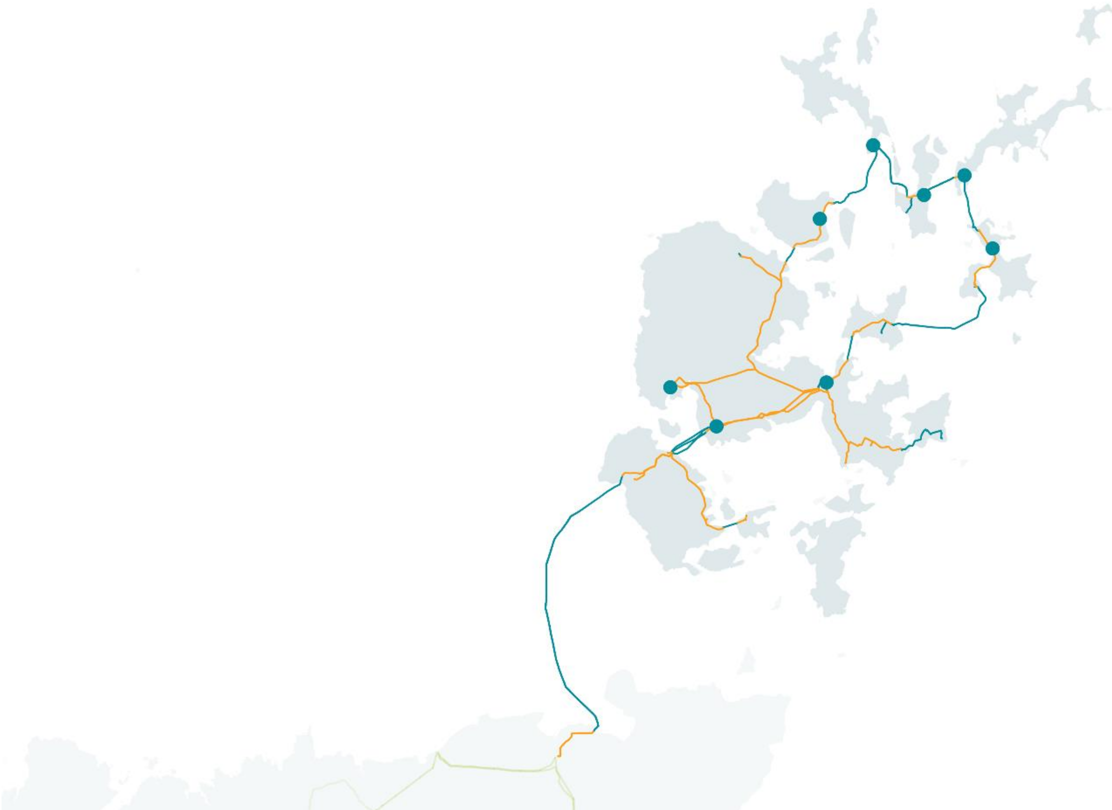
Orkney Islands Net Zero Load Growth Evidence Summary Study

An evidence case report for future electricity generation and demand load growth in the Orkney Islands



March 2024

This report was produced for:	Andy Wainwright, DSO Whole System Manager, SSEN
Issue date:	18 March 2024
Version:	Final report
Written by:	Ray Arrell, Associate Director Becky Fowell, Energy Market Analyst Shona Reid, Energy Analyst Charlotte Wason, Graduate Energy Analyst
Approved by:	Ray Arrell, Associate Director

Regen, Bradninch Court, Little Castle Street, Exeter, EX4 3PL

T +44 (0)1392 494399 E admin@regen.co.uk www.regen.co.uk

Registered in England No: 04554636

Scottish & Southern Electricity Networks

About Scottish and Southern Electricity Networks (SSEN)

SSEN is the electricity Distribution Network Operator (DNO) responsible for delivering power to over 3.8 million homes and businesses across central southern England and the north of Scotland. SSEN serve some of the most diverse and unique geographies across the UK, including many of the Scottish Islands. SSEN are committed to keeping customers and communities connected whilst developing a flexible electricity network vital to achieving net zero.

About Regen

Regen is an independent centre of energy expertise with a mission to accelerate the transition to a zero-carbon energy system. We have nearly 20 years' experience in transforming the energy system for net zero and delivering expert advice and market insight on the systemic challenges of decarbonising power, heat, and transport.

Regen is also a membership organisation, managing the Regen members network and the Electricity Storage Network (ESN) – the voice of the UK storage industry. We have over 150 members who share our mission, including clean energy developers, businesses, local authorities, community energy groups, academic institutions, and research organisations across the energy sector.

Authors

Ray Arrell – Associate Director
rarrell@regen.co.uk

Becky Fowell - Energy Market Analyst
rfowell@regen.co.uk

Shona Reid - Energy Analyst
sreid@regen.co.uk

Charlotte Wason - Graduate Energy Analyst
cwason@regen.co.uk

Executive summary

SSEN's RIIO-ED2 business plan included proposed investments in 15 subsea cables to enable the transition to net zero and maintain security of supply for specific Scottish Islands. Through SSEN's final business plan dialogue with Ofgem, the planning and approval of these cables were to be assessed under an investment re-opener, the Hebrides and Orkney Whole System Uncertainty Mechanism (HOWSUM).

SSEN commissioned Regen to support the HOWSUM assessment by collating evidence around future electricity load growth on the island groups. This builds on existing data and engagement from SSEN's 2022 Distribution Future Energy Scenarios (DFES) analysis – completed by Regen – supplemented where possible with analysis and updated data from SSEN's 2023 DFES, which is currently underway. Additional desktop research and industry engagement were undertaken to gain further insight into future electricity loads across industries that are not currently in the DFES technology scope, e.g., maritime decarbonisation, aviation, distillery electrification and aquaculture.

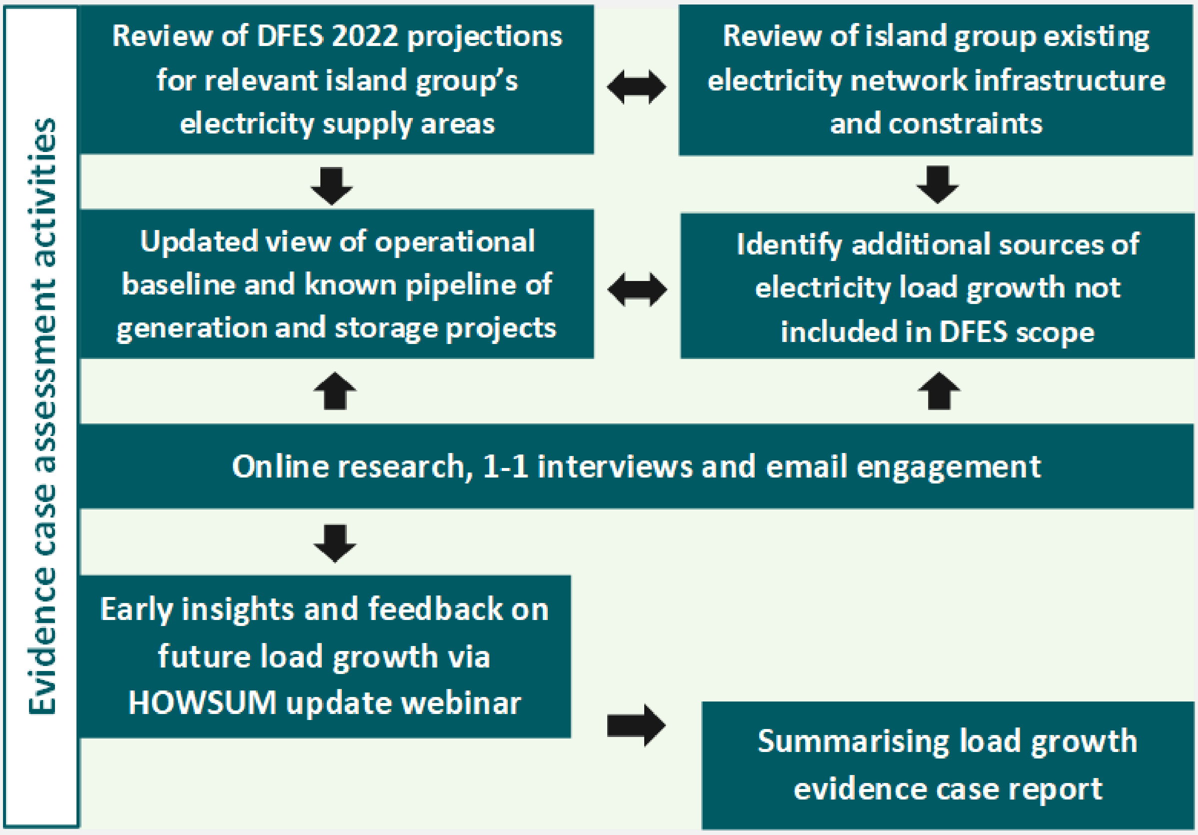


Figure 1

Overview of load growth case methodology

Orkney Islands Council's (OIC) Sustainable Energy Strategy covering the period 2017-2025 includes several commitments that aim for Orkney reach net zero by 2030. In addition to this, there are several commitments relating to energy planning, transport, climate change and broader island decarbonisation within Orkney Islands Council's Delivery Plan 2023-2028.

Many of these commitments could drive increased demand on the island's electricity network in the future. This will likely include increased renewable energy development, green hydrogen production, the installation of low-carbon heating systems and an increased adoption of low-carbon transport. The strategy highlights commitments to gain further buy-in from island stakeholders that have a role in developing and managing energy resources in Orkney. The Council are also developing the Orkney Community Wind Farms, a council-owned organisation to develop wind farm projects and maximise community benefits across Orkney. However, these developments significantly depend on the proposed transmission network link that SSEN Transmission is progressing.

The broader analysis, research and engagement suggest potentially significant future electricity load growth in the Orkney Islands. There is significant market and community interest and unexploited resource driving further development of distributed renewable energy generation. Under a Consumer Transformation scenario, there could be more than 400 MW of distributed electricity generation in Orkney by 2045 (dominated by a notable expansion of onshore wind and marine generation). This is compared to the c. 58 MW of renewable generation and 15 MW of fossil fuel generation seen today (see Figure 2).

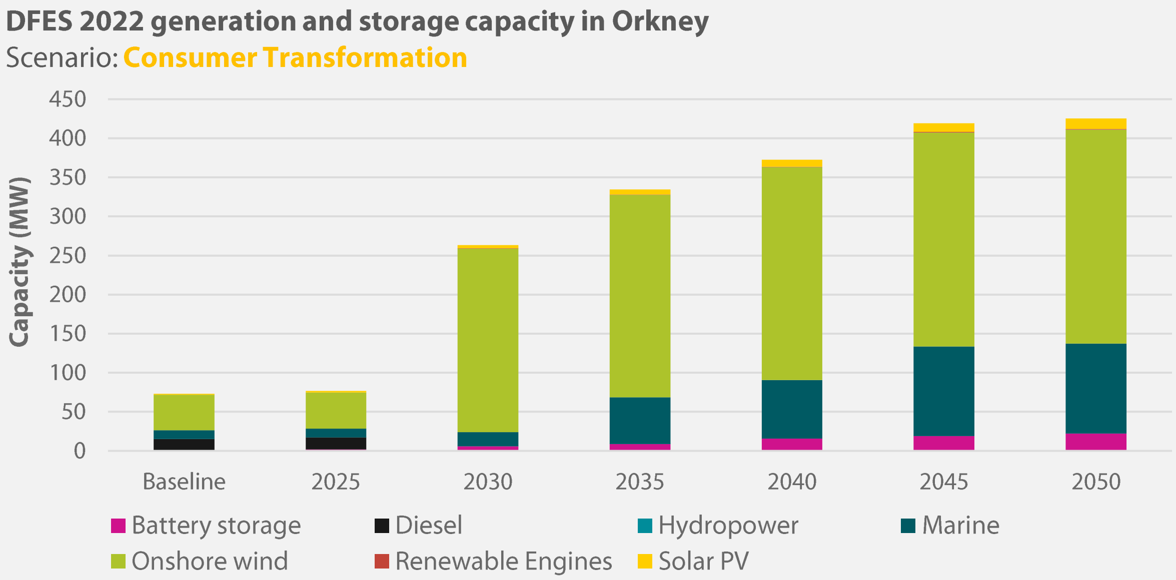


Figure 2

Cumulative distributed generation and storage capacity on Orkney, Consumer Transformation scenario

Source: SSEN DFES 2022 projections.

The electrification of transport, heat and other commercial decarbonisation activities could also increase electricity demand in Orkney in the future. Under a Consumer Transformation scenario, there could be more than 200 MW of electricity demand capacity across Orkney by 2050, stemming from additional demand from electrified heating, transport and hydrogen electrolysis. This is compared to the c. 85 MW of equivalent demand capacity today (see Figure 3).

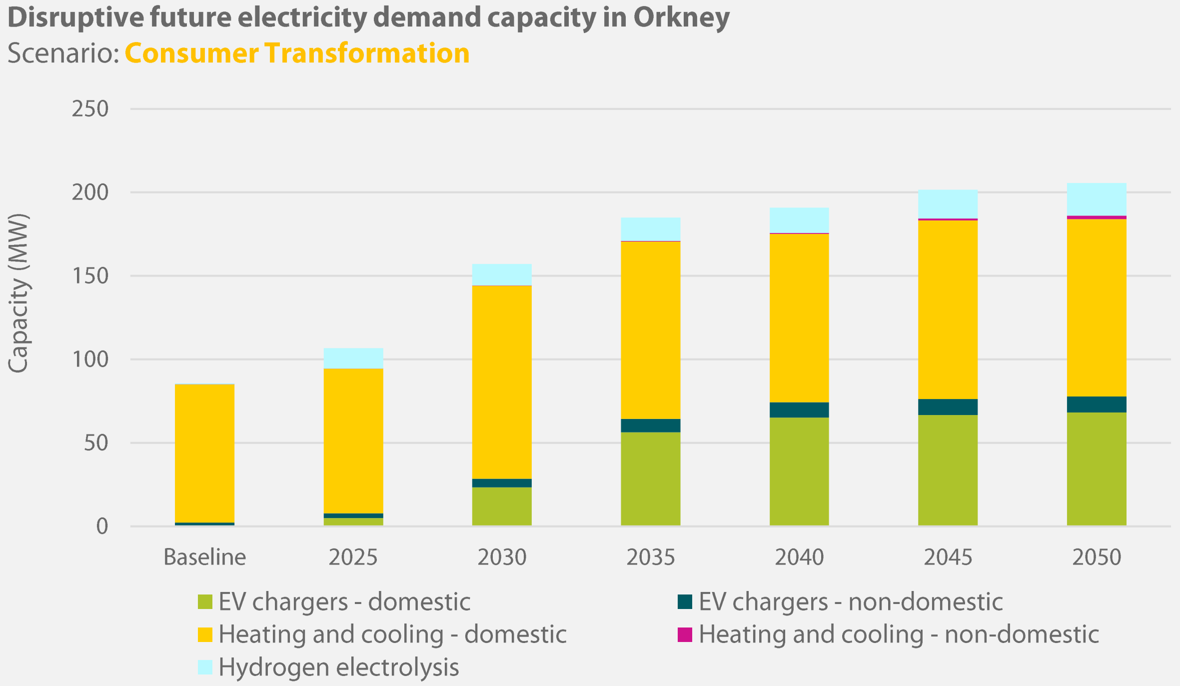


Figure 3

Cumulative disruptive electricity demand capacity in Orkney, Consumer Transformation scenario

Sources: SSEN DFES 2022 projections. SSEN connections data.

Note that this does not include all domestic, commercial and industrial demand sources.

Communities and industries across Orkney are in the process of shifting to a net zero future, but this is, in part, limited by the challenges and constraints of the current network.

Investment in the island's network will see significant new capacity through the development of a new transmission cable; however, this capacity has been largely allocated already. Whilst not directly impacting the distribution network, coordination between SSEN's distribution network reinforcement and this major new HVAC transmission link to Finstown will remain key.

SSEN will need to ensure that future reinforcement and T-D coordination around the island's electricity system can enable the development of additional near-term generation capacity whilst also preparing island infrastructure for the increased electricity demand that the net zero transition will bring for residents, businesses and island industries. In addition to T-D coordination, SSEN should supplement with meaningful engagement and collaboration with relevant communities and councils. Not only will this provide support to local Net Zero transition plans but it allows parties across the islands to benefit from future network investments.

A summary of the evidence gathered by sector can be found in Table 1.

Table 1

Sector summary of potential distribution future load growth

Energy Sector	Summary of future load growth on the distribution network
Renewable energy	Renewable energy, particularly onshore wind and marine generation, will remain a significant source of future generation load growth in Orkney. Additional distribution network capacity and the fulfilment of the proposed transmission link to Finstown will likely drive further wind, solar and marine projects to come online.
Battery storage	As one of the most rapidly developing sectors, battery storage has the potential to be a disruptive source of demand and generation load in the future at various parts of SSEN's network. Whilst there is currently very limited development in Orkney, this may change as use cases and business models constantly evolve. Further generation and hydrogen development spearheaded by EMEC may see electricity storage (including potentially long duration storage) as a solution to increase on-island energy use.
Hydrogen	Green hydrogen could see notable development in Orkney under some scenarios as a source of electricity demand from electrolysis and a potential offtake of local wind and marine generation for local usage. With several innovation trials and specific plans to investigate hydrogen at existing assets like Flotta Oil Terminal, Orkney is seen as potentially one of the hydrogen development hubs in Scotland. SSEN should continue engaging with the European Marine Energy Centre (EMEC) and hydrogen innovation project developers in Orkney and across Scotland to understand the impact this may have on the island's electricity network.
Transport	Future electricity demand from transport could come from three different transport sectors on very different timelines. EV charging and associated infrastructure are likely to see rapid adoption to meet the demand from residents and visitors. The development of electrified propulsion systems and shore power capacity for maritime vessels and electrified on-ground units and thrust systems for aviation are already being tested at specific locations across Orkney. Marine vessels and aviation sectors are committing to longer-term net zero strategies, with hydrogen also considered a potential fuel source for both industries.
Heating	Space heating could be a significant source of electricity demand in the future in Orkney. Many households are already using electrified heating, with more expected to come online in the future with heat pumps replacing some fossil fuel heating systems. There could also be a pathway in which hydrogen is considered for space heating. However, the low viability of hydrogen heating in homes in general makes this unlikely and so electrification remains the primary low carbon heating technology option being considered for Orkney.
Commercial and Industrial	The decarbonisation of industries specific to northern Scotland (i.e. whisky distilleries, fish and seaweed farming) and broader industries (e.g. agriculture and other commercial businesses) could involve a range of potential electrification outcomes.

Contents

Section 1:

Introduction and approach

SSEN's RIIO-ED2 business plan included proposed investments in 15 subsea cables to various Scottish islands. These cables were identified as having a significant need for replacement or strategic reinforcement to allow for net zero and security of supply for specific island groups. Through SSEN's final business plan dialogue with Ofgem, the funding for some of these cables was determined to be assessed under an investment re-opener, the Hebrides and Orkney Whole System Uncertainty Mechanism (HOWSUM). These investment re-openers are being assessed in January 2024 and January 2025. SSEN is continuing to engage with island stakeholders and developing a cost-benefit analysis to provide evidence to submit to these investment windows.

The broader optioneering approach taken to the HOWSUM whole system assessment can be summarised in five steps (see Figure 4). The process begins with collecting evidence about future electricity load requirements (demand, generation and storage) on the islands. This evidence feeds through to an assessment of options/solutions, a cost-benefit analysis and the identification of the proposed solution and associated capital design scheme.

Figure 4
HOWSUM whole system optioneering assessment

After ongoing work to deliver SSEN's annual Distribution Future Energy Scenarios (DFES) assessments,[1] Regen was commissioned to support SSEN to collate a body of evidence around future load growth on the island groups to support the HOWSUM assessment. This work is intended to identify future electricity needs and tailor the subsea cable network investment requirements for both net zero and security of supply within the island groups.

[1] Regen, 2017-2023, SSEN Distribution Future Energy Scenarios

1.1. Purpose of this report

This report summarises the approach taken and the evidence collected across the latter half of 2023 for future electricity load growth in Orkney. The report includes a summary of the existing electricity network, constraints and an overview of the evidence collected around potential future electricity load growth, categorised by:

- Distributed electricity generation
- Electricity flexibility technologies (battery storage and hydrogen)
- Electrified transport
- Electrified heat
- Industry electricity demand
- New property developments
- Offshore wind sector growth

This report will be combined with SSEN's wider evidence base and a companion cost-benefit analysis, completed by engineering consultants Jacobs, to feed into the HOWSUM dialogue and application process with Ofgem in January 2025.

1.2. Methodology

This evidence case report compiles existing data from SSEN's 2022 Distribution Future Energy Scenarios (DFES) analysis completed by Regen, supplemented where possible with analysis and updated connections data from SSEN's 2023 DFES. This has been augmented with online research and input from industry stakeholders to inform future load growth in Orkney.

The current baseline of operational generation, storage and demand on the Islands was determined using SSEN's latest data, supplemented with information on pipeline projects currently in development. Future scenario projections of generation, storage and demand were extracted from SSEN's 2022 DFES analysis, providing a forward-looking view of how generation and demand may evolve on the island group out to 2050. For this report, the 'Consumer Transformation' DFES scenario was chosen, as it is the scenario that most closely aligns with Scottish policy ambition and sector-specific targets. SSEN will continue to review the latest scenario updates once DFES 2023 has been published.

In addition to the data sourced from SSEN's DFES 2022 and 2023, additional desktop research was undertaken to provide insight into additional sources of future electricity load from industries/sectors not currently included in the DFES technology scope. This includes maritime decarbonisation, aviation, distilleries, agriculture and aquaculture. The findings were supplemented, where possible, with interviews with industry experts to gain insight into specific appetite/intention for potential future electrification on the Islands.

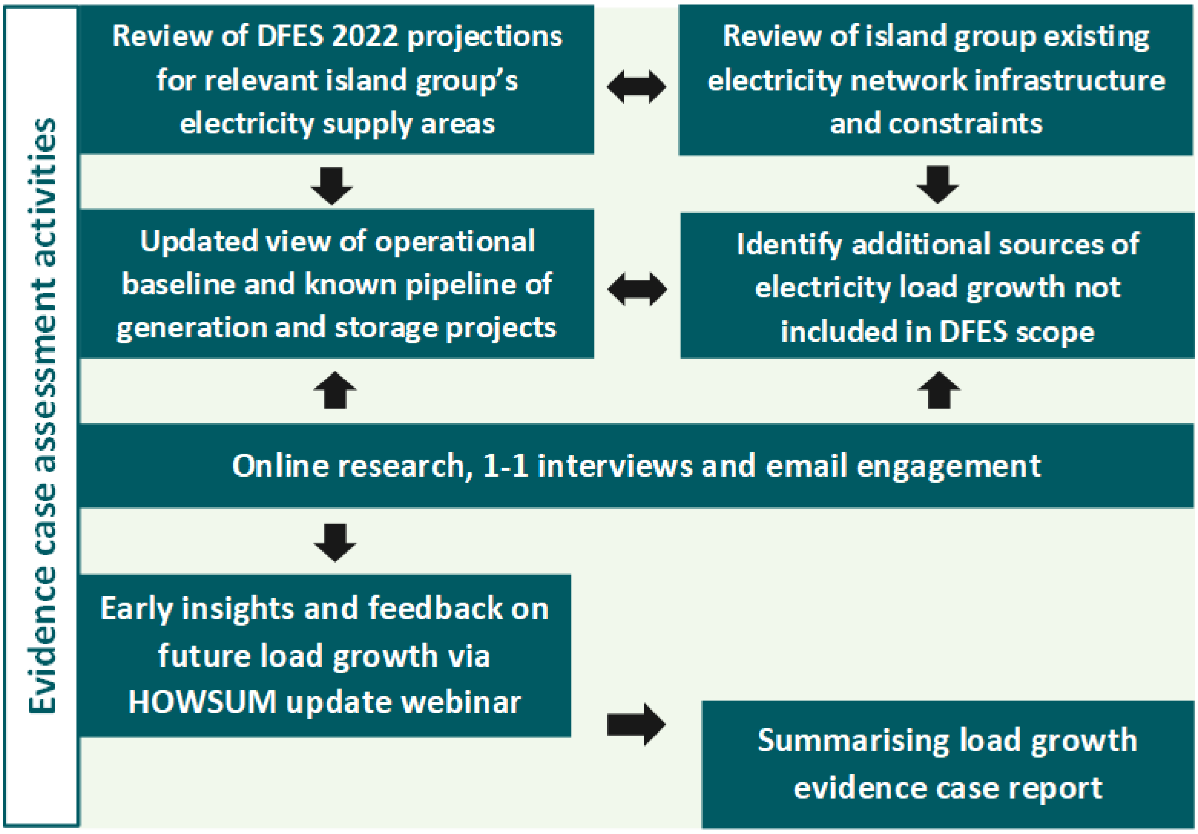


Figure 5
Overview of load growth evidence case methodology

1.3. Policy reform

Outside of the HOWSUM process, there are several wider indusrty reforms currently underway that have the potential to signifncantly impact future load growth of the islands. Significant reforms – including Ofgem's queue management rule, the Transmission Network Use of System (TNUoS) and constraint management reform and the Review of Electricity Market Arrangememts (REMA) – aim to improve challenges within the energy system, including speeding up the grid connections process and addressing the geographical imbalance between generation capacity and demand. Ofgem's development of Regional Energy Strategic Planners (RESPs) will also likely impact network planning processes across the UK. The aim of the RESP is to ensure that regional strategic network planning aligns with national and local net zero ambitions and priorities. Current efforts and engagement activities from SSEN at this stage of network planning will need to coordinate and interface with the RESPs.

Any policy reform will contribute to the landscape of future load growth, influencing the scale and pace of wider future electricity generation deployment, the use of flexible assets and the ability for the network to manage load. Although the impact on electricity load growth from individual policy reforms is not assessed within this report, SSEN will closely observe the progression of relevant reforms to ensure that network reinforcements align with the wider energy market.

Section 2:

The Orkney islands group

This section provides some context in Orkney as an island group, including population, existing transport infrastructure, electricity network infrastructure and an overview of the relevant local authority's net zero and energy strategies.

2.1. Overview of the islands

Population statistics

Orkney is an archipelago comprising around 70 islands located off the north coast of Scotland. Approximately 22,000 inhabitants live across the Orkney islands,[2] an increase from c.21,350 people recorded in the 2011 Census.[3] The biggest island, 'Mainland', accounts for around 75% of the overall population of Orkney and contains Kirkwall and Stromness, the two main population centres. Kirkwall is Orkney's largest town and administrative centre, with a population of c.10,000, and Stromness has c.2,200 inhabitants (2011 Census data).[4] None of the other islands are individually home to more than 1,000 people.

Figure 6
Orkney Island group

[2] Scotland's Census, 2023. Scotland's Census 2022 – Rounded population estimates.
[3] Scotland's Census, 2022. Orkney Islands: 2011 overview.
[4] National Records of Scotland, 2015. Scotland's Census 2011: Inhabited islands report.

As of the 2022 Census, there are around 10,600 residential properties in Orkney – an increase from c.7,700 in 2011 – primarily situated on Mainland. Although the population and number of residential housing in Orkney have increased, a surge in one-person households has meant that single occupancy housing is now more prevalent across Orkney.

Transport infrastructure

Existing road transport

The islands' transport infrastructure is dominated by road, with an active bus fleet (Figure 7) and a road network spanning the islands. OIC has already undertaken significant action to build upon low-carbon road transport. A lower-emission bus fleet was introduced in 2021, catering to public and school travel. The Council operates the county's largest EV fleet and has introduced evening bus and community transport schemes for island residents. Other organisations, such as NHS Orkney, are also making large strides in fleet decarbonisation.[5]

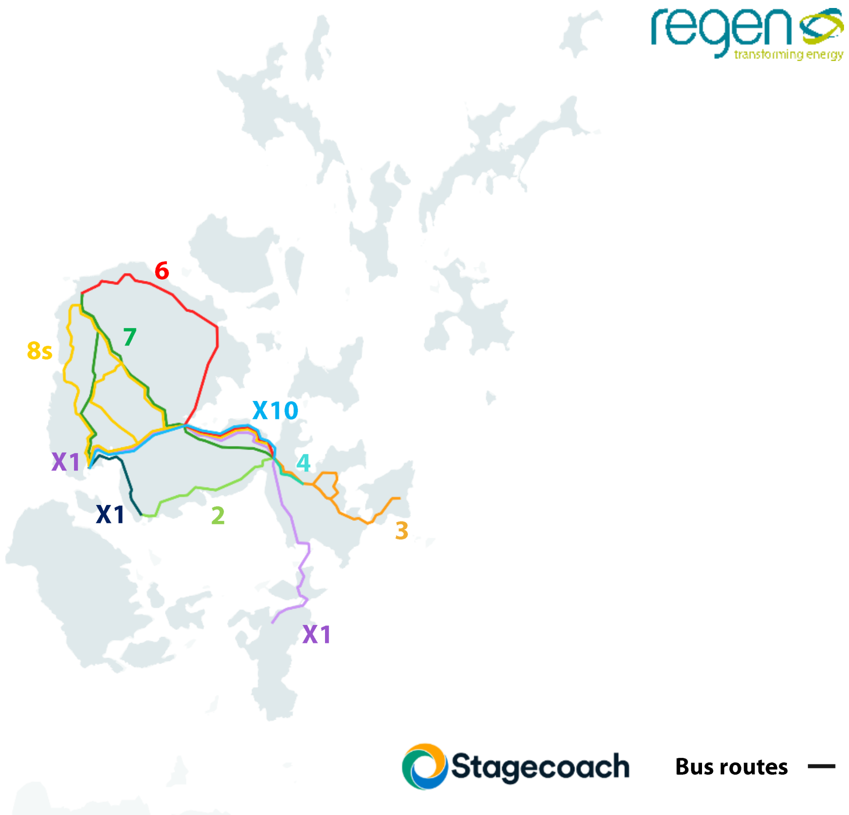


Figure 7

Orkney Mainland bus route map

Source: Orkney Islands Council

[5] Orkney Islands Council, 2023. Orkney Local Transport Strategy 2022-2044 DRAFT.

Existing maritime vessels

As a group of island communities and a prime tourist destination, transport within Orkney relies heavily on marine vessels for inter-island travel and travel to and from the Scottish mainland (see Figure 8). Businesses, residents and visitors rely heavily on these ferry services daily, the significance of which has already led to considerable work on decarbonising maritime transport and its associated infrastructure over the last 20 years.

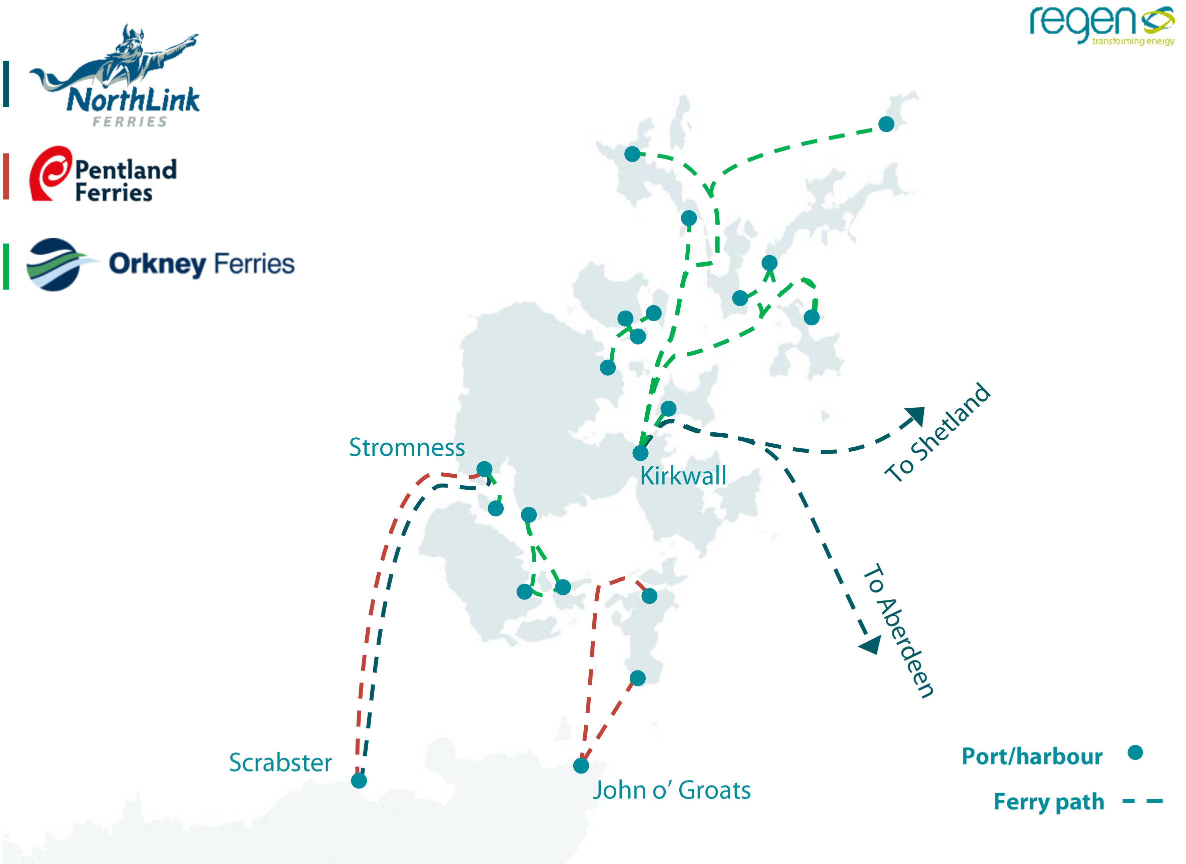


Figure 8

Orkney ferry routes

Maritime decarbonisation in Orkney is expected to continue on a similar trajectory across the next few decades. The potential electrification of the maritime sector considers both future propulsion technology and fuels alongside the introduction of shore power infrastructure at key ports. The potential for the future electrification of the inter-island ferries and ferries connecting Orkney to other parts of the Scottish Isles is explored in more detail in section 3.4. This could be a notable source of future electricity load growth at larger coastal parts of Orkney.

Existing aviation

In addition to maritime transport, there are seven airports that serve Orkney. Kirkwall is the main airport on the islands, and is currently the only airport that serves flights from between Orkney and mainland UK. Six smaller airports are used for inter-island travel, located at Eday, North Ronaldsay, Papa Westray, Westray, Sanday and Stronsay. See Figure 9.

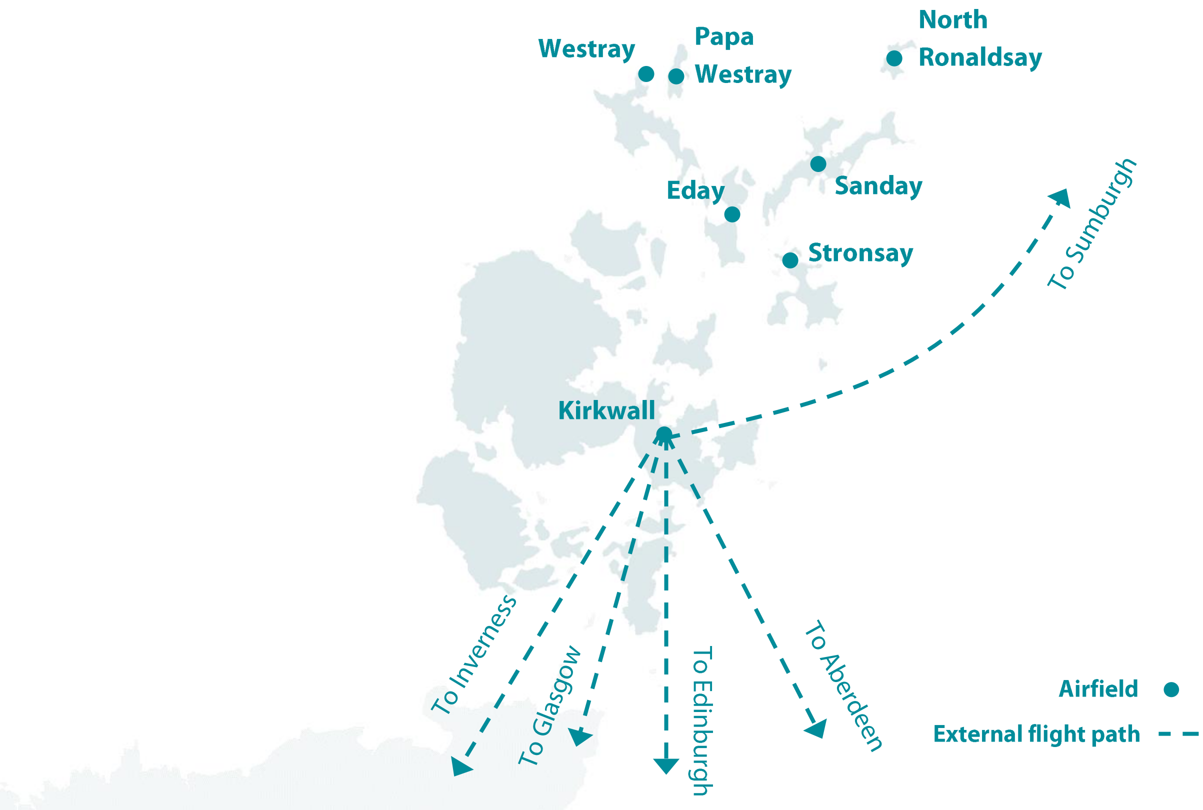


Figure 9

Airports and airfields in Orkney

The potential future electrification of aviation on the islands is discussed in more detail in section 3.4, which considers future thrust and lift technology and associated fuel usage, as well as a shift towards all-electric aircraft turnaround through the electrification of ground infrastructure, vehicles and associated equipment.

2.2. Existing network infrastructure

At present, Orkney is supplied by SSEN's distribution network via two 33 kV circuits, fed from Thurso GSP on the Scottish mainland. These circuits consist of overhead lines, underground cables and subsea cables.

Once on the islands, a 33 kV network is fed from Scorradale GSP, which connects the various islands via a combination of ring and radial circuits (Figure 10). Several primary substations are also located on the islands to supply the 11 kV network. At present, there is no existing transmission network on the islands. This is subject to change, with a capital scheme bringing a new 220 MVA HVAC transmission link between Finstown in Orkney and Dounreay in Caithness by 2028.

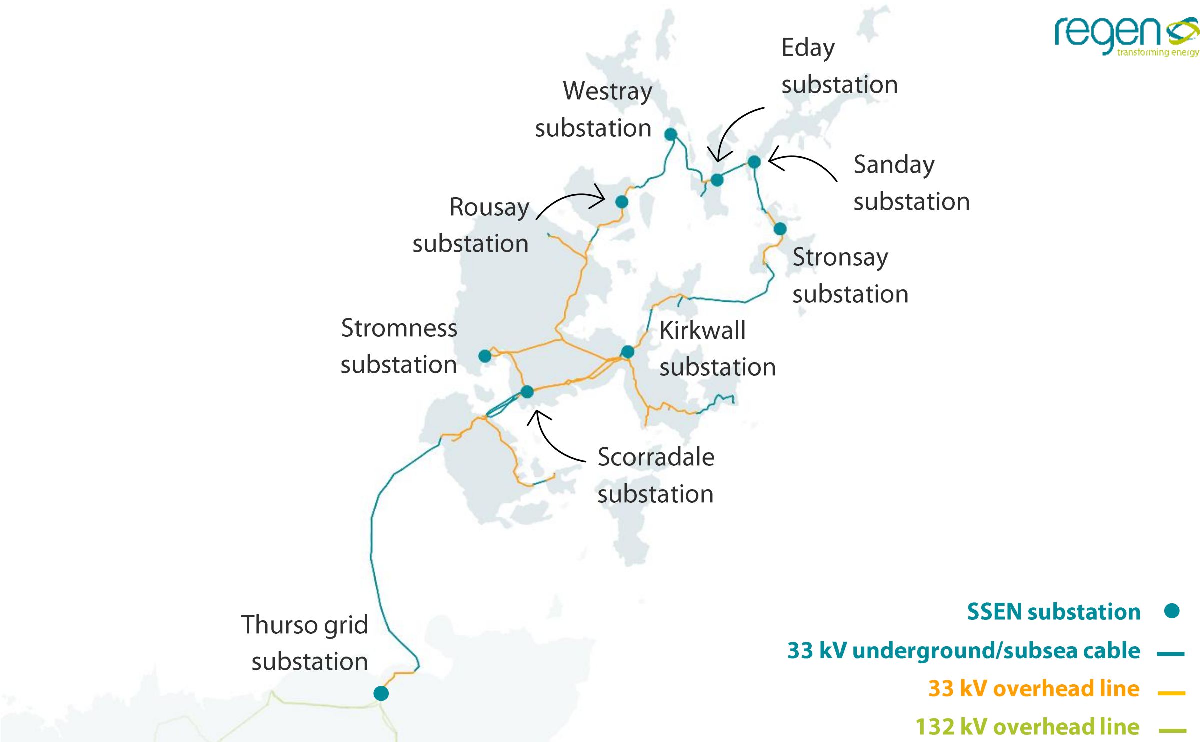


Figure 10
Existing network infrastructure in Orkney

Source: SSEN distribution network mapping data

To ensure the security of supply in the event of the loss of either of the 33 kV feeding circuits, SSEN Distribution owns and operates the Kirkwall diesel power station. This diesel site is only operated when there is an outage or disruption to the main subsea network connection between the island group and the Scottish mainland.

2.3. Network constraints and reinforcement

The physical condition and future requirements of SSEN's network assets supplying the islands are under regular review. Many of the subsea cables connecting the Scottish Islands are c. 40 years old and recent faults on similar vintage cables have raised concerns about the potential impact on network operability, system resilience and consumers if similar faults were reported in the Scottish Islands.

Active Network Management

The use of the networks on the island groups continues to evolve as new renewable energy generation seeks to connect. SSEN (working with Smarter Grid Solutions) installed an Active Network Management (ANM) system in 2009 to manage the growth of distributed renewables and onsite demand. The live power flow monitoring at various parts of the Orkney network has enabled more renewable energy to connect/export (see Figure 11), with 24 generators now operating under the scheme.

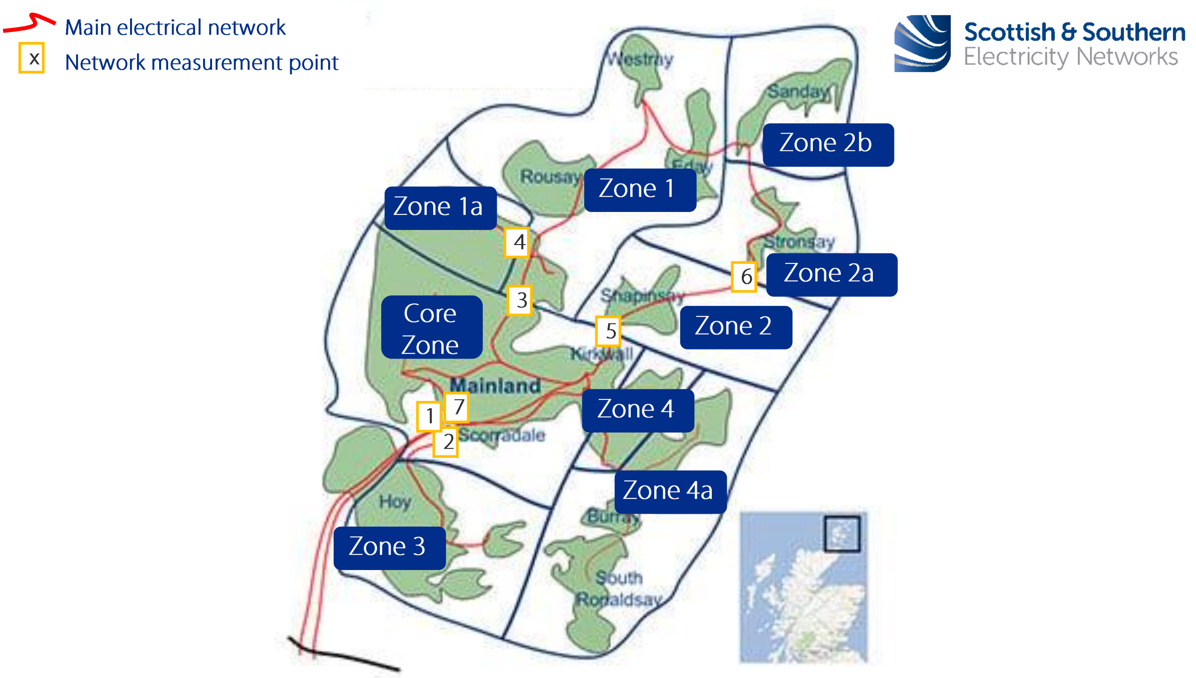


Figure 11

Orkney Active Network Management system

Source: SSEN website

2.4. Orkney Islands Council net zero strategy

Orkney Islands Council (OIC) has published a range of strategies and supporting documents detailing its vision. It aims around climate change, local transport, local heat and energy efficiency, waste, wind energy and green hydrogen.

One of the OIC aims set out in their 2023-2028 Council Plan is to work towards becoming net zero by 2030.[6] Another of these aims includes the delivery of the Orkney Community Windfarms Project, supporting further decarbonisation and providing essential income to offset public funding cuts, creating financial sustainability within the Council.

OIC outlines a delivery plan[7] and timeline of activities to achieve these aims and overall net zero by 2030. This includes:

1. The finalisation of the Orkney Sustainable Energy Strategy Plan
2. Decarbonisation of the council-owned estate and transport (incl. schools and ferries)
3. Progression towards meeting energy efficiency standards for social housing
4. Support the uptake of renewable energy, smart energy or energy efficiency solutions amongst private Orkney homes and businesses.

These identified steps from the Council indicate significant appetite and changes that will be made across the Orkney islands over the coming decade, many of which will likely see an uptick in electricity use and generation across Orkney.

[6] Orkney Islands Council, 2022, Council Plan 2023-2028.
[7] Orkney Islands Council, 2023, Delivery Plan 2023-2028.

Section 3:

Baseline and future electricity load in Orkney

Based on SSEN's DFES 2022 assessment, current (2023) connections data, desktop research and stakeholder engagement, this section summarises the potential load growth (generation and demand) that could be seen in Orkney, categorised by sector.

3.1. Distributed electricity generation

DFES 2022 projections

Based on SSEN's DFES 2022 projections, under the Consumer Transformation scenario, distributed renewable generation capacity across Orkney could increase significantly over the next two decades, from a 2022 baseline of 58 MW to around 350 MW by 2035 and increasing further to just under 445 MW by 2050 (see Figure 12).

Onshore wind is the primary contributor to this potential increase in renewable capacity, seeing an uplift from the 2022 baseline (45 MW) to 260 MW by 2035 and 273 MW by 2050. This reflects strong wind resource and policy support for onshore wind in the region.

Around 13 MW of solar PV capacity (primarily rooftop) is projected to be deployed by 2050 on Orkney. Under this scenario, marine power could also play a significant role on the island, with 60 MW projected by 2035, increasing to over 110 MW by 2050. This reflects the European Marine Energy Centre's (EMEC) role, not only for Orkney's electricity generation mix but for the wider UK marine energy sector. Around 13 MW of solar PV capacity (primarily rooftop) is projected to be deployed by 2050 on Orkney. If further technology cost reductions are realised and battery storage co-location becomes a viable business model, a larger uptake of solar could be seen. In addition to renewable generation capacity, SSEN will continue to assess the role of the opeational diesel generators on Orkney throughout the HOWSUM process.

Overall, significant onshore wind and marine growth demonstrates that Orkney is a strong area for renewable energy development if additional grid capacity is made available.

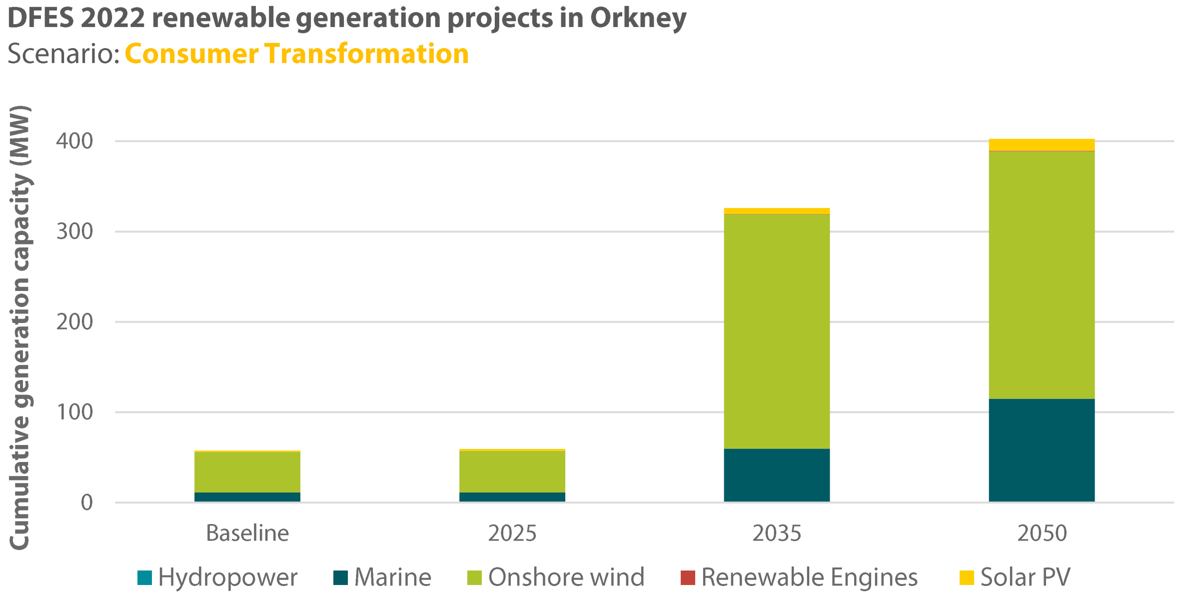


Figure 12

Projected cumulative distributed generation and storage capacity in Orkney

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

Baseline and pipeline distributed generation as of 2023

As of August 2023, 58 MW of renewable distributed generation is operating in Orkney (see Table 2 and Figure 13). Most of the connected generation mix is dominated by 31 onshore wind sites, equating to over three-quarters of the total generation capacity on the island. The rest of the generation comes from two EMEC-maintained marine generation sites at Eday (4 MW) and Stromness (7 MW).

In addition to this baseline, a pipeline of 314 MW of distributed generation sites holds accepted connection agreements with SSEN in Orkney. This is based on an analysis of SSEN's connection data as of October 2023.

This pipeline consists primarily of new onshore wind and marine generation projects, as seen in Table 2 and Figure 14. The largest sites in spatial planning are the Nistill wind farm on the northwest Mainland and the community-developed Rennibister II wind farm near Kirkwall. Both projects are 26 MW in capacity. The Nisthill project has submitted a planning application and is awaiting a decision. The Rennibister project is still in the pre-planning stages.

The pipeline also consists of other technologies, including a 0.01 MW gas CHP power station at Kirkwall airport and a 60 MW offshore wind demonstrator project based at EMEC's Billia Croo facility on the southwest coast of Mainland.

Table 2

Baseline and pipeline distributed electricity generation connected and expected to connect in Orkney.

Generation technology	Number of installed sites	Installed capacity (MW)	Number of pipeline sites	Pipeline capacity (MW)
Fossil fuel (gas)	-	-	1	0.1
Marine	2	11	5	91
Offshore wind	-	-	1	60
Onshore wind	31	47	9	164
Total	33	58	16	314

Source: SSEN 2023 connections data

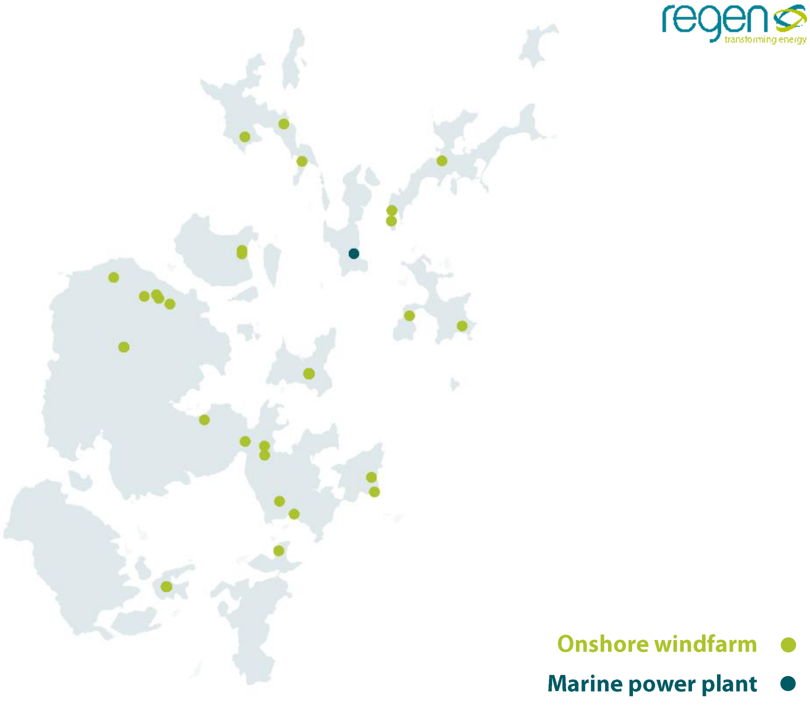


Figure 13

2023 baseline of distributed generation projects

Source: SSEN connections data

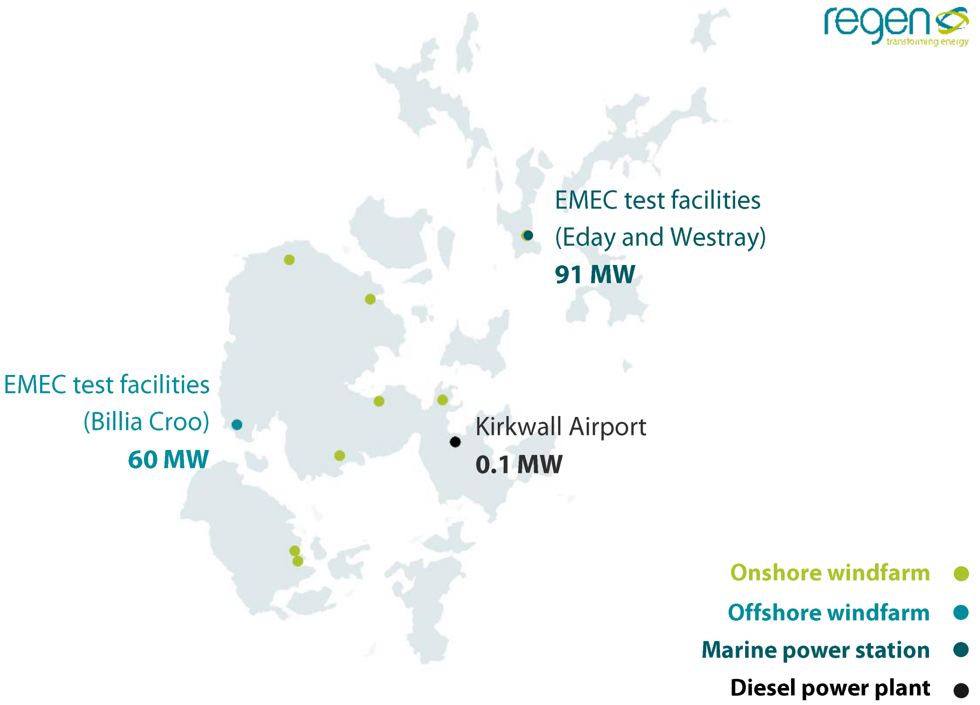


Figure 14

2023 pipeline of distributed generation projects

Source: SSEN connections data

Further industry insights

Repowering of existing onshore wind

Alongside the pipeline of future onshore wind projects, the repowering of existing wind turbines may need to be considered in the context of additional load growth. Onshore wind project operational lifetimes can vary depending on location, size and age. Still, an estimated range is between 15-20 years,[8] with some operators already seeking to repower legacy sites with more efficient, higher yield, higher capacity turbines on existing site footprints.

The 31 onshore wind projects currently operating in Orkney range in age (see Table 3), with most over a decade old. Spurness windfarm (Phases 1 and 2) on Sanday and the Northfield site on the Isle of Burray have been in operation for nearly two decades and are coming to the end of their lifespan. Scottish Government and OIC both support the repowering of existing wind farms, with repowering schemes being treated as new planning applications.[9] In addition, the council deemed the repowering of onshore wind to make a meaningful contribution toward the needs case for the Orkney transmission interconnector.

[8] SIA Partners | CAC, 2022, Repowering existing wind farms will help reach renewable electricity targets faster.
[9] Orkney Island Council, 2017. Supplementary Guidance: Energy.

Table 3

Operational lifetimes of existing onshore wind projects in Orkney

Project Name	Capacity (MW)	Date Connected	Age (yrs)
Barns Of Ayre	2.7	2013	10
Braefoot Community Wind	0.9	2017	6
Cleat	0.08	2012	11
Dale Spot	0.08	2013	10
Dist Gen	0.5	2013	10
Eday Community Wind Turbine	0.9	2012	11
Burgar Hill	2.3	2007	16
Thornfinn, Burgar Hill (plus additional capacity)	4.3	2009	14
Fea Wind	0.08	2012	11
Flotta Wind	2	2010	13
Spurness Point Phase 3	2.45	2012	11
Hammar Wind (plus additional capacity)	5	2010	13
Ore Brae	0.9	2013	10
Ludenhill Wind	0.5	2016	7
New Holland	0.5	2014	9
Isle of Burray (Northfield)	0.9	2005	18
Rennibister	0.9	2014	9
Stronsay Community Wind	0.9	2011	12
Spurness Phases 1 and 2	7.5	2005	18
Scapa	0.08	2013	10
Burgar Hill (NWP)	4.99	2007	16
Thorkell Wind	0.9	2014	9
Towerhill Wind	0.08	2014	9
Tuquoy	1.8	2012	11
Westray Development Trust	0.9	2012	11
Salmon Fish Farm	0.06	Unknown	-
Dounby Wind	0.9	Unknown	-
Haston Industrial Estate	0.9	Unknown	-
Howana Gruna	1.5	Unknown	-
Mid Garth	0.9	Unknown	-
Stromness 300 kW	0.3	Unknown	-

Source: SSEN connections data

Repowering is factored into Regen's DFES projections, but engagement with existing operators could provide more detail on the scale and intention of repowering at specific locations.

Many operational onshore wind projects looking to repower are currently connected under non-firm and managed connections (including the ANM scheme). This largely impacts community-owned sites and those on the more remote Northern Isles in Orkney. Repowering these sites will require consideration in supporting the de-risking of projects as repowered turbines will likely have a larger rated power than current turbines. This increases their likelihood of curtailment under a managed or non-firm connection while increasing costs and losing the financial certainty of the Feed-in Tariffs (FiTs).

Transmission network development

The potential for a transmission connection to the islands has been extensively explored due to the renewable electricity resources around the island, alongside Orkney's position at the forefront of the global marine energy sector. SSEN have been engaging heavily with authorities and stakeholders since 2017. In 2023, Ofgem awarded final approval for a subsea electricity transmission link between Orkney and the Scottish mainland – a point-to-point connection between Finstown and Caithness.[10]This significant new connection includes several proposed elements (see Figure 15):

- A purpose-built substation at Finstown is designed to be the connection point to the local grid and will transform the voltage to 220 kV.
- An onshore HVAC cable, approximately 14 km in length, connecting Finstown Substation to the subsea cable landfall point at Warebeth, Orkney Mainland.
- A subsea HVAC cable, approximately 57 km in length, connecting landfall at Warebeth to landfall in Dounreay, mainland UK. A short underground cable will then connect to the Dounreay Substation.
- A second purpose-built substation at Dounreay will step up the voltage to 275 kV, suitable for connection into the existing infrastructure at the current Dounreay Substation, of which modification work will also be underway.

The timescale for this connection can be summarised as:

- 2023: Ofgem final needs case approval and onshore environmental assessment complete
- 2024: Substation construction commences.
- 2025: Onshore cable installation, HDDs, and marine pre-installation activities start.
- 2026: Begin offshore cable works.
- 2027: Cable installation and substation construction completed.
- 2028: Commissioning and energisation.

[10] Scottish and Southern Electricity Networks – Transmission, 2024. Orkney connection.

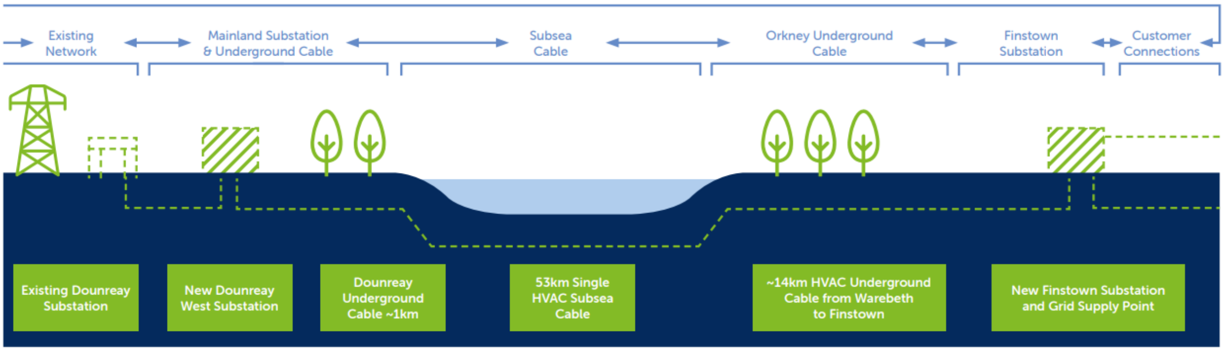


Figure 15
Overview of proposed Orkney transmission link

Source: SSEN

The transmission link is expected to be commissioned and online by 2028, capable of transmitting no less than 220 MW of power.[11] Ofgem required over 135 MW of new projects to trigger the Needs Case for the link, which was met within the 'Conditionality' scenario put forward by OIC. The council also put forward an 'Enabled' scenario, which saw over 300 MW of longer-term renewable growth enabled by the transmission link.[12]

Stakeholder engagement suggested that the proposed transmission connection is already nearing capacity, demonstrating the appetite across Orkney. The existing distribution network (onshore and subsea) will need to support the surge in capacity brought about by the transmission link, both near-term capacity and projects enabled across the longer term.

[11] Scottish and Southern Electricity Networks – Transmission, 2023. Orkney-Caithness 200kV HVAC Subsea link information booklet August 2023.
[12] Orkney Islands Council, n.d. A transmission link for Orkney.

3.2. European Marine Energy Centre

Since its introduction in 2003, the European Marine Energy Centre (EMEC) has played a pivotal role in Orkney's electricity network. As a world-renowned test and demonstration facility for wave and tidal energy convertors, EMEC is at the forefront of global marine energy technology and has significantly contributed to Orkney's renewable electricity generation. However, this has come at a cost and has resulted in Orkney becoming a net exporter of electricity. In 2013, c.103% of Orkney's total electricity demand came from on-island renewable sources, this rose to c.128% by 2020.[13]

Further project developments are expected at EMEC, supported the Scottish Government's Draft Energy Strategy and Just Transition Plan,[14] which targets 40 MW of installed tidal stream capacity by 2027. Across the last two Contracts for Difference (CfD) Allocation Rounds – AR4 and AR5 – Orbital Marine Power[15] was awarded 14.4 MW of tidal stream generation capacity. Around 7.2 MW of this capacity is expected to connect to Orkney's network via EMEC's Eday test site by 2026/27[16], with the additional 7.2 MW of capacity expected to be delivered by 2027/28,[17] also at Eday. Additionally, Orbital Marine Power was awarded a 30 MW Option Agreement from Crown Estate Scotland in 2023 to develop a new tidal energy project in Westray[18] - a grid connection is already in place to supply the project.

EMEC also hosts a 7 MW connection at its wave energy test site at Billia Croo. Recent government suggestions to target the deployment of four wave energy convertors (250 kW each) at EMEC by 2027[14], coupled with European ambition and funding to expand the wave energy portfolio,[19] have already kick-started a prospective pipeline of wave energy projects that could look to test at Orkney. This has been supported with confirmation from wave energy developers to test at EMEC's facility from as early as 2025.[20]

In addition to already-tested tidal stream and wave energy technologies, EMEC is also pursuing a position within the floating offshore wind industry and has concluded a concept design for a floating offshore wind test and demonstration site near the Billia Croo site.[21] This new site will comprise six individual berths accommodating turbines of up to 20 MW rated capacity each. Four berths will be grid-connected, while the others will be reserved for power-to-X applications. EMEC is currently assessing opportunities for a 100 MW lease for this development.

With the confirmation of the new subsea transmission cable, additional capacity at EMEC could pursue a connection to the higher-voltage network. Despite this, the distribution network will still need to support the upfront build-out and ongoing maintenance of projects seeking to connect at EMEC's sites. This could also create additional electricity demand for any necessary development

[13] Orkney Renewable Energy Forum, 2021. Orkney's energy.
[14] Scottish Government, 2023. Draft Energy and Just Transition Plan.
[15] Orbital Marine Power.
[16] DESNZ, 2022. Contracts for Difference (CfD) Allocation Round 4: results.
[17] DESNZ 2023. Contracts for Difference (CfD) Allocation Round 5: results.
[18] Orbital Marine Power, 2023. Orbital Marine Power unveils new 30MW tidal energy project in Orkney waters.
[19] Ocean Energy Europe, 2022. Ocean Energy – Key trends and statistics.
[20] EMEC, 2023. Mocean Energy secures Europewave funding for wave energy demo at EMEC.
[21] EMEC, 2023. EMEC floating wind demo site offers £690 million opportunity to UK.

and use of port facilities, as well as through the use of towing vessels and heavy machinery. Further to this, the introduction of low-carbon operational maritime vessels could contribute to shore power charging as renewables developers look to decarbonise the entire project lifecycle. There is also the consideration for additional indirect demand growth for housing and accommodation for relevant construction and operations teams.

The development and installation of renewable energy projects at EMEC align with suggestions in the Scottish Government's Draft Energy and Just Transition Plan (as mentioned above), where a lack of distribution grid reinforcement could significantly impact their build-out and put the targets at risk.

In addition to renewable generation, EMEC hosts flexible storage technologies. EMEC operates a hydrogen research and development ecosystem focusing on the full value chain (from production and storage to transportation and end-use). EMEC's Hydrogen Production Plan on Eday is currently integrated with locally sourced renewable energy, where installed switch gear determines whether the onsite electrolyser is powered using tidal energy from the Fall of Warness or the 900 kW community wind turbine on Eday.

Discrepancies between tidal-generated power supply and the demand for the electrolyser will be smoothed using a 1.8 MWh Vanadium flow battery at EMEC's tidal test site at Eday.[22] This will allow continuous hydrogen production from variable renewable generation, optimising annual hydrogen production.

SSEN should continue engaging with EMEC and hydrogen innovation projects developing in Orkney and across Scotland to understand the impact this may have on the electricity network. Further generation and hydrogen development spearheaded by the European Marine Energy Centre (EMEC) may see electricity storage (including potentially longer duration storage) as a solution to increase on-island energy use.

[22] European Marine Energy Centre, 2020. Press release: FLOW batteries to combine with tidal power to produce world's first continuous green hydrogen.

3.3. Flexibility technologies

Battery storage

Electricity storage could be a significant source of flexibility in a net zero electricity system. Regen's analysis suggests electricity storage could account for 20-25 GW of flexibility capacity by 2035. Whilst other longer-duration storage technologies are being pioneered across the UK,[23] lithium-based battery storage is the most dominant technology being developed and leveraging flexibility markets. Thousands of battery storage projects are being developed at various scales across the UK, with a pipeline of around 200 GW of capacity.

Battery assets can be categorised in the following ways:

- Standalone grid services – typically MW scale, modular, containerised battery storage assets that provide a range of ancillary services to the network.
- Generation co-location – typically MW scale, designed to geographically co-locate, grid connection share, or physically co-operate with large-scale generation projects (i.e. wind farms or solar farms) to reduce curtailment and optimise pricing and revenues.
- High energy user – 'hundreds of kW' scale, located onsite at commercial or industrial business premises, for onsite energy management, backup supply support, or to maximise the self-use of onsite generation (i.e. commercial rooftop PV).
- Domestic batteries – potentially 1-15 kW scale, designed to enable households to increase the self-consumption of domestic solar PV and act as a backup power supply for rural households.

In recent years, the ESO has evolved their suite of response and reserve services, including the new trio of frequency response markets: Dynamic Containment, Dynamic Regulation and Dynamic Moderation. Large commercial batteries are very active in these and other ancillary service markets. Under the Government's Review of Energy Market Arrangements (REMA), opportunities for flexibility services will continue to evolve, and battery storage is likely to remain a significant market participant.

DFES 2022 projections

The North of Scotland licence area has seen a notable increase in applications to connect new battery storage projects. In 2022, this totalled 4.2 GW of contracted or quote-issued sites, of which 1.8 GW was active in planning. However, no pipeline sites are seeking to connect in Orkney. As a result, only a moderate capacity (c.23 MW) was projected to connect by 2050. This included 18 MW of large commercial-scale batteries (standalone grid assets, batteries co-located with renewable generation and those co-located with high energy users) and 4 MW of domestic batteries located across homes that have rooftop PV installed (see Figure 16).

[23] See Longer Duration Energy Storage Demonstration competition funding, managed by DESNZ

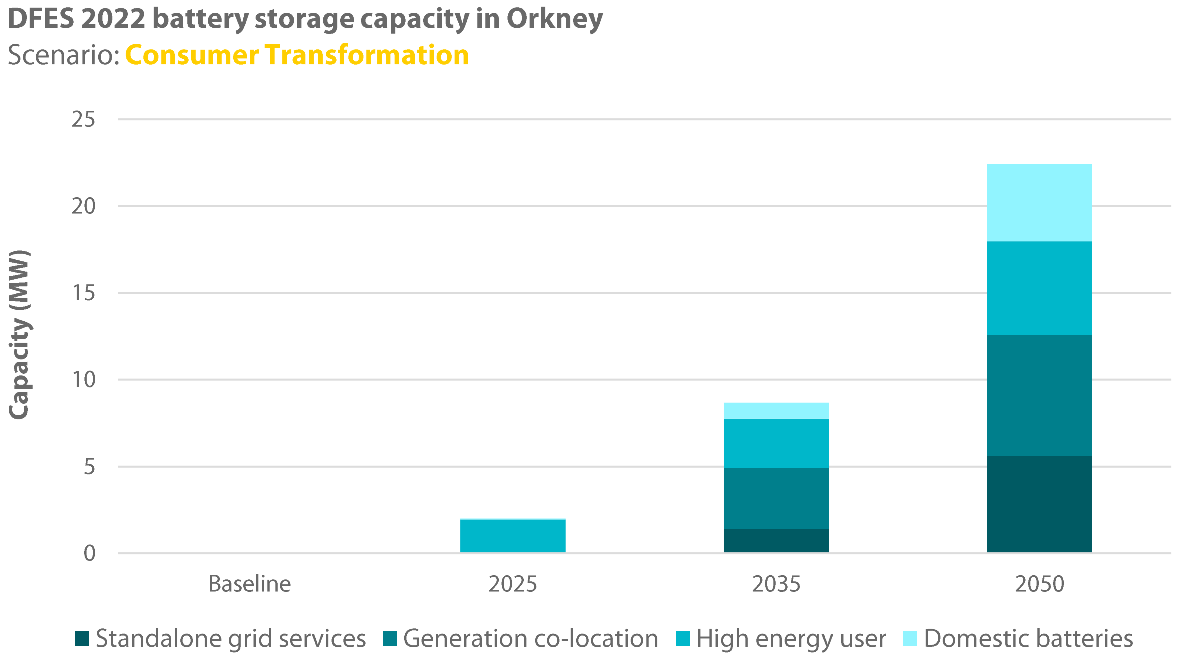


Figure 16
Projected cumulative battery storage capacity in Orkney by storage business model

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

Baseline and pipeline as of 2023

The pipeline of battery storage projects has surged across the country in the last couple of years, reaching upwards of 180-200 GW as of September 2023.[24] Whilst this has created a bottleneck to secure grid connections and long connection queues, there remains significant interest in connecting battery storage projects of various scales across GB.

The North of Scotland licence area has seen a significant increase in battery projects seeking to connect to the distribution network, with the total pipeline of contracted or quote-issued sites now reaching 7.7 GW, of which 4.1 GW (52%) is currently active in planning.

However, the only storage asset connected in Orkney to date is a 1.8MWh flow battery system, connected in August 2022 at the European Marine Energy Centre (EMEC) on the island of Eday.[25] This site is also not designed to export, as the aim is for the flow battery to smooth the supply of electricity from tidal generation to an onsite 670kW hydrogen electrolyser.

Beyond this flow battery, no other battery storage projects hold accepted connection agreements in Orkney based on SSEN's connections data.

[24] Regen analysis completed for Energy Storage Summit 2023
[25] See Invinity, Aug 2022, Invinity

Table 4

Baseline and pipeline distributed flexibility technologies connected and accepted to connect in Orkney.

Generation technology	Number of installed sites	Installed capacity (MW)	Number of pipeline sites	Pipeline capacity (MW)
Battery storage	1	1.8	0	0
Total	1	1.8	0	0

Source: SSEN 2023 connections data

Further industry insights

Future battery storage projects connecting in Orkney will be largely developer-led. The presence of wind and marine energy generation developments through EMEC suggests that the co-location of more battery storage could be seen in the future. However, with the network constraints and logistical limitations of the island group, battery developers are currently prioritising mainland Scotland and other parts of the UK to develop battery projects.

Hydrogen electrolysis

Orkney has already seen the development of several low-carbon hydrogen projects (Table 5). These projects have stemmed from Orkney's excess of renewable electricity, which is curtailed under ANM as the network is at capacity. The production of hydrogen as a storage medium mitigates constrained local grid infrastructure and can potentially reduce the reliance on costly carbon-intensive fossil fuels for rural communities across Orkney.[26]

Table 5
Hydrogen-based projects within Orkney

Project	Timeline	Total budget	Description
Surf 'n' Turf	2016 - 2022	£3m	0.5 MW electrolysis in Eday from tidal and wind. Looked into logistics of hydrogen transport.
BIG HIT	2016 - 2022	€7.3m	Follows from Surf 'n' Turf to implement a fully integrated hydrogen model for hydrogen.
Dual Ports	2016 - 2019	€5.2m	Aims to decarbonise Regional Entrepreneurial Port resources through a shared programme.
HyDIME	2018 - 2019	£1.2m	Design and integration of a hydrogen injection system on a commercial passenger and vehicle ferry.
HySEAS III	2019 - 2023	€12.6m	Integration of a hydrogen fuel cell propulsion system on inter-island ferry.
ITEG	2017 - 2023	€11.79	Develop an all-in-one solution for production of hydrogen from excess capacity.
HyFLYER	2019-2023	£5.3m	Decarbonise medium-range small passenger aircraft using electric motors, hydrogen fuel cells and gas storage.
ReFLEX Orkney	2019 - 2023	£28.5m	Demonstration of a virtual energy system that interlinks electricity generation, transport and heat.

[26] Orkney Renewable Energy Forum, 2020. Orkney Hydrogen Strategy 2019-2025.

ReFLEX Orkney

ReFLEX Orkney is a £28.5 million smart grid project, funded through UKRI's Industrial Strategy Challenge Fund, which aims to create an integrated energy system in Orkney. This system will integrate local electricity generation, transport and heat networks and create one controllable, overarching system (FlexiGrid) which digitally connects distributed and variable renewable generation to flexible demand in real time. The project aims to fully decarbonise Orkney by 2030 and intends on providing a replicable model that can be implemented across other communities in the UK. To achieve this, the consortium has laid out several targets which will directly affect the local grid, including:

- Install over 1,000 interlinked flexibility assets covering domestic, business and gird-scale batteries, vehicle-to-grid chargers and electric heating systems.
- Establish a community electric bus and e-bike integrated transport system.
- Create a hydrogen fuelled, commercial scale CHP system.

The demonstration of flexible technologies is key to this project. Alongside technologies such as battery storage, EVs and smart chargers, larger-scale and community-focused initiatives are being assessed. This includes electric buses, a local electric car hub and the integration of green hydrogen for storage and transport. Since the project's launch in 2019, ReFLEX Orkney has:

- Introduced over 100 EVs intOrkney.
- Introduced two people-carriers operated by community groups
- Submitted grid connection applications for over 350 Orkney properties looking to install batteries and/or solar panels.

SSEN should continue to engage with ReFLEX Orkney to understand impact this could have on the grid across Orkney.

Although the production of green hydrogen through electrolysis plants could be a potentially significant source of future electricity demand, as an emerging technology, there is uncertainty around the scale of development of green hydrogen production that could be seen nationally, regionally and locally.

At present, several factors are unclear regarding hydrogen production:

- Whether electrolysis will be largely transmission or distribution network connected
- The volume of hydrogen that will be produced via electrolysis (green hydrogen) versus via CCUS-enabled methane reformation (blue hydrogen)
- The degree to which electrolysers will be located near storage facilities for distribution versus near potential end-user sectors.

However, the British Energy Security Strategy[27] outlined a target for 5 GW of low-carbon hydrogen from electrolysis by 2030, including an electrolytic hydrogen fund to support new projects. The Scottish Government Hydrogen Action Plan[28] also confirmed ambitions to install 5 GW of low-carbon hydrogen by 2030 and 25 GW by 2045, with £100m of funding to develop a Scottish hydrogen economy.

DFES 2022 projections

For the whole of the North of Scotland licence area, SSEN's DFES 2022 analysis projected 395 MW of hydrogen electrolysis capacity by 2050 under Consumer Transformation.

Other scenarios (Leading the Way and System Transformation) see moderately higher projections (560-820 MW) due to the higher demand for low-carbon hydrogen from heating, transport and industry consumers.

Of the regional projections for electrolysis under Consumer Transformation, only a relatively small amount of capacity is modelled to operate in Orkney, totalling just under 20 MW by 2050. This reaches 90 MW under Leading the Way.

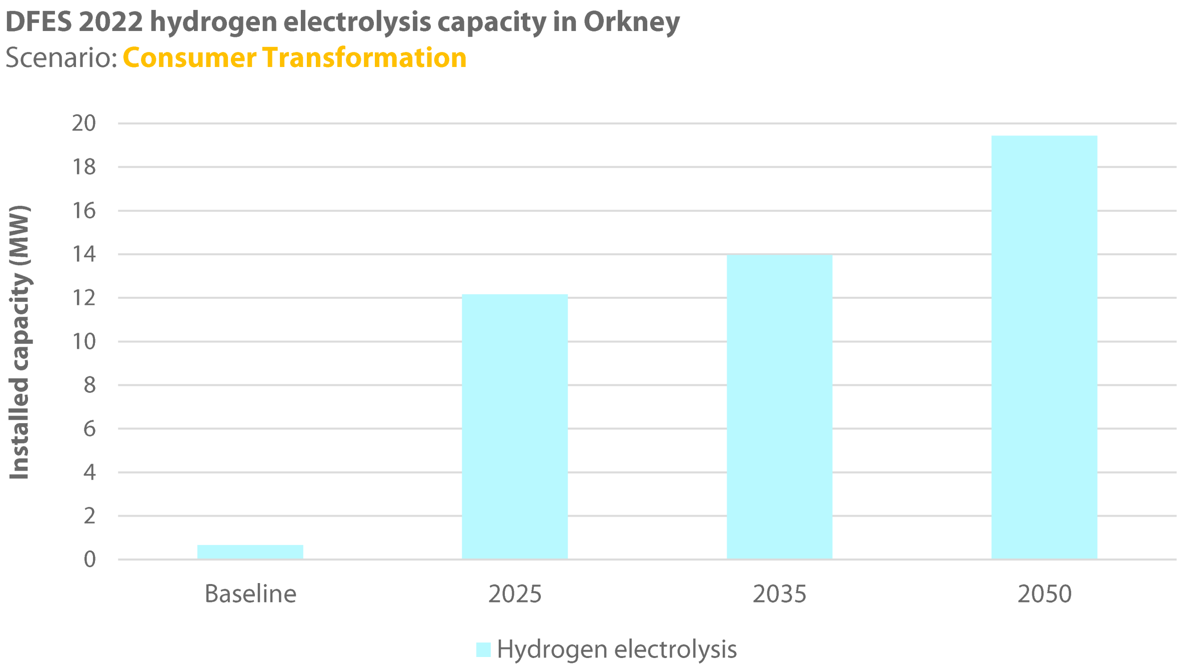


Figure 17

Projected cumulative hydrogen electrolysis electricity demand capacity in Orkney

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

[27] UK Government, 2022, British Energy Security Strategy
[28] Scottish Government, 2022, Hydrogen Action Plan

Baseline and pipeline as of 2023

There are two operational electrolysers located in Orkney (a 1 MW electrolyser at Shapinsay and a 0.5 MW electrolyser at Eday). These were developed and used as part of the Building Innovative Green Hydrogen Systems in Isolated Territories (BIG HIT) project.[29]

Beyond these sites, there are currently no pipeline electrolysis projects seeking to connect to SSEN's distribution network in Orkney, based on SSEN data. However, initiatives are being pursued on the islands that could lead to future grid connections for electrolysers:

- Offshore Wind Power Limited were successful in Crown Estate Scotland's Scotwind leasing round. Their West of Orkney Windfarm could deliver renewable power to a proposed green hydrogen production facility at the Flotta Oil Terminal.[30] OIC recently gave its support for the West of Orkney Windfarm consortium's development plans.[31]
- Through the HySpirits 2 programme, Orkney Distillery will test four different green hydrogen-fuelled technologies to decarbonise the distilling process.[32] The successful technology will be used as a demonstration for the wider distilling sector.
- Loganair and Cranfield Aerospace Solutions (CAeS) have recently signed a Memorandum of Understanding to develop an operational hydrogen-electric aircraft flying from Kirkwall by 2027.[33]

[29] BIGHIT, n.d. About the project.
[30] Flotta Hydrogen Hub, n.d. Flotta Hydrogen Hub: Update coming soon.
[31] EnergyVoice, 2024. Council backing secured for West of Orkney Windfarm.
[32] European Marine Energy Centre, 2021. Green Distilleries Competition: HySpirits 2 Public Report.
[33] The Orcadian, 2024. Project aims to get 'world's first' net zero air service off the ground by 2027.

3.4. Transport electrification

The shift to electrified transport could be one of the biggest sources of electricity load growth across the islands and will need to be a key consideration for strategic network planning. As of November 2023, OIC is collecting feedback on its Local Transport Strategy: 2024–2044.[34] Whilst fossil fuels currently remain the predominant fuel type for public and private transport across Orkney, proposed updates to the local transport policy demonstrate a significant ambition to shift towards low carbon transport - in line with the Scottish Government's 2045 net zero target.

OIC has recognised the decarbonisation of transport as a key priority and is looking to promote initiatives such as an increased proportion of zero-carbon vehicles and marine vessels alongside increased use of public transport and active travelling into and within the islands.

Electric vehicles

Orkney currently has one of the highest numbers of EVs per head of population in the UK[35], with owners charging their vehicles through public charging points and private connections. A greater public sector commitment (i.e., OIC's Orkney's Electric Future[36] report and council-owned EV charging infrastructure) alongside initiatives such as ReFLEX Orkney[37] can be attributed to an increase in private EV ownership, alongside an increase in tourists visiting the islands, either bringing their own EVs or hiring one locally.

DFES 2022 projections

Based on SSEN's 2022 DFES analysis, there could be just under 12,000 EV cars and light goods vehicles (LGVs) registered in Orkney by 2035 (see Figure 18). This is in line with an accelerated uptake of battery EVs across the next decade as a ban on the sale of new petrol and diesel cars comes into force, coupled with an increase in consumer confidence and an expected decrease in EV capital costs.

The uptake of EVs does slow in Orkney post-2035, increasing to just under 14,000 by 2050, which is likely due to increased use and deployment of public transport and active travel across the islands. All road vehicles considered in this scenario are projected to be fully electric rather than hybrid due to policies favouring fully electric battery EVs.

[34] Orkney Islands Council, 2023. Orkney Local Transport Strategy 2022-2044 DRAFT.
[35] Orkney.com, n.d. Renewables.
[36] Urban Foresight, 2015. Feasibility study: Orkney's electric future.
[37] ReFLEX Orkney, n.d. ReFLEX Orkney.

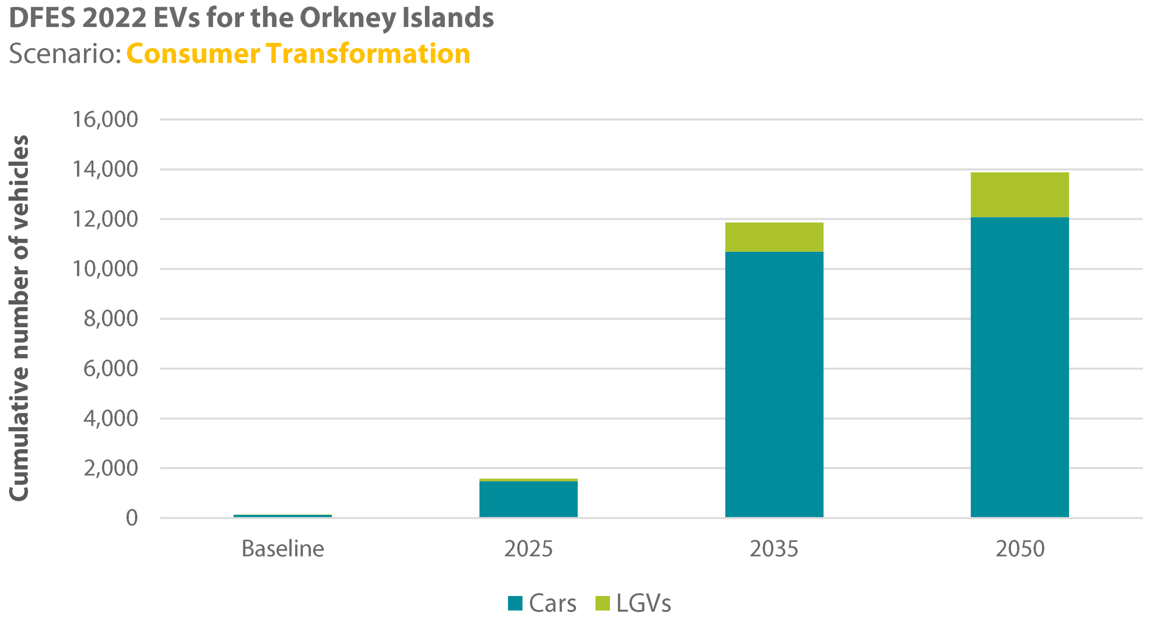


Figure 18

Projected cumulative number of EV cars and LGVs in Orkney

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

The additional electricity demand that this uptake of EVs could create on the network in Orkney can be conveyed through the projected EV charger capacity (expressed in MW) from SSEN's DFES 2022 analysis. Using the projections of vehicle types, an analysis of mileage driven and a range of different EV charger archetypes considered, the total connected EV charger capacity across Orkney could reach 8.5 MW by 2035, increasing to 10.3 MW by 2050 (Figure 19). This capacity is purely for non-domestic EV archetypes, such as chargers at car parks, workplaces, fleet depot locations and en-route/local charging stations.

As well as the non-domestic demand, there is expected to be a significant uptake in the number of domestic EV chargers installed in households across Orkney. DFES 2022 projections show just under 8,000 off-street domestic chargers by 2035 under Consumer Transformation, increasing to over 9,600 by 2050 (Figure 20). This is in line with the Building (Scotland) Regulations[38] – in force since June 2023 – which requires at least one EV charger (minimum rating of 7 kW) in all new residential buildings with a parking space and those under major renovation. Domestic EV charger uptake will be concentrated in more populated areas such as Kirkwall and Stromness.

[38] Scottish Government, 2023. Building Scotland (Amendment) Regulations 2022.

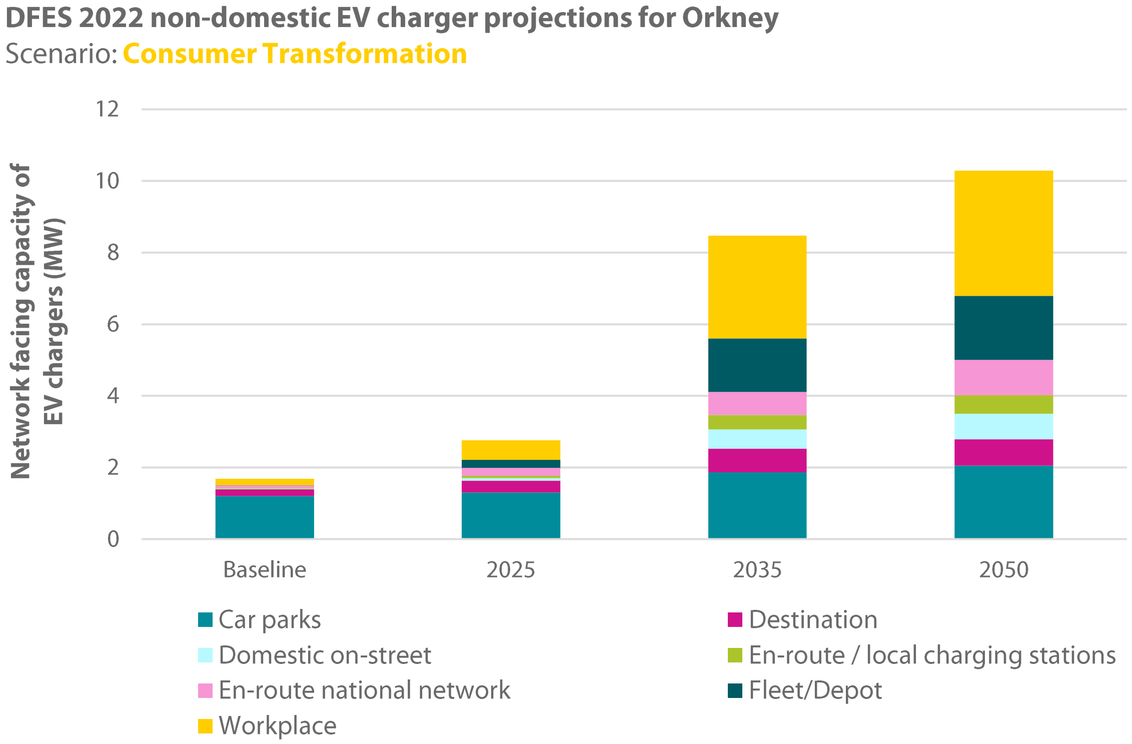


Figure 19

Projected cumulative EV charger capacity in Orkney

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

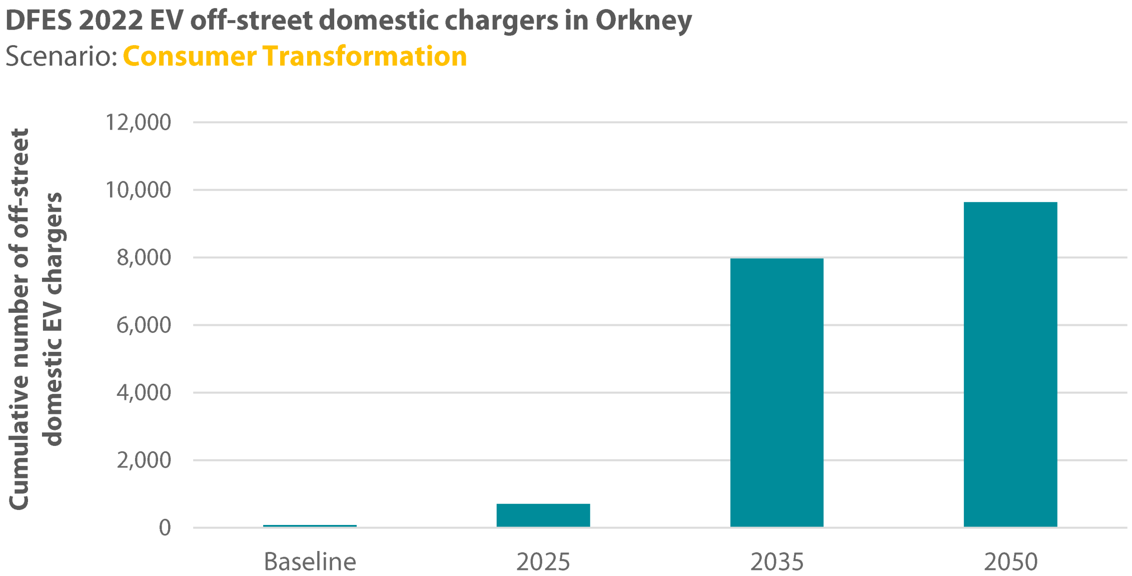


Figure 20

Cumulative domestic off-street chargers in Orkney

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

When considering the various potential EV charging behaviours that could be adopted by drivers in Orkney, the actual diversified peak EV charging demand that could be seen on SSEN's LV network is unknown. There are a variety of factors that would affect the combined diversified charging profile and peak demand from EVs, including types of car, vehicle use and the type of property the EVs are associated with. These factors, coupled with the uptake and increased use of public transport, could all significantly affect the charging profiles that could be used to determine a diversified peak transport electricity demand. However, it is clear from the DFES projections that the electricity demand from road transport in Orkney will increase significantly between 2025 and 2035.

Further industry insights

A key consideration for Orkney's future transport load growth is the number of tourists that visit the islands each year. In 2019 (the year of the last visitor survey), Orkney welcomed 394,000 visitors,[39] nearly 20 times the number of permanent residents. This additional capacity across summer months could significantly impact the distribution network.

Several low-carbon initiatives are already in place to support tourists and local residents travelling around the island group, demonstrating forward-looking developments for sustainable transport across Orkney. Examples include:

- Orkney's Co Wheels Car Club stems from a national membership-based service that allows users to rent electric vehicles.[40] In 2023, the Orkney initiative expanded by adding two new EVs – one at Kirkwall Pier and one at the Orkney Research and Innovation Centre (ORIC) in Stromness.
- JP Orkney uses all-electric EVs when offering visitor tours around the islands.[41]
- The Stromness ferry terminal is already equipped with two 7 kW AC fast chargers,[42] with both rapid and fast chargers close to the terminal.

Alongside EVs, public transport should also be considered as a potentially significant impact on future electricity demand. The island's bus network is heavily used all year by school children and particularly by visitors in the summer months. There is also free bus travel available across Scotland for under 22-year-olds.

OIC recently signed a contract with Stagecoach, which has seen £5.4 million invested in a new low-carbon bus fleet for the islands[43]. Whilst this fleet will be diesel-powered, the new buses meet Euro 6 standards and are classed as a low-emission fleet. The council also has ambitions to bring onboard green hydrogen and electric-powered buses when feasible. This shift towards electrifying bus transportation in Orkney could be a significant source of load growth. Current range considerations, alongside the necessary number of vehicles and their associated network charging profiles, will need to be discussed with relevant transport operators.

---

[39] Visit Scotland, 2022. Orkney Tourism Strategy 2020-2030.
[40] Co Wheels, n.d. Electric car share across the Orkney Mainland.
[41] JP Orkney, n.d. Green Policy.
[42] NorthLink Ferries, n.d. Electric vehicles.
[43] Orkney Islands Council Harbour Authority, 2021. The brand-new low carbon bus fleet for Orkney.

Maritime transportation

Three main ferry companies operate frequent external and internal ferry routes around Orkney. NorthLink Ferries (owned by Serco) and Pentland Ferries Limited both operate external ferries between Orkney and the Scottish mainland, with NorthLink Ferries also operating from Orkney to Shetland. Both fleets can accommodate between 230 to 600 passengers per crossing, with the addition of cars and freight. Inter-island ferries are operated by Orkney Ferries. Their nine ferries operate 74 different point-to-point connections across the network, accounting for over 20,000 sailings annually.[44]

All three ferry operators have committed to decarbonising their vessel fleets, with initiatives ranging from electrifying propulsion systems and associated fuel to installing energy-efficient measures on board (i.e., LED lightbulbs). See Figure 21.

NorthLink Ferries, in partnership with OIC and Schneider Electric, has already piloted the Hamnavoe Shore Power project, which has seen the MV Hamnavoe' plug in' whilst docked at Stromness overnight since 2019.[45] The initiative has lowered the ship's annual fuel consumption by around 500 – 2,500 tonnes of CO_2 and is expected to save approximately 97,000 gallons of fuel each year.[46] Other elements, such as an electric bus charger at the ferry terminal, electric vehicle charging points and the procurement of electric bicycles, are also underway as part of this project.

More recently, Orkney has been awarded funding from the Department for Transport to operate two battery-electric hydrofoil passenger vessels across the islands across a three-year period and install associated charging infrastructure for the batteries.[47] The first of these (a smaller 12-metre vessel) will likely be delivered in 2024 and will carry passengers between Kirkwall and the islands of Shapinsay, Rousay, Egilsay and Wyre on an annual daily service. The larger 24-metre vessel is expected in 2025 and will take passengers and light cargo between Kirkwall and the outer islands of Westray, Eday, Sanday and Stronsay, completing a circuit up to five times a day.[48] The expected electricity demand from charging these vessels is unclear. SSEN should engage with Orkney Ferries and the Harbour Authority to ensure the local network can support these vessels' peak charging and associated charging profiles.

[44] Orkney Ferries, n.d. The fleet.
[45] NorthLink Ferries, n.d. Hamnavoe Shore Power Project.
[46] British Ports, 2020. Orkney: UK's first intermediate voltage shore power connection.
[47] Department for Transport, 2023. Zero Emission Vessels and Infrastructure (ZEVI) competition winners.
[48] Orkney Islands Council, 2023. £15m funding award for electric vessels in Orkney.

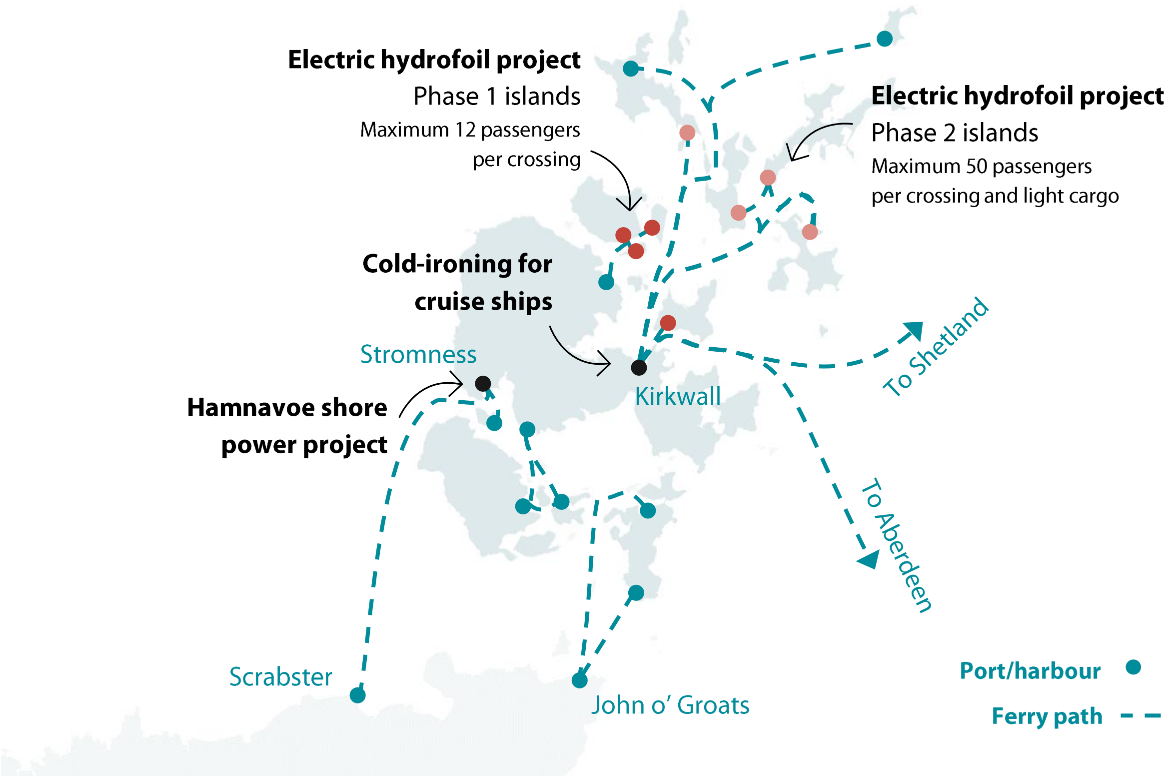


Figure 21

Known maritime electrification initiatives in Orkney

Outside of the trials, the timeframe of possible electricity load growth is heavily linked to the timeline of individual vessel propulsion systems being changed. This timeline is difficult to quantify due to uncertainties around technology readiness. However, partial/hybrid or full electrification at some scale (as opposed to ammonia or biomethane) is being considered, particularly for smaller-scale roll-on/roll-off ferries. Any associated use of shore power – to charge these vessels – could equate to a significant load at each of the relevant ferry terminals.

Ferries are one of the primary modes of maritime transport across Orkney, and their shore power requirements, charging profile and ability to charge EVs will be major considerations for any network reinforcement. However, shore power requirements for other vessels and the roles they provide to residents and businesses should also be considered:

- Recreational sailing – may require shore power installed at marinas and harbours.
- Fishing and aquaculture – Orkney has a strong commercial inshore fishing fleet across the islands and is home to Europe's largest crab processing plant. Commercial fishing for prawn, lobster and large-scale salmon farms contributes significantly to the local economy and significant volumes are shipped to the mainland once processed.[49]

[49] Orkney Islands Council Harbour Authority, n.d. About.

- Cargo – dedicated freight vessels operate between Aberdeen and Kirkwall six days a week, catering to all types of traffic including project cargoes for renewable energy, construction and the oil and gas sector.
- Cruises – as a popular location, Orkney received around 132,000 cruise passengers and 50,000 crew in 2019,[50] and cruise numbers across Orkney are expected to increase each year. Several organisations in Orkney were recently awarded funding through the Clean Maritime Demonstration Competition (CMDC) – Round 4 to develop a solution for cold-ironing at Kirkwall port, capable of sustaining hotel loads of cruise ships at anchorages.[51] This could become a significant source of future electricity demand at key port locations.

An estimate of the electricity load requirements from these industries requries a more detailed assessment, with most of these industries acknowledging that shore power for their vessels is a vital part of their current route to net zero. SSEN is already assessing the significant increases in electricity demand at ports and harbours from the shipping sector through the SEACHANGE project.[52] Having recently secured funding from Ofgem's Strategic Innovation Fund to progress, SEACHANGE will see SSEN partner with EMEC, the Power Networks Distribution Centre (PNDC) and Ricardo to model how ports and harbours could support the maritime sectors net zero ambition.

Aviation

The electrification of aviation could play a large role in the future electrification demand of Orkney. Highlands and Islands Airports Limited (HIAL) has ambitions to decarbonise operations by 2040,[53] and both the Scottish Government and HIAL have committed to creating the world's first zero-emission aviation region through decarbonising airport operations, infrastructure and flights across the Highlands and Islands. This will be supplemented with activity to progress low and zero-emission planes.

The six outer north isles of Orkney (Eday, North Ronaldsay, Papa Westray, Sanday, Stronsay and Westray) can be reached through inter-island flights from Kirkwall airport, which is home to the £3.7 million Sustainable Aviation Test Environment (SATE) project.[54] The SATE project was created to test low-carbon aviation technologies alongside supported airport infrastructure, with Kirkwall airport hosting the UK's first operationally-based, low-carbon aviation centre. In 2021, SATE completed the UK's first series of demonstration flights of a hybrid-electric aircraft,[55] including a flight across the Pentland Firth from Kirkwall Airport to John O'Groats airport on the Scottish mainland using Ampaire technology.[56]

A separate project, created through a Memorandum of Understanding between Loganair – the main flight operator across the Scottish islands – and Cranfield Aerospace Solutions (CAes), is

[50] Visit Scotland, 2022. Orkney Tourism Strategy 2020-2030.
[51] Department for Transport, 2024. Multi-year clean maritime demonstration competition.
[52] Scottish and Southern Electricity Networks, 2023. SSEN Distribution secures funding for pioneering new innovation projects.
[53] Highlands and Islands Airports Limited, 2022. Sustainability Strategy 2023-33.
[54] Highlands and Islands Airports Limited, 2020. Sustainable Aviation Test Environment.
[55] Sustainable Aviation Test Environment, 2021. Ampaire Demonstrates First Hybrid Electric Aircraft in Scotland.
[56] Ampaire, 2023. Ampaire.

developing a hydrogen-electric aircraft, which is expected to be operational by 2027. The aircraft will run across the shorth-haul inter-island flights from Kirkwall.[57]

Following the success of its GreenSkies[58] initiative in the Outer Hebrides, Loganair has announced that electric ground equipment for aviation turnaround will be installed at Kirkwall Airport. This will allow the current diesel-powered ground equipment to be phased out and replaced by electrically powered alternatives, ultimately increasing the electricity demand across the airport. This included electric baggage trucks, solar-powered boarding ramps, hybrid ground-power units and on-ground EVs. There is ambition to establish this technology across all their Highlands and Islands airports, mitigating 70,000 litres of diesel annually.

Engagement with aviation organisations operating within the Scottish Islands provided some estimates of the potential electricity load that could be seen from electrifying aviation:

- Ground power unit - 225 kW.
- Electric Tug (for towing aircraft) - 400 kW.

The decarbonisation of future thrust/drive systems for aircraft themselves is difficult to quantify due to:

- Drive system technology readiness levels
- Fuel/charge range uncertainties
- Challenges around energy density versus aircraft payloads

It is anticipated that most aircraft fleets will electrify. However, whether aircraft fully electrify or use hybrid systems – particularly for long-duration flights – will depend on these and other considerations. As such, the electrification of the aircraft will likely be a longer-term consideration than the electrification of ground-handling equipment.

[57] The Orcadian, 2024. Project aims to get 'world's first' net zero air service off the ground by 2027.
[58] Loganair, 2023. Annual archive.

3.5. Electrification of heat

Decarbonising space heating technologies in homes and businesses could be a significant consideration for future electricity load in Orkney. The island currently has no mains gas connection, so households rely on electricity, oil and solid fuels for heating.[59] Direct electric/night storage heaters are the primary form of domestic heating across Orkney, used in approximately 43% of households. Oil is the primary form of heating in approximately 25-30% of households on the island, and 14% of domestic households use solid fuels as their primary heating fuel[21]. Community Climate Action Plans have been produced for Scottish Islands that are part of the Carbon Neutral Islands project, with Hoy and Walls (Orkney) indicating that 46% of emissions on their islands are from the residential sector (1,462 tCO_2e), with the average household using 8,600 kWh of electricity per annum.[60]

In addition, Orkney's climate and relatively older housing stock result in households using more fuel for space heating over the year than most other parts of GB.

Therefore, the transition to heat pump systems could notably increase the number of properties with electrified heating. That being said, as most households in Orkney currently rely on electrified heating, a transition to heat pump systems across the islands may not equivalently increase the overall electricity demand as heat pumps use much less power to deliver equivalent levels of heat. The resultant impact on network planning for an island with significant existing electrified heating will require SSEN to consider diversification factors, the coefficient of performance of heat pumps in homes on the islands and the resultant impact on the low voltage network in more urbanised areas.

DFES 2022 projections

Orkney's household heating demand comes primarily from direct electric heating (approximately 4,000 units). Under the Consumer Transformation scenario, there is expected to be an increase in the uptake of heat pumps, with just under 7,000 heat pumps operating in homes by 2035 in Orkney – including hybrid and standalone domestic variants. This could increase to over 8,200 by 2050 (Figure 22). According to 2022 DFES projections, all heat pumps deployed until 2050 will be in a domestic setting – no non-domestic heat pumps are anticipated.

This adoption of heat pumps is aligned with several targets and policies, including the Scottish Government's ban on gas boiler installations in new builds from 2024[61] and a target peak installation rate of 200,000 new heat pump systems per annum in Scotland in the late 2020s.[62]

In addition to these targets, the Scottish Government have recently provided additional support by amending the Home Energy Scotland Scheme in 2022,[63] making it easier for households to access funding for heat and energy efficiency measures. This scheme also provides additional support for

[59] Orkney Islands Council, 2014. Orkney's Fuel Poverty Strategy 2017-2020.
[60] Carbon Neutral Islands, 2023. Hoy & Walls, Community Carbon Neutral Pathway
[61] Scottish Government, 2021. Heat in Buildings strategy.
[62] Scottish Government, 2023. Housing/Net Zero Freedom of Information release
[63] Scottish Government, 2022. Enhanced support to make homes warmer and greener

rural areas, including in Orkney, by increasing the maximum funding to £9,000 per household. This could create enough incentive for residents to transition to low-carbon heating.

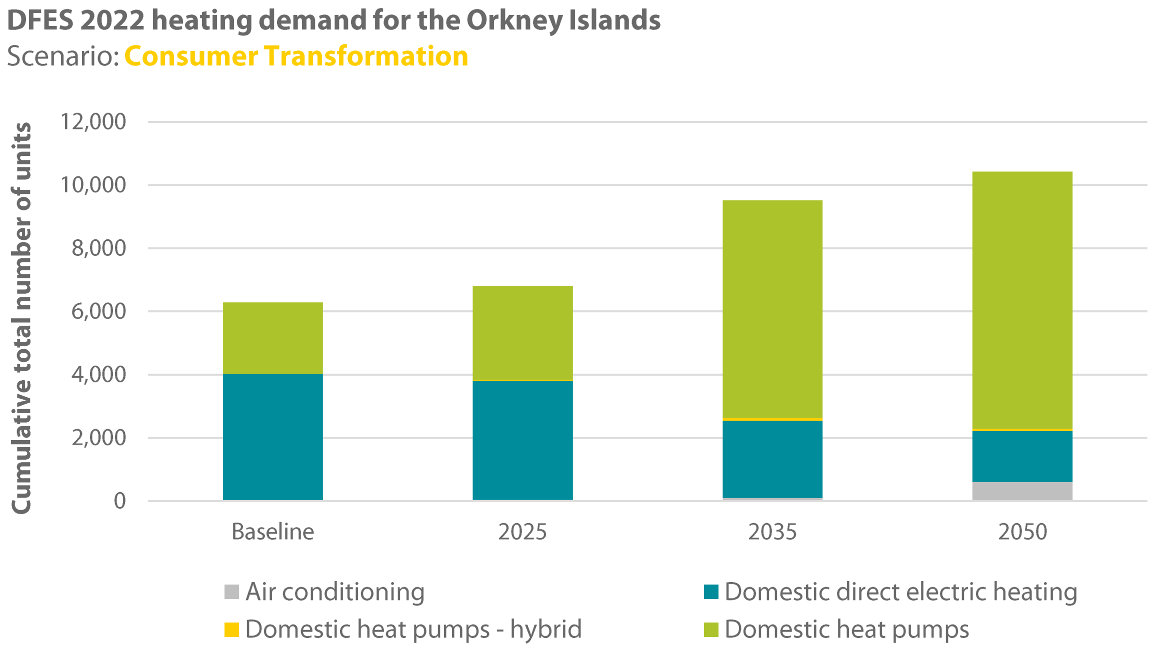


Figure 22

Projected cumulative number of heat pump types in Orkney

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

The Consumer Transformation scenario does not prioritise hydrogen-fuelled space heating. As such, heat pumps are this scenario's dominant low-carbon heating technology.

Within their Hydrogen Strategy,[64] Orkney Island Council have mentioned the potential for hydrogen to help with the islands' heating demand. The strategy highlights the potential to replace traditional fossil fuel heating systems with hydrogen boilers. It also mentions how 'waste heat' – generated by converting hydrogen back to electricity – could be captured and used for domestic purposes. This strategy also references pioneering hydrogen initiatives in Orkney, specifically 'Surf 'n' Turf'[65] and 'BIG HIT'[66], which have included heating offtake as one of the sectors that could be supported through hydrogen production.

However, the outcomes of these initiatives should be considered alongside broader strategic decisions and policy developments by both the UK Government and the Scottish Government on using hydrogen for home heating. Recent engagement with the OIC team also highlighted that since the OIC Hydrogen Strategy's publication, these aforementioned government announcements may mean that hydrogen for space heating is not being prioritised. Therefore, the role of hydrogen for residential heating in Orkney is unclear.

[64] Energy of Orkney, 2020. Orkney hydrogen strategy.
[65] Community Energy Scotland, 2020. Surf 'n' Turf.
[66] BIG HIT, 2020. Building innovative green hydrogen systems in isolated territories.

3.6. New building developments

DFES 2022 projections

Based on an analysis of a register of new developments supplied by Orkney Island Council, there are projections for new housing in Orkney, totalling 350 new homes by 2035, increasing to 630 by 2050, see Figure 23.

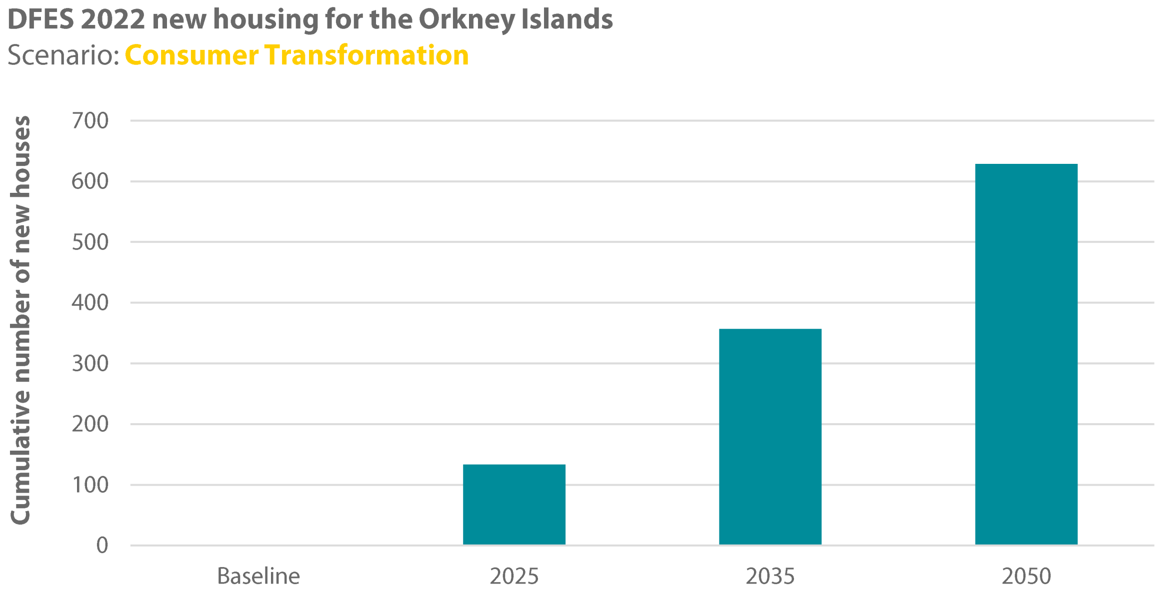


Figure 23

Projected cumulative number of new houses developed

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

In addition to domestic properties, Orkney Island Council shared data for non-domestic developments. By 2035, new non-domestic developments in Orkney are projected to total just under 450,000 m^2 of floorspace (Figure 24). This includes c.320,000 m^2 of factories and warehouses, just under 100,000 m^2 of new office floorspace and c.30,000 m^2 of university/ education buildings.

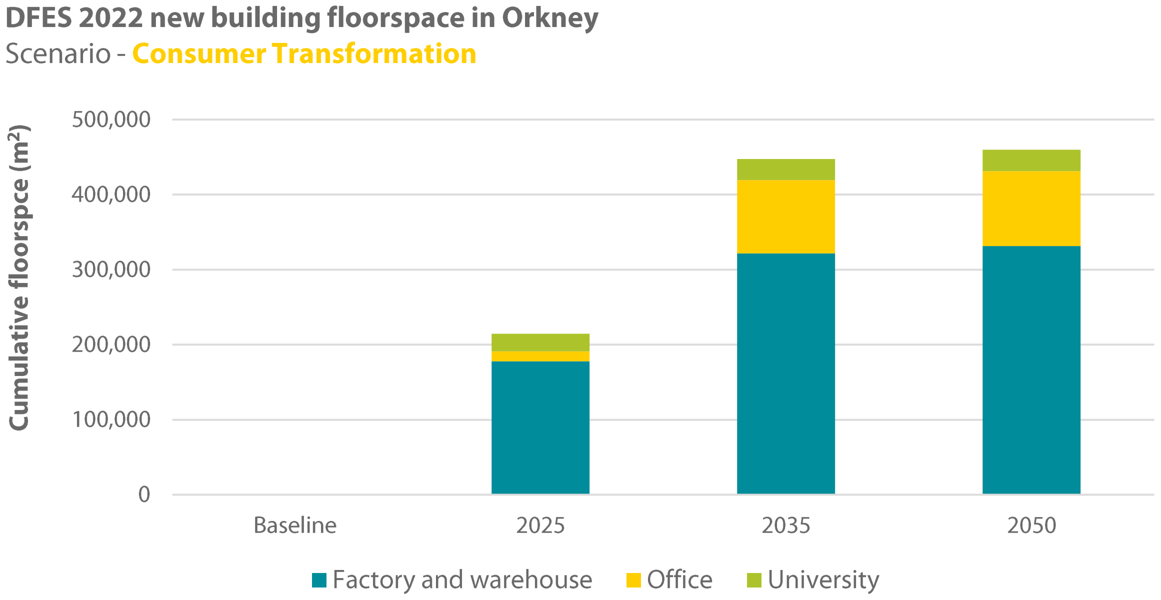


Figure 24

Cumulative floorspace for new non-domestic buildings

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

Further industry insights

In July 2025, Orkney will be hosting the 20th International Island Games. The week-long event will see Orkney welcome an expected total of 2,500-3,000 athletes and supporters from 24 global island groups.[67] The event will be the largest ever hosted in Orkney and has a mission to make the 2025 Games as environmentally friendly as possible. There is a significant opportunity for low-carbon developments, many of which will remain on the island after the games are over.

Not only will the network need to be able to support any new developments brought about by the Island Games, but it will also need to ensure it can cope with the increased electricity demand expected from the number of visitors the island will be hosting during the event period.

[67] Orkney 2025, n.d. About the Games.

3.7. Commercial and industrial electrification

In addition to the electrification of transport and space heating, Orkney is home to a range of commercial businesses and industries. The future decarbonisation pathways and resultant electricity requirements from these businesses are rapidly evolving areas. Engagement with several businesses and island representatives provided some insight into several areas of energy-intensive sectors operating in Orkney. This included views on the electrification of processes, transport and heat as well as broader aspirations and installation plans related to decarbonisation and net zero commitments of businesses.

Distilleries

Orkney currently hosts seven operational distilleries which produce spirits including whisky, gin and rum (Figure 25). Highland Park Distillery and Scapa Distillery, located on the Mainland, primarily focus on producing whisky – one of the most energy-intensive products to produce in the food and drink industry[68]. This accounts for a large proportion of energy demand on the islands.

Figure 25
Distilleries currently operating in Orkney

Estimates suggest that whisky production is more energy intensive than gin production, with 12.7-13.9 kWh per litre needed for whisky compared to only 1.7-2.3 kWh per litre needed for gin.[69] This is extremely relevant as the Orkney Distillery and Deerness Distillery, both of which currently produce gin on the Mainland, are expanding operations to accommodate the production of their own

[68] Heriot Watt University, 2021. Distilleries need blend of green energy and storage for net zero.
[69] EMEC Hydrogen, 2019. Industrial Fuel Switching Competition – HySPIRITS Public Report

whisky. As distilleries evolve into whisky distilling, this could increase energy demand at specific locations in Orkney. Irrespective of the product, distillery decarbonisation could be a significant source of future electricity demand.

Engagement with Edrington (the parent group of Highland Park distillery) highlighted that they are seeking to transition away from kerosene, which currently fuels the production of steam for distilling, cleaning/washing and space heating. Electrification of these processes could include using a high-temperature electric boiler to provide steam for the distilleries or potentially a high-temperature heat pump and mechanical vapour recompression. In addition to the electrification of the distilling process, most of Edrington's vehicle fleet has already been converted to EVs or biofuels.

Electrification could be a priority for their Orkney site, as there is no gas network on the island, and biomethane is only considered a short-term option. Solar PV has been explored in other locations across their portfolio, but solar is not being prioritised due to low irradiance levels on Orkney. However, it has not been fully dismissed. Onsite wind generation is challenging as the Highland Park distillery is on a flight path. However, there is potential for the Orkney site to have access to curtailed wind generation, and as such, a private wire to existing operational wind farms may be more feasible. Other technologies like battery storage are not a priority at the moment, as if renewable generation were feasible, the electricity would all be used directly. Hydrogen electrolysers are not attractive due to conversion losses.

Edrington is exploring funding for feasibility studies and is keen to engage with SSEN to consider what can be implemented within the next 3-5 years.

As discussed, the distilling process requires high-temperature heat, mostly provided by solid and liquid fossil fuels (such as kerosene in Orkney). The wider whisky industry has made progress towards decarbonisation, with non-fossil fuels making up 20% of its energy use in 2018, up from only 3% in 2008.[70] Engagement with the Scotch Whisky Association (SWA) highlighted that in their 2023-25 strategy, they are committed to achieving net zero emissions in their own operations by 2040.[71] A Riccardo report commissioned by the SWA in 2019 investigated how carbon reduction in the distillery industry could be achieved.[72] This included various options and technologies to reduce emissions, from energy efficiency to onsite renewables and hydrogen (see Figure 26).

---

[70] Heriot Watt University, 2021. Distilleries need blend of green energy and storage for net zero.
[71] Scotch Whisky Association, 2021. The Scotch Whisky Industry Sustainability Strategy.
[72] Scotch Whisky Association (Ricardo), 2020. Scotch whisky pathway to net zero.

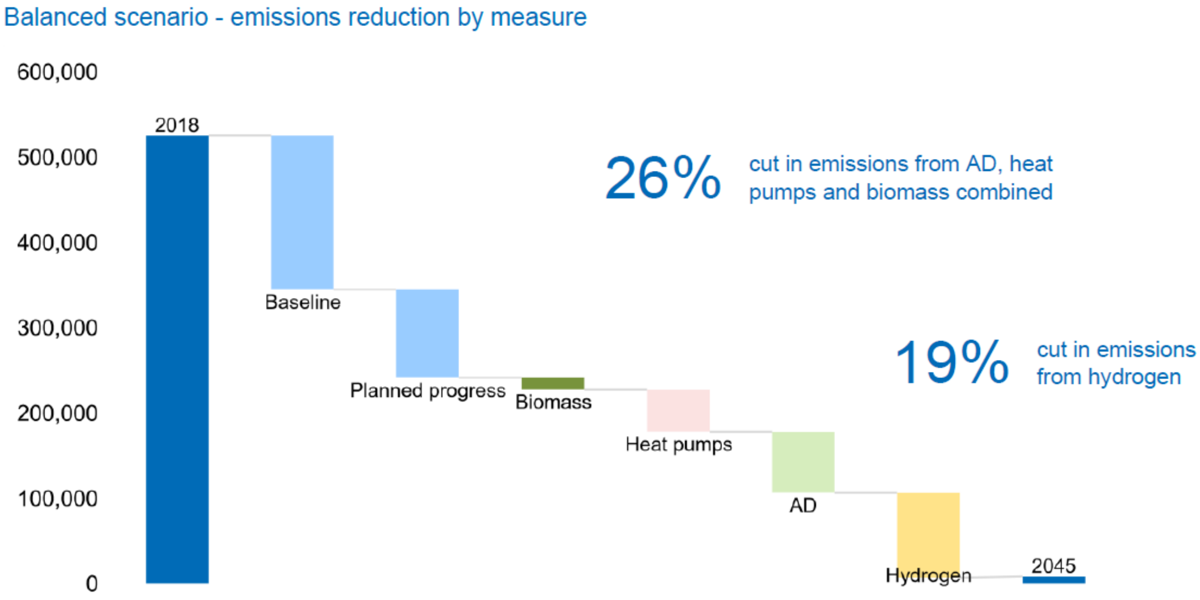


Figure 26

Emissions reductions in the Scotch Whisky industry by measure – Balanced scenario

Source: Scotch Whisky Association

Both the Orkney Distillery and Highland Park took part in the HySpirits 2 project[73] in partnership with EMEC and Edinburgh Napier University. The purpose of the project was to produce a feasibility study for the use of green hydrogen as a fuel in decarbonising small-scale distilleries. The government-funded project concluded that a duel fuelling system (using hydrogen and LPG) was the most practical solution – EMEC could currently supply Orkney Distillery's annual hydrogen demand with LPG used in case of failure. There is currently no direct consideration of electric boilers in the dual fuel system, although the overarching challenge of hydrogen or electricity is still a contentious topic.

A demonstration pilot-scale project of a dual fuel system was designed in phase 2 of HySpirits for the Orkney Distillery in Kirkwall. Deployment of this would allow the system to be properly evaluated for its impacts and commercial viability.

Alongside replacing fossil fuels for the distilling process, companies are looking to decarbonise other aspects of their businesses, including electrifying/decarbonising associated operations (such as bottling plants), distribution and export via road and sea, and onsite decarbonisation for shops, visitor centres and offices. From engaging a broader range of distillery organisations, a significant barrier to decarbonisation is the lack of available electricity network capacity.

This is more prevalent on some Scottish Islands, with some new or expanding distilleries planning to run almost solely on diesel generators due to a lack of local grid capacity. Electrification of high-

[73] EMEC Hydrogen, 2021. Green Distilleries Competition: HySpirits 2 Public Report

temperature process heating for distilling could reduce energy use by up to half;[74] however, the lack of grid capacity is forcing some companies to explore alternatives, such as biofuels, first.

Alongside energy use, the distilling process also needs large quantities of fresh water. As a result of this and water resource challenges, many distilleries are looking into energy-intensive desalination to meet freshwater demand and not impact local water resource needs. There will also be a further need for fresh water and desalination if distilleries look towards using the production of hydrogen through electrolysis as a fuel source for high-temperature heating.

The specific initiatives related to the major distilleries in Orkney should be a clear interest in the long-term electrification of distilling processes. This could bring significant future electricity demand to specific SSEN substation locations in Orkney.

Agriculture

Agriculture, forestry and fishing accounted for 42.3% of the workforce in Orkney in 2020.[75] There are around 1,900 farms across Orkney (as of 2018), with general cropping and forage farms making up most of these, closely followed by cattle and sheep farms. In 2018, there were approximately 193,000 sheep and cattle in Orkney[76], roughly nine times the population.[77] A small proportion of agriculture is held in crofting tenure, with only 459 registered crofts compared to 3,322 in Shetland and 6,361 in the Western Isles.[78] Most crofting land is used for small-scale, low-impact farming with minimal use of large-scale farm machinery. The volume of agricultural petroleum consumed by the agricultural sector in Orkney is difficult to establish, with the former Department for Business, Energy and Industrial Strategy (BEIS) estimates suggesting around 127 GWh used in 2019.[79] However, research by Aquatera Ltd and Community Energy Scotland in the 2019 Orkney Energy Audit[80] suggests there may be significant discrepancies between this estimated figure and the actual energy consumption. The scale of the agricultural sector in Orkney means this figure is still likely to be high, and the need for large-scale decarbonisation of farm machinery and processing will be key to a wider transition to net zero.

There is no clear decarbonisation pathway for farm machinery. Electrification could be one solution, with alternative fuels such as ammonia, hydrogen and biofuels also being considered.

The potential electrification of processing centres and heavier livestock transportation vehicles could increase demand load growth. However, as a fairly specialist subset of HGV electrification, the scale of electrification is unclear. Further engagement with the National Farmers Union and livestock transportation companies (both national scale, such as WM Armstrong and Gilders Transport, and locally in Orkney, such as Sinclair Haulage and B & F Kemp Haulage) would be recommended to explore the direction of travel for these vehicles.

[74] Based on engagement with Diageo, 2023.
[75] Orkney Islands Council, 2020. Orkney Economic Review 2020
[76] Orkney Agricultural Society, 2018. Orkney Farming Statistics
[77] Orkney Islands Council, 2018. Orkney Economic Review 2018
[78] Scottish Government, 2021. National Development Plan for Crofting: Island Communities Impact Assessment
[79] BEIS, 2021. Sub-national residual fuel consumption: 2005-2019
[80] ReFlex Orkney, 2019. Orkney Energy Audit 2019

Aquaculture

Fishing and aquaculture are key industries in Orkney, with the sector directly supporting around 90 local businesses, equating to around 5% of the local economy.[81] There is a focus on shellfish and salmon, with the islands home to Europe's largest crab processing plant.[82] Around 3,000 tonnes of crab, lobster and scallops, and approximately 20,000 tonnes of farmed salmon are produced annually in Orkney.

Salmon farms are especially important for the smaller outer isles with Cooke Aquaculture and Scottish Sea Farms the main producers, employing 165 people across Orkney.[83,84] Salmon Scotland, the representing organisation for all salmon producers in Scotland, has a net zero 2045 target which includes working towards 100% renewable energy use across powering farms and facilities to electrifying modes of transport.[85] Orkney has seen an increasing volume in salmon production, and as such, there is potential for a move towards increased electrification, particularly for marine vessels. However, the role of other renewable energy sources, such as anaerobic digestion, could see a similar increase, leading on from the Outer Hebrides Local Energy Hub example, which utilised fish processing waste in an anaerobic digestor.[86]

Fishing vessel electrification and reduced fossil fuel usage for processing crab, salmon and scallops could be a notable source of future electricity demand at key port locations.

---

[81] Orkney.com, n.d. Economy
[82] Orkney Harbours, n.d. Aquaculture & Fishing
[83] Orkney.com, n.d. Scottish Sea Farms
[84] Orkney.com, n.d. Cooke Aquaculture
[85] Salmon Scotland, 2020. A Better Future For Us All
[86] Community Energy Scotland, n.d. Outer Hebrides Local Energy Hub (OHLEH)

3.8. Community energy initiatives

The Orkney community energy sector is represented by Community Power Orkney, which is made up of five community groups: Eday Renewable Energy Ltd, Hoy Energy Ltd, REWIRED Ltd (Rousay, Egilsay & Wyre), Shapinsay Renewables, and Stronsay Renewable Energy Ltd. These five groups, alongside Westray Renewable Energy Ltd, own a total of 5.4 MW of onshore wind projects comprising six 900 kW turbines. Several wind projects are either wholly or partly locally owned, with the Hammars Hill wind farm comprising five turbines and a combined capacity of 4.5 MW. This project has the local authority, OIC, as the main investor and 90% of its total equity is held within Orkney.[87]

OIC is also engaged in constructing three new community wind farms at Quanterness, Hoy and Faray, each comprising six turbines. When constructed, the total capacity of all three wind farms will be almost 90 MW. These developments contributed to the needs case for constructing a new transmission-level interconnector between Orkney and the Scottish Mainland.[88] This interconnector is now approved, and the proposed capacity has been met with a pipeline of new projects, demonstrating the appetite for new renewable energy generation projects where investment in network capacity is enabled.

Orkney is also well known for innovative community energy models, with several projects, including Surf 'n' Turf, BIG HIT, SMILE, Heat Smart, ReFLEX and Net Zero Living Orkney. These innovative projects highlight the enthusiasm and determination of Orkney's residents to utilise their large renewable resources to help their communities thrive and lead the way in decarbonising their islands. Many of these projects have come about due to existing grid constraints across the islands and demonstrate the levels of curtailment imposed on community-owned turbines, especially across the North Isles.

Surf 'n' Turf

The Surf 'n' Turf hydrogen project generated the world's first tidal-powered hydrogen in August 2017. The project, managed by Community Energy Scotland, involved using excess wind energy from the Eday Community Turbine and EMEC's tidal test site to generate hydrogen when the grid was curtailing exports. This hydrogen was then transported to the Mainland where a fuel cell converted the hydrogen back into electricity for the cold ironing of ferries docked in the harbour, allowing them to reduce the amount of marine fuel burned.

[87] Orkney Renewable Energy Forum, n.d. Wind
[88] Orkney Community Wind Farms, n.d. Home

BIG HIT

The Building Innovative Green Hydrogen Systems in Isolated Territories (BIG HIT) scheme, was built upon the experience of Orkney's Surf 'n' Turf project with an additional, larger, electrolyser located on Shapinsay and powered by the community wind turbine there. The produced hydrogen was to be used to heat the community centre and school in Shapinsay, as well as transported to the mainland to continue to act as cold ironing for ferries and for five hydrogen fuel cell council vehicles.

As mentioned in Section 3.1, a large proportion of community-owned wind turbines currently operational across Orkney are over a decade old, reaching the end of their lifespan and are potentially looking to repower in the next few years. Most of these repowered sites will comprise turbines with greater rated capacity than those originally installed to match the advancement of wind turbine technology since the installation of the original projects.

Engagement with Orkney community stakeholders highlighted that the local ambition to repower community wind turbines has partially stemmed from difficulties community groups have experienced when developing a new project. The challenge of grid capacity and business cases for new sites has triggered a shift in appetite from developing new community projects to repowering existing ones. There is a clear need to increase capacity on the local grid to facilitate these projects. Grid constraints are forcing local community groups to choose between repowering existing wind turbines or installing new onshore wind capacity where, for a positive net zero outcome, both should be being progressed.

Orkney is also home to the Islands Centre for Net Zero,[89] a pan-island innovation project to support Orkney, Shetland and the Outer Hebrides to become global leaders in decarbonisation. This is located at the Orkney Research and Innovation Campus (ORIC)[90] in Stromness, also home to Heriot-Watt University's International Centre for Island Technology. They undertake research projects as well as offering both master's and PhD degrees. ORIC is also home to Solo Energy and Robert Gordon University and is located next to EMEC. Furthermore, two of the outer isles (Hoy and Walls) are taking part in the Scottish Government's Carbon Neutral Islands project to help decarbonise six island communities, reaching net zero by 2040.

SSEN could seek to engage the Islands Centre for Net Zero to further discuss future network design and reinforcement plans for the Orkney electricity network.

[89] Islands Deal, n.d. Islands Centre for Net Zero
[90] Orkney Research & Innovation Campus, n.d. Orkney Research & Innovation Campus

Section 4:

Conclusions

From reviewing the projections from SSEN's DFES 2022 analysis and undertaking additional research and engagement, there is evidence that the requirements of the electricity network in Orkney will notably evolve in both the near and longer term.

There is currently 75 MW of distributed generation and storage capacity in Orkney. This includes c.58 MW of renewable generation and 15 MW of diesel generation. DFES analysuis suggests that this generation capacity could increase to c. 440 MW by 2050. Most of this generation capacity will consist of onshore wind, which could see an additional 190 MW deployed between 2022 and 2030. Marine electricity generation may also significantly increase capacity from an 11 MW baseline to 115 MW by 2045. Unabated diesel-fuelled generation is projected to cease by 2030 compared to a 15.5 MW baseline. This could bring about an increase in electricity generation from renewable sources and an increase in the use of battery storage to support Orkney's distribution network.

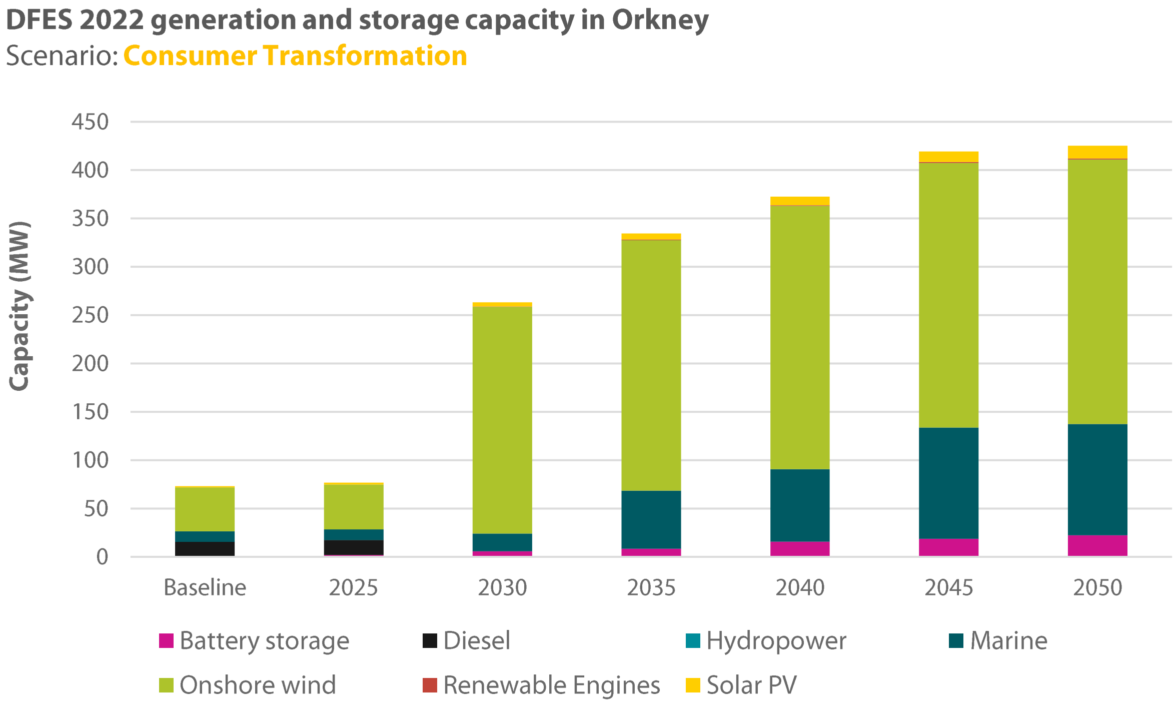


Figure 27

Cumulative distributed generation and storage capacity in Orkney, Consumer Transformation scenario

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

Distributed electricity demand in Orkney is projected to follow a similar trend to distributed generation capacity. The DFES 2022 baseline shows 85 MW of demand capacity from domestic heating and cooling systems (including direct electric heating and heat pumps). The electricity demand from domestic heating and cooling systems is projected to reach around 115 MW by 2030. From this point, it plateaus to 2050 as direct electric heating demand and other technologies are replaced with domestic heat pumps.

The electricity demand from domestic and non-domestic EV chargers – and the assumed uptake of EVs – is estimated to be limited out to 2025, with just 5 MW of additional demand capacity. However, this is expected to increase to around 56 MW by 2035 and 70 MW by 2050. The installation of non-domestic EV chargers sees a similar trend, although the total capacity is much smaller than that of domestic EVs, with c.10 MW of charging expected by 2050. This is alongside an estimated 20 MW of network-connected hydrogen electrolysis expected to connect by 2050.

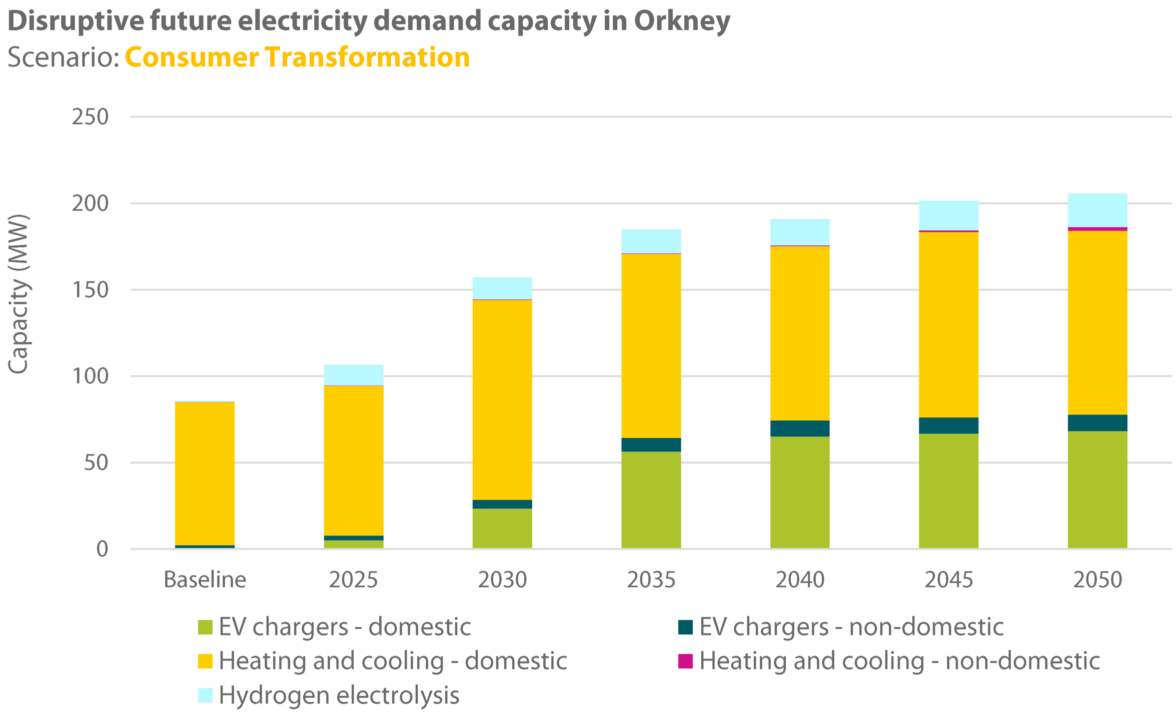


Figure 28

Cumulative distributed generation and storage capacity in Orkney, Consumer Transformation scenario

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

The graphs above detail projections of the potential future electricity load growth in Orkney. Although this data alone demonstrates the potential need for reinforcement in the distribution network, engagement with stakeholders and industry experts has highlighted additional future demands on the distribution network from other industries.

SSEN will need to ensure that future reinforcement and T-D coordination around the island's electricity system can enable the development of additional near-term generation capacity whilst also preparing island infrastructure for the increased electricity demand that the net zero transition will bring for residents, businesses and island industries. This should be supplemented with meaningful engagement and collaboration with relevant communities and councils, to provide support to local Net Zero transition plans but also allows parties across the islands to benefit from future network investments.

An overall position on future electricity load growth across the sectors covered in this evidence case report is outlined in Table 6 below.

Table 6

Summary of potential future load growth on the distribution network in Orkney by sector

Energy Sector	Summary of future load growth on the distribution network
Renewable energy	Orkney has extensive resources for wind, wave and tidal energy. This has enabled the existing onshore wind baseline of 45 MW to develop and a near-term pipeline of 163 MW of prospective new onshore wind projects. It has also enabled Orkney to be a development hub for marine generation technology, with 11 MW of existing capacity developing into a near-term pipeline of 90 MW. These renewable resources could expand further into the future to upward of 270 MW of onshore wind and 110 MW of marine energy by 2050 under some scenarios. Whilst Orkney has very low irradiance levels compared to other parts of the UK, there is potential for a moderate development of new small-scale solar PV, including on domestic and commercial buildings. Some businesses on the islands are looking to explore the potential for solar to reduce electricity costs. The development of a new transmission link between Finstown and the Scottish mainland will support the development of future offshore wind and marine energy adjacent to the island. Whilst this will not directly impact the distribution network in Orkney, coordination between SSEN's distribution network reinforcement and this major new HVAC transmission link to Finstown will be essential. Renewable energy, particularly onshore wind and marine generation, will remain a significant source of future generation load growth in Orkney. Additional distribution network capacity and the fulfilment of the proposed transmission link to Finstown will likely drive further wind, solar and marine projects to come online.
Battery storage	There is currently only one commercial battery storage asset operating in Orkney, a 1.8 MWh Vanadium Flow battery at EMEC. Despite a very large, growing pipeline of new battery projects seeking to connect to the wider SHEPD network, there are no battery sites with an accepted connection offer in Orkney. Under some scenarios, battery storage capacity has been projected to reach c.20 MW by 2050. However, with the development of more onshore wind sites and increased marine electricity generation, the potential for storage co-location as a business model could drive the development of more battery storage projects. As one of the most rapidly developing sectors, battery storage has the potential to be a disruptive source of both demand and generation load in the future at various parts of SSEN's network. Whilst there is currently very limited development in Orkney, this could change as use cases and business models constantly evolve. Further generation and hydrogen development spearheaded by EMEC may see electricity storage (including potentially longer duration storage) as a solution to increase on-island energy use.

Hydrogen	Orkney has been identified as one of the hubs for future hydrogen development, with grant funding awarded to several projects across the past decade that have looked into hydrogen production as both a storage medium and to supply local offtakers across the islands. EMEC has played a significant role across many of these initiatives and has been producing hydrogen since 2016, using surplus generation from tidal stream and onshore wind projects. Two major distilleries also took part in an initiative which looked into hydrogen as a fuel to decarbonise their distillation processes. Both as a source of electricity demand from electrolysis and a potential offtake of local wind and marine generation for local usage, green hydrogen could see notable development in Orkney under some scenarios. With several innovation trials and specific plans to investigate hydrogen at existing assets like Flotta Oil Terminal, Orkney is seen as potentially one of the hydrogen development hubs in Scotland. SSEN should continue engaging with EMEC and hydrogen innovation project developers in Orkney and across Scotland, to understand the impact this may have on the island's electricity network.
Transport	There are currently just over 140 EV cars and LGVs registered in Orkney. Under some scenarios, this could significantly increase, reaching over 11,000 by 2035. Orkney Islands Council has ambitions to increase the uptake and use of low-carbon transport across the islands. The council owns and operates EV chargers across the islands and actively encourages public transport and active travel. Orkney welcomed 394,000 visitors in 2019, with numbers expected to increase year-on-year. Tourism will continue to significantly impact the local economy and infrastructure, including EV charging requirements for tourists travelling to the islands via vehicle ferry routes. Under some scenarios, non-domestic EV charger capacity reaches over 10 MW, and the number of domestic EV chargers totalling over 9,500 by 2050. Marine vessels could also be a significant source of future electricity demand at particular locations across the Orkney island group. Local ferry operators NorthLink, Pentland Ferries and Orkney Ferries operate several routes both inter-island and between the island and the mainland. All operators are considering options to decarbonise their fleets and surrounding infrastructure, including electrification. There are seven airports in Orkney, with several flights operated from Kirkwall to the Scottish mainland and other Orkney islands. Loganair has ambitions to electrify on-ground assets and future thrust/drive systems of aircraft. The role of hydrogen is also being investigated. The airports could become a further source of electricity demand. Future electricity demand from transport could come from three different transport sectors on very different timelines. EV charging and associated infrastructure are likely to see rapid adoption to meet the demand from residents and visitors. The development of electrified propulsion systems and shore power capacity for maritime vessels and electrified on-ground units and thrust systems for aviation are already being tested at specific locations across Orkney. Both marine vessel and aviation sectors are committing to longer-term net zero strategies, with hydrogen also being considered as a potential fuel source for both industries.
Heating	Orkney has no mains gas connection, so households rely on electricity, oil and solid fuels for heating. Currently, around 43% of Orkney households use electricity. Under some scenarios, the number of homes with electric heating is set to increase to c.9,000 across Orkney by 2050. Previous initiatives in Orkney have looked into the possibility of using hydrogen for heating, although this will depend on the direction of UK and Scottish Government policy. Space heating could be a significant source of electricity demand in the future in Orkney. Many households are already using electrified heating, with more expected to come online in the future with heat pumps replacing some fossil fuel heating systems. There could also be a pathway in which hydrogen is considered for space heating. However, the low viability of hydrogen heating in homes in general makes this unlikely

	and so electrification remains the primary low carbon heating technology option being considered for Orkney.
Commercial and Industrial	There are several specific commercial businesses and industries operating on/ around Orkney. There are seven distilleries across the island group. Two of these distilleries focus on producing whisky, and two others (currently producing gin/rum) are looking to expand into producing whisky. Parent companies are looking to decarbonise the high-temperature processes that rely on fossil fuels. This could include hydrogen electrolysis, electric boilers and other low-carbon fuels such as bioenergy. The decarbonisation of associated operations (bottling and distribution) is also being explored, which may involve the development/use of onsite renewables and EVs. Orkney has significant agriculture and aquaculture industries, which are both looking to decarbonise their machinery, processing facilities and produce transportation. The decarbonisation of industries specific to northern Scotland (i.e. whisky distilleries, fish and seaweed farming) and broader industries (e.g. agriculture and other commercial businesses) could involve a range of potential electrification outcomes.

Regen
Bradninch Court,
Castle St,
Exeter
EX4 3PL

01392 494 399
www.regen.co.uk

18/03/2024