

Hydrogen:

A Business Opportunity for the North East Region

Chair: David Caine, ERM

Session 1: Hydrogen Policy

- > **Scotland's Plan for Hydrogen** - Dave Holman, Scottish Enterprise
- > **OGA and the Energy Transition** - Andy Samuel, Oil & Gas Authority
- > **Hydrogen for remote communities** - Mark McKean, The Crown Estate
- > **Phased Hydrogen, H100 etc.** - Angus McIntosh, Scottish Gas Network

Scotland's Plan for Hydrogen

Speaker: Dave Holman, Scottish Enterprise

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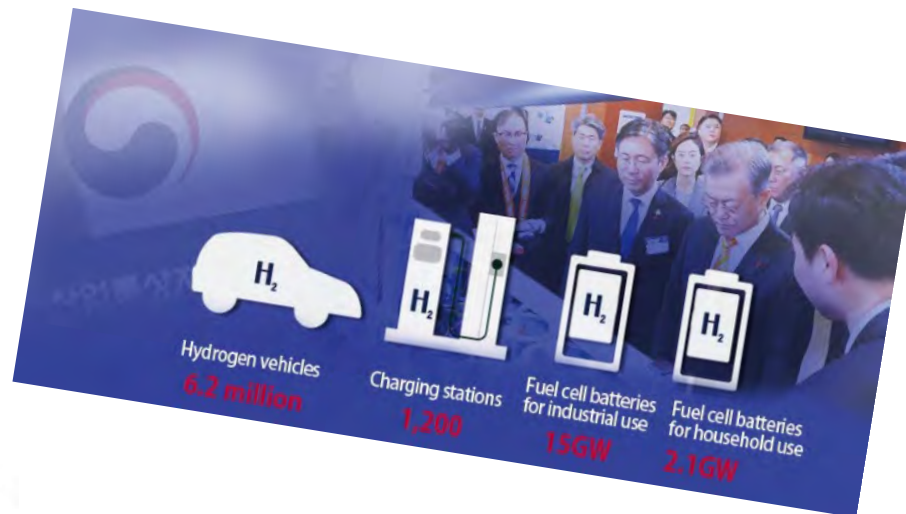
Hydrogen Scotland

David Holman
Scottish Enterprise
1st October 2019

Hydrogen Scotland

David Holman
Scottish Enterprise
1st October 2019

Global Hydrogen



Hydrogen Roadmap Europe

WHY HYDROGEN

BESIDES CO₂ ABATEMENT, DEPLOYMENT OF THE HYDROGEN ROADMAP ALSO CUTS LOCAL EMISSIONS, CREATES NEW MARKETS AND SECURES SUSTAINABLE EMPLOYMENT IN EUROPE

2050 hydrogen vision



~24%

of final energy demand¹



~560 Mt

annual CO₂ abatement²



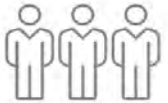
~EUR 820bn

annual revenue
(hydrogen and
equipment)



~15%

reduction of local
emissions (NO_x)
relative to road transport



~5.4m

jobs (hydrogen,
equipment, supplier
industries)³



Hydrogen Scotland

Categories	Strengths			
Existing Pilots		Western Isles Local Energy Hub	Orkney Surf n'Turf & Big Hit	Levenmouth Smart Local Energy System Aberdeen Bus & Fleet Vehicles
North East of Scotland		O&G Supply Chain Strengths	OGTC Low Carbon Industry Transition Vision	Project Acorn CCUS & Aberdeen Vision Offshore Hydrogen Supply Programme
Transport		Existing pilots and proposed projects/strategies	Existing Strengths: ADL, Ferguson Marine	Inward Investment linked to demand. Powertrain Optimisation & Maintenance
Energy Networks		SG Energy Networks Vision	Scottish Gas Networks activities & ambition	Grid balancing including gas turbines
Production & Supply		Huge resource potential	Renewables and gas supply	O&G expertise & infrastructure Supply opportunities locally & globally
Integrated Energy Systems		Distinct & remote communities	Grid constraint can drive innovation	Fuel poverty and rural equity opportunities
Industry		Decarbonisation of Industry	Grangemouth Vision and transition	Chemical & Industrial Biotechnology

Projects & Opportunities

Project SWIFT. CMAL LCITP project. Feasibility only to look at green hydrogen production and supply to inter island ferry & buses. Significant constrained wind. Circular Economy project, local energy hub – hydrogen production, oxygen use.

Speyside & Tain. CCU and hydrogen opportunity at whisky distillery cluster. Hydrogen for heat, feedstock for chemicals, biorefining, green fuels.

Inverness to Fort William. Potential extension of gas network? Inverness – Rail depot currently used for diesel refueling

Oban. Independent gas network. Currently supplied by LNG using road tanker.

Glasgow. First LEZ in Scotland (2018). Low carbon vehicle strategy. HV Systems.

East Kilbride. Scottish Hydrogen Park approach at SE Tech Park

Mull of Kintyre. Macrihanish – potential H100 site. Campbeltown – independent gas network supplied by LNG. Timberlink project.

Chapelcross, Annan. Redevelopment site with grid connection. Road and rail transport nearby.

Offshore wind potential.
Power to Gas

No grid connection. Large gas transmission pipe to St Fergus.

Kirkwall, Shapinsay, Eday. Electrolysers, trailer logistics, fuel cell, van fleet, ferry. H2 for power, heat, chemicals (Flotta) and transport. Significant constrained wind and high fuel prices. Number of ongoing projects of interest.

Both Thurso & Wick have independent gas networks, currently supplied by LNG using road tanker

St Fergus. Project ACORN. Aberdeen Vision Project. Blue hydrogen.

Aberdeen. Buses (JIVE), H2 vehicles, AECC FC-CHP, Net Zero Solution Centre, ERM Dolphyn. Hydrogen Coast Concept.

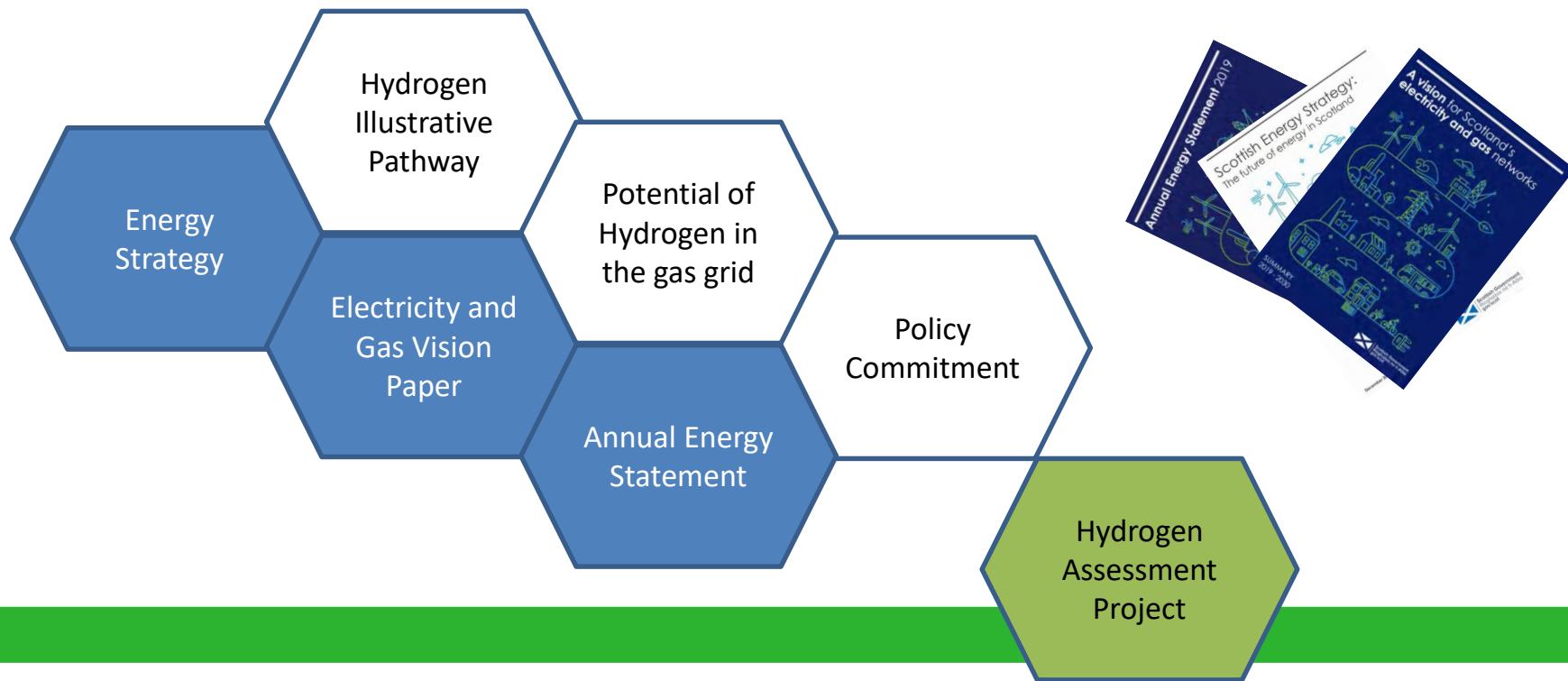
Dundee. JIVE2 bus fleet. MVV EfW project/hydrogen production. Michelin Energy Innovation Park

St Andrews. Innovation and research cluster around fuel cell technology. Centre for Innovation in Energy Storage. Eden Campus.

Levenmouth. Hydrogen Office. Smart local energy system. H100 potential site.

Grangemouth. Largest industrial H2 user at refinery. Chemicals cluster. CCU, longer term CCS.

Hydrogen Assessment Project



CCC Net Zero



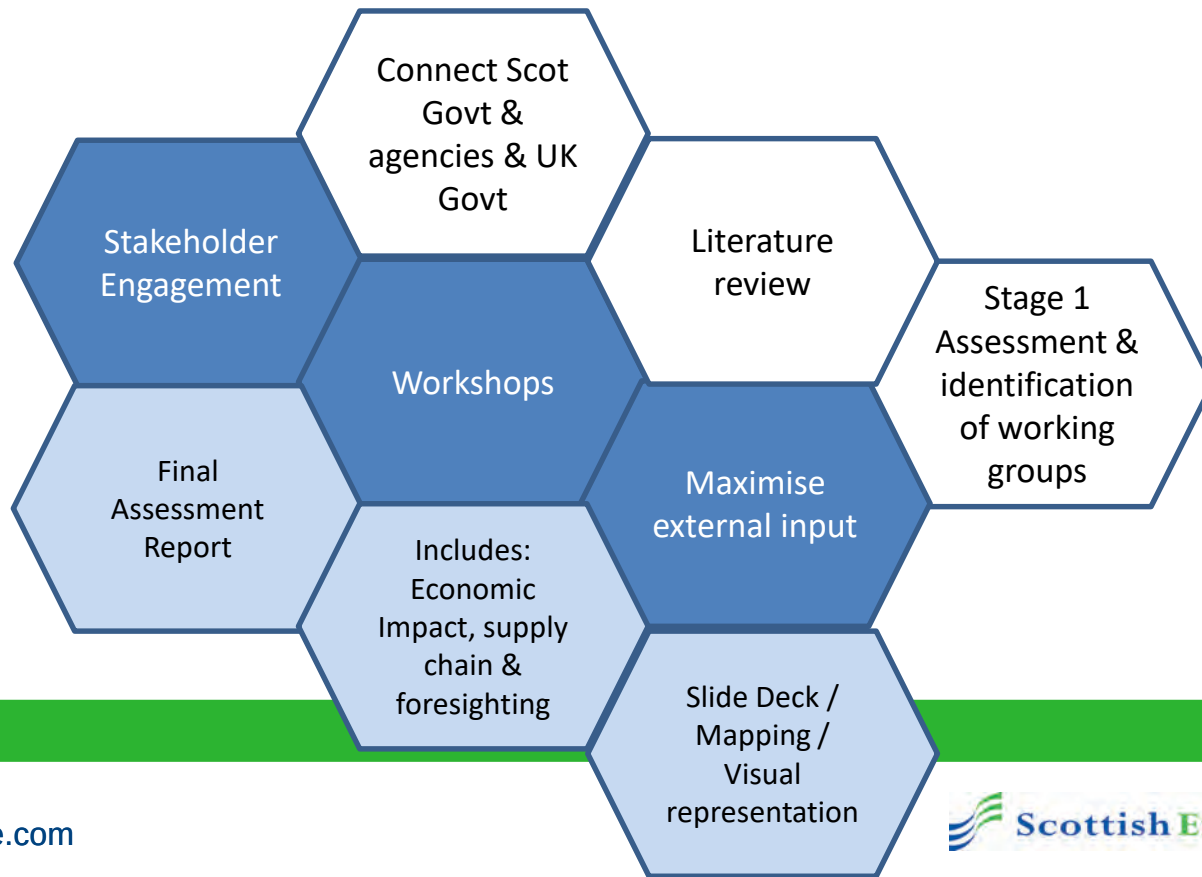
- UK Net zero by 2050
- **Scotland net zero by 2045. (70% by 2030 and 90% by 2040).**
- No-where to hide anymore....there's no 80% reduction target with a 20% window for breathing space.
- Significant reference to hydrogen in terms of industrial decarbonisation, heat, heavier vehicles and back up storage.
- Both blue hydrogen with CCS and green hydrogen.
- Report a game changer for the UK.

Hydrogen Assessment Project

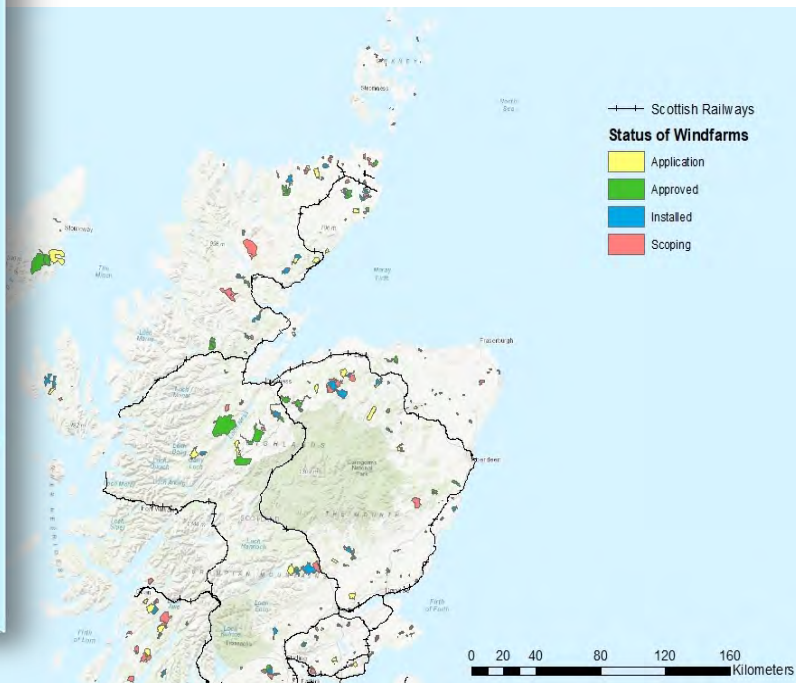
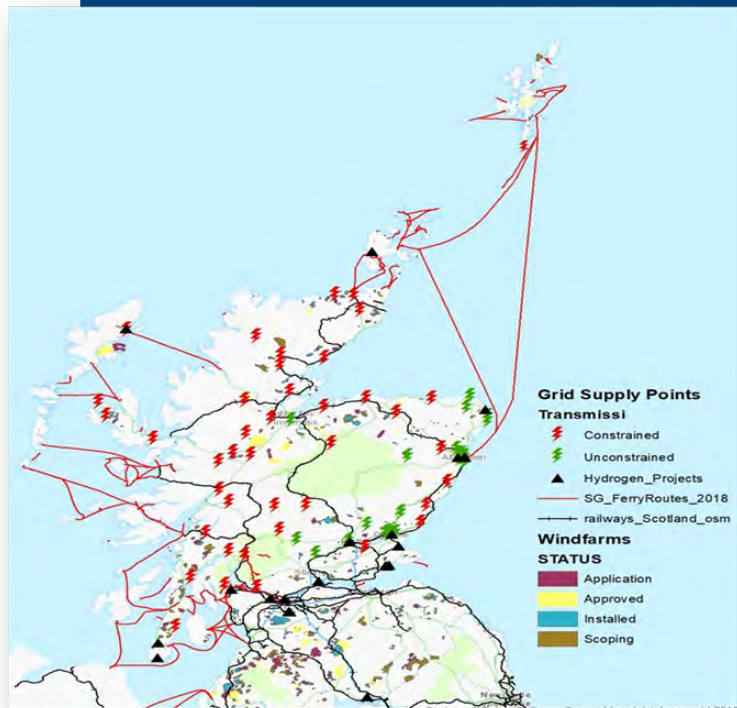
Phase 1 - Internal

Phase 2 - External

Phase 3 - Analysis



Hydrogen Mapping



Aim is to visualise and connect:

- Projects
- Resources
- Utilities
- Transport links

Contact

Thank you

David Holman

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Supporting the Energy Transition – The OGA's Role

Speaker: Andy Samuel, Oil and Gas Authority

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Oil & Gas
Authority

Supporting the energy transition

The OGA's role

Dr Andy Samuel
Chief Executive

October 2019

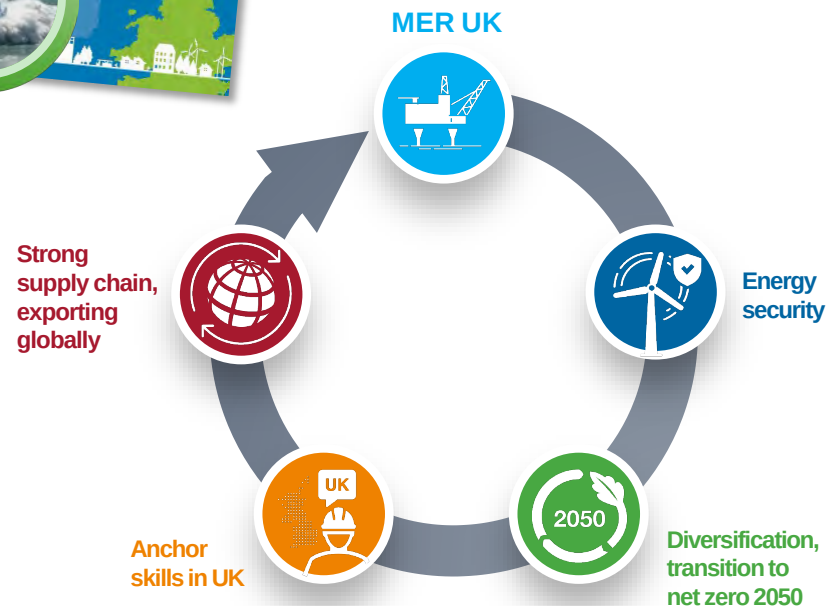
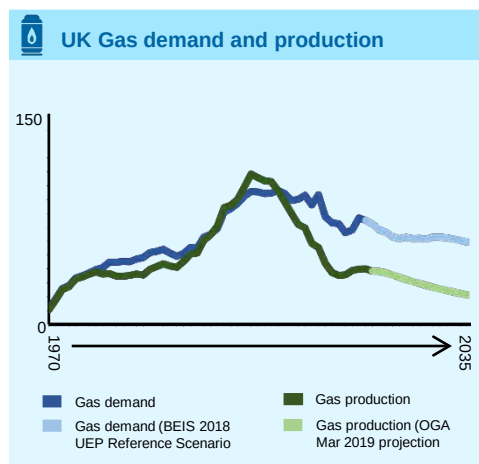
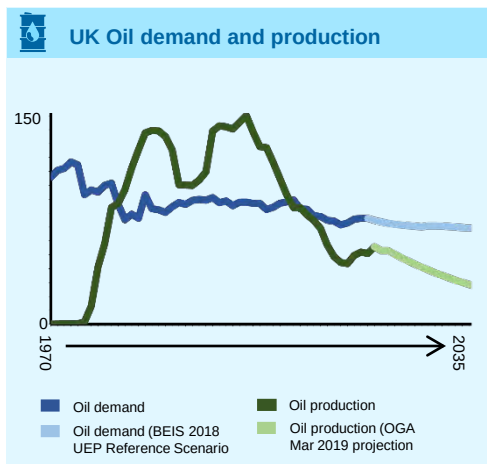
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Case for change



Oil & Gas Authority

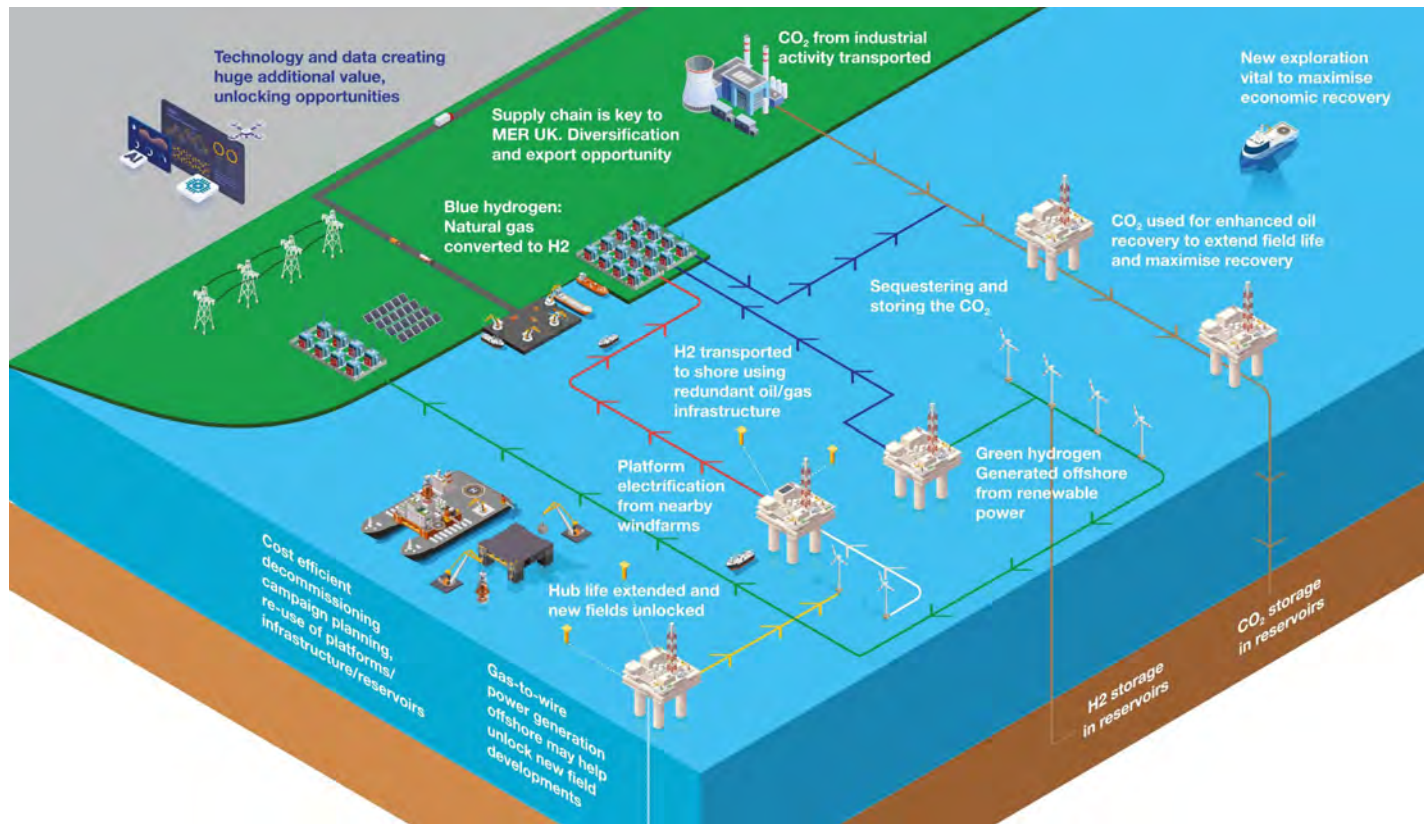


Debate more polarised than ever – quality dialogue and evidence based action required

UKCS is a critical energy asset



Oil & Gas Authority



Huge opportunity ahead

OGA current role on energy transition



Oil & Gas Authority



Maximising
domestic
gas
production



Increasing
operating
efficiency:
emissions
benefits



Offshore
flaring and
venting



Licensing of
carbon storage



Enhanced Oil
Recovery



Promoting
offshore energy
integration



Supporting
supply chain

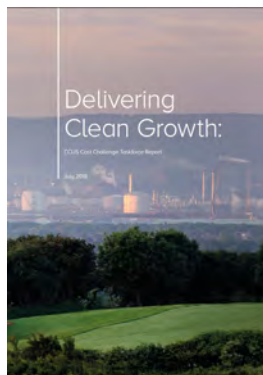
Carbon capture and storage



Oil & Gas Authority



Positive steps in BEIS policy development



2019 important year for CCUS with action plan underway

OGA's CCS role



Oil & Gas Authority



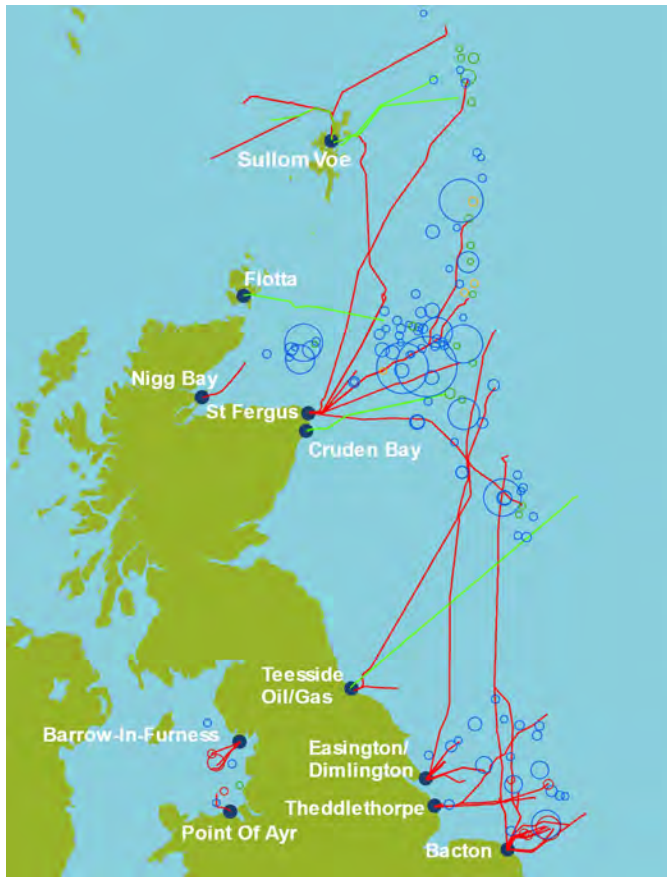
Working collaboratively with government and industry

Licensing and permitting authority for carbon storage –
OGA issued first licence Dec 18

Consider re-use as part of the OGA Cessation of Production process

Promoting role of CO₂ EOR

CCS as blue hydrogen enabler



78

GtCO₂

total UKCS
CO₂ storage
resource
estimate

75-175

MtCO₂

CCC estimate of annual
requirement in 2050

6-15

large scale
(12 MtCO₂ per year)
CCS projects
in 2050

to support CCS transport
and storage to offset UKCS
production emissions

(5% of the reduction in operating costs
achieved since 2014)

<\$0.5

boe

UKCS Energy Integration project



Oil & Gas Authority

Funded by £1m grant

Led by OGA, in collaboration with BEIS
Crown Estate and Ofgem

Quantify and help unlock UKCS energy
integration opportunities

CCS enabler for energy transition –
leverage O&G infrastructure

Potential integrating multiple sources:
renewables, O&G, and H₂

Oil and gas companies and supply chain
will play a critical role in delivery



Activity	Schematic
Platform Electrification Reduce costs and emissions	
Gas-to-Wire Power from gas offshore, Transmitted to shore	
CO2 transport and storage Re-use of infrastructure and fields	
Power-to-Gas Offshore windfarms produce hydrogen	
North Sea Wind Power Hub Large scale hydrogen production	



Oil & Gas
Authority



Department for
Business, Energy
& Industrial Strategy

THE CROWN
ESTATE

ofgem

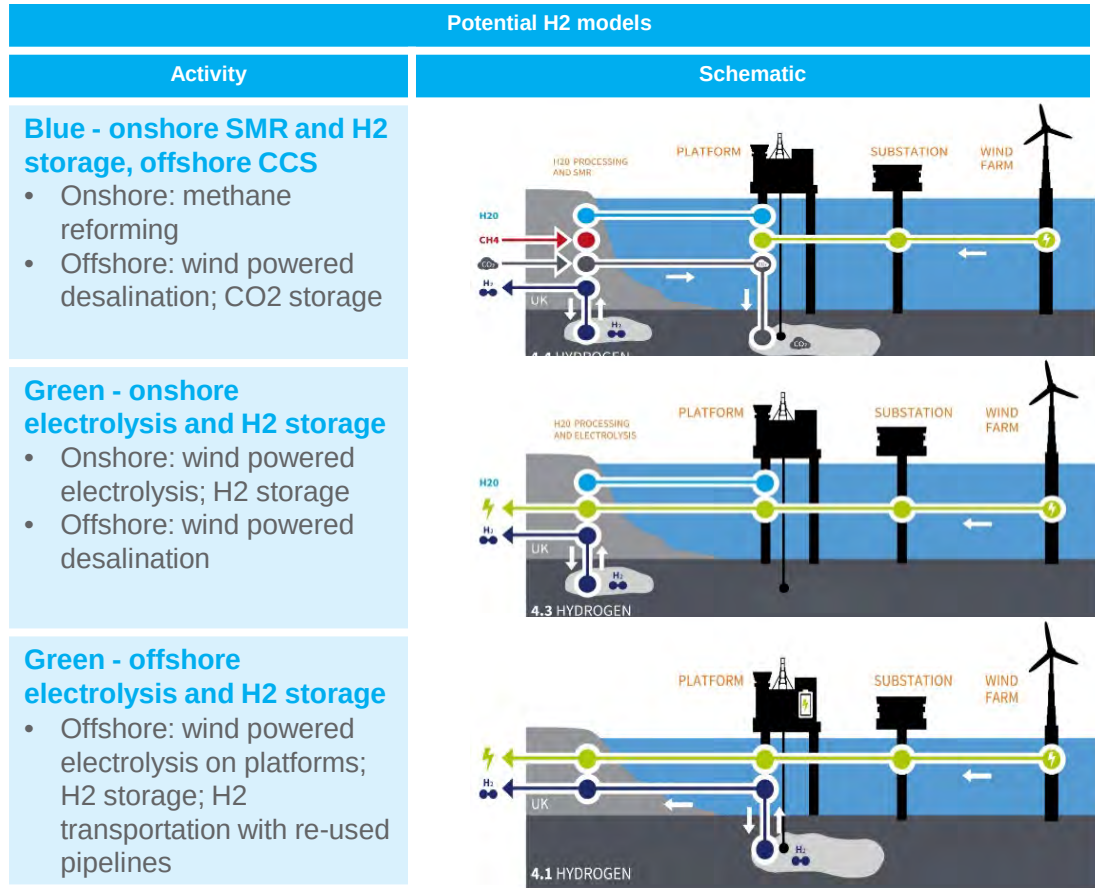
Hydrogen: initial findings

Onshore proven but still upside

Offshore to be piloted (Q13a in Netherlands)

Re-use potential: SNS, EIS and NNS

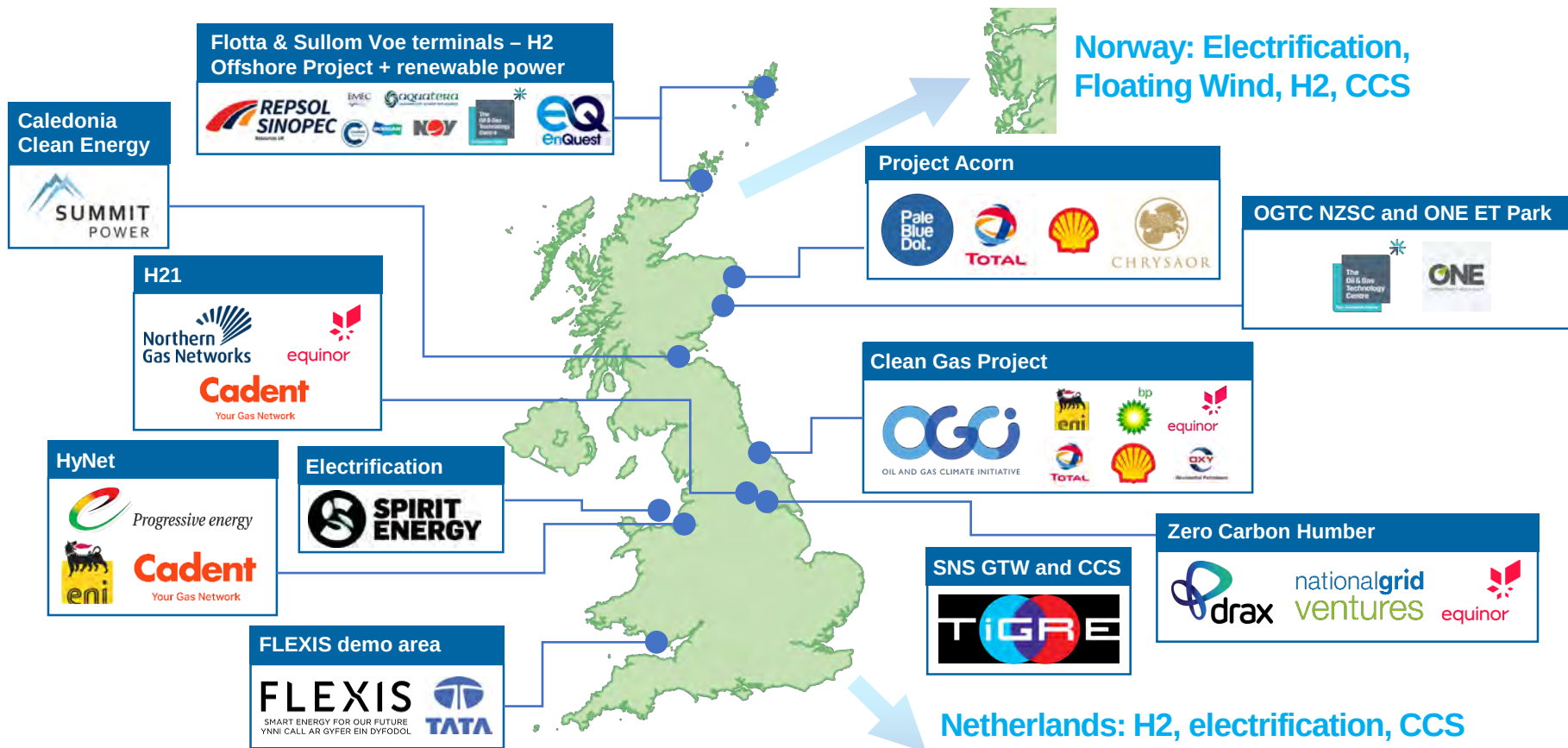
Larger hubs can help capture full potential:
Shetland, Orkney, SNS, EIS and NNS



Encouraging industry interest and activity



Oil & Gas Authority



We all need to work together to get projects over the line as soon as possible

Hydrogen for Remote Communities

Speaker: Mark McKean, The Crown Estate

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Hydrogen for Remote Communities

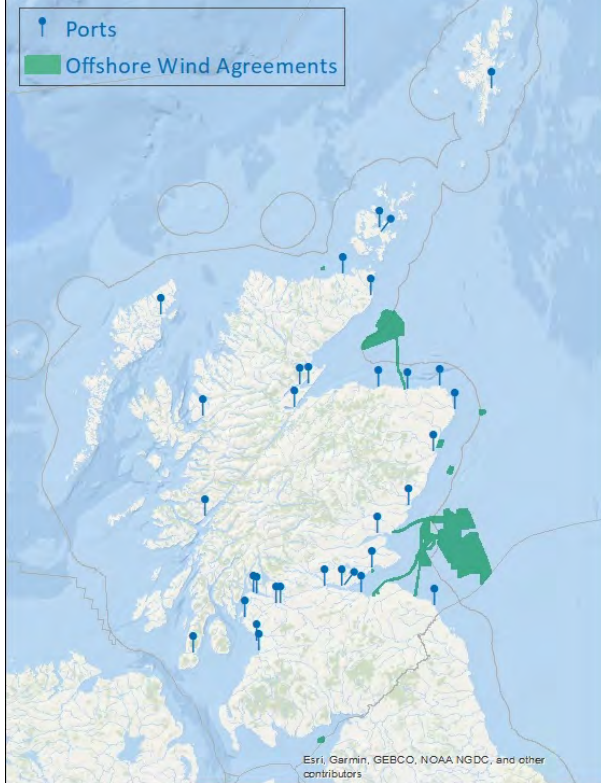
Mark McKean

Who we are and what we do



- Investing in property, natural resources and people to generate lasting value for Scotland.
- Scottish Crown Estate spans length and breadth of Scotland. Includes rural estates, commercial property, mineral and salmon fishing rights, just under half of the foreshore and almost all of the seabed.
- Return all revenue profit to Scottish Government.

Offshore Wind Agreements and Ports



Building the blue economy

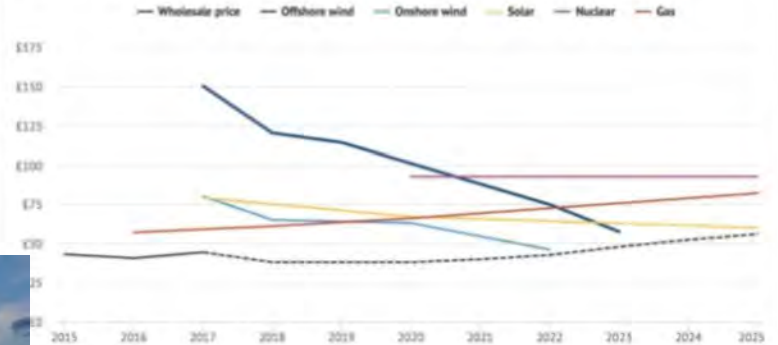
- Offshore renewables
- Ports & harbours
- Marine tourism
- Local energy systems
- Carbon capture, utilisation & storage
- Oil & gas, telecommunications
- Sustainable aquaculture

The Energy Landscape is changing

Offshore Wind
Cost Reduction
Task Force Report
June 2012



UK electricity costs



Offshore wind costs have reduced significantly over the past 8 years

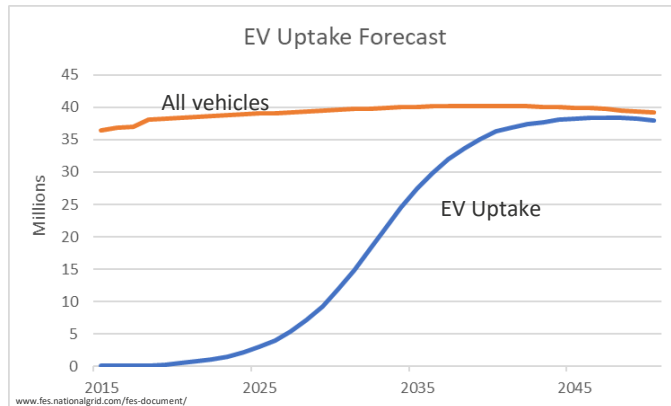
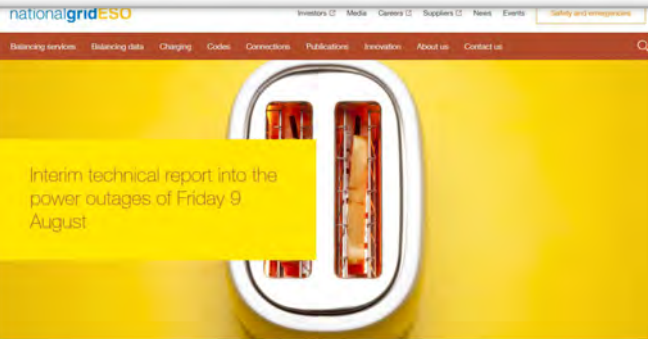
The Energy Landscape is changing

UK electricity generation in 2018 was the lowest since 1994

The UK has saved 103TWh versus per-capita generation remaining at 2005 levels



www.carbonbrief.org/analysis-uk-electricity-generation-2018-falls-to-lowest-since-1994



National Grid PLC

+ Add to myPT

UK energy minister questions future of National Grid

Kwasi Kwarteng says company might lose role operating country's electricity system



A power cut in August disrupted more than 1m homes and businesses in England and Wales © Christopher Furlong/Getty Images

Nathalie Thomas in London SEPTEMBER 6, 2019

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UK energy minister Kwasi Kwarteng has questioned whether National Grid should retain its flagship role operating the country's electricity system following a power cut last month that disrupted more than 1m homes and

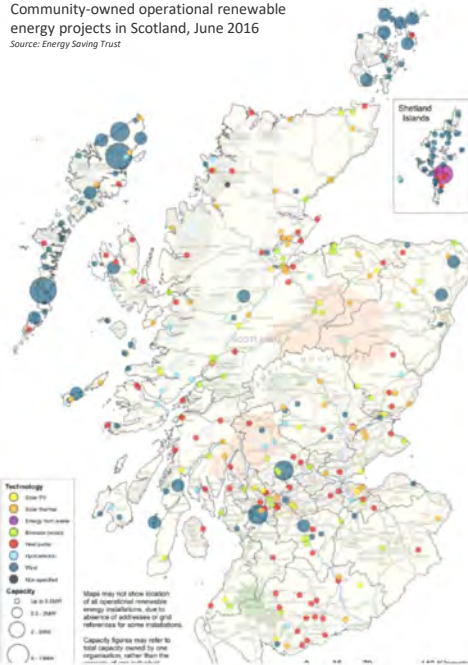
Our energy system is challenged to respond to our changing demand



**Crown Estate
Scotland**
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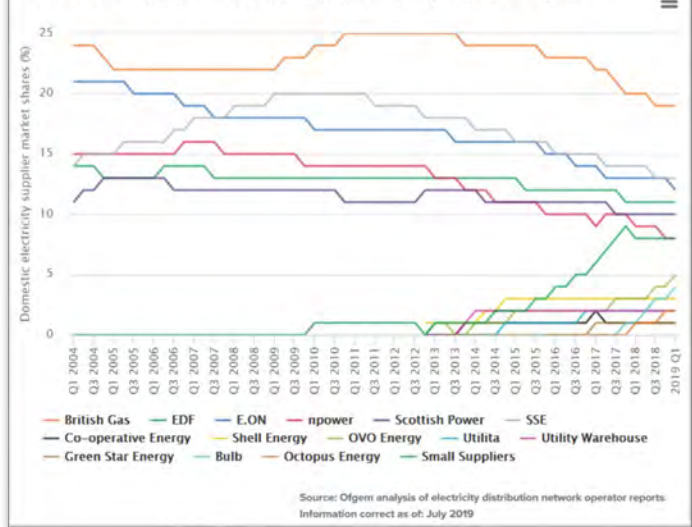
The Energy Landscape is changing

Community-owned operational renewable energy projects in Scotland, June 2016
Source: Energy Saving Trust



Communities interest in and ownership of energy assets has increased

Electricity supply market shares by company: Domestic (GB)



The Energy Landscape at present

The energy sector is a key to responding to the net zero challenge



What does this mean for Communities?

Increasing opportunities for regional/local/ island solutions



Drive to capitalise on capturing 'spilled' energy generation from renewable technologies



Decentralised energy storage and systems utilising hydrogen for communities

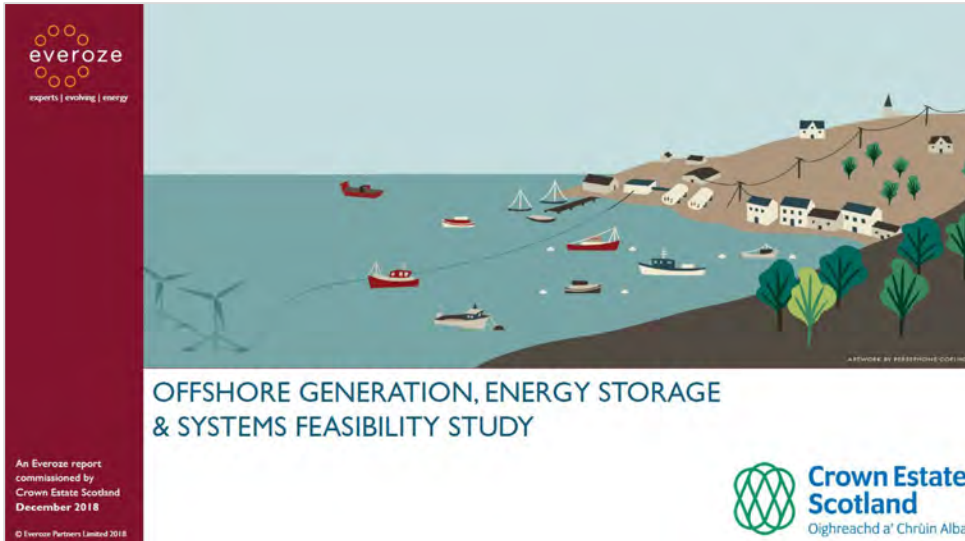


Scalable renewable generation solutions enabling a zero carbon future



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Scotland**
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What we've done to explore this further

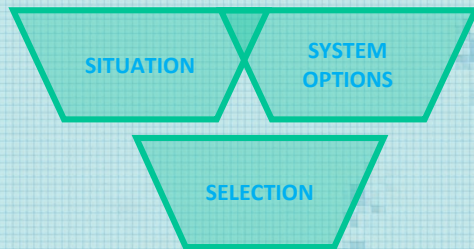


<https://www.crownestatescotland.com/media-and-notice/news-media-releases-opinion/new-study-can-help-coastal-communities-benefit-from-local-energy-solutions>

What we've considered - Six (model) Scenarios

1. FRAMING

Situation
Options
Selection



2. ASSESSMENT

Techno-economic modelling
Case studies
Regulatory issues
Investment options
Barriers & opportunities



3. RECOMMENDATIONS

Defining specific actions



SCENARIO 1a: SMALL WAVE
CONNECTING TO REMOTE ISLAND
WITH PRIVATE NETWORK



SCENARIO 1b: WAVE TO
AQUACULTURE



SCENARIO 2: TIDAL CONNECTING
INTO LARGE ISLAND WITH
SIGNIFICANT INDUSTRIAL USERS



SCENARIO 3: TIDAL CONNECTING TO
REMOTE MAINLAND PORT WITH
MARITIME HYDROGEN SYSTEM



SCENARIO 4: TIDAL ARRAY WITH
BATTERY STORAGE PROVIDING AN
ALTERNATIVE GRID UPGRADE



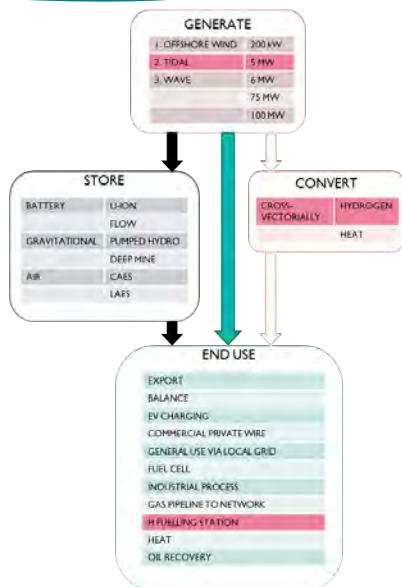
SCENARIO 5: LARGE SCALE FLOATING
WIND WITH OFFSHORE ELECTROLYSIS
AND USE OF GAS PIPELINES



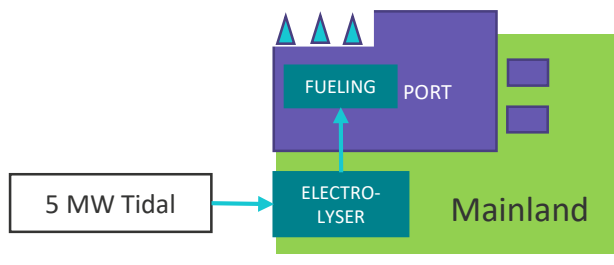
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Tidal Connecting to Remote Mainland Port with Maritime Hydrogen System (Scenario 3 in Study)

SUMMARY OF PROPOSED ENERGY SYSTEM



Conceptual model

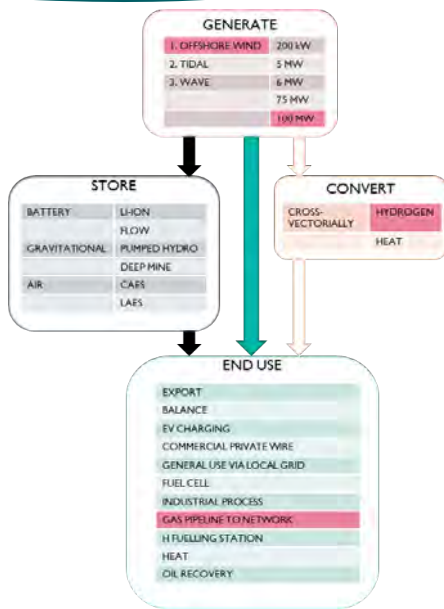


THEORETICAL POTENTIAL BENEFITS OF THIS ENERGY SYSTEM AND WHICH STAKEHOLDERS COULD POTENTIALLY BENEFIT		Tidal developers	Local community	Other*
Integration into local energy systems	Offering potential for larger deployment if viable.	x		
Diversity of revenue streams	Provides tidal generator with range of revenue streams. Could potentially include heat, O ₂ and electricity.	x		
Decarbonisation of vessels / port	Vessels are a major contributor to carbon emissions in coastal communities.			x
Air quality benefits	Reduction of pollutants in local area through move to hydrogen vessels.		x	
Marketing for port and vessels	Could help attract companies to port and people to the area.	x	x	x

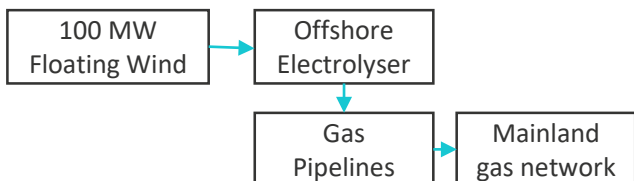
* Others include vessel operators and public sector

Large Scale Offshore Wind with Offshore Electrolysis and Use of Gas Pipelines (Scenario 5 in Study)

SUMMARY OF PROPOSED ENERGY SYSTEM



Conceptual model



THEORETICAL POTENTIAL BENEFITS OF THIS ENERGY SYSTEM AND WHICH STAKEHOLDERS COULD POTENTIALLY BENEFIT		Developers	Local community	Other*
Overcomes grid constraint	Provides export route for the energy. May open up new areas.	x		x
Delivers renewable heat at scale	Large scale hydrogen production.			x
Postpones decommissioning of pipelines	Offers potential to repurpose assets coming to end of life.			x
Reduced electrical connection for wind farm	No connection needed to island.	x		
Employment benefits locally	Through deployment of large scale wind farm.		x	

* Others include electrical infrastructure operators, gas pipeline operators, and the public sectors

What else we are doing

- Understanding opportunities for energy systems with offshore renewable developments, potential developments and operating assets in Scotland –



XODUS
ADVISORY

elementenergy



BALDOCK ENERGY
CRAFTING THE FUTURE

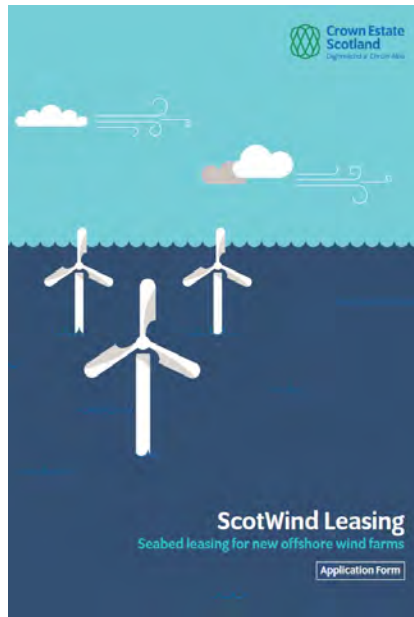
Index A.1 Wind and Tidal Resource off the Scottish Coastline



Index A.3 Electricity Demand



ScotWind Leasing

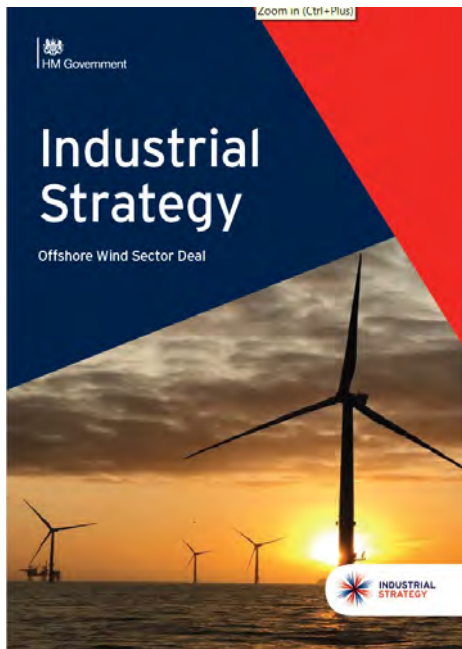


A case study on the wider value of local energy systems alongside offshore renewables, including remote hydrogen projects



**Crown Estate
Scotland**
Oighreachd a' Chrùin Alba

What else is happening



UKCS Energy Integration

To support the cost-effective deployment of offshore wind, the sector will establish a System Management and Optimisation Task Group which will explore innovative solutions to support grid integration. This will include managing variability of demand and supply, and the ***potential for generation and storage of hydrogen*** for other key applications in a decarbonised energy system.

What can Communities take away from all this activity?

- There is a growing interest in linking local/regional communities with decentralised energy and the hydrogen economy;
- Demonstration projects and innovation success are key to cost reduction;
- Good knowledge of our local energy networks and demand requirements (data, constraints, opportunities) will inform and support development;
- Public sector, communities and technology developers collaboration is important for development of local hydrogen systems;
- Scotland's seas remain a valuable national resource that can be utilised as part of Scotland's hydrogen future.

Thank you

www.crownestatescotland.com
marine@crownestatescotland.com



[@CrownEstateScot](https://twitter.com/CrownEstateScot)

SGN Energy Futures – SGN Phased Hydrogen

Speaker: Angus MacIntosh, SGN

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SGN Energy Futures

SGN Phased Hydrogen

Angus McIntosh

Director of Energy Futures

October 2019



SGN

Your gas. Our network.

A reminder of SGN

Upgrade

1,000km mains
replaced per year



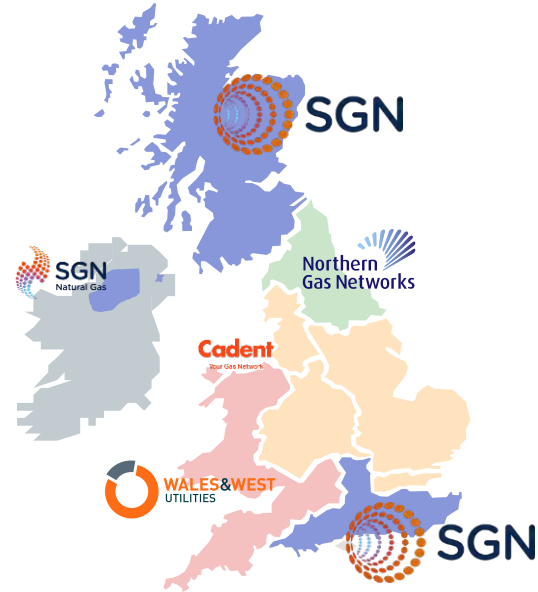
Connect

20,000 connections
(5,000 fuel poor) per
year

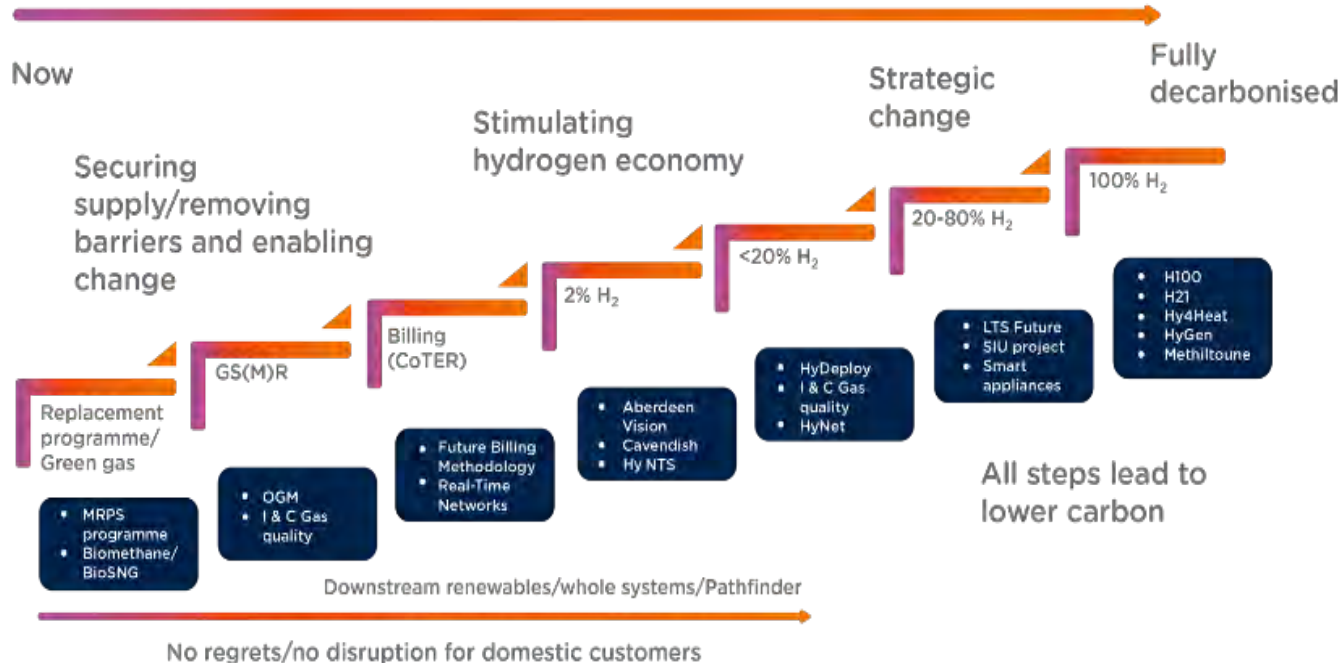


Emergency

230,000 calls
50,000 repairs per year



Gas quality decarbonisation pathway



Aberdeen Vision & Integrated projects



SMR plant



Aberdeen Vision Project

Facilitation of demand and applications for hydrogen



Acorn Hydrogen /Carbon Capture

SMR - Hydrogen production from natural gas with CCS at St Fergus



Acorn CCS

Transport and storage of CO₂

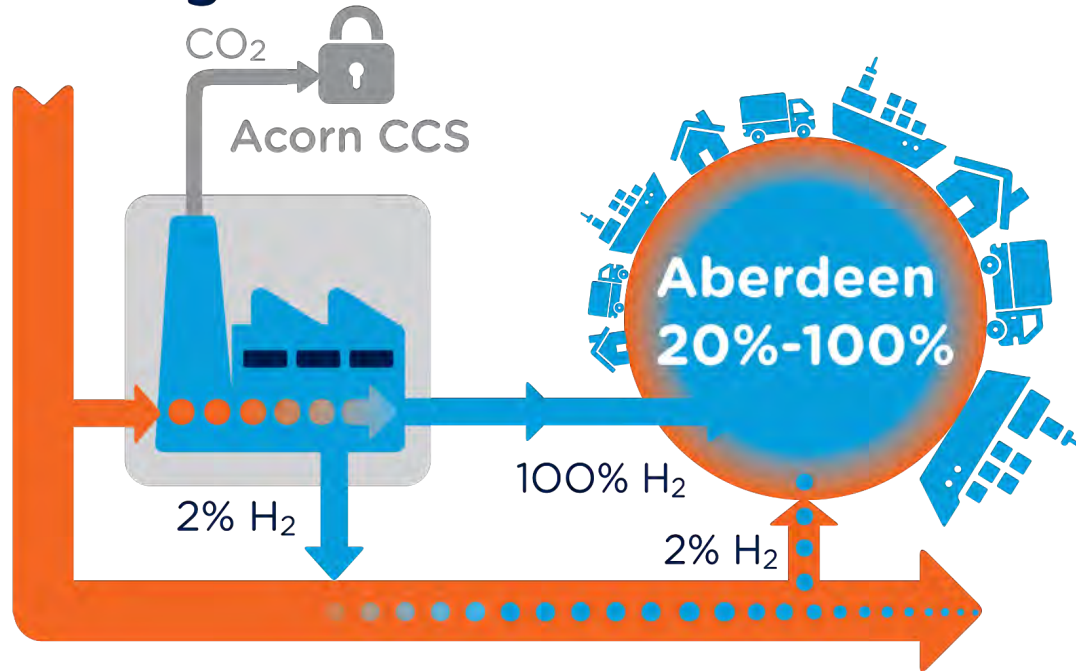
Key attributes for choosing St Fergus for Hydrogen Production

- Delivers approx. 35% of UK gas
- Existing Industrial Site
- Opportunity for Hydrogen blending on a large scale
- Key Transport Hub – Aberdeen Buses/Marine/Rail
- CO₂ Transport via Existing Structure
- CO₂ Storage capacity offshore

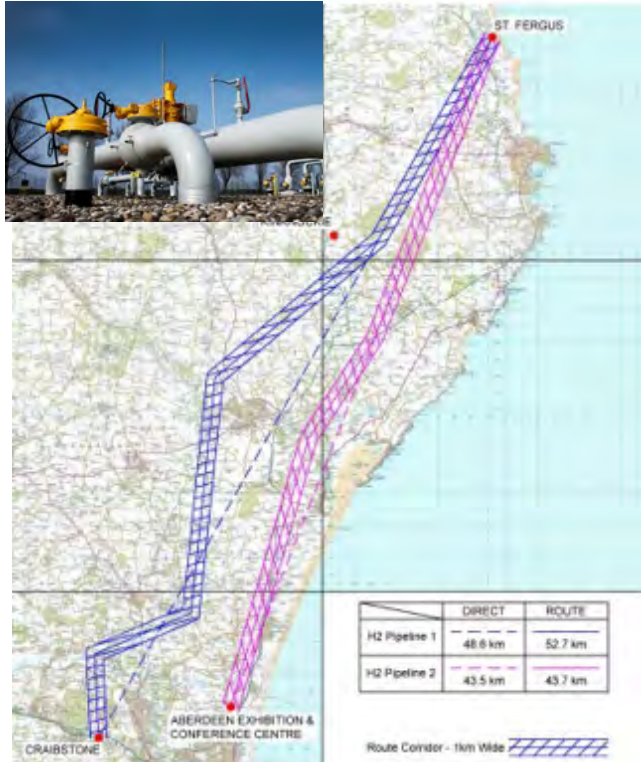


Aberdeen Vision

St Fergus



St Fergus to Aberdeen LTS pipeline route



- Current proposed options for hydrogen pipeline route.
- 450mm diameter pipeline **based on 100% conversion of Aberdeen gas network**
- Project to determine and consider all aspects related to Hydrogen storage requirements

Aberdeen Conference Centre



LEGEND

- Ownership Boundaries
- Site Boundary
- 1km Boundary

NOTES

This selection of data is the ownership boundaries surrounding the site.

Data Source: Inspire

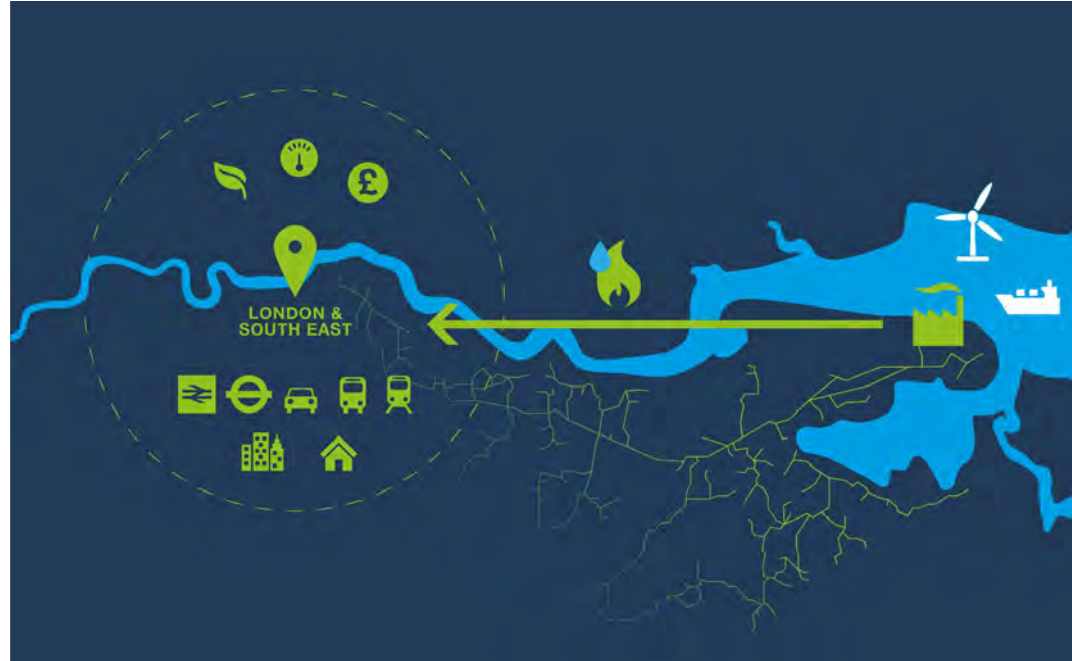
Ownership Boundaries within 1km of the site SGN-CTN-07-001

REV	DATE	CREATED BY	CHECKED BY	APPROVED BY
01	10/05/19	KD	SS	SC

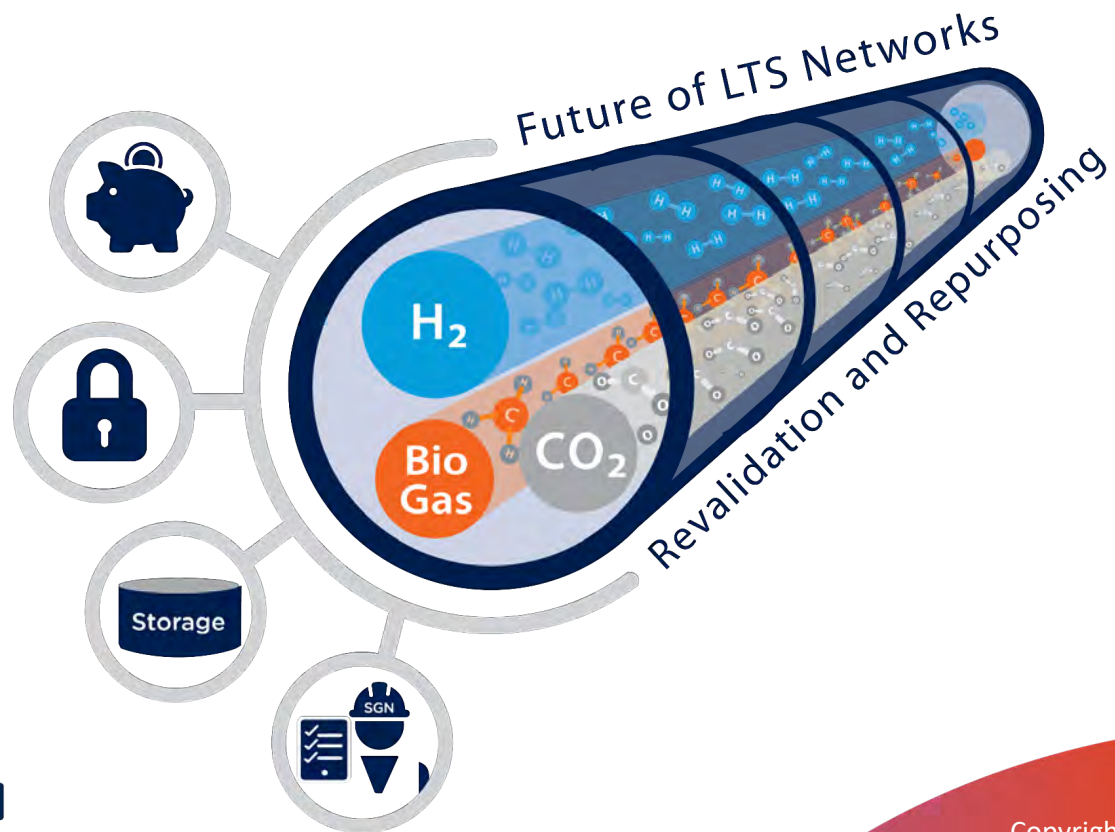
SGN

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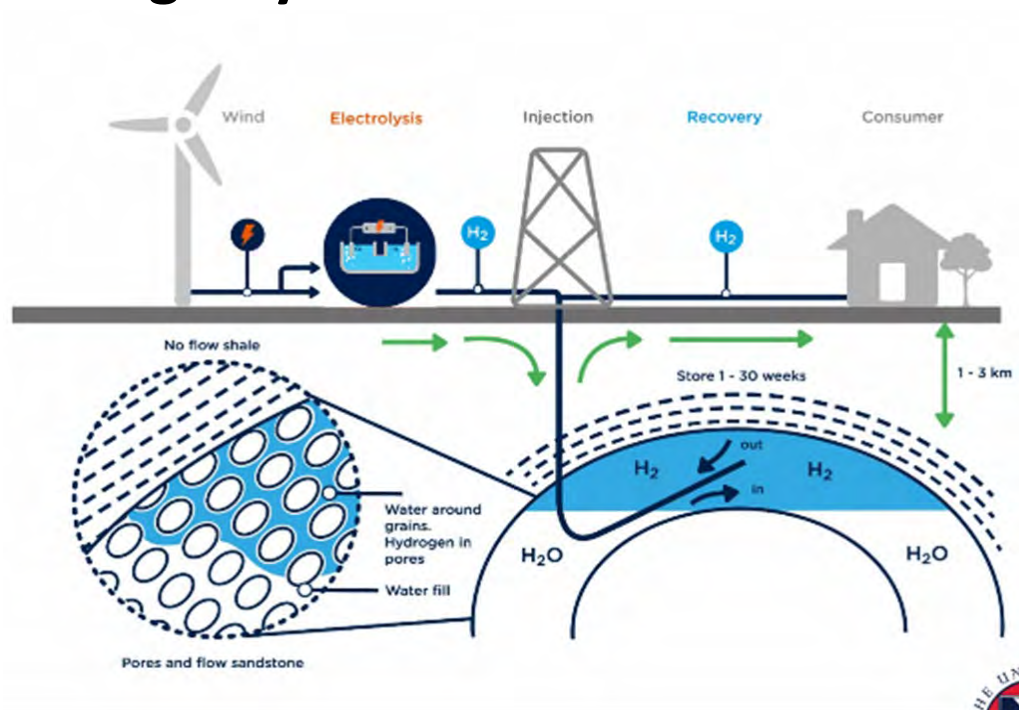
Project Cavendish Hydrogen for South London



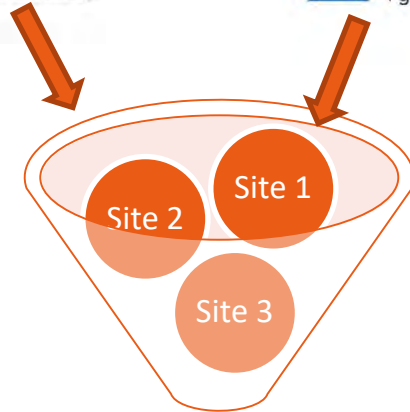
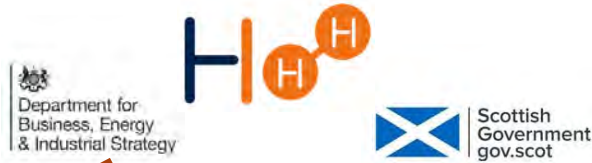
LTS Future Granton to Grangemouth



Storage HyStorPor

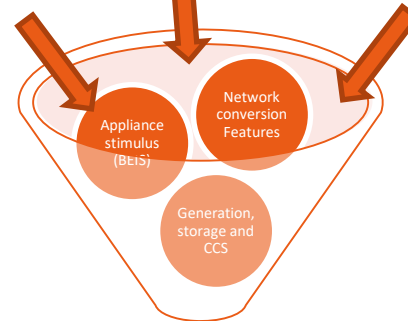
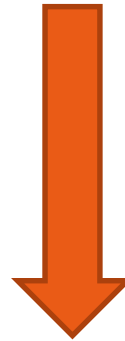


100% H₂ Projects



Construction
Demonstration

100% H₂



Collaborative Parallel
evidence toward
conversion

Hydrogen ready Boilers: Customer Value Proposition



Projects

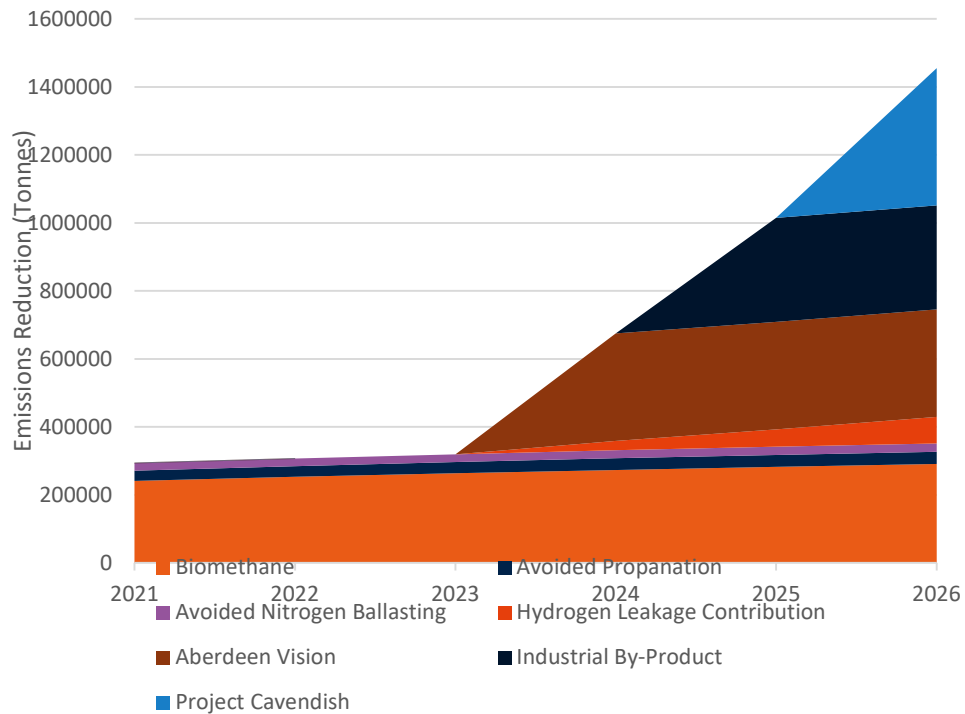
- 1 Opening up the Gas Market
- 2 Aberdeen Vision
- 3 Project Cavendish
- 4 LTS Future project
- 5 H100 project
- 6 SIU project
- 7 Methiltoun project
- 8 East Neuk project
- 9 Mossmorran project
- 10 Dolphyn project
- 11 BioSNG City project
- 12 Green Billing for Industry
- 13 Hydrogen City Design
- 14 HyStorPor
- 15 National T5
- 16 100% H₂
- 17 100% H₂

Map labels: Orkney Islands, Shetland Islands, Wick, St Fergus, Peterhead, Aberdeen, East Neuk, Fife, Dundee, Perth, Glasgow, Edinburgh, Inverness, London.

Projects

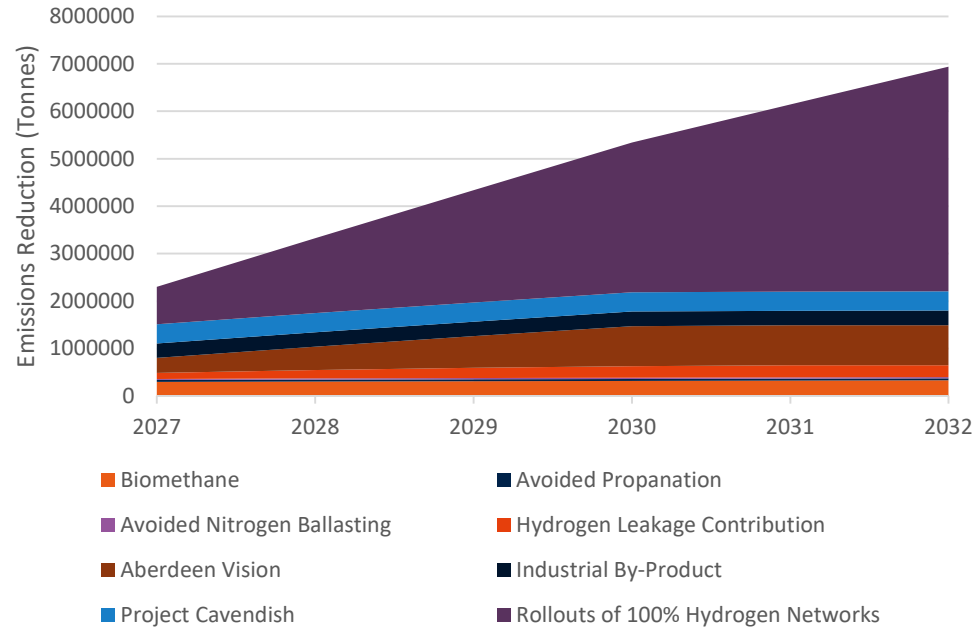
- 15 Real-Time Networks
- 16 Portsmouth Hill Biomethane Entry Facility
- 17 Pathfinder Modelling
- 18 100% H₂ in Isle of Wight
- 19 Smart Control of Biomethane
- 20 Increase Green Gas Capacity
- 21 Smart Gas Control

Avoided Carbon potential in GD2 (Hubs approach)

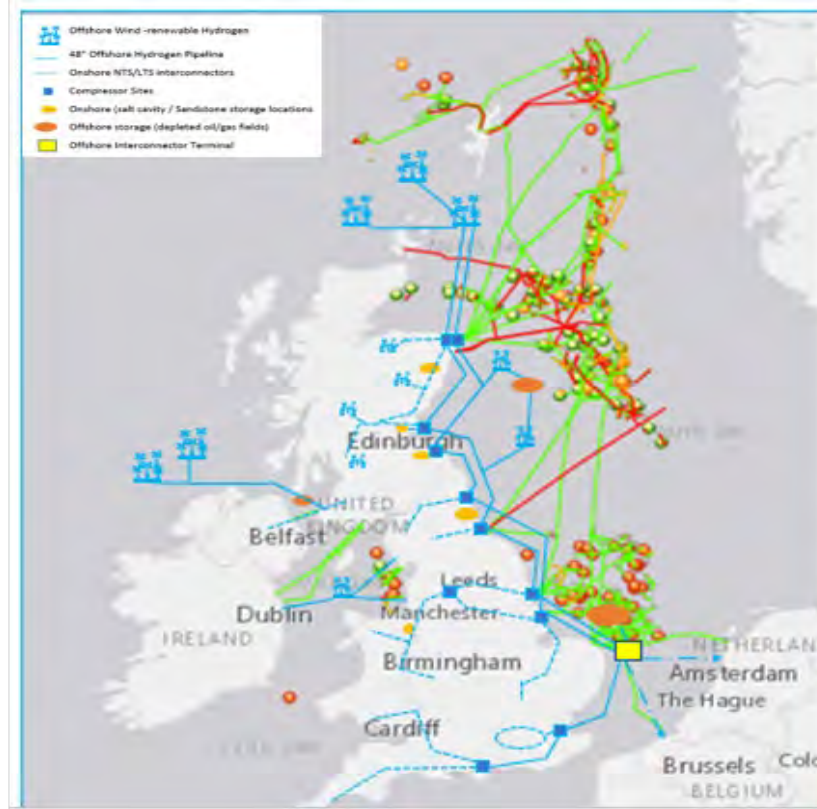


GD3 Potential Carbon

Enabled by GD3 R&D
Reduction



H₂ Supergrid?



Thank you



SGN
Your gas. Our network.