



Learning by Doing
Scaling up Hydrogen
across Scotland
for Net Zero by 2045

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Scaling up Hydrogen across Scotland

Scotland has a 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:

- **Mobility & Logistics:** Aberdeen H₂ fleets with Aberdeen H₂ Hub
- **Industry:** Cromarty Green Port, Aberdeen ETZ, Grangemouth/Fife
- **Heat:** key evidence to deploy 100% H₂ 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 ₂ 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

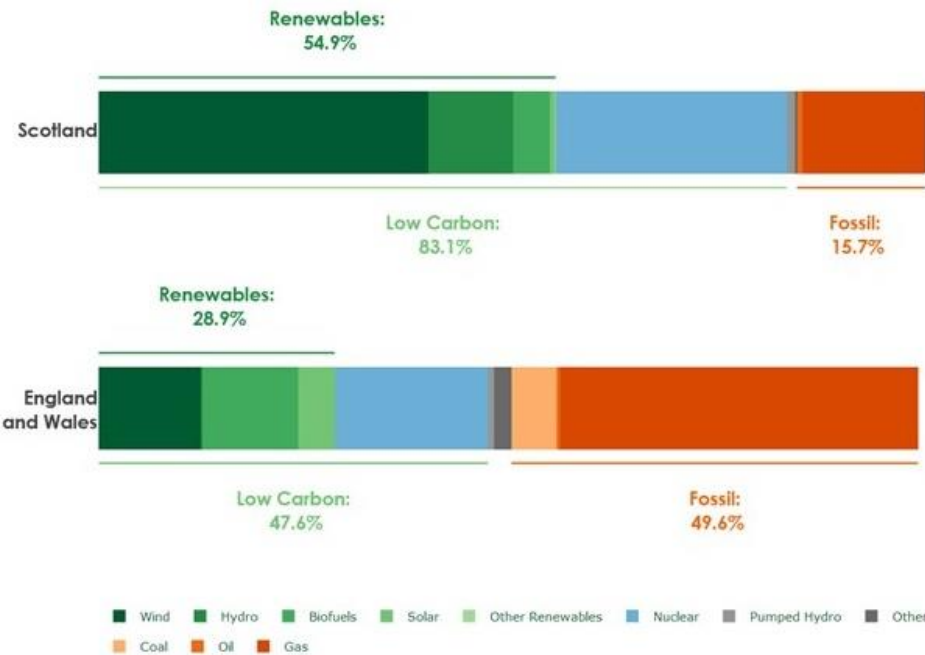




AN INCLUSIVE ENERGY
TRANSITION

Scotland's Transition to Low Carbon Electricity

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



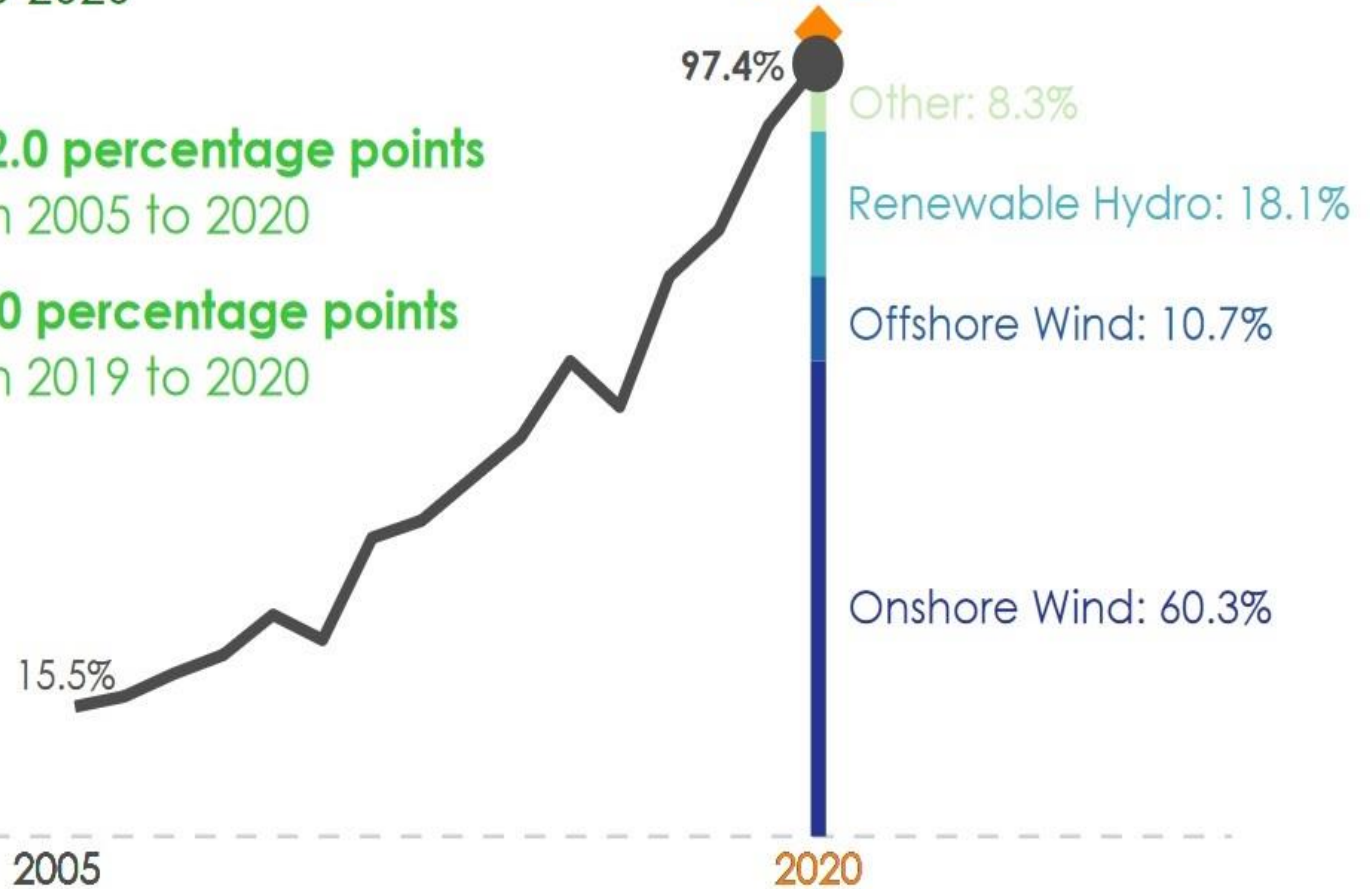
Renewable electricity target
2005-2020

100%
by 2020

Provisional

↑82.0 percentage points
from 2005 to 2020

↑8.0 percentage points
from 2019 to 2020

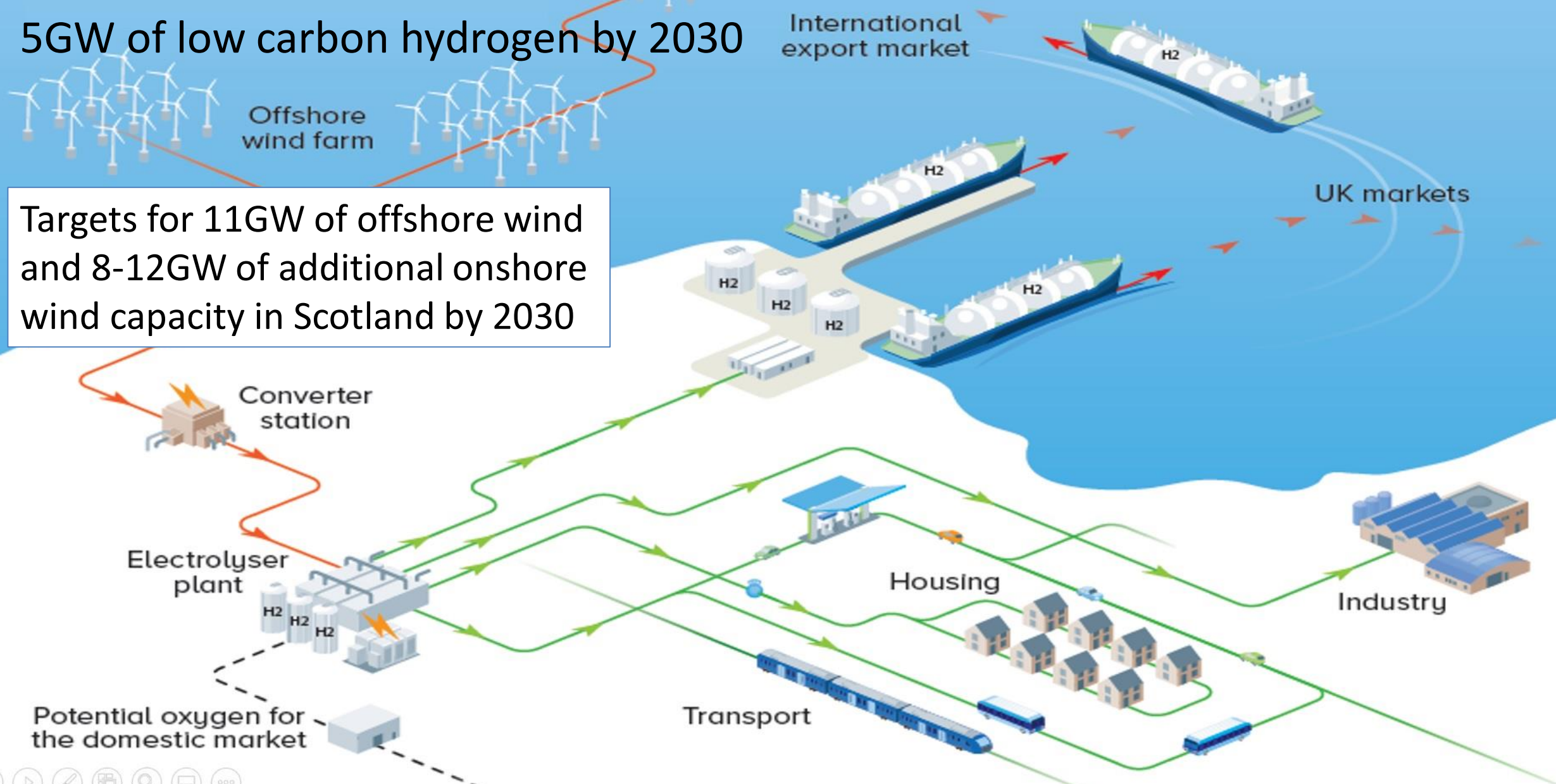


Energy Statistics for Scotland: Q4 2020 Figures (March 2021)

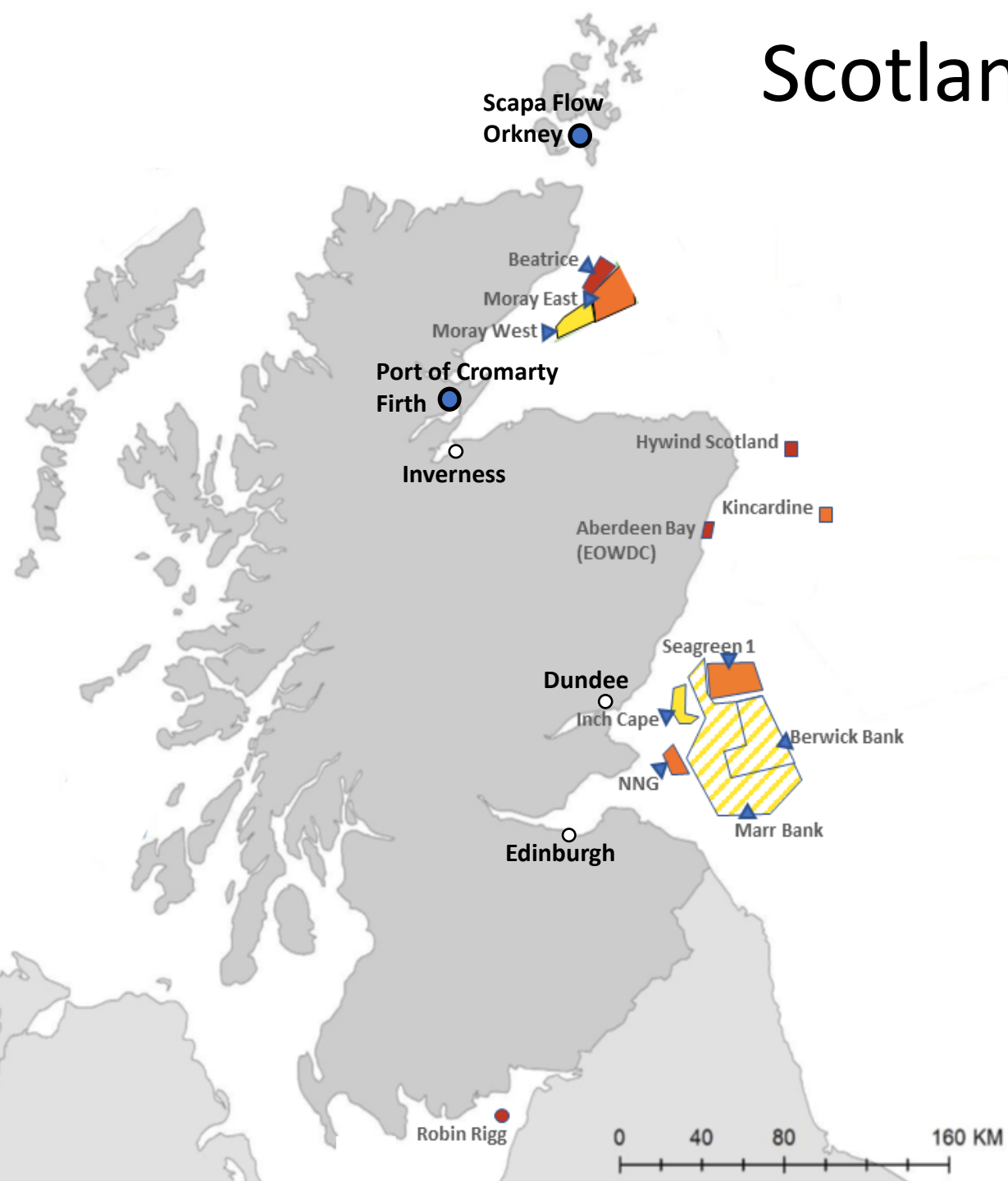
Hydrogen Policy Statement, Dec 2020

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



Scotland's Offshore Wind Potential



SITE	DEVELOPER	CAPACITY
Robin Rigg	RWE Renewables	174MW
Hywind Scotland	Equinor	30MW
Aberdeen Bay	Vattenfall	93MW
Levenmouth	ORE Catapult	7MW
Beatrice	SSE/Red Rock Power	588MW
Kincardine	Cobra	50MW
Moray East	Ocean Winds	950MW
NNG	EDF Renewables/ESB	448MW
Seagreen 1	SSE Renewables/Total	1075MW
Inch Cape	Red Rock Power	1000MW
Moray West	Ocean Winds	850MW
ForthWind	Cierco	12MW
Berwick Bank	SSE Renewables	2300MW
Marr Bank	SSE Renewables	1850MW

0.89 GW

2.5 GW

1.9 GW

4.15 GW

Current Wind Farms (total 9.4GW)

By status

- Operational
- Under construction
- Consented
- Planned



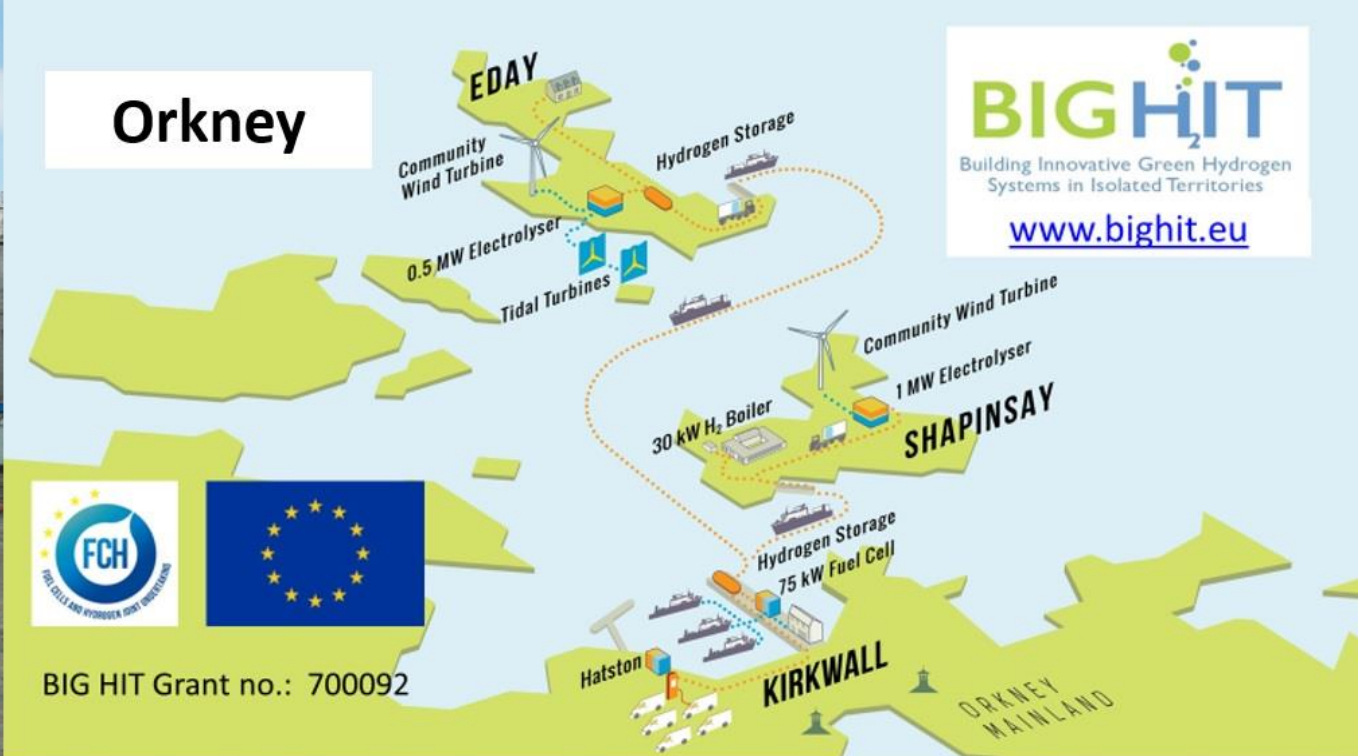
Aberdeen



Levenmouth



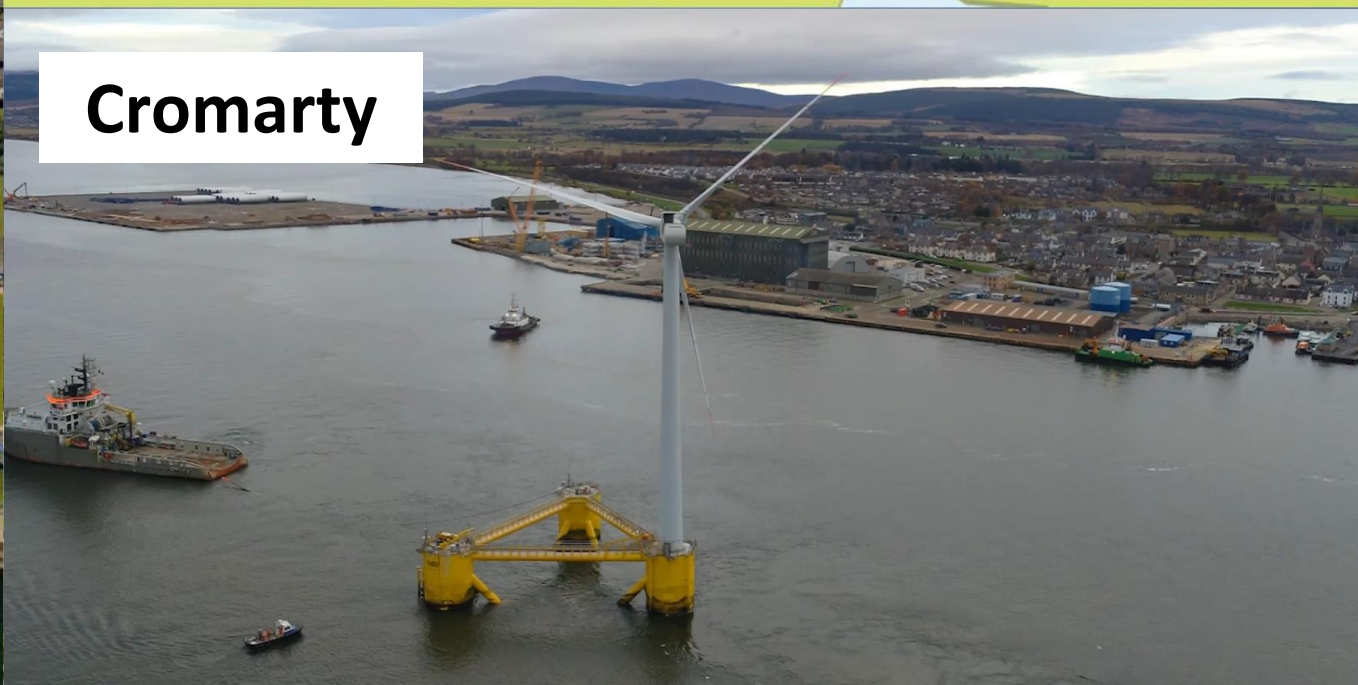
Orkney



BIG HIT Grant no.: 700092



Cromarty



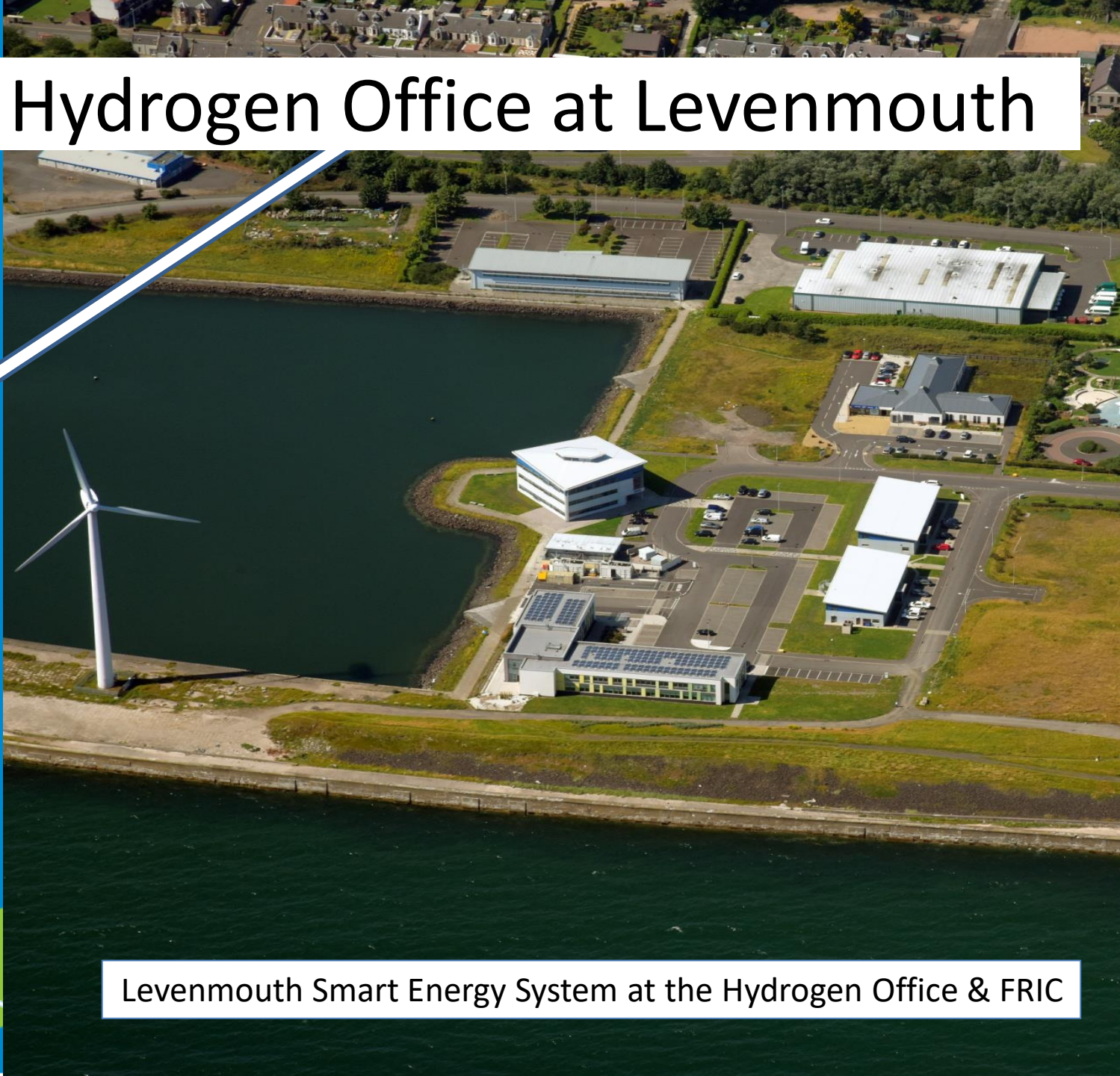


Net Zero The UK's contribution to stopping global warming

Committee on Climate Change
May 2019

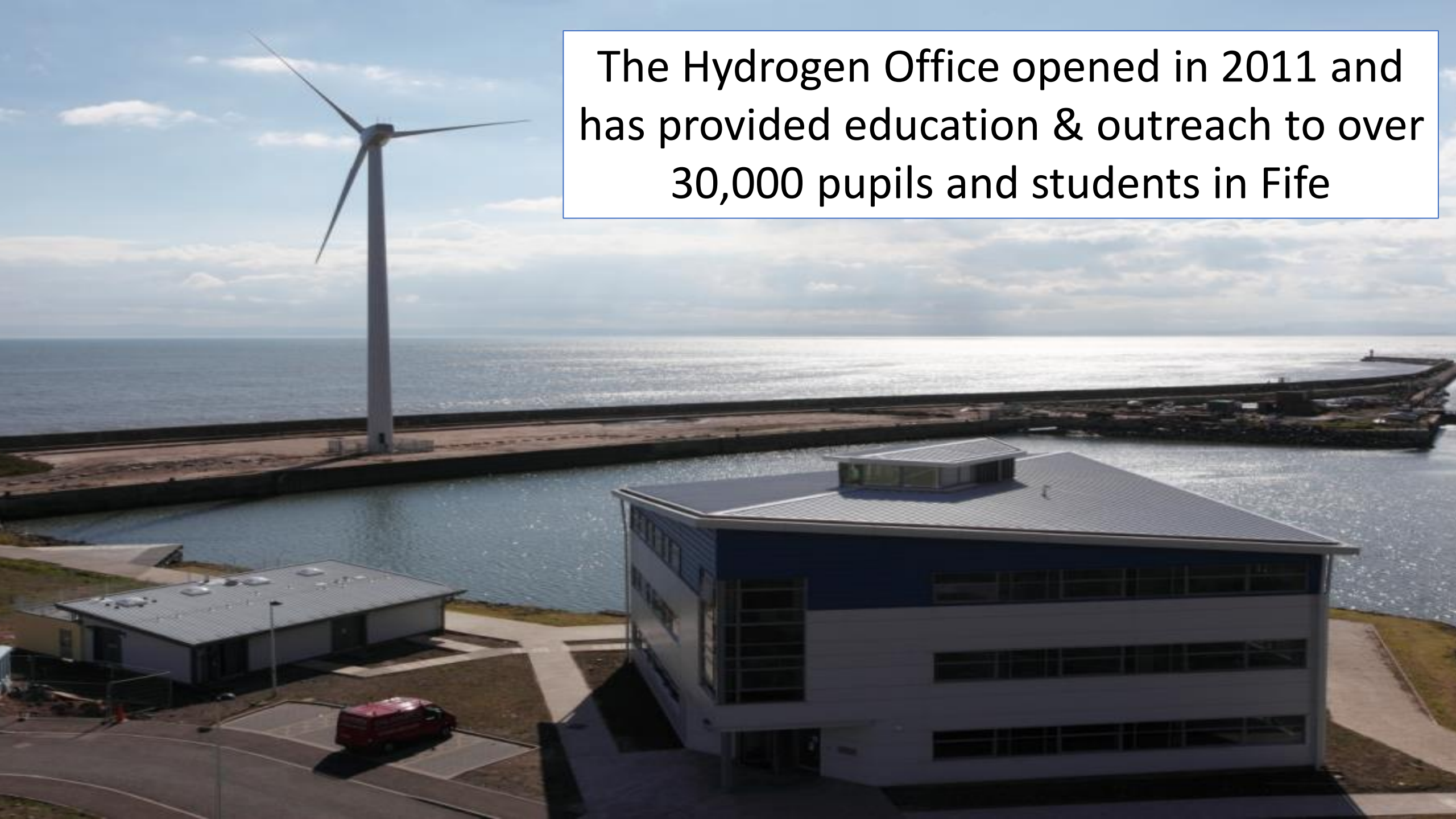


The Hydrogen Office at Levenmouth

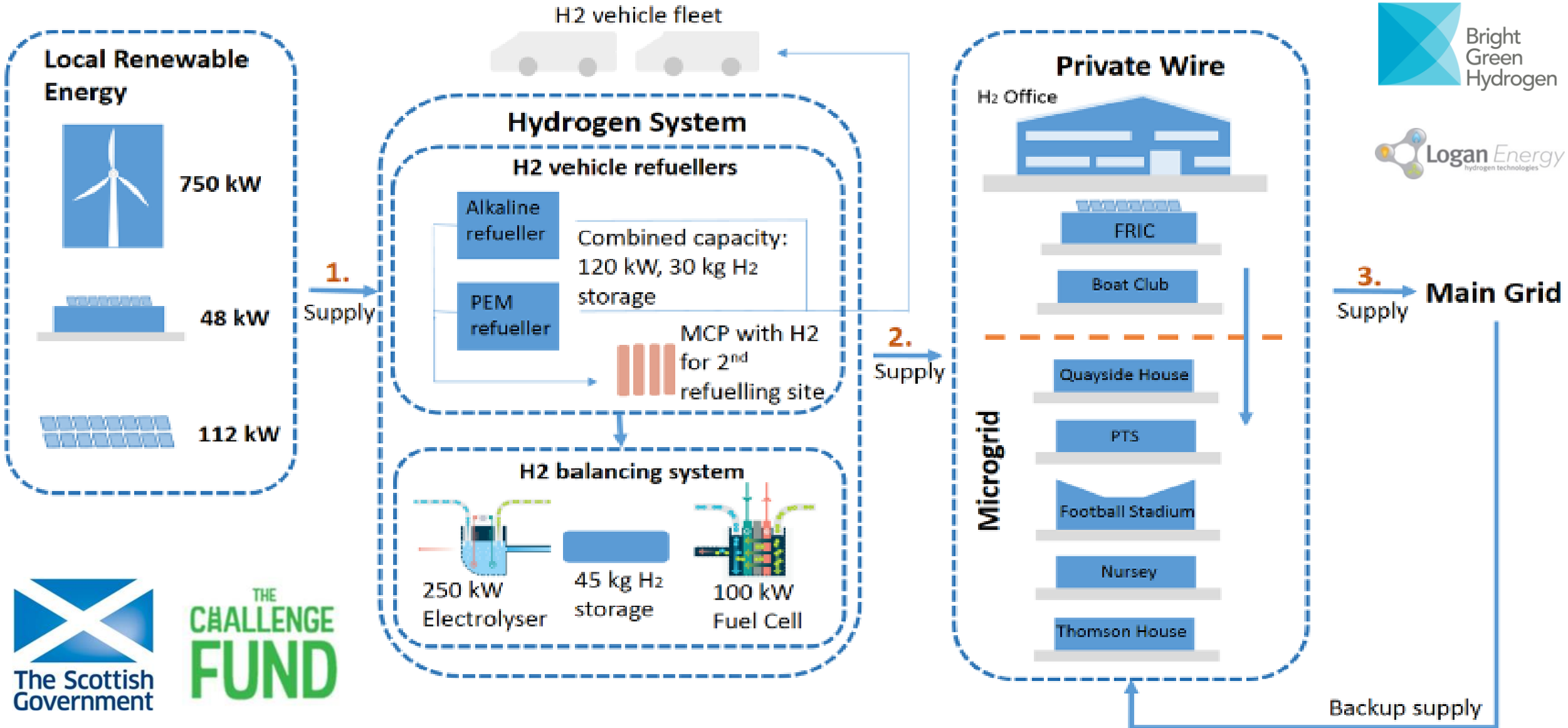


Levenmouth Smart Energy System at the Hydrogen Office & FRIC

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



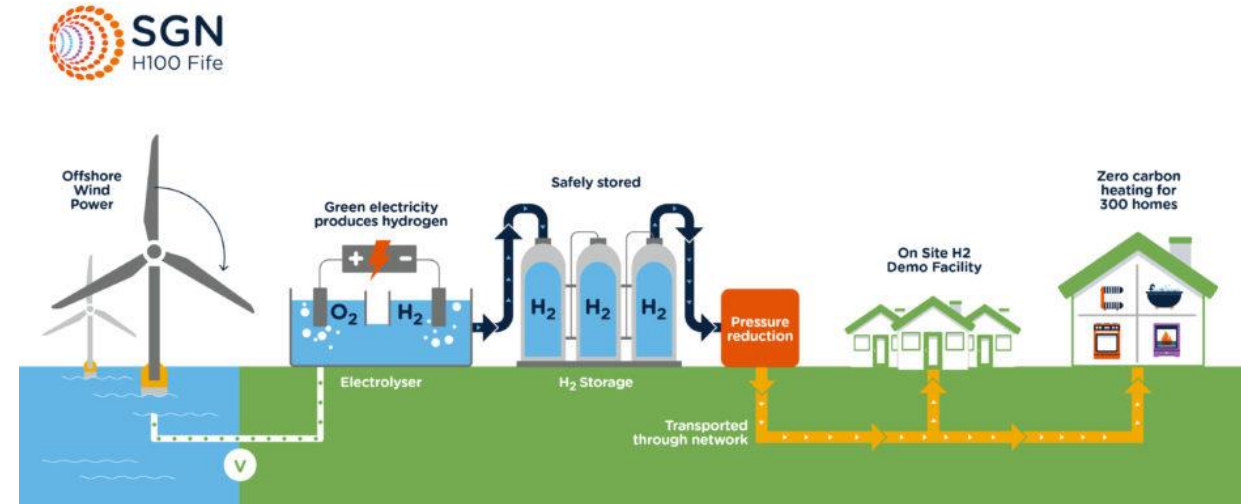
2017: Levenmouth Smart Energy System



Next steps: Consumer Acceptance with H100 Fife



Energy Park Fife



100% H₂ 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 H100 Fife in Levenmouth

Your gas. Our network.

Proving safe use of 100% H₂ for heat





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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 H₂ 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 H₂ used
- 10-12 mins refuel time
- >98% HRS availability



Locally Produced Hydrogen for Bus Fleet



The Kittybrewster HRS in Aberdeen is one of the most intensively used in Europe, dispensing on average 35 tons of hydrogen per year for the past 5 years. Project supported by FCH JU & EU.



Hydrogen produced at the Kittybrewster site using three Hydrogenics (Cummins) electrolysers, with two BOC Linde ionic liquid compressors for ultimate reliability.





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

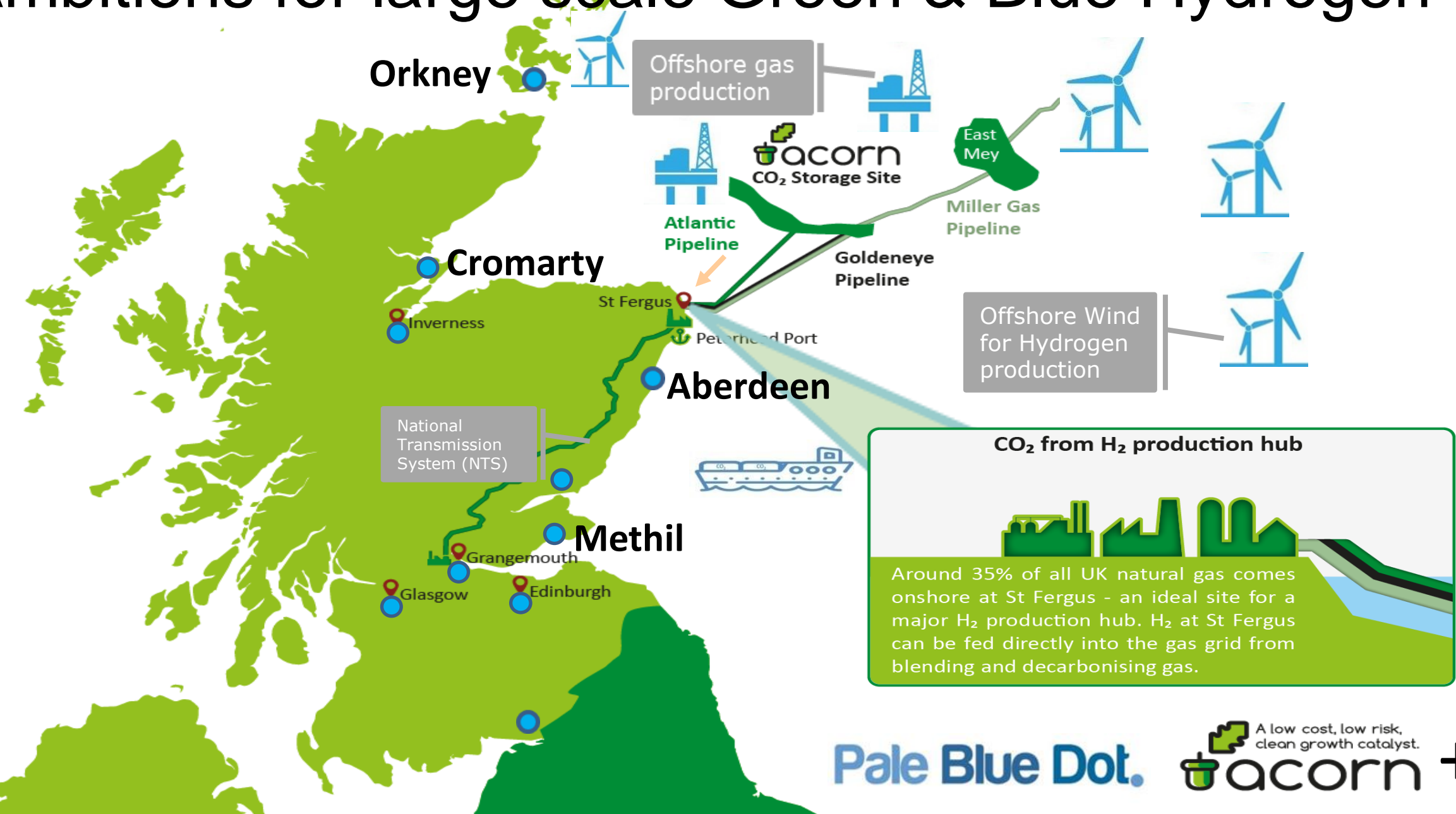
Energy Transition Zone - Hydrogen Campus Concept

Green Hydrogen Test & Demonstration Facilities



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

Ambitions for large scale Green & Blue Hydrogen



Pale Blue Dot.

acorn +
A low cost, low risk, clean growth catalyst.

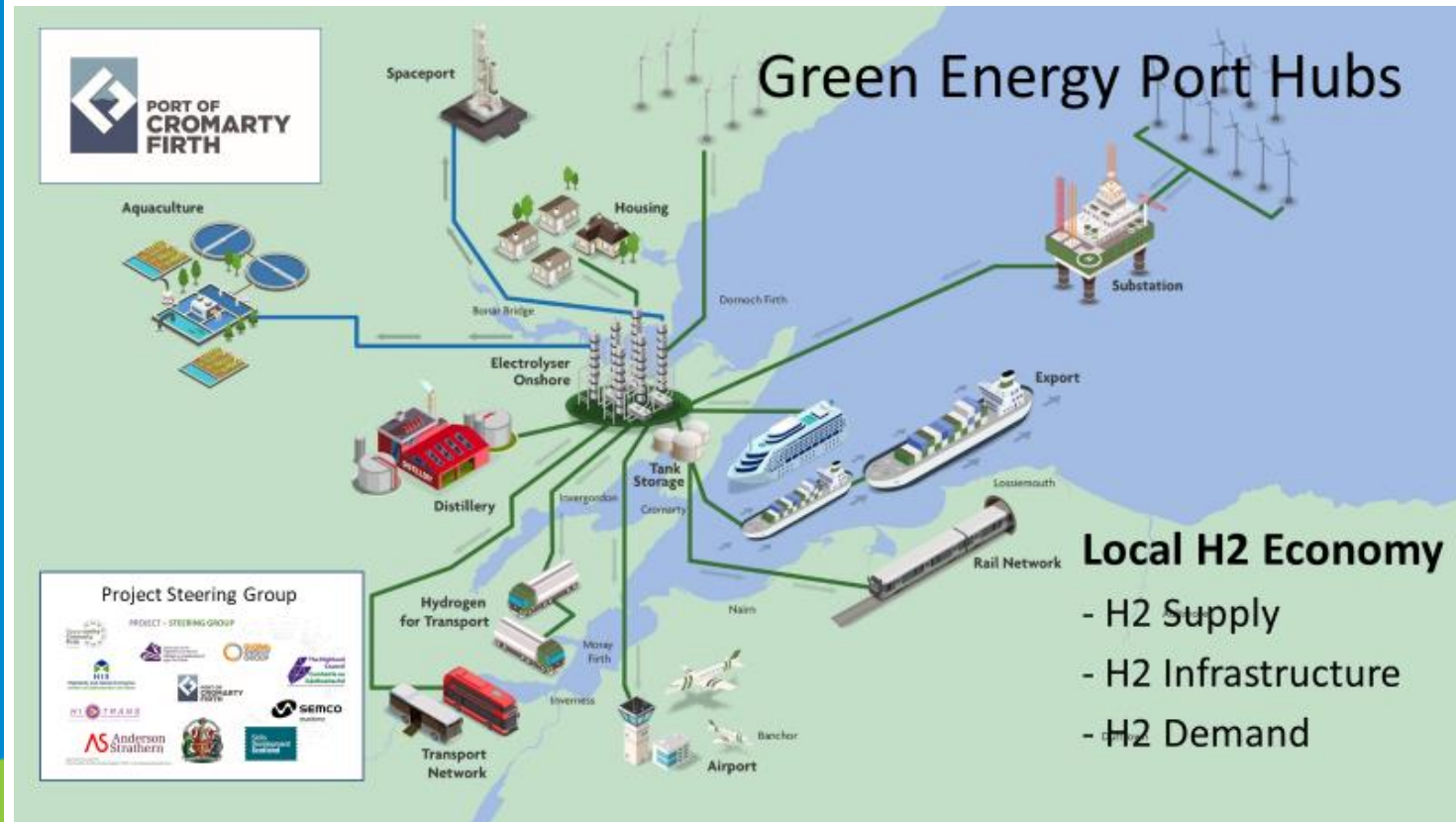


Net Zero
The UK's contribution to
stopping global warming

Committee on Climate Change
May 2019

Cromarty: Green Hydrogen Hub

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



Building local industry demand for green H2



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

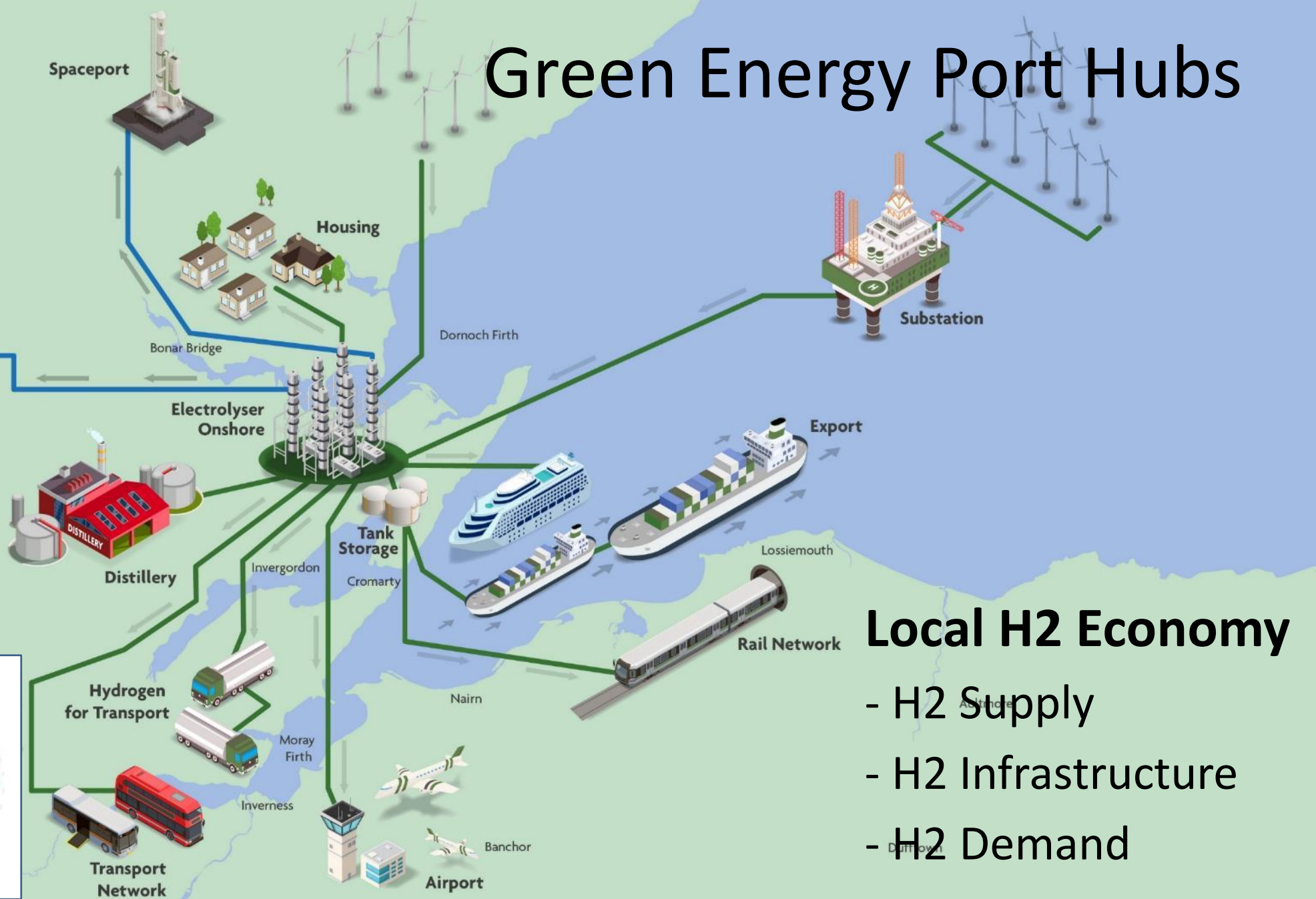


**PORT OF
CROMARTY
FIRTH**



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

Green Energy Port Hubs



Local H2 Economy

- H2 Supply
- H2 Infrastructure
- H2 Demand

Project Steering Group





Net Zero
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Committee on Climate Change
May 2019

Orkney: >100% Green Electricity

Renewables generate > 100% of Orkney's electricity

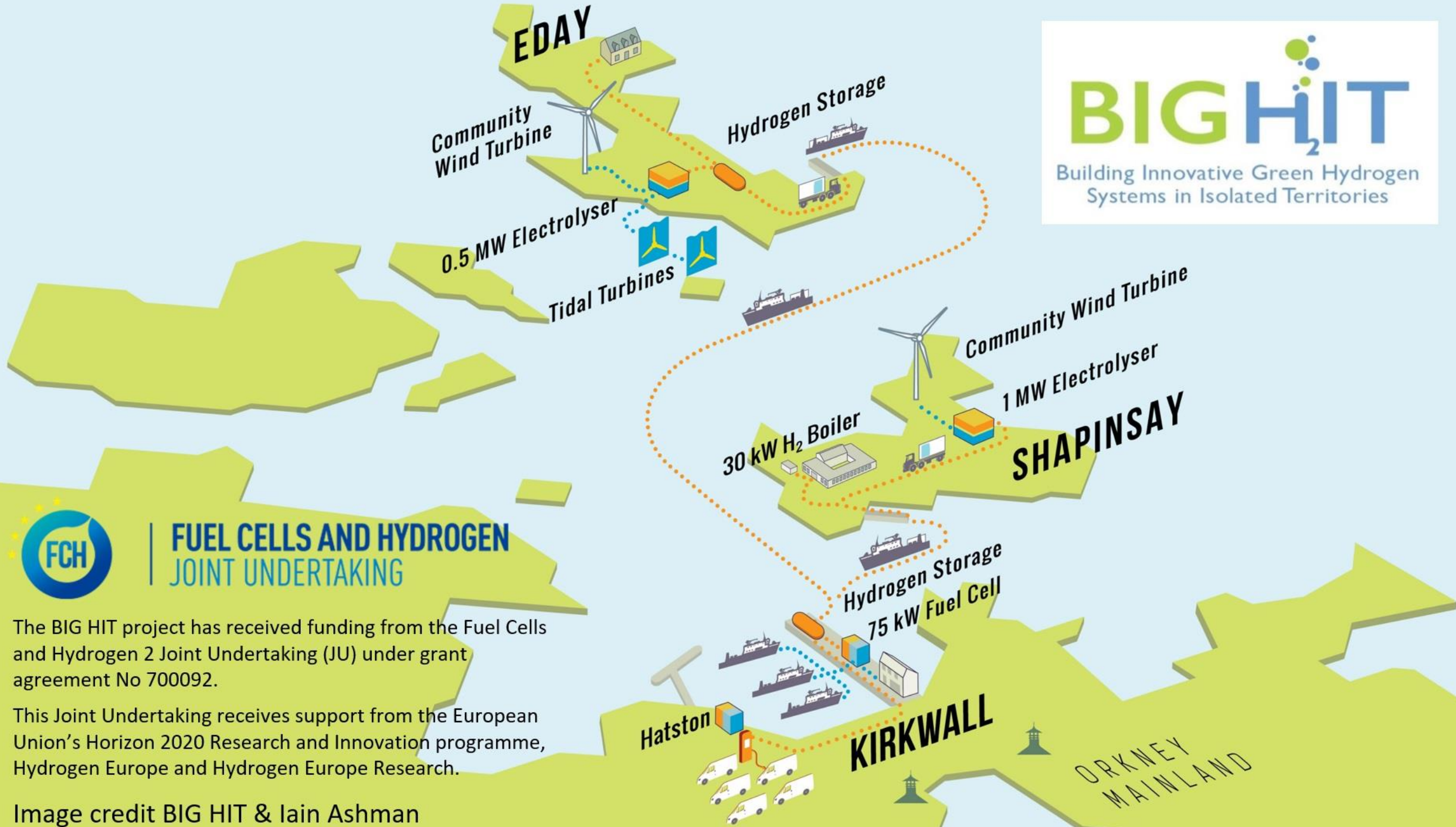
Over 50MW of installed renewable capacity

>1000 renewable installations for 10,000 households



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





**FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING**

The BIG HIT project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under grant agreement No 700092.

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

Image credit BIG HIT & Iain Ashman

Green Hydrogen for heat, power, & transport



Orkney: Growing the H₂ Portfolio



Next steps with H₂ for marine, aviation, and industry

Zero Emissions H2 Aviation Trials in Orkney



HyFlyer1 ZeroAvia 6-seater zero-emissions aircraft. Trials at Cranfield in July 2020.



Britten Islander 9-seaters already used in Orkney Islands. The project Fresson H2 version flight trials are planned for 2022.

Kirkwall Airport: Sustainable Aviation Test Hub

**H2-ICE genset for
heat and power**



Where Next? Scaling Up Green Hydrogen...





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



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



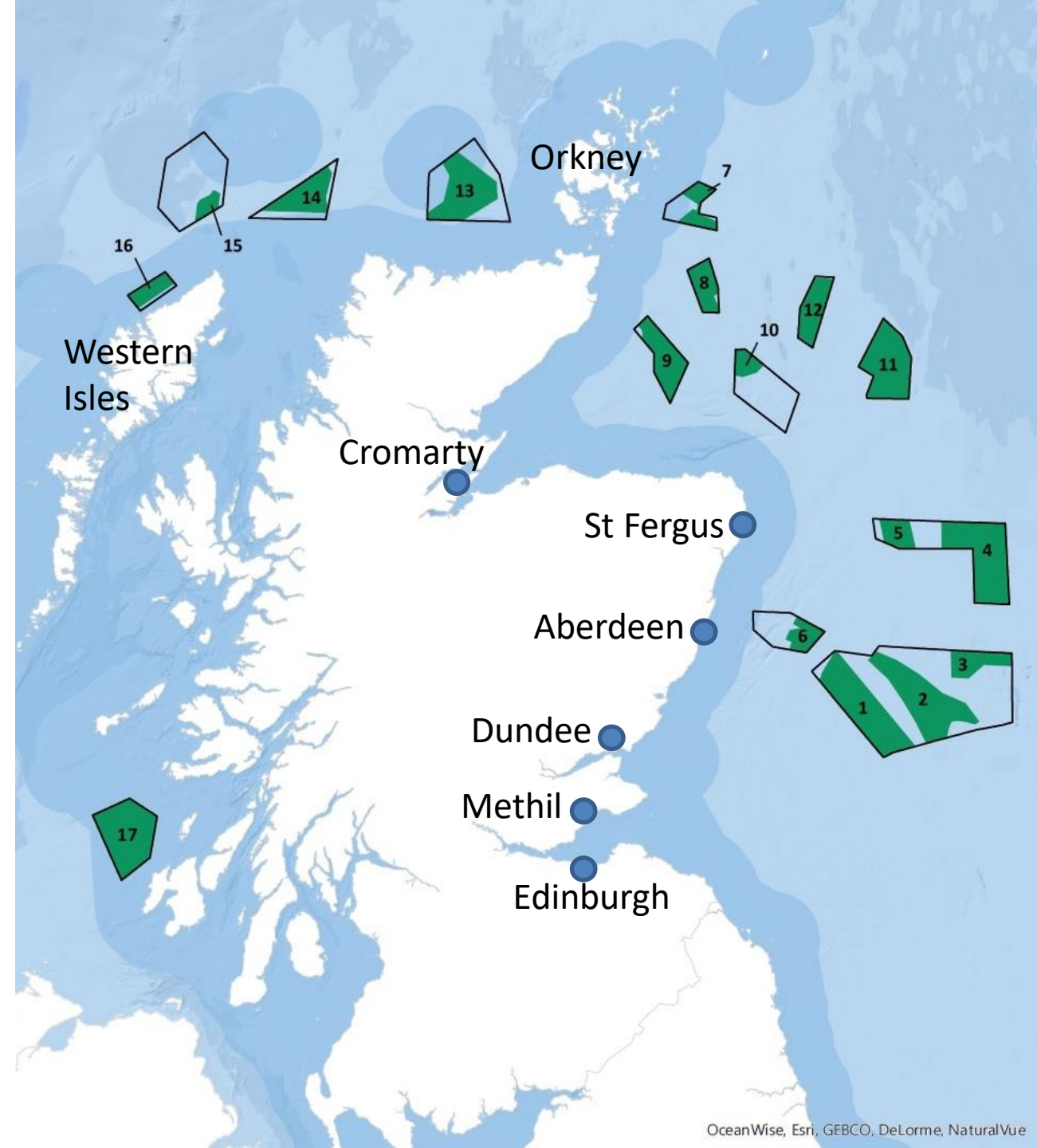
Shetland ORION Clean Energy Project
Green H₂ from onshore & offshore wind
Repurpose Sullom Voe oil & gas terminal

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

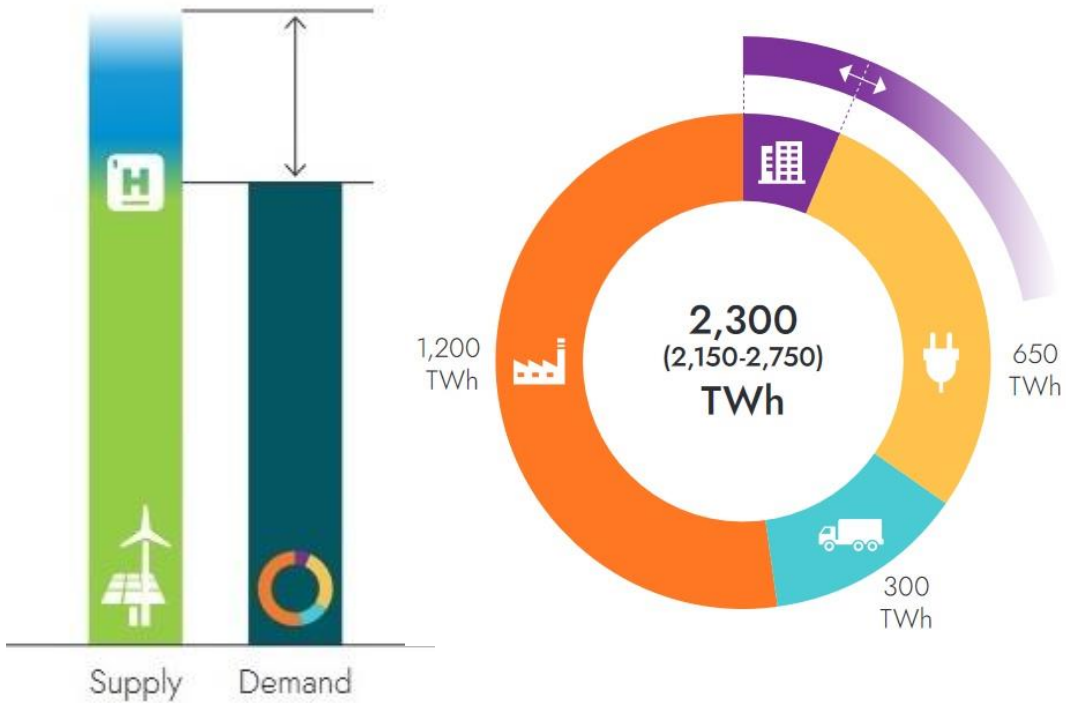
Scaling up Hydrogen for 2030 with Offshore Wind

Scotwind announcement 17 Jan 2022

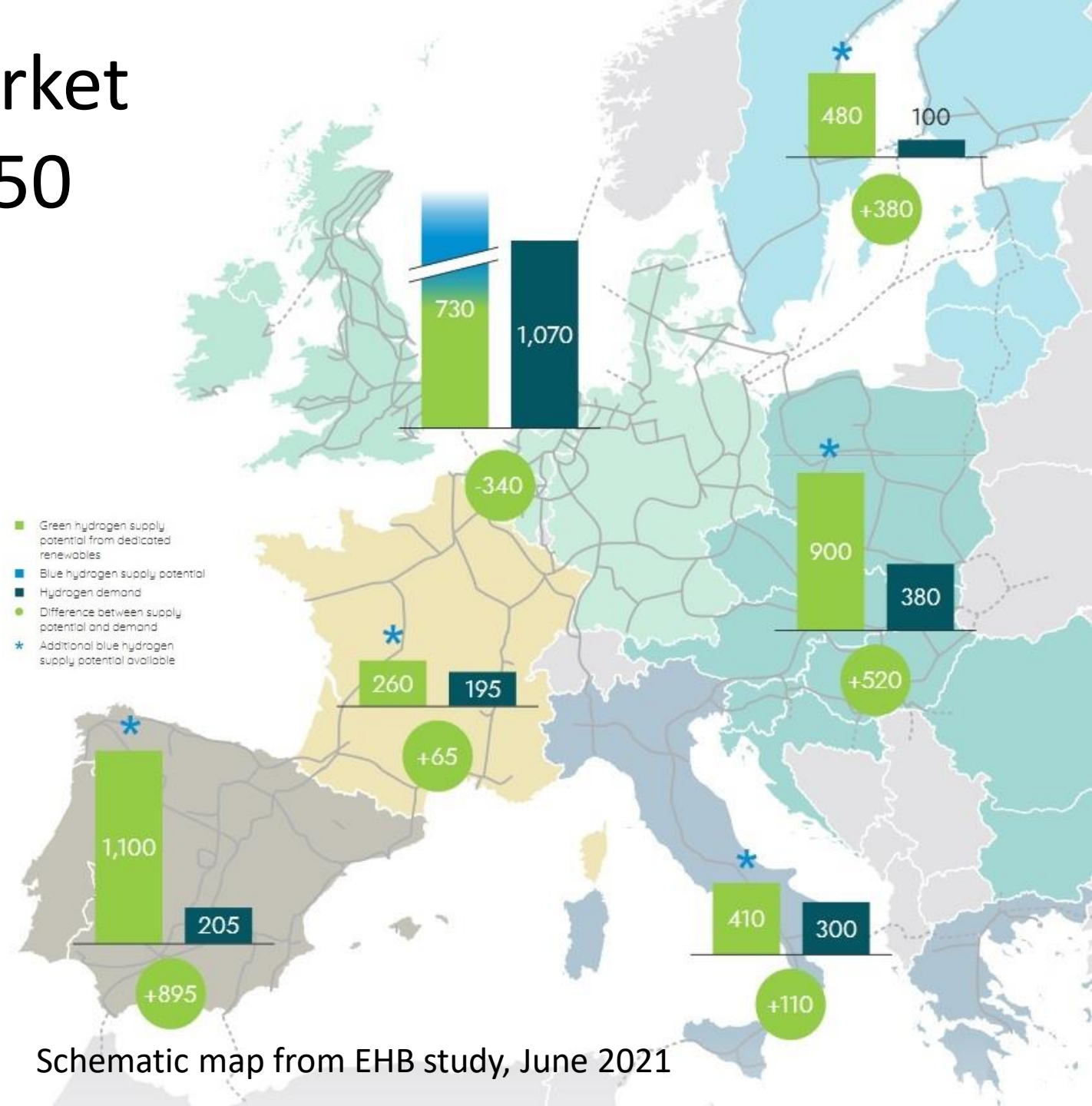
- successful bidders been offered option agreements for rights to specific areas of seabed around Scotland.
- 17 projects with a total of 24.8 GW of proposed offshore wind capacity have been selected
- £700m will be paid by the successful applicants in option fees
- The area of seabed covered by the 17 projects is just over 7,000km²



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

Scaling up Hydrogen across Europe

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

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



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