An Accelerated Hydrogen Pathway

Alastair Scott

SGN Energy Futures

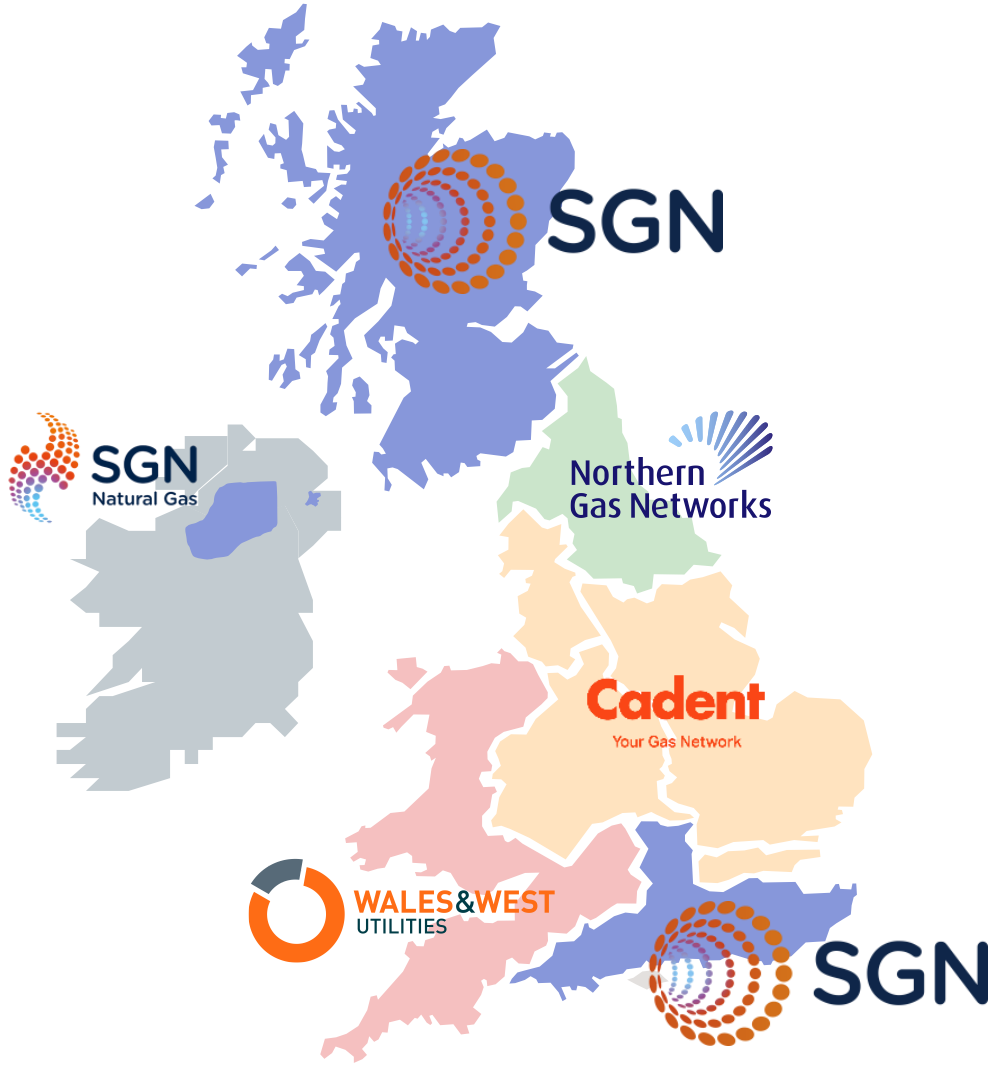
October 2022

SGN

Your gas. Our network.

SGN – Decarbonisation Strategy

- SGN own and manage the gas networks in Scotland and the South of England, with SGN Natural Gas owning and operating the network area in Northern Ireland
- 5.9 million homes and businesses are connected to our networks, providing over 14 million people with gas for heating and cooking
- SGN aim to collaboratively provide evidence to enable the system transition of the gas network to 100% hydrogen, including the hydrogen neighbourhood (H100 Fife) and the LTS Futures Programme.
- In parallel, we are preparing for the System Transformation through the strategic planning of new assets, preparing for network conversions and working closely with potential hydrogen producers.



Our Approach to Decarbonisation

Placing customers at the heart of the energy transition

Place customer at the heart of delivering a net zero solution that maintains the levels of service they experience today

Build the hydrogen evidence base with industry and government

Build a credible net zero pathway through collaboration with other networks

Collaborate with energy sector, wider business and local authorities

Engage with stakeholders to understand needs to help create a thriving net zero market

- UK Government decision on the role of hydrogen for domestic heat in **2026**
- Prepare our network for a hydrogen system transformation
- Strong downstream and upstream industry partnerships

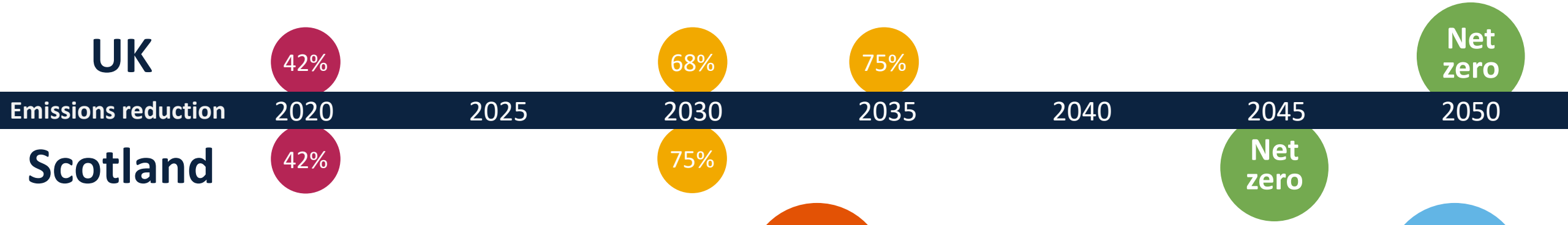
UK and Scottish Government decarbonisation targets

Heat

- Awaiting hydrogen ready boiler consultation
- Decision on hydrogen blending by end of 2023
- **UK Government decision on hydrogen for heat in 2026**
- Ambition for 600,000 heat pumps/year by 2030
- Biomethane could treble from current levels by 2030
- Heat networks 5% by 2030 and 20% by 2050

H2

- UK production 10GW by 2030 (with at least half green hydrogen)
- UK Government supporting the development of hydrogen for domestic heat evidence base



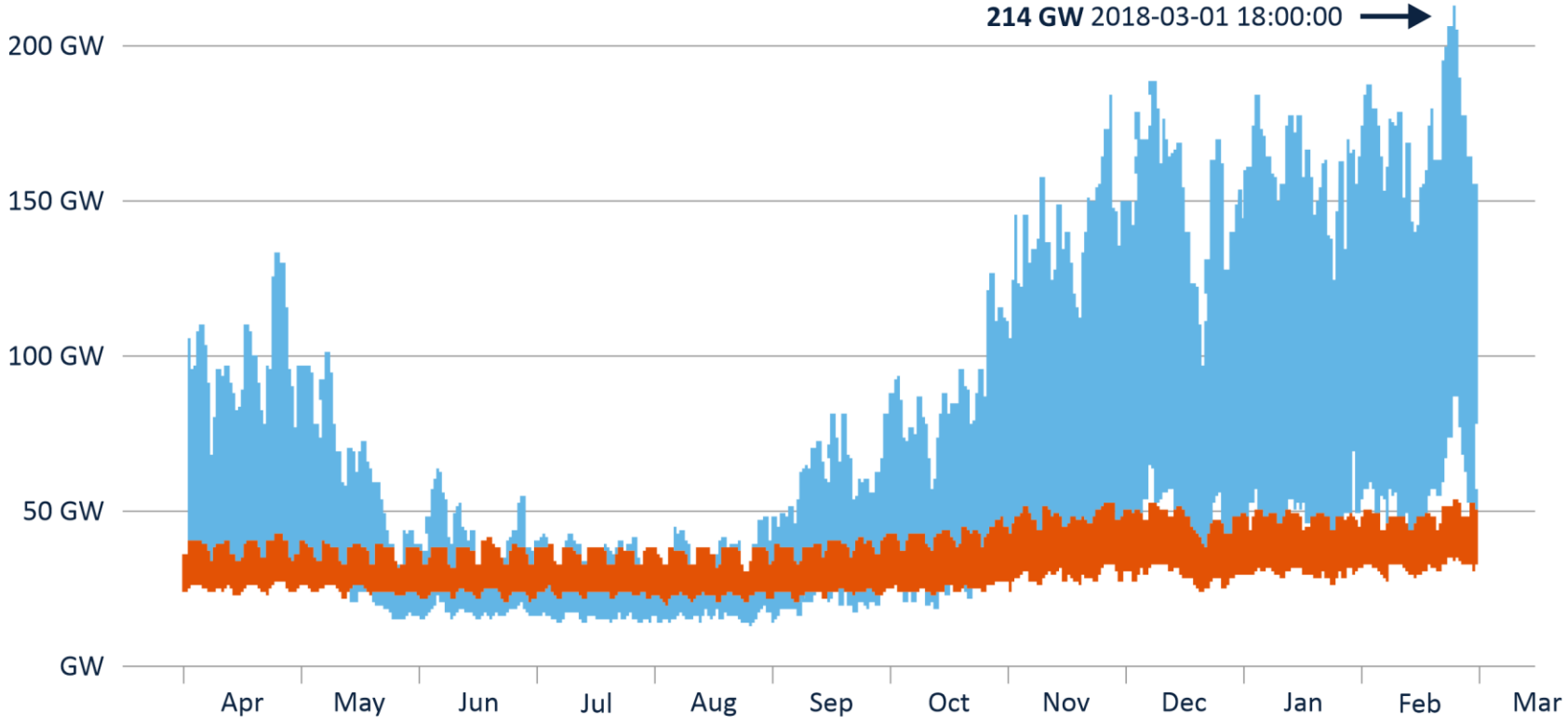
Heat

- 1 million homes and 50,000 non-domestic buildings equivalent by 2030
- 20% blended hydrogen by 2030, 5% biomethane
- No natural gas in new homes consented from 2024
- 64,000 homes a year being converted to net zero by 2025 – the focus is on heat pumps and heat networks

H2

- Scottish production 5GW by 2030, 25GW by 2045
- Scottish Government supporting the development of hydrogen for domestic heat evidence base

System challenge: Decarbonisation of Heat



Gas and electricity demand during the 'Beast from the East' in 2018

The gas network transports

four times

more energy a day than electricity networks in the winter and we need to ensure the energy system remains secure and reliable as we decarbonise heat.

System challenge: Decarbonisation of Heat

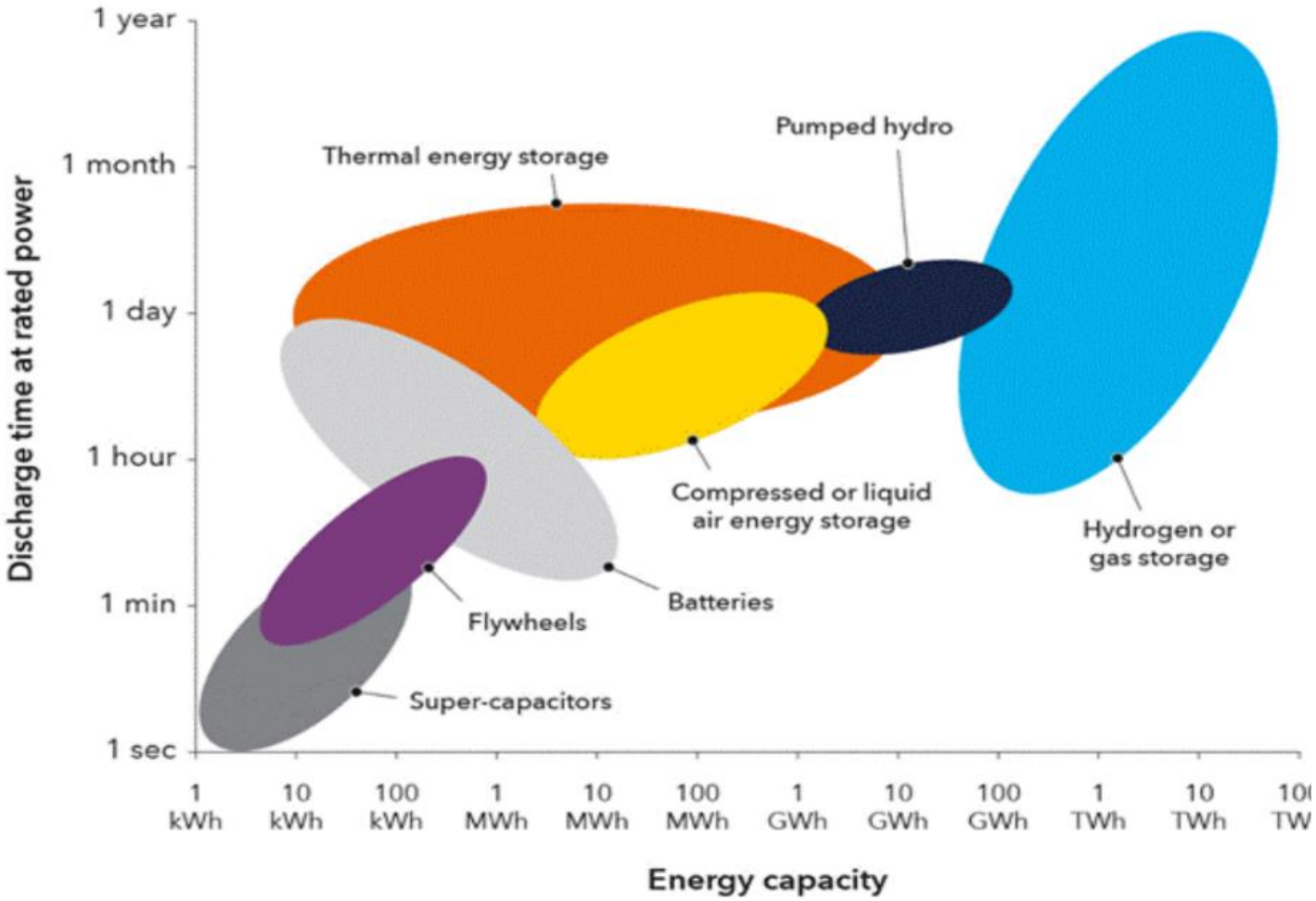
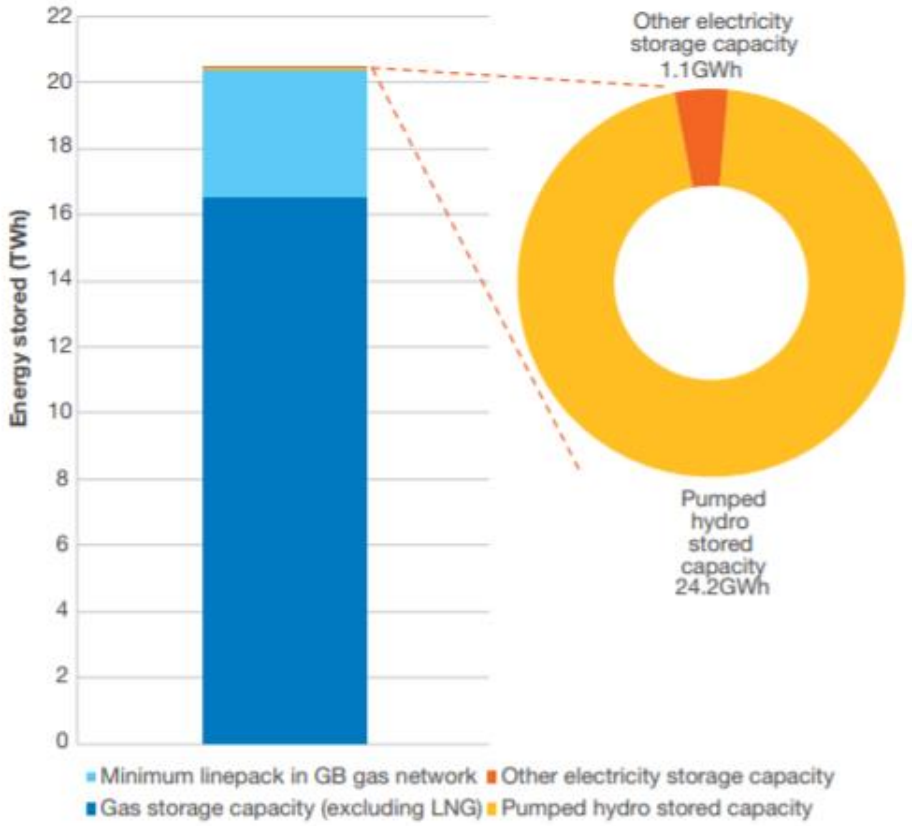


Figure FL.1: Electricity and gas storage capacity in 2020



SGN
H100 Fife

An end to end 100% hydrogen system

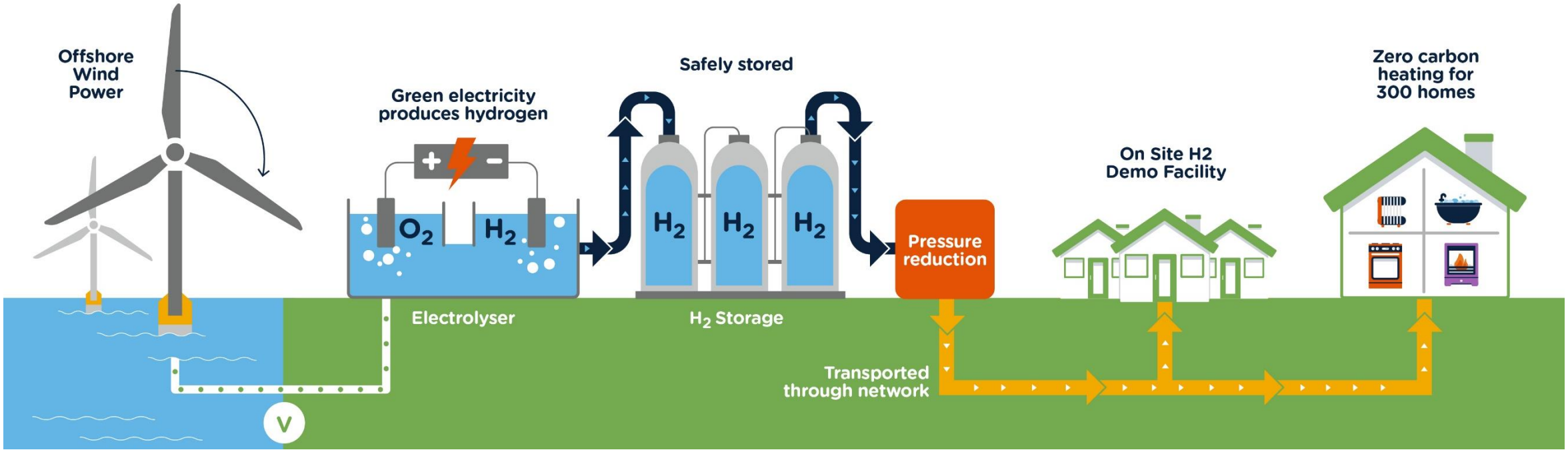
H100 Fife – Levenmouth Site

Defined network area with up to 300 customers, minimum of 270

Energy Park Fife

SGN

H100 Fife – End to End System



H100 Fife will provide technical and consumer evidence to support government policy decisions on heat decarbonisation

2020

Funding from shareholders, Ofgem and Scottish Government secured

2021

Planning and consent

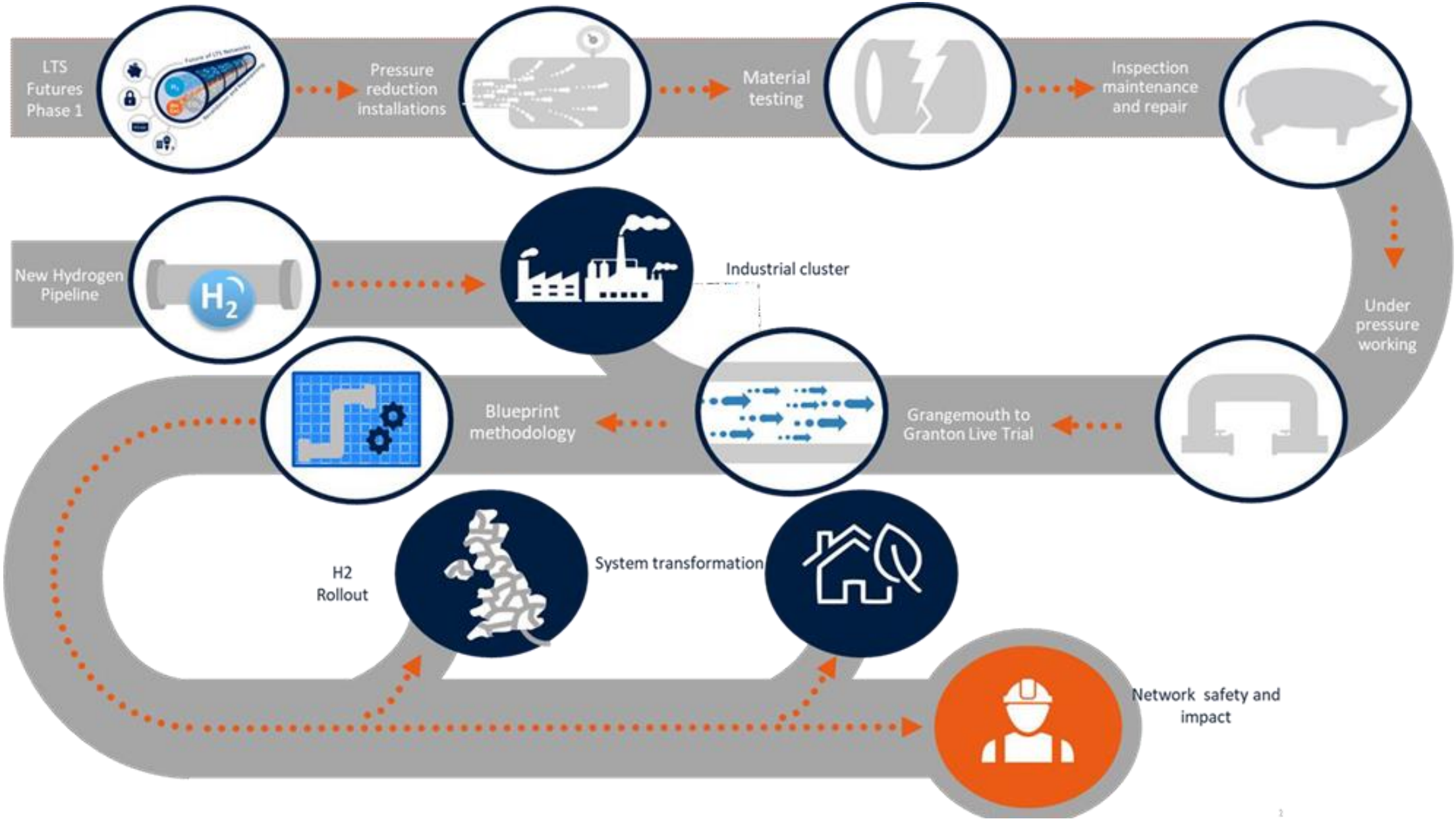
2022

Procurement and construction

2024

Delivering zero carbon heat/green hydrogen to customers

LTS Futures


LTS Futures Phase 1
Pressure reduction installations
Material testing
Inspection maintenance and repair
Under pressure working
Grangemouth to Granton Live Trial
Blueprint methodology
New Hydrogen Pipeline
Industrial cluster
H2 Rollout
System transformation
Network safety and impact

Feasibility Study for Hydrogen in Multi-Occupancy Buildings

BUILDING CATEGORISATION

ASSET INFORMATION REVIEW

OPTIONEERING FOR SOLUTIONS

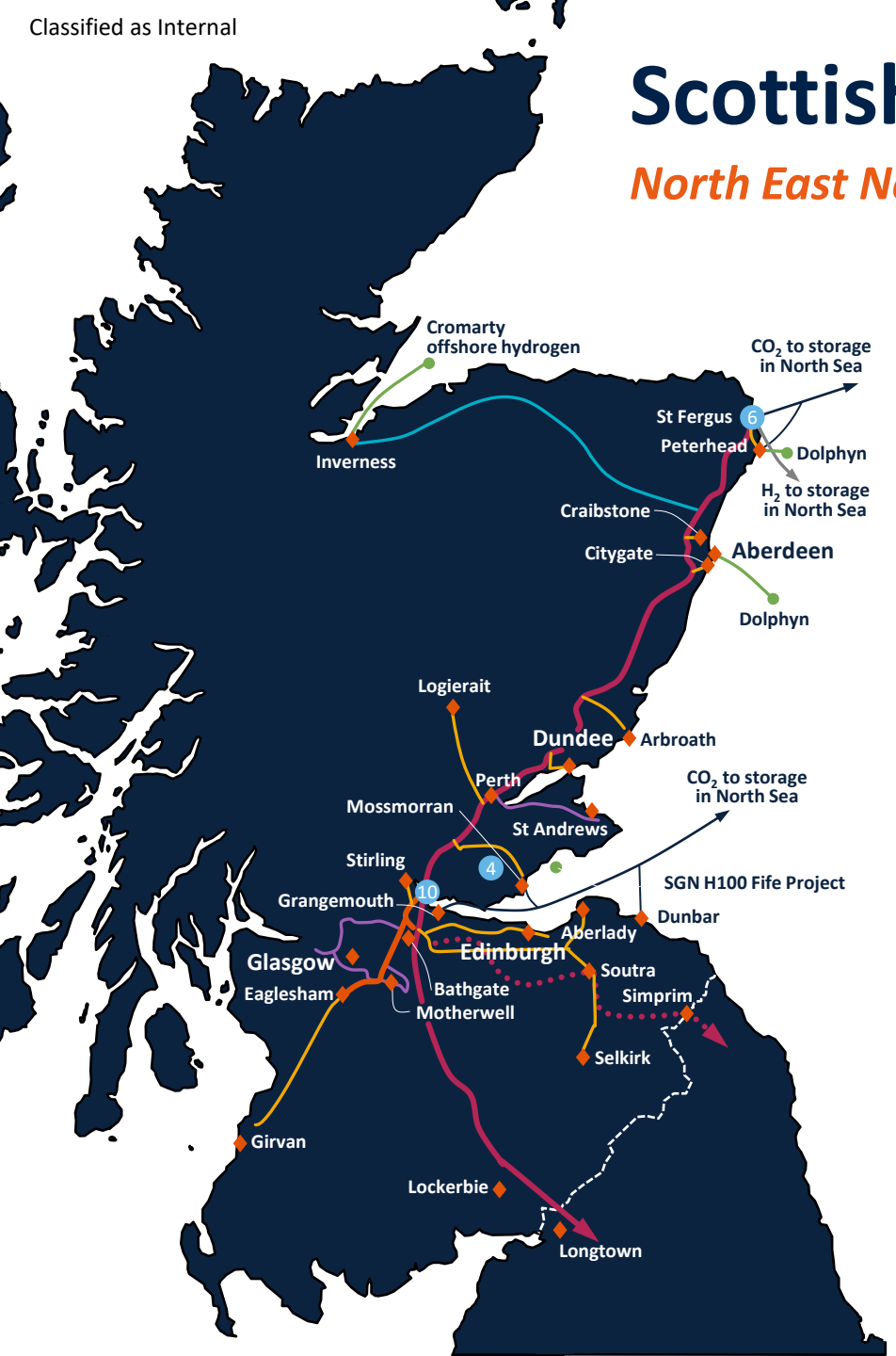
DEVELOPING AND TESTING PROGRAM

We are undertaking a feasibility study with subsequent infrastructure testing of MOB's to assess the technical and safety requirements for introduction of hydrogen - Split into above and below 6 storey buildings + complex buildings to build QRA to be applied to a MOB within a mapped Risk range

- Assessment for Above 6 storeys (additional control & safety systems)
- Assessment for Below 6 Storeys standard evidence testing.

Scottish Pathway Feasibility

North East Network and Industrial Cluster Project – Accelerated Scottish Pathway



- Co developed by Wood plc with stakeholder input
- Distributed hydrogen production throughout Scotland
- Onshore hydrogen transmission system
- Offshore CO2 transmission to geological storage
- Acorn project is a central part of the pathway, producing hydrogen and capturing carbon

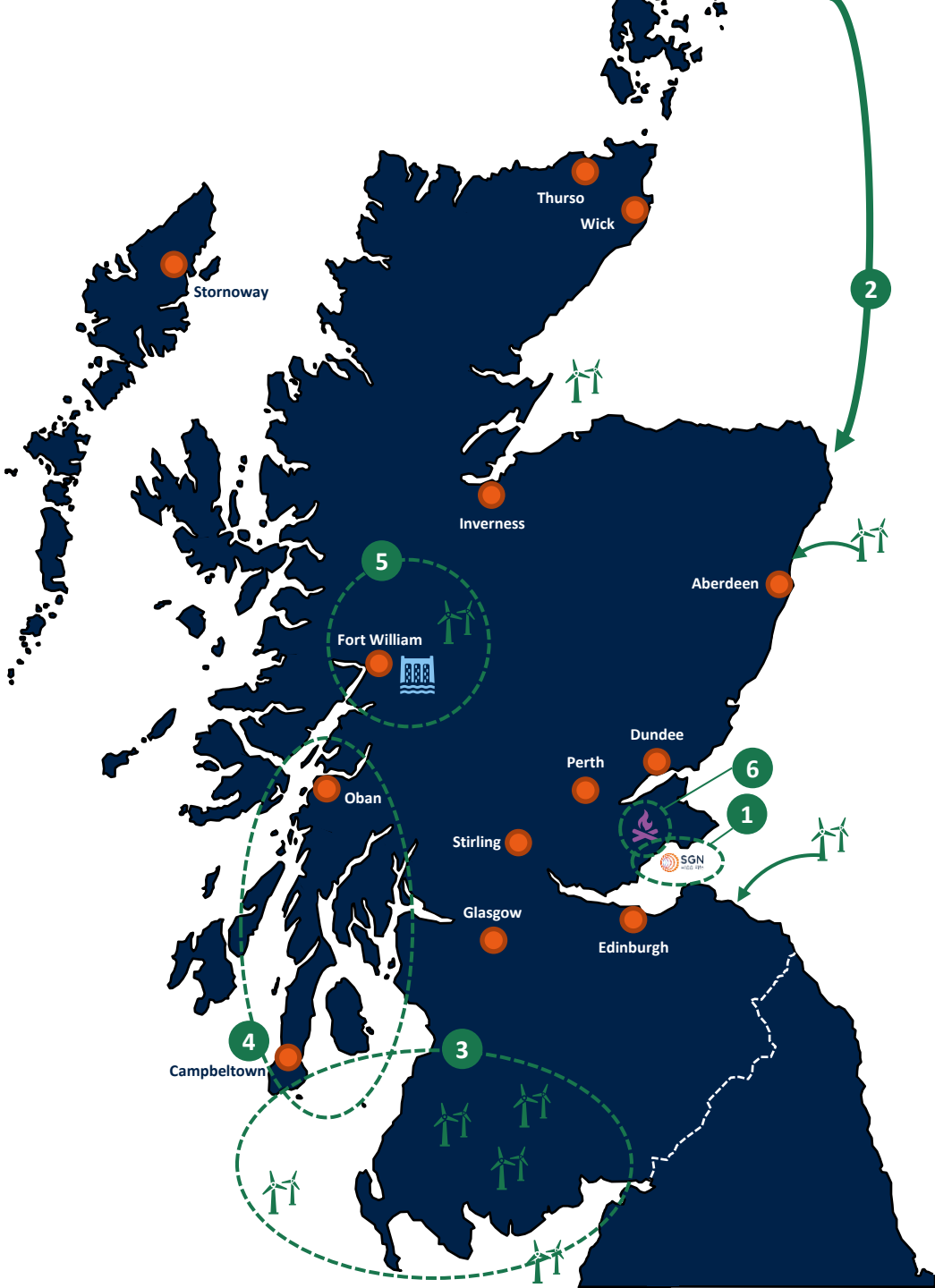
A three-phase approach is anticipated to deployment:

- Phase 1
  Aberdeen and St Fergus
- Phase 2
  Central Belt
- Phase 3
  East Coast

New main hydrogen trunkline
Alternative main hydrogen trunkline
Main hydrogen spur line
Repurposed existing spur line
New hydrogen spur line
New or repurposed spur line
CO_2 network
H_2 network (offshore storage)
Proposed green hydrogen production
Proposed blue hydrogen production (No. = SMRs/ATRs to be constructed)
City/Town

Projects - Renewable hydrogen

1. H100 Fife
2. Large Scale Green Hydrogen from Offshore Wind including Scotwind
3. South-West Hydrogen – Green Hydrogen from existing and future onshore and offshore wind generation for injection to south-west coast and flowing to Glasgow and the Central Belt
4. Green Hydrogen production for SIUs
5. Fort William Hydrogen from Hydropower and onshore wind
6. Renewable hydrogen production at Markinch



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3 South-West Hydrogen – Green Hydrogen from existing and future onshore and offshore wind generation for injection to south-west coast and flowing to Glasgow and the Central Belt

4 Green Hydrogen production for SIUs

5 Fort William Hydrogen from Hydropower and onshore wind

6 Renewable hydrogen production at Markinch

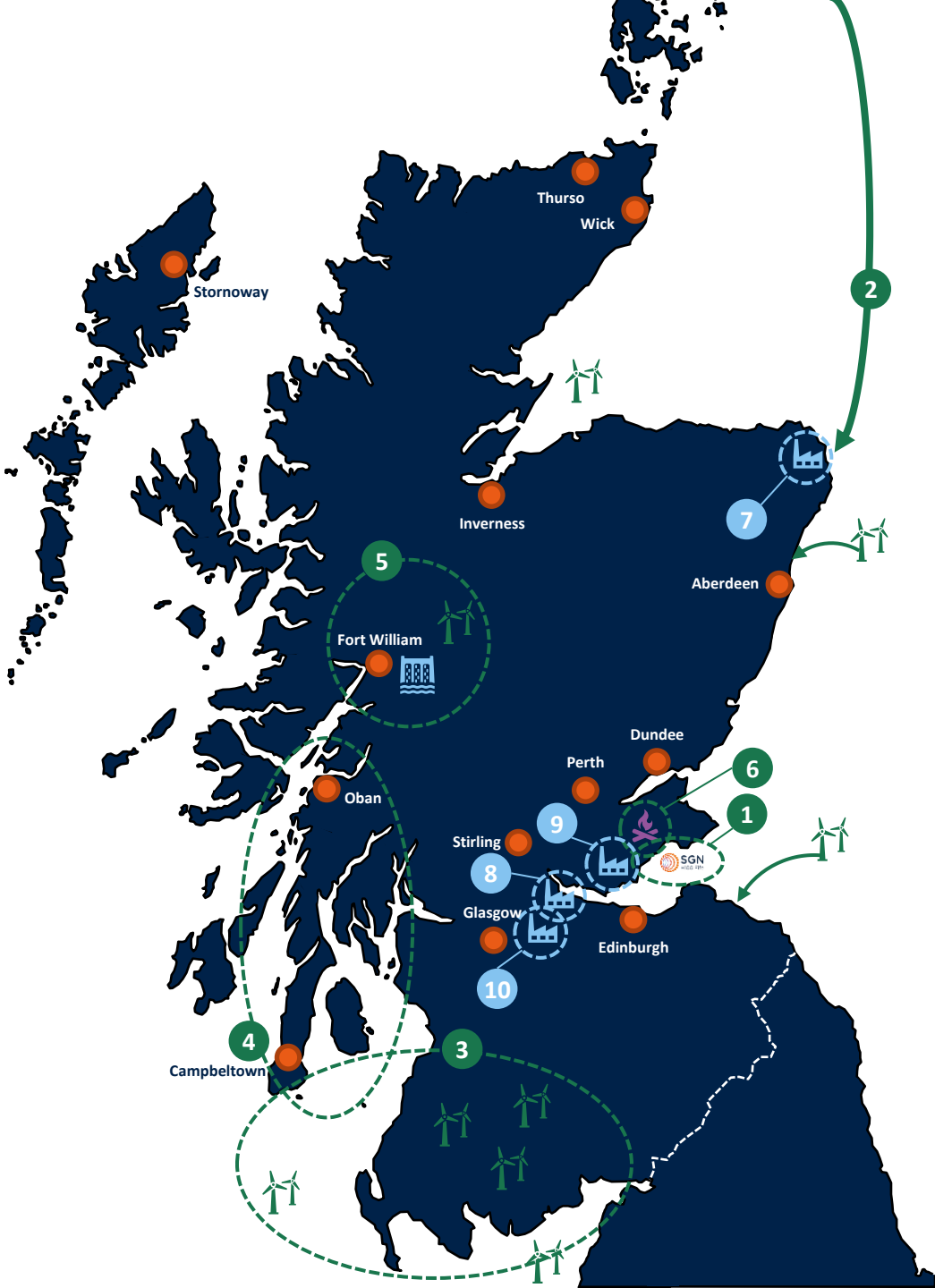
Projects - Low carbon hydrogen

7 Blue Hydrogen Production at St Fergus

8 Blue Hydrogen Production at Grangemouth

9 Blue Hydrogen Production at Mossmorran

10 Glenmavis Masterplan – Blue and/or Green Hydrogen Production



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Studies

11 H2 Edinburgh & south east Scotland Hydrogen Study

12 H2 Tayside Study

13 Balgonie Hydrogen Storage

14 HyScale LOHC Feed

15 SIU CNG Biomethane

16 Water Study

17 Just Transition Study

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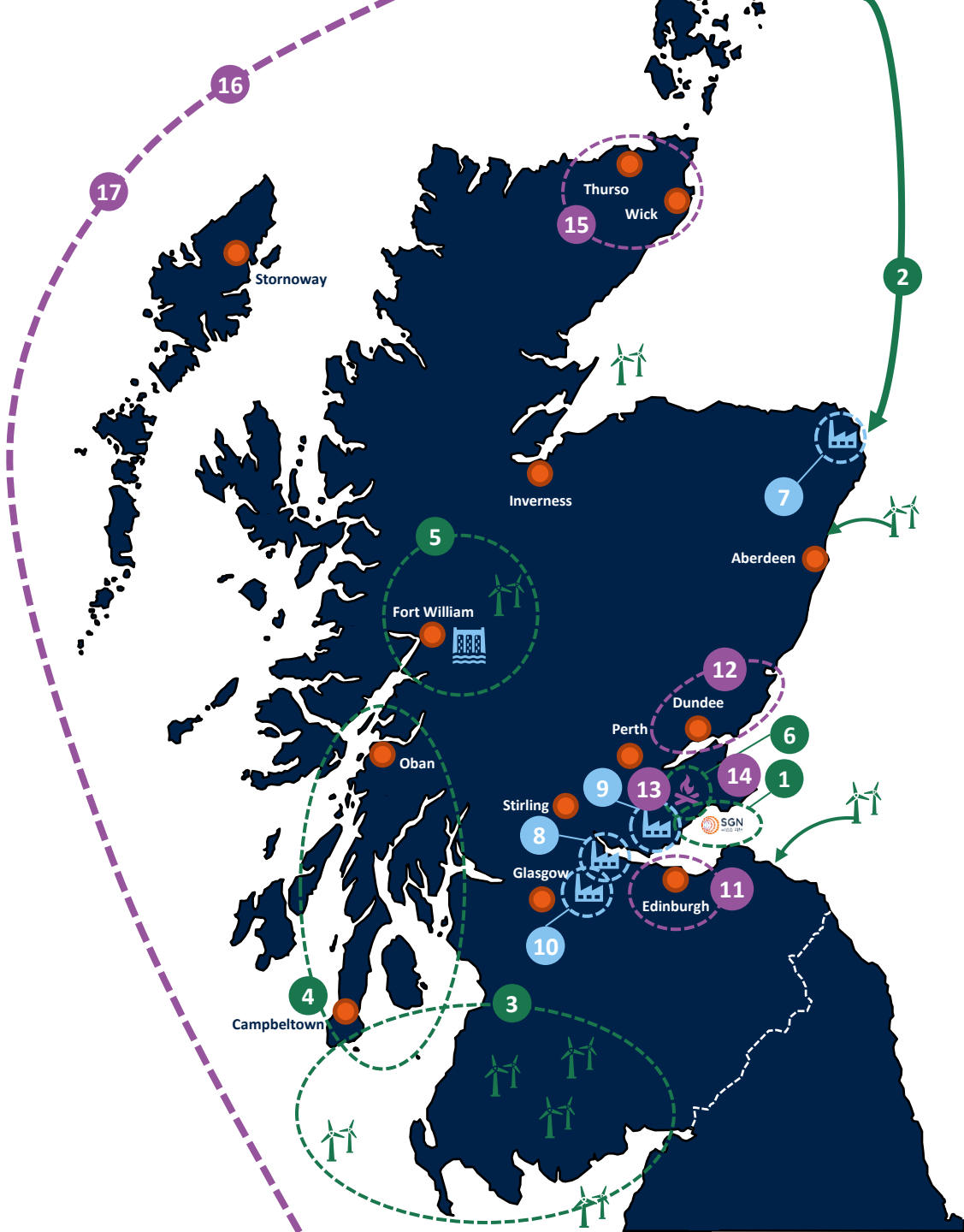

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Pre-FEED Projects

18 Aberdeen Vision

19 Fife and East Coast

20 Edinburgh/Central Belt

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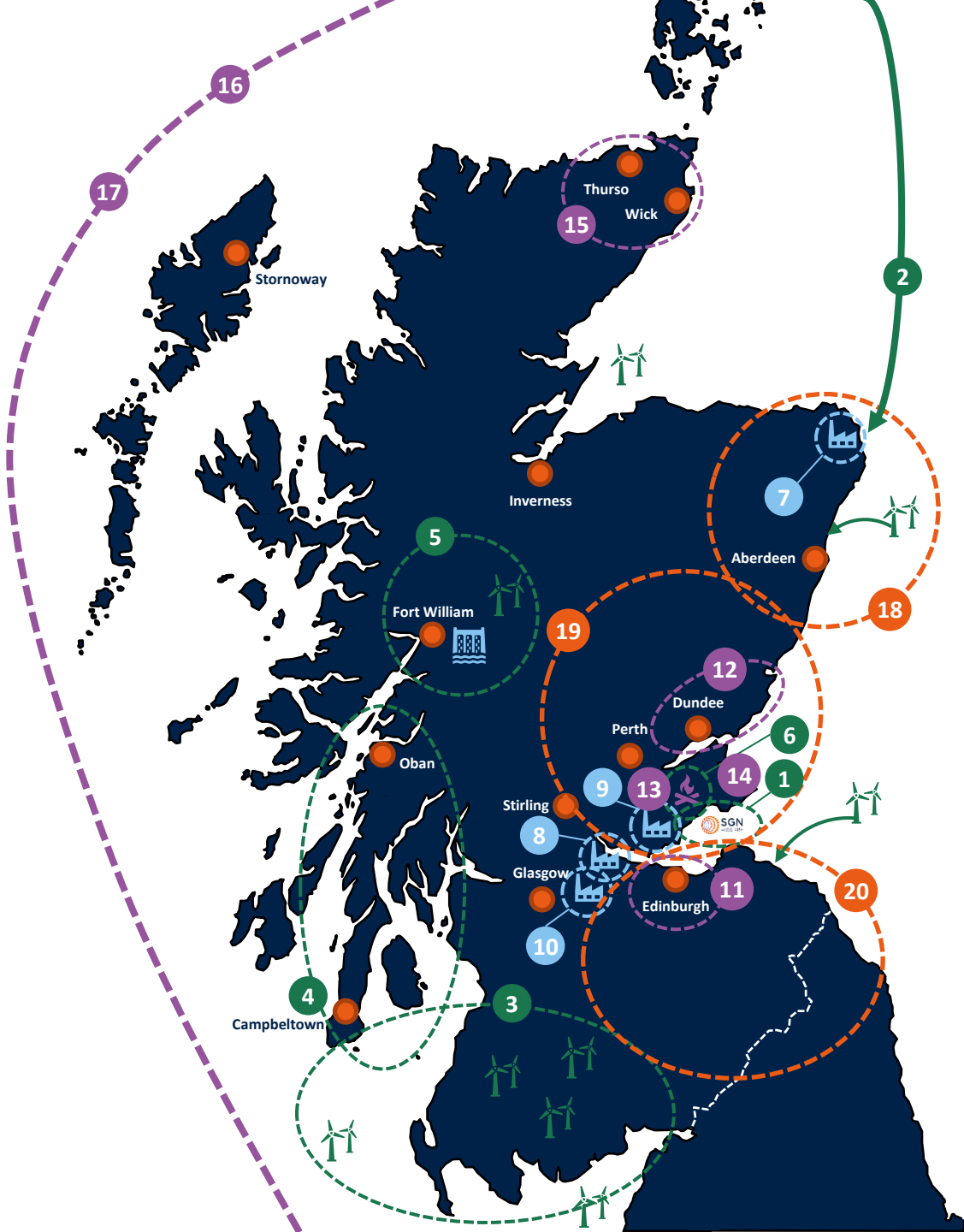
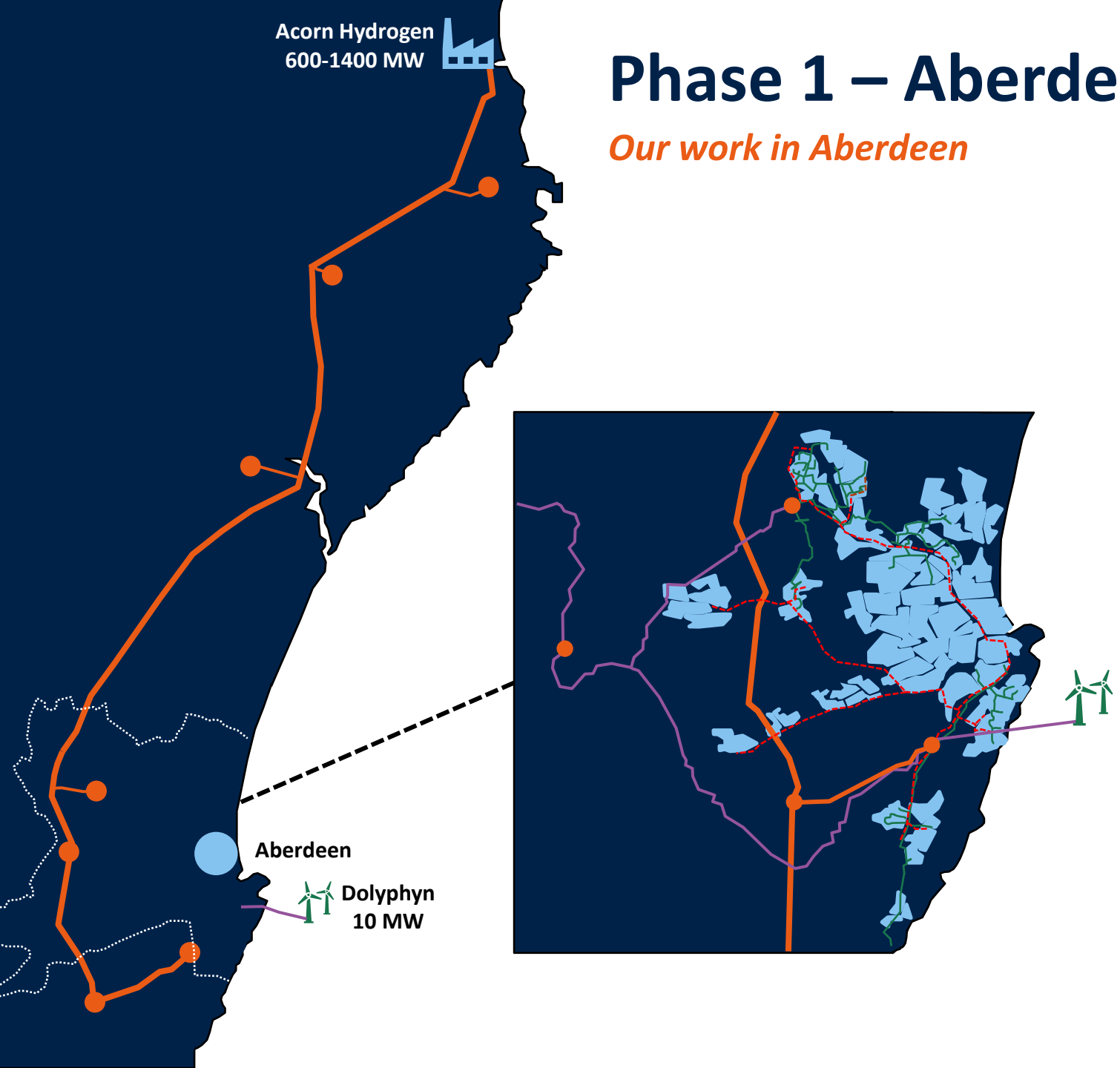


Pre-FEED Key Project Outputs

- Building on feasibility study assessments, determine route corridor for new hydrogen transmission trunklines and spur lines connecting to strategic network locations, hydrogen production and hydrogen storage, minimising cost, environmental impact and overall constructability risk.
- High level crossing assessment for road, rail, rivers etc.
- High level design requirements for above ground installation, piping infrastructure and any associated ancillary equipment required.
- Costing and construction requirements for new required pipelines and infrastructure
- Project roadmap development integrating development timelines of hydrogen production, storage and conversion timelines informed by below 7 bar analysis.
- Land acquisition and planning roadmap/strategy to inform FEED
- Stakeholder engagement Strategy

Phase 1 – Aberdeen Vision

Our work in Aberdeen



- NE Network and Industrial Cluster project phase 1 conversion (Aberdeen Vision); targeting the conversion of Aberdeen City and Aberdeenshire
- Pipeline pre-FEED phase underway linking hydrogen production and key network locations
- Below 7-bar planning underway to deliver sectorisation and conversion plan to enable system transformation of north east gas networks
- Facilitating blue hydrogen production at St Fergus and green hydrogen production from offshore wind

Green Hydrogen from Offshore Wind

High levels of potential generation capacity in Scottish Territorial Waters, particularly from recent ScotWind leasing round (over 25 GW)

Complex and costly transmission reinforcement and development requirements

Opportunity to repurpose existing Oil & Gas assets

SGN

Thank you

SGN

Your gas. Our network.

PHOENIX NATURAL GAS

BALLYLUMFORD POWER 2 X

Department for Business, Energy & Industrial Strategy

Ballylumford Power-to-X Project

Phoenix Renewable Gas Conference

By David Surplus OBE

Project Director

19th October 2022

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Islandmagee Energy

Net Zero Technology Centre
Technology Driving Transition

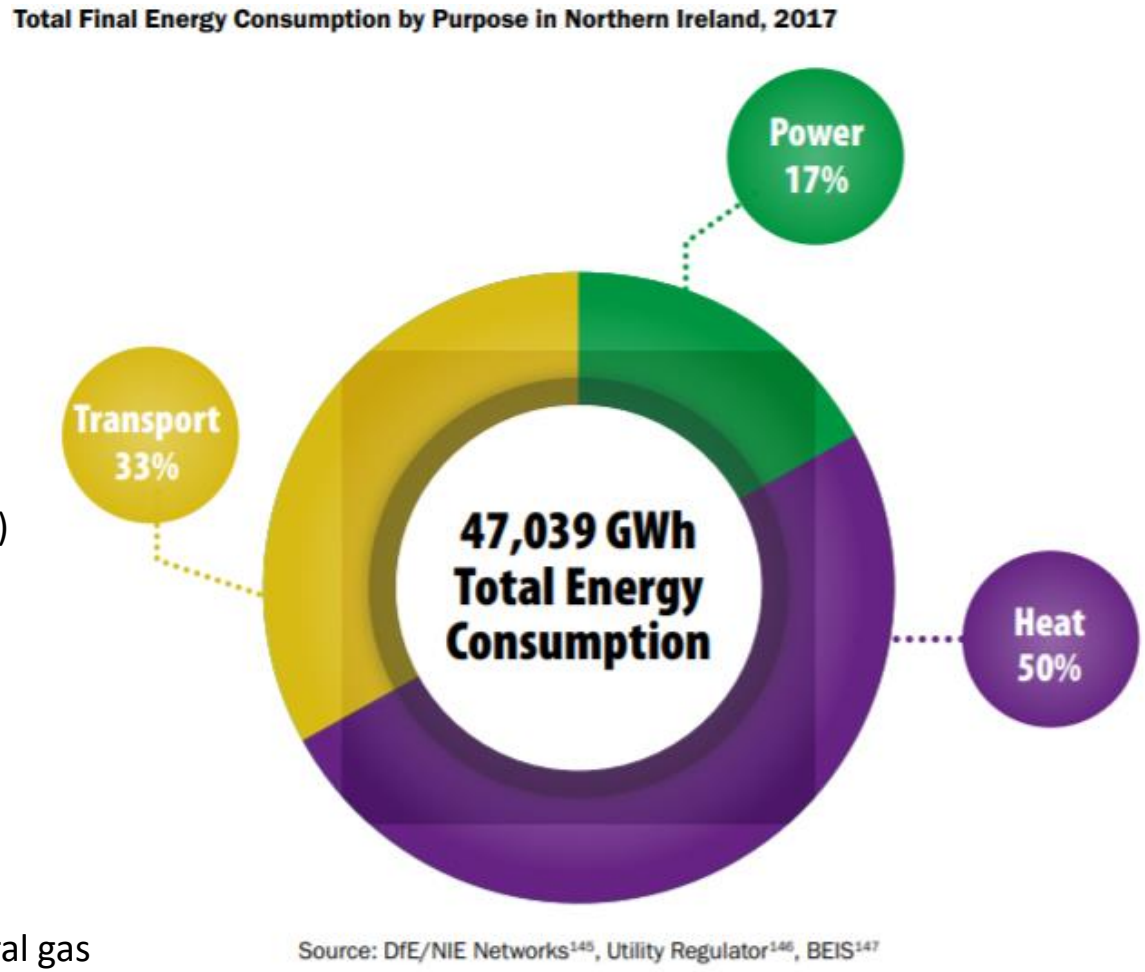
We're in a Climate Emergency!

- Decarbonisation by 2050 means…
- removal of almost all fossil fuel, i.e. 80% of the fuel we use today
- most of which is used for heating (see diagram).

- We can replace fossils with wind and solar PV, but…
- power grid capacity is already constrained i.e. too small, so
- also need to use larger capacity gas networks,
- otherwise real prospect of energy shortages.

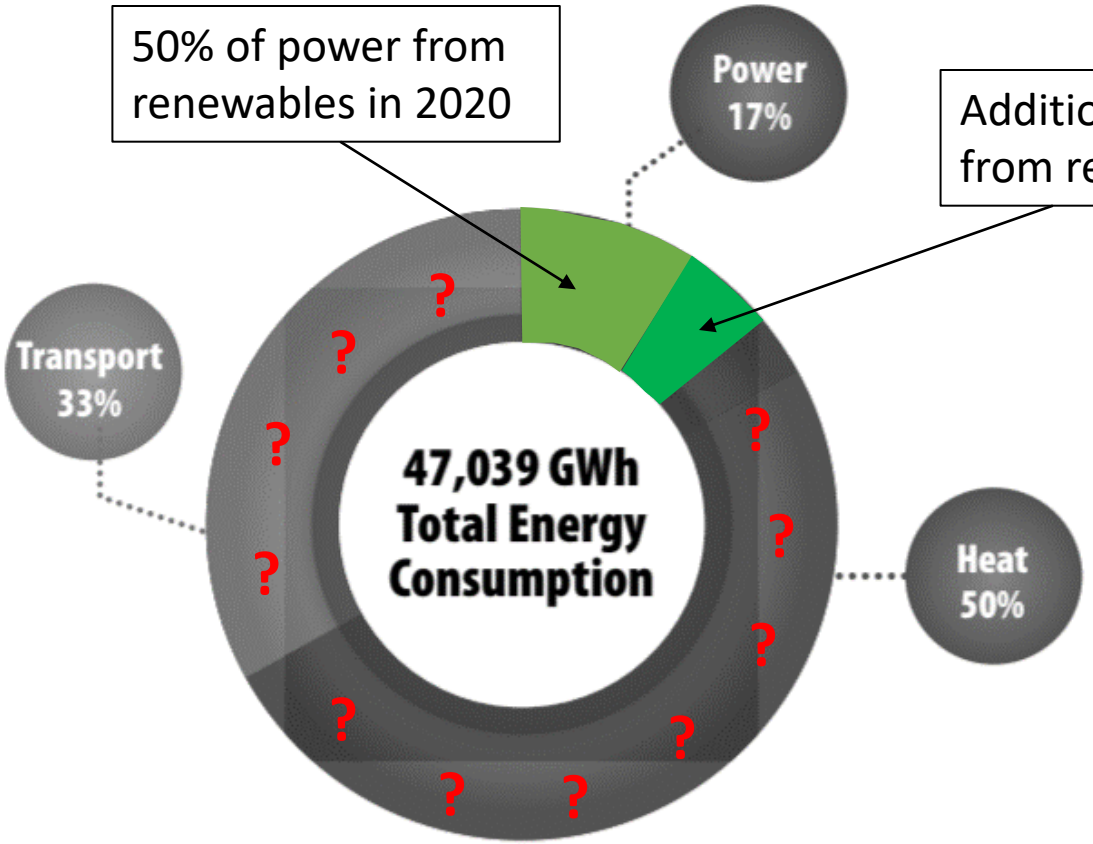
- Also, the lack of balancing load for wind will…
- worsen dispatch down of wind farms, (14.8% for 2020 i.e. >£50m lost revenue)
- undermine wind farm investor confidence,
- increase wind farm compensation payments, leading to…
- increased electricity bills and exacerbated fuel poverty.

- Solution is to add controllable load to the electrical grid,
- partly in the form of Power-to-X installations,
- and use excess wind power to make green hydrogen for displacement of natural gas

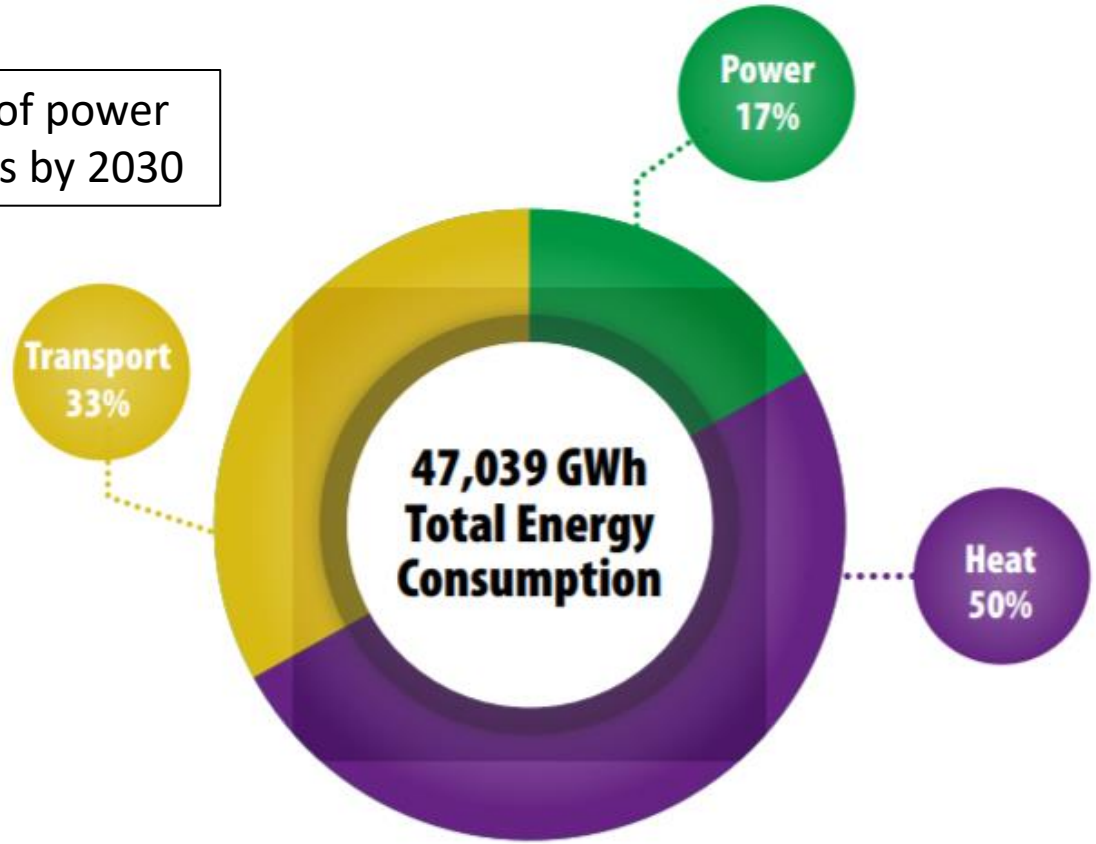


Power looks OK,

But what about heat and transport?



Source: DfE/NIE Networks[145], Utility Regulator[146], BEIS[147]



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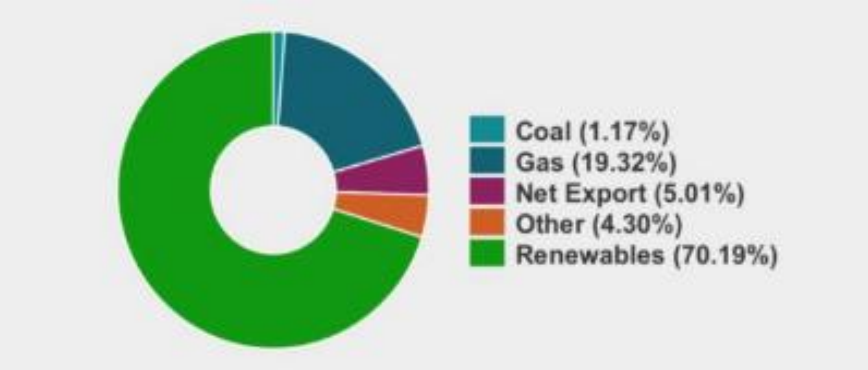
Victims of our own success!



✓

70% Instantaneous wind penetration on Northern Ireland's electricity network

BUT

Month	2019 NI	2019 IE	2019 AI	2020 NI	2020 IE	2020 AI
Jan	9.7%	3.8%	5.1%	12.3%	9.0%	9.8%
Feb	10.7%	6.8%	7.7%	17.4%	12.3%	13.4%
Mar	11.8%	9.2%	9.8%	14.5%	10.7%	11.4%
Qtr1	10.8%	6.8%	7.7%	14.9%	10.9%	11.7%
Apr	11.4%	9.0%	9.6%	21.8%	9.0%	11.8%
May	3.8%	4.1%	4.0%	19.8%	12.6%	13.9%
Jun	11.2%	5.6%	6.7%	26.2%	15.4%	17.5%
Qtr2	9.4%	6.6%	7.2%	22.7%	12.7%	14.6%
Jul	8.2%	3.8%	4.8%	12.4%	9.2%	9.8%
Aug	15.2%	8.4%	9.8%	14.4%	11.4%	11.9%
Sep	8.4%	8.2%	8.2%	9.0%	9.0%	9.0%
Qtr3	11.0%	7.3%	8.0%	11.6%	9.8%	10.2%
Oct	7.4%	6.4%	6.6%	12.4%	13.9%	13.6%
Nov	7.4%	3.9%	4.5%	12.8%	13.4%	13.3%
Dec	16.2%	9.6%	11.0%	9.8%	9.7%	9.7%
Qtr4	11.1%	6.9%	7.8%	11.6%	12.3%	12.2%
Year Total DD	10.7%	6.9%	7.7%	14.8%	11.4%	12.1%
Constraints	4.7%	3.8%	4.0%	6.6%	6.1%	6.2%
Curtailments	6.0%	3.1%	3.7%	8.2%	5.3%	5.9%
Wind Installed Capacity (MW)	1,276	4,120	5,396	1,276		
Wind Generation (GWh)	2,462	9,532	11,994	2,630	11,138	13,768
Wind Capacity Factors	22%	28%	26%	24%		
SNSP Limit	65%			65%		

14.8% dispatch down of wind farms!

Q4 2020 Dispatch Down = 14.8% for NI = >£50m lost revenue

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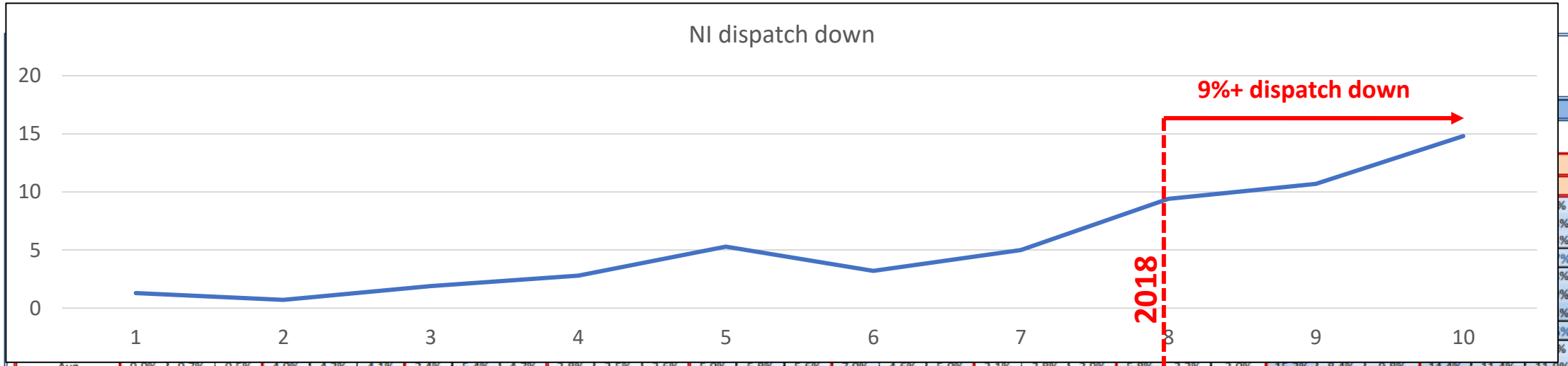
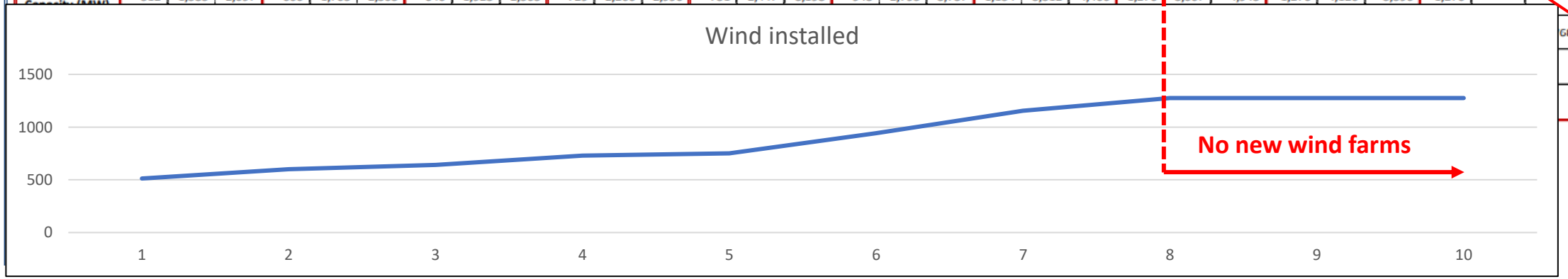


Aug	0.0%	0.7%	0.5%	4.0%	4.2%	4.1%	2.4%	5.4%	4.7%	3.8%	3.5%	3.6%	5.0%	5.8%	5.6%	7.0%	4.6%	5.0%	3.1%	2.8%	2.9%	5.8%	2.2%	3.0%	15.2%	8.4%	9.8%	14.4%	11.4%	11.9%
Sep	2.4%	3.9%	3.7%	0.4%	4.8%	3.7%	0.5%	4.2%	3.3%	0.1%	2.2%	1.8%	1.5%	2.7%	2.5%	5.8%	5.6%	5.6%	4.2%	5.4%	5.1%	13.1%	5.5%	7.4%	8.4%	8.2%	8.2%	9.0%	9.0%	9.0%
Qtr3	1.5%	3.1%	2.8%	1.5%	3.8%	3.3%	1.3%	4.6%	3.9%	2.4%	3.3%	3.1%	3.1%	4.1%	3.9%	6.3%	4.4%	4.8%	3.9%	3.9%	3.9%	8.7%	3.6%	4.8%	11.0%	7.3%	8.0%	11.6%	9.8%	10.2%
Oct	2.4%	4.7%	4.3%	0.0%	0.3%	0.2%	1.6%	5.9%	5.0%	4.5%	8.2%	7.4%	4.2%	3.8%	3.9%	1.9%	1.8%	1.8%	14.6%	9.2%	10.6%	10.2%	6.9%	7.7%	7.4%	6.4%	6.6%	12.4%	13.9%	13.6%
Nov	1.2%	2.3%	2.1%	0.1%	1.0%	0.8%	4.0%	3.0%	3.2%	2.0%	3.2%	3.0%	6.9%	6.8%	6.9%	2.7%	1.0%	1.3%	3.2%	2.5%	2.6%	10.2%	5.2%	6.4%	7.4%	3.9%	4.5%	12.8%	13.4%	13.3%
Dec	0.7%	2.2%	1.9%	0.8%	2.8%	2.5%	2.0%	4.4%	3.8%	4.5%	5.0%	4.9%	6.2%	6.3%	6.3%	3.8%	3.1%	3.3%	5.3%	2.5%	3.1%	14.9%	7.2%	8.9%	16.2%	9.6%	11.0%	9.8%	9.7%	9.7%
Qtr4	1.4%	2.9%	2.6%	0.4%	1.6%	1.4%	2.4%	4.5%	4.0%	3.9%	5.7%	5.3%	6.1%	6.0%	6.0%	3.0%	2.1%	2.3%	8.5%	4.9%	5.7%	11.7%	6.4%	7.7%	11.1%	6.9%	7.8%	11.6%	12.3%	12.2%
Year Total DD	**1.3%**	**2.4%**	**2.2%**	**0.7%**	**2.5%**	**2.1%**	**1.9%**	**3.5%**	**3.2%**	**2.8%**	**4.4%**	**4.1%**	**5.3%**	**5.1%**	**5.1%**	**3.2%**	**2.8%**	**2.9%**	**5.0%**	**3.7%**	**4.0%**	**9.4%**	**5.0%**	**6.0%**	**10.7%**	**6.9%**	**7.7%**	**14.8%**	**11.4%**	**12.1%**
Constraints	0.3%	0.5%	0.4%	0.3%	0.9%	0.8%	0.5%	1.0%	0.9%	1.0%	1.5%	1.4%	1.9%	1.8%	1.8%	1.3%	1.4%	1.4%	1.9%	1.0%	1.2%	4.0%	1.7%	2.2%	4.7%	3.8%	4.0%	6.6%	6.1%	6.2%
Curtailments	1.1%	2.0%	1.8%	0.4%	1.5%	1.3%	1.3%	2.5%	2.3%	1.8%	2.9%	2.6%	3.4%	3.3%	3.3%	1.9%	1.4%	1.5%	3.1%	2.6%	2.7%	5.4%	3.3%	3.8%	6.0%	3.1%	3.7%	8.2%	5.3%	5.9%
Wind Installed Capacity (MW)	512	1,585	2,097	600	1,703	2,303	640	1,923	2,563	729	2,266	2,996	751	2,447	3,198	943	2,795	3,737	1,154	3,312	4,466	1,276	3,667	4,943	1,276	4,120	5,396	1,276		



14.8%

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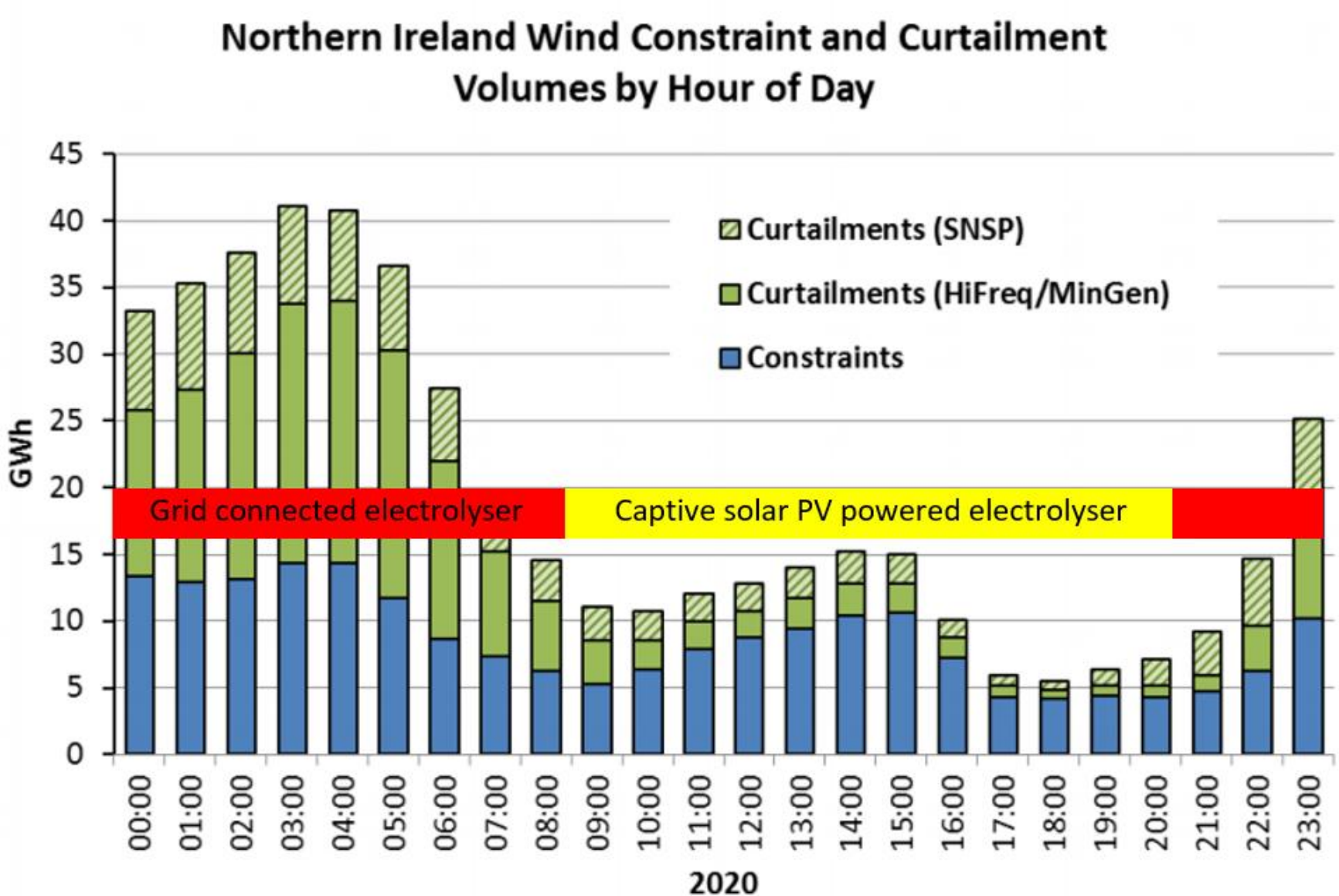
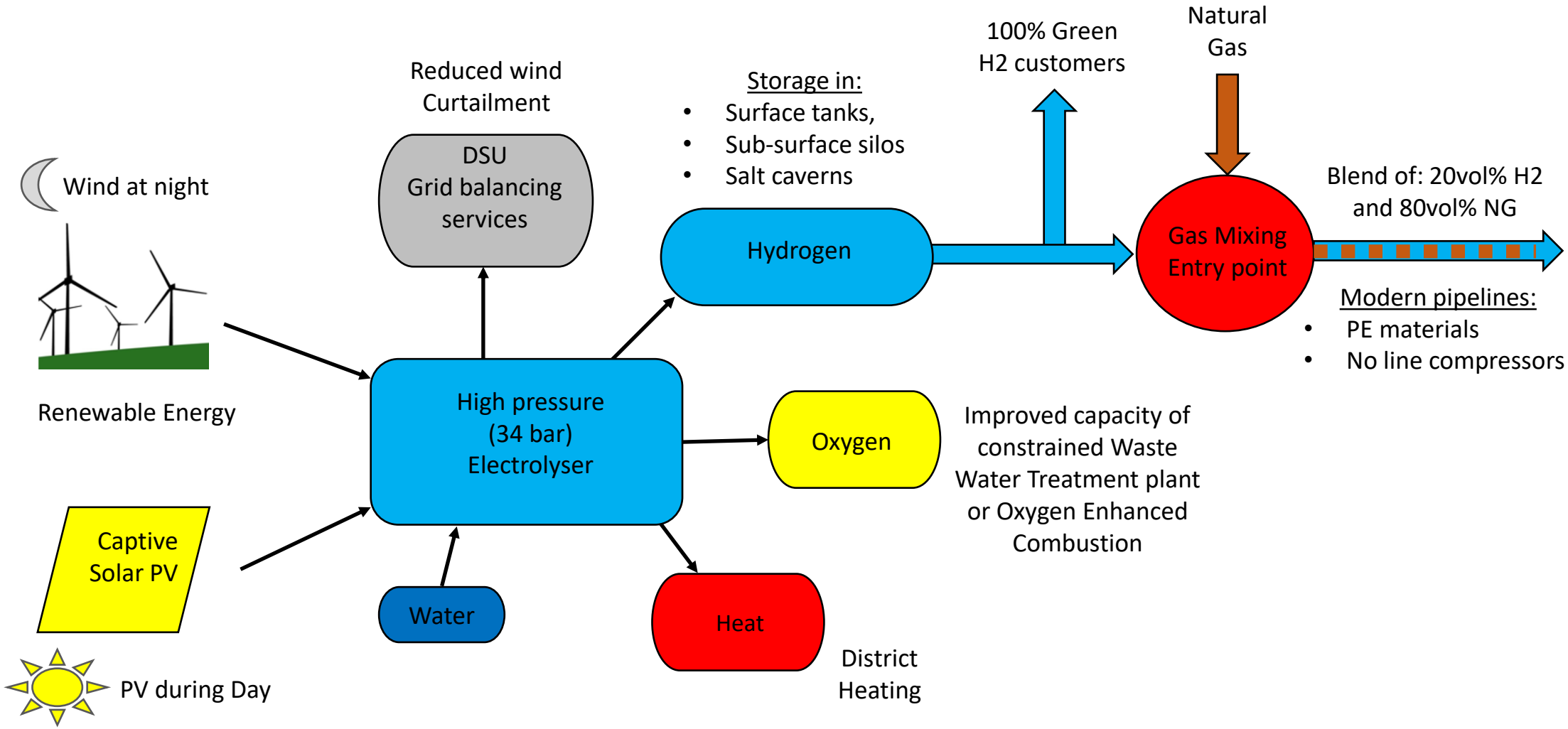
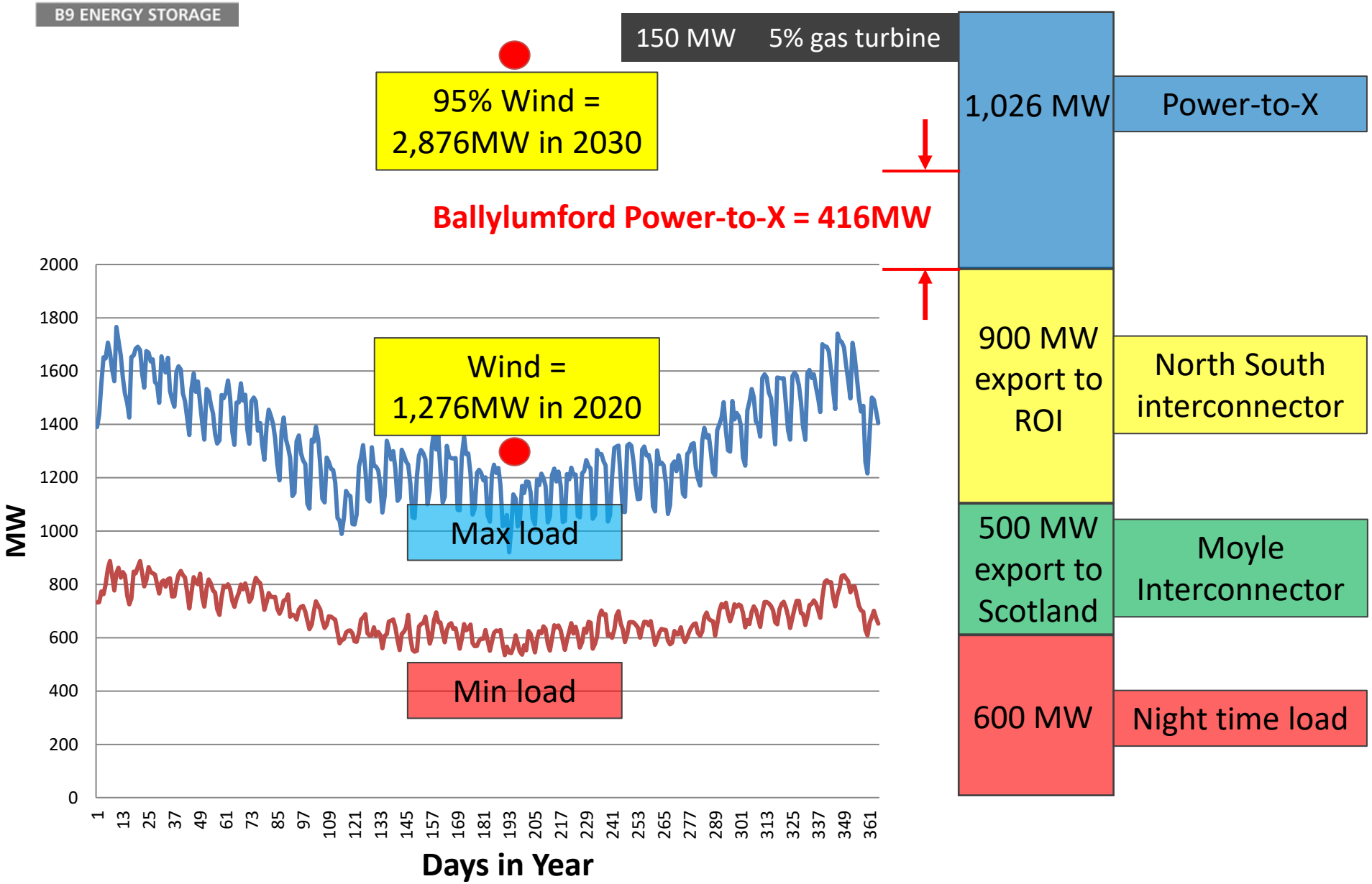


Power-to-X schematic diagram



Balance of electrical load and generation in NI



BUT

At peak wind in NI it is likely that ROI and Scotland will also have high wind penetrations, so these export routes might not be fully available.

Introduction to Ballylumford Power-to-X Project:

- Internationally significant project
- Seeks to create a full-cycle hydrogen economy, from production, storage and distribution through to usage.
- £986,000 funding awarded through the BEIS Longer Duration Energy Storage Competition
- 12 month FEED study in the Power-to-X category – it is the only project in the UK to be supported in this way, and…
- BEIS 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:

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 STORAGE

Hydrogen Production:

20MW Electrolyser

Hydrogen Use:

Tube trailer filling and export

mutualenergy

Hydrogen Transmission:

100% hydrogen pipeline

Islandmagee Energy

Hydrogen Storage:

Salt cavern storage system

Net Zero Technology Centre

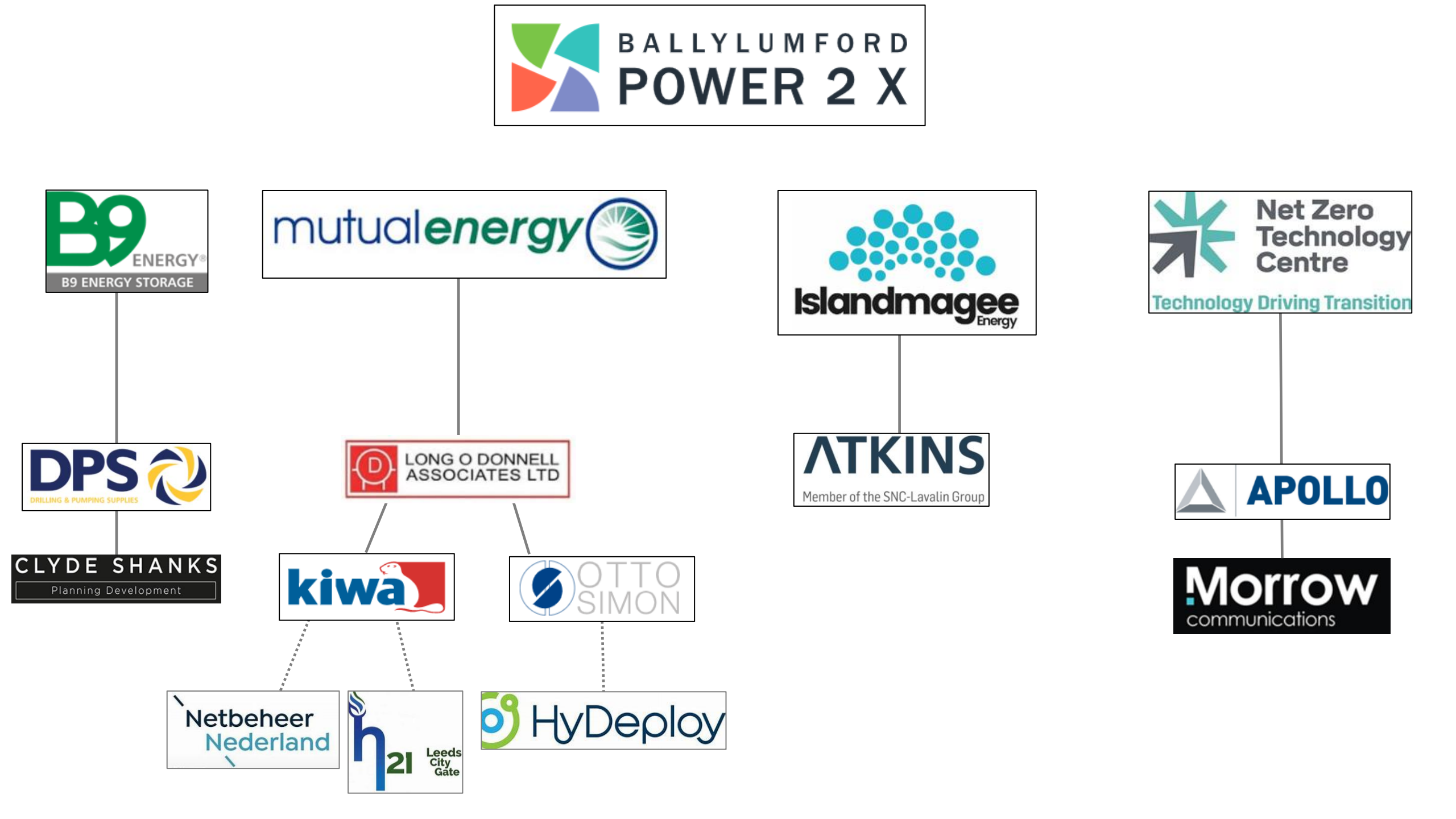
Technology Driving Transition

Hydrogen Use:

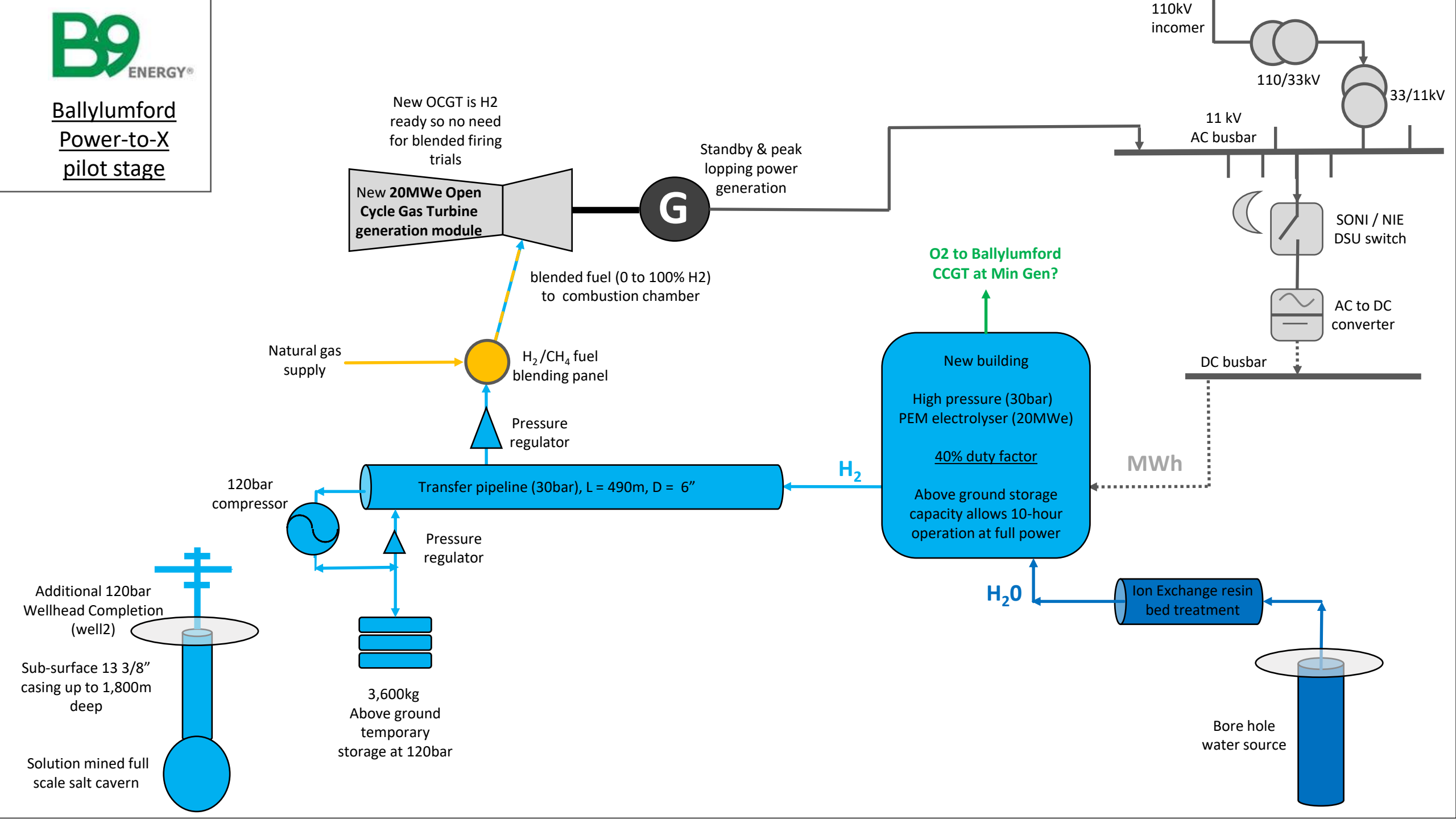
20MW Open Cycle Gas Turbine

Funded by:

Department for Business, Energy & Industrial Strategy


BALLYLUMFORD
POWER 2 X
B9 ENERGY
B9 ENERGY STORAGE
mutualenergy
Islandmagee Energy
ATKINS
Member of the SNC-Lavalin Group
Net Zero Technology Centre
Technology Driving Transition
DPS
DRILLING & PUMPING SUPPLIES
LONG O DONNELL ASSOCIATES LTD
APOLLO
CLYDE SHANKS
Planning Development
kiwa
OTTO SIMON
Morrow
communications
Netbeheer Nederland
h21
Leeds City Gate
HyDeploy

Ballylumford Power-to-X pilot stage



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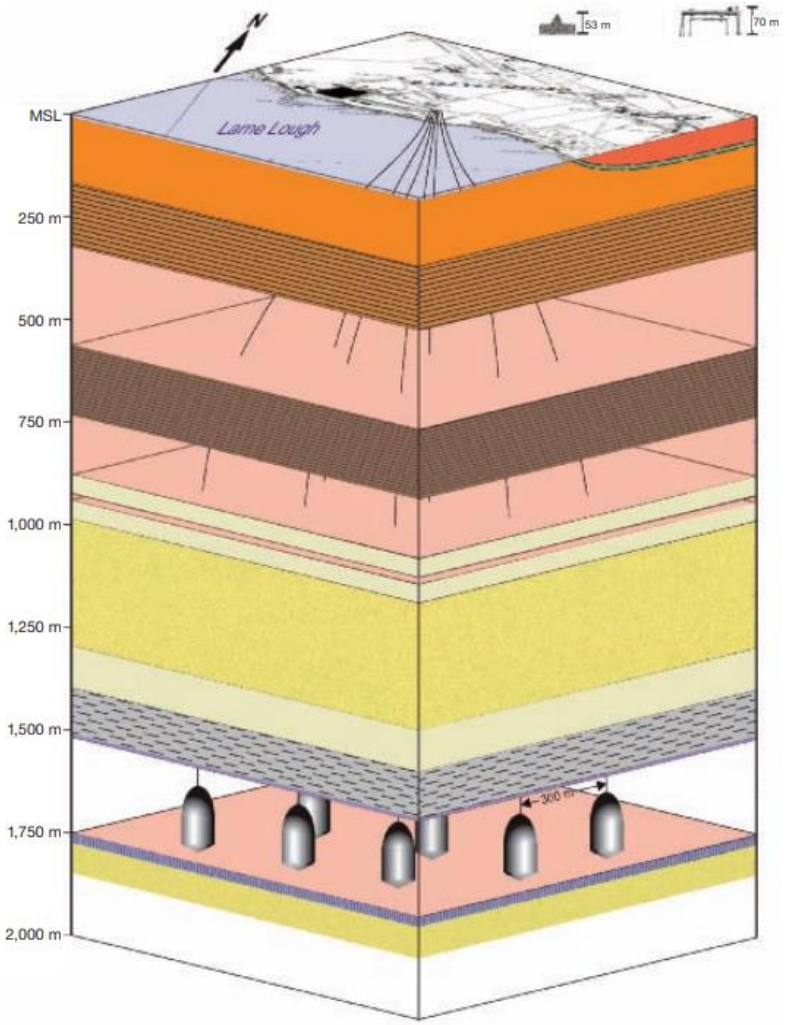

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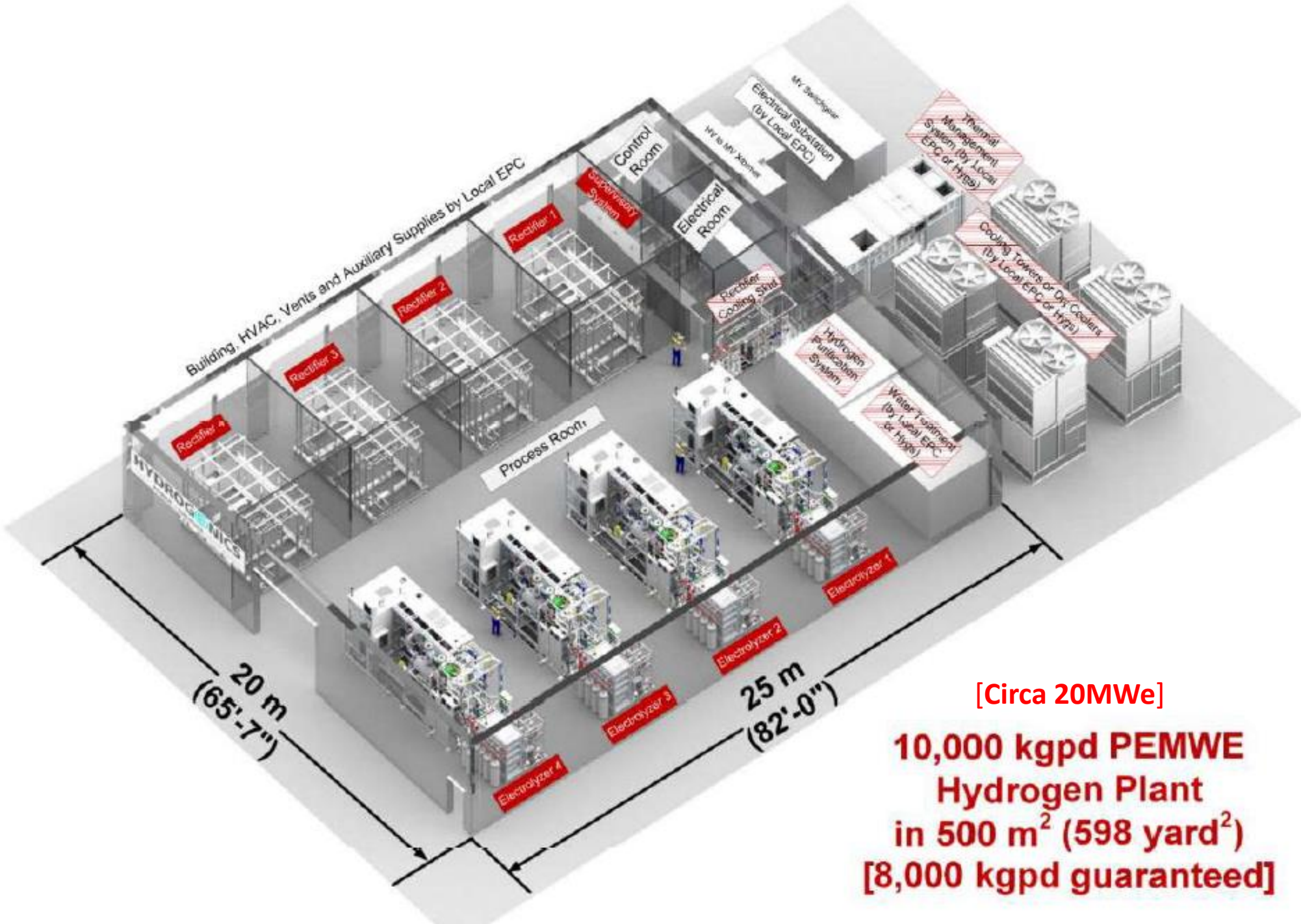
B9 ENERGY®
B9 ENERGY STORAGE

mutualenergy

Islandmagee Energy

Net Zero Technology Centre
Technology Driving Transition



[Circa 20MWe]

10,000 kgpd PEMWE Hydrogen Plant in 500 m^2 (598 $yard^2$) [8,000 kgpd guaranteed]

PHOENIX NATURAL GAS

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
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Phone:	07545 696346
Website:	info@ballylumfordp2x.co.uk

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Islandmagee Energy

Net Zero Technology Centre

Technology Driving Transition

Tomorrow’s idea today

Translink’s journey to Net Zero

Paddy Anderson
Group Chief Financial Officer, Translink

Translink

Translink – By Numbers

- 4,200 staff – one of largest employers in NI
  - Supporting over 6k jobs in NI
- Operates 13k services every day
  - 300k passenger journeys per day
- Maintains 1,400 buses and trains
  - 44m miles per year
- Maintains over 80 bus and rail stations & halts
  - 9,000 P&R spaces
- Maintains a £3bn railway asset
  - 300 miles of rail track and over 1,600 civil structures

TOGETHER FOR OUR PLANET

Translink

Our Vision:

Your first choice for travel, today for tomorrow.

Our Mission:

To lead the transformation of transport in Northern Ireland.

Translink

Better. Connected

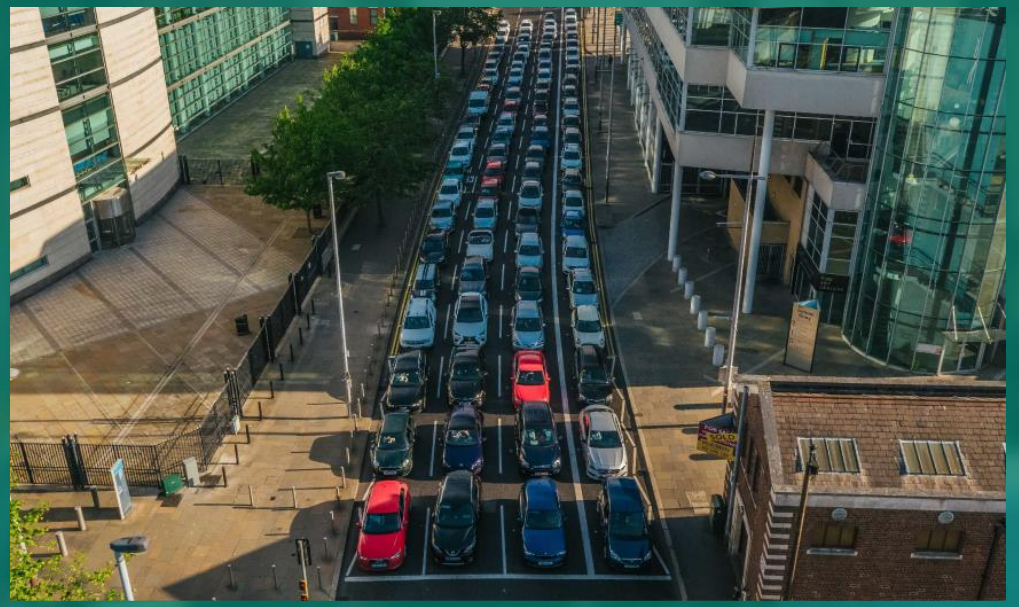
The Need for Change

Climate: Transport emits 20% of NI's total GHGs, an increase of 22% since 1990, the biggest contributor is cars

Energy: Transport consumed 35% of NI's total energy in 2019 – mainly fossil fuels and this will transition to renewables in the future

Health: Poor air quality is the biggest environmental risk to public health in the UK, contributes to 800 deaths a year in NI

Economy: Transport is crucial to connecting society and the economy



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What is needed?

Climate – Net Zero: Modal shift away from cars to mass transport (public transport) – continue to invest in the NI PT network

Clean Air – Net Zero: Decarbonised/zero emission public transport - continue to invest in bus and rail fleet decarbonisation

Health – Net Zero: Create clean air zones in major cities and towns – already happening across UK

Economy: Extend public transport support schemes for young people, people with disabilities, low-income families, employees

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Climate/Clean Air Action

The Road to Zero

50%
reduction in emissions by 2030 or sooner

Net Zero
by 2040 or sooner

Climate Positive
by 2050 or sooner

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Translink Zero Emission Programme

3 Hydrogen buses for Belfast - live Dec 2020

20 Hydrogen and 80 Electric buses for Belfast – live March 2022

43 Electric buses for Derry~Londonderry - go live Summer 2023

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NIH2 Consortium Project (Proof of Concept)

- Consortium formed with Energia Group and Wrightbus
- £4.2m project
- £1.9m OZEV funding (UK Government)
- 3 Hydrogen Double Deck Buses – entered service December 2020
- First Hydrogen Refuelling Station in Ireland
  - Future proofed to scale
- Upgrades to Workshop to make Hydrogen safe facility

Zero Emission Bus Phase 1

- **100 Zero Emission Buses**
  - 80 Battery Electric Buses
  - 20 Fuel Cell Electric Buses
- **Associated Infrastructure**
  - 80 Charge Points, Control System and protection measures
  - Hydrogen Refuelling Station (Scaled up)
  - Hydrogen Safe Workshop
- **Fuel Supplies**
  - Hydrogen supply contract
- **Business Change**
  - Business processes/Working Practices
  - Upskilling/Training
  - Safety
  - Stakeholder Management

Battery Electric

- Wrightbus StreetDeck Electroliner (BEV)
- Battery electric power train with 340kW battery pack
- Batteries distributed throughout the vehicle i.e., underfloor, under the stairs and in the rear

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Fuel Cell Electric

- Wrightbus StreetDeck Hydroliner (FCEV)
- Hydrogen Fuel Cell power train and its battery pack can store up to 48KWh
- 6 hydrogen gas storage tanks which can hold 27KG/1120 Litres
- Filling Pressure – 350 Bar

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Climate Action
Zero Emission Rail
All Island Rail Review
Zero emission Technologies
Enterprise Development Strategy
Translink
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New Zero Emission Hourly Enterprise

- Fleet to be replaced in the medium term to provide an hourly service that ultimately will be capable of zero emission operation.
- Reduced Journey time circa 1 hr 55 minutes
- Focus on sustainability, facilitating a pathway to net carbon zero rail between Belfast and Dublin.
- Capital investment including fleet and necessary depot modifications.
- Aligned with the objectives of the PEACE PLUS Programme.

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Belfast Transport Hub – Transport Led Regeneration

- Sustainable construction
- Energy efficient building
- Efficient water consumption
- Biodiversity
- Modal Shift – Active Travel

THAT'S THE TRANSLINK Spirit FIRST CHOICE FOR TRAVEL

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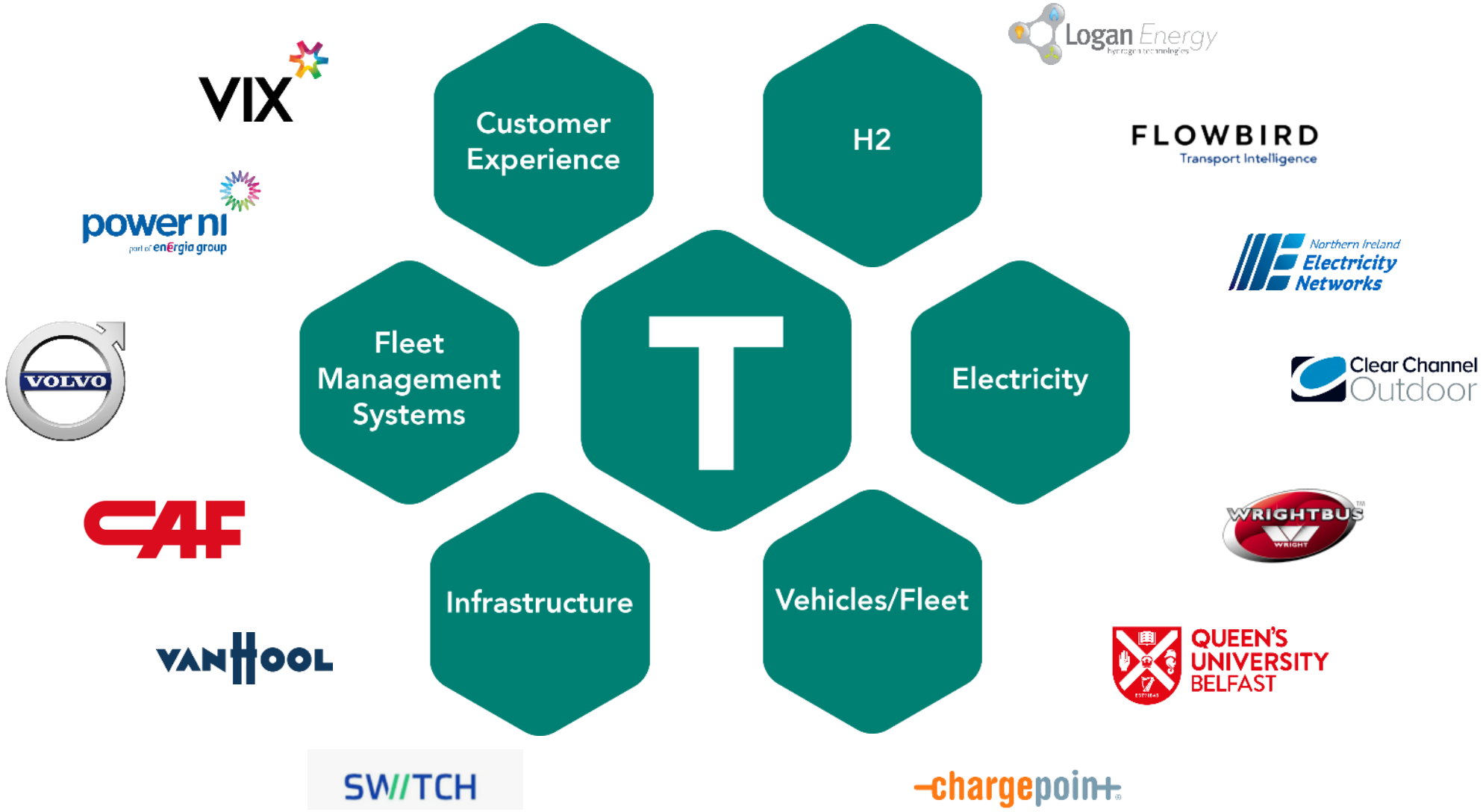
Zero Emission Collaboration - A Whole System Approach



THANK YOU!

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