet

Compositions and coatings. Demonstrating improved strength and radical light weighting

Smart packaging, Re-Use and new business models to market faster

Industry 4.0 implementation for efficiency, secure supply chains and more business intelligence

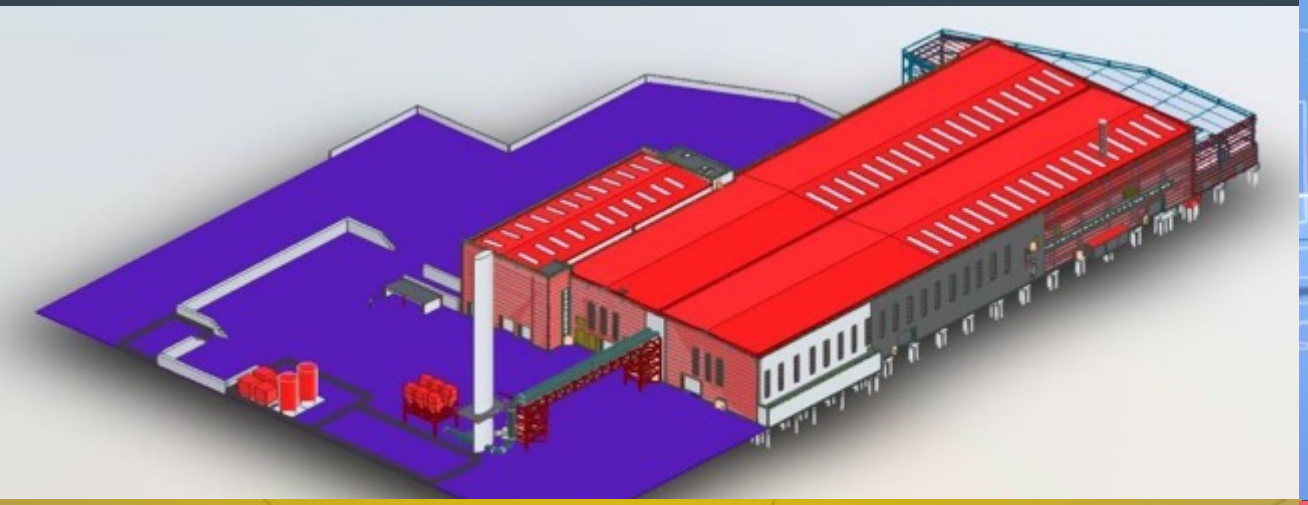
Heat recovery and carbon capture demonstrations to reduce industrial impact

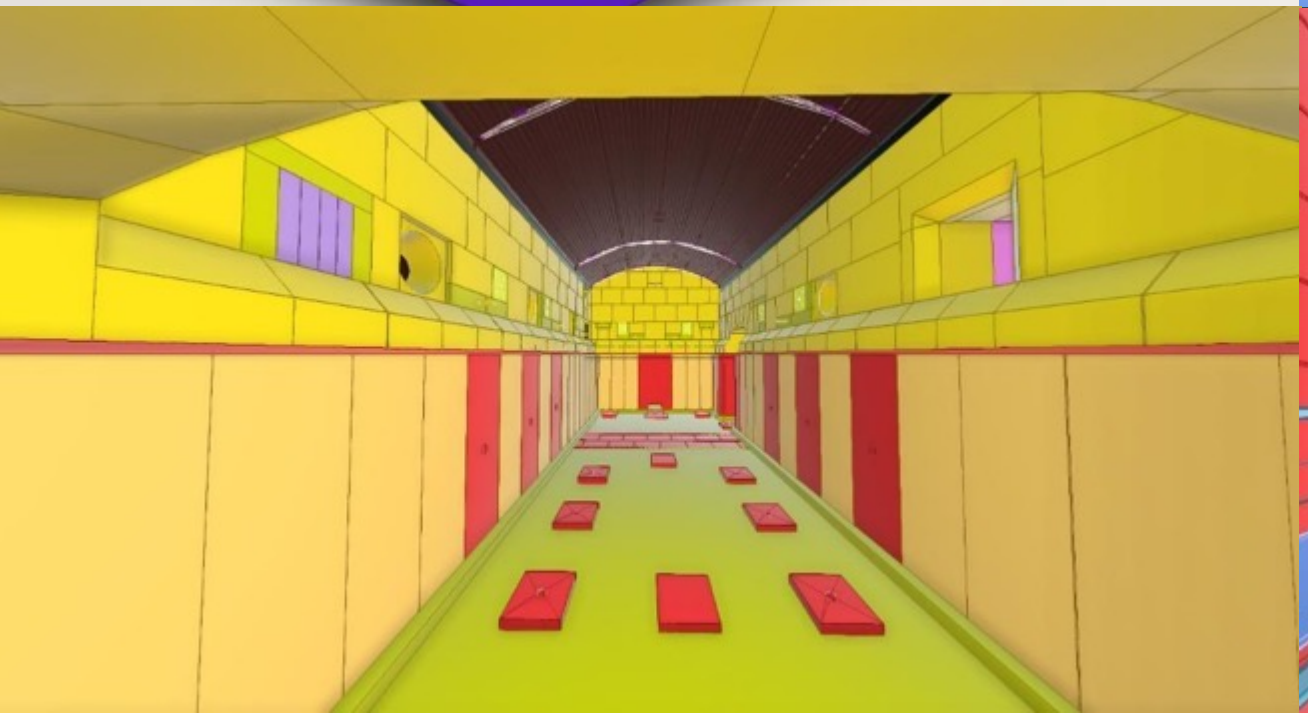
Low carbon fuels to drive low carbon manufacturing faster

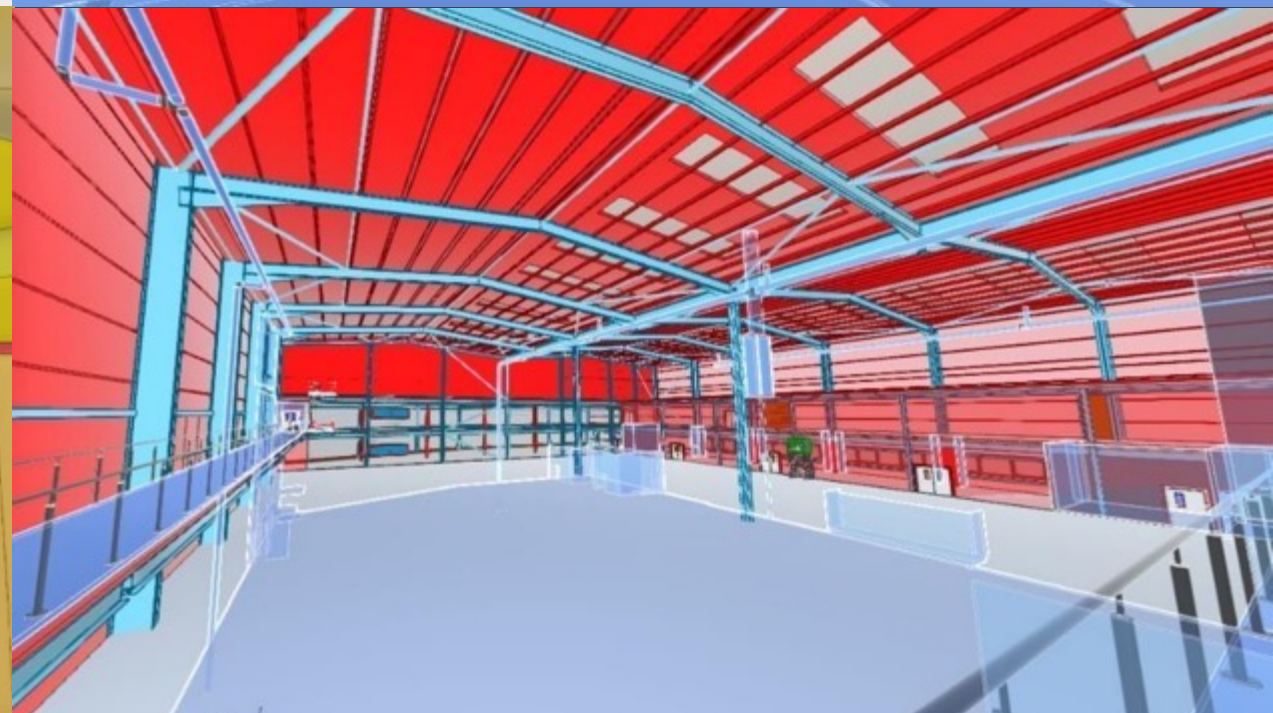
Pilot Facility: St Helens, UK

- 30T/day glass R&D capability
- Scope to develop new technologies
- Low-carbon fuels:
  - Natural Gas
  - Hydrogen
  - Electric
  - Bio-fuels
- Industrial grade waste heat
- Fluctuating site energy needs
- 400kW peak solar array
- Warehousing and logistics
  - Digital supply chain proving ground
- Highly skilled jobs and apprenticeships
- Construction has begun
- Due to be commissioned: 2023
- Fully online in Jan 2024

Facility 3D Model WIP 1







Pilot Facility: St Helens, UK

The Opportunity

Up-Scaling Technologies

- 3 week 100% Biofuel Trial on commercial manufacturing plants
- Study into converting a commercial glass plant from natural gas to hydrogen (H&S, economic, engineering)
- Computer modelling of fuel scenarios
- Proving R&D activities in real manufacturing plants

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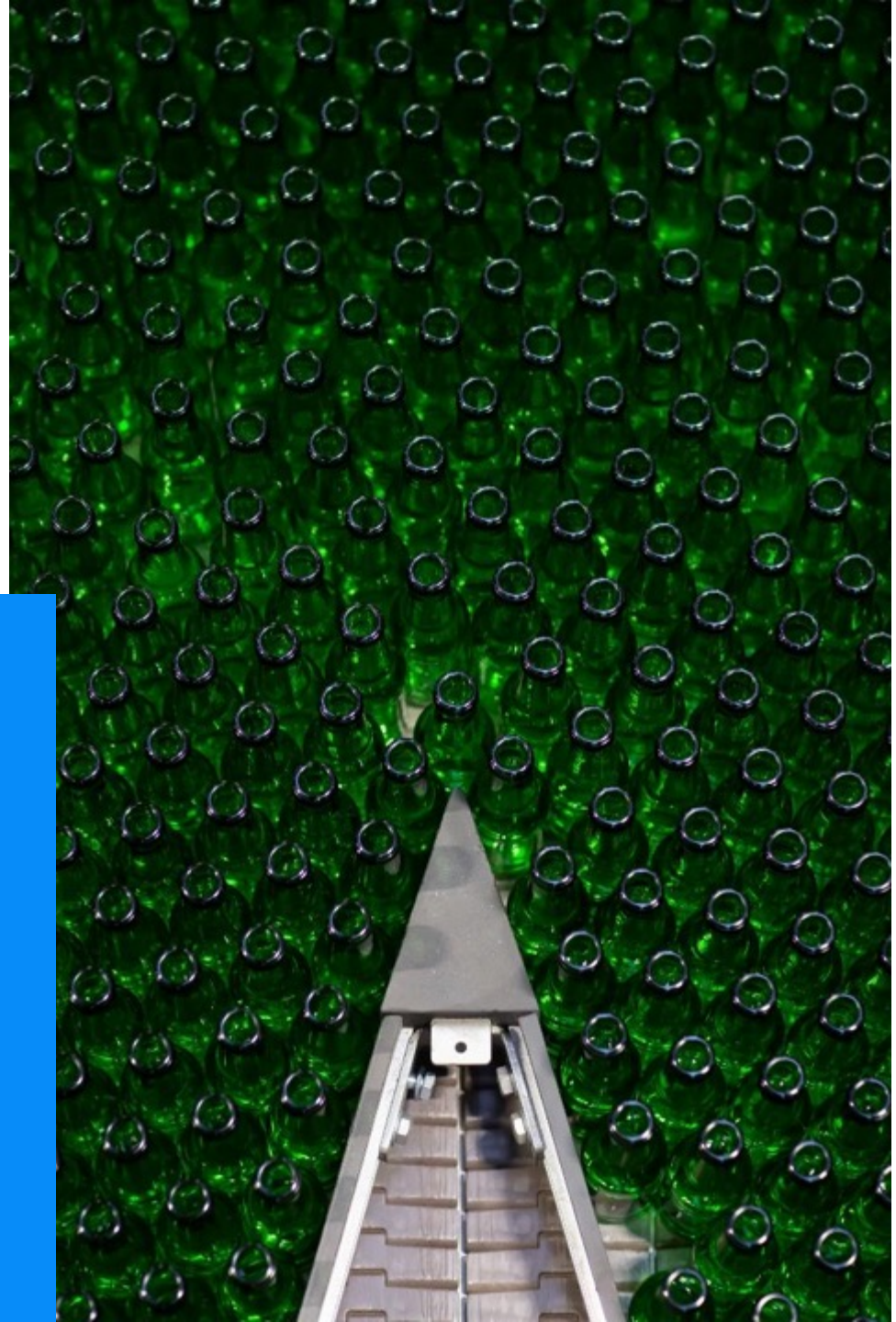
St Helens Recycling and Re-Use Project

A shared ambition to decarbonise the glass industry, to promote re-use and recycling, this project was developed across the Public and Private sector in St Helens, from discussions at COP26.

A variety of organisations have pledged to collaborate and pilot a range of approaches to:

- Raise public awareness
- Engage differently and drive behaviour change
- Demonstrate new technologies
- Showcase a circular waste economy
- Eliminate all forms of glass waste including domestic, commercial and flat glass

A collaborative re-use trial in St Helens is planned for Q3 2022, together with Major Brands, St Helens council, Liverpool City Region and British Glass



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Advancements in Melting Technology

Glass Futures will be working towards testing fuels and creating melting technology to reduce the CO2 footprint

- **Lab studies on combustion,** 2021
- **Encirc Derrylin**, 2021- Lowest CO2 bottle
- **NSG Low Carbon Float Glass Trials**, 2022
- **ECOLowNOx Trials**, 2022
- **BCC low carbon ceramics trials**, 2022

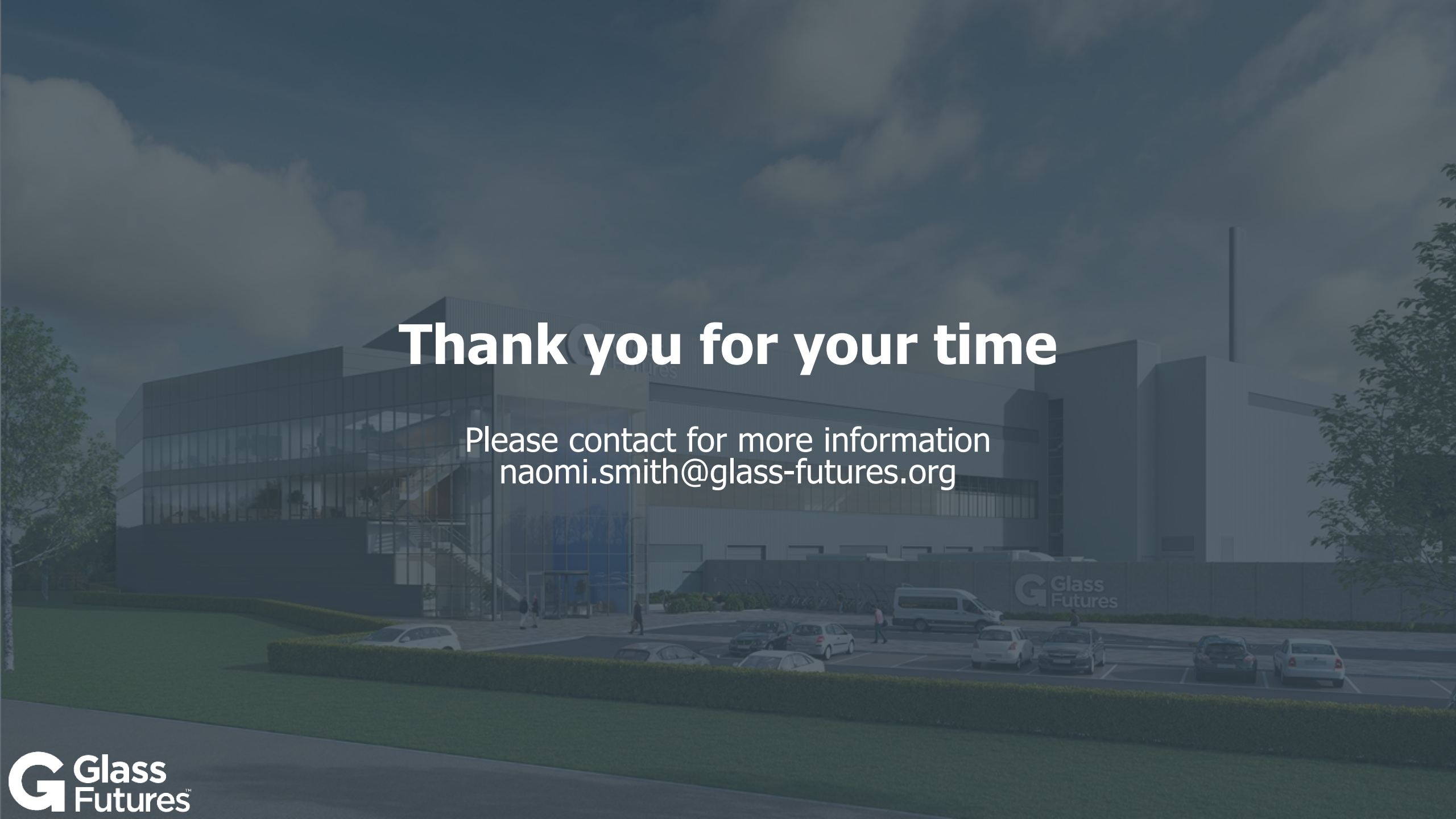
- CCUS WG, 2022

Under the CCUS working group, a research study will investigate the output of CO2 from Regenerative, Oxy-Fuel, Hybrid and all Electric furnaces.

Radical solutions to net zero

- The Centre of Excellence will have both batch plant and furnace melting available for experimentation and will be the ideal testing ground for achieving developments towards net zero
- It gives the opportunity to test energy use in a live production facility

Glass Futures



Thank you for your time

Please contact for more information
naomi.smith@glass-futures.org

Glass Futures™

Long Duration & Storage at Scale Showcase Pitches

13th July 2022

Department for Business, Energy & Industrial Strategy

UKRI Innovate UK KTN

Close to Commercialisation Project overviews

1.	Project Name: Cheshire Energy Storage Centre	Dean Comand
2.	Project name: GraviSTORE	Nigel Voaden
3.	Project Name: Vanadium Flow Battery Longer Duration Energy Asset Demonstrator	Thomas Johnston
4.	Project name: Long Duration Offshore Storage Bundle	Daniel Buhagiar
5.	Project Name: Ballylumford Power-to-X	David Surplus
6.	Whitelee Hydrogen Production & Storage Facility	Camila Blanco
7.	Highview Power, CRYOBattery	Mark Vyvyan-Robinson

Innovate UK KTN

Pitch 1

1

Innovate UK
KTN

StrataStore

CHESHIRE ENERGY STORAGE CENTRE

Department for Business, Energy & Industrial Strategy

HYDROSTOR

EDF

io consulting

Reliable, Safe, and **Affordable** long duration energy storage enabling Britain's sustainable net-zero future.

Project Overview

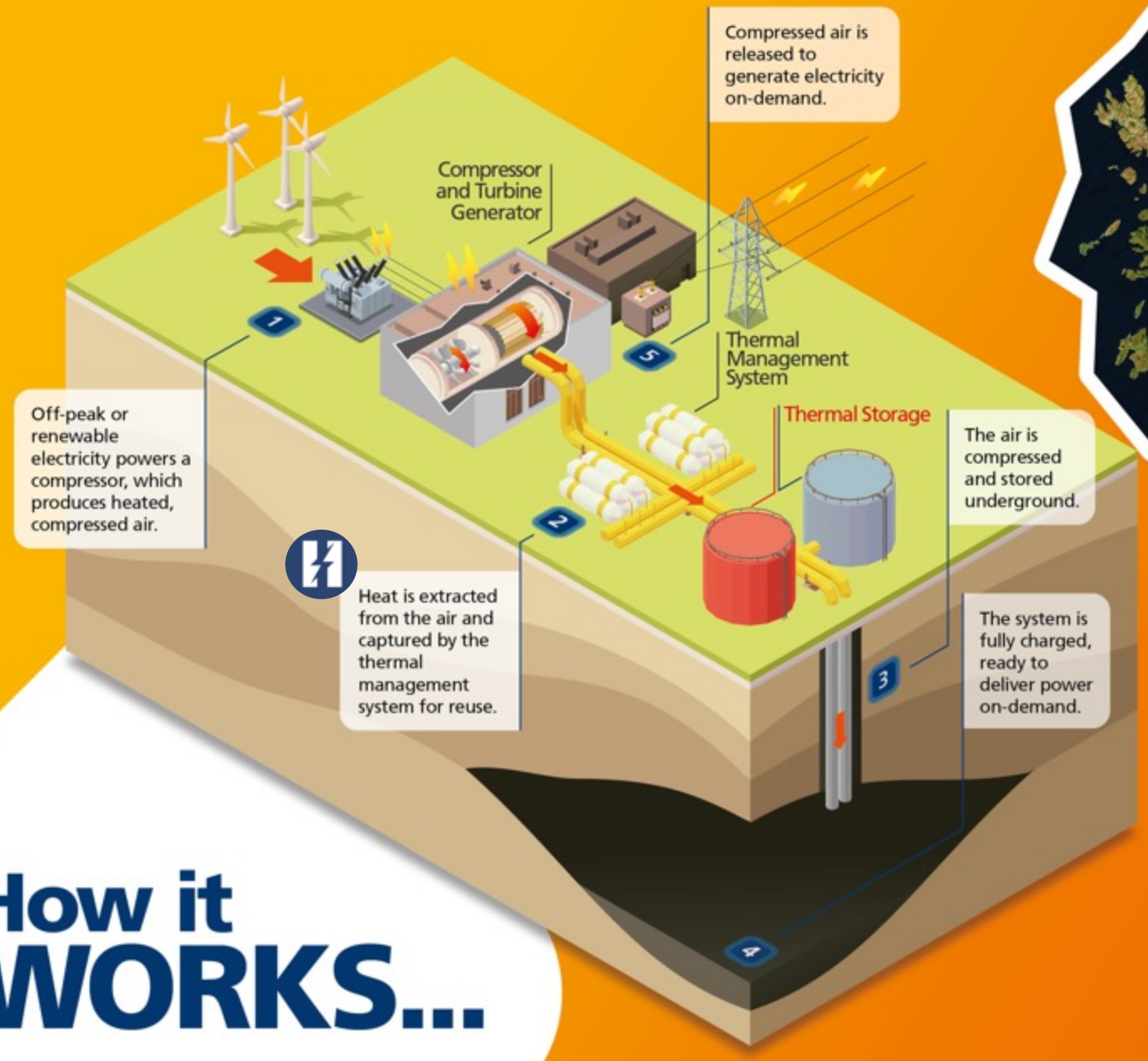
Advanced Compressed Air Energy Storage (A-CAES), Cheshire Energy Storage Centre

breakthrough for large-scale energy storage

- Low-cost & emissions-free long-duration energy storage
- Uses only water, pressurised air & standard equipment with proven supply chain
- Can be flexibly sited where the grid needs it
- Variable sizing capability

Advanced Compressed Air Energy Storage

- 5 MW - 40 MWhr storage pilot facility
- Option for 100 MW - 800 MWhr storage facility
- Adiabatic thermal storage facility
- Located at EDF's Hole House Facility, Cheshire
- Utilises existing salt caverns



How it WORKS...

Unique to Hydrostor's A-CAES technology

Technology Benefits

Advanced Compressed Air Energy Storage (A-CAES), Cheshire Energy Storage Centre

A-CAES solves numerous challenges in the global energy transition

Replace fossil fuel fired power plants clean solution to replace fossil-fuel base load and peaker plants

Renewables Integration bypass renewables intermittency and manage short term variability of power grid

Transmission & Distribution Deferral, deferral of electrical upgrades for distribution by reducing T&D peak demand needs

Grid Stability, synchronous technology compensates for reduced grid inertia

Baseload Renewables, supporting large corporate electricity consumers, such as data centres and mining companies

A-CAES uses only water, pressurised air & standard equipment

- Lowest Cost
- Patented Process
- Flexible Siting
- Successful Projects
- Emission Free
- Proven Technique
- Scalable Design
- Bankable

Project Status & Contact Information

Advanced Compressed Air Energy Storage (A-CAES), Cheshire Energy Storage Centre

Status:

- Project Development Progressing on Schedule & Budget
- Risk Management Identification & Mitigation Plans ongoing
- Supplier Engagement ongoing
- Commercialisation pathway & regulatory framework under review

Contact information:

- Project Title: **StrataStore**
- Contact name: Jim Isherwood
- Town/City: Cheshire
- Email: jim.isherwood@ioconsulting.com
- Phone: +44 20 3934 2396
- Website: ww.strata-store.com

Pitch 2

2

Innovate UK
KTN

GraviSTORE
Nigel Voaden
Edinburgh
nigel.voaden@gravitricity.com
www.gravitricity.com

Project Overview

- £912k BEIS, 40% partner match
- Industrial Systems and Control (ISC) partner
- Collaboration with Huisman (winches) and Careys (shaft sinking)

250KW demonstrator built at Leith Docks in 2021

Project Overview - Key dates

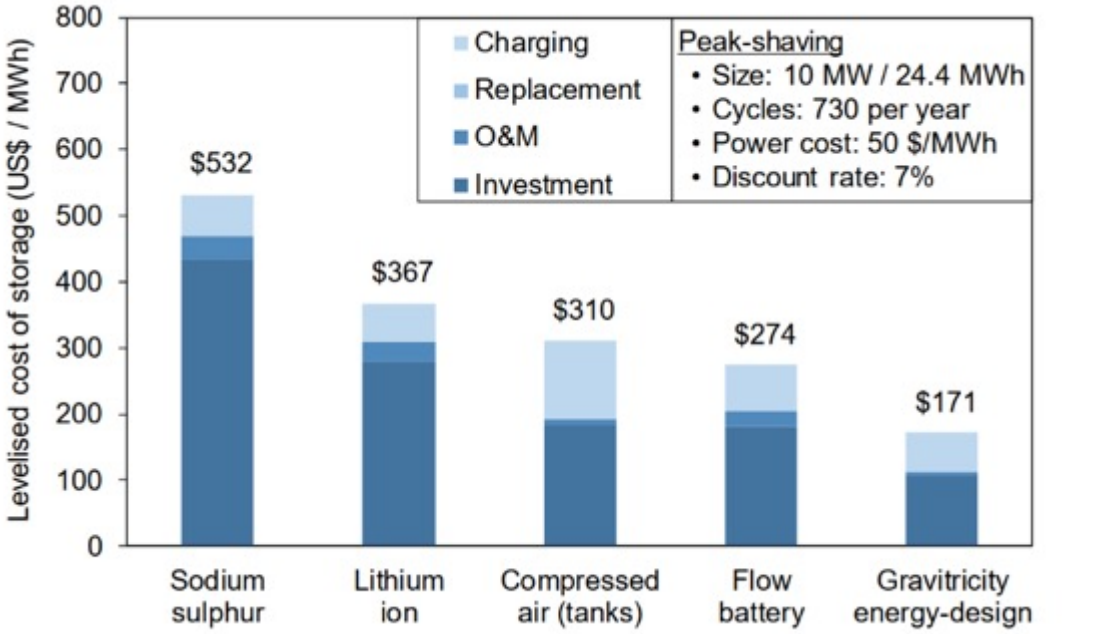
gravitricity

	Q1	Q2	Q3	Q4	Phase 2 – Q1
Technical	Scopes of works Basis of design	Initial simulation model Weights concept design	Civil Engineering FEED Control architecture and control strategy design	Lifting system FEED Final FEED report	Ground / site investigation Detailed design works
Commercial	Funding awarded Collaboration / commercial agreements	Knowledge dissemination Land lease discussions	Planning application submitted Grid connection agreement	Phase 2 application Financial close	Funding awarded EPC

Industry Challenge/requirement for project

Key results and highlights

Category	Feature / benefit	
Economics	• High efficiency, every year (no degradation) • Long life • No standing losses or parasitic loads	✓
Performance	• Rapid response (<1s) for lucrative fast response markets • Versatile energy / power ratio (15 mins – 8 hrs)	✓
Implementation	• Low embedded carbon footprint (no ore mining) • No explosive chemistry • Small footprint	✓



Ref: Report *Levelised Cost of Storage for energy-designed Gravitricity storage systems*, O Schmidt, **Imperial College. July 2019.**

Long-life, reliable, energy storage for Critical National grid support infrastructure

LCOS = (Capex (initial) + Capex (replacement) + O&M + Charging cost) / units generated; n.b. no end of life costs are included

gravitricity

Marketplace and opportunities

Behind the year-on-year growth, this progression through these 'Phases' will drive changes in market requirements

Key trends in global large scale energy storage market

Longer duration

- Increased renewable penetration will drive need for longer duration energy storage – average duration of 1.8 hours in 2013 has already grown to 3.3 hours
- Ancillary services … daily peak shaving … solar & storage for 24/7 power

Longevity of service

- Growing vision of storage as an infrastructure asset, with associated requirements for asset lifetime
- Short term opportunism vs. long term strategic

Higher cycling

- Storage increasingly used to balance fast changing, localised variations in supply & demand
- Fast changing = need high cycling

Value and opportunity will attach increasingly to flexibility services and technology solutions which can meet these evolving market needs

Pitch 3

3

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Department for Business, Energy & Industrial Strategy

INVINITY ENERGY SYSTEMS

VFB Longer-duration Energy Asset Demonstrator (VFB LEAD) /

EDF ENERGY

pivot power
EDF renewables

Thomas Johnston

connect@invinity.com

www.invinity.com

VFB LEAD - Project Overview

- Developing a new zero-carbon, flexible electricity generation archetype – enabling stable, secure, carbon-free electricity.

- Working with consortium partners Pivot Power (part of EDF Renewables) and EDF R&D, VFB LEAD aims to develop a 50MW PV-coupled hybrid energy storage site incorporating 10MW-40MWh Vanadium Flow Battery, delivered by the start of 2025

- Through BEIS funding, Invinity are progressing the design and manufacture its core VFB product, the VS3, from TRL 7 to TRL 9, opening up additional investment opportunities.

Invinity VFB Value Proposition

SAFER

Zero risk of thermal runaway
Exceptional personnel safety

HIGH THROUGHPUT APPLICATIONS

Ultra low capacity degradation allows no warranty limitation on cycles/day

LONGER LIFE

Suitable for 25+ years of constant cycling

PROVEN

Demonstrated performance in commercial applications

SUSTAINABLE MATERIALS

No conflict minerals
All components easily recyclable

FACTORY BUILT

Standardized product drives price down & quality up

THE RESULT: Energy storage superior to and complementary with lithium systems.

INVINITY ENERGY SYSTEMS

Invinity's Customers

UTILITIES & DEVELOPERS

- T&D cost deferral/avoidance
- Balancing & ancillary services
- Wholesale market trading

COMMERCIAL & INDUSTRIAL

- Energy cost reduction
- Carbon reduction
- Improved resiliency

OFF GRID & MICROGRID

- Secure 24/7 renewable power
- Fuel cost reduction
- Carbon emissions reduction

INVINITY ENERGY SYSTEMS

Pitch 4

4

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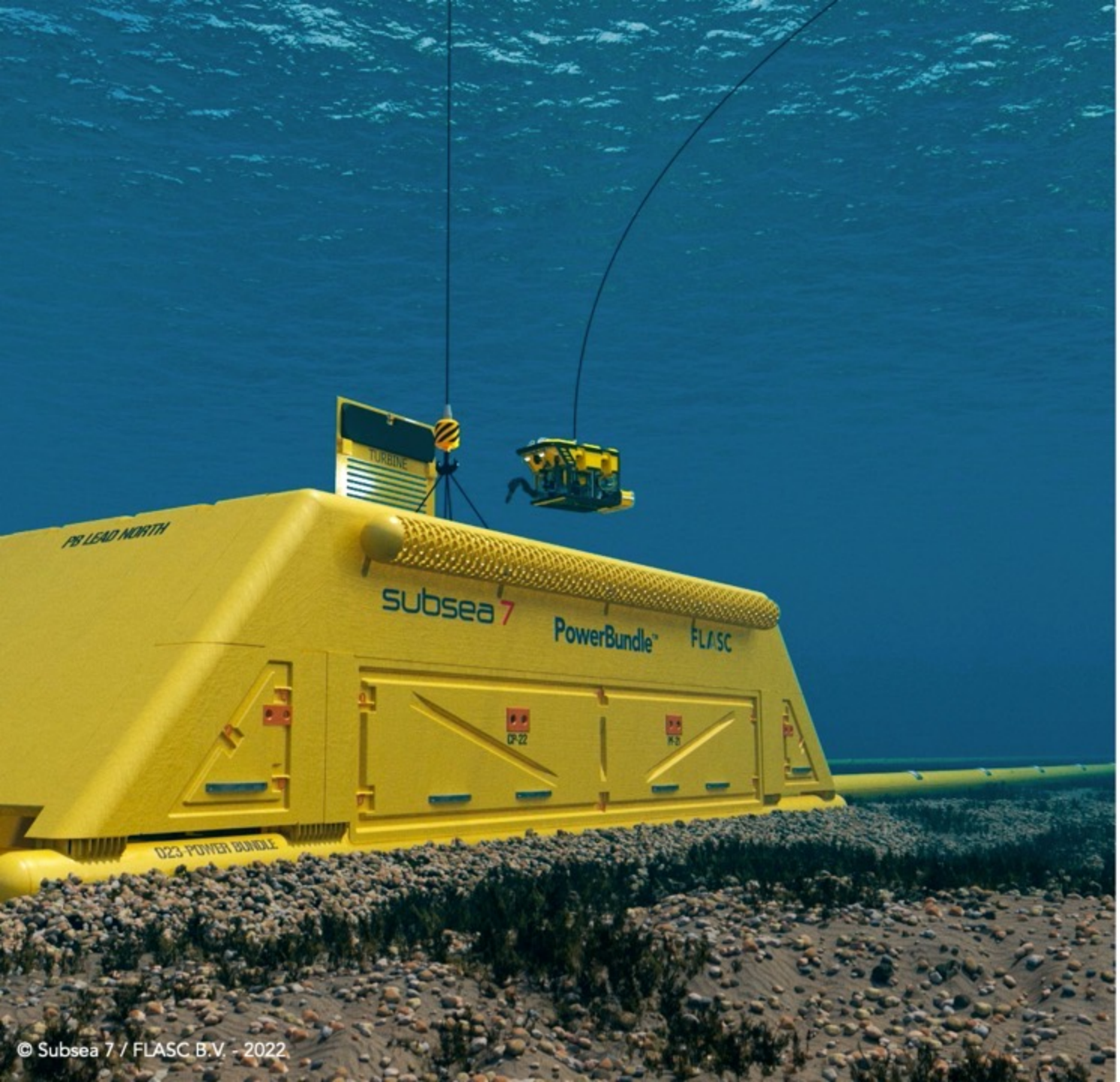

Department for Business, Energy & Industrial Strategy

subsea 7

FLASC
Renewable Energy Storage

Long Duration Offshore Storage Bundle

[Stream 1: Demonstration]

Subsea 7
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FLASC B.V.
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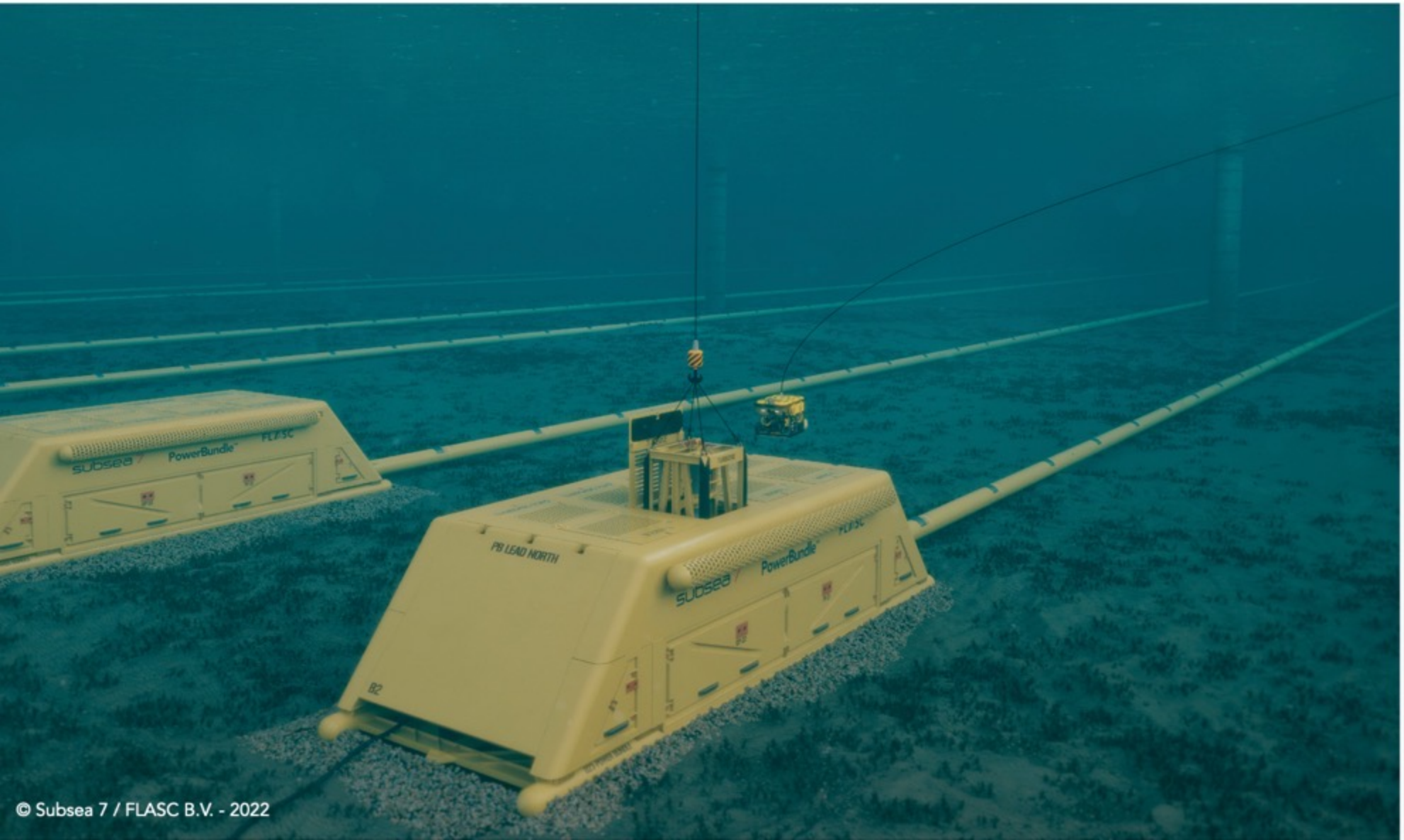
UK LODES Showcase Event
13-07-2022

The PowerBundle - Long-Duration Energy Storage for Offshore Applications

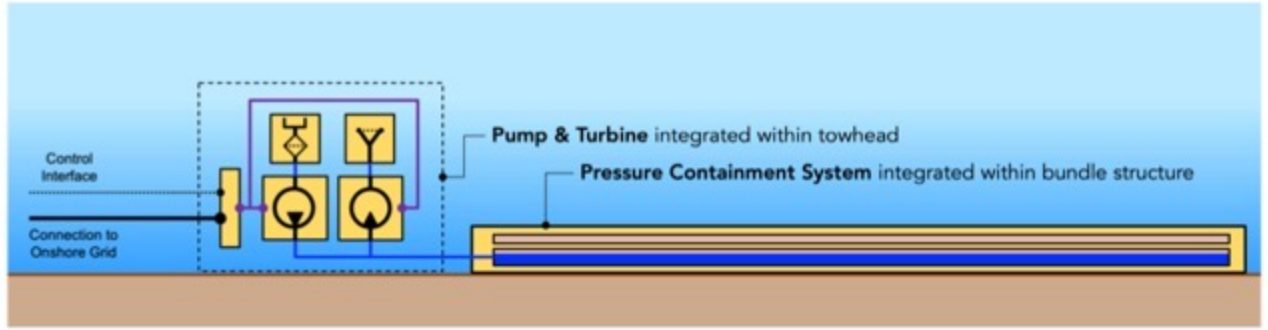


Applications:

- Large-Scale Offshore Wind
- Small-Islands & Sensitive Regions
- Offshore Green H_2 Production
- Decarbonisation of Oil & Gas
- Repurposing Offshore Pipelines

Project Overview

- Deploy a 1MWh PowerBundle demonstrator
- Stand-alone offshore system connected to onshore grid
- Validate technical and commercial viability



Subsea 7 and FLASC B.V., have been awarded a grant of **£471,760** from UK BEIS to execute Phase 1 (FEED & mobilisation) under Stream 1 of the Longer Duration Energy Storage (LODES) Competition.

Department for Business, Energy & Industrial Strategy

(image: Subsea 7)

Phase 1 Status (Q2 2022)

✓ Selected Offshore Deployment Site

✓ Preliminary Engineering Design

✓ Grid-Connection Feasibility

- Off-taker Agreements (in progress)

- Marine Permits & Consenting (in progress)

▸ **Seeking Strategic Partners and Investors for Phase 2**


(image: Subsea 7)


(image: Subsea 7)


(image: Subsea 7)

Pitch 5

5

Innovate UK
KTN

MANCHESTER CONFERENCE CENTRE

BALLYLUMFORD POWER 2 X

Department for Business, Energy & Industrial Strategy

Project Title: Ballylumford Power-to-X Project
Contact name: David Surplus OBE
Town/City: Larne, Northern Ireland
Email: d.surplus@b9energy.co.uk
Phone: 07545 696346
Website: info@ballylumfordp2x.co.uk

13th July 2022

B9 ENERGY B9 ENERGY STORAGE

mutualenergy

Islandmagee Energy

Net Zero Technology Centre
Technology Driving Transition

About Ballylumford Power-to-X Project

This internationally significant project seeks to create a full-cycle hydrogen economy, from production, storage and distribution through to usage.

BEIS Longer Duration Energy Storage Competition

Department for Business, Energy & Industrial Strategy

The project has been awarded £986,000 of funding through the BEIS Longer Duration Energy Storage Competition to carry out a 12 month FEED study in the Power-to-X category – it is the only project in the UK to be supported in this way.

The BEIS project co-ordinator has described the project as being "challenging but super- exciting" which acknowledges the powerful combination of solutions being developed for Northern Ireland's unique set of decarbonisation challenges.

Project Objectives

This Project sets out to:

1. Support NI economic and environmental ambitions of a net zero energy sector;
2. Deliver security of energy supply while facilitating the energy transition;
3. Position NI to become self sufficient and even a net exporter of hydrogen, subject to indigenous production costs;
4. Deliver a holistic 'end-to-end' green energy value chain;
5. Provide effective utilisation of otherwise curtailed and constrained renewable energy systems including GW scale offshore wind developments;

BALLYLUMFORD POWER 2 X

B9 ENERGY
B9 ENERGY STORAGE

DPS
DRILLING & PUMPING SUPPLIES

CLYDE SHANKS
Planning Development

mutualenergy

LONG O DONNELL ASSOCIATES LTD

kiwa

h21 Leeds City Gate

Netbeheer Nederland

OTTO SIMON

HyDeploy

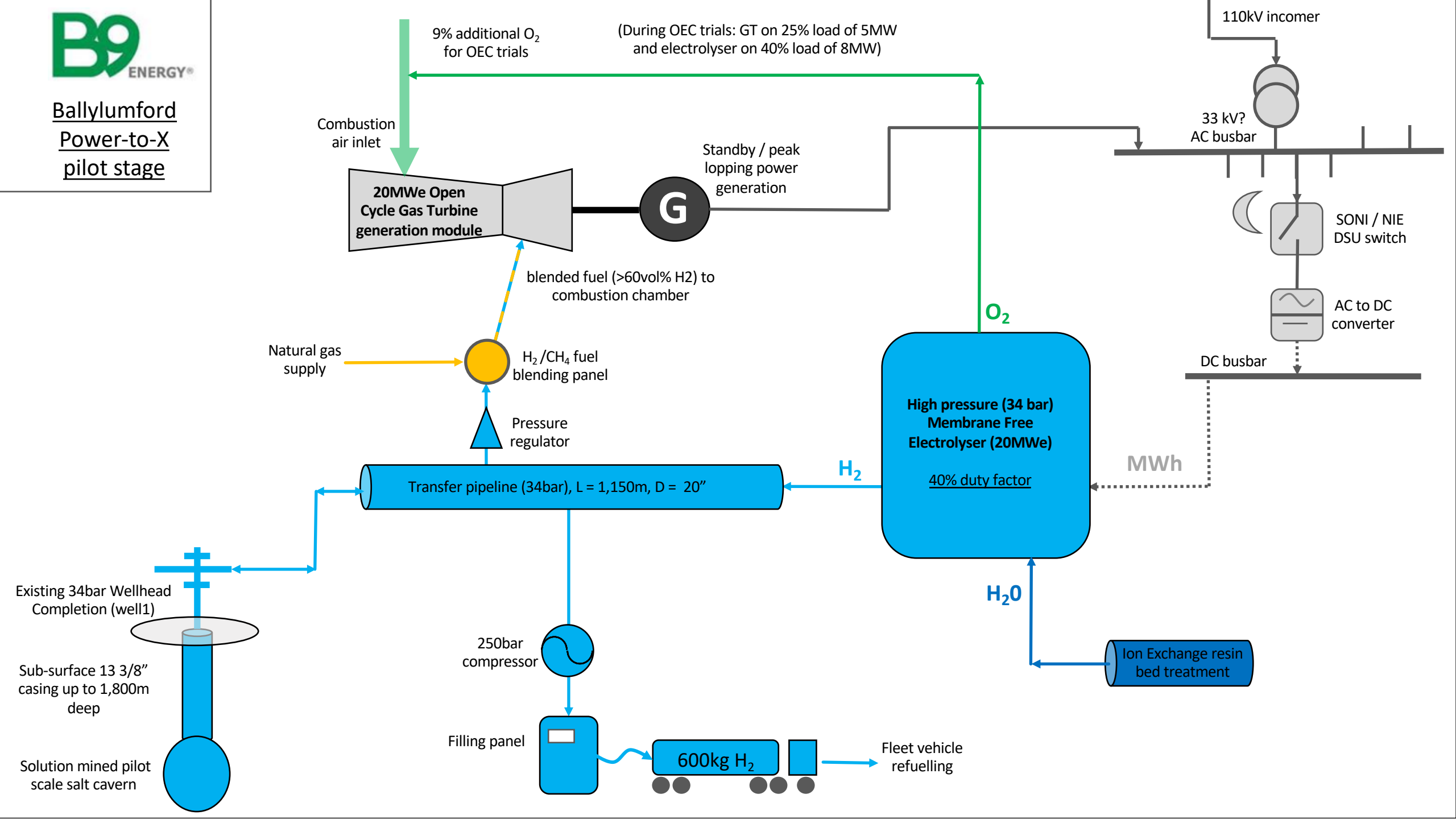
Islandmagee Energy

ATKINS
Member of the SNC-Lavalin Group

Net Zero Technology Centre
Technology Driving Transition

APOLLO

Morrow communications


B9 ENERGY
Ballylumford Power-to-X pilot stage
9% additional O_2 for OEC trials
(During OEC trials: GT on 25% load of 5MW and electrolyser on 40% load of 8MW)
110kV incomer
Combustion air inlet
33 kV? AC busbar
Standby / peak lopping power generation
20MWe Open Cycle Gas Turbine generation module
G
SONI / NIE DSU switch
blended fuel (>60vol% H2) to combustion chamber
AC to DC converter
O_2
Natural gas supply
H_2 /CH_4 fuel blending panel
DC busbar
Pressure regulator
High pressure (34 bar) Membrane Free Electrolyser (20MWe)
40% duty factor
MWh
H_2
Transfer pipeline (34bar), L = 1,150m, D = 20"
Existing 34bar Wellhead Completion (well1)
H_20
250bar compressor
Ion Exchange resin bed treatment
Sub-surface 13 3/8" casing up to 1,800m deep
Filling panel
600kg H_2
Fleet vehicle refuelling
Solution mined pilot scale salt cavern

Strategic Advisory Committee

This committee is comprised of:

Sector	Name	Job title	Organisation
Wind (onshore)	Steven Agnew	CEO	Renewables NI
Wind (Offshore)	Sam McCloskey	Director of Climate Resilience	Simply Blue
Power grid	Alan Campbell	Managing Director	System Operator for Northern Ireland
Gas distribution	Jonathan Martindale	Director of Business Development	Phoenix Natural Gas
Road Transport	Gordon Best	Regional Director	Mineral Products Association NI
Marine Transport	John Garner	Chairman	Lloyds Register Technical committee
Decarbonisation	Chris Goodall	CEO	Carbon Commentary
Government	John Green	Strategic Advisor	Strategic Investment Board

MANCHESTER CONFERENCE CENTRE

BALLYLUMFORD POWER 2 X

Department for Business, Energy & Industrial Strategy

Opportunities for furthering the project:

- **Existing consortium agreement to be expanded to include gas turbine owner/operator role.**
- **Match funding partner for B9 Energy is being sought.**
- **Funding partners for £10m phase 2 grant application will be needed.**
- **Owners of hydrogen gas whilst in longer duration storage will be needed, and**
- **Additional diversified hydrogen off-takers in the mobility sector will be welcomed.**

d.surplus@b9energy.co.uk

B9 ENERGY B9 ENERGY STORAGE

mutualenergy

Islandmagee Energy

Net Zero Technology Centre
Technology Driving Transition

Pitch 6

6

Innovate UK
KTN

Department for Business, Energy & Industrial Strategy

SCOTTISHPOWER

ITM POWER

Whitelee

13 July 2022

Camila Blanco, Project Manager

Sheffield, UK

cblanco@itm-power.com

+44 (0) 7999028234

www.itm-power.com

WHITELEE | PROJECT OVERVIEW

SCOTTISHPOWER

ITM POWER
Energy Storage | Clean Fuel

Storage at Scale £9.4M

Whitelee Wind Farm

10 MW PEM 2.5 - 4 tonnes

Low carbon fuel

200MWh

Enablement of system flexibility for the grid

Timeline

2022

Q2

Q3 - ELY Design Finalised

- FID

Q4

2023

Q1

Q2 - ELY delivered

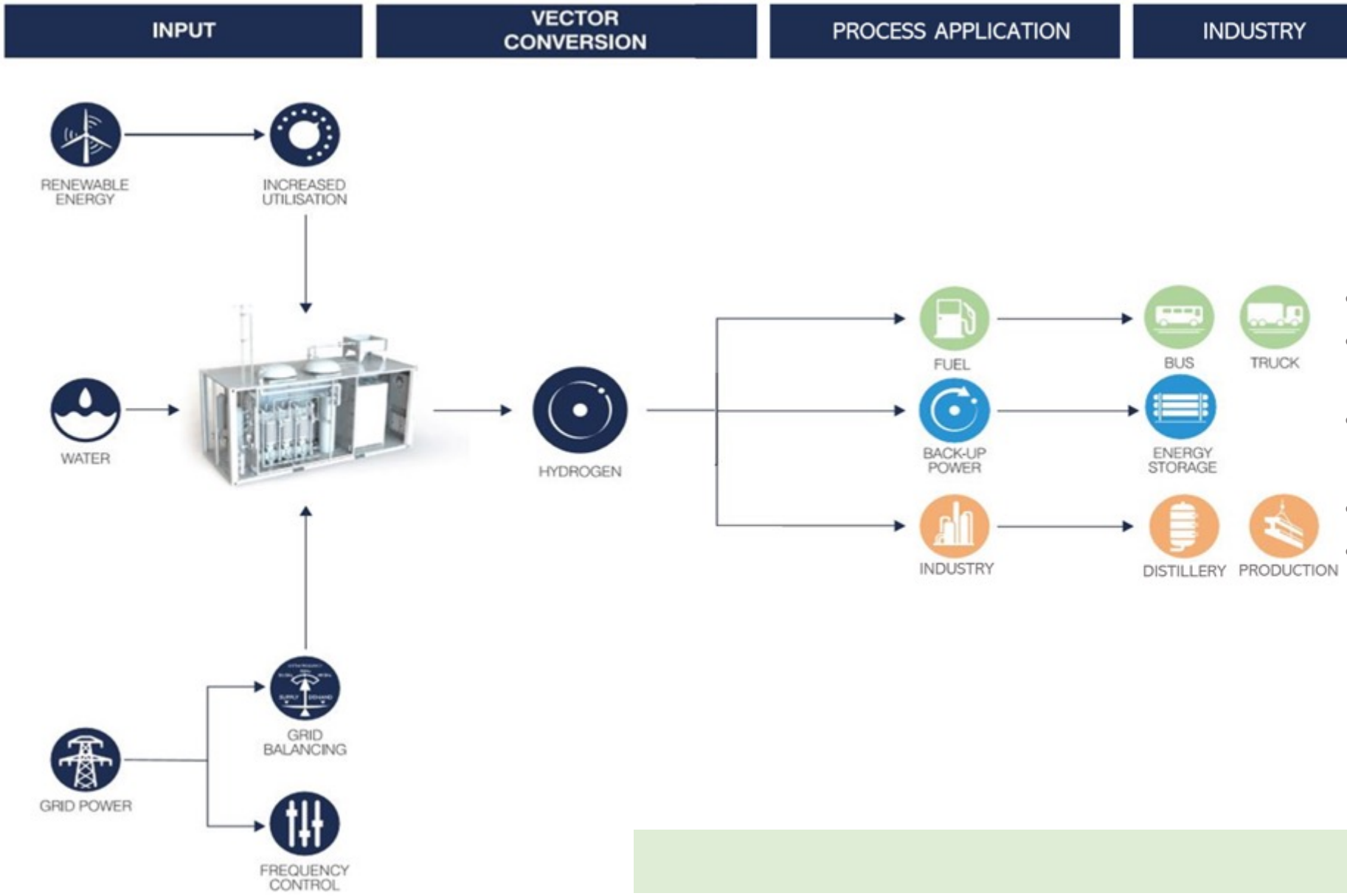
Q3 - Site Install Complete

Q4 **- Hydrogen Produced**

WHITELEE | KEY RESULTS

SCOTTISHPOWER

ITM POWER
Energy Storage | Clean Fuel



OVER 30 PARTIES

- Local Authorities
- Private logistics firms
- Back-up Power
- Whiskey Distilleries
- Fuel Cell Manufacturers

WHITELEE | FURTHERING THE PROJECT

SCOTTISHPOWER

ITM POWER
Energy Storage | Clean Fuel

Offtakers Glasgow Area

Mark Griffin
mgriffin@scottishpower.com
+44 7554513771

Electrolyser Supply Chain

Camila Blanco
cblanco@itm-power.com
+44 7999028234

PEM Electrolyser Need

Johanna Rosario
jrosario@itm-power.com
+44 114 244 5111

Thank you

Department for Business, Energy & Industrial Strategy

SCOTTISHPOWER

ITM POWER

Pitch 7

7

Innovate UK
KTN

Liquid Air Energy Storage

BEIS Energy Storage Showcase, July 2022

Department for Business, Energy & Industrial Strategy

Highview Power

A UK BUSINESS WITH A GLOBAL AMBITION TO DELIVER THE NET ZERO GRID

SUMITOMO

Partnering to expand cryogenic long-duration energy storage projects globally

AUSTRALIA

Finalising a programme to integrate LAES with solar and lithium-ion to enable the retirement of coal generation

IBERIA

Collaborating with Endesa to identify opportunities in the Canaries
to enable the retirement of diesel generators.

BEIS & HIGHVIEW:
A HIGHLY PRODUCTIVE AND SUPPORTIVE RELATIONSHIP

Collaborating since 2010

2011 Smart Grid Capital Grants programme
–
2015 Energy Entrepreneurs Fund
–
2017 Industrial Strategy Challenge fund
–
2020 £10 million grant 'Storage at Scale' competition
First Commercial CRYOBattery Facility

NET ZERO PERFECT STORM

GLOBAL COMMITMENT TO
ENERGY TRANSITION

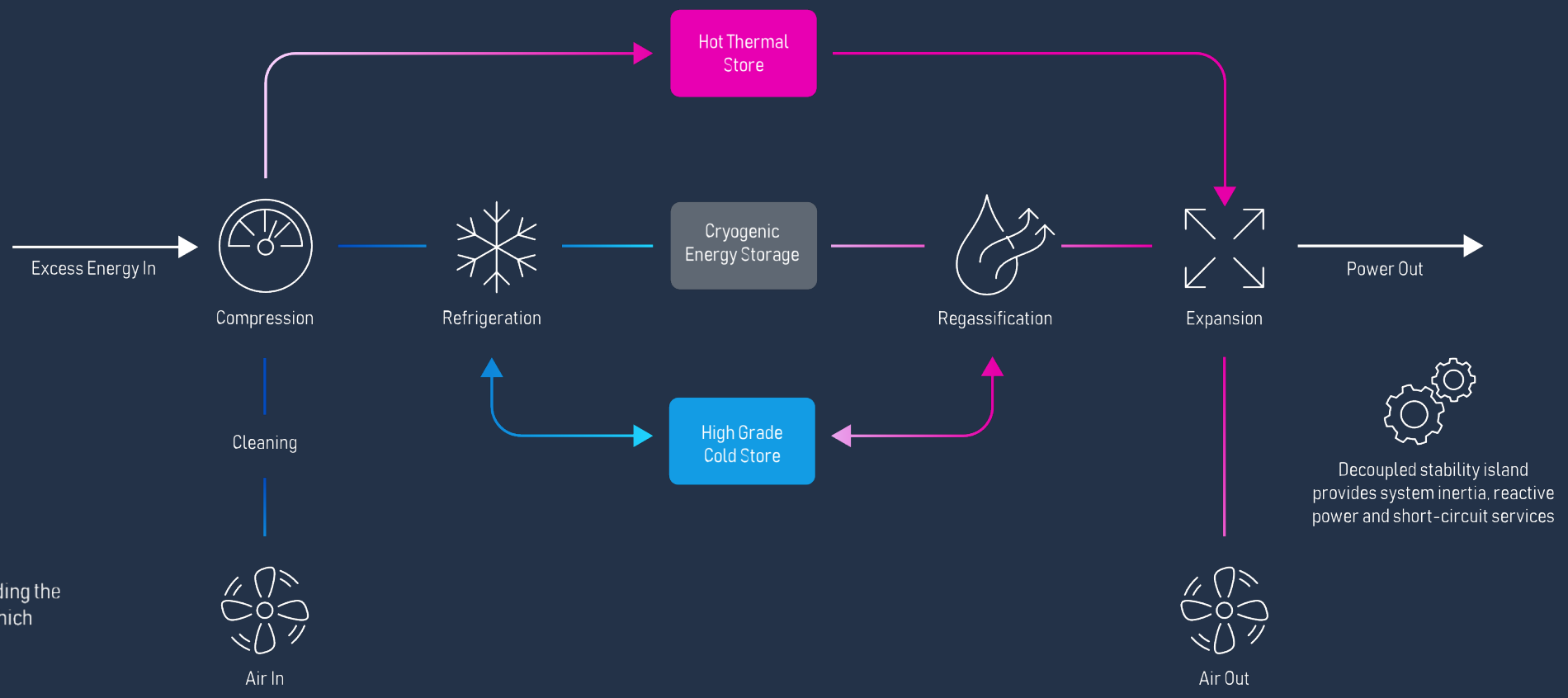
INTERMITTANCY
OF RENEWABLES

3X DEMAND GROWTH FOR ELECTRICITY

GRID INSTABILITY
RISES EXPONENTIALLY

ONGOING RELIANCE
ON FOSSIL FUELS

OUR LIQUID AIR ENERGY STORAGE TECHNOLOGY STORES ENERGY FOR LONGER WITH GREATER EFFICIENCY



Charge
Turning ambient air into liquid

Store
Storing the liquid air in tanks

Recover
When needed, expanding the liquid air into a gas which generates electricity

LONG DURATION ENERGY STORAGE AND STABILISATION SERVICES ARE THE ONLY SOLUTION TO A NET ZERO GRID

Renewable energy that's available 24/7/365

At grid scale and in all the right locations

With the flexibility to match output to demand

Providing stabilising services to balance the grid

Ending dependence on fossil fuels to fill gaps in supply

WE ARE READY TO DEPLOY TODAY AND CAN DELIVER 18 STATIONS BY 2035A 43GWh+ PROGRAMME

Shovel-ready first commercial grid-scale plant in Carrington, Manchester, a 50 MW / 300 MWh facility, COD 2024.

It supports the integration of wind and provides grid services in NW England. A second 200 MW / 2.5 GWh site planned for the North West, 2026. These two sites can power 1,000 homes, non-stop for a year. Backed by the UK Government.

1. Scotland
2. North West
3. North
4. Wales
5. East Anglia
6. South
7. West

READY TO MEET THE CHALLENGES OF THE NET ZERO GRID TODAY

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Break

Coffee break, networking and exhibition open

Innovate UK
KTN

Project overviews session 1 - Stream 2 Feasibility study

8.	**Project Name: PTES Demonstrator**	Prof. Win Rampen
9.	**Project Name: Renewable Copper**	Nick Kitchen
10.	**Project Name: Sustainable Single Liquid Flow Battery**	Brenda Park
11.	**Project Name: High-Density Hydro® Energy Storage**	Michael McKee
12.	**Project Name: Marine Pumped Hydro**	Kamila Heywood
13.	**Project Name: Feasibility of Compressed Air Energy Storage in the Offshore UK Continental Shelf**	Dr Murray Anderson
14.	**Project Name: FlexiTanker**	Michael Simpson

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Pitch 8

8

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KTN

LODES Stream 2
PTES Demonstrator

(Pumped thermal energy storage)

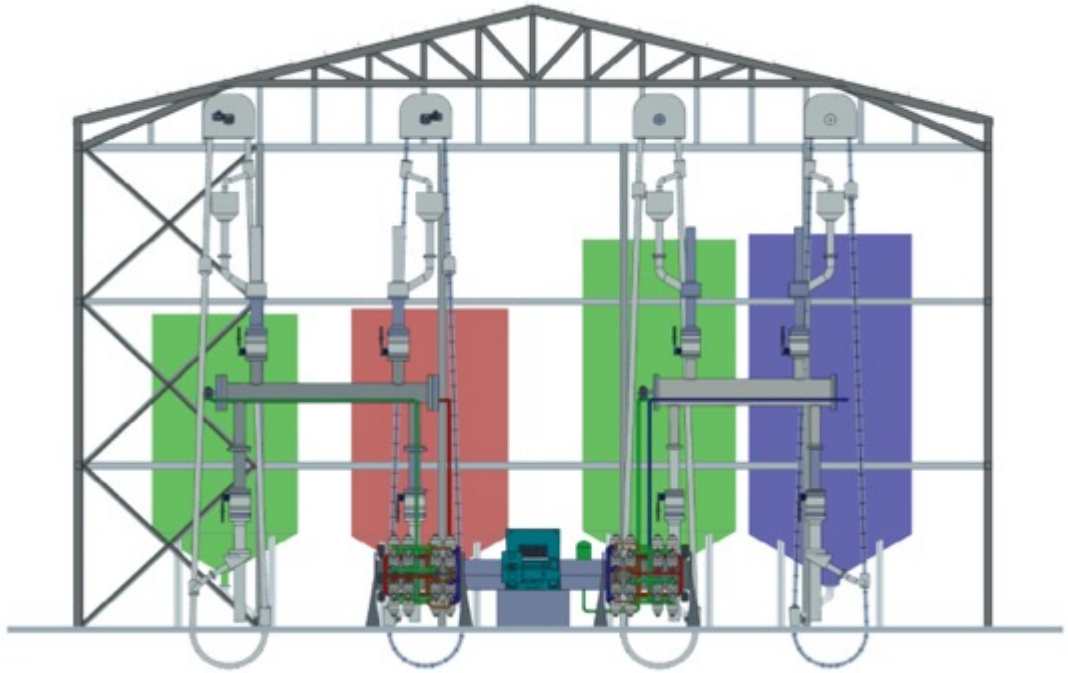
Department for Business, Energy & Industrial Strategy

Professor Win Rampen

SynchroStor
Unit 2, Edgefield Trade Park
Edinburgh, EH20 9TH
United Kingdom

0131 448 0232

www.synchrostor.co.uk
info@synchrostor.co.uk



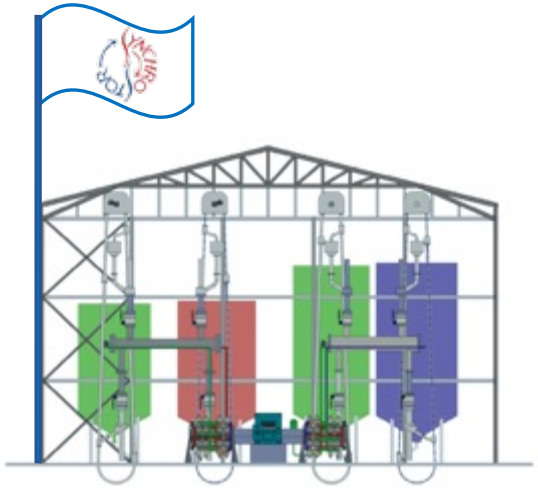
SHORT DURATION

(2-4 HOURS)

Li-ion

LONG DURATION

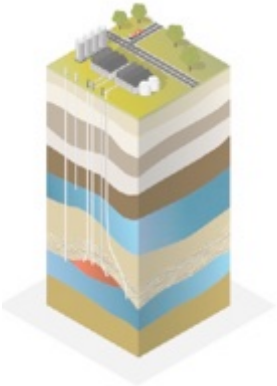
(10-50 HOURS)



Pumped Thermal Energy Storage

VERY LONG DURATION

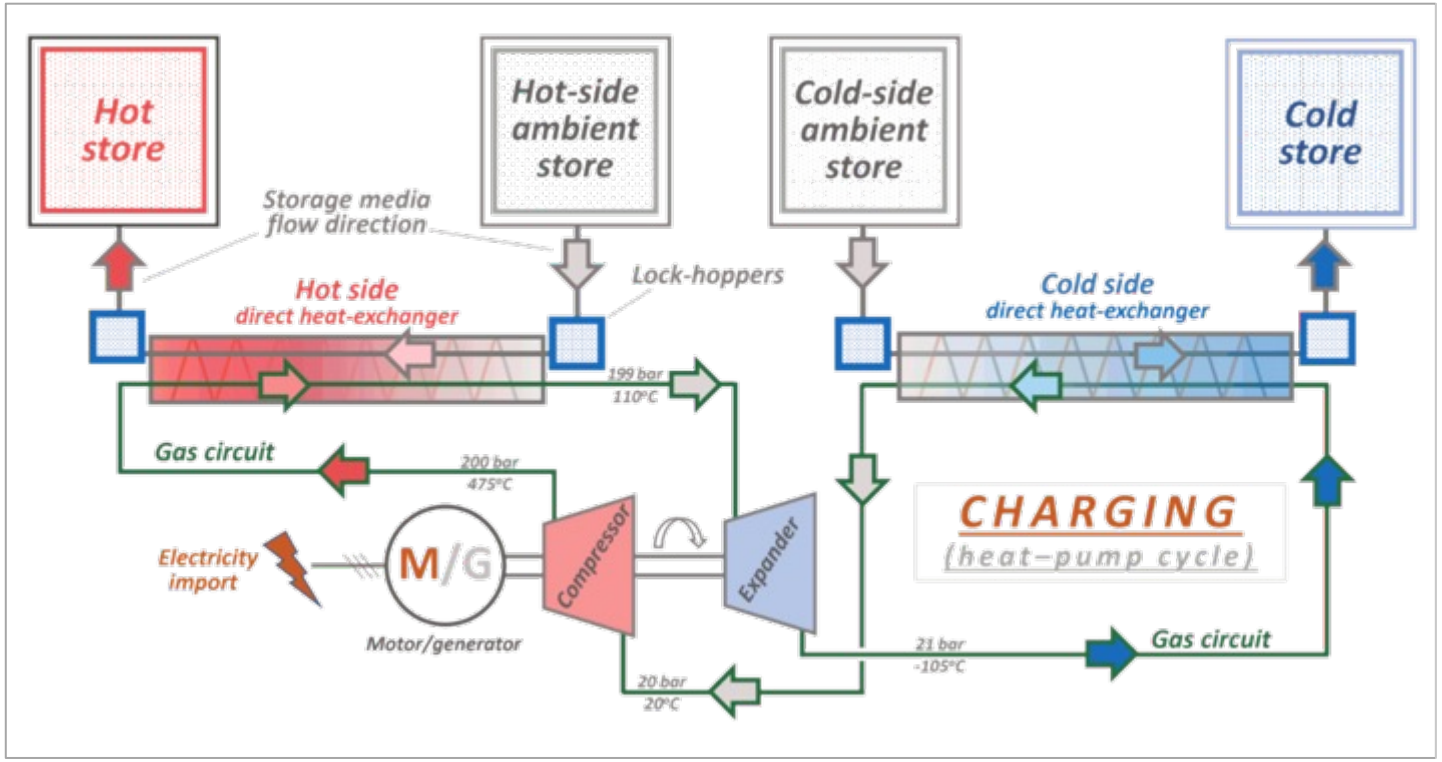
(WEEKS)

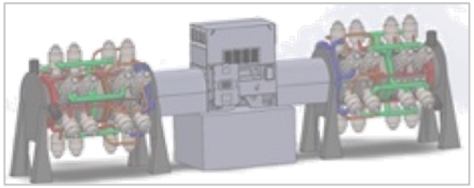


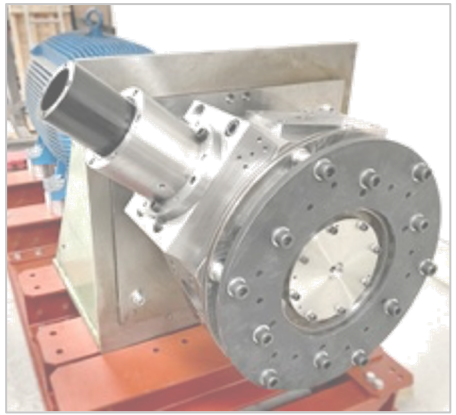
H_2

Closed-loop energy storage.

- ***CHARGING*** *- as a heat pump, it moves energy from electricity to heat.*
- ***STORING*** *- Low-cost thermal stores offer long-duration storage.*
- ***DISCHARGING*** *- as a heat-engine, it moves energy from heat to electricity.*





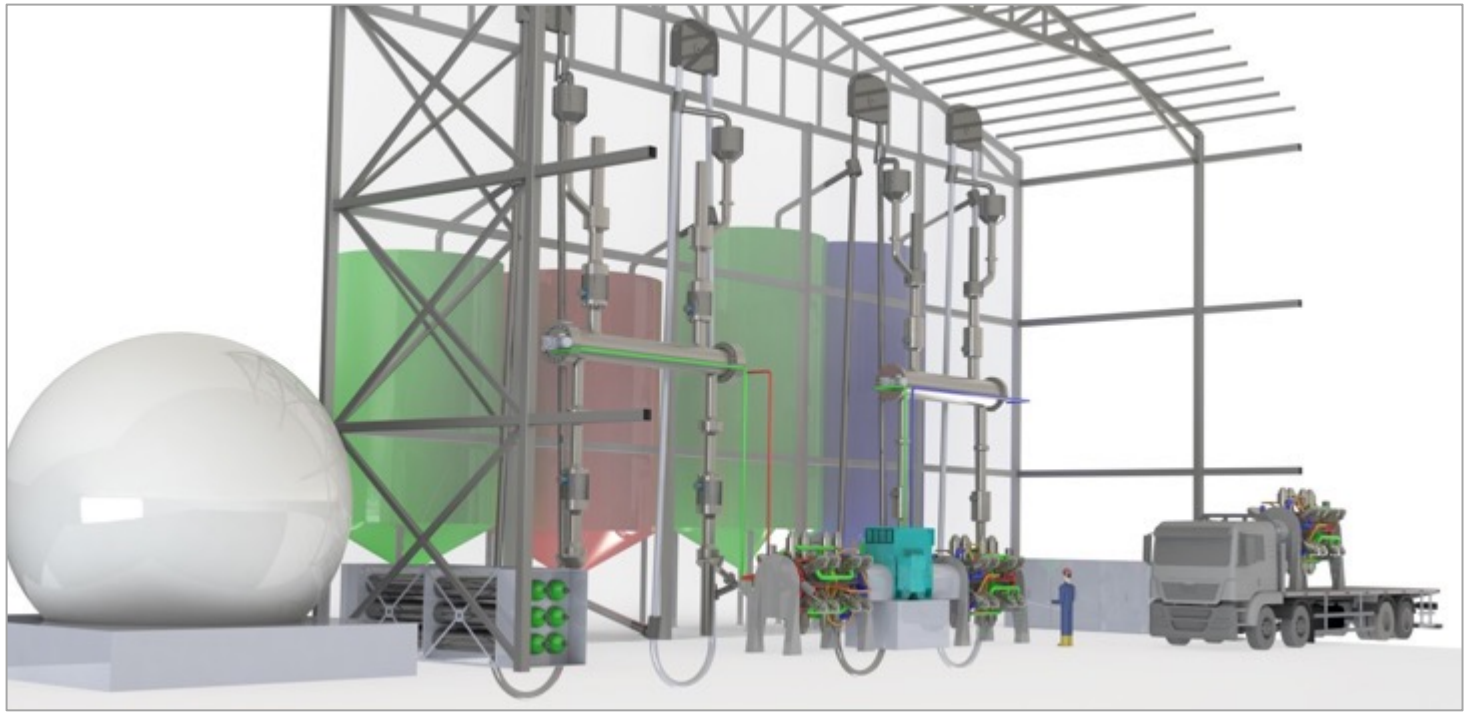


SynchroStor PTES – *Key Findings*

- ✓ ***Synchronous motor-generator*** *- provides grid inertia and fault ride-through.*
- ✓ ***Fully reversible within milliseconds*** *- frequency support as well as long duration.*
- ✓ ***Power and energy are separately scalable*** *– for peaking, wind curtailment, PV, islanded grids, etc.*
- ✓ ***Long system life*** *- 99% fully recyclable steel and mineral, no hazardous materials on site.*
- ✓ ***Modest footprint*** *- can be sited anywhere, including next to substations.*
- ✓ ***Competitive round-trip efficiency.***
- ✓ ***Lower CAPEX than competing technologies*** *- particularly for long duration storage.*
- ✓ ***Very low energy loss when charged*** *- 0.5% per day*

As of July 2022, SynchroStor is:

- ***Designing & building a 1MW x 10MWh pilot plant;***
- ***Continuing technology development;***
- ***Engaging with stakeholders.***



Pitch 9

9

Innovate UK
KTN

Department for Business, Energy & Industrial Strategy

Renewable Copper: Reducing Windfarm Curtailment using Longer Duration Energy Storage

Cumulus Energy Storage

CATAPULT Energy Systems

University of Southampton

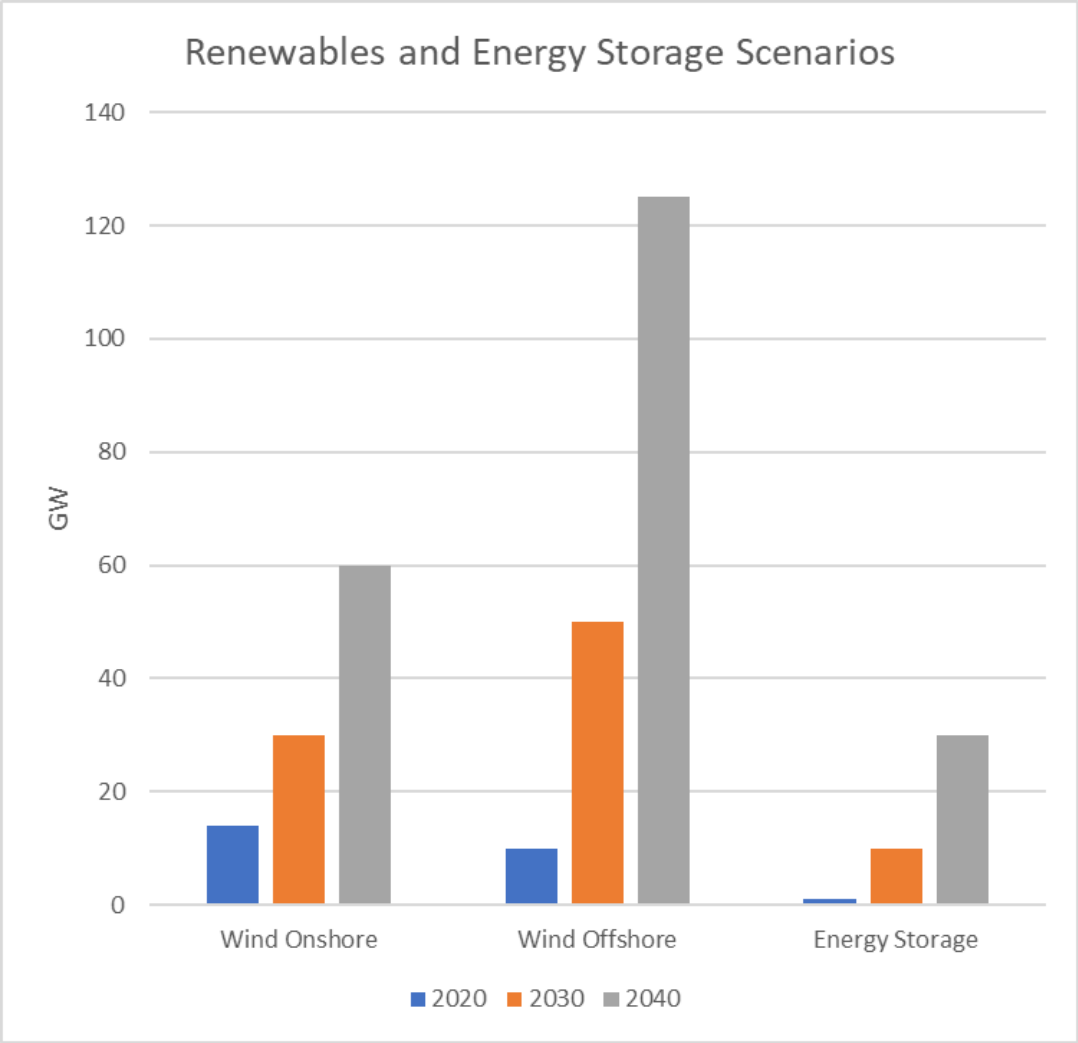
community windpower

Enabling Renewable Electricity…

www.cumulusenergystorage.com Nick Kitchin CEO nick.kitchin@cumulusenergystorage.com +44(0)7870 455995 +44(0)1433 410033

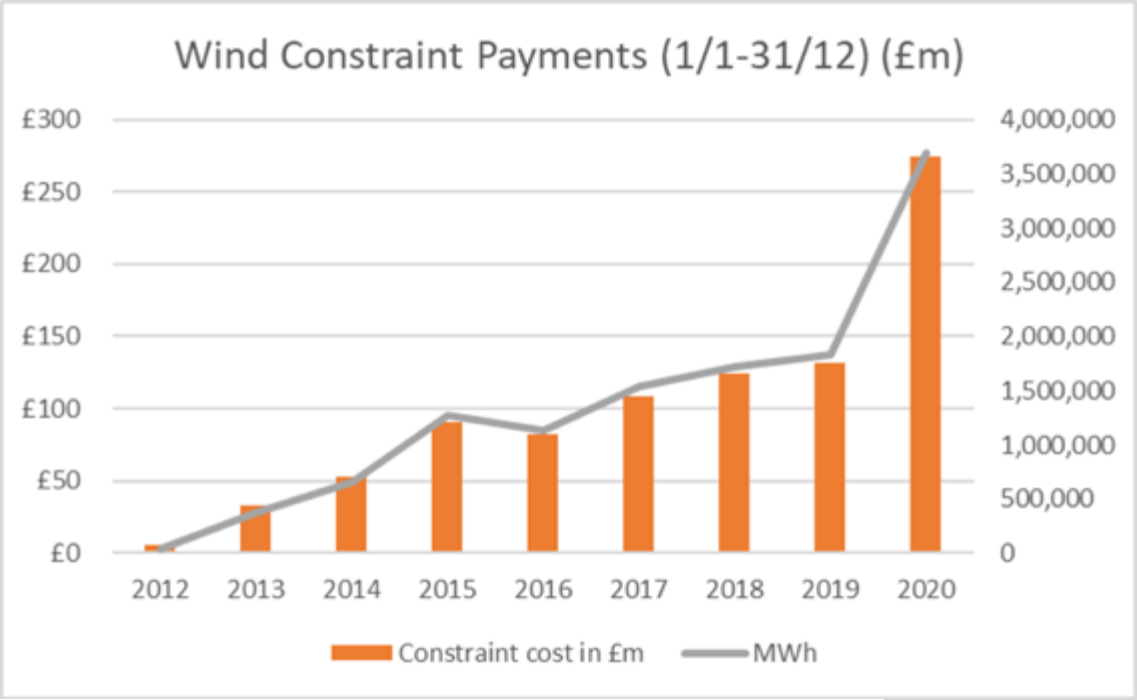
Background

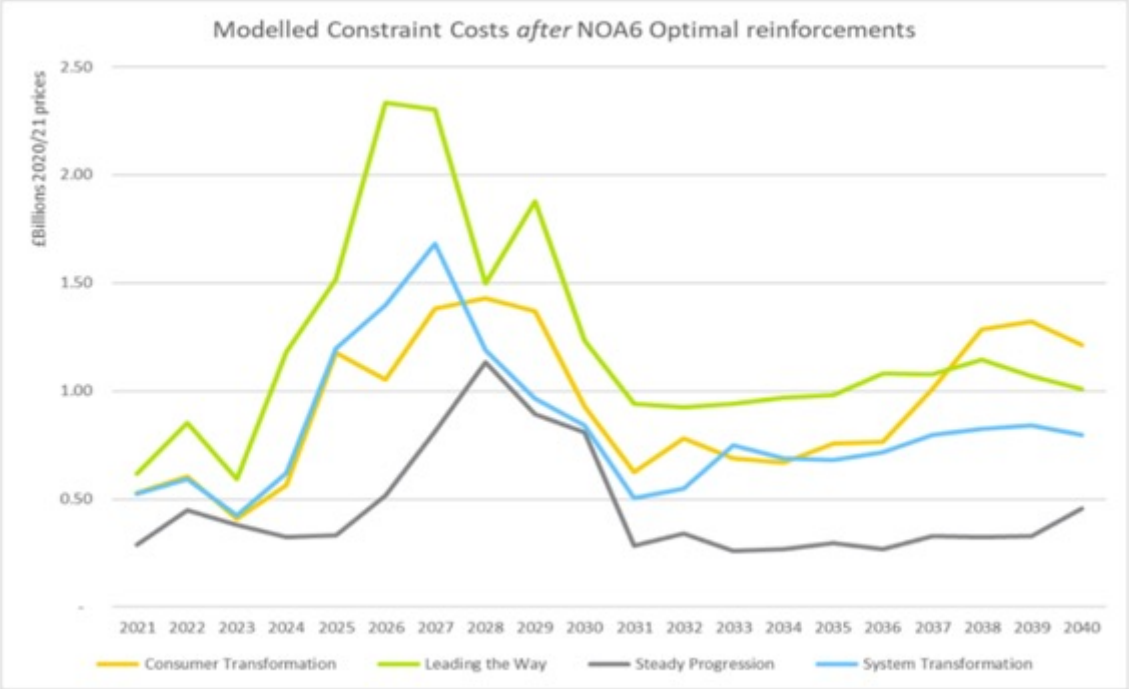
- Scotland has 25% of Europe's offshore wind resource and around 60% of the UK's onshore wind capacity.
- 14GW onshore wind now – Scotland has 8.5GW operational, 5GW in construction and 5GW in planning currently. Renewable UK are calling for 30GW by 2030. BEIS modelling suggests up to 60GW by 2050.
- 10GW offshore wind now - 50GW by 2030 and up to 125GW by 2050
- BEIS 2050 scenarios include 20-30GW of 4-hour duration (80-120GWh) battery energy storage



The Problem

- In 2020:
- Constraint payments to windfarms more than doubled to £274m.
- 3.75TWh windfarm generation was curtailed
- 17.6% of Scotland's onshore windfarm generation was curtailed.





The Problem

- The main issue for GB windfarms is constraint in the electricity network at the Scotland/England border
- Kilgallioch, a 228MW windfarm in Ayrshire, increased curtailment from 38% to 57% in 2020 (213GWh – 319GWh), which is 8.6% of UK's total wind curtailment
- Out of 146 windfarms curtailed in 2020, the 29 shown here accounted for 80% of this curtailment. All are based in Scotland.

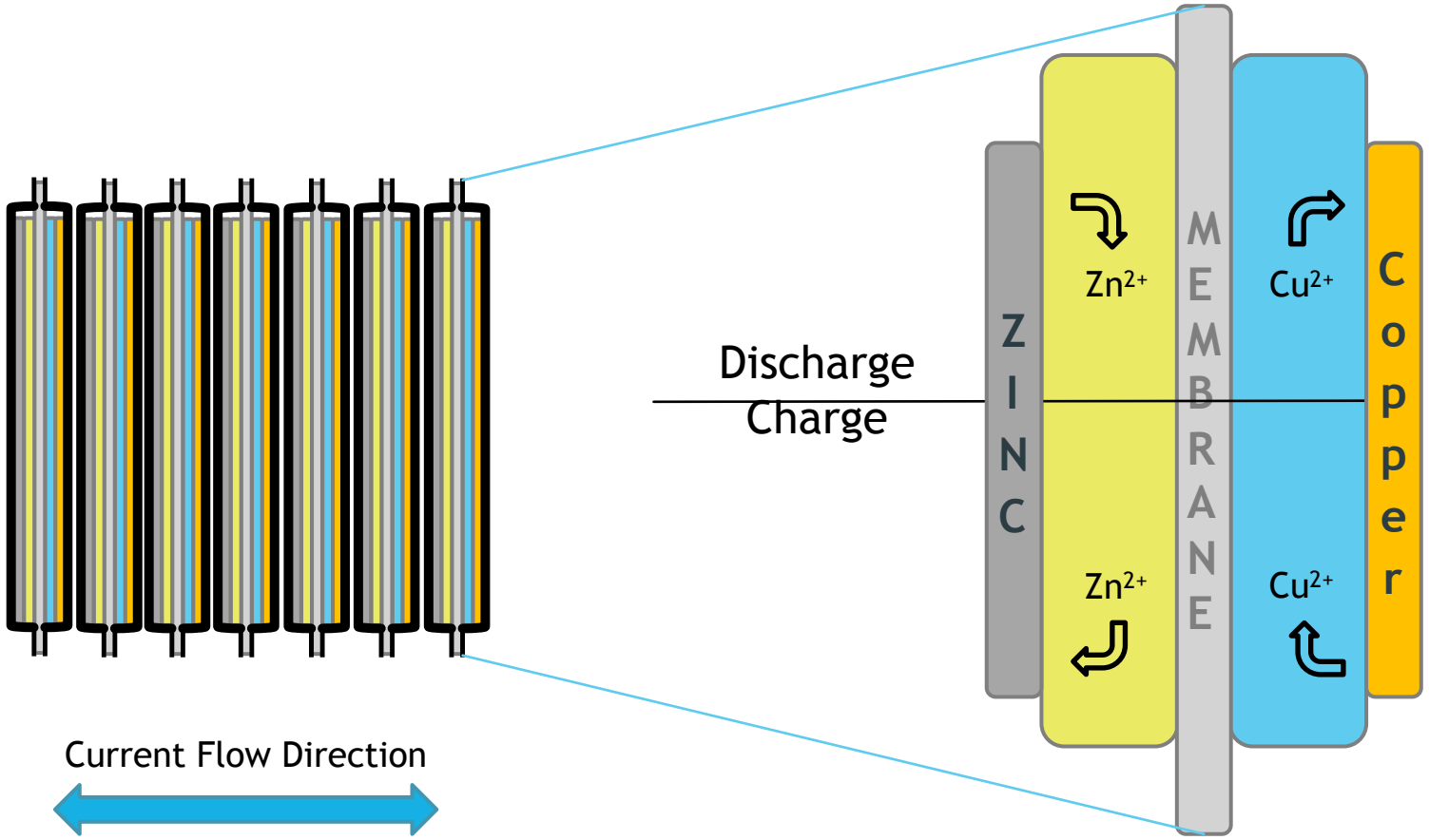
The Cumulus Solution

1MWh

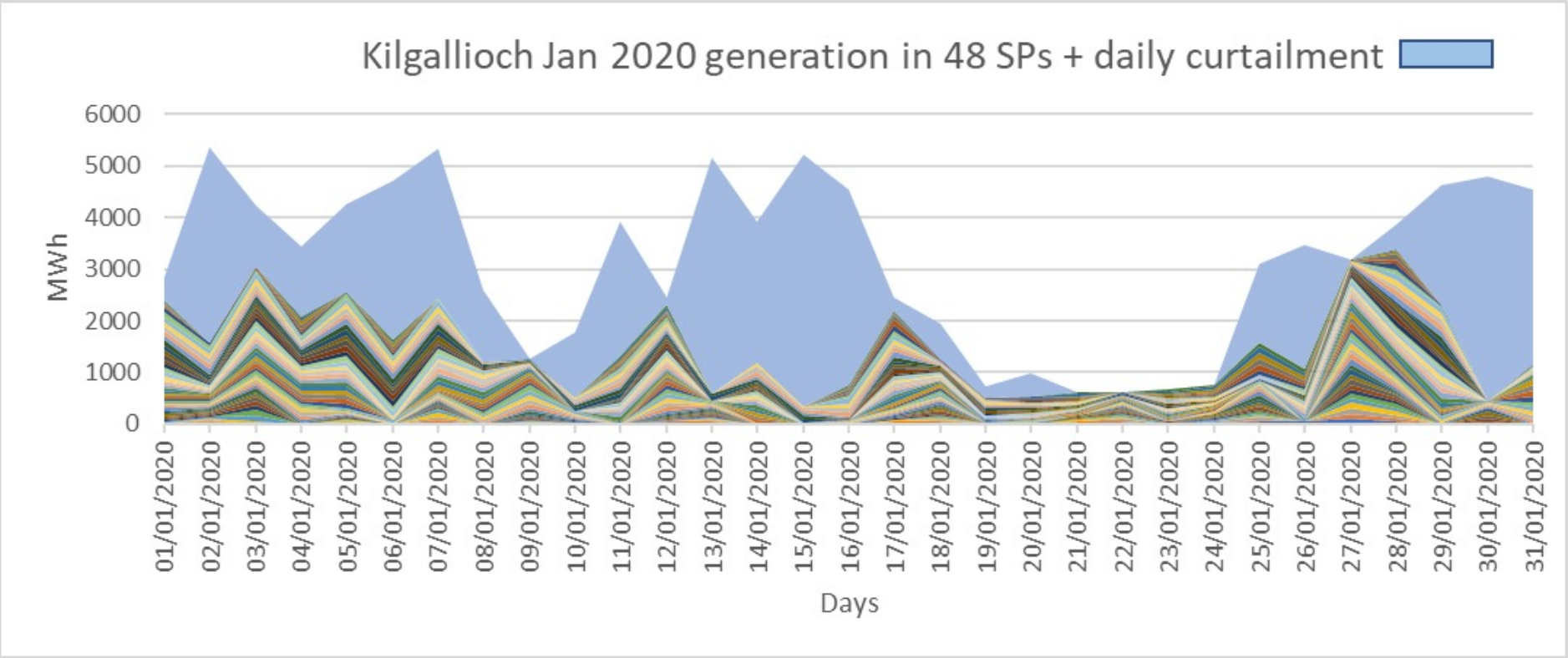
100MWh

The above are examples of what our rechargeable Copper/Zinc battery will look like both individually and at industrial “Gigafactory” scale.

Technology - The Copper-Zinc System

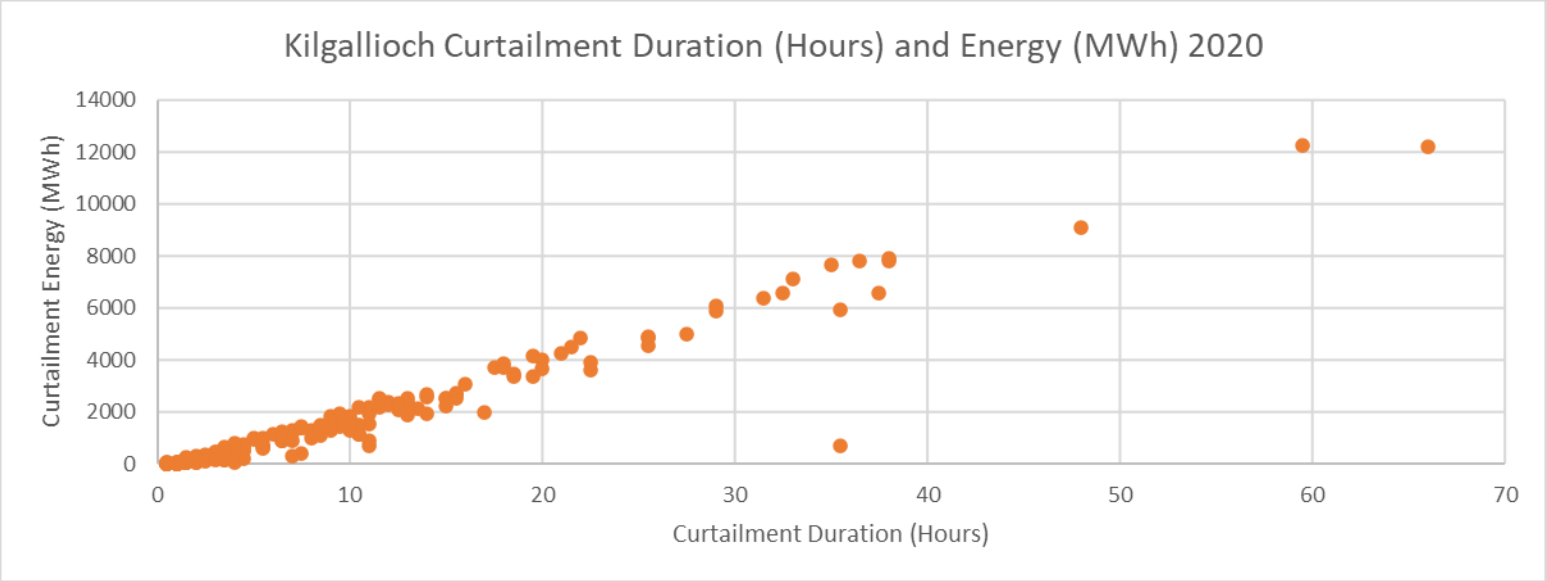


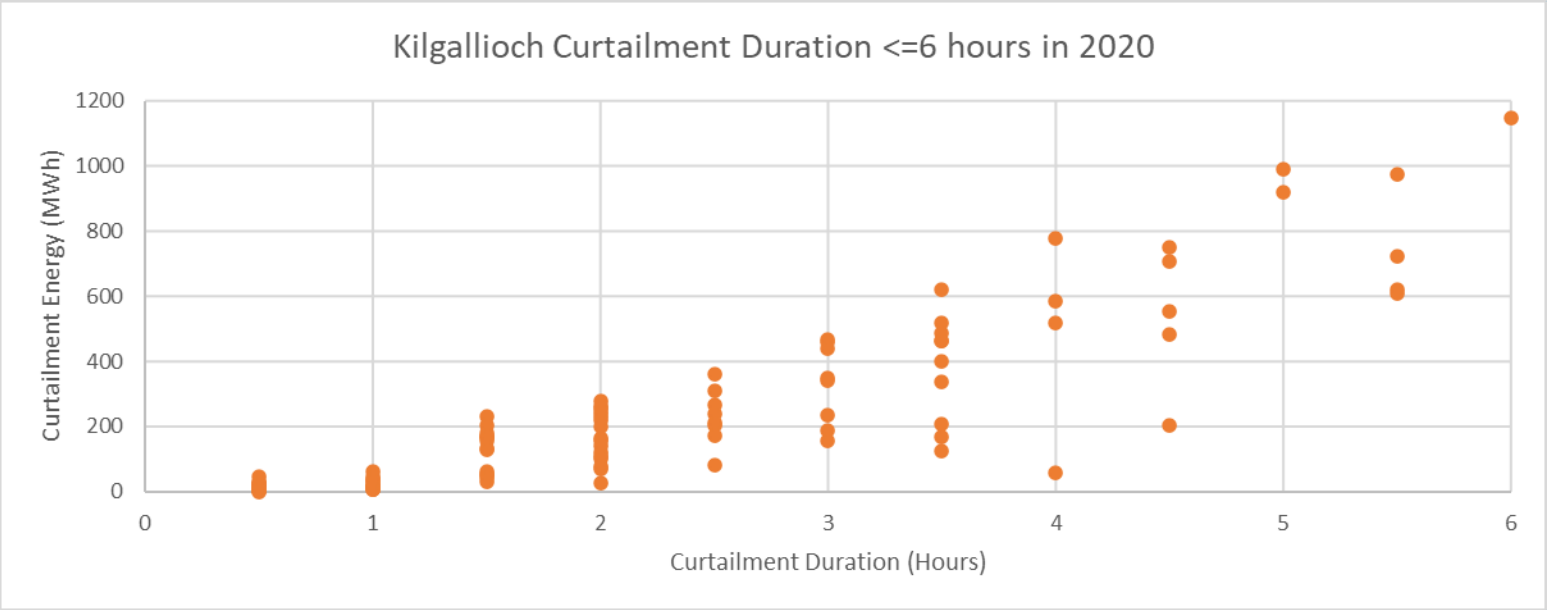
Kilgallioch Generation/Constraint Jan 2020



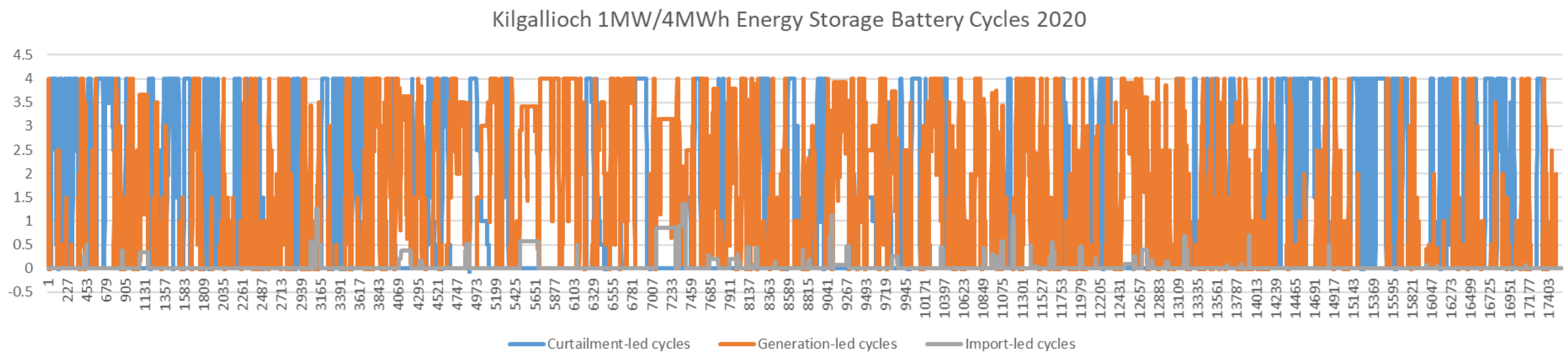
Curtailment Duration

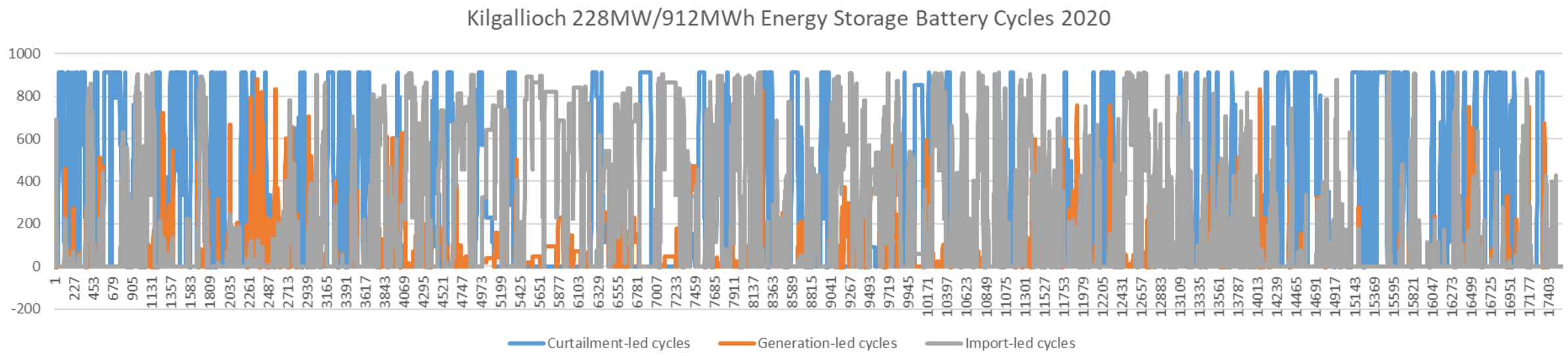
- 199 curtailment events in 2020
- Duration ranged from 1 to 66 hours
- Many were at full power (228MW)





Energy Storage - Revenue Generation





Revenue Streams (with Ancillary Services)

System size	Constr/Arbitrage	Reactive Power	Capacity Market	IRR% (£250/kWh)	IRR% (£150/kWh)
1MW/4MWh	£77k	£7k	£13k	7.4%	15.3%
10MW/40MWh	£771k	£73k	£133k	7.4%	15.3%
100MW/400MWh	£7,631k	£925k	£1,328k	N/A	15.6%
200MW/800MWh	£14,858k	£2,019	£2,656k	N/A	15.3%

Renewable Copper project

- £9.1m project over 2 years, to build and commission 1MW/4MWh rechargeable Copper/Zinc energy storage at 81.7MW Aikengall IIa windfarm in East Lothian.

- 8 work packages: Technology, site and system-level benefits.

Opportunities

- Curtailment reductions of 27%, 18% and 20% (65% total) with first and second battery and Hydrogen electrolyser respectively.
- Energy storage is the enabler that reduces Green Hydrogen electrolyser electricity cost by £40/MWh and Green Hydrogen by £2/kg.
- The 29 most curtailed windfarms (all in Scotland) offer 4.0GW/16GWh, £2.4bn energy storage sales opportunity for Cumulus.

Investment Opportunity

Investment:

- Equity raise £5m, Q4 2022
- Equity raise £14.2m, Q3 2023

Funded Activities:

- Completion of engineering product development
- Further build the team
- Installation of first full production 10MWh/month/shift line
- Deployment of demonstration battery systems

Pitch 10

10

Innovate UK
KTN

StorTera

Sustainable Single Liquid Flow Battery

Dr Brenda Park, Edinburgh
brenda@stortera.com
07975906023
www.stortera.com

Department for Business, Energy & Industrial Strategy

The Challenge

StorTera

- Energy storage unlock renewables
- Next gen batteries need:
  - High performance
  - Sustainable
  - Safe

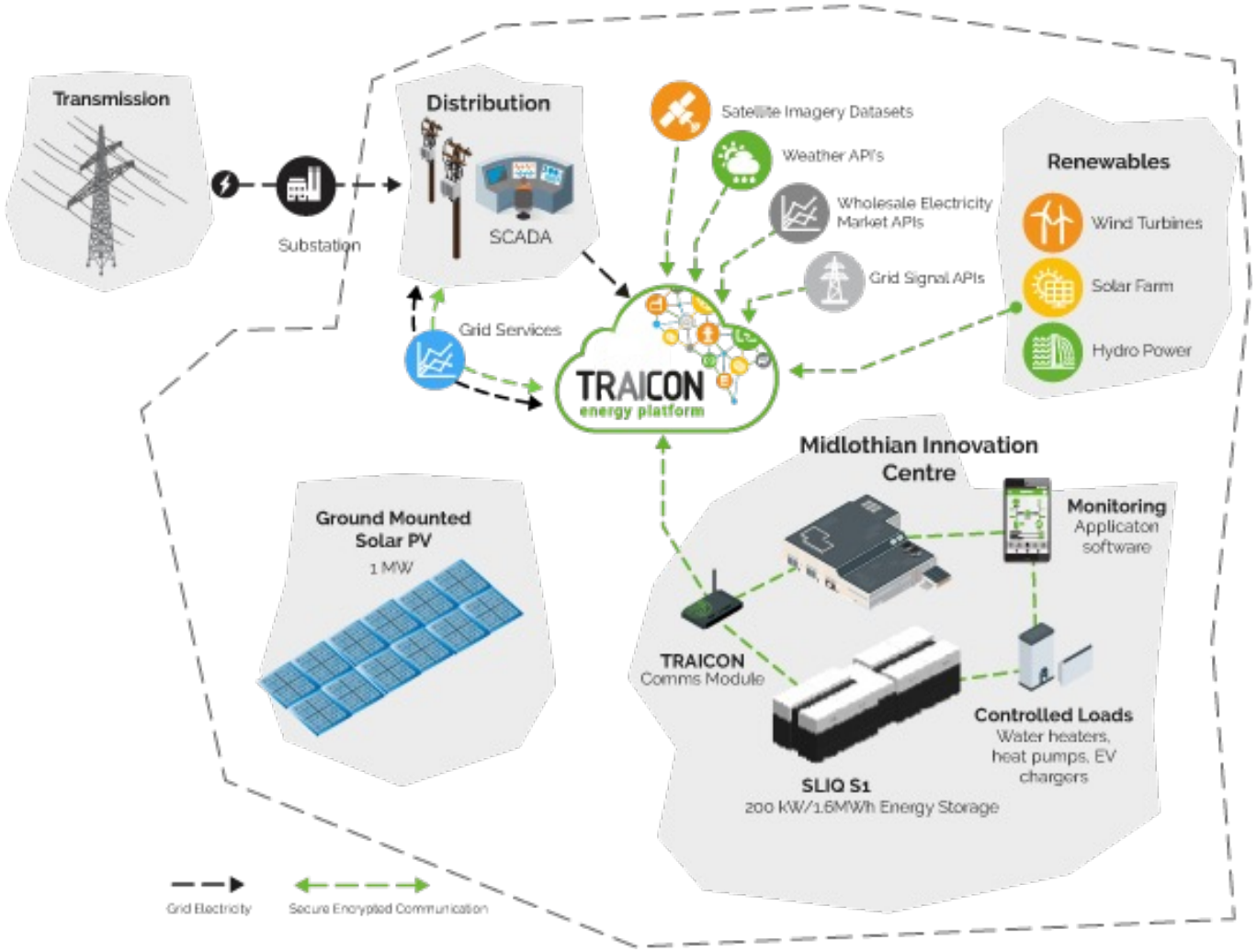
The Solution

StorTera

Single Liquid Flow Battery

- One energy dense liquid
  - Energy density 250Wh/L
- Flushing and dosing regime
  - 93% efficiency over 20,000 cycles
- Spiral cell design
  - Low manufacturing cost <£10/MWh
- Scalable energy and power
  - Short & long duration (ms & 4+ hours)
- Sustainable raw materials
  - Low embodied carbon (reusable/recyclable)

Intelligent Controls



TRAICON Platform

- Continuous optimisation
- API for control & aggregation
- Data security

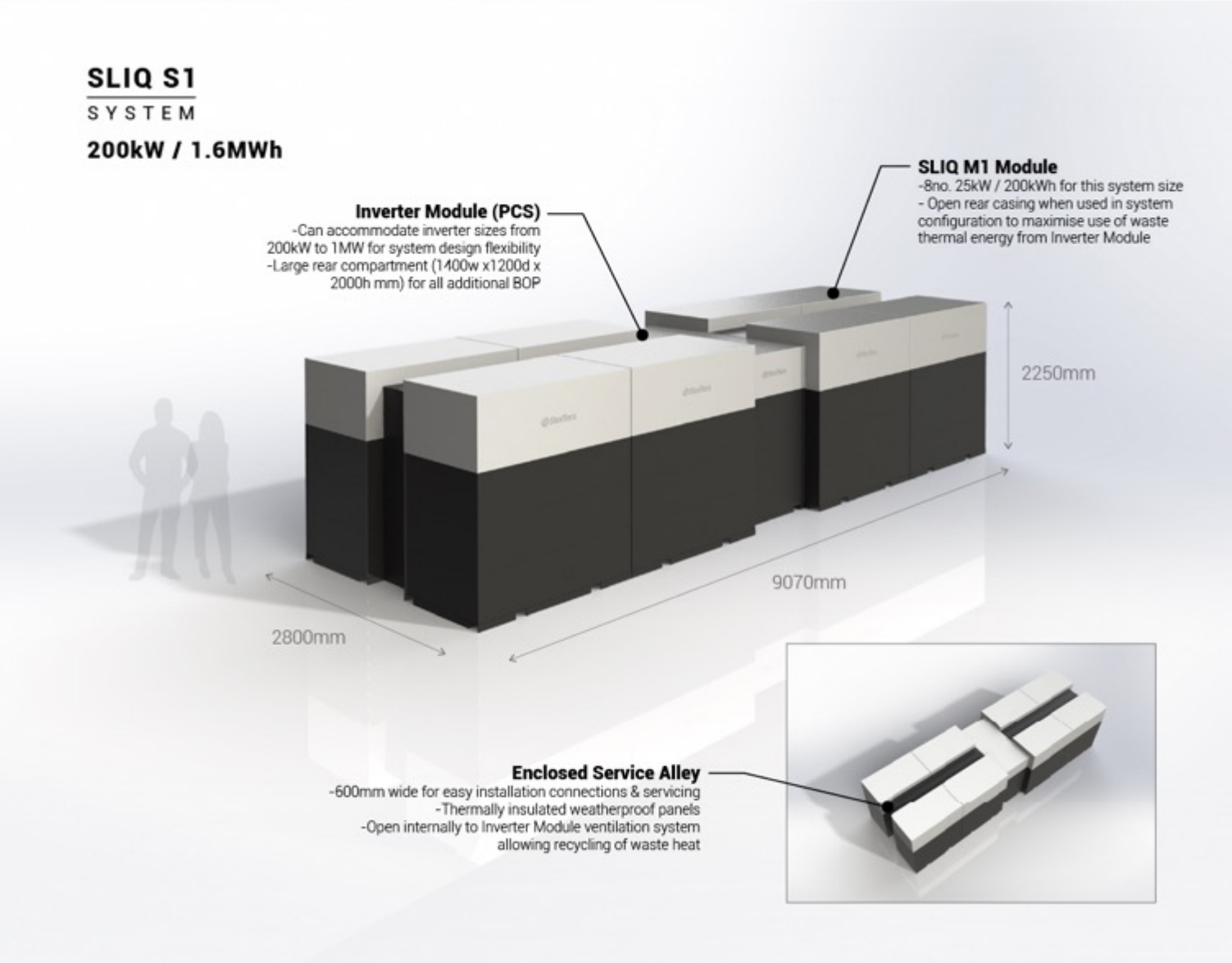
Battery Management System

- AI improves efficiency and lifetime
- Cell level optimisation

Phase 2 plan

StorTera

- 200kW/1.6MWh prototype system
- TRL 5 up to TRL 7
- Modular units 25kW/200kWh
- TRAICON platform integrated
- Grid connection and MOU for site
- Flexibility services



Thank you

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www.stortera.com

Pitch 11

11

Innovate UK
KTN

High-Density Hydro®

Enabling the energy transition with low-cost, scalable storage

Stephen Crosher, CEO & Co-Founder
Micheal McKee, LoDES Project Lead
July 2022

Department for Business, Energy & Industrial Strategy

We all know worlds energy systems must rapidly and completely decarbonise to net-zero to avoid damaging climate change.

We also know that the energy crisis means we must do it faster.

RheEnergise

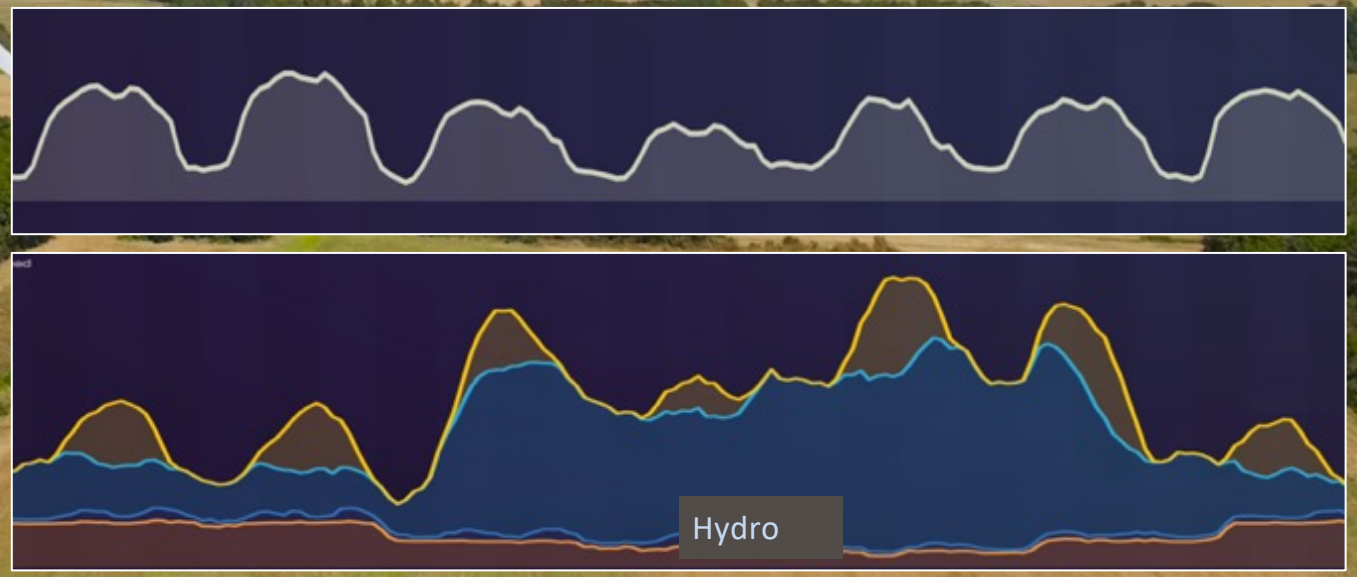
THE SOLUTION

Renewable energy

But … the solution gives us a new problem

Intermittent generation from renewables.

The solution to intermittency is long duration energy storage.



An “Express Train of Opportunity”

McKinsey & Company, LDES Council, Nov 2021

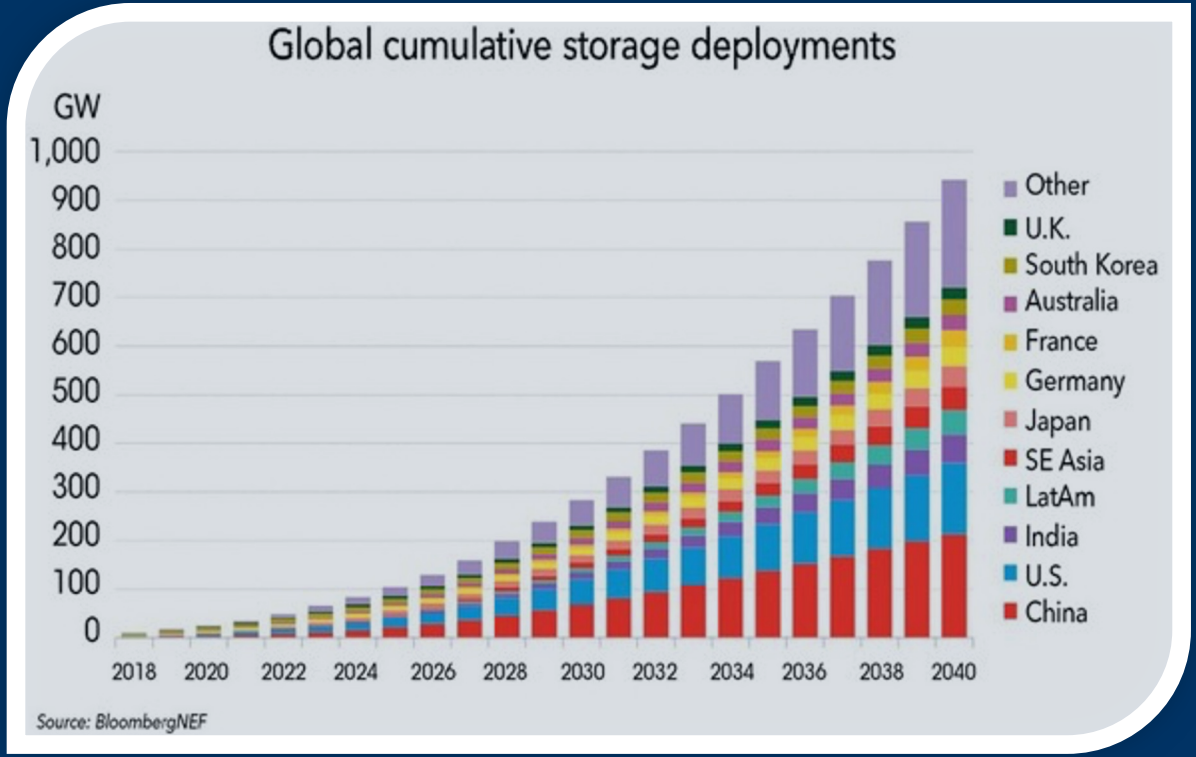
1.5 - 2.5 TW
85 - 140 TWh LoDES by 2040

Bloomberg New Energy Finance, 2020

$620bn market by 2040

IEA Energy Outlook 2021

“2,100GW required by 2040”
more than 10x capacity installed to date

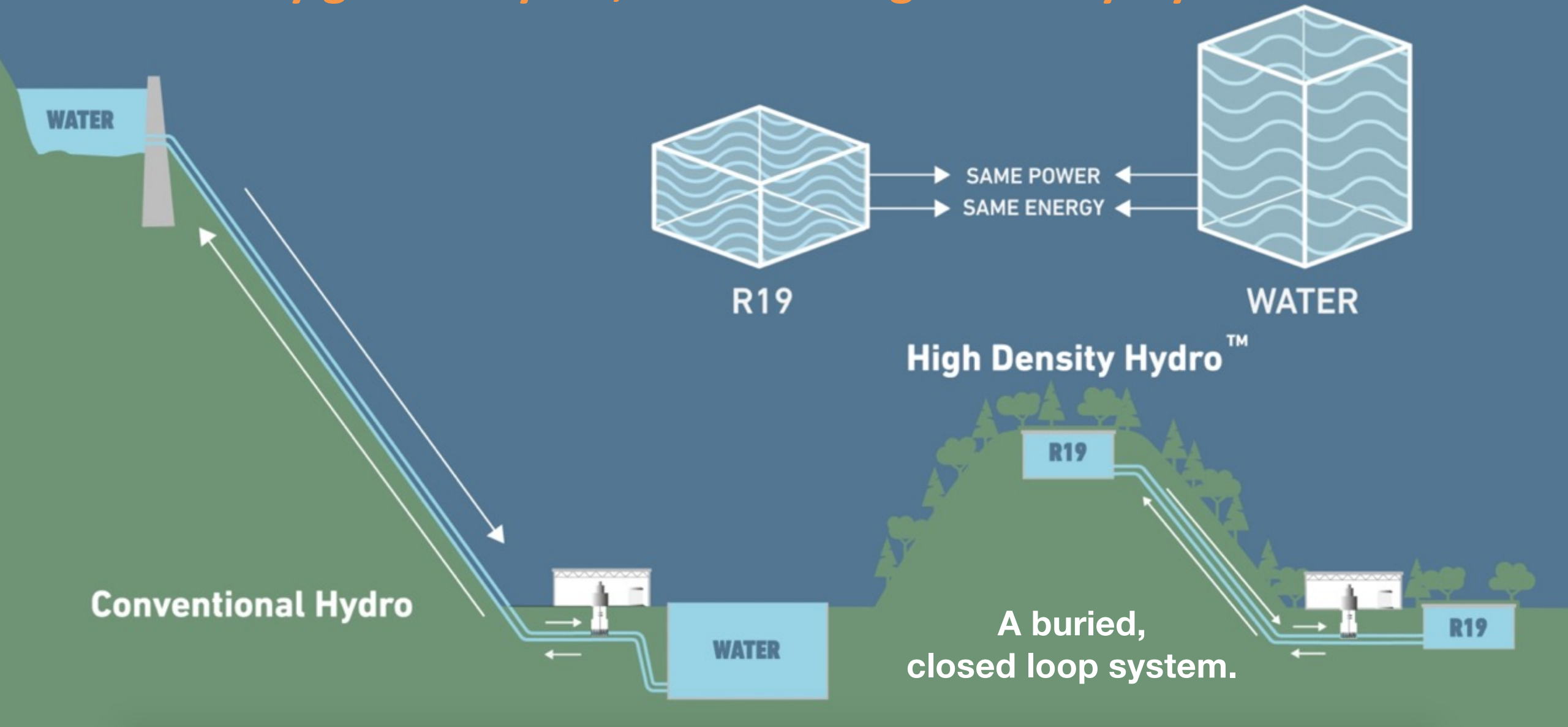


RheEnergise

Pumped hydro: huge projects; mountainous locations; large vertical drops, water abstraction, too few sites, social and environmental issues, long distances from demand and generation.

The RheEnergise Solution

It is the holy grail of hydro, we call it High-Density Hydro ®



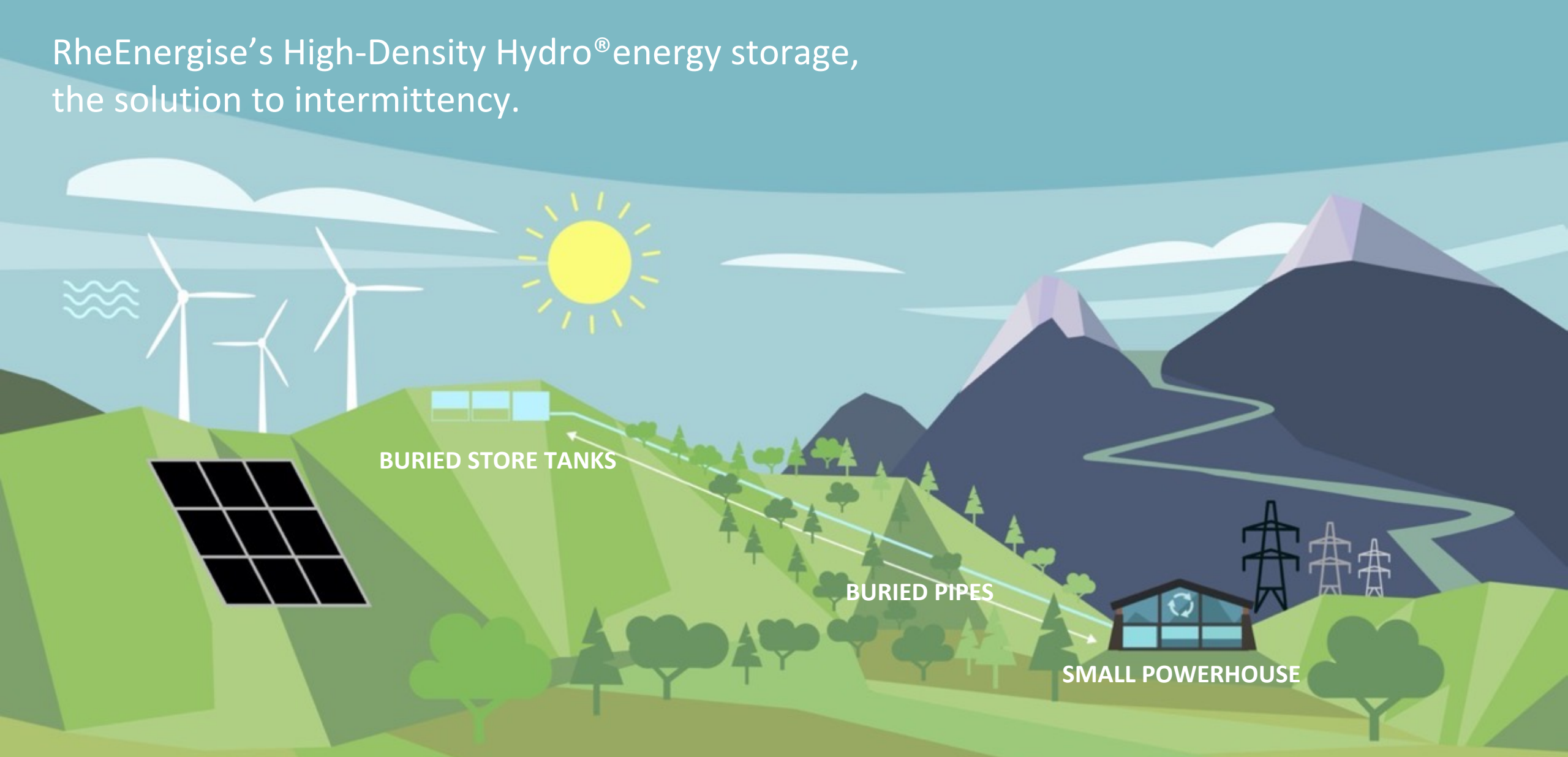
A buried,
closed loop system.

However, RheEnergise's High-Density Hydro® is different, we can install projects on small hills, found nearly everywhere, rather than massive projects in protected mountainous areas.

- Founders are serial entrepreneurs
- 9 full-time, 5 part-time employees
- 9 engineers, two chartered accountants
- Four PhDs

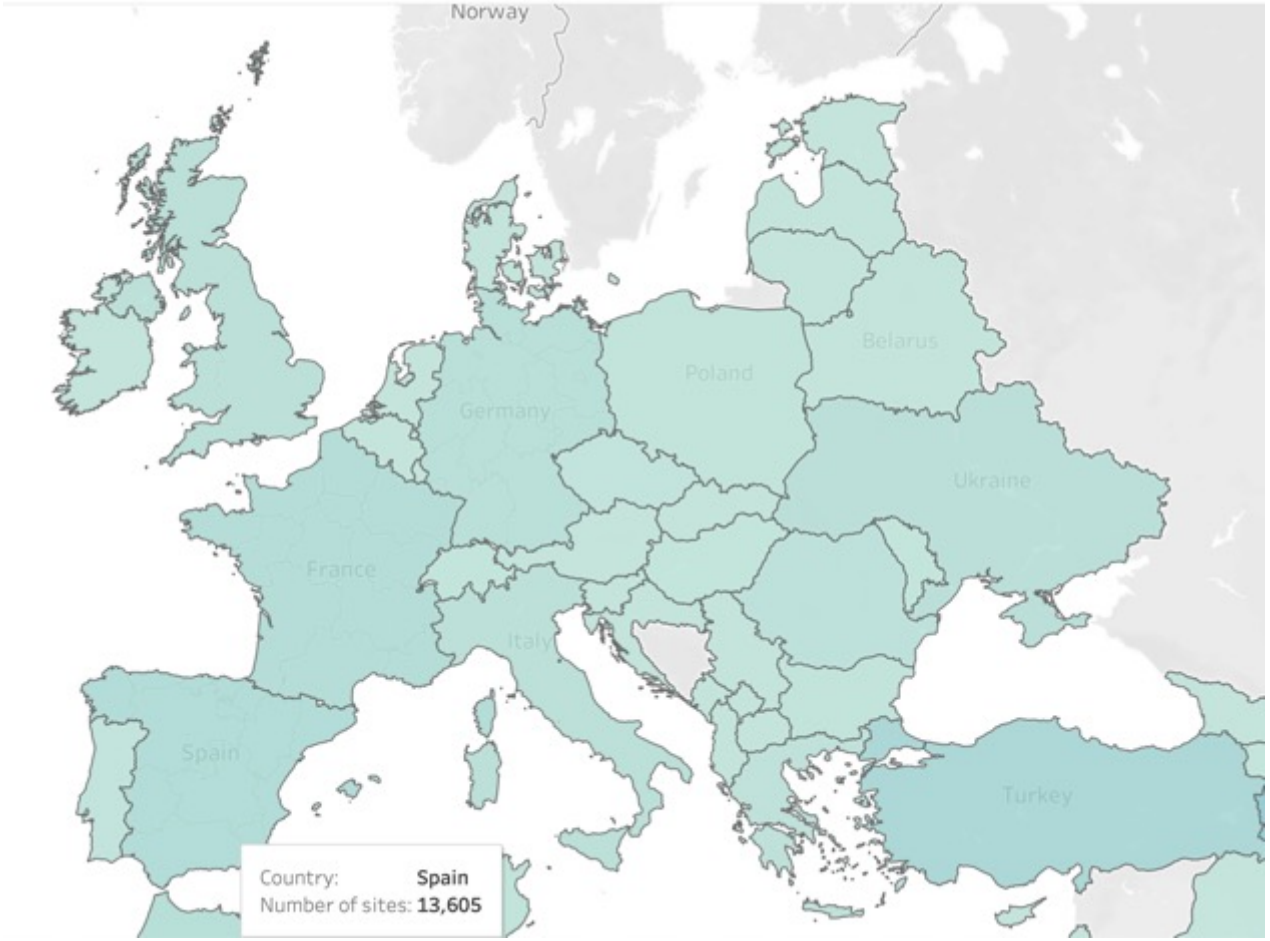
- HQ in London
- HD-Hydro Technology Centre, Montréal
- Chemistry Formulation Team, U. Greenwich

RheEnergise's High-Density Hydro®energy storage,
the solution to intermittency.



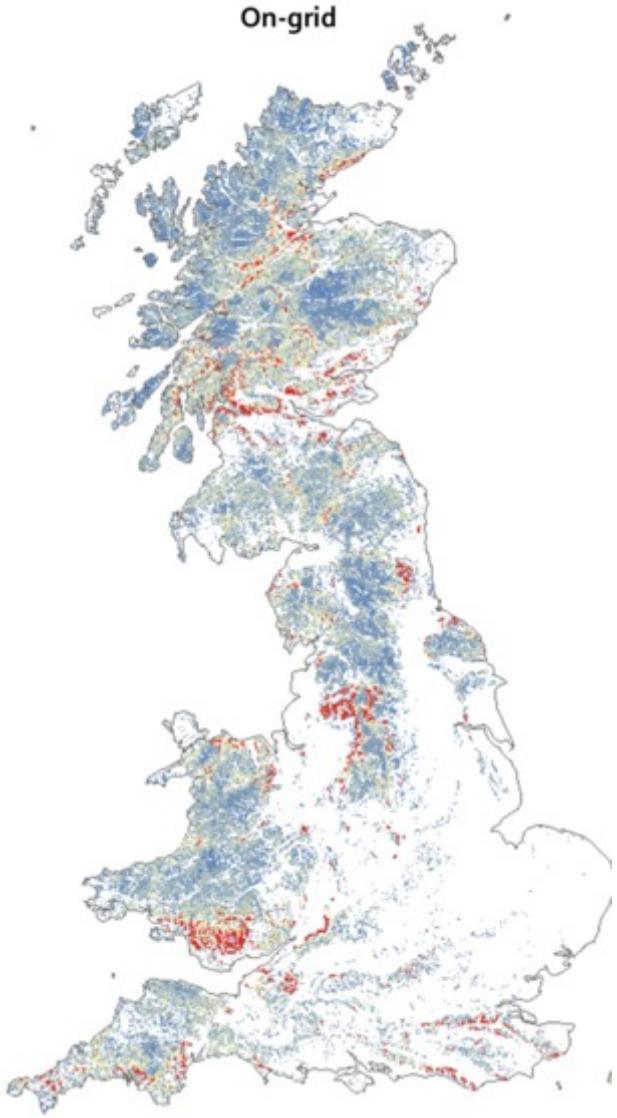
High-Density Hydro®is like convention pumped hydro (water).
However HD Hydro can be installed on small hills rather than mountains.

There Is No Shortage of Sites Across The World



Potential Site Numbers / Country

7 181,879



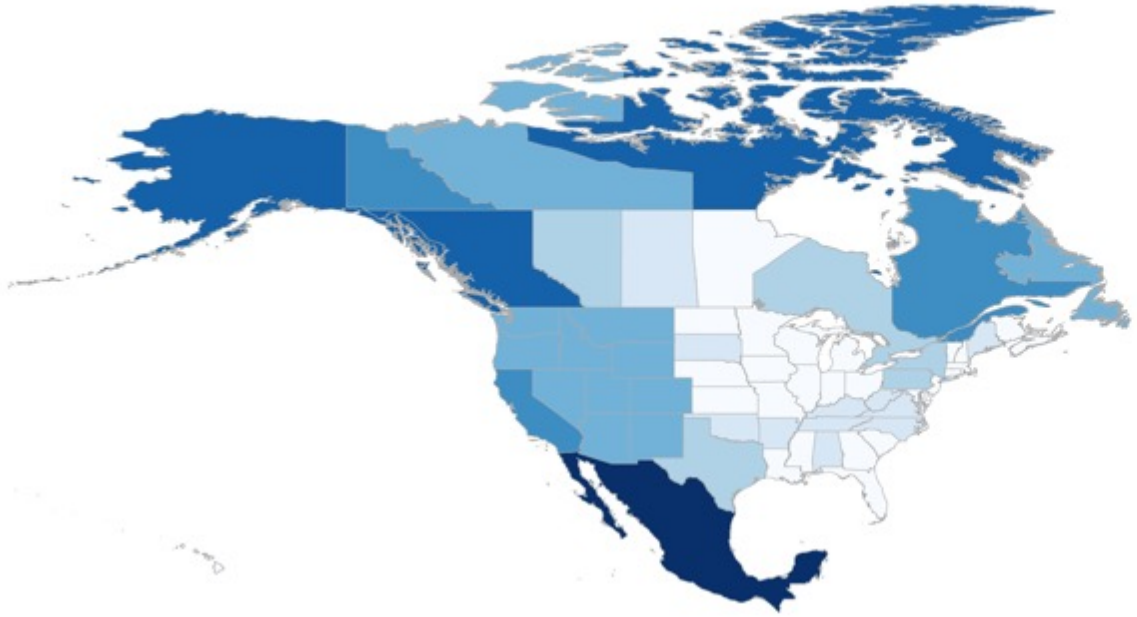
No shortage of project sites:

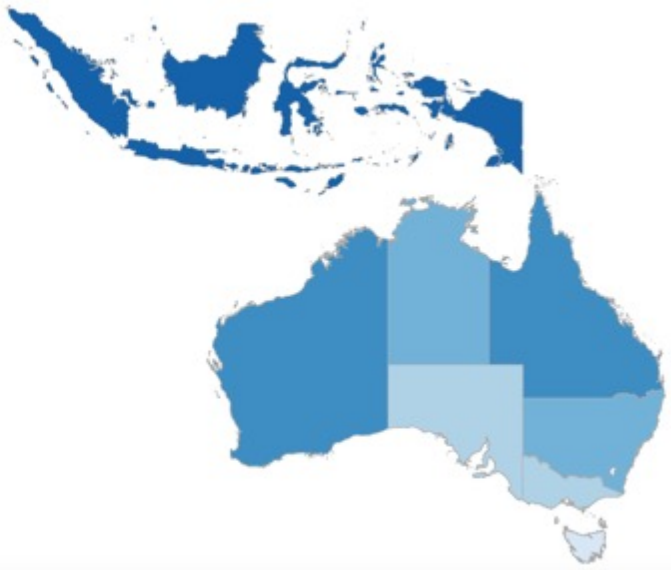
UK	6,600
Europe	116,000
Africa	445,000

In the UK:

Only ~330 High-Density Hydro projects would provide ~10GW or ~25% of the UK's predicted 2040 energy storage needs (Aurora).

RheEnergise





Total available market (GW) by country/state

Below 1,000 sites	Below 20 GW potential
1,000 – 2,500	20 – 50 GW
2,500 – 5,000	50 – 100 GW
5,000 – 10,000	100 – 200 GW
10,000 – 25,000	200 – 500 GW
25,000 – 50,000	500 – 1000 GW
Over 50,000 sites	Over 1,000 GW potential

Assumptions:

3,000m max horizontal
8,000sqm site area
75m to 300m vertical elevation
Ave site capacity 20MW

No shortage of sites.

Opportunities for projects where there is a shortage of water, due to the advantage of closed loop system minimising evaporation and HD-Hydro is not affected by high ambient temperatures.

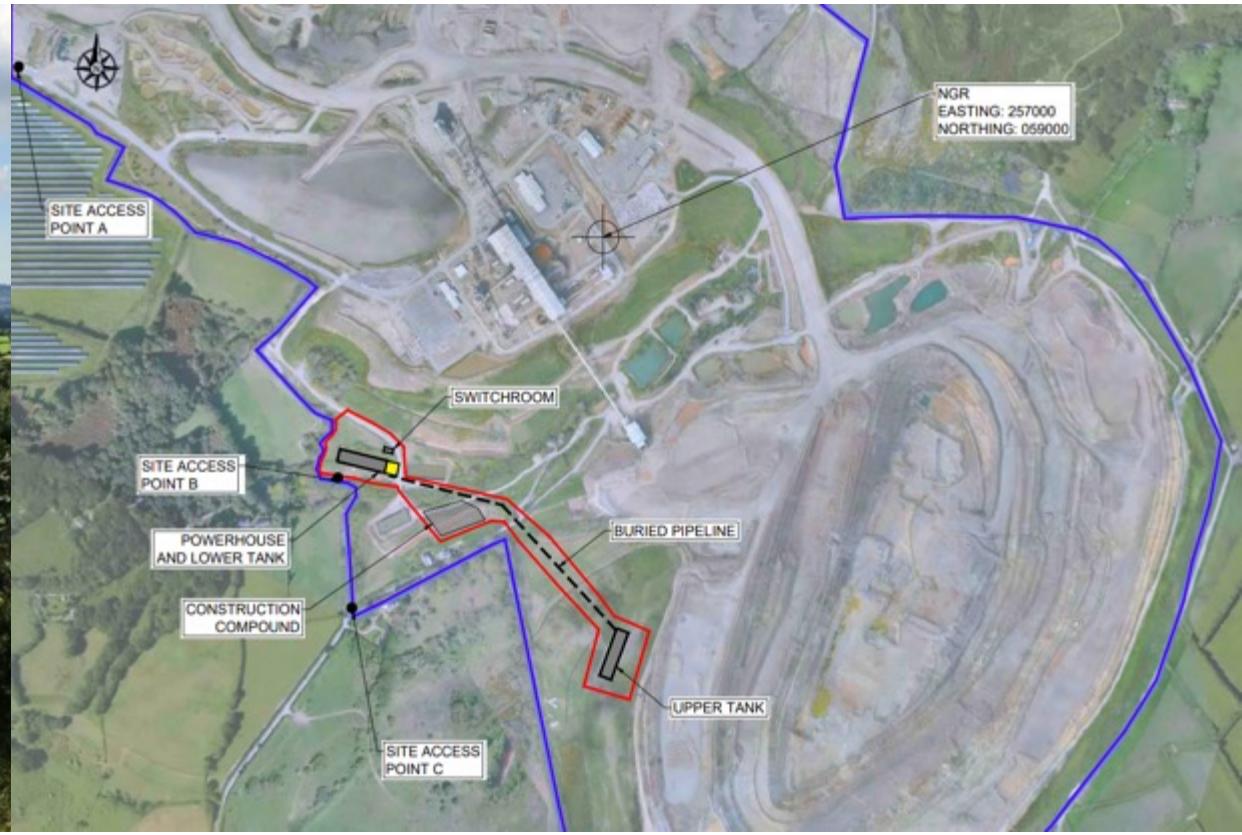
RheEnergise

High-Density Hydro®

Enabling the energy transition with low-cost, scalable storage

Michael McKee, The LoDES project

Department for Business, Energy & Industrial Strategy



Project Overview

RheEnergise

3rd Party Fluid Testing

BLUE FROG SCIENTIFIC

SOCOTEC

High Density Hydro Phase2 (condensed)		Start Date	End Date	Weeks
#	Activity	1-Sep-22	31-Jul-24	99.9
WP1	Mobilisation Phase 2	1-Sep-22	24-Feb-23	25.1
WP2	Integration, Coordination & Management	23-Sep-22	31-Jul-24	96.7
WP3	System Design	23-Sep-22	28-Feb-23	22.6
WP4	EPC & Site Works	1-Mar-23	31-Jul-24	74.0
WP5	HD Turbine: Research, Design & Development	1-Sep-22	31-Jul-24	99.9
WP6	Fluid Management System, Design & Development	1-Sep-22	6-Jan-24	70.3
WP7	Power Conversion & Control	22-Sep-22	30-Nov-23	62.0
WP8	HD Valves: Research, Design & Development	22-Sep-22	13-May-24	85.6
WP9	Planning	25-Sep-22	31-Jan-23	18.3
WP10	Fluid Supply Chain	23-Sep-22	20-May-24	86.4
WP11	Knowledge Dissemination	1-Sep-22	18-Jul-24	98.0

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Michael Mc Kee,
Cost Engineer
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NW5 1LP

https://www.rheenergise.com/

Pitch 12

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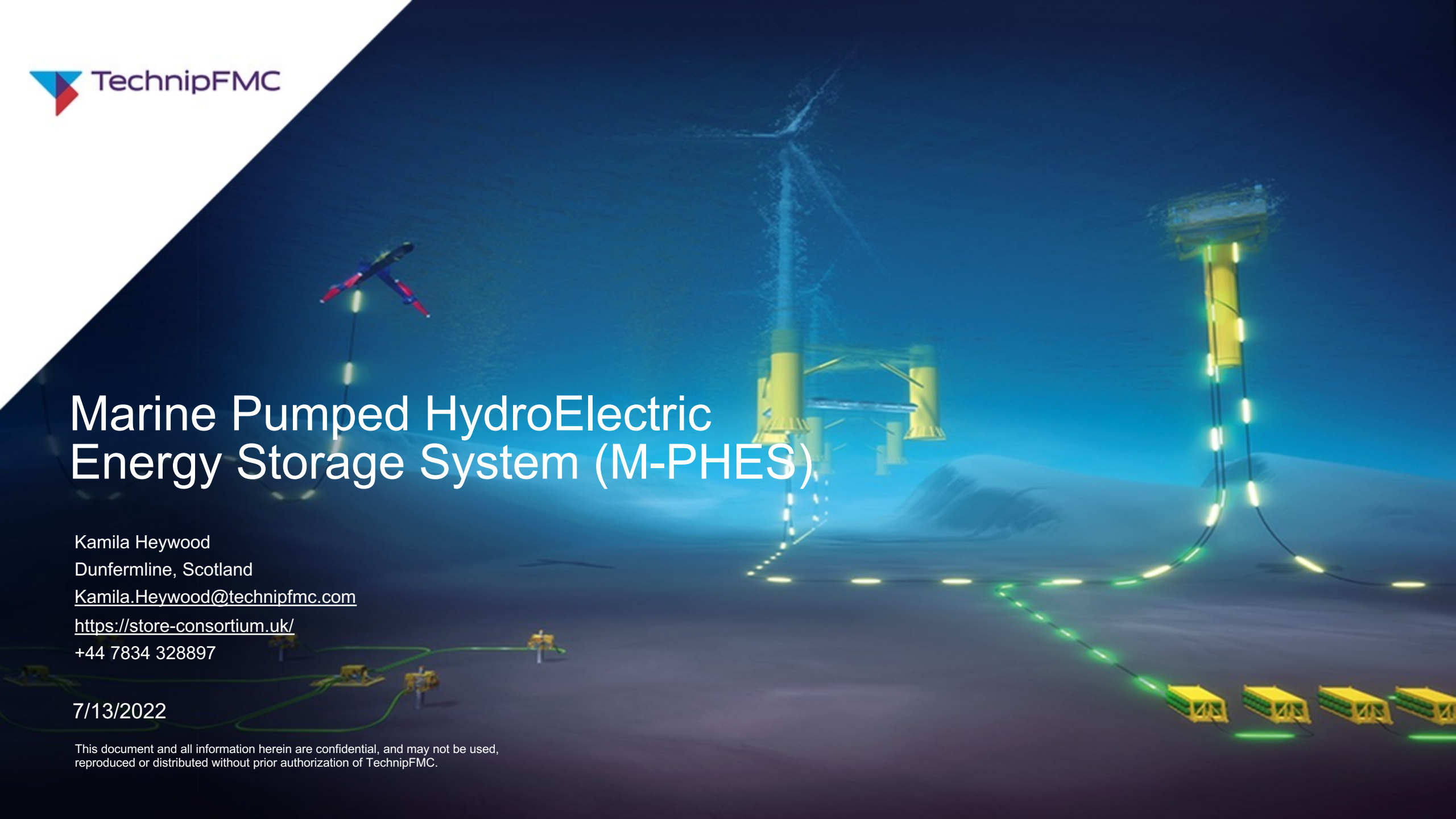
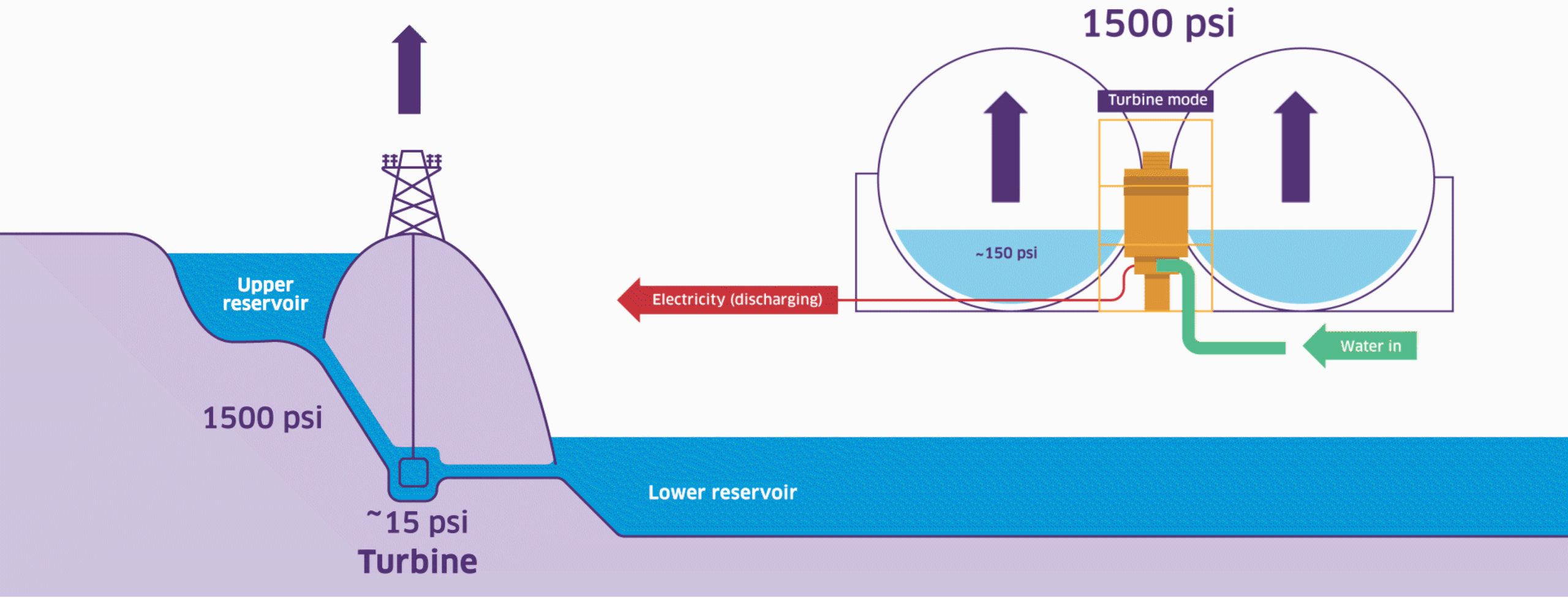
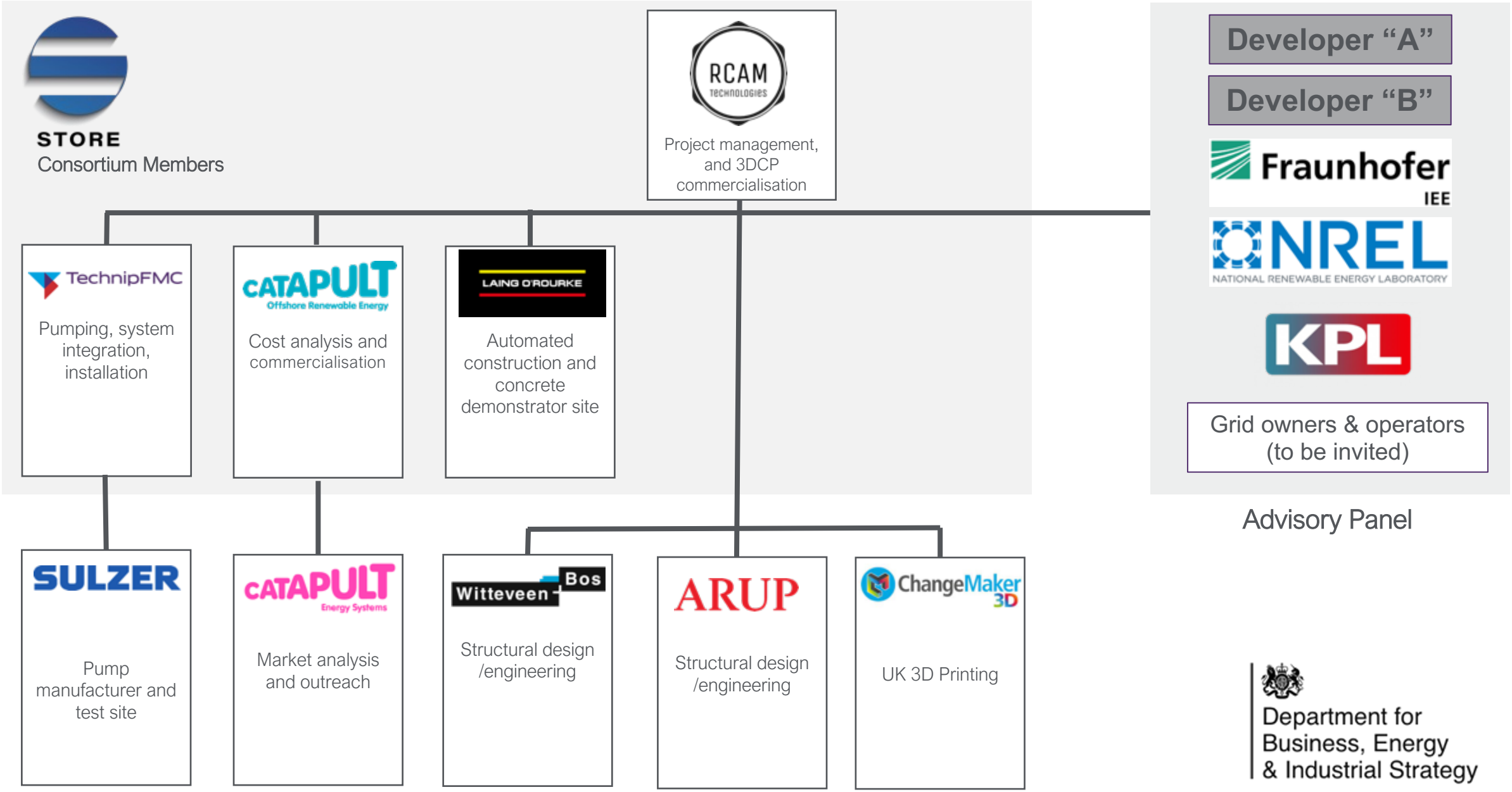


Marine Pumped HydroElectric Energy Storage System (M-PHES)

Kamila Heywood
Dunfermline, Scotland
Kamila.Heywood@technipfmc.com
https://store-consortium.uk/
+44 7834 328897

7/13/2022

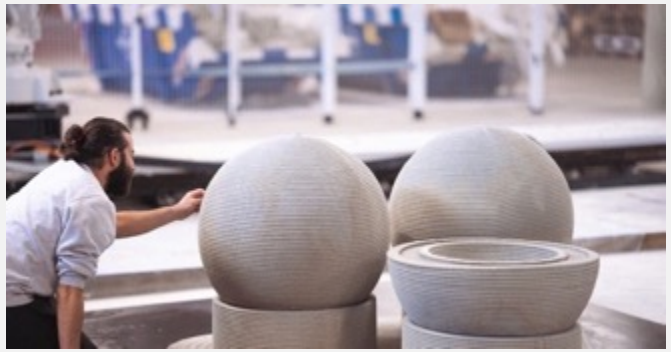

1500 psi
Turbine mode
~150 psi
Electricity (discharging)
Water in
Upper reservoir
1500 psi
Lower reservoir
~15 psi
Turbine


STORE
Consortium Members
RCAM TECHNOLOGIES
Project management, and 3DCP commercialisation
TechnipFMC
Pumping, system integration, installation
CATAPULT Offshore Renewable Energy
Cost analysis and commercialisation
LAING O'ROURKE
Automated construction and concrete demonstrator site
SULZER
Pump manufacturer and test site
CATAPULT Energy Systems
Market analysis and outreach
Witteveen+Bos
Structural design /engineering
ARUP
Structural design /engineering
ChangeMaker 3D
UK 3D Printing
Developer "A"
Developer "B"
Fraunhofer IEE
NREL NATIONAL RENEWABLE ENERGY LABORATORY
KPL
Grid owners & operators (to be invited)
Advisory Panel
Department for Business, Energy & Industrial Strategy

M-PHES Full Scale Demo Project

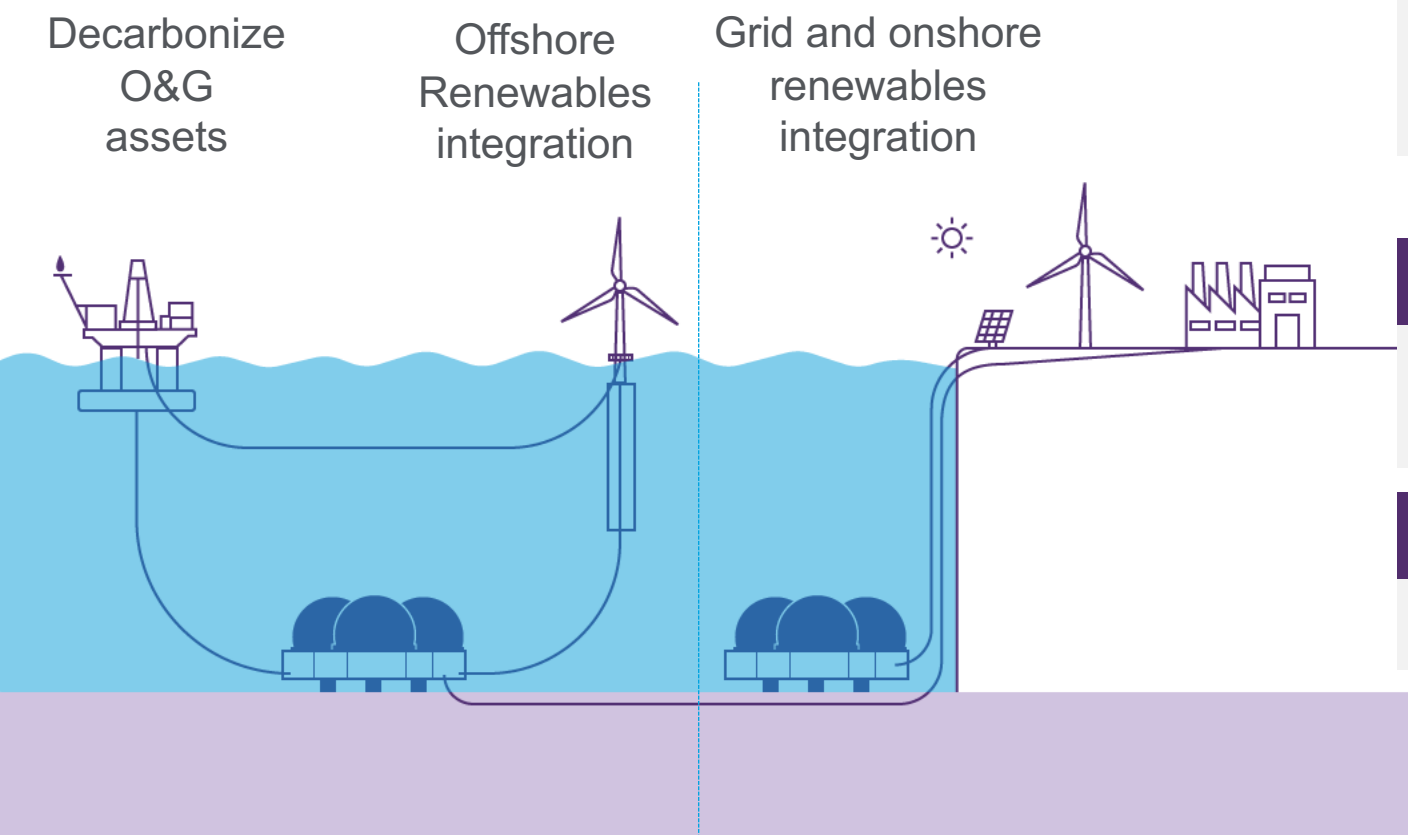
Phase 1: £150,000 Phase 2: £9,500,000

- Technical and commercial feasibility proven through BEIS LODES Phase 1 project
- TRL 4 achieved by earlier 1:10 scale prototype demonstration by Fraunhofer Institute in Germany
- TRL 6 full scale (5MW) prototype test is planned in simulated working environment at Sulzer test facility
    - Min 4 hours operation in pump mode (charging)
    - Min 4 hours operation in turbine mode (discharging)
- Demonstration of concrete additive manufacturing capability in the UK
- Market outreach and revenue streams assessment
- LCOS and development CAPEX assessment



Feasibility Study Q1-Q2 2022 → Full scale (TRL 6) prototype demonstration 2022-2024 → First commercial pilot (TRL7) 2026 → First commercial scale storage park (TRL8) 2027 → Commercial production (TRL9) 2029

M-PHES Commercial Applications



Integration with the grid:

- Wholesale energy market, where energy is bought at low cost and sold at peak prices
- Fast reserve market, where energy is used to control grid energy variations
- Balancing mechanism and capacity markets

Integration with renewable floating offshore power sources:

- To overcome power intermittency
- To facilitate O&G infrastructure decarbonisation

Integration with renewable power sources and the grid:

- To balance supply and demand in power systems

TechnipFMC

Pitch 13

13

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Project Title:	Compressed Air Energy Storage in Pipelines
Contact name:	Dr Murray Anderson
Town/City:	Aberdeen
Email:	murray.anderson@crondall-energy.com
Phone:	07427 644100
Website:	www.crondall-energy.com

Feasibility of Long-term Storage using Decommissioned Pipelines

Crondall Energy Subsea and Durham University have formed a partnership

- Develop a prototype compressed air energy storage (CAES) system using decommissioned oil & gas pipelines as the storage

Principal of compressed air energy storage (CAES)

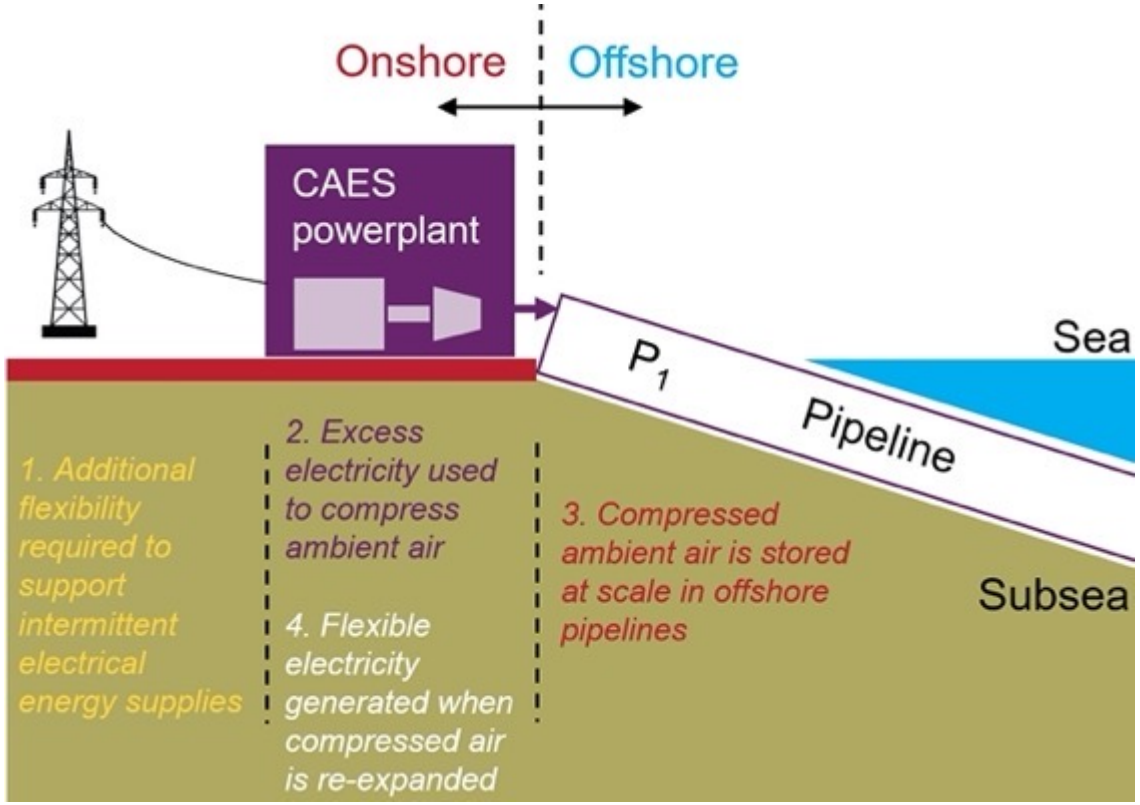
- Air is compressed into a high-pressure fixed volume store during periods of excess power generation.
- Air is decompressed during periods of excess demand through turbines to recover stored energy.

The systems are well-established and cost effective

- Major components are well proven and include:
  - electrically driven air compressors
  - gas turbine driven generators
  - storage medium

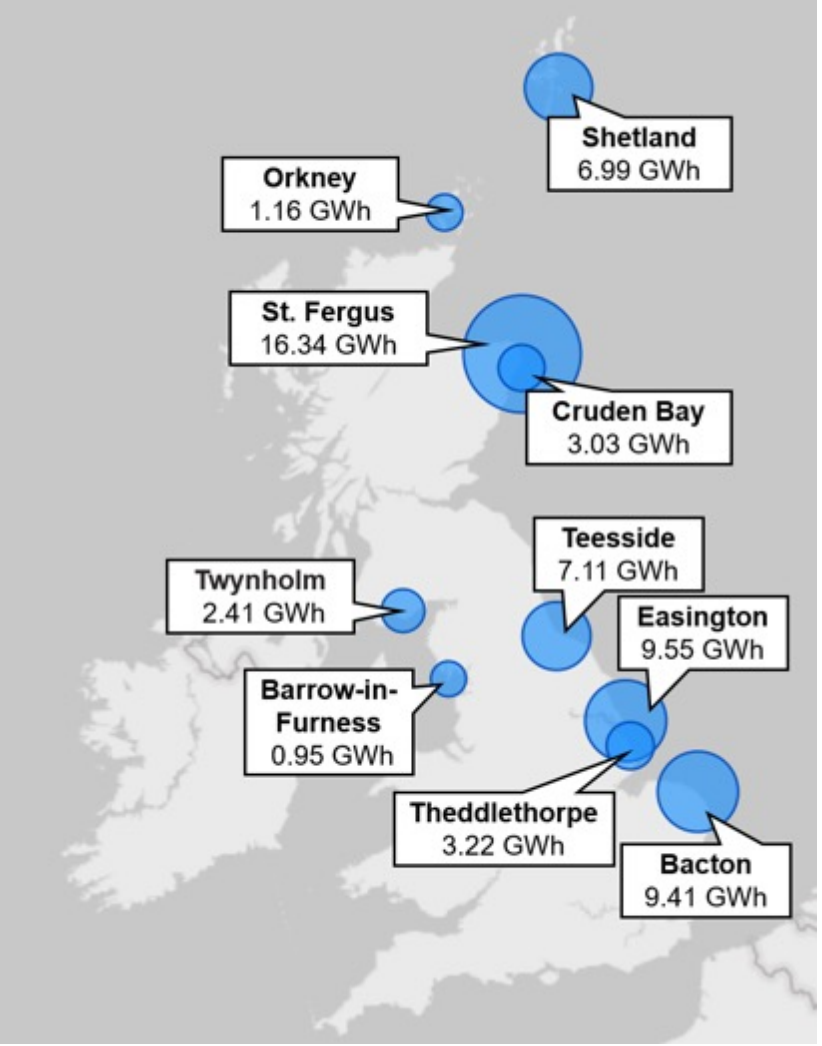
Use of pipeline systems as the storage medium

- UK has a large portfolio of mature offshore pipelines
- High operational pressures (100 -500 bar) and long lengths (hundreds of kilometres) mean a high storage volume for compressed air



Key Highlights

High potential storage capacity	•The total rated energy storage net capacity available for the 52 UK connected large pipelines is 60.17 GWh
Each individual element of the system is at a high TRL	•CAES is a very well established storage method
Pipeline and Energy infrastructure in similar locations	•Co-located systems enable for local decarbonisation to take place at lower cost, with pace, and with greater certainty on managing networks and market conditions.
Decouples the power and energy components	•Enables high energy storage capacity (~1GWH range) for a range of storage durations of between an hour and a month.
Fully developed prototype design and development plan	•Prototype system at designated site within DNV Spadeadam •CAES system, pipeline and other components will be designed, procured and installed within the proposed timeframe between September 2022 and September 2024.



Future Opportunities

Crondall and Durham University working closely on the technology

- Support from TAQA energy to provide information and data on their pipeline assets
- Support from Third Energy to explore opportunities for a pilot project or scaled up commercial development
- Discussions with several major oil & gas operators within the UK

Outwith BEIS competition there are wider opportunities

- Grid connected charging and discharging linked to pipeline with beach connection in UK (BEIS Scope)
- Charging energy offshore (Wind farm) and discharging energy onshore at beach connection
- Electrification of offshore platforms providing fully offshore battery system with infield pipelines
- International opportunities

Funding Opportunities

- Prototype system (~£9m) will allow TRL of 8 or 9 and de-risk the technology for a full pilot plant
- Ideal for public innovation funding – ambitious project with scope to support the just energy transition by improving the energy system resilience but also repurposing legacy oil & gas assets that will require decommissioning
- Oil & gas majors – Technology can be a major assistance in decommissioning and interlinking new renewable projects with collocated oil & gas assets
- Private Equity – Can provide a high percentage of storage potential in what's expected to be a multibillion-pound market

Pitch 14

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Innovate UK
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Cheesecake Energy

FlexiTanker project

Mike Simpson

mike@cheesecakeenergy.com

Nottingham

www.cheesecakeenergy.com

Department for Business, Energy & Industrial Strategy

Project Overview

Objective: Assess our thermal and compressed air **energy storage** system to support a new mixed-use development for **Colchester Borough Council**

Phase 1 (complete)

Economic and technical feasibility of integrating CEL's systems to support Colchester Northern Gateway development

- Engaged with DNO and grid connection secured
- Planning engagement
- Extension studies (heat network integration & real inertia)

Total cost: £139,410

Phase 2 (Dec 22 – Mar 25)

Install a total energy storage capacity of 2.25 MW at 5-hour duration

Integrate with existing heat network and decarbonise sports centre heating

Unlock access to electricity supply to support the Northern Gateway development

Total cost: £9.44m

Delivery Date: 2024

Storage capacity: 2.25 MW /11 MWh

Department for Business, Energy & Industrial Strategy

Colchester AMPHORA ENERGY

Colchester

Cheesecake Energy

Key results, marketplace and highlights

Identified need for 15 modules across two locations in Colchester

Work with UKPNS identified a strong need for energy storage due to a **severely constrained grid** in the local area

Grid upgrades estimated to cost **£10-15m** with timescales potentially running out to 2030

Technoeconomic study carried out by Cornwall Insight showed an attractive business case for the energy storage system

Feasibility studies identified the possibility for the CEL's technology to **remove the need for gas heating** of the Colchester Northern Gateway Sport Centre, saving significant cost and emissions

CEL's energy storage offers the potential to **reduce bills by 10%** for the district heat network customers on top of grid upgrade savings

A market opportunity assessment by UKPNS showed a range of promising applications for the technology across grid upgrade avoidance, solar plus storage and behind-the-meter energy bill management

A grid upgrade for this site has been quoted at £10-15m – a CEL system could reduce the upgrade cost by almost 50%

With thanks to:

Department for Business, Energy & Industrial Strategy

UK Power Networks Services
The power to deliver a better future

CORNWALL INSIGHT
CREATING CLARITY

hsp consulting

Opportunities for furthering the project

For end users seeking longer-duration storage at commercial and industrial scale to expand and decarbonise their electricity and heat supply, we offer:

- Robust and affordable alternative to delays and cost of major grid upgrades
- Ability to decarbonise heat and opportunity to capture and monetise waste heat too
- Use of existing supply chains, allowing major industrial and automotive manufacturers and infrastructure to be part of the clean energy transition
- Directly creating 30 further skilled roles by 2025, drawing on existing automotive and power generation knowhow

Department for Business, Energy & Industrial Strategy

We'd love to hear from prospective end users, manufacturing partners and suppliers – do approach us afterward.

Investing in Energy storage Panel Debate

Katherine Vinnicombe, **Eel Power** *(Panel Chair)*

Geoffrey Smith **UKIB**

Nomi Ahmad, Operating Partner, **Sandbrook Capital**

John Metzler **Shell**

Paul Mason **Harmony Energy**

Panel Debate/ Q&A, Panel welcome all questions

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Project overviews session 2 - Stream 2 Feasibility study

15.	**Project Name: INHERENT**	Charles Taylor
16.	**Project Name: Exergy3**	Markus Ronde
17.	**Project Name: ADSorB**	Dr Robert Barthorpe
18.	**Project Name: Hydrilyte™ Refueller Prototype**	Willie Reilly
19.	**Project Name: HEOS**	Dan Perry
20.	**Project Name: HyDUS**	Tom Scott

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Pitch 15

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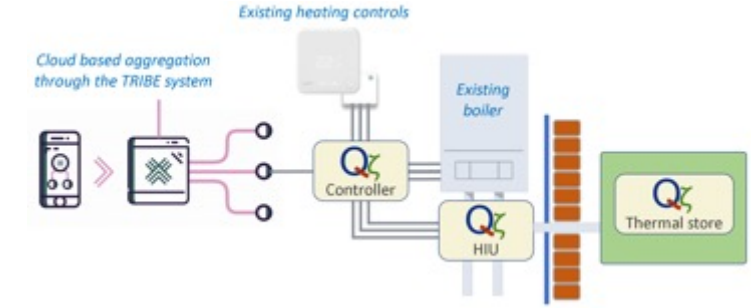
LODES Showcase 13/07/2022

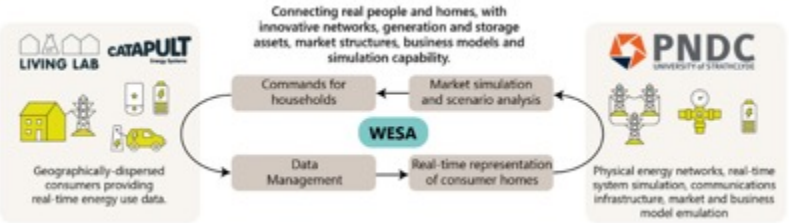
Project Title:	**Project INHERENT**
Contact name:	Charles Taylor
Town/City:	Edinburgh
Email:	Charles.taylor@q-zeta.com
Phone:	078844358974
Website:	www.q-zeta.com



Q-zeta & Project INHERENT

- **Q-zeta is a re-imagined and re-engineered indirect hot water store for domestic space and water heating:**
  - ⇒ Step change improvements in energy-density and RTE
  - ⇒ Low-cost & rapidly scalable – built from existing industrialised components
  - ⇒ Easy to integrate with existing heating systems in over 90% of UK homes
- **Lightsource Labs Tribe/Atlas platform provides coordinated charging control to deliver low cost heat & flexibility services**
- **Result – decarbonised heat and large-scale grid storage with a single technical solution & investment**

  >50MtCO2e reduction, 1TWh/140GW of distributed storage
- **Project INHERENT accelerates demonstration of the whole system to allow market launch as early as 2024**



'WESA' Whole Energy Systems Accelerator

INHERENT – key Phase 1 outcomes

Thorough technology assessment completed

- Capable of mitigating 85%+ of GHG from typical installation within current electrical distribution system constraints
- Expected RTE 97%
- £3,000 per 50kWh installation achievable

Integrated Q-zeta system design for the Phase 2 trial created

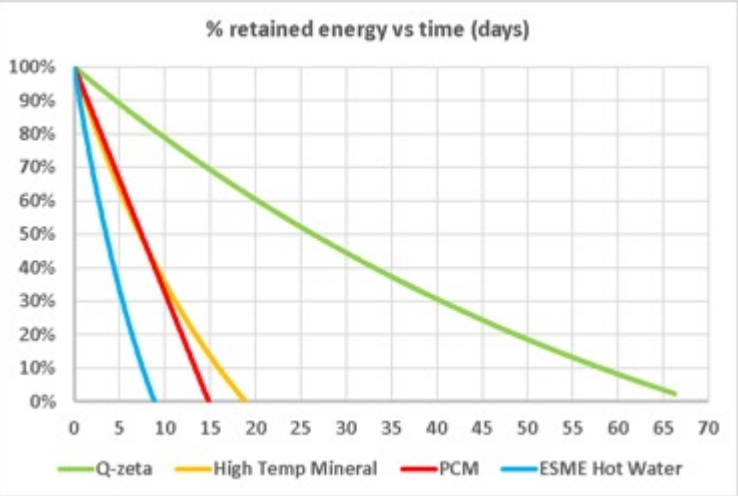
- Met or exceeded target metrics
- Supply chain established
- Fully costed design & qualification process produced

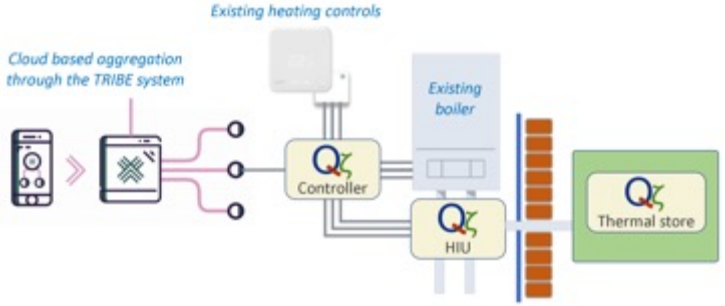
Sophisticated Phase 2 validation programme defined

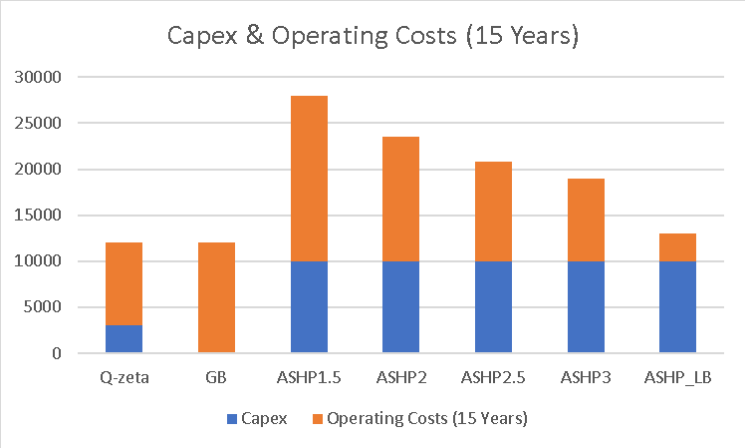
- 25 units to be deployed in the ES Catapult Living Lab
- A further ~100 “digital-twin” units included
- All real-time data to be fed to the ‘WESA’ test platform to simulate a large-scale deployment under various real and simulated conditions

Route to market assessed

- Initial and longer-term addressable market defined (c.15 million homes)
- Preliminary analysis shows can be <u>at least</u> cost competitive with ASHP
- Opportunities identified within existing grid flexibility markets



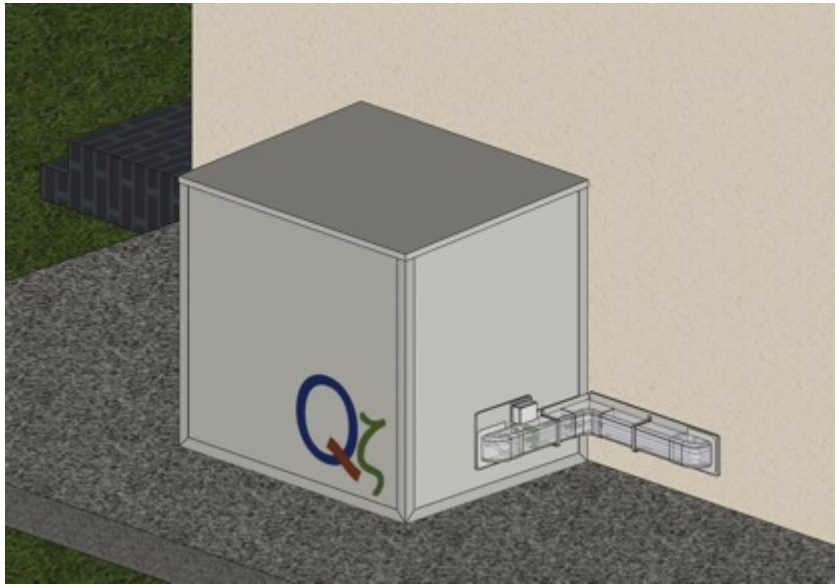




Next steps & opportunities

LODES Phase 2 Project

- Rapid progression to TRL8 and CRL3a
- Demonstration of reliable space and water heating in real homes
- Demonstration coordinated control can deliver grid flexibility benefits
- Validation of whole energy system impact of a large scale array
- Position for market launch 2024/25



Parallel commercialisation activities

- Secure parallel investment in Q-zeta Ltd
- Productisation & certification
- Build initial order book
- Position for industrial partnership or acquisition

Thank you – any questions

www.q-zeta.com @Q_ZetaHeat

Pitch 17

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ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

Project ADSorB

Advanced Distributed Storage for grid Benefits

Contact: Dr Robert Barthorpe
Email: r.j.barthorpe@sheffield.ac.uk
Phone: 0114 2227762
Website: abc-rp.com

mixergy | Loughborough University | The University Of Sheffield. | Swansea University Prifysgol Abertawe

The challenge

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

Decarbonisation of domestic heat offers both huge opportunities and challenges.

Increased penetration of renewable energy generation allied to the electrification of domestic heating systems is expected to create substantial grid balancing issues.

Imbalances in inter-seasonal supply and demand present a particular challenge, promoting interest in long-duration electrical and thermal energy storage.

Our approach

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

Modular units

for domestic energy systems, for use in new build or retrofit

Thermal storage

utilising innovative, extended-duration thermal storage technologies

Decoupling generation

from heat demand over time periods ranging from a few hours to weeks

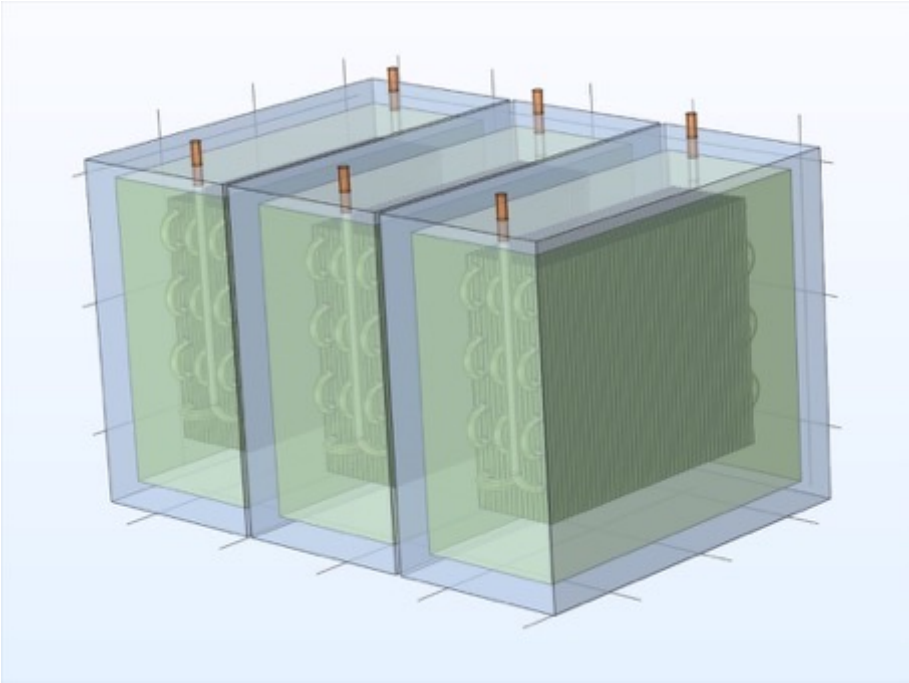
Occupant benefits

through reduced consumption and grid benefits through deferral

Phase 1: Phase Change Material

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

0.18m^3 system comprising 3 modules containing bio-based material.



Flexible system enables variable power outputs, modulated based on demand.

10 kWh Thermal storage capacity

17+ kW Power output for 20 minutes at 50°C with inlet temperature of 10°C

24+ hours Storage duration.

mixergy

Swansea University Prifysgol Abertawe

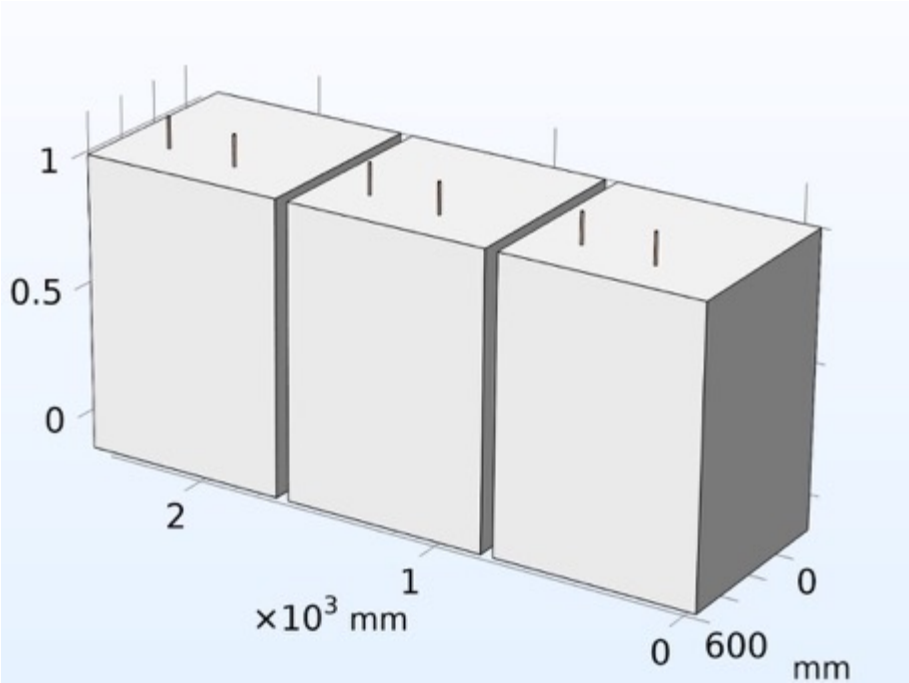
The University Of Sheffield.

Loughborough University

Phase 1: Thermochemical

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

1m^3 system comprises 3 modules containing salt hydrate active material.



Flexible system enables variable power outputs, modulated based on demand.

144 kWh — Thermal storage capacity

12+ kW — Target power output at 60°C and above

∞ hours — Standing losses over days, weeks, or months.

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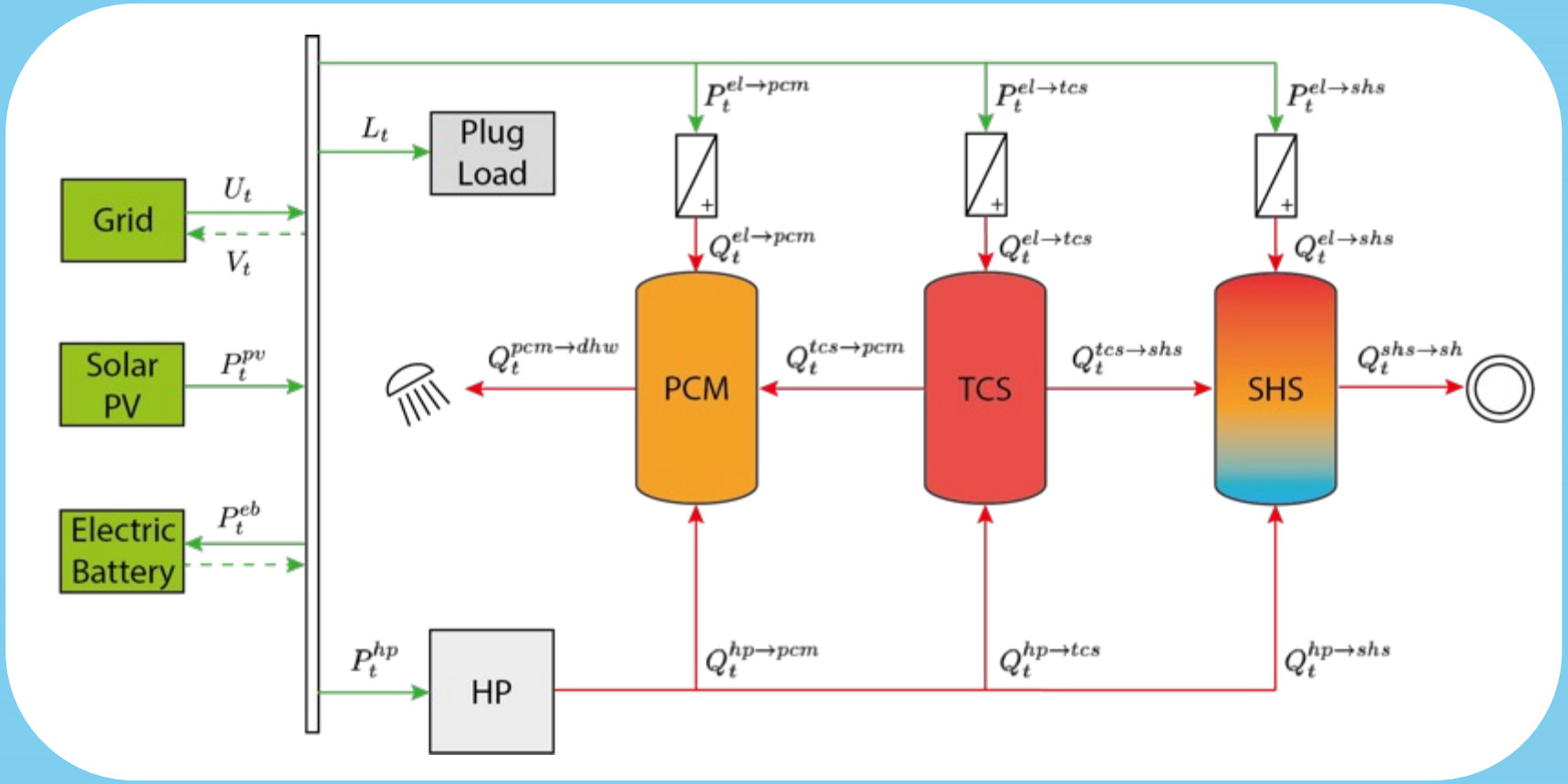
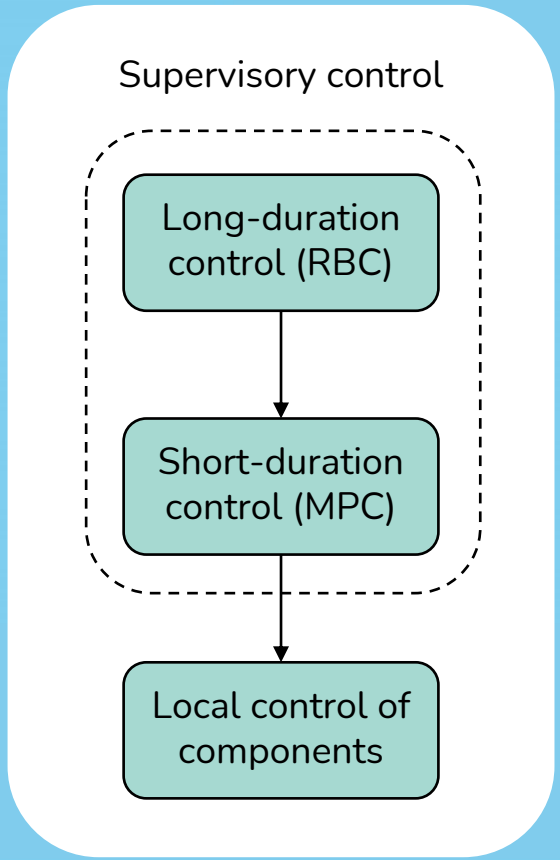
Swansea University Prifysgol Abertawe

The University Of Sheffield.

Loughborough University

Phase 1: Controller development





Phase 1: Carbon reduction

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

672
$kgCO^2/pa$

Thermochemical store

218
$kgCO^2/pa$

Phase Change Material store

Phase 1: UK Market

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

27
million

Domestic properties

600
thousand/pa

Heat pump installs by 2030

£100
Million/pa

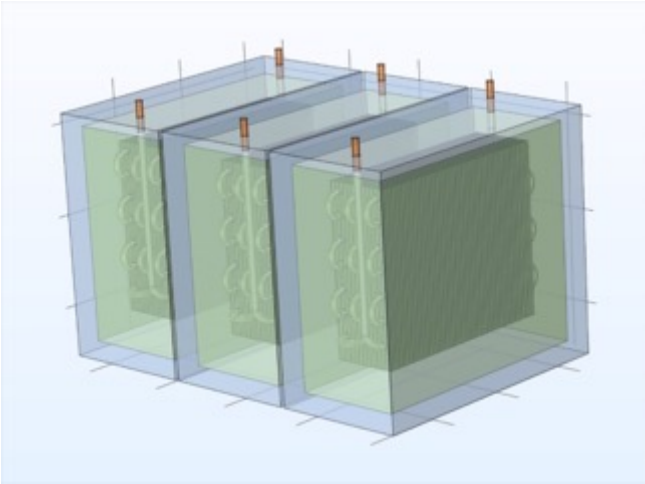
Total addressable market by 2030

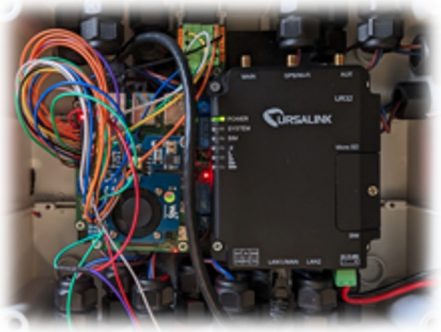
Phase 2: Development and Live demonstration

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

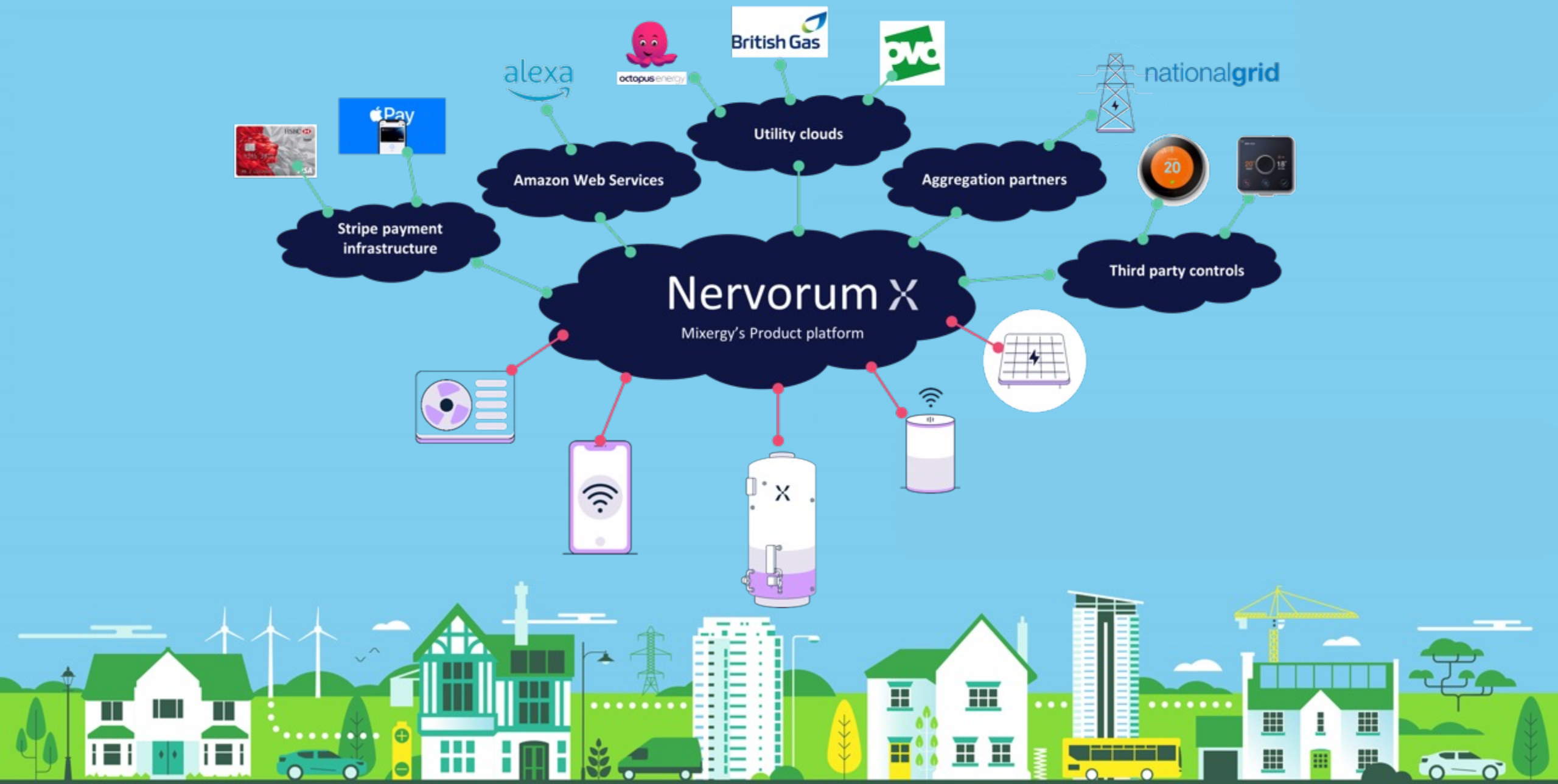
Phase 2: Productisation

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME





Phase 2: Productisation



Get in touch

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

info@abc-rp.com

@BuildingActive

www.abc-rp.com

Pitch 18

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corre.energy®

hydrogen based energy storage

Project Title: **Hydrilyte™ Refueller Prototype**

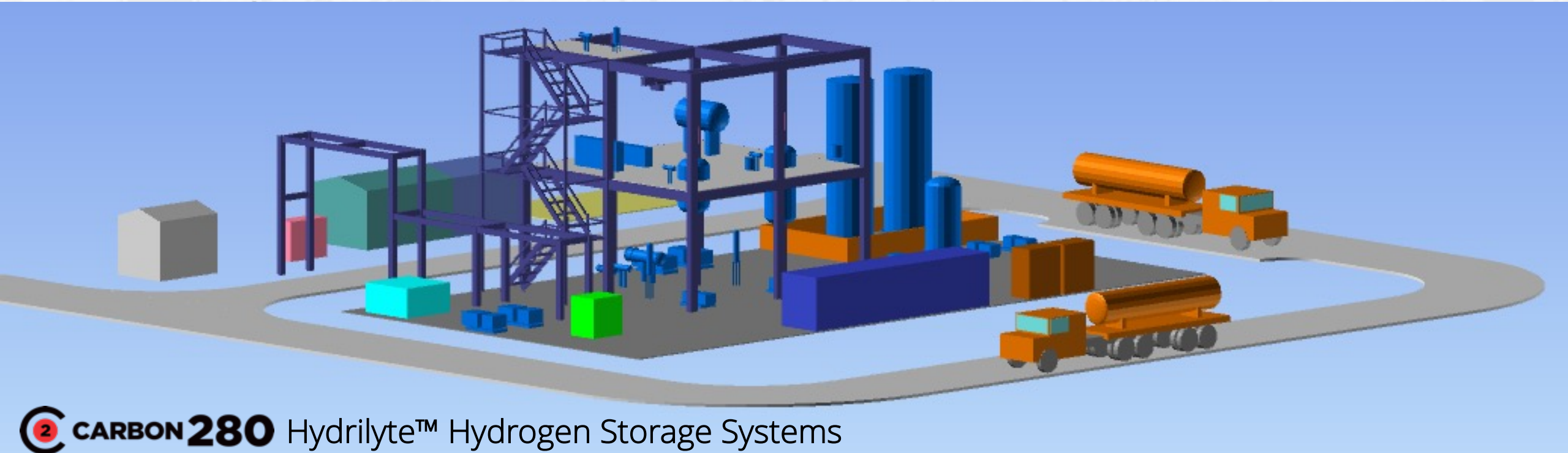
Contact name: Willie Reilly

Town/City: Glasgow

Email: willie.reilly@worley.com

Phone: 07584576349

Website: https://hydrilyte-refueller.com/



CARBON 280 Hydrilyte™ Hydrogen Storage Systems

Project Overview

Consortium Partners : Corre Energy, Carbon280, Worley, Element 2, Mentor Mon

The project will also demonstrate the viability of Carbon280's Hydrilyte™ for long duration storage and safe transportation of hydrogen from hydrogen hubs to hydrogen HGV refuelling stations.

Scheduled to start in Sept 2022, Mechanical Completion by March 2024 and Operational Testing complete by July 2024.

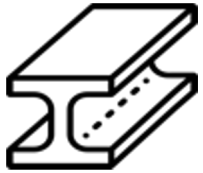
The project will design, build and test a prototype refueller with 50% capacity of a full-scale refuelling unit.

Key Applications for Carbon280's Hydrilyte™

corre energy

Renewable Firming

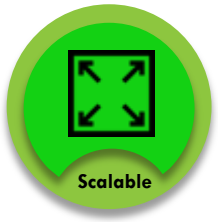
Gas Networks



Industrial

Refuellers

Energy Export



CARBON 280

Opportunities for furthering the project

- HRP Consortium member Element 2 – offtake agreement for Hydrilyte™ at UK hydrogen Refuellers.
- An alternative to LOHCs to enable UK Oil terminal transition from crude oil storage to hydrogen storage.

Carbon280 is planning a Series A Round in 2024

- For more information contact
- Mark Rheinlander, CEO Carbon280 mark@carbon280.com

Pitch 19

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KTN

Department for Business, Energy & Industrial Strategy

HEOS Project

Dan Perry (GHD)

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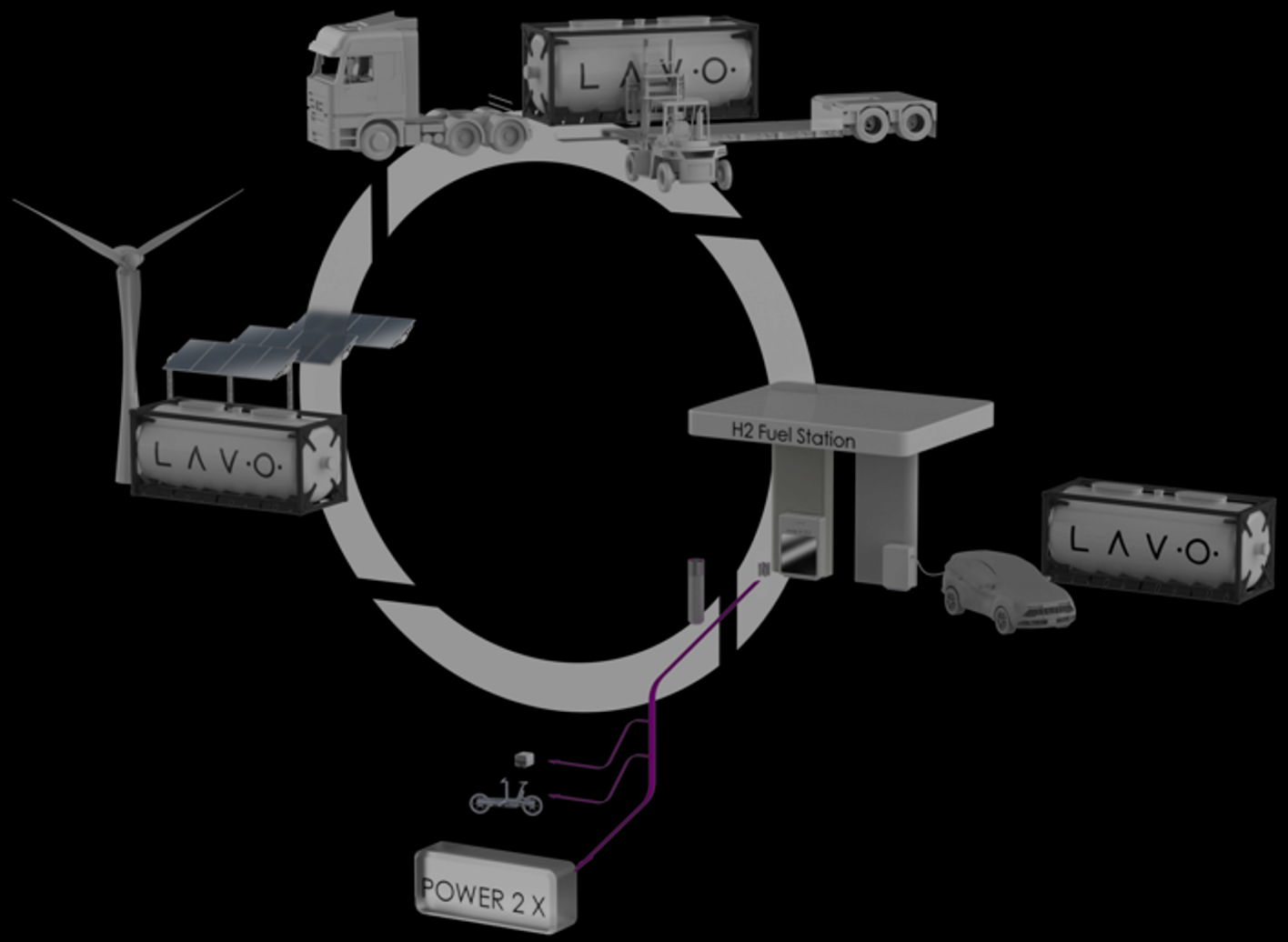
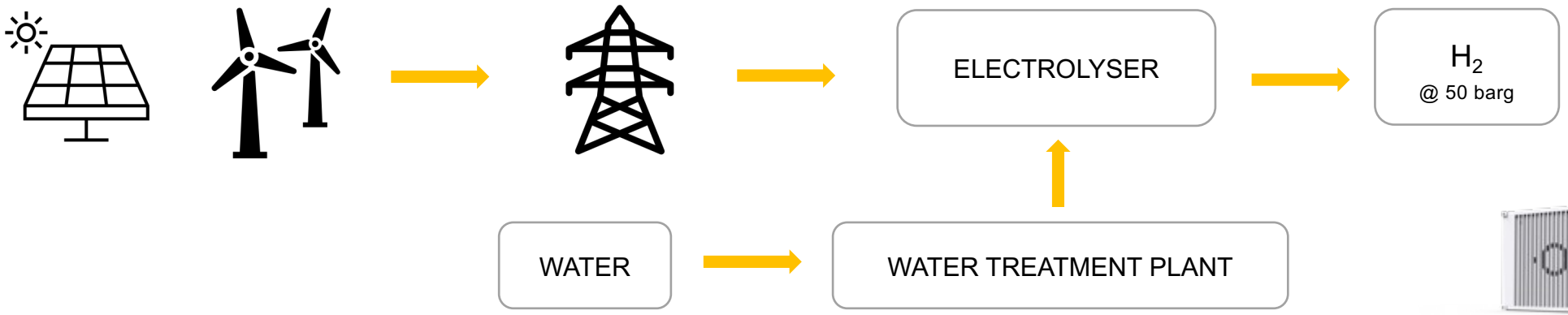
www.ghd.com



→ Project Summary

- Demonstrating creation of hydrogen in times of excess renewables electricity generation, and storing in long-duration energy storage medium (metal hydrides)
- Modular solution demonstrating scalability, providing benefits across multiple elements of an integrated energy system
- A simple, stackable hydrogen energy storage device, able to supply low or zero carbon hydrogen to a wide range of configurations and applications
- Cost-effective, safe and efficient lower pressure storage of hydrogen



→ Proposed Technology Engineering Design

100% Recyclable

Manufactured from non-toxic, non rare earth materials. Hydride is 100% recyclable at end of life of storage product.

Low Pressure

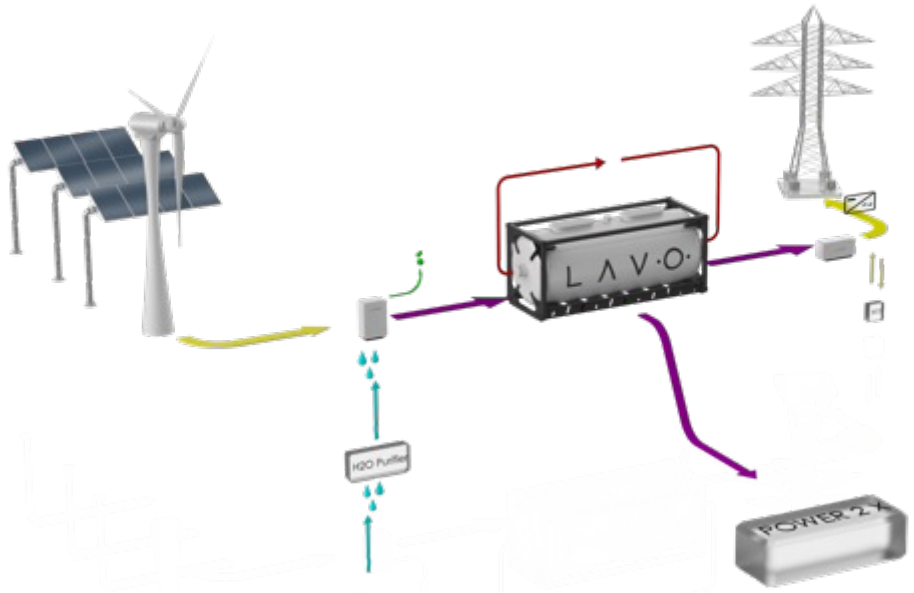
50 bar storage pressure. Solid state storage reduces risks and limits or eliminates compression requirements – higher efficiency, less cost and maintenance.

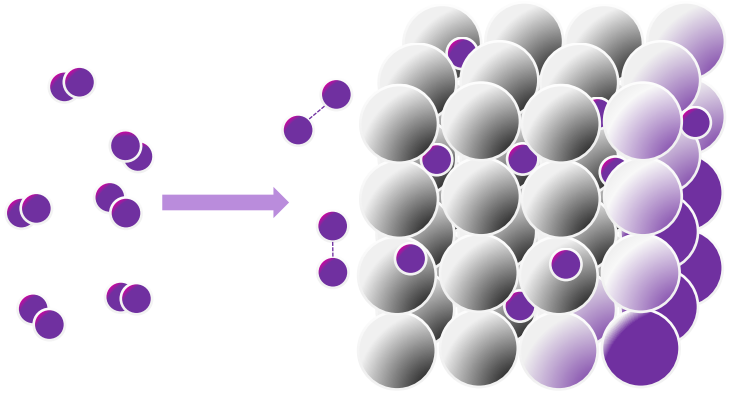
Long Life

Up to 20,000 cycles with minimal degradation of metal hydride performance. Less pressure vessel maintenance and testing requirements over lives of up to 30 years.

Compact

High energy density – equivalent energy density of hydrogen compressed to 1000 bar. Less than 10% the footprint of compressed hydrogen at same pressure.





Hydrogen Gas

Metal Hydride Lattice Structure

→ End Use Case: Industrial Fuel Switching

Glass Futures Partnership

We have partnered with Glass Futures and chosen to locate the HEOS demonstration plant at its Innovation Centre in Saint Helens.

Key benefits

- Glass Futures will utilise the hydrogen produced by the HEOS plant to fuel its glass furnace as a replacement for natural gas and for research and development of low carbon equipment for manufacturing glass, metals, ceramics and textiles.
- High grade heating is difficult to electrify and as such this use case is important to decarbonise with hydrogen.
- Hydrogen can be piped directly to the end user, thus negating the carbon emissions associated with transport via road tanker.

Thank You.

→ The Power of Commitment

BEIS
LONGER
DURATION
ENERGY
STORAGE
PHASE 1

↳ *For more information please visit our stand…*

Department for Business, Energy & Industrial Strategy

GHD

LAVO

Glass Futures

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HyDUS

urenco
The Energy to Succeed

EDF

UK Atomic Energy Authority

University of BRISTOL

Department for Business, Energy & Industrial Strategy

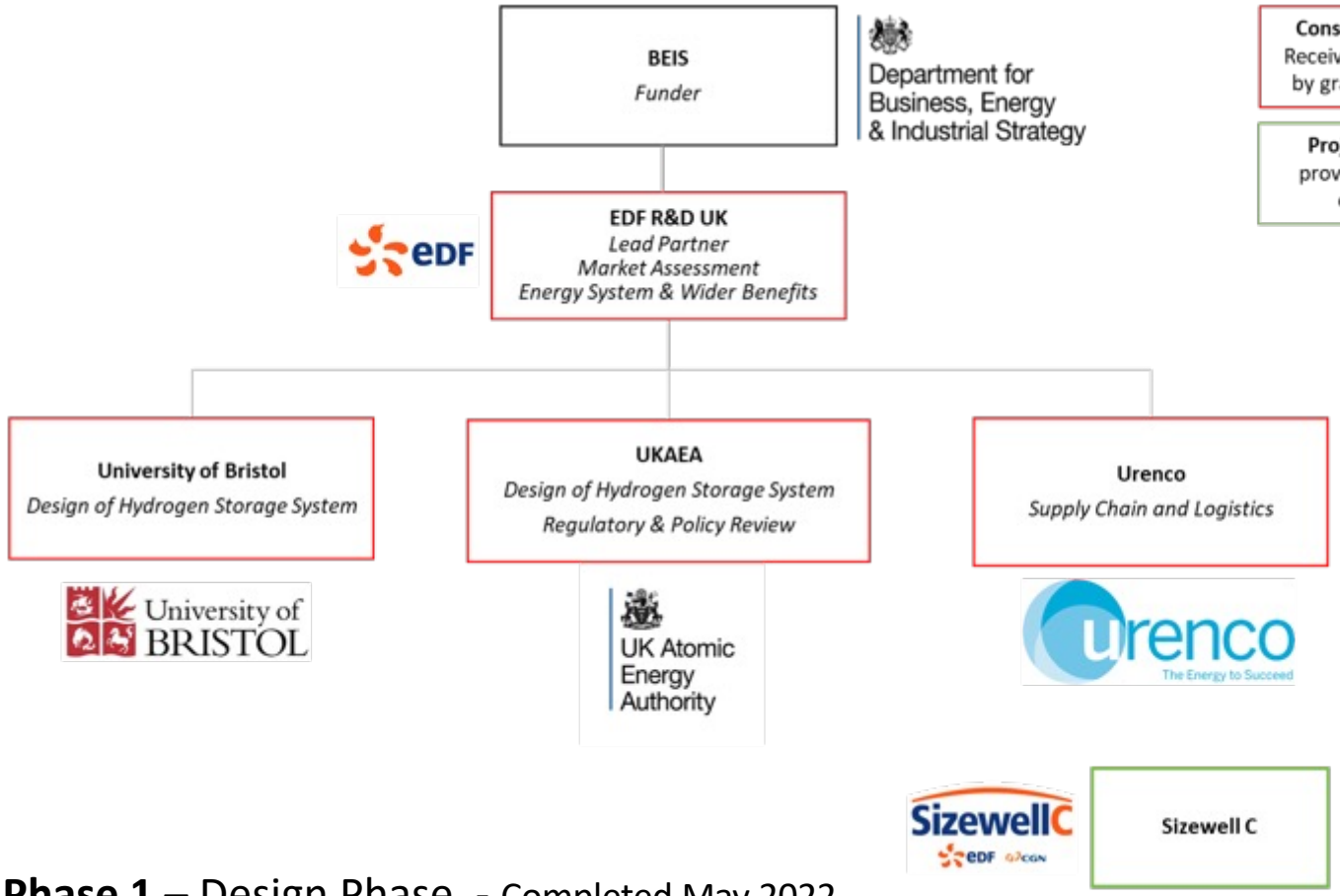
EDF

HyDUS – Hydrogen Depleted Uranium Storage

Responsive grid energy storage using heavy-metal hydrides

Contact: Professor Tom Scott
Email: t.b.scott@bristol.ac.uk
Website: southwestnuclearhub.ac.uk

Project Overview



Phase 1 – Design Phase - Completed May 2022
Phase 2 – Demonstrator Phase - Start in September 2022

Reaching Net Zero by 2050

If we move to a green energy future where nuclear energy provides the baseload electricity supply and is supplemented by renewables then we must have novel energy storage technologies to overcome production intermittency issues.

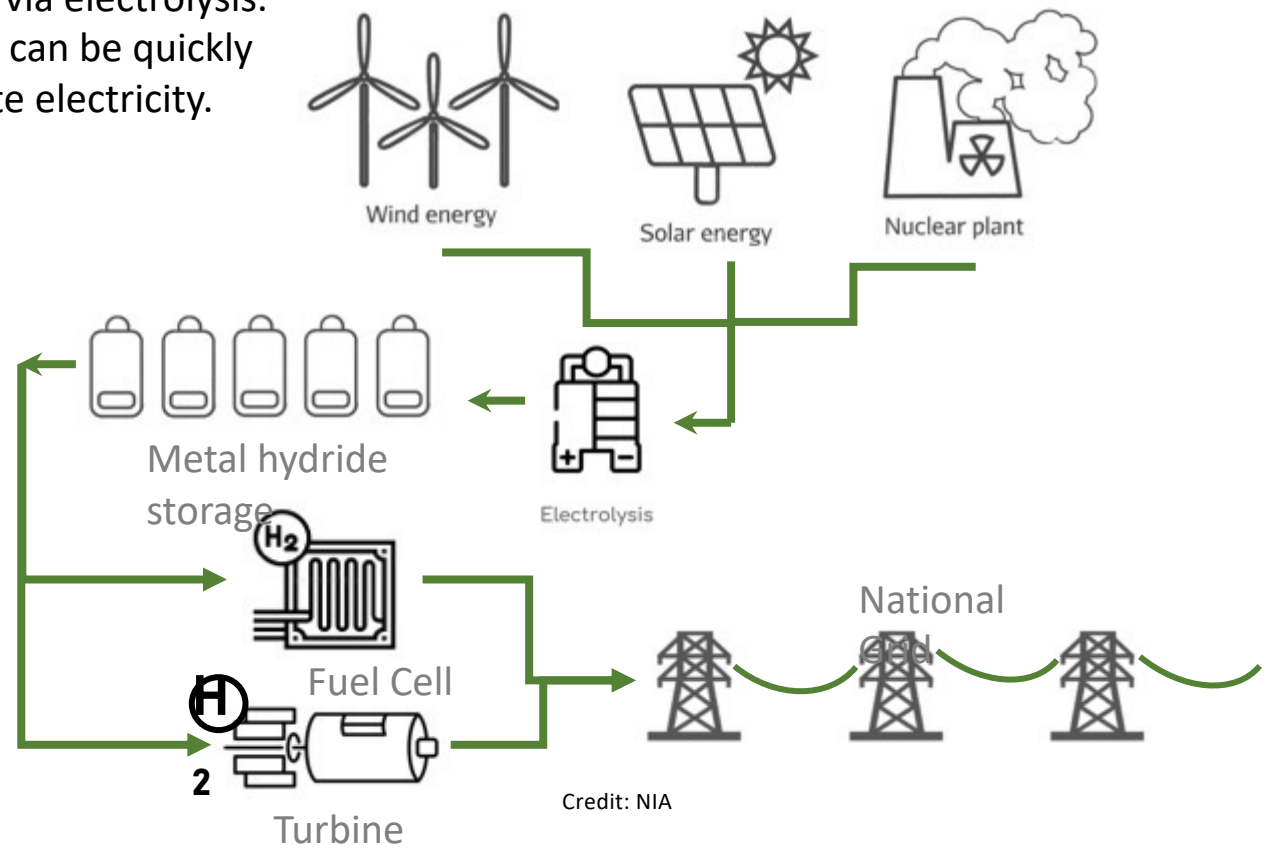
Natural gas has always been able to give an instant fix for electricity production but now **we need an alternative**, with **Hydrogen** looking a very promising candidate!

Key results, marketplace and highlights

A connected 'systems' concept for using reversible hydrogen storage that makes nuclear and renewables more competitive.

In off-peak periods, green electricity can be used to generate hydrogen via electrolysis. In turn, the hydrogen is stored on a series of modular hydride beds and can be quickly driven off in times of peak demand via a fuel cell or gas turbine to create electricity.

This means that the hydrogen is converted to electricity when it is **worth the most**. And the obvious place to initially locate this technology is on nuclear sites where it is **already regulated**.



Credit: NIA

Key Results

- **Clear business case** for commercialisation, which makes sustainable use of a national liability (depleted uranium).
- **Detailed design** and **safety case development** of a modular hydride storage bed.
- Concept design for a **full storage bed system**.

Opportunities for furthering the project

HyDUS technology utilises the unique opportunity that hydrogen enables, to both:

- Support the electricity system like conventional storage technology, and
- Provide hydrogen to decarbonise other sectors

Three key differentiators of HyDUS vs other H2 storage technologies are:

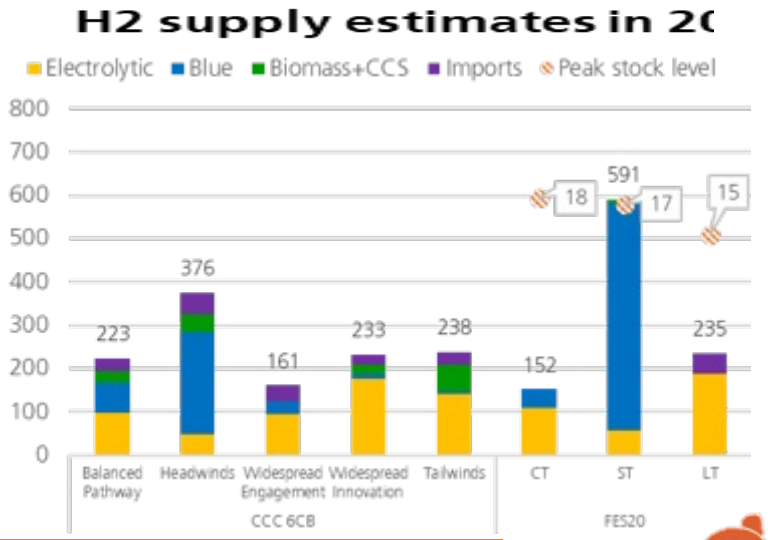
- **High storage density** by volume vs liquefied H2 stored in tanks – all at ambient Pressure and Temperature
- Can be deployed across the country with a **small footprint** that **is easily upscaled** by modularisation
- H2 released from the beds is **exceptionally clean**

Hydrogen Market

An evolving market intricately linked to global decarbonisation targets.
H2 can support decarbonisation in:

- Shipping
- Aviation
- Heavy Goods Vehicles
- Industrial Fuel Switching
- Peak Power

The CCC 6CB and National Grid FES20 estimate c.150-600 TWh of H2 demand by 2050, with up to 20TWh of H2 storage required



The Ofgem Strategic Innovation Fund

Kate Jones
Innovation Lead - Ofgem Programme

Innovate UK (UKRI)

The 3 pillars of the Strategic Innovation Fund

Strategic Alignment

Bring in the best businesses and academics from across energy and other sectors

Aligning energy innovation funding across government, UKRI and Ofgem

Enabling responsive policy and regulatory change informed by innovation

Agile 'Challenges'

1. Whole system integration

2. Heat

3. Data and Digital

4. Zero emissions transport

Discovery Projects
3 months / £150k

Alpha Projects
6 months / £500k

Beta Projects
c.4 yrs / c. £10m+

Commercialisation

Efficient procurement frameworks

Investor Expert Panel

Finance for rollout

International route to market (networks, utilities, investors)

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UKRI Innovate UK

What are we aiming to achieve?

1) Deliver a net zero energy system at lowest costs to consumers

2) Position the UK as the 'Silicon Valley' of energy systems

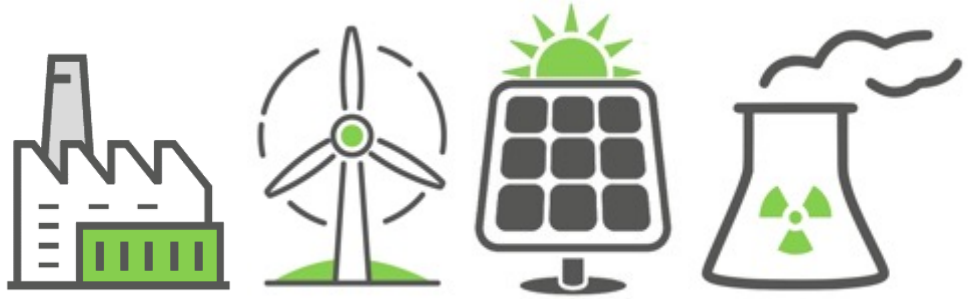
Cost of energy for consumers

Carbon reductions in the energy system

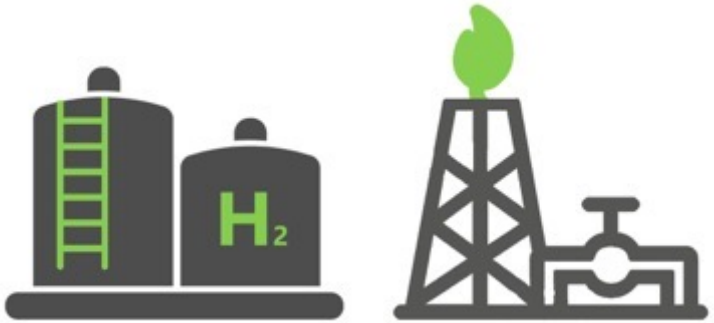
Improved access to revenues and markets

New products, processes, and services

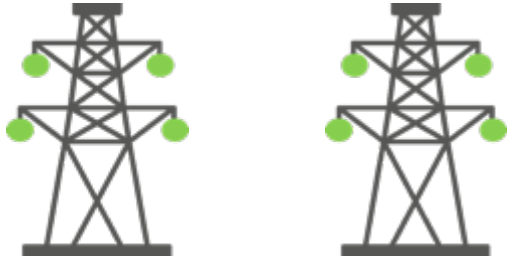
The UK Energy System



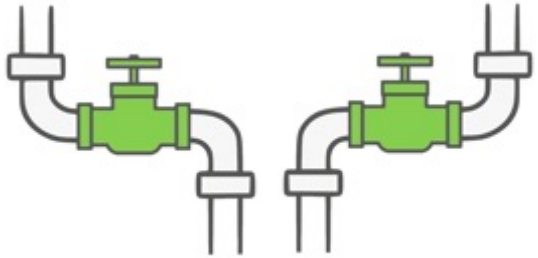
Electricity



Gas



Transmission



Distribution

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UKRI Innovate UK

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Innovate UK

Heat Balance – SPEN

Funding alignment scenarios

Scenario 1

Past Innovate UK funded projects develop a new project idea with energy network relevance, and use those previously funded assets as contributions in kind.

Scenario 2

Collaborative knowledge sharing and interaction between programmes, projects claim a proportion of resource funded by UKRI as a contribution in kind to the parallel SIF project

Scenario 3

Projects with shared partners and work packages across multiple programmes, funding from the other programme is considered a contribution

SIF Round 2 Challenges – open for ideas!

1. Supporting a just energy transition

2. Preparing for a net zero power system

3. Improving energy system resilience and robustness

4. Accelerating decarbonisation of major energy demands.

For more info visit - www.ofgem.gov.uk/publications/strategic-innovation-fund-round-two-innovation-challenges

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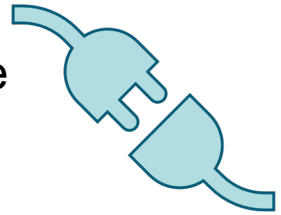
Regulatory change

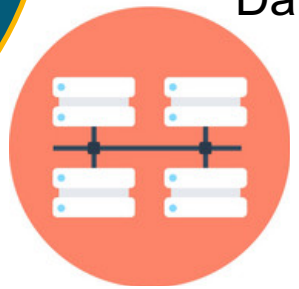
Public/private partnerships



Communications & outreach

Agile, aligned and goal-orientated innovation

Data science



Finance and investment

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The Energy Innovation Summit – 28th-29th September 2022

Energy Innovation Summit

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CATAPULT Network
ena energynetworks association
nationalgridESO
nationalgrid
SGN Your gas. Our network.
Scottish & Southern Electricity Networks
SP ENERGY NETWORKS
Northern Gas Networks
NORTHERN POWERGRID
Cadent Your Gas Network
WESTERN POWER DISTRIBUTION Serving the Midlands, South West and Wales
electricity northwest
UK Power Networks Delivering your electricity
WALES&WEST UTILITIES

Partners from across the energy system

Innovation learning

Wider Energy Systems Audience

Problem Solving Workshops

Aligned Innovation Programmes

Live Debate

ofgem UKRI Innovate UK

There is a famous saying…

"You can't cross a chasm in two small steps"

Net Zero is our chasm. We aim to cross it by taking one

Giant Leap, Together.

Challenges **Ideation** **Incubation** **Acceleration**

…the Giant Leap Together process

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