

ISLANDS COUNCIL

Sparsely populated archipelago (70 islands – 20 of which are inhabited)

Situated 16km north of the northernmost tip of mainland Scotland

Largest settlement and administration centre: Kirkwall



Housing; Waste; Education; Burial Grounds; Marine Services (acts as harbour authority for islands' 29 piers and harbours)

Background

From the first commercial wind turbine to connect to the national grid at Costa Head in 1951, to the more recent establishment of the ground-breaking research and development of wave and tidal energy at the European Marine Energy Centre (EMEC) in 2003, Orkney has long since been at the forefront of energy innovation in Scotland.1

Orkney's hydrogen future

Orkney Islands Council, The Orkney Hydrogen Economic Strategy, Appendix 1, http://www.orkney.gov.uk/Files/Committees-and-Agendas/Development%20a nd%20Infrastructure/2015/10-09-2015/111_App1_Draft_Orkney_Hydrogen_Econ omic_Strategy.pdf





Background

Despite the Orkney islands being rich in energy resources, Orkney as a whole imports high levels of fossil fuels and has some of the highest levels of fuel poverty in the country? However, renew-able energy production uptake has proved extremely successful throughout the community of Ork-ney, to the point where energy generation now exceeds Orkney's own needs, and is also greater than the capacity of Orkney's existing grid



connection to mainland Scotland. Orknev The Hydrogen Economic Strategy summaries how hydrogen offers a way to address these issues, as well de-tailing as the potential economic benefits a transition to an improved grid connection could bring; with along more general and immediate and sustainable economic benefit for future generations.

Orkney Islands Council, the local authority at the heart of this economic strategy, has aspirations for a low carbon economy, not just because it seems the correct moral standing to take, but also due to the potential social and economic benefits it could bring. The Council's Hydrogen Economic Strategy addresses energy challenges faced by these islands and highlights the Council's role in enabling and encouraging communities and businesses to develop and increase their use of hy-drogen, to the benefit of everyone.

Well known for its extended daylight hours in the summer, and with some of the strongest wind, wave and tidal resources in Europe, Orkney's 2014 renewable energy production was 104% of its own needs. The biggest challenge facing Orkney's over-production of energy is a lack of capacity on the existing grid connection to the mainland – and with a moratorium in place since 2012 from Scottish and Southern Energy (SSE) on new grid connections – further investment and develop-ment in renewable energy generation has all but stalled.

The local authority understands that developing hydrogen-based projects provides a solution to turn these challenges into opportunities, making use of the energy which is currently under-utilised, making it one of the first hydrogen strategies to date to focus on using green electricity which would otherwise be wasted.

Orkney Islands Council also recognises that considering a hydrogen-focused strategy makes good use of an abundance of renewable electricity, allowing storage where there

² Orkney Islands Council, Orkney Fuel Poverty Strategy 2017-2022,

http://www.orkney.gov.uk/Files/Consultations/Fuel-Poverty/Draft-Orkney-Fuel-Poverty-Strategy-2017-2022.pdf

once was wastage or loss, to be used for heating, power, transport and other purposes, including agriculture.

There are many potential benefits to the Orkney community by generating hydrogen, including turning a number of existing challenges into opportunities; supporting Orkney communities and businesses; reducing the negative impacts to marine energy innovation; alleviating the loss of in-vestment for energy producers; working with a wide variety of European partners; Leading the way for other territories to replicate a hydrogen economy; developing training opportunities provided locally; attracting wider investment to the local area and; working around the existing curtailed local energy production to maximise renewable energy resources.

The Orkney Hydrogen Economic Strategy aims to ensure that Orkney meets sustainability targets set out by the European Union (EU), Scottish and UK governments.





The Vision

Despite hydrogen being one of the most abundant elements in the universe, little of it is freely available. Producing hydrogen through electrolysis of water (H2O) – by using an electrical current to split it into its component parts of Hydrogen (H2) and Oxygen (O2) – allows Orkney to make good use of an abundance of renewable electricity that would otherwise be wasted.

A number of policy drivers helped shape Orkney's hydrogen strategy, including requirements from the following:

European Union (EU)	Requirements
	20% reduction in carbon emissions by 2020
	Limit emissions of new vehicles of 95g CO2 p/km for new cars by 2021
	Compliance with requirements of the EU Clean Air Policy Package
	Achieving resilience through Energy Security as per European Energy Security Strategy
	Expansion of renewables capacity through mass deployment of alternative fueled vehicles that use electricity as the main feedstock; EU 2020 targets; H2Mobility
UK and Scottish Govts	Requirements
	Respectively 40% and 42% reductions in carbon emissions by 2020, relative to 1990 levels
	80% reduction of carbon emissions by 2050, relative to 1990 levels
	Mass market transition to low emissions vehicles
	Compliance with National Air Quality Strategy (UK)
	Compliance with the Scottish Air Quality Strategy 2015
	In accordance with the Scottish Electricity Generation Policy Statement 2013, that Scotland's generation mix should deliver the four principles of security of supply, affordable to the consumer, decarbonization by 2030 and to achieve the greatest possible economic benefit and competitive advantage
	Resilience through Energy Security as in Energy Security Act 2015

UK and Scottish Govts	Requirements
	Expansion of renewables capacity through mass deployment of alternative fueled vehicles that use electricity as the main feedstock; EU 2020 targets; Climate Change Act (2008) UK; UK H2Mobility; Climate Change Act (2009) Scotland
	Energy storage – Scotland's renewable energy targets include 100% electricity demand equivalent from renewables by 2020; grid balancing; low carbon vehicles using electricity as power and storage

Furthermore, Orkney Islands Council has the following ambitions in its current Council Plan:

- Promote successful and thriving communities
- Have a low carbon Orkney approach
- Attract investment, investors and companies
- Make use of resources to capture energy
- Produce policy to deal with the development of renewable energy and associated infra-structure
- Ensure community benefit from renewable investments; ensure a skilled workforce and training in Orkney associated to energy

Orkney has over 1,000 domestic scale micro generators – 700 wind and 350 solar – a combination of both private and community investment, and following the 2012 moratorium on new grid connec-tions, Orkney's Distribution Network Operator (DNO) developed a zoned Active Network Manage-ment scheme (ANM).

The ANM initially allowed additional renewable generation to connect under arrangements where the DNO could curtail generators at times when energy output exceeds capacity on the local distribution grid. However, that curtailment has been greater than anticipated, with some renewable generators having 40-60% of their potential energy production curtailed.



A number of pipeline projects to help address the issue of over production were identified, including the use of hydrogen in sea and road transport; local solutions which could potentially be replicated in other areas facing similar challenges. Importantly, the Orkney community was behind the idea, and with support from the public sector and some innovative industries with successful track records, and in partnership with the local authority's existing networks, industry and academia worked together to take proof concept projects to the next level – commercial reality.

Driving factors for the projects included a number of policy and practical issues. Opportunities to develop hydrogen in Orkney were already identified through existing projects such as the European Marine Energy Centre's hydrogen electrolyser and the Orkney Surf 'n' Turf projects. Both projects involve producing hydrogen from curtailed marine and community-owned wind renewables, to be transported and used to provide electricity at Kirkwall Harbour, including providing auxillary power for ferries tied up at pier.

In addition, the Wind-Agri Energy project received initial funding from the Scottish Government to explore the feasibility of using hydrogen that has been produced using otherwise curtailed electrici-ty, to provide synthetic diesel and agricultural fertilizer.



Projects



Based in Eday, the £1.3million Surf 'n' Turf project is a system which draws renewables electricity either from tidal turbines at the test site at the European Marine Energy Centre (EMEC), or from the onshore wind turbine run by the Eday community. An electrolyser then uses the electricity to split water into its component parts of hydrogen and oxygen.

Funding was primarily received through the Local Energy Challenge Fund (Scottish Government) is led by the Kirkwall based team of Scotland-wide energy charity, Community Energy Scotland, in close partnership with the EMEC, Orkney Islands Council, Eday Renewable Energy and ITM Pow-er.

Launched in September 2017, Surf 'n' Turf is laying the foundations for hydrogen to be used at sea. That involves proving the technology on dry land, and letting potential users get hands-on. The fuel cell is designed to marine standards, so it can act as a training rig for ship engineers and crew members.







The BIG HIT (Building Innovative Green Hydrogen systems in an Isolated Territory: a pilot for Eu-rope) is a five-year, European-wide project aimed at overcoming local grid constraints. BIG HIT sees energy from community-owned wind turbines on the islands of Shapinsay and Eday, used to produce hydrogen. The otherwise 'curtailed' capacity will be used to produce low carbon hydrogen and oxygen, using an electrolyser similar to that of the Surf 'n' Turf project. Indeed, BIG HIT builds on the work of the Surf 'n' Turf project and features a total of 12 partners from across 6 European countries.

BIG HIT will enable 10 electric vans to be fitted with a hydrogen fuel cell range extender, as well as the construction of a hydrogen refueling station. BIG HIT also involves the installation of two hy-drogen powered boilers to provide zero carbon heat, to demonstrate the potential scope for hydro-gen in Orkney.

Both Surf 'n' Turf and BIG HIT aim to put in place a fully integrated model of hydrogen production, storage, transportation and utilisation for low carbon hear, power and transport. The projects ad-dress a number of challenges – including the logistical and regulatory aspects for transport of hy-drogen fuel between islands, and the orientation and familiarisation with new hydrogen building and transport technologies.

BIG HIT is funded by the European Commission's Fuel Cells Hydrogen Joint Undertaking (FCH 2 JU) and BIG HIT was selected as the only hydrogen project of its kind to receive funding.



The 12 partners involved in BIG HIT are as follows:

Orkney Islands Council

Significant role Providing 5 electric vans fitted with hydrogen fuel cell Hydrogen refueling station construction near Kirkwall Vans to form part of the council's fleet Planned installation of hydrogen-powered boilers at 2 premises

Shapinsay Development Trust

Working to secure the future sustainability of their community (300 people) Many islanders involved with the Trust as trustees, volunteers or emloyees Increased revenue for the community by alleviating curtailment on the turbine

Community Energy Scotland (CES)

Registered Scottish Charity At the forefront of community energy developments in Scotland Lead on Surf 'n' Turf project

European Marine Energy Centre (EMEC)

First and only centre of its kind in the world Preparing to install a 0.5MW electrolyser for use in Surf 'n' Turf project

Calvera

Specialists in the manufacture of storage and transportation systems for compressed gas, particularly hydrogen

Provided bespoke systems for 30 years to industrial and medical gas companies (certified official supplier)

Composed of 2 production facilities with a workforce of 60 people Also maintain and refurbish gas transport systems

Giacomini

Leader in the field of components for heating and cooling Involvement in hydrogen as a renewable energy source for over 10 years Use innovative condensing boiler based on hydrogen catalytic burner

ITM Power

Energy storage and clean fuel company committed to sustainable energy solutions based on water electrolysis using Polymer-Electrolyte-Membrane (PEM) technologies Providing BIG HIT's electrolyser, hydrogen refueling station and much of the safety

analysis



Symbio FCell

European leader in hydrogen fuel cell systems designed for transportation markets

Danmarks Tekniske Universitet (Technical University of Denmark, DTU)

One of Europe's foremost technical universities

World class expertise in fuel cells, electrolysis, hydrogen storage and related technologies

Scottish Hydrogen & Fuel Cell Association (SHFCA)

Sector body for the development and deployment of hydrogen and fuel cell technologies in Scot-land

The Ministry for Transport and Infrastructure (MTI)

Promotes and develops transport sector in Malta by means of proper regulation and by promotion and development of related services, businesses and other interests

Locally and internationally

Malta to act as lead follower territory for project replication

The Foundation for the Development of New Hydrogen Technologies in Aragon (FHa)

Non-profit entity founded in 2003

Carries our organisation, management and deployment of a wide range of actions with the purpose of promoting the use of hydrogen as an energy vector

Based in Huesca, Spain

Research & development as well as consultancy projects

Cooperation with local, national and international companies



HySeas III



HySeas III is the final development stage of a programme to deliver what the team hopes will be the world's first sea-going vehicle and passenger ferry that will employ carbon-free hydrogen as energy source.

The project is constructing and testing the vessel hybrid fuel cell power system at full scale to con-firm its readiness for integration into the vessel that will subsequently be built (development of the latter is also part of the project). Moreover, HySeas III is producing the final specification for the vessel fuelling infrastructure and examining a range of techno-economic and social factors that will influence the transition to zero-carbon marine transport.

The underlying thinking seeks to adapt zero-carbon road transport technology, which has been greatly supported and developed by and across a wide range of EU initiatives, to the marine envi-ronment.³

³ https://ec.europa.eu/inea/en/horizon-2020/projects/h2020-transport/waterborne/hyseas-iii



The Future



Despite the ongoing efforts of those involved in all of Orkney's hydrogen energy projects, there are ongoing curtailment issues that have yet to be addressed when it comes to Orkney's overproduc-tion of energy.

It is clear, however, that there is significant commitment and enthusiasm from both the Orkney Islands Council and the local community, as well as a number of public sector partners, for the development of further hydrogen development projects in Orkney.

The local authority intends to help create the conditions required to facilitate the development of the infrastructure required for future integration of hydrogen, into the local economy, and beyond.

