



*INFORM  
CONNECT  
GROW*

Lower Saxony & Scotland  
Partnerships for Growth

Hydrogen in Scotland  
Learning by Doing

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& Fuel Cell Association

[www.shfca.org.uk](http://www.shfca.org.uk)

# Partnerships for Scaling up Hydrogen

Scotland has a target for Net Zero by 2045, and annual electricity demand is now almost all met by renewables. Orkney BIG HIT established one of the first Hydrogen Valleys, with others now developing:

- **Mobility & Logistics:** Aberdeen H<sub>2</sub> fleets with Aberdeen H<sub>2</sub> Hub
- **Industry:** Cromarty Green Port, Aberdeen's Energy Transition Zone
- **Heat:** key evidence to deploy 100% H<sub>2</sub> for heat with H100 Fife trials

Scotland is now scaling up hydrogen production and demand, with the ambitious target for 5GW low carbon hydrogen production by 2030.

Further scale-up will support the Just Transition from fossil fuels to low carbon energy, with opportunities for partnerships and sharing experience.

# Our Contribution to Stopping Global Warming

Scotland's target: **Net Zero by 2045**

Year	Scottish CO <sub>2</sub> Reduction
2030	75%
2035	80%
2040	90%
2045	100%

2009 Climate Change (Scotland) Act  
set an ambitious stretch target for  
42% GHG reduction by 2020



Climate Change (Scotland) Act 2009

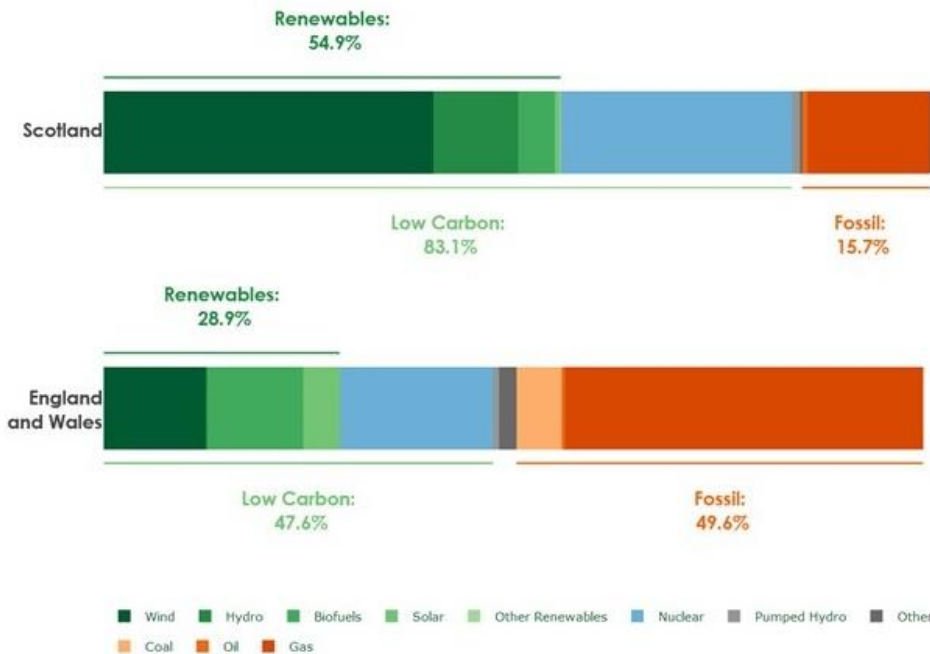




AN INCLUSIVE ENERGY  
TRANSITION

# Scotland's Transition to Low Carbon Electricity

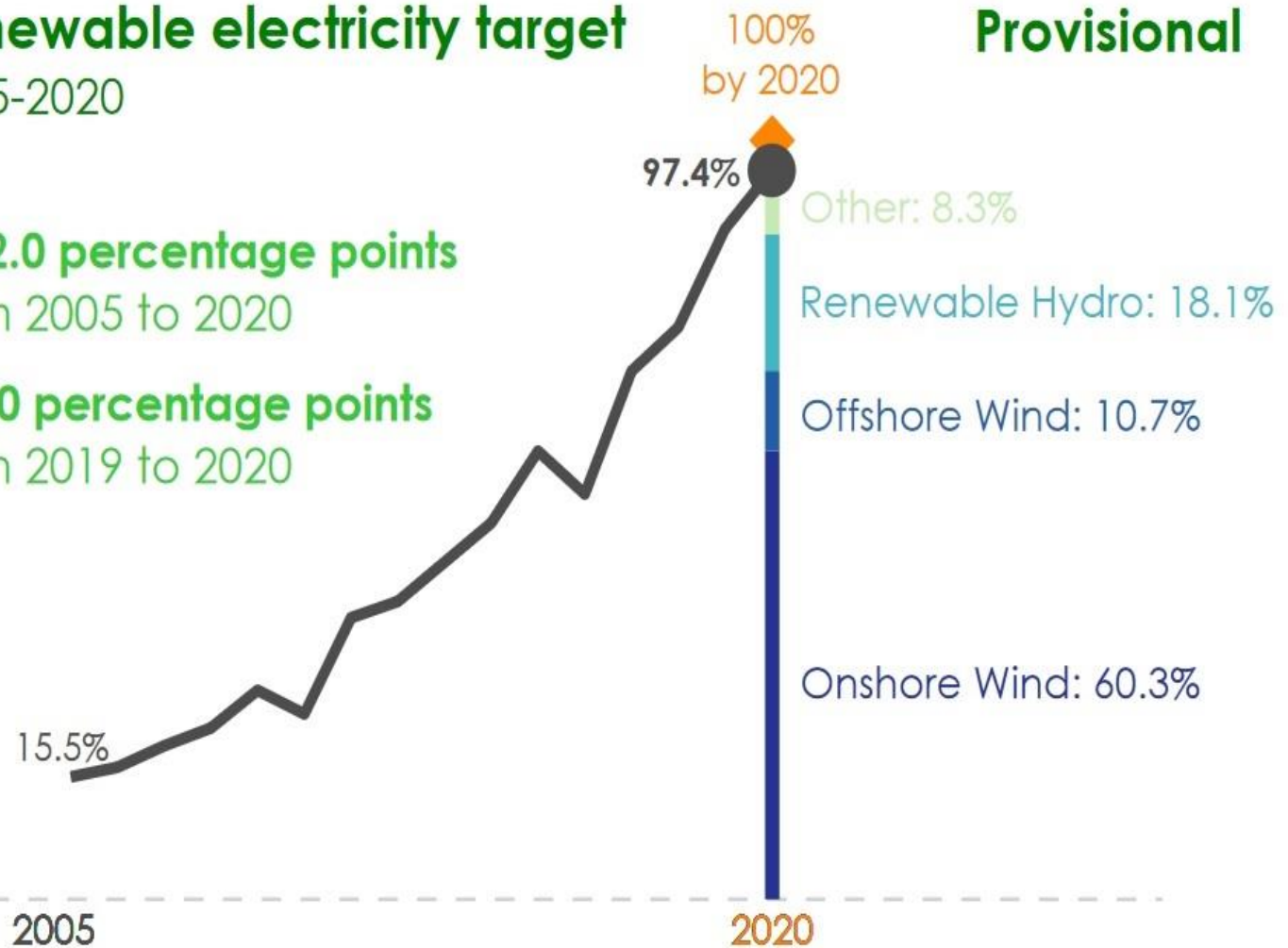
Proportion of electricity generation  
by fuel type in 2018 (BEIS data)



**Renewable electricity target**  
2005-2020

↑82.0 percentage points  
from 2005 to 2020

↑8.0 percentage points  
from 2019 to 2020



Energy Statistics for Scotland: Q4 2020 Figures (March 2021)



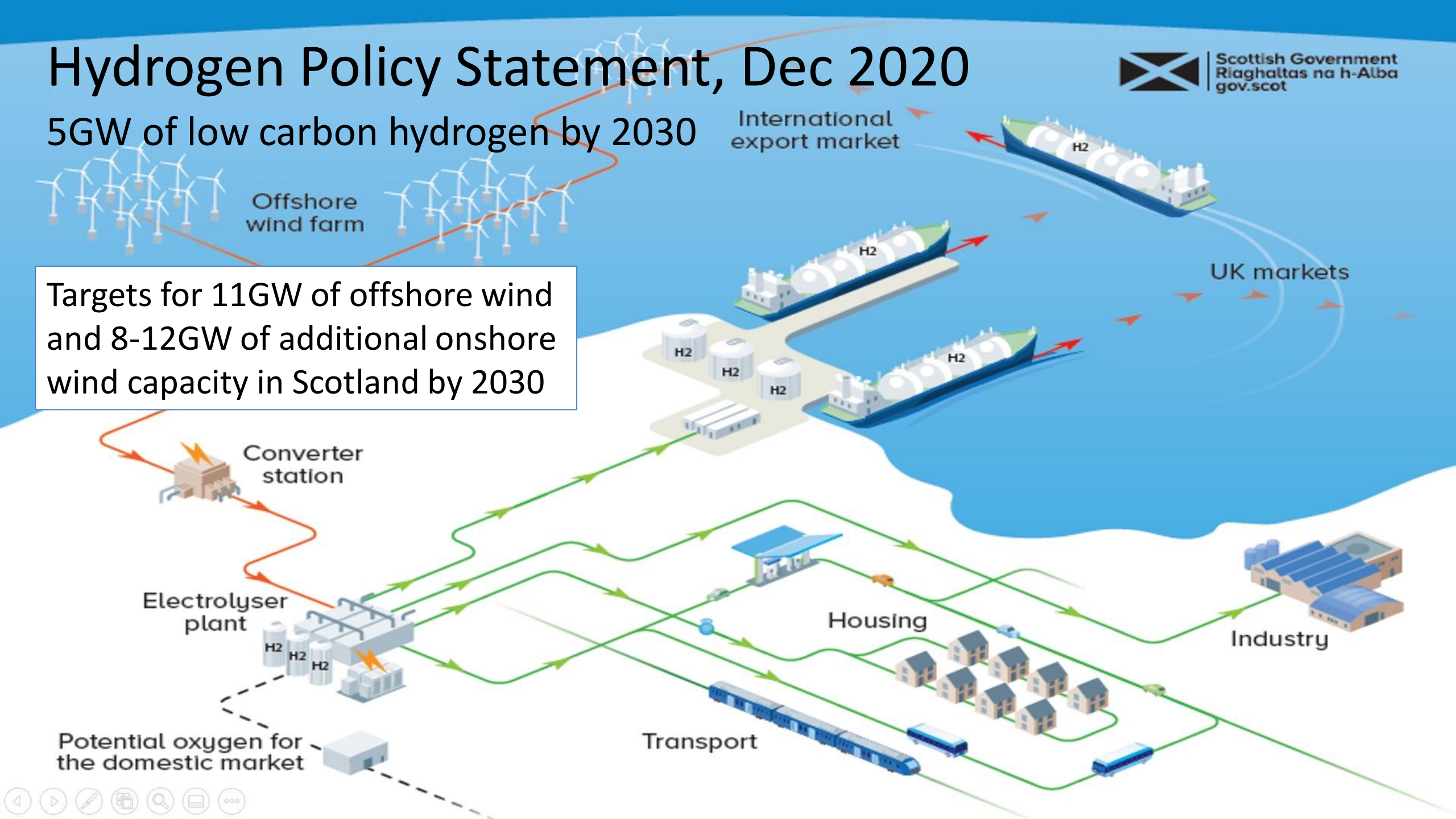
# Hydrogen Policy Statement, Dec 2020




Scottish Government  
Riaghaltas na h-Alba  
gov.scot


5GW of low carbon hydrogen by 2030

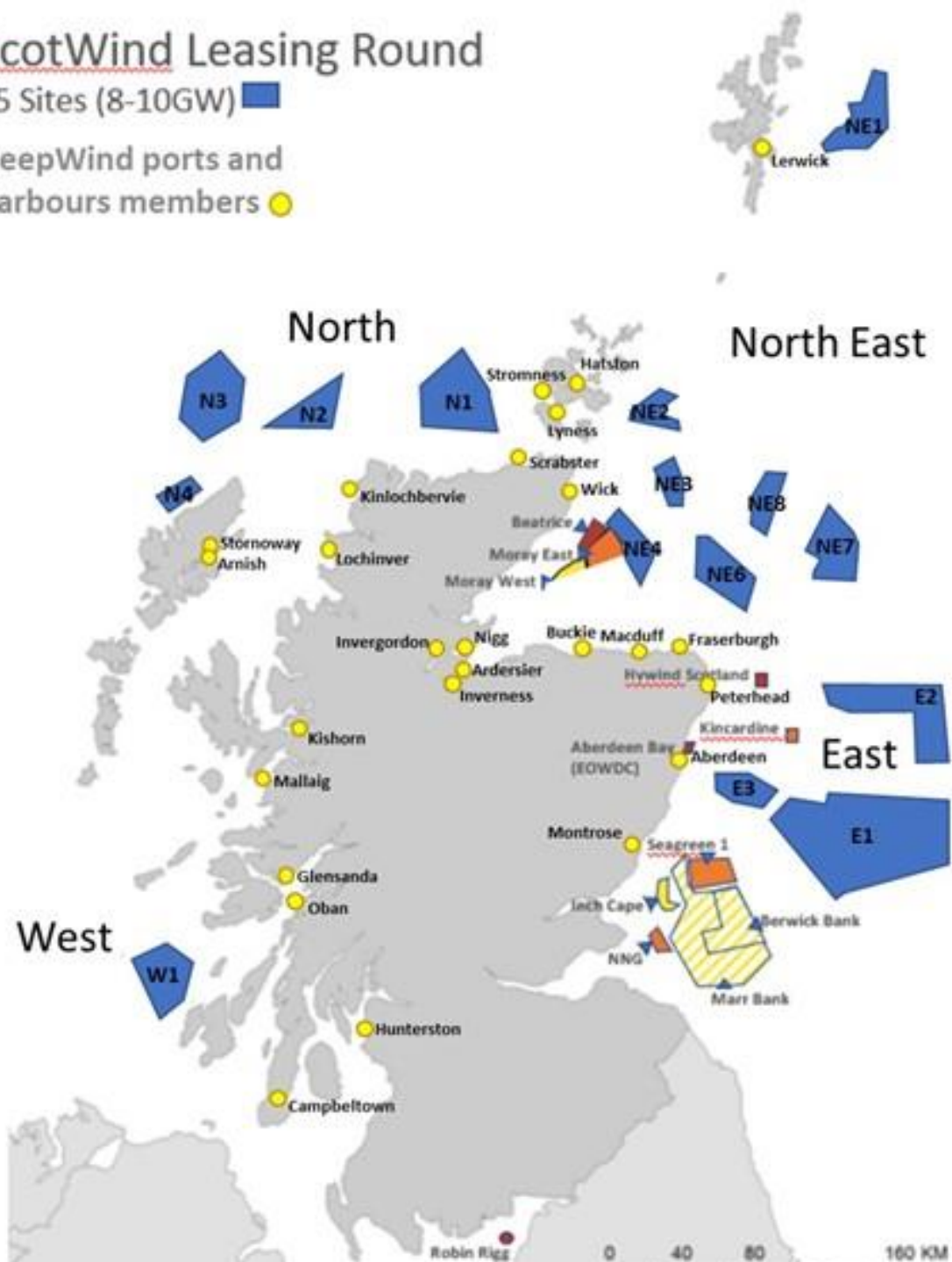
Targets for 11GW of offshore wind and 8-12GW of additional onshore wind capacity in Scotland by 2030



# ScotWind Leasing Round

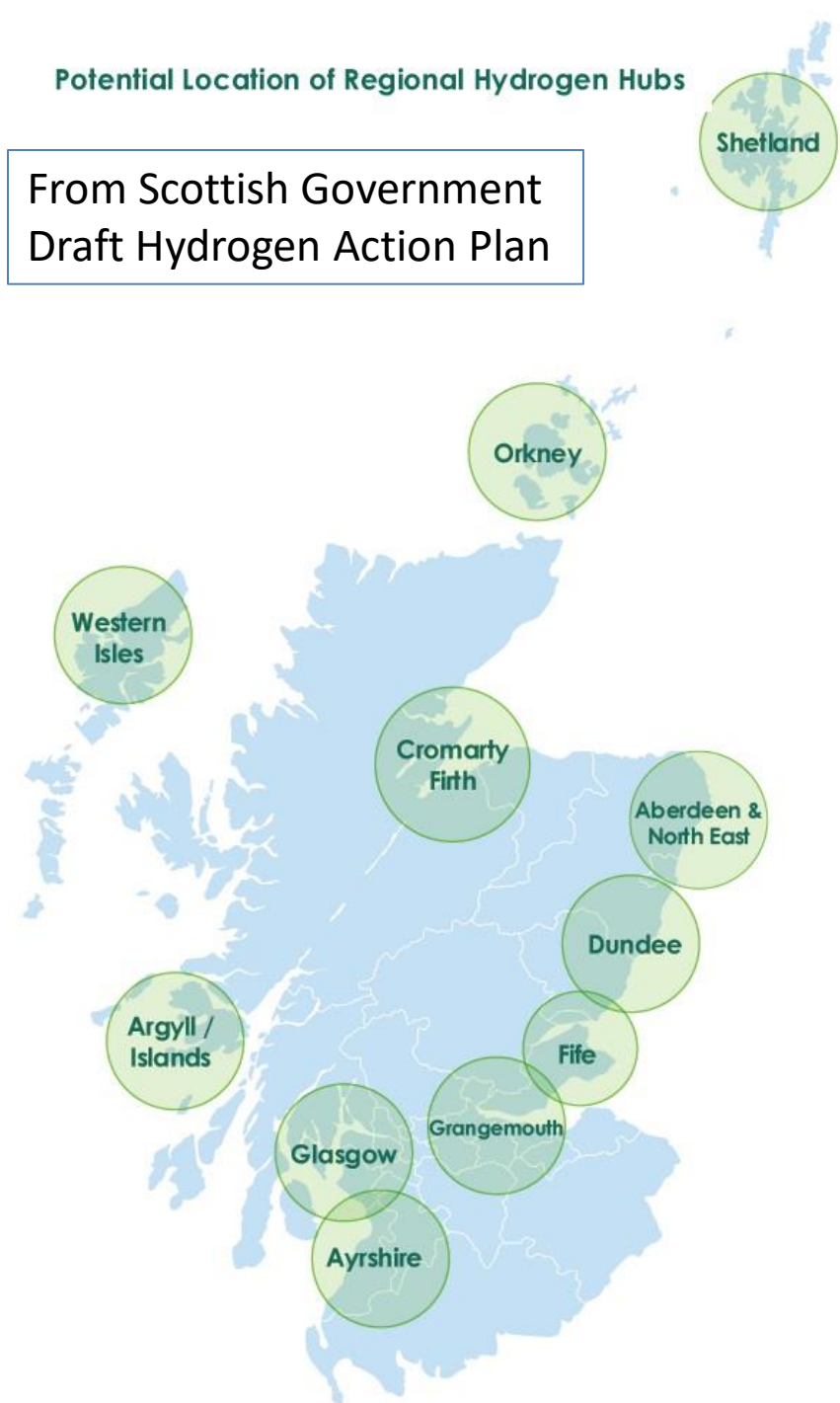
15 Sites (8-10GW) 

DeepWind ports and  
harbours members 



## Potential Location of Regional Hydrogen Hubs

From Scottish Government  
Draft Hydrogen Action Plan





## Some of Scotland's Current Hydrogen Projects

### End User

- 01 Cloverhill's Aberdeen Hydrogen First
- 02 Eden Mill distillery
- 03 Glasgow Hydrogen Gritters
- 04 HECTOR project
- 05 HyDIME
- 06 HyFlyer
- 07 HySeas III
- 08 HySpirits
- 09 Hytransit Project - Aberdeen Hydrogen Busses
- 10 Hytrec
- 11 JIVE 2 - Dundee Hydrogen Transport
- 12 Kirkwall Airport Decarbonisation
- 13 Liquid Organic Hydrogen Carriers (LOHC) for the transportation of hydrogen
- 14 Project HyLaddie
- 15 Scottish Hydrogen Train project
- 16 TimberLINK
- 17 Uist Distilling Company

### Multi-vector

- 18 Aberdeen Hydrogen Hub
- 19 Aberdeen Vision
- 20 BIG HIT
- 21 East Neuk Power to Hydrogen
- 22 GENCOMM - AD
- 23 ITEG - Integrating Tidal Energy into the European Grid
- 24 North of Scotland Hydrogen Programme
- 25 OHLEH - Outer Hebrides Local Energy Hub

- 26 Orion Project
- 27 PITCHES
- 28 ReFLEX (Responsive Flexibility) Project
- 29 SWIFTH2
- 30 PURE Energy Centre
- 31 Flotta Hydrogen Hub

### Production

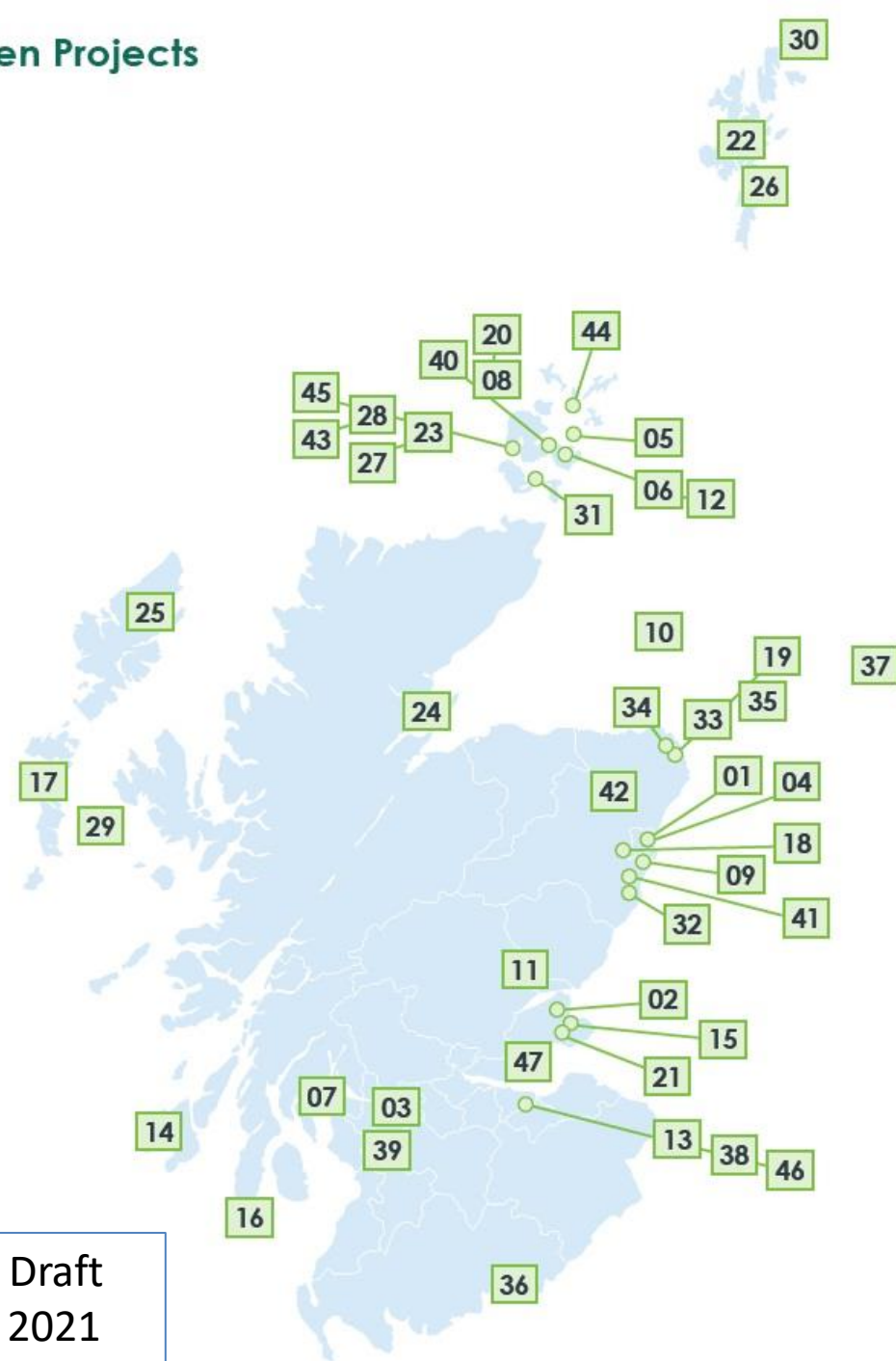
- 32 Aberdeen Hydrogen Centre (ACHES)
- 33 Acorn CCS
- 34 Acorn Hydrogen
- 35 Caledonia Clean Energy Project
- 36 Chapelcross Initiative
- 37 Dolphyn Project
- 38 Edinburgh International Festival decarbonisation project
- 39 Green Hydrogen for Glasgow
- 40 Hammar Hill Green Ammonia project
- 41 Kittybrewster Refuelling Station
- 42 Skelmonae Green Hydrogen
- 43 'Surf 'n' Turf'

### Storage

- 44 Eday Flow Cell Battery Project
- 45 HyAI
- 46 HyStorPor Project

### Transmission/distribution

- 47 H100 Fife project



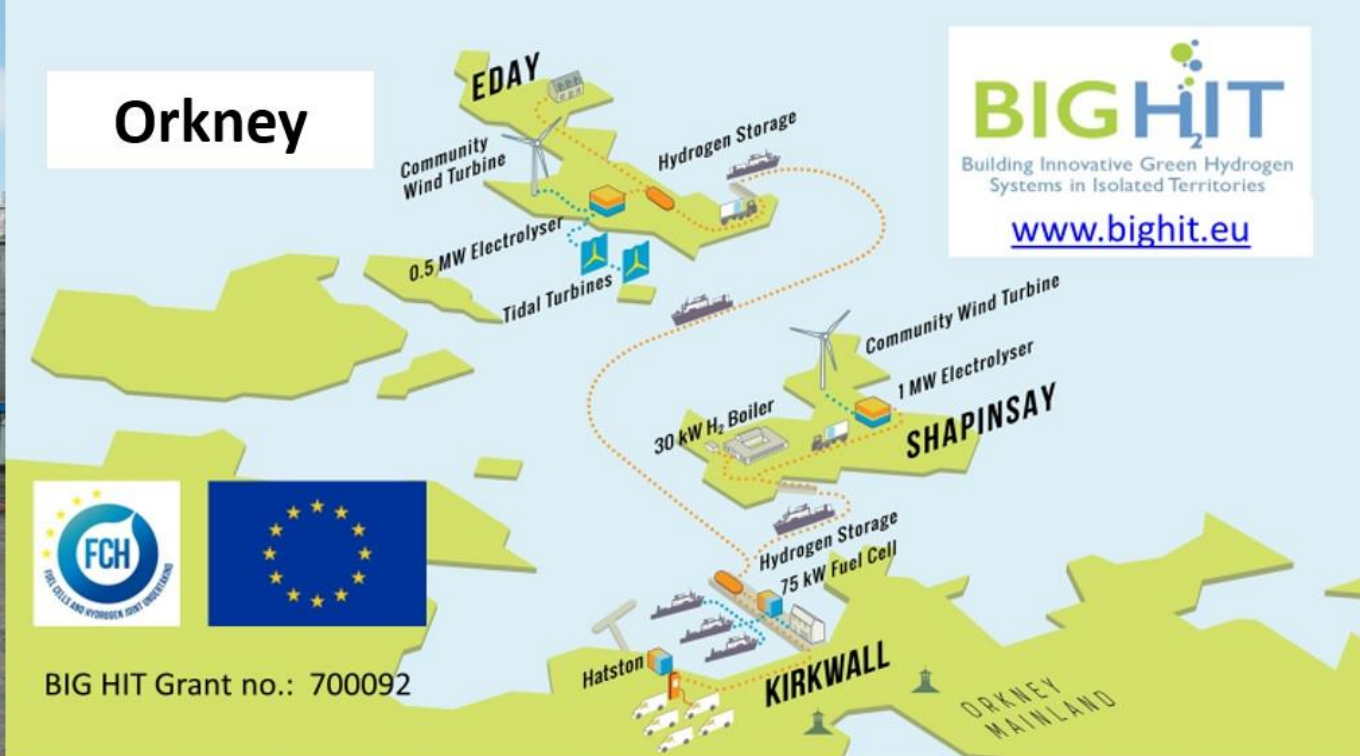
From Scottish Government Draft Hydrogen Action Plan, Nov 2021



# Aberdeen



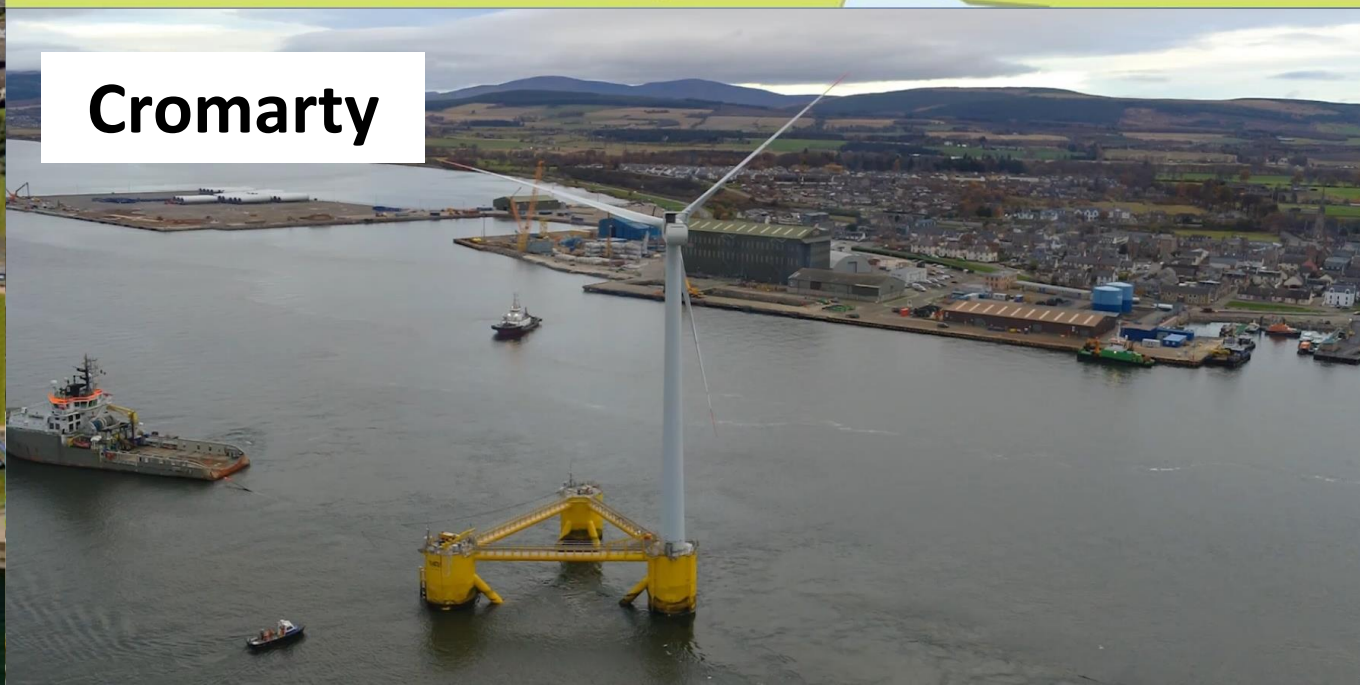
# Orkney



# Levenmouth



# Cromarty



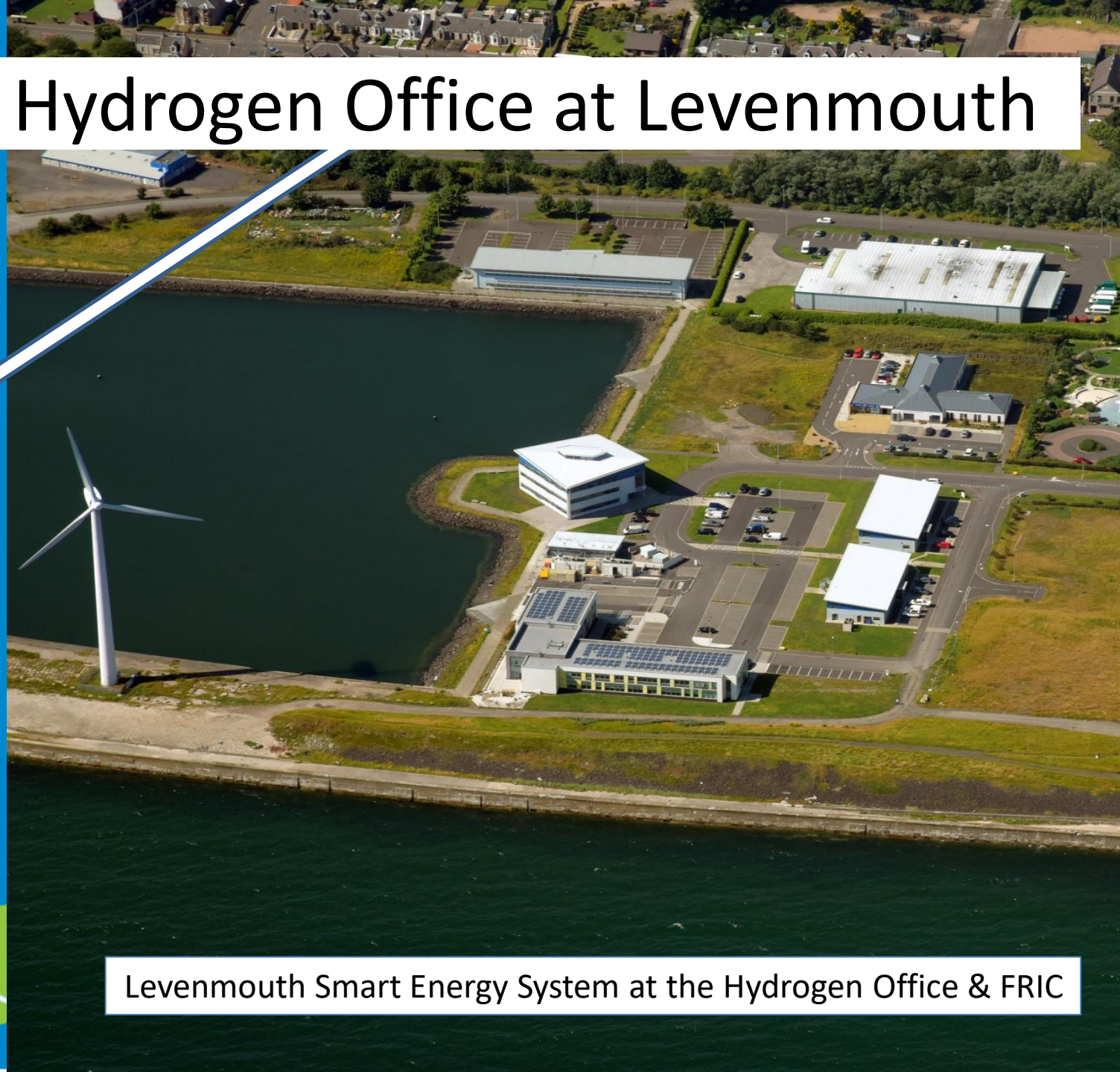




# Net Zero The UK's contribution to stopping global warming

Committee on Climate Change  
May 2019

## The Hydrogen Office at Levenmouth



Levenmouth Smart Energy System at the Hydrogen Office & FRIC



# METHIL



ON NORTH SIDE OF FIRTH OF FORTH

## Principal Coal-Shipping Port in Scotland

Modern Equipment Ensuring Rapid Handling

*For full particulars apply*

Goods Manager, LNER Glasgow

## Methil Docks – Exporting Coal



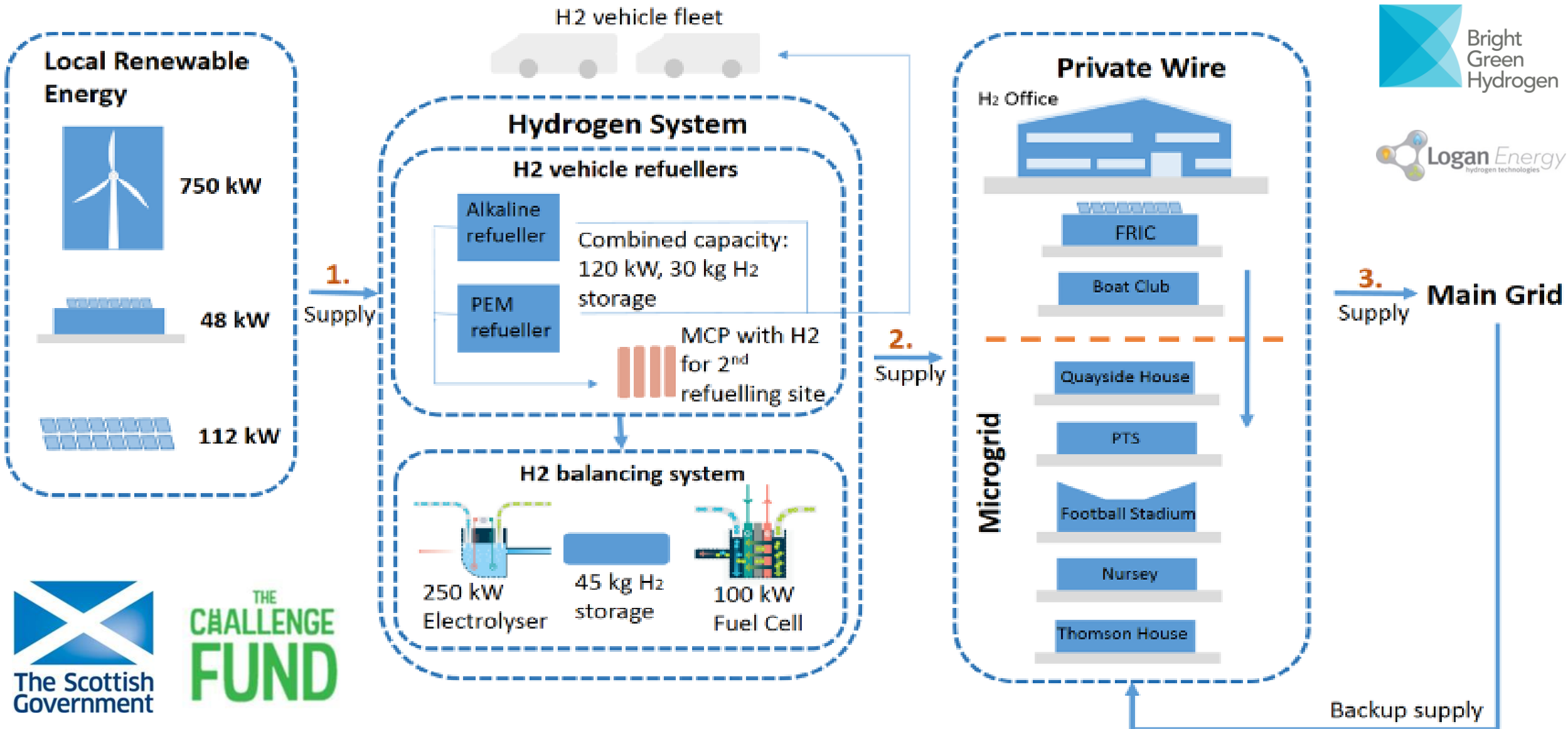


The Hydrogen Office opened in 2011 and has provided education & outreach to over 30,000 pupils and students in Fife





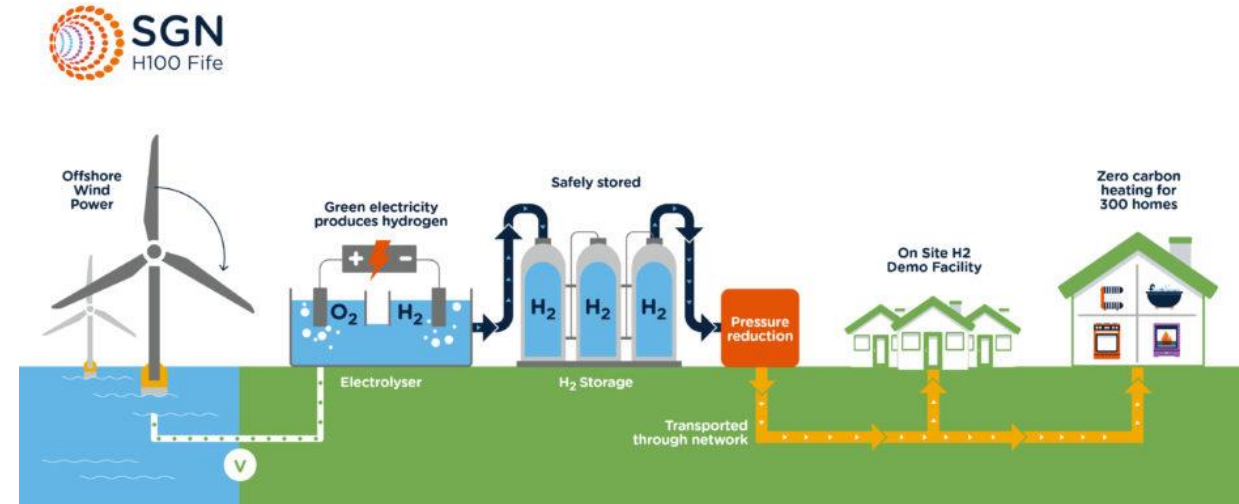
# 2017: Levenmouth Smart Energy System



# Next steps: Consumer Acceptance with H100 Fife



Energy Park Fife



## 100% $H_2$ for household heating & cooking

- Demonstration of safety, technical R&D
- Households can make a positive choice to join the H100 trial
- Match supply/demand in representative and scalable network
- Quantified risk to inform household conversions
- Market creation and key learning of customer acceptance



ARUP







**SGN**  
Your gas. Our network.

# H100 Fife in Levenmouth

Proving safe use of 100% H<sub>2</sub> for heat







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Committee on Climate Change  
May 2019



# Aberdeen & Energy Transition Zone



# Clean Hydrogen for Fuel Cell Bus Fleet



Some of Aberdeen's 65+ Hydrogen Vehicle Fleet in 2019 including fuel cell and H<sub>2</sub> internal combustion power

## €22m FCH-JU project

- Started March 2015
- 10 x Van Hool FC buses
- 2 million passengers
- 1.1 million kilometres
- 89% bus availability
- 200+ tonnes H<sub>2</sub> used
- 10-12 mins refuel time
- >98% HRS availability







# New Hydrogen Double-deckers in operation January 2021







# Building the Ambition with Aberdeen H2 Hub

**3 February 2022:** Aberdeen City Council announces bp as strategic partner for the H2 Hub to accelerate the city's ambitions to become a world-class hydrogen hub with estimated £700M GVA.

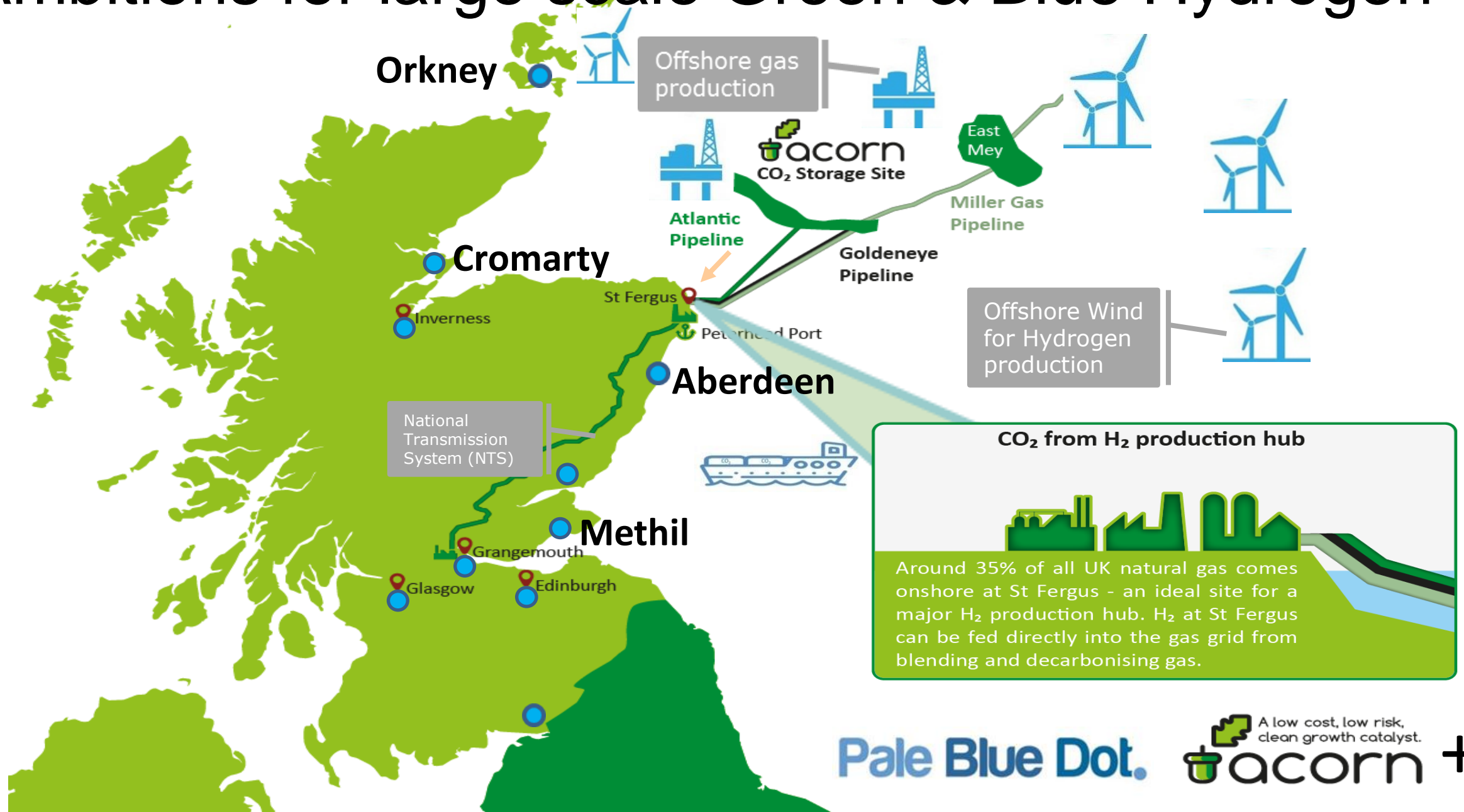
A key part of the programme will involve the creation of Scotland's first scalable green hydrogen production facility.

This hydrogen hub will enable supply & export of renewable hydrogen, creating up to 700 skilled jobs in the regional hydrogen economy by 2030.

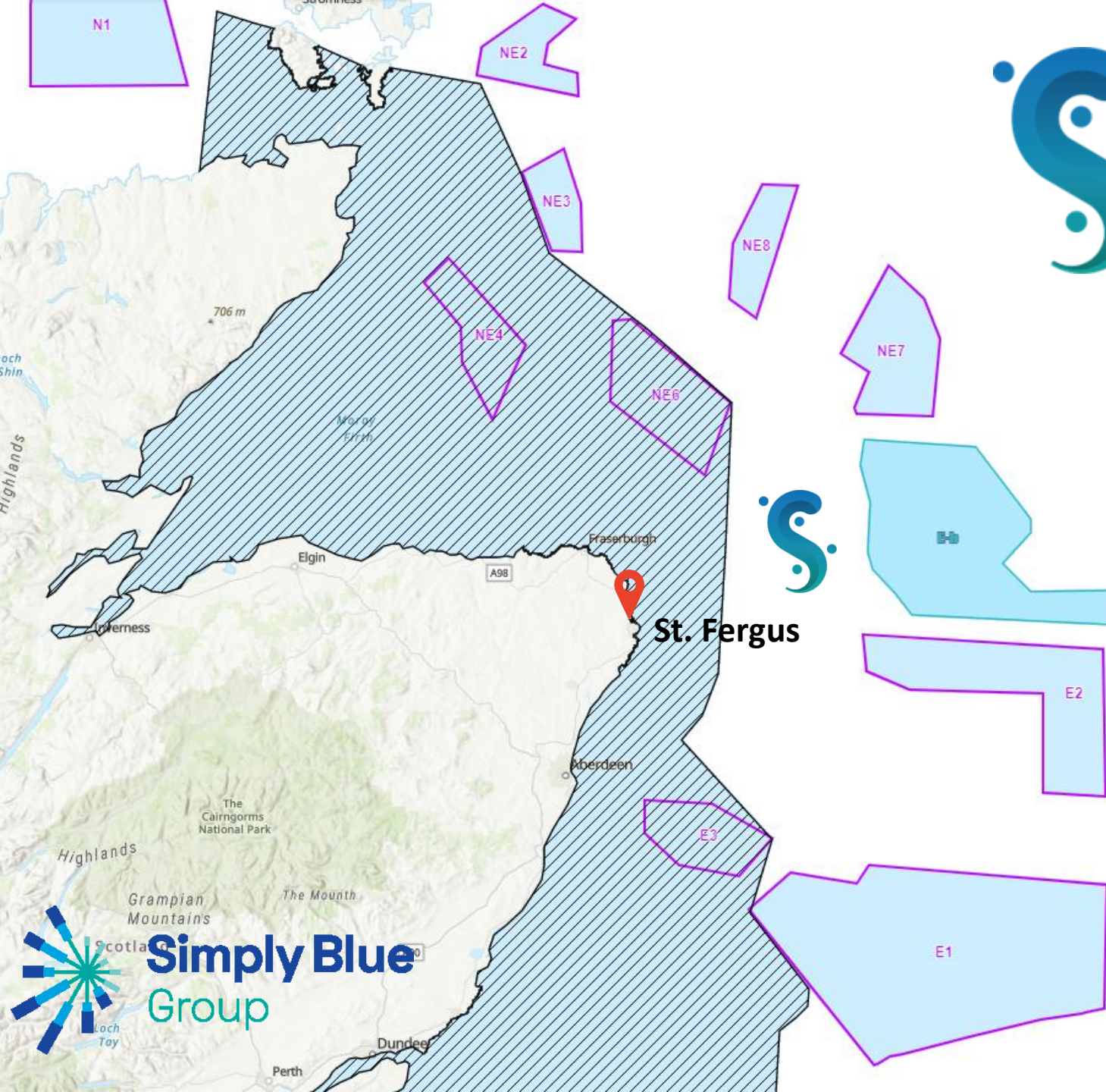


Louise Kingham OBE of bp with Aberdeen City Council Leader Laing

# Ambitions for large scale Green & Blue Hydrogen







200 MW pre-commercial  
'stepping-stone' floating offshore  
wind project

Just east of St Fergus, Aberdeen

Exploring multiple potential routes  
to market including green  
hydrogen production

MoU with ERM, for ERM Dolphyn

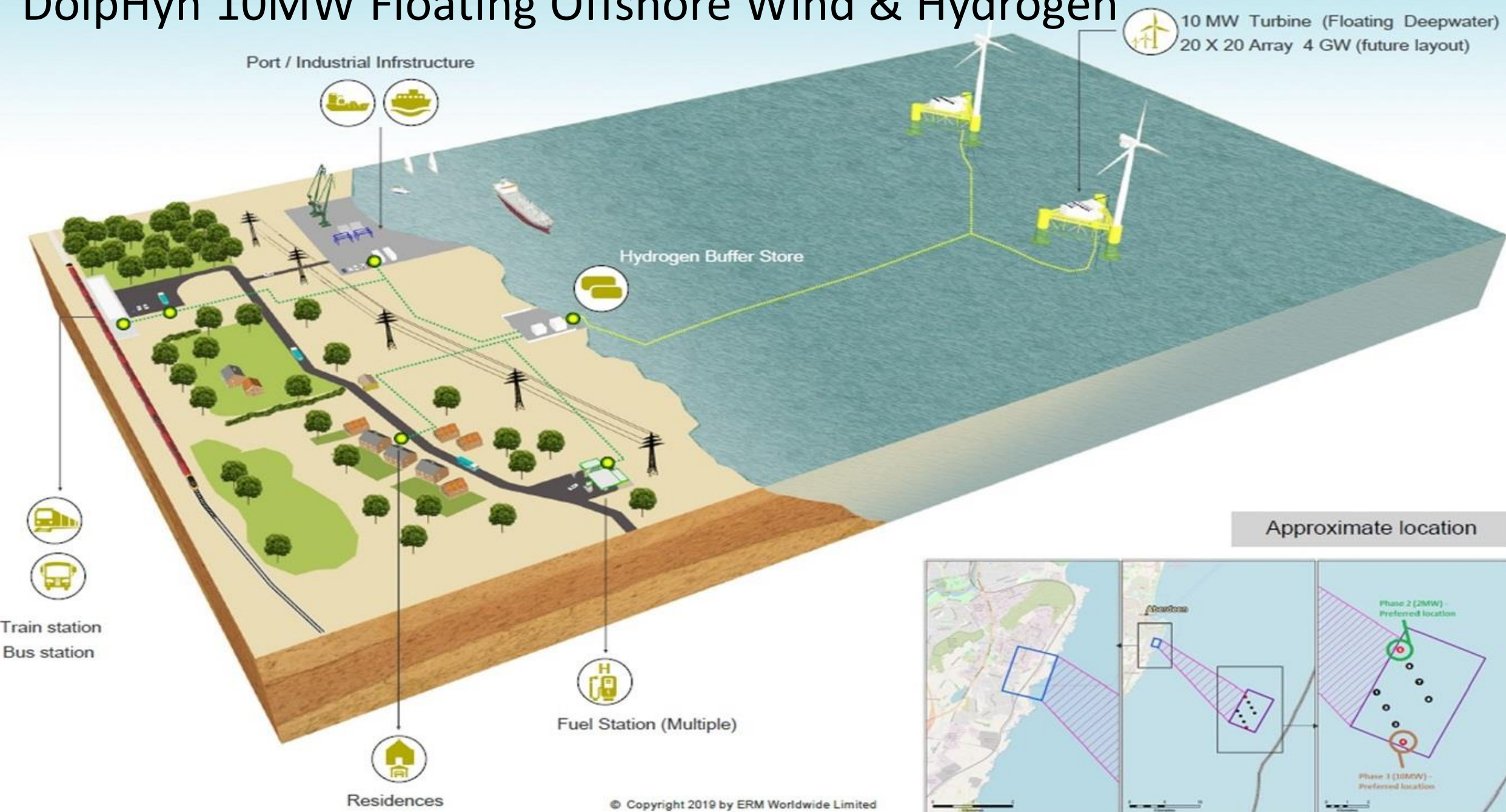
Exploring options with SGN

Links into Aberdeen ETZ

<https://salamanderfloatingwind.com/>



# DolpHyn 10MW Floating Offshore Wind & Hydrogen



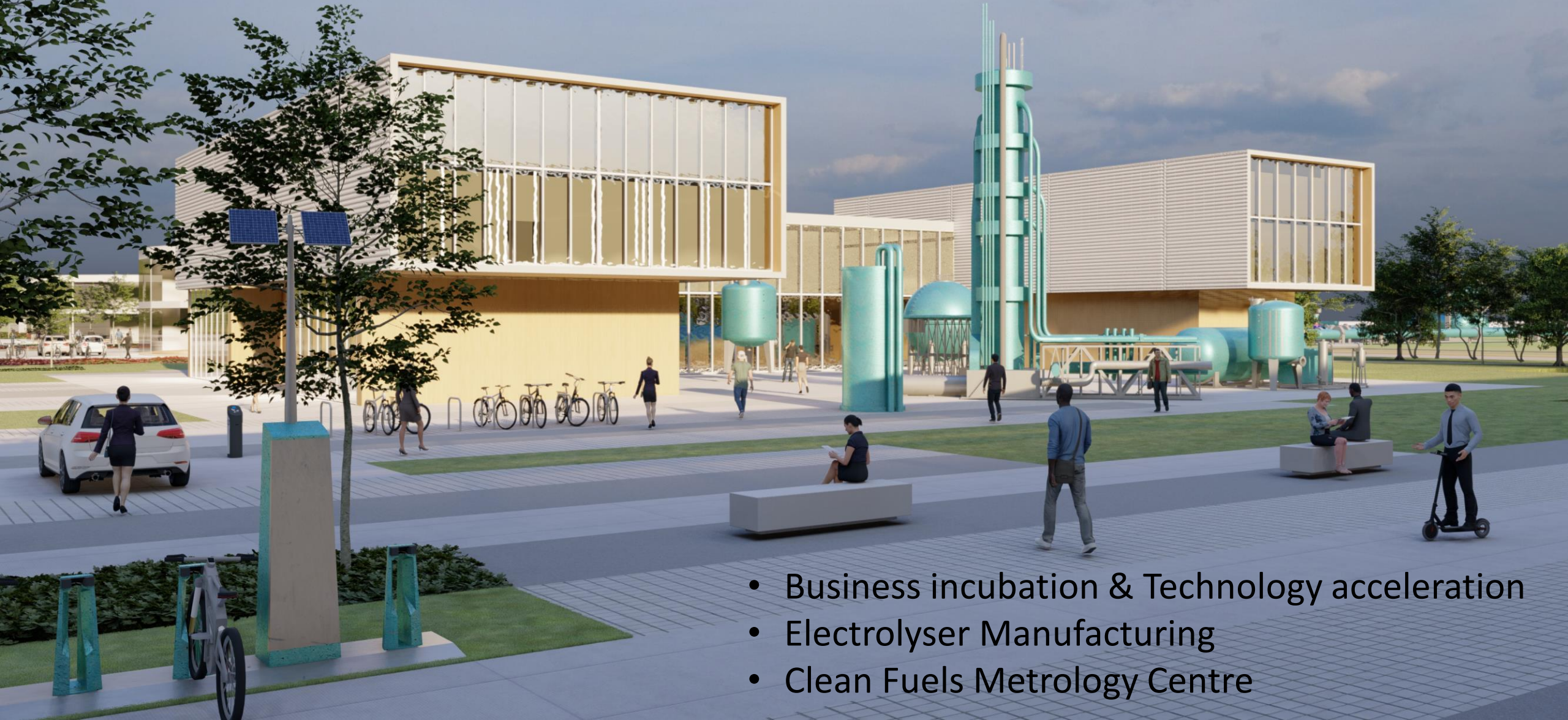
Approximate location





# Energy Transition Zone - Hydrogen Campus Concept

## Green Hydrogen Test & Demonstration Facilities



- Business incubation & Technology acceleration
- Electrolyser Manufacturing
- Clean Fuels Metrology Centre





# One of Scotland's largest natural harbours and connection point to offshore wind power







SCOTTISHPOWER



PORT OF  
**CROMARTY  
FIRTH**

**5 March 2021:** Port of Cromarty Firth and ScottishPower launch the North of Scotland H2 Hub with 35MW electrolysis capacity





PORT OF  
**CROMARTY  
FIRTH**

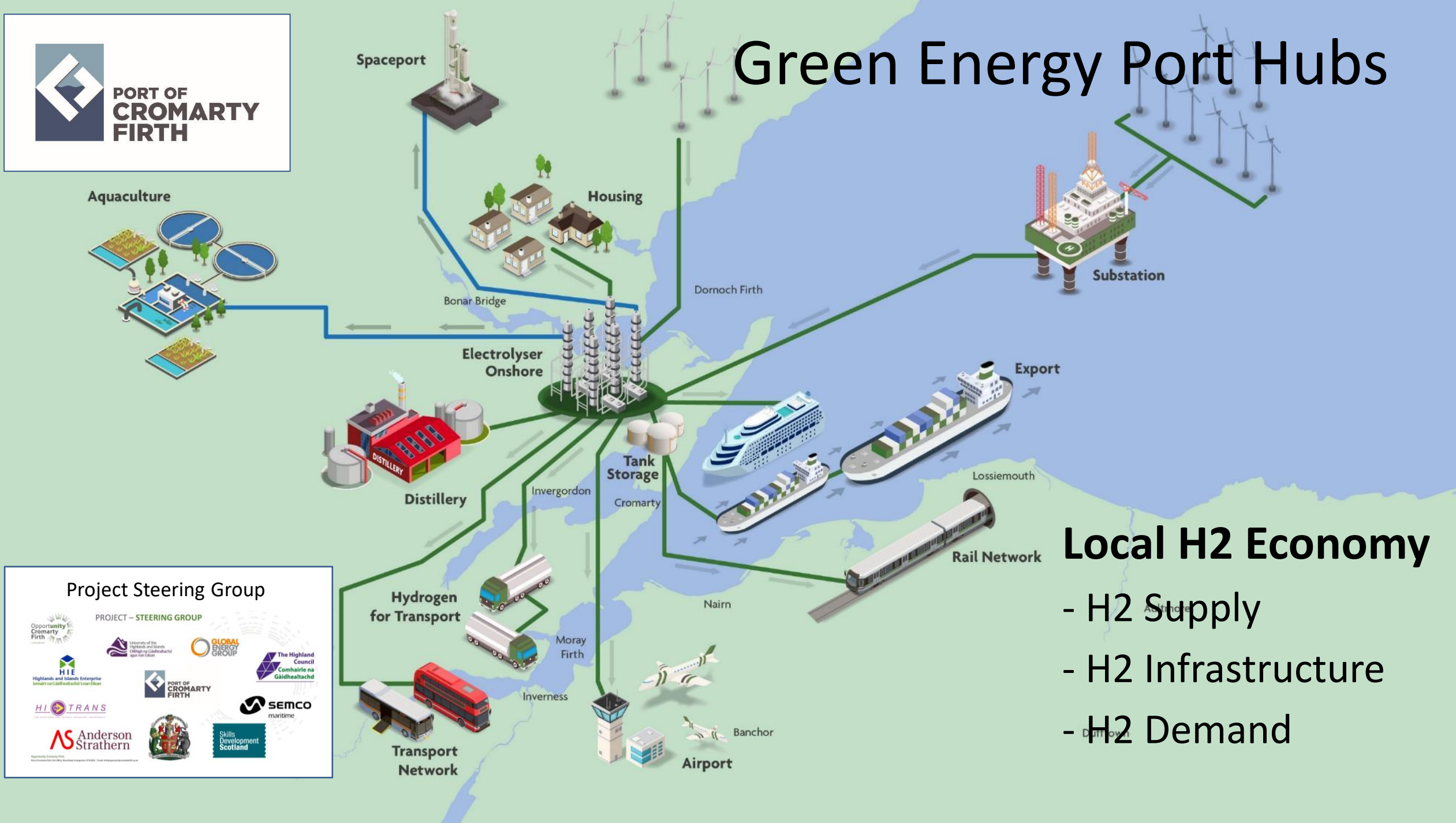
**24 May 2021:** Port of Cromarty Firth signs MoU for import and transhipment into Europe of green hydrogen from Norway





**PORT OF  
CROMARTY  
FIRTH**

# Green Energy Port Hubs



## Local H2 Economy

- H2 Supply
- H2 Infrastructure
- H2 Demand

### Project Steering Group

PROJECT – STEERING GROUP





**Net Zero**  
**The UK's contribution to**  
**stopping global warming**

Committee on Climate Change  
May 2019

# Orkney: >100% Green Electricity

Renewables generate > 100% of Orkney's electricity

Over 50MW of installed renewable capacity

>1000 renewable installations for 10,000 households

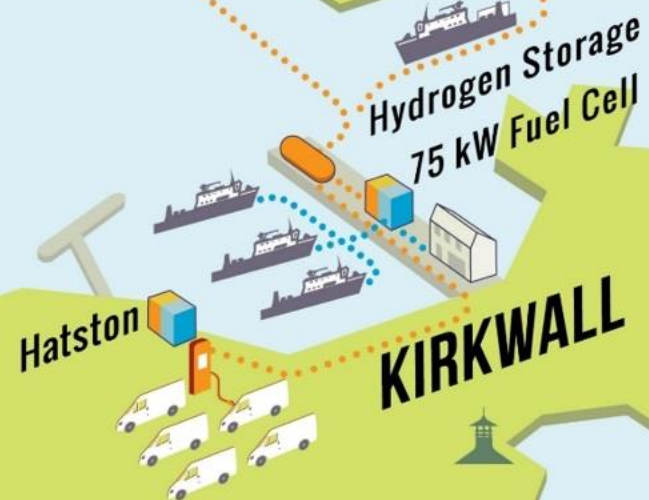
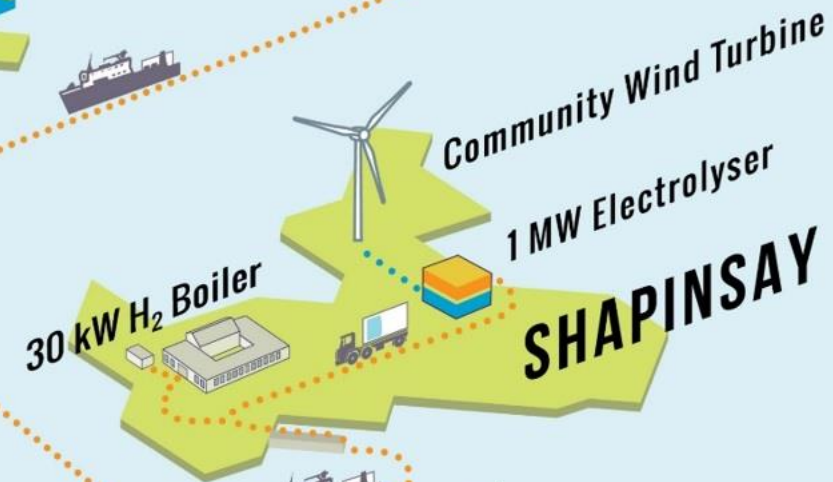
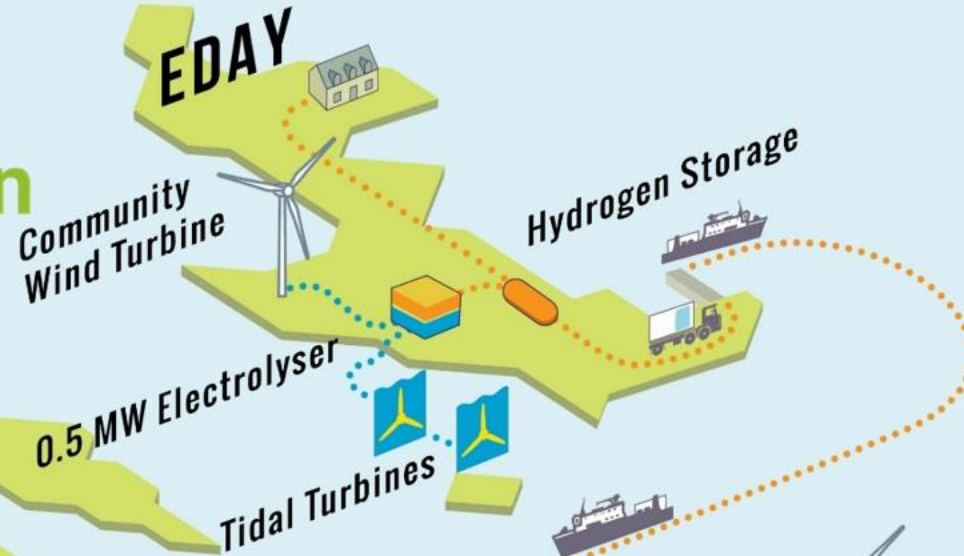


By 2014 Orkney was generating 120% of its  
annual electrical demand from Renewables



# Clean Hydrogen Partnership

**BIG H<sub>2</sub> IT**  
Building Innovative Green Hydrogen  
Systems in Isolated Territories



The BIG HIT project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 700092.

This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research

Image credit BIG HIT & Iain Ashman



# Green Hydrogen for heat, power, & transport





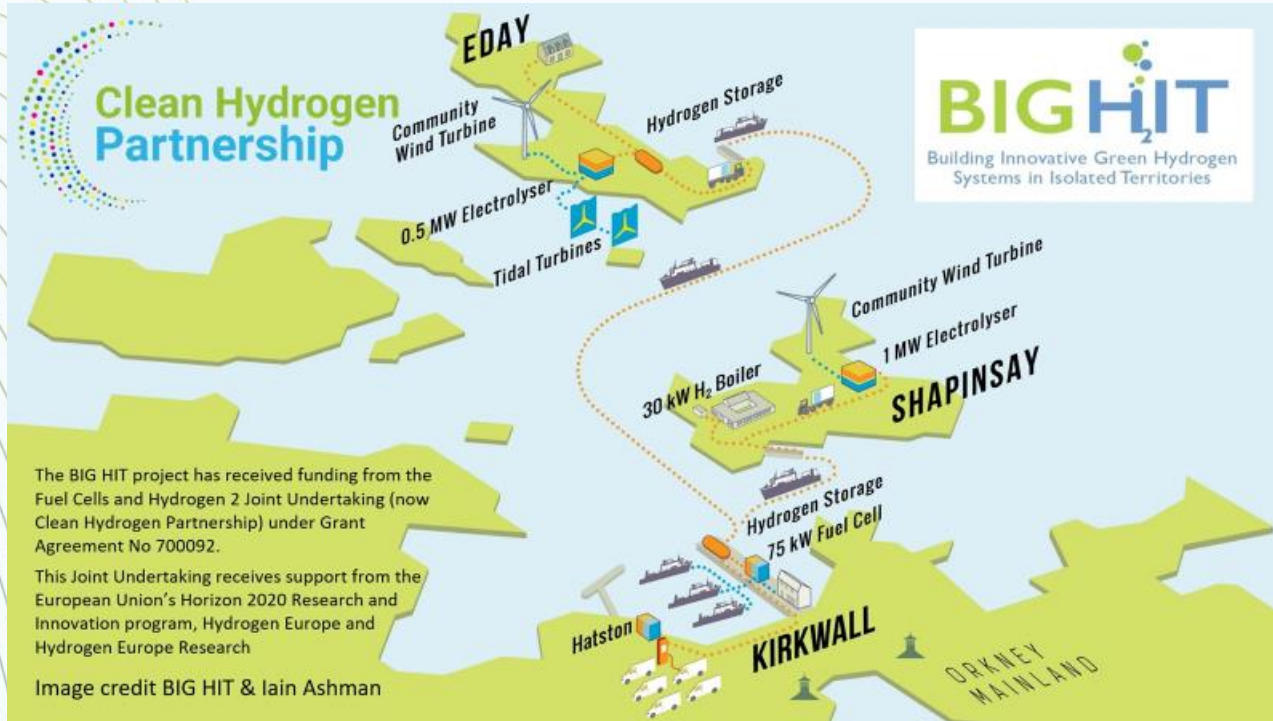
# Orkney: Growing the H<sub>2</sub> Portfolio



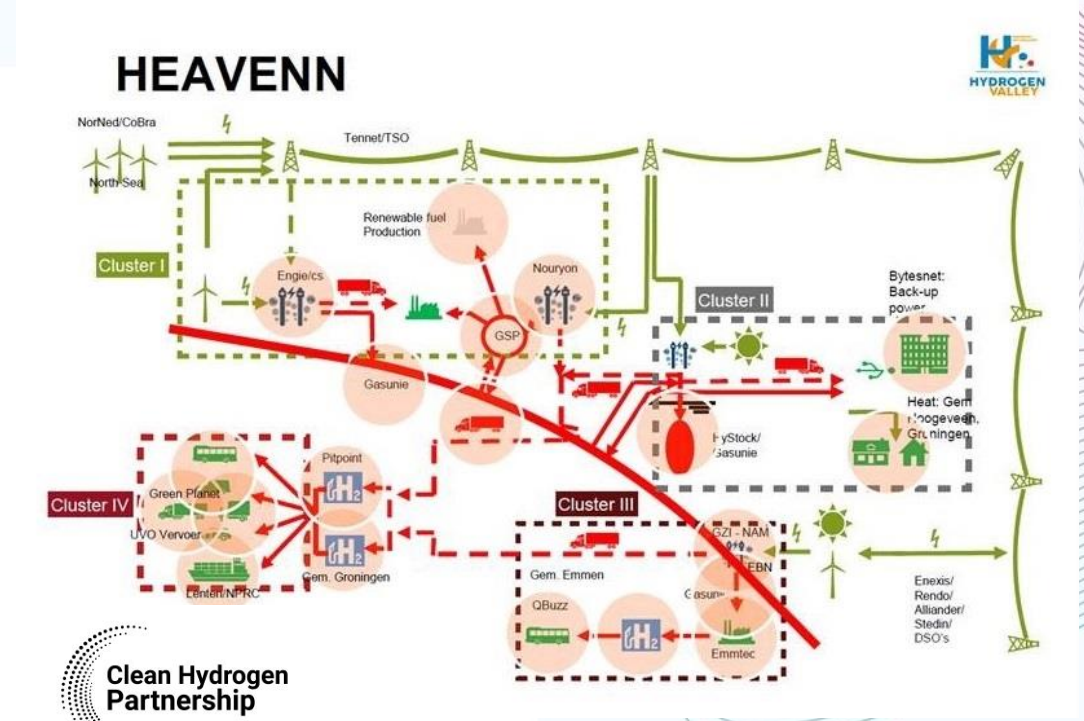
Next steps with H<sub>2</sub> for marine, aviation, and industry



# Scaling up Hydrogen Valleys



Experience and learning from the Clean Hydrogen Partnership supported BIG HIT project in Orkney



Shared with the CH2P's first Hydrogen Valley project in the North Netherlands

**HYDROGEN TERRITORIES PLATFORM**

<http://h2territory.eu/about-the-htp/#become-a-member>





# Where Next? Scaling Up Green Hydrogen...

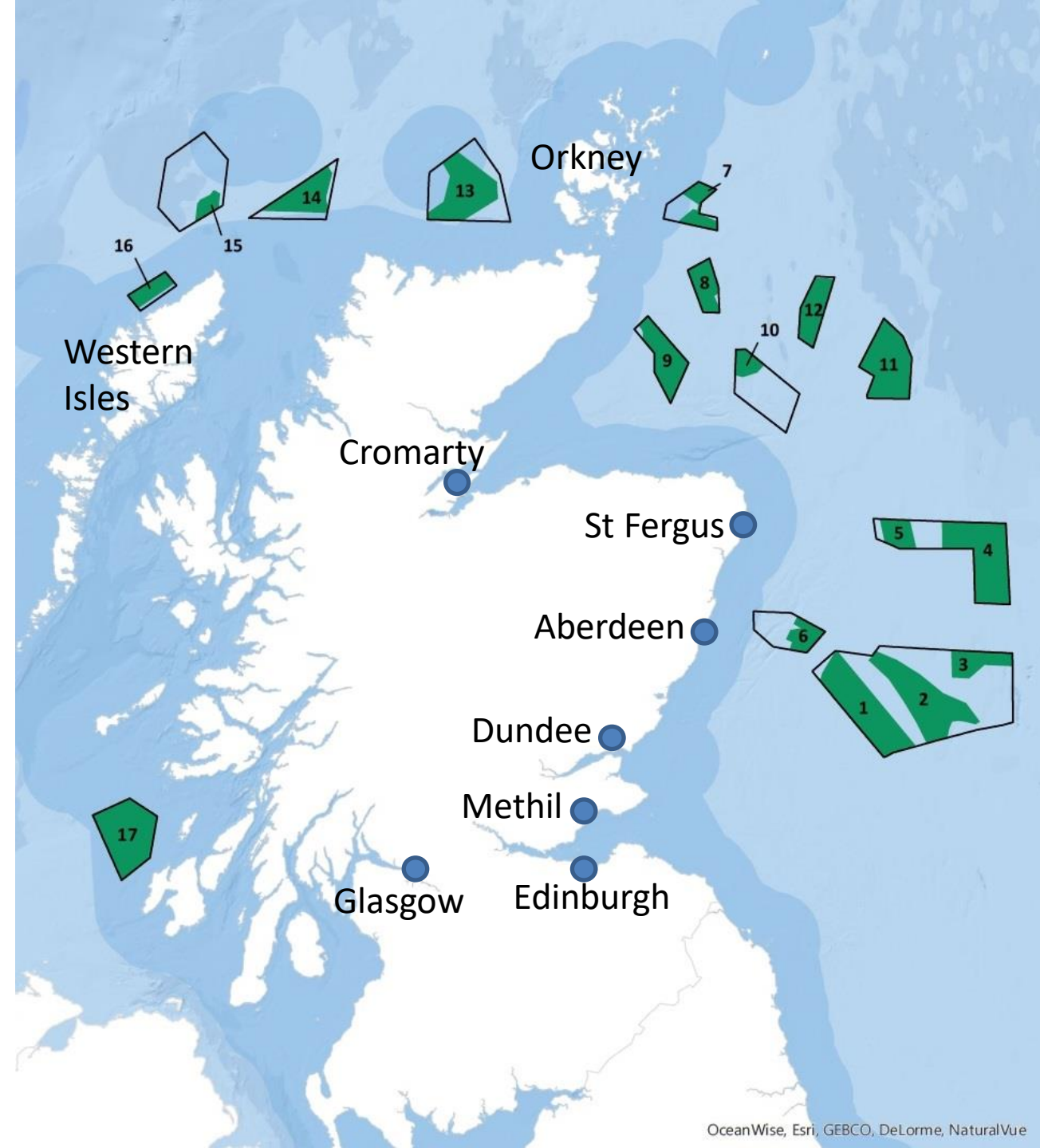




# Scaling up Hydrogen for 2030 with Offshore Wind

Scotwind announcement 17 Jan 2022

- successful bidders been offered option agreements for rights to specific areas of seabed around Scotland.
- 17 projects with a total of 24.8 GW of proposed offshore wind capacity have been selected
- £700m will be paid by the successful applicants in option fees
- The area of seabed covered by the 17 projects is just over 7,000km<sup>2</sup>







**Flotta Hydrogen Hub**  
Orkney

**Orkney** proposed Flotta Hydrogen Hub  
Using up to 2GW offshore wind from N1  
Green H2 production by late 2020's



<https://www.flottahydrogenhub.com/>



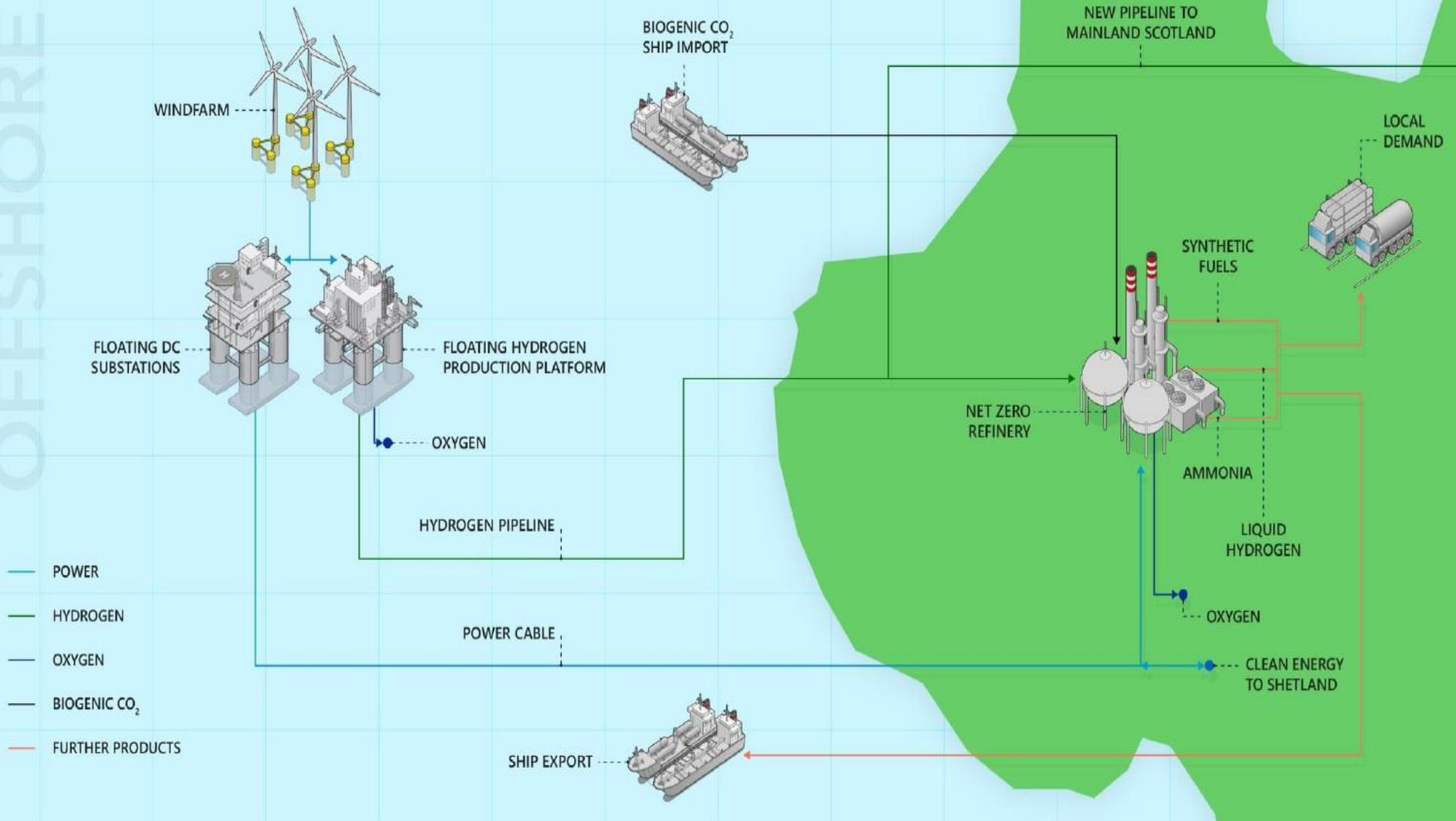


**Shetland ORION Clean Energy Project**  
Green H<sub>2</sub> from onshore & offshore wind  
Repurpose Sullom Voe oil & gas terminal

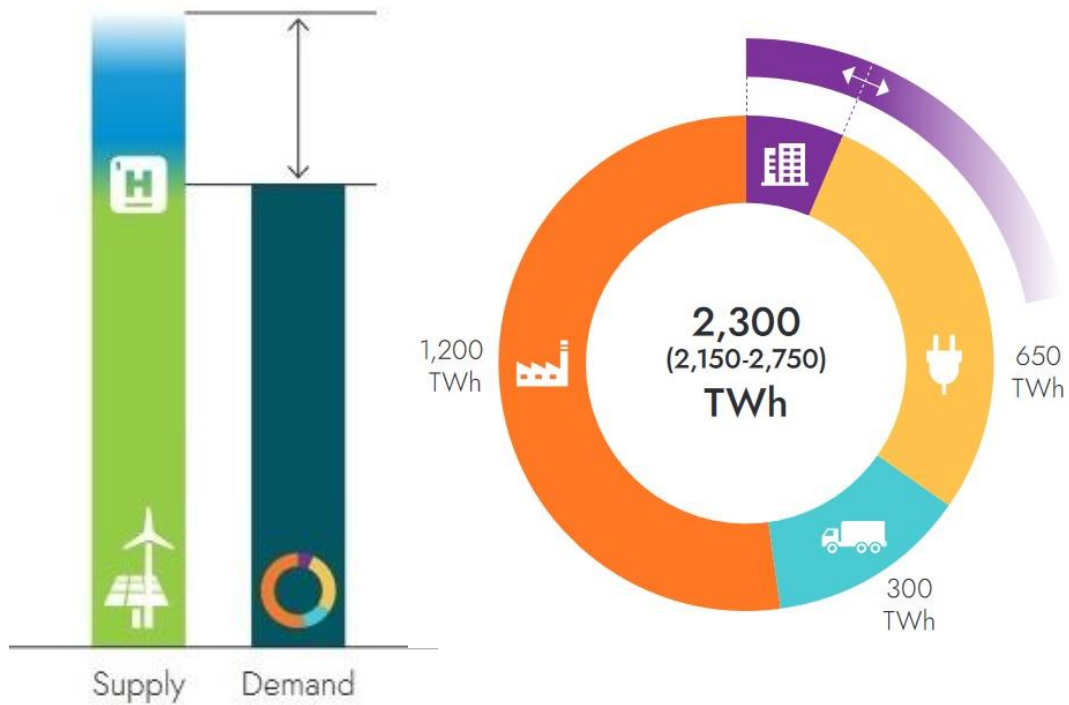


<https://www.orioncleanenergy.com/>

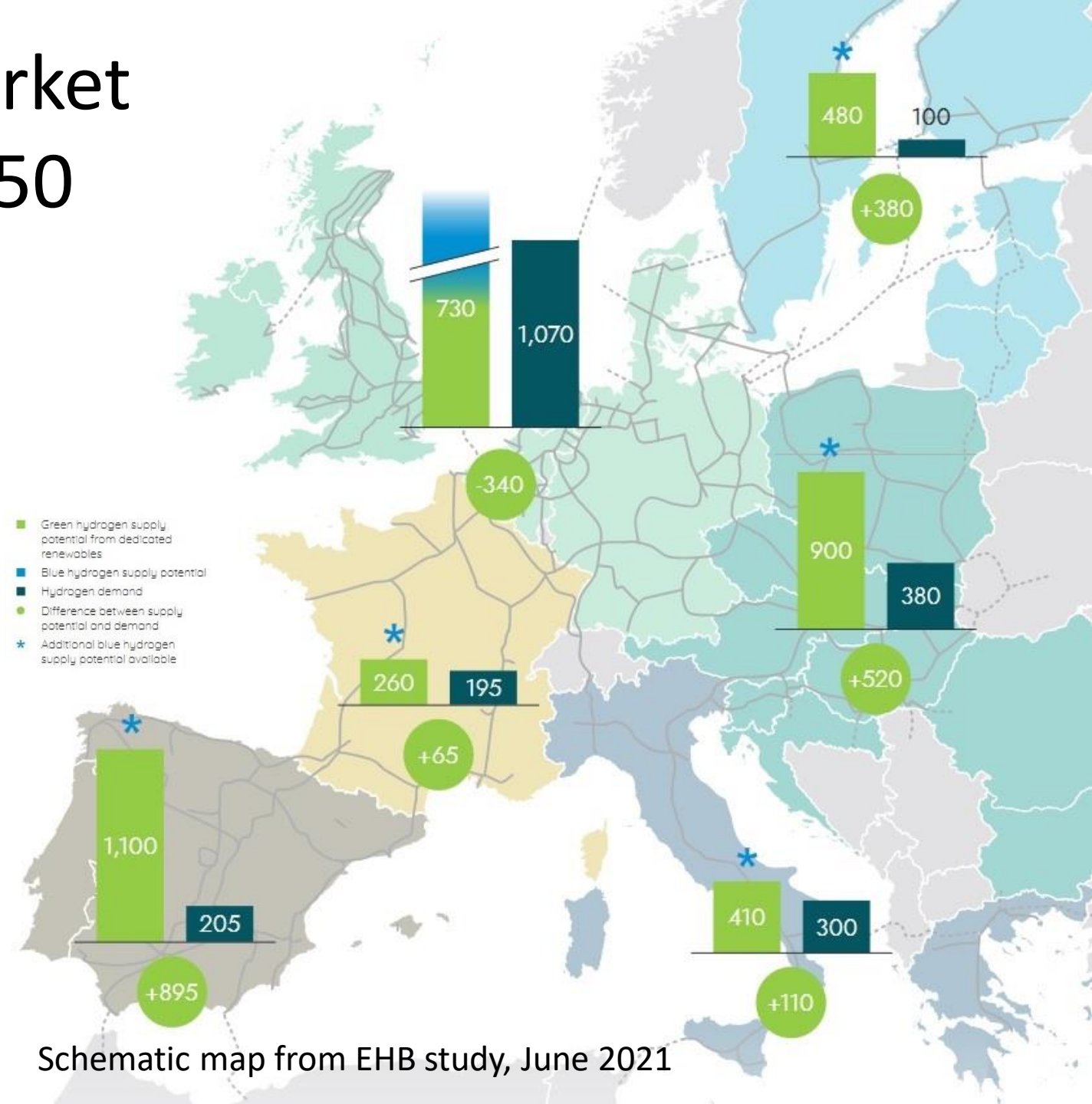




# European Hydrogen Market Supply & Demand in 2050

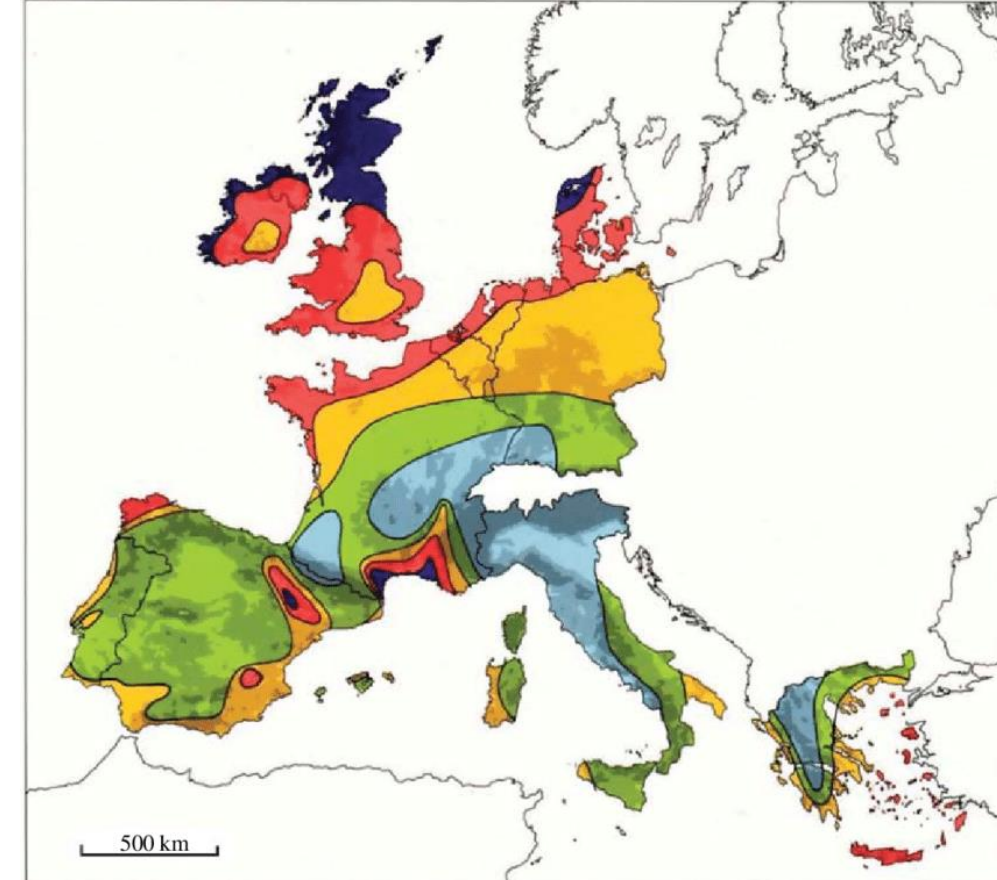
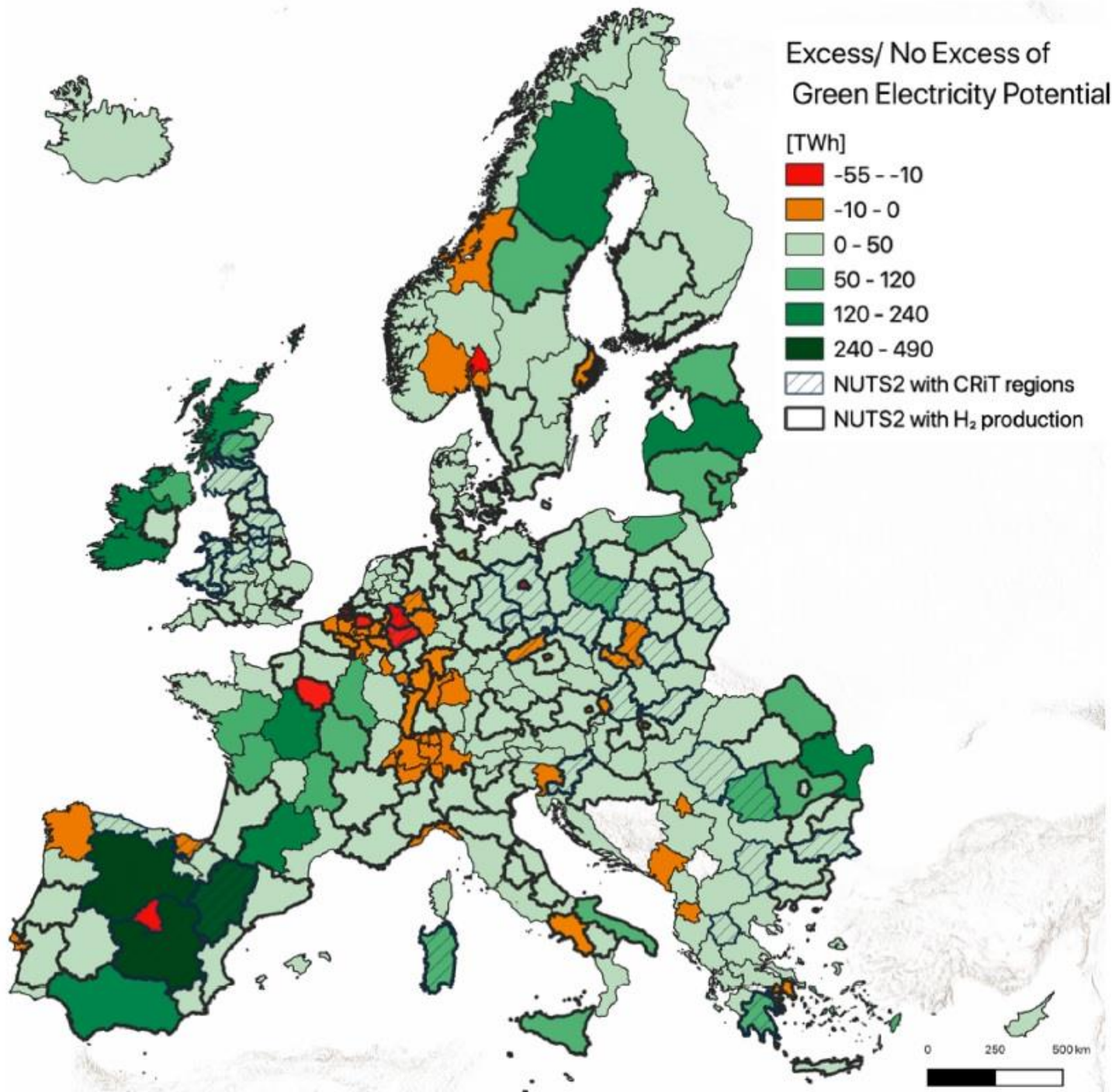


*Hydrogen will be crucial to ensure that Europe becomes a climate-neutral continent (EHB study, June 2021)*



Schematic map from EHB study, June 2021





wind resources at 50m above ground level for five different topographic conditions										
	sheltered terrain		open plain		at a sea coast		open sea		hills and ridges	
	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>	ms <sup>-1</sup>	Wm <sup>-2</sup>
	>6.0	>250	>7.5	>500	>8.5	>700	>9.0	>800	>11.5	>1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0-8.5	400-700
	<3.5	<50	<4.5	<100	<5.0	<150	<5.5	<200	<7.0	<400

European onshore wind potential (above):

<https://www.hindawi.com/journals/jwe/2014/415898/>

Green H<sub>2</sub> in Europe – a regional assessment (left):

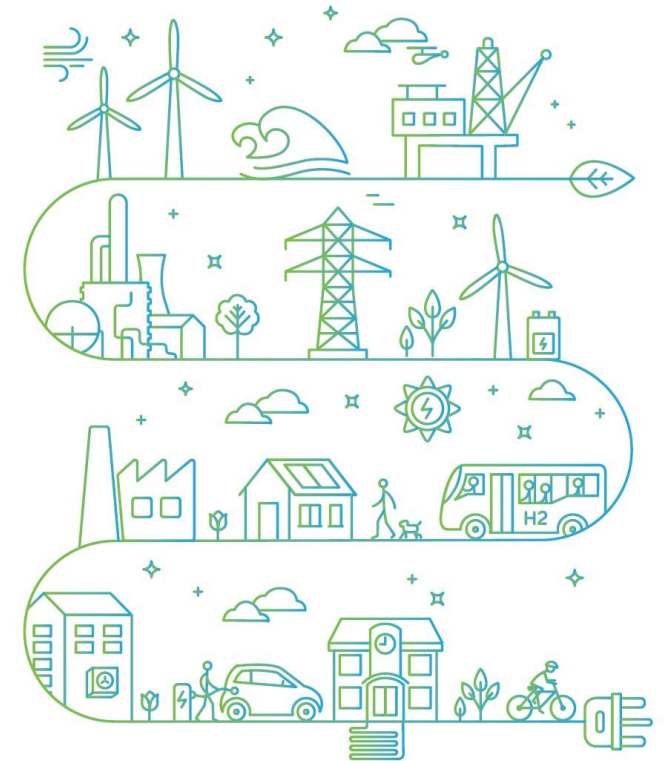
<https://www.sciencedirect.com/science/article/pii/S0196890420311766>

# Turning Scotland's Hydrogen Policy into Actions

Scotland's [Draft Hydrogen Action Plan](#) outlines the actions to enable delivery of key targets for the hydrogen economy in Scotland, with areas for partnerships on innovation and trade:

- **Action 22:** support the development of H2 backbone infrastructure for low carbon hydrogen export to rest of UK and Europe
- **Action 29:** support for the Scot2Ger project on shipment of green H2 from Scotland to Germany – Phase 1 planned for NRW
- **Action 31:** inward and outbound SDI trade missions, for example in Spring 2022 with Germany
- **Action 33:** strengthen existing relationships and develop bilateral partnerships, including North Rhine-Westphalia, with MoUs to help build H2 markets and shared H2 economies
- **Action 36:** support multi-national collaboration on H2 R&D challenges, including Mission Innovation and the Clean Hydrogen Partnership
- **Action 37:** support calls for joint Scotland-Germany academic and applied research proposals on key H2 challenges

## Draft Hydrogen Action Plan





# Scaling up H2 - Partners across Europe



Scotland has target for Net Zero by 2045, and annual electricity demand is now almost all met by renewables. Hydrogen Valleys are developing in Orkney, Aberdeen, Levenmouth in Fife, and the port of Cromarty region.

Scotland's Draft Hydrogen Action Plan outlines the actions to enable delivery of key targets for the hydrogen economy in Scotland, with areas for partnerships on innovation and trade.

Scaling up green hydrogen production and demand, with much of Scotland's 5GW low carbon hydrogen by 2030 likely to be from offshore wind.

Partnerships for scaling up Hydrogen will support the Just Transition from fossil fuels to low carbon energy, with opportunities for sharing experience.

# SHFCA Members: Building the Hydrogen Economy



Some of our 200+ SHFCA members... contact [info@shfca.org.uk](mailto:info@shfca.org.uk) for membership details





Lower Saxony & Scotland  
Partnerships for Growth

Hydrogen in Scotland  
Learning by Doing

Dr Nigel Holmes, SHFCA

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