Annex 3 Technical and background information

Section 1 – Introduction

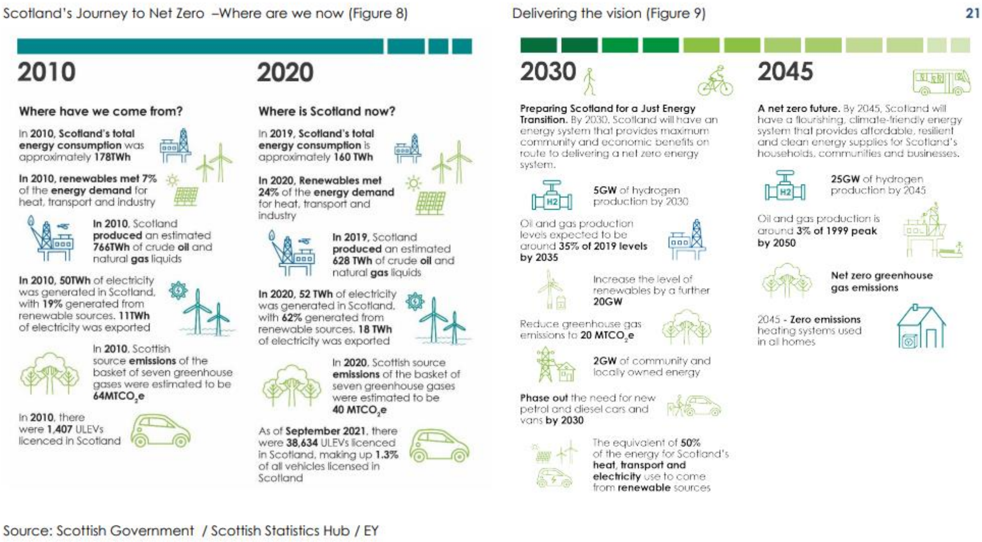

Figure 1 Example of net zero change profile from the Scottish Government's Energy Strategy and Just Transition Plan, a Shetland version of this is in development

Figure 2 below provides a simplified web of some of the groups engaged in different aspects of energy transition in Shetland. For further details on the groups along with their roles and remit see Annex 4.

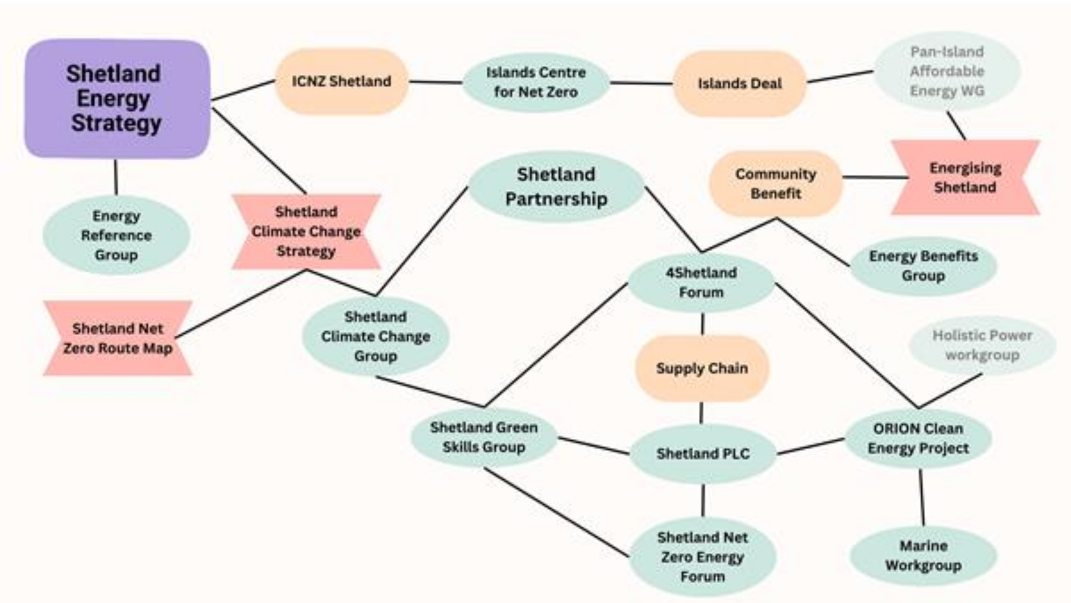

Figure 2 Shetland Energy Ecosystem

Section 2 – Drivers for change and the Pathways to Change

Section 2 and previous section 3 Our Energy Futures have been incorporated.

Section 3 – Energy Generation

Oil & Gas

How does it work

Oil and gas are formed from organic material mainly deposited in sediments on the seabed and then transformed through a set combination of events over hundreds of millions of years.

Oil and gas deposits can be recovered in areas where there is a suitable combination of source rock, reservoir rock, cap rock and a trap[1], these are summarised in Figure 3. The waters off the coast of Shetland to both the east and west have been well explored. We therefore, do not anticipate the discovery of any further large reservoirs[2]. However, the UK Government continues to promote exploration as part of its current energy security policy.

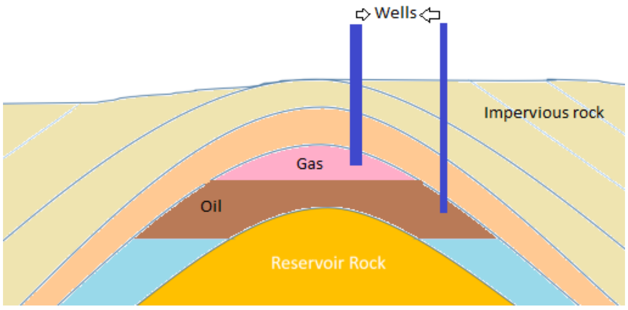

Figure 3 Components required for oil and gas to be trapped to enable recovery - to be redrawn

Governance,

Governments react to public pressure. The Climate Change movement has been a significant driver for UK and Scottish Government policy decisions in recent years, with the spotlight on Glasgow for COP26 in November 2021. Since then the world energy crisis has accelerated thus putting energy security and the cost of living at the top of the political agenda. Overall the policy environment is facilitating a shift towards a low carbon future. The draft Scottish Government Energy Strategy and Just Transition Plan[3].

> *"supports the fastest possible just transition for the oil and gas sector in order to secure a bright future for a revitalised North Sea energy sector focused on renewables"*

This is at odds to the recent UK Government policy paper: Powering up Britain[4], where one of the vision points is:

> *"maximising the vital production of UK oil and gas as the North Sea basin declines".*

At this time a balance has to be met between the climate emergency and energy security.

In the coming decades, government policy will swing with the mood of the electorate, with inconsistent government energy policy an enemy to the confidence of energy investors.

Energy Majors Business Planning – all of the Energy Majors have signed the UN Paris Climate Change Agreement to limit global temperature increase to 2°C in this century. We need to understand how they plan to meet this target, along with the opportunities and challenges for Shetland. We must ensure that these plans engage with the Energy Development Principles and the holistic energy solution for Shetland. The electrification of offshore assets for example will require a clean source of

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[1] How is petroleum formed? - Norwegianpetroleum.no (norskpetroleum.no)
[2] Draft Energy Strategy and Just Transition Plan - gov.scot (www.gov.scot)
[3] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/documents/
[4] Powering up Britain - GOV.UK (www.gov.uk)

power and a substation onshore to supply the power at the correct voltage and frequency, along with a cable network to connect to the assets.

Eventually, companies relying solely on profiting from oil and gas will struggle to compete in an energy market where consumers and investors favour cleaner forms of energy.

Global Energy transition would be much quicker if international energy companies switched more of their extensive research and development budgets and negotiation experience towards the new technologies required to advance the green agenda. In order to engage fully in the development of renewable energy these companies will need to reinvest the money earned from their main trade, oil & gas, into new technology projects and supply chain development. The integration of renewable energy with the established oil & gas industry is a key part of a just energy transition and will last until renewable energy becomes the predominant source of energy on the planet.

Onshore wind

How does it work?

Power from the wind has been harnessed for thousands of years, the most historically notable being sailing ships and windmills for grinding grain.

Wind turbines work by utilising the power in moving air. As the blades turn, the rotational energy created turns a shaft which is converted into electricity by a generator. This electricity can then be used to supply a house or building, or be fed into the National Grid system.

Figure 4 Luggies Knowe Wind turbine – original photo saved in Teams

Governance,

In Scotland, applications for consent for the construction, extension and operation of electricity generation stations with capacity in excess of 50MW are made to the Scottish Ministers for determination[5]. Applications below this threshold are made to the relevant local planning authority.

Policy	Target or ambition
• Scottish Government Onshore Wind Policy Statement, published in December 2022[6]	• Deliver an additional 12 GW of installed onshore wind by 2030, Total of 20GW

[5] Scottish Government - Energy Consents Unit

[6] Onshore wind: policy statement 2022 - gov.scot (www.gov.scot)

Offshore Wind

How it works

Offshore wind turbines, similar to onshore wind turbines, work by utilising the power of moving air. As the blades turn, the rotational energy created turns a shaft which is converted to electricity by a generator. This electricity can be transmitted to shore via a network of subsea cables or potentially used directly offshore to produce hydrogen.

Figure 5 Offshore wind from the Orion website

Depending on the water depth turbines can either be fixed or floating. Floating technology is advancing, allowing access to deeper waters such as those around Shetland. Advantages of floating turbines include:

- Expansion of the viable area for wind energy development
- Reduced visibility from shore
- Access to areas with higher and steadier wind characteristics

There are different technologies available depending on the sea conditions and depth, with fixed-bottom foundations functioning in shallower waters near shore. The floating foundations can take the form of a spar, semi-submersible or Tension Leg Platform (TLP) and are anchored to the seabed by mooring lines.

The Offshore Renewable Energy Catapult is the UK's leading technology innovation and research centre for offshore renewable energy. They use their facilities to bring industry and academia together to drive innovation in renewable energy[7].

Governance

Offshore wind is already Scotland's second largest source of renewable energy. This is set to increase further with both the UK and Scottish Government's setting ambitious targets for offshore wind. The offshore wind generation potential in the waters around Shetland is large and there will be a role to play in contributing towards these targets.

The Crown Estate for Scotland, agree leases for a specific area of foreshore or seabed to be occupied by a third party "tenant" for an agreed purpose, such as renewable energy, and give consent for the tenant to develop on the lease site, if other required permissions are granted.

Applications for offshore wind are made to the Marine Directorate at the Scottish Government[8]. The Scottish Ministers have developed the overarching National Marine Plan, along with the Sectoral Marine Plan for offshore wind[9].

For projects within the 12NM limit these will also require a works license from the Council.

[7] About The Offshore Renewable Energy Catapult (ORE Catapult)
[8] Marine renewable energy - gov.scot (www.gov.scot)
[9] https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/

Policy or plan	Ambition or target
• Scottish Government Offshore wind Policy Statement[10]	• As much as 11GW of offshore wind capacity is possible in Scottish Water by 2030
• UK Government Net Zero Strategy: Build back Greener[11]	• 40GW of offshore wind by 2030, including 1GW of floating offshore by 2030.

Tidal

How it works

Tidal energy is produced by the ebbing and flowing of the tides and can be converted into electricity via tidal turbines. Due to the nature of the tides, this form of renewable energy is very predicable when compared to wind or solar. This gives it advantages when used for electricity production, as the generation output:

- is guaranteed and predictable to the minute, and
- is not determined by the weather.

A tidal stream turbine works in the same way as a wind turbine and they can be floating or placed underwater on the seabed. As sea water is nearly a thousand times denser than air, tidal flows have a higher energy density than wind, despite moving slower. Tidal turbines can generate the same power as a wind turbine, but from a smaller area.

Governance,

The Crown Estate for Scotland, agree leases for a specific area of foreshore or seabed to be occupied by a third party "tenant" for an agreed purpose, such as renewable energy, and give consent for the tenant to develop on the lease site, if other required permissions are granted.

Applications for tidal projects are made to the Marine Directorate at the Scottish Government[12]. The Scottish Ministers have developed the overarching National Marine Plan, which covers the management of both Scottish Inland (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles)[13].

For projects within the 12NM limit these will also require a works license from the Council.

Policy or plan	Ambition or target
• Scottish Government, Draft Energy Strategy and Just Transition Plan - Draft marine energy vision for Scotland	• The industry group recommends the introduction of marine energy deployment targets, including at least 40 MW of installed capacity from tidal stream energy by 2027.

[10] Offshore Wind Policy Statement (www.gov.scot)
[11] net-zero-strategy-beis.pdf (publishing.service.gov.uk)
[12] Marine renewable energy - gov.scot (www.gov.scot)
[13] Scotland's National Marine Plan - gov.scot (www.gov.scot)

Case Study - Nova Innovation

Nova Innovation launched their first tidal turbine in 2014, a 30kW grid connected device. A great deal of learning came out of this trial including demonstrating that turbines can be deployed quickly, safely and cost effectively, using small local workboats.

In 2016, Nova developed the world's first offshore tidal array with multiple turbines in Bluemull Sound. Nova worked with Tesla in 2018, adding energy storage to the site, creating the world's first tidal power station to deliver baseload power.

After winning EU funding for the EnFait project, Nova continued to develop their turbines and the array. In August 2020, the deployment of the fourth turbine marked a significant milestone as it boasted a direct drive generator, eliminating the need for a gearbox. Turbines five and six, along with a subsea hub that enables the two turbines to use a single export cable, were installed in 2023 as part of the EnFait project. The objective was to demonstrate the full life cycle benefits of the turbines. Nova decommissioned the three original turbines later the same year. This has given regulators confidence and helped to demonstrate sustainability and recyclability of materials used in the turbines.

Through the EnFAIT project, Nova Innovation has been able to reduce the cost of tidal energy by 40%. The EnFAIT project also analysed the wake effects between turbines in a real-world environment to help identify the optimum spacing between turbines in an array and increase generation within a specific seabed area. This is an invaluable learning for the industry, and it paves the way for more turbines to be installed at the site near Cullivoe in the future.

In 2021, a groundbreaking milestone was achieved with the installation of the world's first "water to wire" electric vehicle (EV) charge point, exclusively harnessing tidal power. This cutting-edge facility stands as a testament to progress, embraced by the local community and is regularly utilised by local residents.

In 2022, Nova Innovation was awarded an Option Agreement from Crown Estate Scotland to look at the potential to develop a 15MW tidal array at Yell Sound, between the islands of Yell and Bigga.

In 2023, Nova Innovation secured funding from the Scottish Government's Hydrogen Innovation Scheme. Along with partners including: the University of Strathclyde, Shetland Islands Council and Ricardo Energy, they are set to investigate potential markets for both the hydrogen and oxygen produced from electrolysis.

Jobs and economic value were created for Shetland through an integrated supply chain:

- Substructures fabricated in Lerwick
- Manufacture of the blades in Lerwick
- Concrete ballast blocks manufactured in Shetland
- Installation and maintenance using local vessels
- Shore logistics using local haulage companies
- Lifts by Crane companies in Shetland
- Maintenance and engineering support services in Lerwick

Wave

How it works

Wave energy harnesses the motion of the waves. There are several different technologies available depending on the site under consideration.

The amount of energy generated is determined by the height, speed and wavelength of the wave.

Governance,

The Crown Estate for Scotland, agree leases for a specific area of foreshore or seabed to be occupied by a third party "tenant" for an agreed purpose, such as renewable energy, and give consent for the tenant to develop on the lease site, if other required permissions are granted.

Applications for wave projects are made to the Marine Directorate at the Scottish Government[14]. The Scottish Ministers have developed the overarching National Marine Plan, this plan covers the management of both Scottish Inland (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles)[15].

For projects within the 12NM limit these will also require a works license from the Council.

Hydro

How it works

Hydroelectric power is energy derived from flowing water. Hydro power has been used for hundreds of years globally. Locally, there were small horizontal wheeled water mills built in every Shetland community. These mills were powered from burns (streams) and, for most of the rural population, provided the oatmeal part of their diets. Larger vertical wheeled water mills were located at places such as Quendale, Girlsta and Weisdale. This form of water powered milling had largely disappeared by the middle of the 20th century.

Figure 6 Quendale mill

The amount of hydroelectric power generated depends on the water flow and the vertical distance (known as 'head') the water falls through. There are various types of turbine to suit different sites. Hydro turbines range in size from pico schemes of 200-300W providing power to a single property to small ~12kW devices like the one which used to operate in Foula, through to the largest hydroelectric power station the 22.5GW Three Gorges in China.

Solar

How it works

Solar energy harnesses the heat and light from the sun's rays:

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[14] Marine renewable energy - gov.scot (www.gov.scot)

[15] Scotland's National Marine Plan - gov.scot (www.gov.scot)

Solar PV (Photovoltaic), capture the sun's energy converting it into electricity.

Solar thermal, capture energy from the sun to heat a liquid flowing through glass tubes.

Passive solar, this when a property is designed, constructed and orientated so that it maximises the sun's energy. While this is best applied to new buildings, it should also be a considered when designing extensions or renovations.

For further information on solar see the Energy Saving Trust Website[16]

Although regions closer to the equator have more solar energy, solar energy benefits from having fewer moving parts and less maintenance requirements than other renewable energy technology.

Governance,

For the majority of householders the installation of solar panels typically fall within what is known as "permitted development rights". This means that, if a solar panel or system is more or less flush with an existing roof, the Council will not ask for a planning application[17].

However, your property may be covered by certain designations and it is therefore recommended that installers of PV or solar panels contact/or write to the Council's Planning Service to obtain confirmation as to whether planning permission is required. Similarly the Council's Building Standards Service should be contacted to ascertain whether a building warrant is required, prior to commencement of works.

Similar to onshore wind projects in excess of 50MW are made to the Scottish Ministers for determination[18]. Applications below this threshold are made to the relevant local planning authority.

Policy or plan	Ambition or target
• UK Government – Power Up Britain[19]	• 70GW of Solar by 2035
• Scottish Government	• To finalise and update their Solar Vision in 2023

Case Study – Bressay Development Ltd.

Bressay Development Ltd (BDL) is a community led organisation with a wide vision to support the community of Bressay.

Following a Community Asset Transfer, BDL, now owns the former Bressay school and site. BDL undertook the Speldiburn Green energy and heating project, which was completed in April 2021. This project has seen a 60% reduction in the energy consumption and CO_2 emissions on the site.

Work undertaken

- Removal of all storage heaters and replacement with air source heat pumps
- Additional loft insulation in the old part of the building.

[16] A comprehensive guide to solar panels - Energy Saving Trust
[17] PLANNING ADVICE NOTE (shetland.gov.uk)
[18] Scottish Government - Energy Consents Unit
[19] Powering up Britain - GOV.UK (www.gov.uk)

- 40 solar panels split across the east and west elevation were added to the roof of the wooden extension. Output 15kW.

"It is so lovely to walk in the front door and feel instantly comfortable and that's appealing to visitors and customers too."

Lessons learnt

"We weren't sure we would get either this level of savings or this change in temperature - we didn't expect both to be so impressive!"

Hypothetical example Solar

The cost of a solar installation varies greatly depending on:

- whether the project is a new build or a retro fit,
- the type of panels and the size of the array,
- whether the array is roof or ground mounted, and,
- associated equipment such as batteries and controllers to make use of the energy generated within the property.

The Energy Savings Trust has an online solar calculator [Use the solar energy calculator - Energy Saving Trust]

Annual generation will depend on:

- the size of the array
- the efficiency of the panels, and,
- the location, orientation and direction of the panels.
- The main variable is how overcast the skies are, while the panels can generate energy on a cloudy day they are more efficient when the sun shines.

As electricity import prices are high and export prices are low, it is advantageous to use as much electricity on site as possible.

Operating costs will depend on:

- Operating costs are low as there are limited moving parts.

Size a domestic PV array is around 20m^2 compared to a solar thermal array which is around 5m^2

Payback period

For an initial cost of £8,000 and annual generation of 3,086kWh the payback period for this hypothetical example is around 12 years. However, it assumes no financial assistance, a zero interest loan, 80% energy use on site and electricity prices to remain at 27p/kWh.

Lessons learnt

- Do your research, there are lots of options available.
- Learn how the system works so that use within the property can be maximised.

Geothermal

At shallow depths of less than 200m the energy is largely derived from solar energy, a typical example of this is a ground source heat pump.

Deep geothermal generally refers to depths of over 500m. Good geothermal potential sites either need large 'radiothermal' granites or hot sedimentary aquifers. It is unlikely that there would be any substantial hot aquifers beneath Shetland due to the geology but there are several granite masses which were investigated and could be investigated further in conjunction with a heat load.

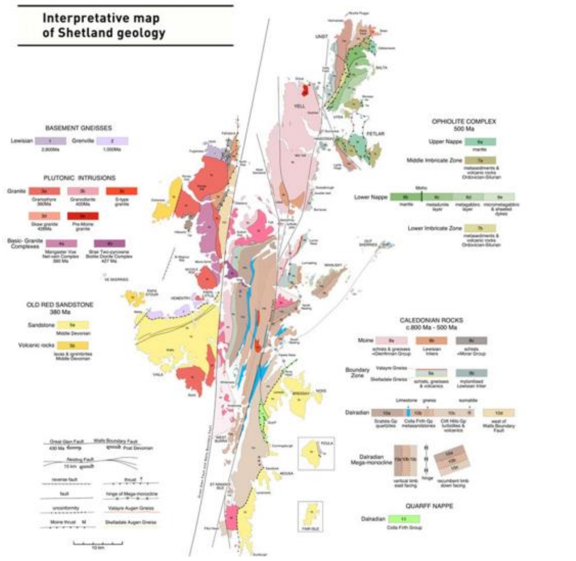


Figure 7 The variety of geology found in Shetland, the red areas relate to igneous rocks

Nuclear

The Scottish Government is currently opposed to the building of new nuclear stations using current technologies.

Existing nuclear is expensive and the construction of new nuclear plants take decades. As Shetland is highly restricted on energy export routes and there are various other alternative options nuclear would appear more suited to sites close to population centres.

Support mechanisms for renewable energy generation - CfD

The UK and Scottish Government along with others have a number of mechanisms to support renewable energy generation and the transition to net zero. Contracts for Difference (CfD) is the UK Government's main mechanism for supporting low-carbon electricity generation. CfDs incentivise investment in renewable energy by providing project developers with protection against volatile wholesale prices. Additionally, they protect consumers from paying increased support costs when electricity prices are high[20]. In February 2022 it was announced that CfD rounds are to become annual to speed up deployment[21]. However, CfD has made it more difficult for smaller community energy projects to find a financeable route to market. Although with rising wholesale energy prices long-term, Power Purchase Agreements (PPAs) are becoming an option in some circumstances[22], where generators enter into a long term agreement with a customer to sell their electricity at a predetermined price.

To further the Hydrogen Economy, the UK Government is in the process of developing the Hydrogen Production Business Model, which is set to act in a similar way to CfD to incentivise investment in hydrogen production[23].

[20] Contracts for Difference - GOV.UK (www.gov.uk)
[21] Government hits accelerator on low-cost renewable power - GOV.UK (www.gov.uk)
[22] Webinar: an introduction to Power Purchase Agreements · Local Energy Scotland
[23] Hydrogen Business Model and Net Zero Hydrogen Fund: Electrolytic Allocation Round 2022 - GOV.UK (www.gov.uk)

Hydrogen and its derivatives

How it works

Hydrogen is an abundant gas that can be used to power vehicles, homes, generate electricity and can be converted into other useful fuels. It doesn't emit CO_2 during use, so can be considered a clean fuel and will be key in the decarbonisation of many sectors.

Hydrogen doesn't occur naturally, so power is required in order to produce pure Hydrogen. There are various different production pathways for making hydrogen, denoted by a colour depending on the method of production.

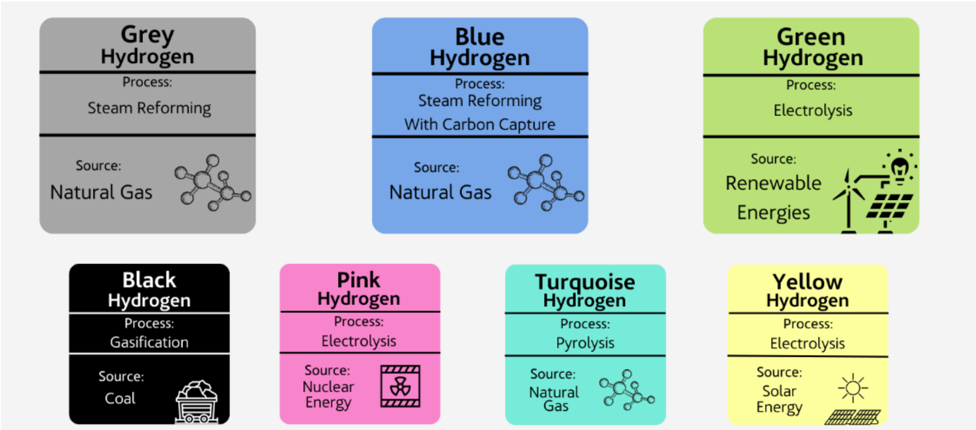


Figure 8 Summary of the hydrogen rainbow[24]

Governance, Policy and Frameworks

The UK currently has no dedicated planning regime for hydrogen, however, the UK Hydrogen Strategy aims to have a regime in place before 2024. Currently, planning permission is based on regimes applicable to the chemical and gas processing industries, as well as power generation and carbon capture and storage[25].

Policy or plan	Ambition or target
• UK Government Hydrogen Strategy[26]	• Deliver 5 GW of hydrogen production capacity by 2030,
• Scottish Government Hydrogen Action Plan[27]	• Ambition of 5 GW of renewable and low-carbon hydrogen production by 2030 and 25 GW by 2045

[24] https://www.acciona.com.au/updates/stories/what-are-the-colours-of-hydrogen-and-what-do-they-mean/?_adin=02021864894

[25] https://www.shlegal.com/docs/default-source/news-insights-documents/2021/hydrogen-projects-regulation-and-consents.pdf?sfvrsn=15c6eb5b_2#:~:text=A%20hydrogen%20project%20that%20is,England%20(onshore%20and%20offshore) .

[26] UK hydrogen strategy (accessible HTML version) - GOV.UK (www.gov.uk)

[27] Introduction - Hydrogen action plan - gov.scot (www.gov.scot)

The UK Hydrogen Strategy and Scottish Hydrogen Action Plan currently has a planned investment of £240 million and £100 million respectively to ramp up hydrogen production to 20 GW, with a 10 GW contribution highlighted in the Scottish Action Plan[28].

The EU's ambition is to have 100 GW of electrolyser capacity by 2030 with Europe currently being the most ambitious continent for hydrogen production, which is based on available and commercially mature technologies. Companies developing electrolysers include NEL, Thyssenkrupp, and ITM, who are developing in the UK[29]. In July 2020, the EU announced their €1 billion Hydrogen Strategy[30].

National hydrogen strategies are also being developed including Germany and France who have invested €7 billion each to enable production, use, and import of hydrogen.

Case Study – Hydrogen Production in Orkney

The Orkney Islands have been home to, and centre of, renewable energy innovation for more than 60 years.

EMEC alongside other local organisations including Community Energy Scotland, Eday Renewable Energy and Orkney Islands Council kickstarted hydrogen activity in Orkney through a project called Surf 'n' Turf. An electrolyser was installed at EMEC's onshore facilities in 2016 near its tidal test site on the northern island of Eday. Funded by the Scottish Government, the project demonstrated how green hydrogen could be generated via electrolysis using tidal and curtailed wind energy and act as an energy storage solution. In 2017, EMEC generated the world's first tidal-powered hydrogen.



Left to right: Fuel cell range extender vans, mobile hydrogen refuelling solution and the hydrogen production site at Caldale on Eday. (Photo credit: EMEC, Colin Keldie)

Ammonia NH_3

What is it?

Ammonia is a colourless gas with a characteristic pungent smell. It is soluble in water and is an essential feedstock in the chemical industry being primarily used in the production of nitrogen based fertilisers.

Ammonia is produced using the Haber-Bosch process developed in the early 20th century. This process uses a metal catalyst under high pressures to react nitrogen and hydrogen to create ammonia. For further information Innovation Outlook Renewable Ammonia (irena.org).

Ammonia production is an energy and emissions intensive global industry. According to the International Energy Agency (IEA) global ammonia production accounts for 2% of total final energy

[28] Hydrogen action plan - gov.scot (www.gov.scot)
[29] https://energypost.eu/green-hydrogen-is-ready-to-scale-this-decade/
[30] https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen/key-actions-eu-hydrogen-strategy_en

consumption. As the majority of the current ammonia produced is from grey or brown hydrogen associated emissions are also significant.

Current situation

According to a report by the IRENA and the Ammonia Energy Association published in May 2022[31]:

Ammonia is one of the seven basic chemicals used to produce all other chemicals and is the second most produced by mass after sulphuric acid. Around four-fifths of all ammonia is used to produce nitrogen fertilisers, such as urea and ammonium nitrate; as such, it supports food production for around half of the global population.

Ammonia also has an emerging market for use as a fuel for transport.

Since ammonia consists of hydrogen and nitrogen it has the advantage and potential of being a CO_2 neutral substance. However, there are still emissions associated with NO_x which represent a significant challenge. Along with the direct use of ammonia, it can also be used as a hydrogen carrier by cracking the molecule to separate the nitrogen and hydrogen molecules.

Methanol CH_3OH

What is it?

Methanol is a colourless water-soluble liquid. It is an important organic feedstock in the chemical industry.

At present nearly all methanol is produced from natural gas ~65% and coal 35%. However chemically identical renewable methanol can be produced by either combining green hydrogen and captured CO_2 from a range of sources or from biomass.

Current Situation

Methanol is one of the key basic chemicals used to produce all other chemicals. Methanol also has an emerging market for direct use as a fuel for transport and heat.

According to a paper produced by IRENA and the Methanol institute published in 2021[32] around 98 million tonnes of methanol is currently produced per year, a figure which has doubled over the past decade. Lifecycle emissions from the production of methanol are responsible for around 10% of the emissions for the chemical industry around 0.3 gigatonnes of CO_2 per annum.

E-methanol is several times more expensive than conventionally synthesised methanol. With production costs directly linked to the cost of the feedstock namely green electricity for the production of hydrogen and the cost of extracting CO_2.

Synthetic Fuels and biofuels

Synthetic fuels also known as e-fuels, are manufactured fuels like the production of methanol discussed above from the combination of hydrogen and carbon dioxide. In addition there are biofuels which are produced from plants or bio-waste, these are discussed further below. Both synthetic and biofuels can be a drop–in replacement for fossil fuels with the same chemical formula.

[31] Innovation Outlook Renewable Ammonia (irena.org)
[32] Innovation Outlook: Renewable Methanol (irena.org)

Bio energy and bio fuels

How it works

Biofuels are produced through various processes from plants and bio-waste.

Examples of the processes include:

Bio refinery

How it works

Bio refineries are processing facilities that convert biomass into value-added products such as biofuels and biochemicals.

Current Situation

Various feed stocks are being investigated locally, including: farming kelp and fallen stock from aquaculture.

Anaerobic digestion is a process in which bacteria breakdown organic matter such as food waste, in the absence of oxygen. As the bacteria consume the organic matter, they give off biogas which rises to the top of the digester. Biogas consists mainly of methane, which can be used for various applications.

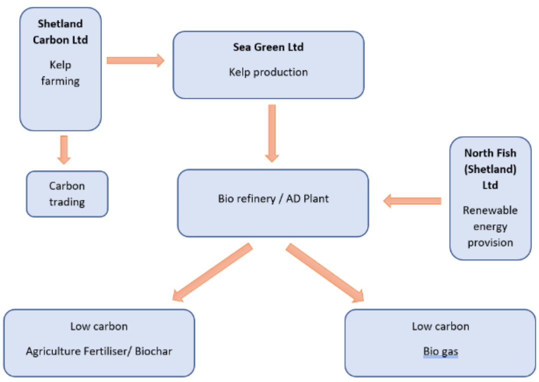
Case Study - Seagreen

North Fish (Shetland) Ltd, have established a new business, Shetland Carbon Ltd to develop opportunities within the kelp/marine regeneration environment using the Sea green branding.

The North Fish proposal is to create an inward investment opportunity with sequestration opportunities for businesses looking to offset their carbon footprint, and in so doing generate the income to develop the concept offshore where a bigger potential exists.

As part of the process, Shetland Carbon is currently evaluating seabed licence opportunities to enable the process to be developed at scale. Competition with existing aquaculture sectors makes inshore opportunities very limited.

North Fish will provide all of the energy demands of the distillation of ground kelp into bioethanol. Distillation requires significant volumes of energy, and North Fish (Shetland) Ltd propose to utilise their own wind generation to provide the energy required with a private wire connection to produce very low process costs



To get the venture started nearshore licences are required to develop both the technology in offshore farming, and also to raise the short term volume of product to allow the development of the bio refinery.

Section 4 – Whole Energy System

Energy Systems

Components of the Electricity Network

Governance.

In Scotland, certain applications in relation to energy infrastructure are made to the Scottish Ministers for determination. These cases are administered by the Energy Consents Unit. In terms of the electricity network these include:

- Applications for the installation of certain overhead electric lines and associated infrastructure;
- Applications for necessary wayleaves to confer rights over land to install electric lines;
- Compulsory purchase orders promoted under the Electricity Act 1989;

Ofgem as the independent energy regular for Great Britain are responsible for approving investments by the Transmission and Distribution Network Operators[33]. Price controls balance the relationship between investment in the network, company returns and the amount that they can charge for operating the networks.

The Council's Planning Department have a role as a consultee on all applications and are the decision making authority for certain overhead lines and associated infrastructure not covered by the Energy Consents Unit.

Transmission Network

How it works

The transmission network transports electricity long distances at high voltages which is 132kV and above in Scotland. This network is responsible for transporting electricity from large generation sources, such as power stations and large wind farms, towards areas of demand, where it supplies the distribution network. Historically, the electricity network was designed with centralised generation and a predictable output, but this is changing, with smaller renewable sources spread out across the country.

National Grid Electricity System Operator (ESO) are responsible for the secure and stable operation of the GB transmission system, while there are four Transmission System Operators (TSO) who are responsible for developing, operating and maintaining the transmission system within their region. The TSO for the North of Scotland is SSEN Transmission.

Governance

The Electricity Networks Commissioner recently published a letter to the Secretary of State for Energy Security and Net Zero with a number of recommendations to accelerate the deployment of strategic electricity transmission infrastructure in Great Britain[34]. This was accompanied by a companion report

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[33] Network price controls 2021-2028 (RIIO-2) | Ofgem

[34] Electricity Networks Commissioner letter to Secretary of State for Energy Security and Net Zero (publishing.service.gov.uk)

produced by the Energy Systems Catapult[35]. These reports provide an analysis of the current process to deliver transmission infrastructure in Great Britain. From this analysis a number of recommendations were made on how the process could be accelerated. Including the development of a Strategic Spatial Energy Plan which will forecast supply and demand characteristics along with their location. This would allow decisions to be made earlier rather than waiting to see which energy sources and demands arise.

Distribution Network

How it works

The distribution network transports electricity to homes and businesses at voltages of 33kV and below. This is supplied by small scale electricity generation connected directly to the distribution network, or from the transmission network via a transformer.

The GB network is separated into 14 different regions, managed by six distribution companies called Distribution Network Operators (DNOs). Scottish and Southern Electricity Networks (SSEN) own and operate the distribution network in Northern Scotland, including Shetland.

Smarter Systems and Digitalisation

How it works

The way in which electricity is generated and consumed is changing, and these changes are necessary in order to reach net zero. A smart electricity grid monitors and manages the electricity network through digitalisation and other advanced technologies. This maximises the efficiency and flexibility of the system, thereby reducing overall infrastructure costs.

Due to the unpredictable nature due to intermittency of many renewable sources, these smart systems are necessary to ensure renewable energy is used to its maximum potential, as well as ensuring the reliability and stability of the electricity grid. This requires investment, and grid operators have already begun modernising their infrastructure.

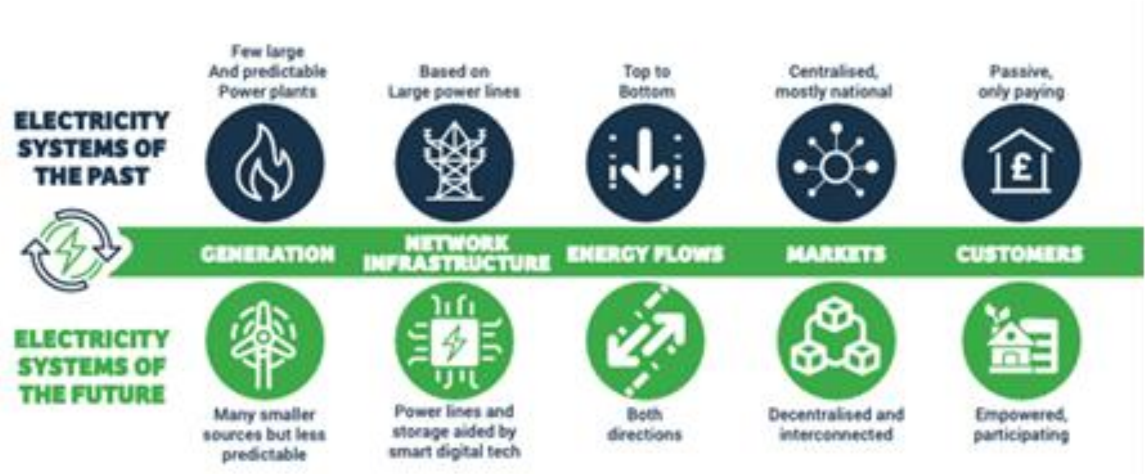


Figure 9 From the electricity banner at the energy showcase - image to be updated once text finalised

[35] esc-production-2021.s3.eu-west-2.amazonaws.com/wp-content/uploads/2023/08/03165030/Electricity-Networks-Commissioner-Companion-Report-by-ESC.pdf

Private Wire Systems

How it works

A ***private wire system*** is a localised electricity grid connected to privately owned generation. Private wire networks can happen on all scales from domestic small wind turbines connected to heating systems, through to offshore wind turbines connected to an industrial scale electrolyser plant.

Private wire agreements essentially allow an energy generator to sell power to neighbouring premises without transmitting through the public network, thus avoiding the need to pay for additional charges from the grid, however they do need to invest in additional infrastructure.

Case Study: Fair Isle and Foula

Fair Isle and Foula are the most isolated islands of Shetland and both require either a 2-3 hour inter-island ferry or a flight for access and supplies. Both islands have developed their own energy companies to manage their own needs, and they are responsible for their own electricity networks. For instance, the Fair Isle Electricity Company manage a system that includes three 60kW wind turbines, a solar array with a capacity of around 50kW and battery storage capable of holding 50 hours of power[36]. The Foula Energy Trust manage their system, which includes solar, hydro, and wind power, and Foula is one of seven off-grid electricity systems in Scotland[37]. These islands are not connected to the Shetland Distribution Network and there are also some micro arrangements with off-grid wind turbines feeding domestic and industrial buildings.

Both islands have unique challenges associated to their location, which includes maintenance and servicing of their energy systems. This is exasperated by rough sea conditions and weather that can make the islands inaccessible at times. This is an issue when replacement parts need to be imported or when specialists need to travel to the islands. Both islands have developed a resilient system utilising multiple sources of energy, including diesel backup to ensure security of supply. In Fair Isle's case, funding for a new ferry is likely to provide more capability to supply the island in the near future.

In the long-term, the realities around Fair Isle and Foula's place in a future energy system will need to be determined. For instance, if a clean hydrogen fuel is likely to be adopted in future for the ferry routes then refuelling infrastructure will need to be developed at both ends of the ferry sailing to the islands. There are also other challenges associated to the limited grid capabilities at these islands when considering electrification or the use of future fuels.

Summary of Future Electricity Scenarios

The future electricity demand has a large range of predicted increases based on a range of variables. Ricardo undertook sensitivity testing as part of the NZRM[38], highlighting that projected changes in electricity use in Shetland were highly sensitive to assumptions about whether industrial, commercial, and agricultural fossil fuel switch to electricity or green hydrogen.

Figure 10 highlights the extra scenarios that were tested and found that grid electricity use would increase by between 6%-73% between 2019 and 2045.

Scenario		
A1	Pathway A	Fossil fuels in Agriculture switch to electricity

[36] https://www.gov.scot/news/powering-fair-isle/
[37] https://localenergy.scot/casestudy/foula-electricity-trust-wind-turbine-upgrade/#:~:text=FET%2C%20a%20volunteer%2Dled%20charity,a%20high%20voltage%20distribution%20grid.
[38] Shetland Islands Net Zero Routemap (NZSR)

A2	Pathway A	Fossil fuels in Agriculture switch to green hydrogen
B1	Pathway B	Fossil fuels in Agriculture switch to electricity
B2	Pathway B	Fossil fuels in Agriculture switch to green hydrogen
B3	Pathway B	No demand reduction, fossil fuels in agriculture switch to electricity
B4	Pathway B	No demand reduction, fossil fuels in agriculture switch to green hydrogen
B5	Pathway B	No heat pumps, fossil fuels in Agriculture switch to electricity
B6	Pathway B	No heat pumps, fossil fuels in Agriculture switch to green hydrogen

This does not include the additional electricity required to produce green hydrogen or for offshore electrification or the balance between the different fuel choices for marine decarbonisation.

What it does highlight is the need to understand the different decarbonisation routes, timelines and volumes of energy required and how these vary geographically. Significant electricity network upgrades will be required to both distribution and transmission networks at significant cost and will take a number of years to implement. At a national scale National Grid ESO produce a range of Future Energy Scenarios based on speed of decarbonisation and level of societal change. Further information on these can be found here[39].

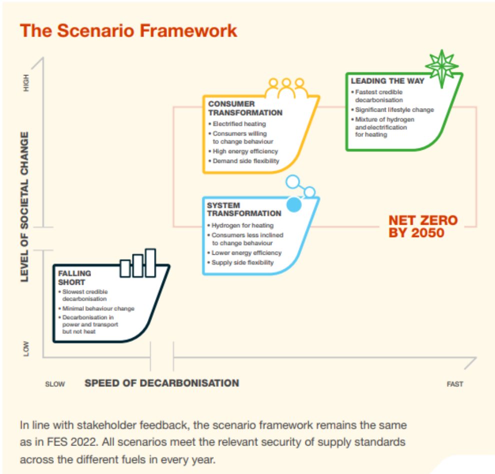


Figure 10 https://www.nationalgrideso.com/document/283056/download

At a more localised level SSEN Distribution have been working with Regen on the North of Scotland

> The DFES process essentially helps SSEN Distribution to understand:
>
> - What technologies will connect/disconnect from their network out to 2050
> - How much installed capacity of each technology will connect, under four future societal and technological scenarios
> - When this capacity could come online and begin supplying/consuming electricity
> - And where across SSEN's licence areas these technologies will likely connect.
>
> SSEN uses the outputs of the DFES modelling to determine the potential impacts on the distribution network, to provide an evidence base to support future network reinforcement and investment, and to identify opportunities for the use of non-network solutions such as storage and flexibility services. For key low carbon technologies, a more detailed, granular, analysis is completed as part of the DFES assessment, producing 'below street level' future scenario projections on the low voltage network, for electric vehicles (EVs), EV chargers, heat pumps, rooftop solar and domestic battery storage.
>
> Direct quote from SSEN Distribution Future Energy Scenarios - Regen

Distribution Future Energy Scenarios (DFES)[40].

The DFES is updated annually and is underpinned by input from local stakeholders. As this information is then used by SSEN to help plan their future projects it is important that we engage. The most recent

[39] Future Energy Scenarios | ESO (nationalgrideso.com)
[40] Distribution Future Energy Scenarios - Regen

report was published in April 2023[41] and contains information specific to Shetland. The level of demand for electricity in the future will help shape what smart systems are required and where they are needed for the electricity grid to reach net zero.

Understanding the future energy scenarios and the different variables will be key to ensuring that we have a clean, secure grid that provides affordable electricity to local consumers.

Energy Storage

How it works

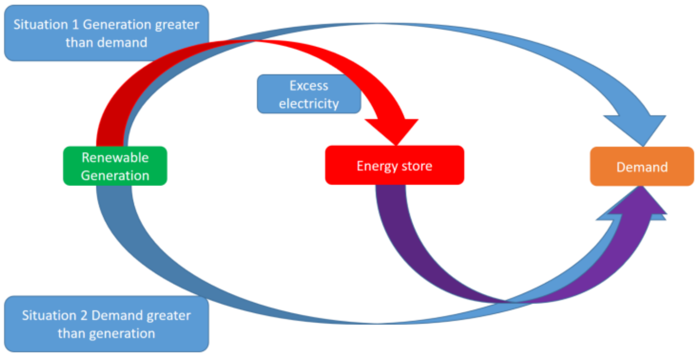


Figure 11 Balancing energy generation, storage and demand - image to be updated to better reflect the situation in Shetland once text confirmed following consultation also needs to complement other figures,

The majority of renewable energy generation is intermittent, and this variability means that matching supply and demand across the network won't be possible with renewable energy alone. Currently, fossil fuel generation plants are used in the electricity network to ensure there is electricity available to match demand at all times. In order to reach a net zero electricity network, a variety of storage technology will be required to ensure that renewable generated electricity is available to customers at all times, and the network retains stability. This storage allows consumption to be separated in time from generation. Storage will also enable a more efficient overall system, reducing the amount of renewable energy generation which required to be curtailed, by storing it at times of low demand for later use.

Current Situation

There is over 4GW of energy storage currently connected to the UK grid, mainly consisting of pumped hydro or battery storage. The various storage options can be categorised into five technology types based on the storage medium:

- electrical (eg supercapacitor)
- mechanical (eg compressed air/pumped hydro)
- low carbon fuel (eg hydrogen)
- electrochemical (eg Lithium Ion battery)
- thermal (eg sand battery)

[41] SSEN DFES 2022 North of Scotland report (regen.co.uk)

Multiple types of storage technology are required, as summarised in figure 12, as they all uniquely cater for different types of energy storage[42][43]. Another important factor for providing storage for grid back up is time taken to initiate. Stored energy that can be accessed instantaneously is more desirable for grid stability and security.

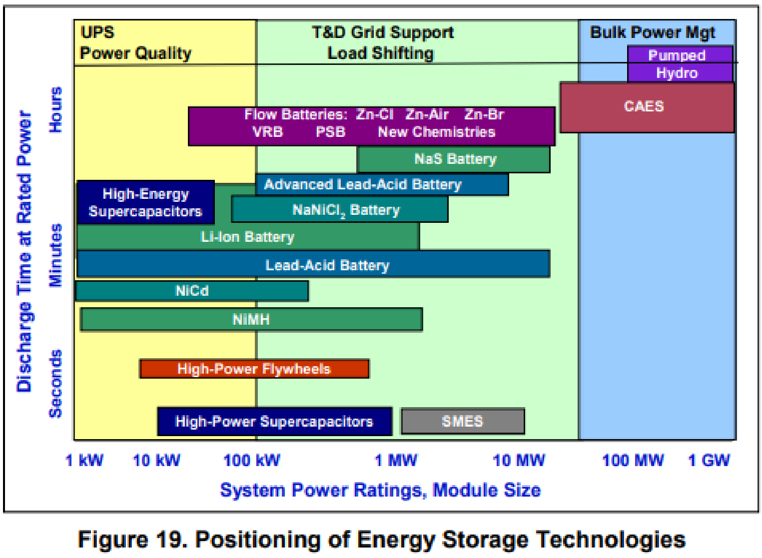


Figure 12 Positioning of energy storage technologies https://www.osti.gov/servlets/purl/1170618 Figure 19 - image to be reviewed once text finalised following consultation process

There is a pipeline of projects of over 20GW of planned storage in the UK, highlighting the huge growth in this area. Battery storage will form the majority of this, but as the requirement to store energy becomes more prevalent, other technologies will become more common, such as hydrogen storage, forming a holistic grid storage system consisting of various technology types and capacities.

Carbon Capture, Utilisation and Storage

How it works

Carbon Capture, Utilisation and Storage (CCUS) is where CO_2, produced from power generation or an industrial process, is captured. The captured CO_2 is then stored, such as in saline aquifers or depleted oil and gas reservoirs, or used, such as in the production of methanol. This is a method of reducing the amount of CO_2 in the atmosphere, and will be required in order to reach net zero to counteract the industries and processes where CO_2 will still be released into the atmosphere. It is a proven process, using technologies that have been used for decades, but will be required to expand rapidly during the transition to net zero.

Governance,

The UK Government's Department for Energy Security & Net Zero (DESNZ) lead government policy on CCUS.

The North Sea Transition Authority (NSTA) are the licensing authority that regulates offshore carbon dioxide storage[44]. This includes pipelines and any other infrastructure required in connection with the development and use of such facilities.

Developers must also obtain the appropriate rights from the Crown Estate Scotland[45].

The UK Government is committed to deploying two industrial CCUS clusters by the mid-2020s, and a further two by 2030. In November 2021, the HyNet Cluster (NW England and N Wales) and East Coast

[42] DOE/EPRI Electricity Storage Handbook in Collaboration with NRECA (osti.gov)
[43] Electricity storage and renewables: Costs and markets to 2030 (irena.org)
[44] Carbon Storage (nstauthority.co.uk)
[45] Carbon capture and storage | Crown Estate Scotland

Cluster (Teesside and Humber) were selected as Track-1 CCUS clusters. The Track-2 clusters were announced in July 2023 as Acorn (NE Scotland) and Viking (Humber). These projects are expected to be the flagship CCS projects in the UK, receiving government support to progress.

District heating

How it works

District heating, also known as a heat network, is a system where heat is generated in a central location and then distributed through a network of pipes to many different buildings. Each property has a heat exchanger or heat pump to take heat from the system for use within the property for space heating and hot water.

Figure 13 District heating pipes at Da Vadil Lerwick, heat supplied by the Energy Recovery Plant, picture from Shetland Heat Energy and Power.

Governance

The Scottish Government have set ambitious target of increasing the amount of heat supplied in Scotland by heat networks to 8% by 2030, the current level for Scotland is 1.5%[46]. In Shetland the Lerwick District Heating Scheme supplies 900 domestic properties and 300 non-domestic properties.

The Scottish Government have also introduced the Heat Networks (Scotland) Act 2021, the act relates to the regulation of the supply thermal energy by a heat network, some elements are yet to be brought into force by the relevant commencement regulations.

Local Authority obligations

- Must carry out a review to consider which areas within its boundaries can be designated heat network zones. Then must comply with a range of requirements in establishing the heat network zone.
- Will have to carry out building assessments on any non-domestic building to assess their capability of connecting to a heat network zone.
- Will be the licencing authority for heat networks within its boundaries.
- Will be the operator of last resort for heat networks within its boundaries.

Electrification for Decarbonisation

Electrification for decarbonisation of oil and gas

Governance,

The North Sea Transition Deal (NSTD), signed by the UK Government and industry in March 2021, supports the North Sea Transition Authority's (NSTA's) approach to cut oil and gas field emissions and set bold targets – down by 10% by 2025, 25% by 2027, and 50% by 2030, against a 2018 baseline.

The electrification of oil and gas assets has been happening in Norway since the 1990s but the UK is yet to power any installations from green power.

[46] Heat networks - Renewable and low carbon energy - gov.scot (www.gov.scot)

In addition, the UK Government has announced that, in a bid to both back the North Sea O&G industry and to make Britain more energy independent, hundreds of new oil and gas exploration licenses will be granted[47]. As 40% of the UKs remaining O&G reserves are located to the West of Shetland, this would suggest that there will be further requirements for electrification from shore if exploration leads to further field developments.

In addition to O&G any clean fuel development at Scatsta and Sullom Voe could require significant amounts of electricity and the NE1 offshore wind sites will require a route to market for their energy. This could be via Shetland.

Case Study - Shetland Heat Energy & Power (SHE&P)

The history and decisions

In 1991 Shetland Islands Council and the Orkney Islands Council were faced with the problem that their existing incinerators were going to be closed down because they did not meet the impending European Union (EU) legislations. This was a massive issue because of the increased need to landfill waste.

The Council looked to other countries and technical studies were undertaken to understand the different options available and the quantities of waste required. From these studies and visits to successful plants, the Council established that waste incineration was a better option than sending each of the different waste streams to landfill. However, there was insufficient waste available in Shetland for the system to work. It would be possible to import waste from Orkney and elsewhere off island to meet the required amounts to make a waste-to-heat plant the most efficient option. Electricity generation from waste was considered but wasn't cost effective for the size of plant proposed.

Following a rigorous business analysis of the waste to heat technology, a decision was taken to build an Energy Recovery Plant and use the energy produced for a district heating scheme in Lerwick.

It was also decided that the most appropriate ownership model would be for the district heating scheme to be owned by SHE&P, which is itself owned by the Shetland Charitable Trust. The Council, would have ownership of and responsibility for the Lerwick Energy Recovery Plant. This is a similar ownership model to district heating schemes in Denmark. To ensure maximum benefits to the customers, the companies which own and operate district heating schemes are not permitted to retain profits.

Other considerations explored included the extent of SHE&P's responsibility. It was decided that SHE&P's responsibility would end at the valves just inside properties, and that the customer had to use an approved plumber to complete the installation inside their own property. As the heat meters were supplied by SHE&P, plumbers had to visit SHE&P regularly enabling good information exchanges to develop and problems to be discussed.

The Scottish Government suggest a 1GW electrolyser will produce around 92,000 tonnes of hydrogen per annum. However, this will depend on how electrolyser technology is developed along with the types of electrolysers that are used. The most advanced are PEM (Polymer Electrolyte Membrane) and Alkaline Water electrolysers. However, there are other electrolyser technologies being developed,

[47] Hundreds of new North Sea oil and gas licences to boost British energy independence and grow the economy - GOV.UK (www.gov.uk)

such as Solid Oxide and Supercritical Electrolysers, which could produce hydrogen more efficiently once the technology is developed further to make it scalable. It may be possible to also improve efficiency through the development of desalination technology associated to hydrogen production, however, this technology is already relatively advanced.

Power 2 X

The term covers a wide range of pathways and technologies and is widely used to summarise the conversion of power into a range of other sectors. The X in the terminology can refer to hydrogen, ammonia, methanol, mobility etc. As there will be times when renewable generation exceeds demand, converting the electricity into 'X' will reduce curtailment and increase overall system efficiency.

Power 2 X is of particular interest as we have an enormous renewable energy generation potential but as our electricity demand is limited, it is necessary to consider what forms of energy will be required in Shetland. Particularly for our more difficult to decarbonise sectors such as marine and aviation, where synthetic fuels may be a suitable substitute. It is also necessary to look at the wider energy markets to understand the global trends.

Hydrogen Vision

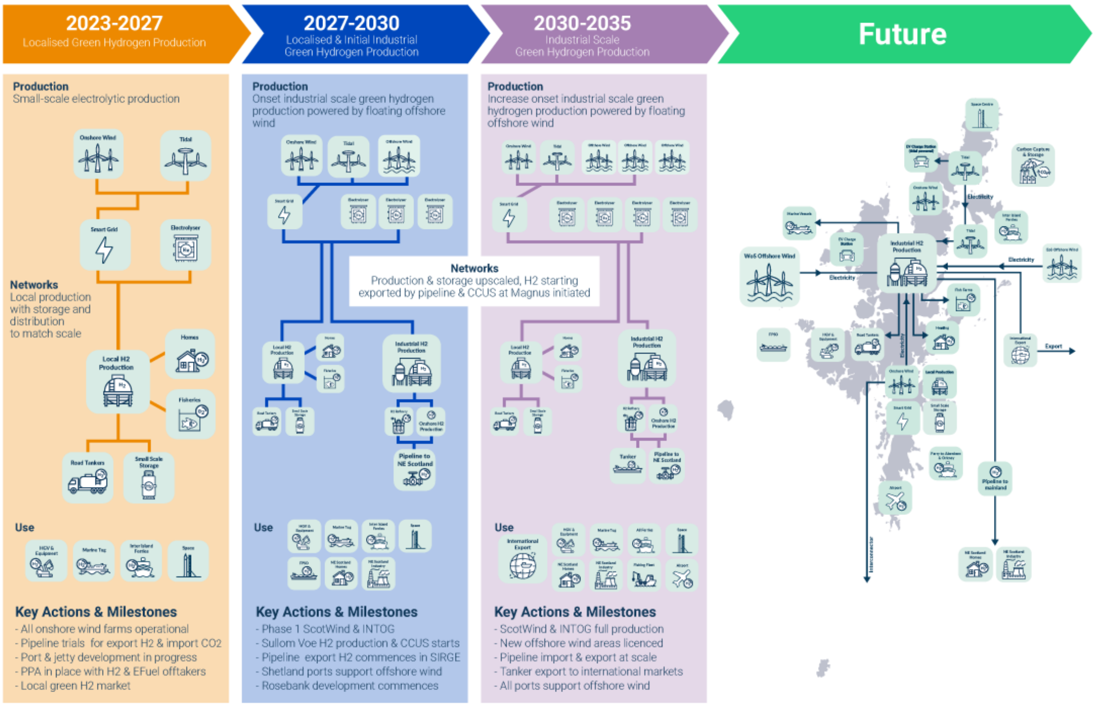


Figure 14 Hydrogen economy road map for Shetland

Hydrogen Storage and Distribution

Experience is lacking in the storage and distribution of green hydrogen. Currently, most hydrogen is grey hydrogen where production is co-located with demand[48] in the oil and gas industry and for producing fertilisers, which represents the current 10-27 TWh of hydrogen produced in the UK[49].

The challenge is that hydrogen has an extremely low density under ambient conditions. To improve the energy density of hydrogen it needs to be:

- transported at high pressure or low temperature,
- converted to another product such as ammonia or methanol, or
- Alternative methods such as a metal hydride or a Liquid Organic Hydrogen Carrier (LOHC).

Consideration must also be given to how the hydrogen will be used. As the most appropriate transport method will link into its end use, the volume and purity required.

The Council have been and are involved in various studies to explore transportation technologies for hydrogen, including LOHC, ammonia, and methanol and the potential of developing a national hydrogen pipeline connecting Scotland to Europe[50].

By products and co-benefits

In order to maximise the return on investment and maximise efficiency, it will be necessary to consider the whole system and seek to use by-products such as surplus heat and oxygen along with making full use of the brine from the desalination of sea water prior to safe disposal.

As highlighted at the start of the section there are a number of factors required for the selection of a suitable site. Some of these are described below.

Oxygen

For each tonne of hydrogen produced, there will be 8 tonnes of oxygen.

There are number of local applications for oxygen. The aquaculture industry in Shetland currently uses significant quantities of oxygen for its operations. By working with local hydrogen producers, they may be able to reduce costs by having a close by source. The future growth from the Shetland Space Innovation Campus could be another use for this by-product.

Water and desalination

Purified water is a key limiting factor for hydrogen production. Due to the volumes of water required sea water is the most likely option for a water source. There are various options and processes under consideration and these must be considered as part of the whole system. As there are opportunities and challenges which require further investigation, with various studies already undertaken. Including a recent report by Ramboll for SGN to undertake a technical assessment and feasibility study into water requirements for hydrogen production[51].

Surplus Heat

A study undertaken by Ramboll highlighted that the system efficiency of electrolyser plants can increase by 14%-32% by recovering waste heat[52]. The surplus heat from electrolysis and compressors can be used in district heating systems and is currently being examined in Denmark.

Ports and Harbours

Lerwick Port & Harbour

Lerwick Port Authority operate the port, including quaysides, at Lerwick and Dales Voe, including Greenhead Base which has Peterson as logistics operator. The sheltered, deep-water port is open to shipping in all weathers and operates around the clock[53].

Lerwick supports a wide range of industries including energy, sailing, fishing, cruise, and ferries. Further information can be found on the Lerwick Port Authority website[54]

There is 1MW of shore power available at Mairs Pier, with six connections used primarily for the pelagic fishing fleet. Plans have recently been announced to create a shore power connection for the

[51] Technical assessment and feasibility study into water requirements for hydrogen production | ENA Innovation Portal (energynetworks.org)
[52] Rambøll UK Study – Heat Recovery From Hydrogen Production (fuelcellsworks.com)
[53] Lerwick Port Authority | Lerwick Harbour is the principal commercial port for Shetland and a key component in the islands' economy. (lerwick-harbour.co.uk)
[54] Lerwick Port Authority | Lerwick Harbour is the principal commercial port for Shetland and a key component in the islands' economy. (lerwick-harbour.co.uk)

Northlink Ferries, showing that the Port Authority is already making advancements to transition its port activity.

Dales Voe

Dales Voe includes a decommissioning base for offshore platforms. This has recently undergone a quayside extension along with the installation of a decommissioning pad.

A project to build an Ultra Deep Water Quay[55] to complement existing facilities is progressing. The ambition is for 24m water depths with 25t/m^2 deck loading and an additional 65,000m^2 laydown. The Ultra Deep Water Quay project has been identified by the Scottish Government as the preferred location for development of an Ultra Deep Water Quay for the UK. This could facilitate large scale offshore wind structures along with enhancing their decommissioning services. The wet storage anchorages could also facilitate floating offshore wind structures.

Port of Sullom Voe

The Port of Sullom Voe (PoSV), operated by the Council, serves the nearby Sullom Voe Terminal. The servicing vessels are based at Sella Ness operate with 24/365 operation. The Port sees an average of 80 oil tanker movements per year. There are four jetties which have primarily been used for crude oil export since the 1970s.

As terminal operations have decreased, the use of the jetties have decreased. However, there is an opportunity to repurpose some of the jetties for clean fuel export, as well as CO_2 import, in line with the creation of a clean energy hub in the area.

Scalloway

The port of Scalloway is operated by the Council and supports the fishing and aquaculture industry, with a new fish market opened in 2020, the building benefits from a high speed fibre connection to Shetland Seafood Auctions[56] providing ready access to the online marketplace for buyers and sellers. Scalloway receives whitefish trawlers, which are likely to require a future fuel[57]. As one of the three largest ports in Shetland, this could become a centre for bunkering, especially for vessels largely based on the west side of Shetland.

The quay length is 373m in total and the depth is around 6.5m to 7m, with bunkering is available for large vessels, along with potable water and shore power. Laydown space is limited but there are small ship repair yards available.

Cullivoe

Cullivoe, on the island of Yell, acts as a major fishing and aquaculture port, operated by the Council. The onshore infrastructure for Nova Innovation's tidal array is based at Cullivoe pier, including cable landings and the world's first tidal powered EV charger.

North Yell Development Council have recently expanded the Industrial Estate at the pier and opened the new North Yell Marina in May 22.

[55] Ultra-deep water port location revealed - gov.scot (www.gov.scot)
[56] https://www.shetlandauction.com/
[57] https://www.orioncleanenergy.com/about/projects-and-studies/neptune-project

Small ports and marinas

In addition to the larger ports, Shetland also benefits from a network of small ports and marinas. These are owned and managed by the Council, community groups and local industry and have a wide range of functions. These include but are not limited to ferry terminals, inshore fisheries, aquaculture, marine tourism and pleasure.

Section 5 – Environmental protection

Background

Social

By protecting our natural environment we will promote fauna and flora diversity and help to improve the resilience of our land, soils and infrastructure against risks such as flooding and landslides. The natural environment benefits our own health and wellbeing.

Economic

Our economic sectors are dependent on transitioning towards a sustainable natural environment. Without the resources provided by nature, these sectors would not provide the incomes necessary to maintain our population in Shetland. Future developments must co-exist with established industries and minimise the impact on the natural resources.

Environmental

Promoting the use and care of our grasslands and heather covered hills as carbon sequestering habitats, as well as areas for grazing, will allow more carbon to be absorbed and reduce carbon emissions from those peatlands made available for restoration. Similarly, our marine environment is a highly important heat and carbon sink which we need to understand further.

According to Science Based Targets Network[58], **“**There is no net zero without meaningful action on nature”

> *There is now clear scientific evidence that achieving* ***net zero is not possible without the direct involvement*** *of our natural world… Nature is the backbone of human well-being and the foundation for all economic activity. The interplay between nature and climate requires collective, joined-up action to stabilize the climate, preserve freshwater resources, regenerate land, secure a healthy ocean and* ***protect biodiversity****. This must be done in line with scientifically defined limits and on a socially equitable basis.*

Case Study – SOTEAG

Shetland has a history of comprehensive environmental monitoring programmes. The Shetland Oil Terminal Environmental Advisory Group (SOTEAG) a world leading model being an example for replication across other projects. SOTEAG[59] was established in 1977, building on the Sullom Voe

[58] Taken from the Science Based Targets Network webpage found at: https://sciencebasedtargetsnetwork.org/how-it-works/the-first-science-based-targets-for-nature/

Environmental Advisory Group (SVEAG). Since 1974, the Sullom Voe Terminal has been the focus on one of the most intensive monitoring programmes of any industrial installation in the UK.

The reviewed area encompasses the zone that the Council is responsible for, including:

Tanker trading to Sullom Voe

Ship-to-ship transfer

West of Shetland activities.

One of the most important functions of SOTEAG is to provide early warning of environmental change and, if appropriate, to advise on remedial action, which if neglected or unheeded, could lead to unacceptable environmental consequences. This is achieved via the Monitoring Committee, compiled of independent scientific experts, who on an annual basis evaluate and analyse, environmental monitoring reports. This ensures that the health of the marine and coastal environment around the terminal is constantly maintained. Monitoring reports can be found here[60]

Shetland Regional Marine Plan case study

The draft Shetland Islands Regional Marine Plan (SIRMP) is currently sitting with the Scottish Ministers for adoption. Has been developed to manage the marine environment in Shetland in a sustainable way to have clean, healthy, safe, productive and diverse seas, managed to meet the long-term needs of nature and the people.

The SIRMP is a policy and data framework which aims to provide clear guidance and evidence to support a wide range of marine decisions throughout Shetland. The SIRMP was created by the Shetland Marine Planning Partnership (Shetland UHI and Shetland Islands Council) with the support of an Advisory Group[61].

The Marine Spatial Planning Team have led the development of marine spatial planning in Shetland using scientific data to underpin its policies, recognising the equal value of economic, environmental, and social factors in maintaining a healthy marine environment.

[61] Marine Spatial Planning - Shetland Islands Regional Marine Plan (uhi.ac.uk)

Section 6 - Changing energy Use and Reducing Emissions

Emissions from oil and gas were excluded from the Shetland NZRM because, even though they are located within the area boundary, the fuels are exported, and therefore classified as Scope 1 emissions for end users outside Shetland[62]. Figure 15 below tries to put emissions from Sullom Voe Terminal (SVT) and the Shetland Gas Plant (SGP) into context.

In addition, the UK Continental Shelf's (UKCS) emission intensity for producing a barrel of oil is 20.81 kgCO2e/boe[63]. In terms of Shetland's midstream oil operations, Sullom Voe Oil Terminal emitted 29,794 tCO2e of Scope 1 emissions and 72,003 tCO2e of Scope 2 emissions[64]. SVT's Extraction Intensity ratio is more than twice as large as the UKCS average at 45.01 kgCO2e/boe, which is due to the relative maturity of SVT's oil fields. Based on the assumption that 0.43 tCO2e is emitted per barrel of oil[65], upstream oil extraction in the UK accounts for roughly 5% of the total emissions resulting from the oil on average.

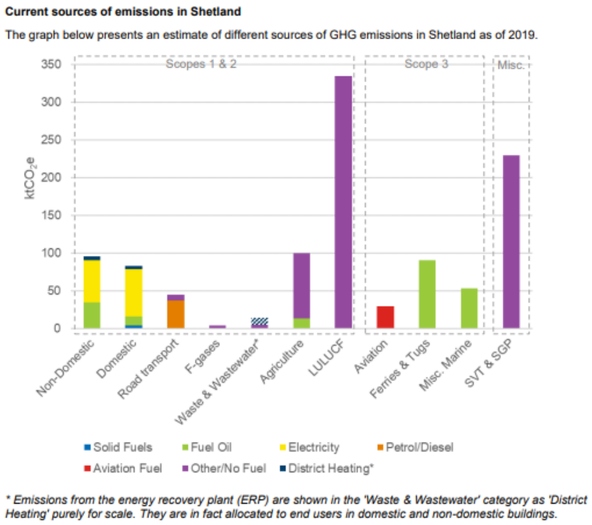


Figure 15 Figure 2 from the Shetland Net Zero Route Map https://www.shetland.gov.uk/downloads/file/6460/shetland-net-zero-route-map

Insulation

How it works

Insulation aims to trap heat within a home, restrict external moisture and when installed correctly allow for ventilation.

Figure 16 Banner from the energy Showcase Oct 22

Types of insulation

- Loft
- Internal wall
- External wall
- Underfloor

Storage Heaters

How they work

[62] Shetland Islands Net Zero Routemap (NZSR)
[63] https://oeuk.org.uk/wp-content/uploads/woocommerce_uploads/2022/10/OEUKs-Emissions-Report-2022-d3g68p.pdf
[64] https://www.enquest.com/environmental-social-and-governance/environmental/environmental-reporting
[65] https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Storage Heaters are one of the most common heating systems found in Shetland. They store off-peak electricity as heat. Heating elements, heat ceramic bricks at set times, this heat is then released slowly.

There are various types of storage heater available. Modern storage heaters are insulated to allow them to hold their heat for longer and have programmable timers, fans and thermostats making them more controllable than older style storage heaters.

Heat Pumps

How they work

A heat pump captures heat from outside and moves it inside. The heat pump uses electricity to do this, however the quantity of heat moved is greater than the amount of electricity required to power the system[66] see footnote[67] for further information.

Figure 17 Air source heat pump external unit

There are 4 types of heat pump: air, exhaust air, ground, and water.

There are also hybrid options available which combine a heat pump with another heating system. For further information see the Energy Saving Trust website[68].

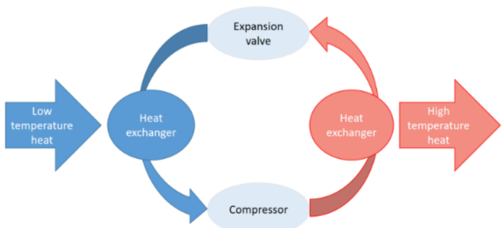


Figure 18 How a heat pump works - images to be updated

Heat Pumps are versatile and can be used for a single property or for district heating, either as a heat source for the network or each individual property can have their own heat pump connected to an ambient loop.

SHE&P has investigated the potential of using heat pumps in the sea in Lerwick as a potential heat source to expand the Lerwick District Heating Scheme. The project wasn't progressed but could be an option in the future[69].

[66] https://energysavingtrust.org.uk/advice/in-depth-guide-to-heat-pumps/
[67] A coefficient of performance (COP) of 3, means 1kW of electricity produces the equivalent of 3kW of heat. All heat pumps have a published datasheet with a measured COP at a specific time, under test conditions. However, in real life temperatures vary, a heat pump installer will calculate the seasonal coefficient of performance SCOP, based on their system design for your property. This will provide a more realistic estimate of the annual running costs.
[68] In-depth guide to heat pumps - Energy Saving Trust
[69] Taking the heat out of the sea | Shetland News (shetnews.co.uk)

Wind to Heat

How it works

Figure 19 Evance turbine at Bridge End Hall

Energy from a wind turbine is stored as heat, either as hot water, storage heaters or a thermal battery. The system can work on a range of scales from micro schemes such as those used in community buildings through to large scale wind turbines with large thermal storage tanks.

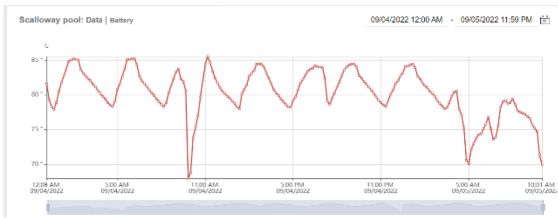
The projects can maximise energy generation from a curtailed grid connection.

Biomass

How it works

Biomass pellets, chips or logs are burnt in a boiler. Biomass heating works on a range of scales from individual buildings through to a heat source for district heating.

Case study - Scalloway District Heating scheme



Scalloway district heating network was developed in 2016, with an annual heating demand of 1,000,000 kWh.

The heat source is 2 * 250 kW Froling biomass boilers, using locally produced, dried wood chip for energy.

Fuel is stored within the integral silo with 100m^3 capacity

Each individual heating demand is monitored remotely with its own online resource, which provides both back up history on performance, but also notifies engineers of faults and maintenance requirements.

The Scalloway District heating scheme project currently supplies energy to the following public buildings: Scalloway Primary School, Scalloway pool, Health centre, Nursery and Games hall

The development cost for the entire project was £500,000 and was funded by

- Developer own resources
- Scottish district heating fund
- RHI support

Key points

- Back up energy is provided by existing oil fired boilers.
- Carbon savings are in the order of 260 tonnes per year.
- Fuel is manufactured locally in Lerwick.
- All maintenance and servicing is carried out by local HETAS certified engineers.

Hydrogen for heat

How it works

Hydrogen can be either used directly in a boiler to produce heat in a similar way to gas or LPG or the surplus heat produced through the electrolysis process can be captured for use either directly or within a district heating system.

Case Study - Malakoff Electric Boat Project

Malakoff Ltd, is a Shetland engineering business specialising in the marine sector with a long history going back over 100 years. Providing innovative solutions over the past century, the business is taking on a new challenge: an electrified fit- for- purpose catamaran boat.

The project is entirely designed, developed, planned, and fabricated in-house. In addition to the significant internal investment by the company itself, the project is part funded by the Department for Transport.

Malakoff has three reasons for taking on this type of project:

- need to decarbonise their own fleet of vessels
- opportunity to develop a new vessel that could be a marketable product
- need to gain skills in working with electric boats so that they can continue to provide relevant maintenance services to vessels operating in Shetland.

Though still in the fabrication stage of development, one of the biggest challenges has been procurement issues in the market due to world events including Brexit, Covid, and the war in Ukraine. Once launched the vessel will be sea trialled to prove endurance and gain certification.

While electrification is one solution to decarbonisation, electric boats is not be the full solution for decarbonising the entirety of the marine fleet in Shetland. At the moment the technology is more suited for smaller vessels that have shorter duty cycles. Adopting hybrid type arrangements to de-risk the application of new technologies such as hydrogen fuels should be a consideration for those boats that cannot be electrified.

What are the next steps to make electric boats a part of our future?

"We believe we need more demonstrator type projects. The launch of our electric vessel will inform what we try next, but it will definitely need a phased approach for demonstrator vessels and then adopters. We would be looking for a collaborative approach towards achieving this."

Ryan Stevenson, Welding Engineer & Contracts Manager, Malakoff Limited

Figure 20 Photos are to be updated for the final draft

Lifestyle

What happens to products once their use is over should be a key consideration for all of us. For example, the raw materials for electronics are precious minerals and metals, so there is a finite amount in the world. Recycling and repurposing as much of the energy and e-waste that Shetland and the UK has will be a way to reduce the amount of extraction needed. This also ties into the Just Transition principles by incorporating the global context and not exploiting the most vulnerable in countries beyond our own.

When considering replacing an appliance, the lifetime emissions of a technology should be considered before replacing a working technology with an updated version. There is a question around the benefits of replacing an already working appliance or vehicle with something that is more 'energy efficient' when there is a still working life left in that original machine. The emphasis should be on replacing technologies at the end of their life with something that is more sustainable and energy efficient.

There is also the financial consideration of adopting new technology such as energy efficient appliances. Technology that is out of the price range of the consumers will not have uptake. With the cost of living on the rise, there will be little extra cash for households to purchase a more expensive technology unless there is messaging around the life-time savings, financial support, and/or different ownership models to help influence consumer choice towards the more efficient technologies.

Advancing technology

What happens to products once their use is over should be a key consideration for all of us. For example, the raw materials for electronics are precious minerals and metals, so there is a finite amount in the world. Recycling and repurposing as much of the energy and e-waste that Shetland and the UK has will be a way to reduce the amount of extraction needed. This also ties into the Just Transition principles by incorporating the global context and not exploiting the most vulnerable in countries beyond our own.

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The use of smart meters

Smart meters are the responsibility of the electricity suppliers and Shetland has the lowest uptake of Smart meters, at only 7% compared to the national rollout reaching 55% of properties and 43% in Scotland[70]. The Government is aiming for 80% of homes to have a smart meter by the end of 2025. Obstacles to smart meter roll out include:

- Unknown smart meter compatibility with existing tariffs and system set-ups such as the Economy and Heating load tariff,
- delays in meter installation,
- signal coverage, and,
- The related challenge of the Radio tele-switch switch off.

Smart meters will enable customers to have a better understanding of their energy use, access smart electricity tariffs and provide a mechanism for customers to make changes to their energy use patterns in return for lower energy costs. However, they can also exacerbate mental health problems if people are concerned about their energy use.

As the transition is being delivered by energy suppliers we need to ensure customers are no worse off. In addition, as the transition is complex and there are a number of unknowns we need to engage in further discussions with energy suppliers to understand how we can accelerate the deployment of smart meters in Shetland and ensure no one is left behind.

Section 7 - Economic Opportunity

Land and seabed rents

The detailed value of rental payments for Onshore Wind projects varies from project to project but are typically £5,000 per installed megawatt per annum. That is around 2.5% of projected wholesale generation value, assuming an electricity price of c£40 per MWh[71] based on the last CfD pricing round and pre-price hike wholesale electricity prices.

The Crown Estate Scotland Annual Report 2021-22 estimate payments of around £4m per GW pa from offshore wind projects once operating[72]. These figures are to be updated as ScotWind projects progress and there is further detail on technology and final design.

In addition to rental payments, the ScotWind auction round has introduced the concept of option payments for time-bound exclusivity to develop an area of sea. In March 2021 Crown Estate Scotland conducted a review of the option fee structure and as a result, increased fees with the option fee cap increasing ten-fold. The first 17 sites secured options payments of £700m for public spending[73], with NE1 securing a further £56m[74].

Case Study – Oil and Gas Supply Chain Development

Shetland's oil and gas experience was mixed:

- Most **upstream** opportunities bypassed the islands being serviced from mainland UK or international sources although some forward staging for project activity and supply services were run out of Lerwick Harbour.
- Significant **midstream** activity was achieved through SVT and the Port of Sullom Voe from the Brent, Ninian and Clair pipelines and production processed at Shetland Gas Plant. However, considerable volumes bypassed Shetland, either via offshore loaded or exported through other pipeline systems to the UK mainland.
- No **downstream** activity developed in Shetland as all products which were landed were then exported near to their raw state for refining and use elsewhere.

Case Study - ScotWind – Supply Chain Development Statement (SCDS) Outlook

Crown Estate Scotland are encouraging early engagement with the local supply chain to maximise the benefits locally through the development of supply chain development statements.

All ScotWind applicants were required to submit a Supply Chain Development Statement (SCDS) Outlook outlining the nature and location of supply chain activity across the four different stages of their project, which have been published by Crown Estate Scotland. They are designed to promote and enable the sharing of information about the way supply chain capability can be developed and to establish a contractual commitment to deliver the finalised SCDS . The three initial outlooks for the NE1 site can be found at the links below for site 18 , 19 and 20 . Crown Estate Scotland estimate that ScotWind will lead to an average of £1.5bn per project investment in the Scottish supply chain. The supply chain statements provide a summary of the commitment and the ambition for each project split across Scottish Expenditure, UK Expenditure, EU Expenditure and Elsewhere, split across

[71] contracts-for-difference-allocation-round-4-results.pdf (publishing.service.gov.uk)
[72] ces-ar-22.pdf (crownestatescotland.com)
[73] ces-ar-22.pdf (crownestatescotland.com)
[74] Three Shetland ScotWind projects announced - News - Crown Estate Scotland

the four stages of development from Development, Manufacturing & Fabrication, Installation and Operations.

As an example the Mainstream Renewable Power and Ocean Winds consortium plan for the project to deliver tangible local benefits by using an Operations and Maintenance (O&M) concept based on UK flagged vessels operating from O&M bases in Shetland .

Case study – Garth Wind Farm

North Yell Development Council

Enterprise - Initiative - Self-Help

The 4.5MW Garth Wind Farm is operated by the North Yell Development Council (NYDC) – a charity dedicated to community development in their area. Their motto 'Enterprise, Initiative and Self Help' fits the project's aspirations well.

After a lengthy lead in phase work began on site in late 2016. Local company EMN Plant Ltd was the contractor for the roads, turbine bases and the electrical cables. The project encountered some early issues which delayed getting on site. However the contractor was able to accelerate the programme of works through the winter of 2016-17 to ensure the turbines could still be erected and commissioned by the 8th March 2017, ahead of the Feed in Tariff deadline. The total construction cost of the windfarm was £8.3m. Now that the wind farm is operational, NYDC manage the farm's operation and finances.

The benefits of the Garth Wind Farm to the community are two-fold:

1. five 900kW wind turbines generate clean electricity for the local grid,
2. profit created is invested back into the local community via NYDC.

These funds have allowed NYDC to employ a Development Manager who is available to assist groups, businesses and individuals within the community. NYDC also have small scale community grants and donations available to local facilities, groups and charities, and provided COVID response packages to community members during the pandemic. The group have recently completed a community consultation to update their development plan for North Yell.

As of March 2022 the Garth Wind Farm had produced 67,341,700 kWh of electricity since it was commissioned.

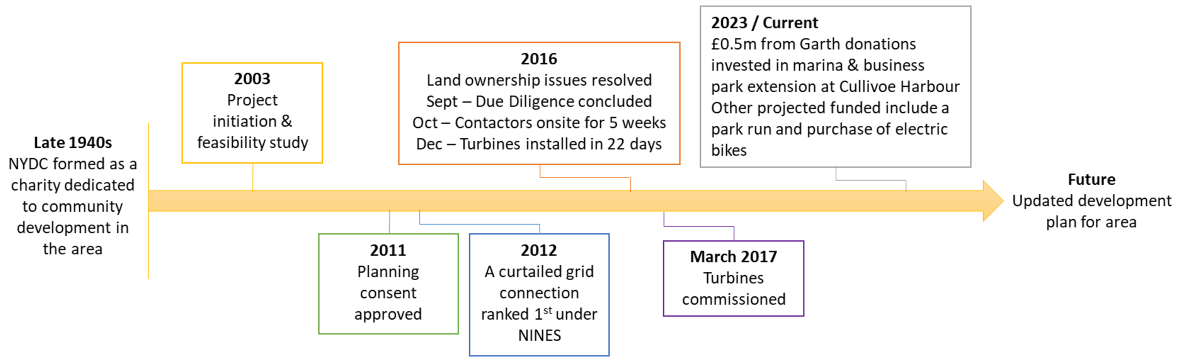


Figure 21 Garth wind farm timeline

Lessons learnt

- Anticipate delays for issues such as obtaining permissions, grid access etc.
- Check landownership early
- Look for local input for maintenance and support service once windfarm commissioned


Figure 22 NYDC team and Garth Wind Farm (Images sourced from NYDC website)

Section 8 - Affordable energy

What is fuel poverty?

The Scottish Government use a two part definition to define fuel poverty[75].

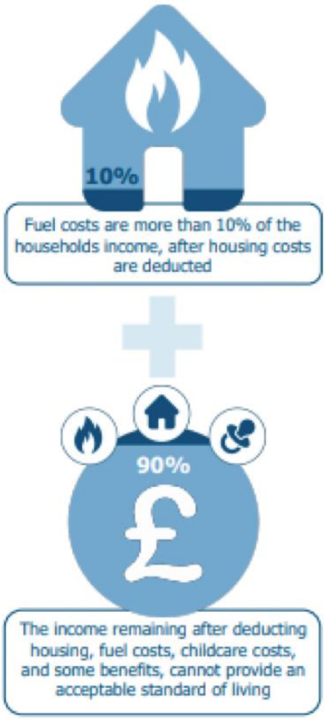


Figure 23 Scottish Government 2 part definition of fuel poverty https://www.gov.scot/publications/tackling-fuel-poverty-scotland-strategic-approach/pages/4/

A household is defined as being in fuel poverty if, in order to maintain a satisfactory heating regime, total fuel costs necessary for the home are more than 10% of the household's adjusted net income (i.e. after housing costs), and if after deducting those fuel costs, benefits received for a care need or disability and childcare costs, the household's remaining adjusted net income is insufficient to maintain an acceptable standard of living. The remaining adjusted net income must be at least 90% of the UK Minimum Income Standard to be considered an acceptable standard of living with an additional amount added for households in remote rural, remote small town and island areas. If more than 20% of net income is needed, the household is defined as being in extreme fuel poverty.

The simple definition of fuel poverty is: a household is defined as being in fuel poverty if they spend more than 10% of their income on energy to heat their home. Extreme fuel poverty is when this figure is above 20%.

Fuel poverty in Shetland

The current figure for household in Shetland that are in fuel poverty is 30.9% from 2019 figures, with 21.7% in extreme fuel poverty[76]. However, the cost of energy has increased significantly since these figures were collected in 2019. The Council estimates fuel poverty could be as high as 66% with extreme fuel poverty around 33% of households in Shetland. This figure is based on the average energy consumption, average energy prices and household income based on CACI paycheck data for 2021.

What is Affordable Energy?

Securing access to affordable clean energy is a key commitment in the Shetland Islands Councils Corporate Plan 2021-26 "Our Ambition"

[75] Tackling fuel poverty in Scotland: a strategic approach - gov.scot (www.gov.scot)
[76] https://www.gov.scot/collections/scottish-house-condition-survey/

"We will campaign to ensure that regulations and arrangements allow Shetland-generated green energy to be made available to Shetland consumers and businesses at affordable prices to close the current energy affordability gap.

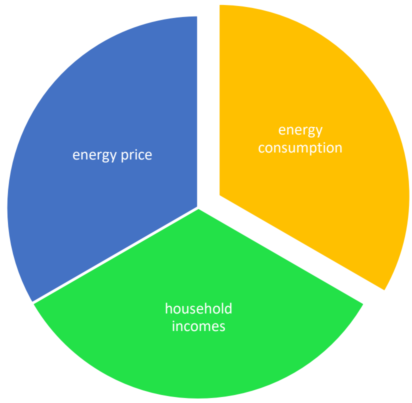
Developing new and innovative arrangements where renewable energy generated in the islands, in particular electricity, could be consumed locally at affordable prices could transform the fuel poverty levels in the islands.

We believe that could create a solution with significant economic, commercial and social benefits for communities, business and government and provide a much-needed growth stimulus for the islands at a very concerning transition point for the oil and gas industry."

Energy transition provides an opportunity to produce our own fuels locally. While the energy will still be subject to global energy markets, there should be a reduction in cost as it will not be necessary to import energy.

Factors driving Affordable Energy

1. **Energy consumption**



Annual household energy consumption has been estimated as being around 21,071kWh in Shetland (Shetland Household Energy Review 2021) as compared to the c14,200kWh (Reduced from 14,900kWh) used for the UK price cap analysis (OFGEM UK Price Cap). This is backed up by the UK Governments regional and local authority electricity consumption statistics which state the GB mean domestic electricity consumption[77] (kWh per household) is 3,709kWh compared to 9,011kWh for Shetland, the highest of any Local Authority area.

The high use of energy due to our climate (greater wind chill, lower average temperature and darker in winter), our housing density (more detached properties and fewer flats) and the very mixed quality of Shetland housing (draughty and poorly insulated houses). Shetland is one of the worst performing local authority areas for the performance of domestic properties. In the Scottish House condition survey Local Authority tables 2017-2019 Shetland had one of the highest proportions of low performing buildings and the lowest proportion of high performing buildings[78]. That projects Shetland at 141% of the UK estimate for annual average household energy consumption.

Section 6 provides further information on energy consumption, how this can be reduced along with projects which are being undertaken to reduce energy consumption.

2. Cost of Energy

The unit cost of all energy used in Shetland is linked to global energy markets. The vast majority of energy used in Shetland has to be imported at additional cost. These additional costs are exaggerated as we need to use more energy, and they add to the high cost of living.

[77] Regional and local authority electricity consumption statistics - GOV.UK (www.gov.uk)

[78] Energy Efficiency - Scottish House Condition Survey: Local Authority Analysis 2017-2019 - gov.scot (www.gov.scot)

Another factor leading to the high cost of energy in Shetland is due to the high use of electricity as there is no access to the UK gas grid. Electricity prices tend to be around four times the price of gas, 28p/kWh compared to 7p/kWh for gas.

The compound price of energy in Shetland[79] provides a summary breakdown of current fuel consumption with electricity at nearly 2/3, nearly 1/3 for oil, with 8% district heating and 1% other fuels including gas. Compared to a typical household which uses 81% gas to 19% electricity[80].

3. Household income

The Shetland Partnership report that according to CACI paycheck data (2021), 47% of household in Shetland do not earn enough to live well, based on the minimum income standard for remote and rural areas[81]. Workforce and participation are covered in section 10.

The recent report A Perfect Storm: Fuel Poverty in Rural Scotland[82], has further broken this down to four drivers:

- High fuel costs
- Poor energy efficiency of homes
- Low household income, and,
- How energy is used in the home.

Which are further compounded by our cold and wet climate, the high cost of living, employment and training along with a shortage of affordable housing, ageing demographics and limited access to support services.

A second report Fuel Poverty in Rural Scotland: The Solutions[83] has identified a number of solutions, these have been referenced as part of the action planning resource in Annex 2.

Ofgem price cap and the energy price guarantee

The energy price cap sets a maximum price that energy suppliers can charge customers for each kilowatt hour of energy they use, with some variation due to differences in Network charges[84]. It does not cap the consumers total bill.

The energy price guarantee was established by the national government as a backstop to protect customers for rising energy prices. It is expected to remain in place from 1st October 2022 to April 2024[85]. The energy price guarantee added a subsidy to the rates a supplier can charge for their default tariff,

[79] Source Shetland Household Energy Review 2021
[80] Source Ofgem TDCV 2023 Decision Letter.pdf
[81] Households in Shetland who do not earn enough to have an acceptable standard of living – Shetland Partnership
[82] changeworks.org.uk/wp-content/uploads/2023/05/A-Perfect-Storm-Fuel-Poverty-in-Rural-Scotland.pdf
[83] Fuel poverty in rural Scotland: The Solutions | Changeworks
[84] Get energy price cap standing charges and unit rates by region | Ofgem
[85] Energy Price Guarantee - GOV.UK (www.gov.uk)

The energy price cap starting January 2024 is £1,928 per household a slight increase from the previous quarter but still below the energy price guarantee.

Figure 24 below provides an approximation for the difference between the UK average energy bills compared to the composite average for Shetland since November 2021 when prices started to increase sharply. Because there are a wide variety of property types in Shetland and consumption varies with occupancy, these figures can only be used as a starting point for further discussion.

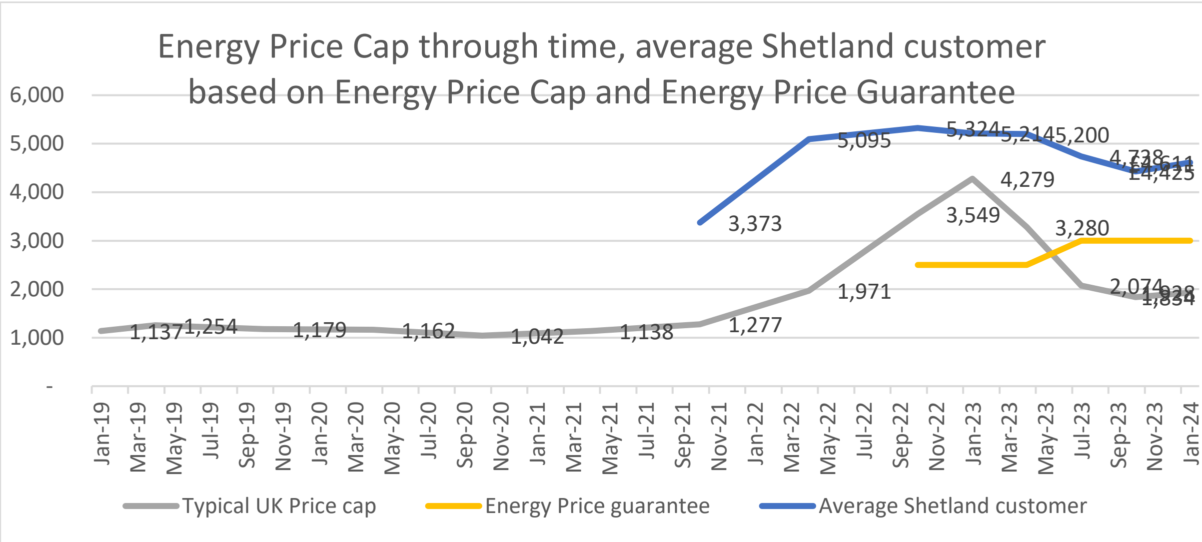


Figure 24 graph from cost of energy spreadsheet graph to be updated for final version investigate how this can be developed as an accessible resource

Breaking down the Cost of Electricity

Reducing the unit cost of electricity or any energy needs to be approached on a number of fronts, as there are a number of costs incorporated into the unit cost.

Ofgem have produced the following graph for a typical multi rate domestic electricity customer to demonstrate how these costs stack up. These costs are a mixture of p/kWh and fixed

Figure 25 Energy bill components

costs, with variations due to payment method and region. A full spreadsheet of data is available from the Ofgem website[86].

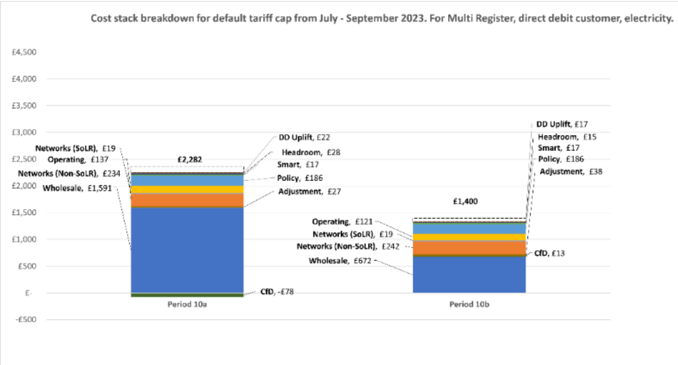


Figure 26 Cost stack graph from Ofgem - may look at alternative formats for final draft

Wholesale energy costs

The cost of generating electricity from renewable resources has reduced significantly over the past 10 years. This decline has been driven by steadily improving technologies, economies of scale, competitive supply chain, government incentives and improving developer experience[87]. The cost of electricity generation from fossil fuels has increased.

Despite the decreasing cost of renewable electricity generation, the wholesale cost of electricity is linked to the global gas market which is currently volatile. This volatility is linked to the Russian invasion of Ukraine. As energy markets decouple from global oil and gas markets, there will be an opportunity for the wholesale cost of electricity to decrease. Electricity market reform is required to allow this to happen and for a closer link between electricity generators, distribution companies and customers local to one another. At present suppliers purchase their energy in advance through forward markets and power exchanges but the markets operate for the whole of the GB without taking location into account[88]. Further information on electricity market reform can be found below.

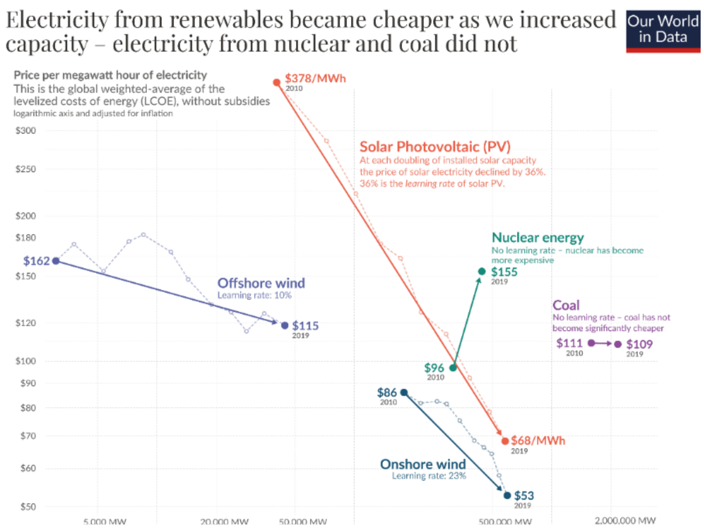


Figure 27 Hannah Ritchie and Max Roser (2021) – Energy. Published in Our World in Data. Online at: ourworldindata.org/energy

As highlighted in the cost stack (Figure 26) provided by Ofgem, wholesale energy costs

[86] https://www.ofgem.gov.uk/sites/default/files/2023-11/Default_tariff_cap_level_v1.20.xlsx
[87] Renewable Power Generation Costs in 2020 (irena.org)
[88] Locational pricing could save £30bn for electricity consumers in the switch to a net zero grid, finds new study - Energy Systems Catapult

only represent around half of the cost of electricity. It is therefore important to give consideration to the other elements.

Network costs

Ofgem set price controls on electricity network companies, to balance the relationship between investment in the network, company returns and the amount they charge[89].

At present we benefit from the Hydro Benefit Replacement Scheme, which protects consumers in the North of Scotland from high electricity distribution costs, and Common Tariff Obligation which ensures that electricity suppliers in the North of Scotland are not able to charge comparable domestic consumers different prices solely on the basis of their location within the region.

High levels of investment will be required in our energy distribution and transmission networks as we transition to distributed generation, with high levels of renewable energy from a system of centralised generation. It is essential that these costs are passed on in a fair and transparent manner. The energy system in Shetland and across the GB Network must be considered in a holistic fashion to maximise efficiencies and avoid duplicate infrastructure, which will ultimately need to be paid for by the energy consumer.

Policy costs

These are the cost of programmes to save energy, reduce emissions and provide financial support to the fuel poor, paid through household energy bills. According to a study undertaken by Cornwall Insight for the Climatexchange the majority of levies are only on electricity and are done on a volumetric basis, putting all electric customers at a disadvantage. Levies for an all-electric domestic property can be up to 28%, excluding VAT[90], the study was published in September 2021 prior to the wholesale cost of electricity increasing significantly. However analysis of the data from Ofgem[91] backs this up and is discussed further in the recent Energising Shetland Appendix 1[92], presented to Council on the 27th September 2023.

These factors along with recent discussions on a hydrogen levy[93] highlight an opportunity for a saving on the cost of electricity and the need for these costs to reflect the carbon intensity of the energy being supplied to help incentivise the transition to clean energy.

Operating costs

The administrative costs of running the supply business, including customer service, marketing metering, plus profits. These are reviewed by Ofgem, who set allowances as part of the price cap. As part of Energising Shetland[94] the Council will investigate the potential of an energy supply company, which could potentially; reduce operating costs or return some of these back to Shetland, if some of the services can be provided locally.

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[89] Network price controls 2021-2028 (RIIO-2) | Ofgem
[90] Review of gas and electricity levies and their impact on low carbon heating uptake (climatexchange.org.uk)
[91] Energy price cap (default tariff): 1 January to 31 March 2024 | Ofgem
[92] Shetland Islands Council Committee Information - Submission Documents
[93] Energy Security Bill factsheet: Hydrogen and industrial carbon capture business models - GOV.UK (www.gov.uk)
[94] Shetland Islands Council Committee Information - Submission Documents

Case studies affordable energy

Here are five examples of where an energy company, developer or community group have offered an alternative option to try and reduce energy prices to the customer by either disconnecting from global energy markets or linking the customer closer to wholesale energy prices.

Ripple Energy

Ripple acts as a facilitator setting up the wind farm co-op and deals with everything from the construction to the maintenance of the wind farm. Electricity customers can buy a share in a cooperative wind farm, with their investment linked to their annual electricity consumption. Note the wind farm is owned by the co-op members rather than Ripple. The saving to the electricity customer is the difference between the wholesale energy price and the wind farms operating costs[95].

Agile Octopus

Agile Octopus is a unique electricity tariff which is linked to half hourly energy prices, tied to wholesale prices and updated daily. When wholesale electricity prices drop, so do customers' bills. The tariff also has a world first, Plunge Pricing, which lets customers take advantage of negative price events, and get paid to use electricity. Unfortunately, as wholesale energy prices are currently at a record high most homes are better off staying on a standard fixed or variable tariff. The tariff does, however, give an insight into a transition to smarter, greener energy. For more information see[96].

Octopus Fan Club

This scheme offers discounted electricity prices to customers within certain postcode districts near an Octopus 'fan' (wind turbine). The level of discount varies depending on wind conditions, with up to 50% discount offered when the turbines are operating at their maximum. This mechanism allows pricing to be more reflective on where electricity is generated[97].

Heat Smart Orkney

Heat Smart Orkney is a partnership project matching otherwise curtailed energy output from a community wind turbine to local domestic space and water heating. Properties received a rebate from the generator for using power which would otherwise have been curtailed[98].

District heating

One affordable energy success story for Shetland is the Lerwick district heating scheme. SHE&P have been able to keep the price of heat stable for the past 20 years. This is because they are protected from global energy prices as the vast majority of the heat comes from the burning of waste at the Energy Recovery Plant. In addition, as the scheme is owned and operated by SHE&P, all revenue generated or saved by the scheme is returned to the local economy. Further discussion on district heating can be found in Section 5[99].

[95] Ripple Energy Review: Who wants to buy a wind farm for £25? You could! (octopusreferral.link)
[96] Agile Octopus | Octopus Energy
[97] Fan Club | Octopus Energy Generation
[98] HSO (rewdt.org)
[99] Shetland Heat Energy & Power (SHEAP) (sheap-ltd.co.uk)

Section 9 - People Powered Change

Projections

The projection for green jobs and skills is amplifying over the coming decades with many of those focused on green energy. We need to place Shetland's students and youth into the position to fill these roles by encouraging the knowledge needed to be successful in these roles. Our educational services will need to connect the dots between what is learned in school to what jobs will be available to the youth in Shetland as the energy transition is underway. Engagement should aim to capture early interest in youth for energy and green job roles. There is also a need to help parents understand that there are jobs in these fields to bring them on-board with the curriculum and encouraging their children to follow these paths.

In addition to teaching our young ones about energy efficient habits and a consciously applying climate adaptation and mitigation practices to everyday situations, there will need to be a re-education and awareness raising for older generation to encourage understanding of how to best adjust habits and lifestyles to match that which is required to eliminate emissions and energy consumption.

Housing and Accommodation

One intersectional challenge that must be addressed is housing. A rise in the number of workers in Shetland will impact the accommodation as well as on-island services. However, not having enough housing will hinder the repopulation and movement of families to Shetland to help build the capacity we need to undertake this energy transition. The housing conundrum is perpetuated by the lack of capacity in the construction industry to build new houses in Shetland.

With the range of energy development types and locations across Shetland, there is an opportunity to grow accommodation throughout Shetland.

However, holistic planning of energy projects through cooperation and collaboration will be necessary to ensure that areas are not sterilised for housing or other developments.

Working together

Islands Centre for Net Zero

The Islands Centre for Net Zero (ICNZ)[100] and Carbon Neutral Islands (CNI)[101] along with other programmes should help to accelerate the learning on the transition to net zero between the isles.

The ICNZ is being established to address the need for fundamental change in how we approach energy transition, empowering the islands to act as lighthouse communities navigating the pathways and owning solutions to decarbonisation as quickly as possible. It will operate across Orkney, Shetland and the Outer Hebrides and will advance 10 work packages. These work packages are summarised in Figure 28 below.

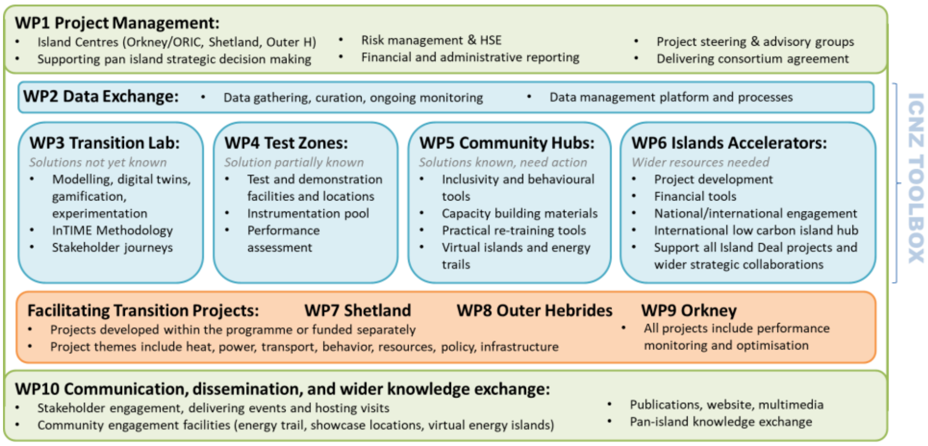

Figure 28 Work package summary from the ICNZ FBC

The ICNZ will be supported through a £16.5M funding package from the Islands Deal, split £5M Shetland, £5M Outer Hebrides and £6.5 Orkney and the core costs.

ICNZ will deliver an integrated cross-sectoral energy transition programme, involving businesses, universities, communities, and the public sector in accelerating our islands transition to net zero. The Centre will build capacity for the transition through the development of a number of tools that can be used across the islands: the ICNZ 'Toolbox'. ICNZ will then use these tools as the basis for seed funding a selection of high-impact and innovative capital energy transition projects in the islands. It is anticipated the suite of capital transition projects will lever in additional match funding over the Growth Deal period.

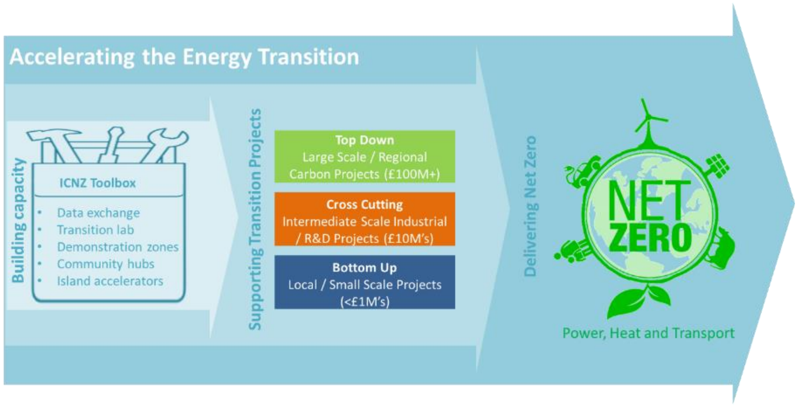

Figure 29 Thematic summary of the ICNZ programme

Carbon Neutral Islands Project

The Carbon Neutral Islands project is a Scottish Government programme aimed at supporting islands to become carbon neutral by 2040 in a fair and just way.

Individual plans are to be developed for each of the six selected islands in collaboration with the key partners and communities involved. The aim is to share good practice and learnings from the project with all other Scottish islands[102]. The islands included as part of the project are: Hoy, Islay, Great Cumbrae, Raasay, Barra and Yell.

ORION Clean Energy Project

The ORION Clean Energy Project is a strategic framework[103] with the aim to shape and promote Shetland as a world leading clean energy island. Led by Shetland Islands Council, with the following partners: Lerwick Port Authority, Net Zero Technology Centre, Highlands and Islands Enterprise (HIE) and the University of Strathclyde.

As a catalyst for change, ORION has and will encourage collaboration with Shetland stakeholders and projects with a net zero focus to help generate clean, affordable power, help eradicate fuel poverty, protect the environment, and provide job opportunities throughout the isles' supply chain.

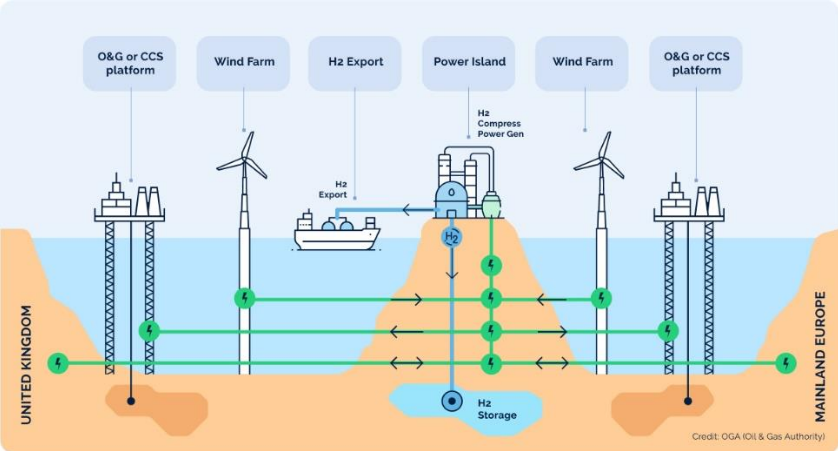

Figure 30 From the ORION website graphic credit OGA (Oil & Gas Authority) placeholder need to select the most appropriate graphic to summarise linkages

Successes achieved in conjunction with the ORION Clean Energy Project

Scottish Government, National Planning Framework 4 – Shetland's energy hub credentials have been recognised and Energy Innovation Development on the Islands, is one of the eighteen developments of national importance.[104]

Recognition of ORION and Shetland within the Scottish Government's Hydrogen Action Plan.

ORION helped to promote significant interest by wind developers in the ScotWind offshore wind licensing process and the award of offshore floating wind licences to ESB, Mainstream RP & Ocean Winds for NE1 to the east of Shetland.

Highlighting the need for an integrated energy system for Shetland and instigating discussion and collaboration between developers and stakeholders. Several studies detailing the potential for Shetland to become a clean energy hub, including marine fleet modelling and power grid analysis. Shetland has also been promoted at several national and international clean energy events.

The future

Now that offshore wind projects are progressing and onshore plans are being discussed for the production of hydrogen and synthetic fuels at scale, the role of ORION needs to change. Our emphasis has switched away from promoting the idea of an energy hub in Shetland towards helping to facilitate the projects that are now being advanced. This is where the 4Shetland Forum and the Energy Development Principles become increasingly important.

4Shetland Forum

The role of the 4Shetland Forum is to take a holistic/ strategic view to the delivery of the Energy Development Principles and facilitate the delivery of an action plan to support the delivery. They also provide a vehicle for engagement with the developers. Membership of the group includes representatives from the Council, Highlands & Islands Enterprise (HIE), Lerwick Port Authority and NORN.

Shetland PLC

The role of Shetland PLC is to focus on the actions that the supply chain need to undertake for Shetland to deliver floating offshore wind. Membership of the group includes: HIE as Chair, SIC Ports and Harbours, Lerwick Port Authority, NORN and UHI Shetland.