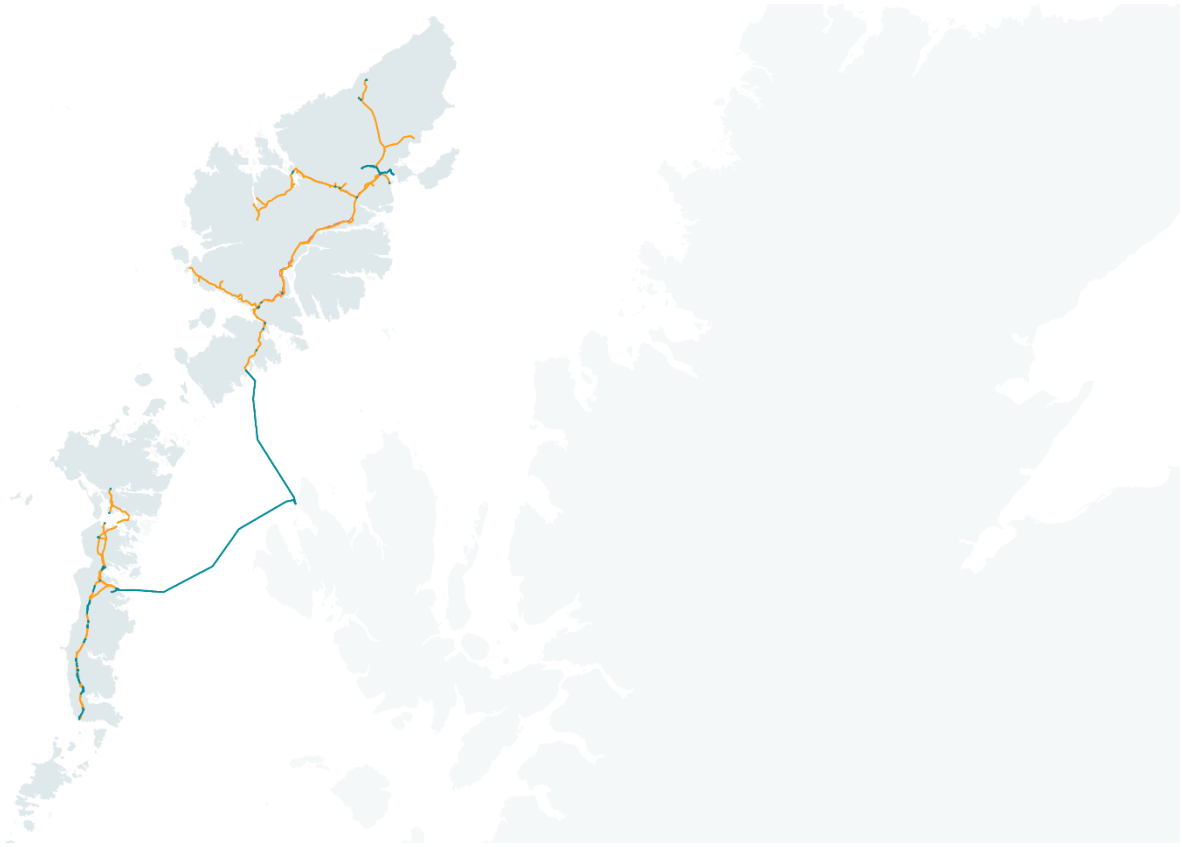
Outer Hebrides Net Zero Load Growth Evidence Summary Report

An evidence case report for future electricity generation and demand load growth in the Outer Hebrides



January 2024

This report was produced for:	Andy Wainwright, DSO whole system manager, SSEN	
Issue date:	24th January 2024	
Version:	Final report	
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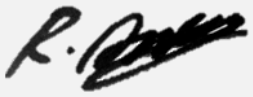
Approved by:	Ray Arrell, Associate Director	

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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.

Regen has been working with SSEN and other DNOs on their long-term network planning for many years, having pioneered the Distribution Future Energy Scenarios (DFES) process in 2015.

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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 a body of 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 was undertaken to gain further insight into future electricity loads across industries that are not currently included in the DFES technology scope, such as maritime decarbonisation, aviation, distillery electrification and aquaculture.

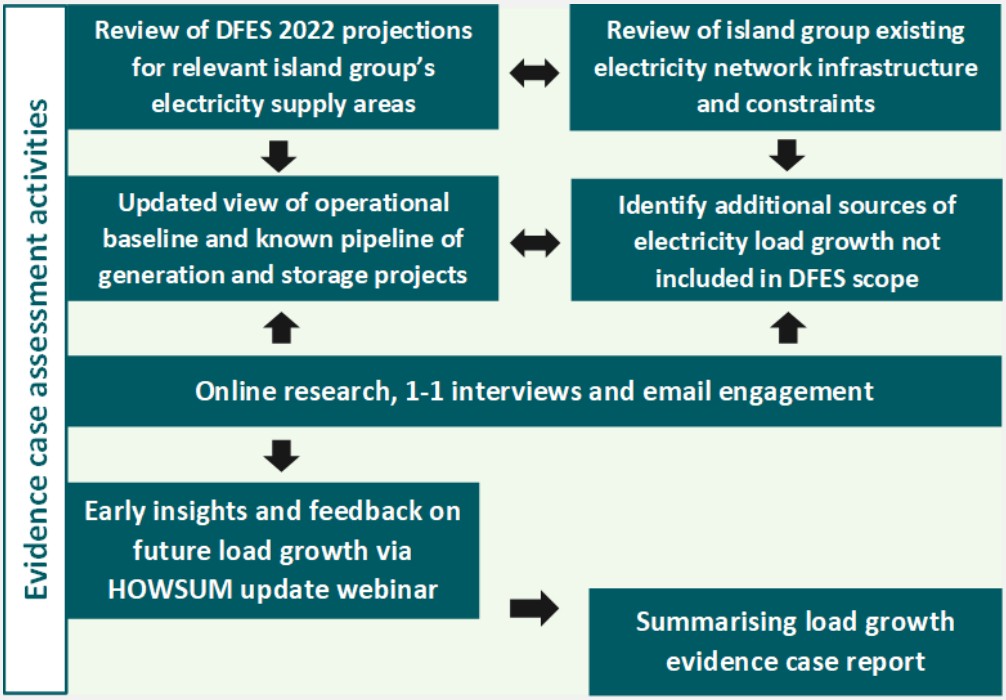

Figure 1
Overview of load growth case methodology

Comhairle nan Eilean Siar's Climate Change Strategy covering the period 2022-2027 includes a number of commitments around energy and net zero. Many of these aims and commitments could drive increased demand on the island's electricity network in the future. This may 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 also specifically includes commitments to push for additional investment in the island group's electricity network, for which the HOWSUM process is a key driver.

The analysis, research and engagement undertaken suggests potentially significant electricity load growth on the Outer Hebrides in the future. There is significant market, community interest and unexploited resource driving the potential further development of distributed renewable energy generation. Under a Consumer Transformation scenario, there could be >400 MW of distributed generation capacity operating on the Outer Hebrides by 2045 (dominated by a notable expansion of onshore wind), compared to the c.70MW connected today. See Figure 2.

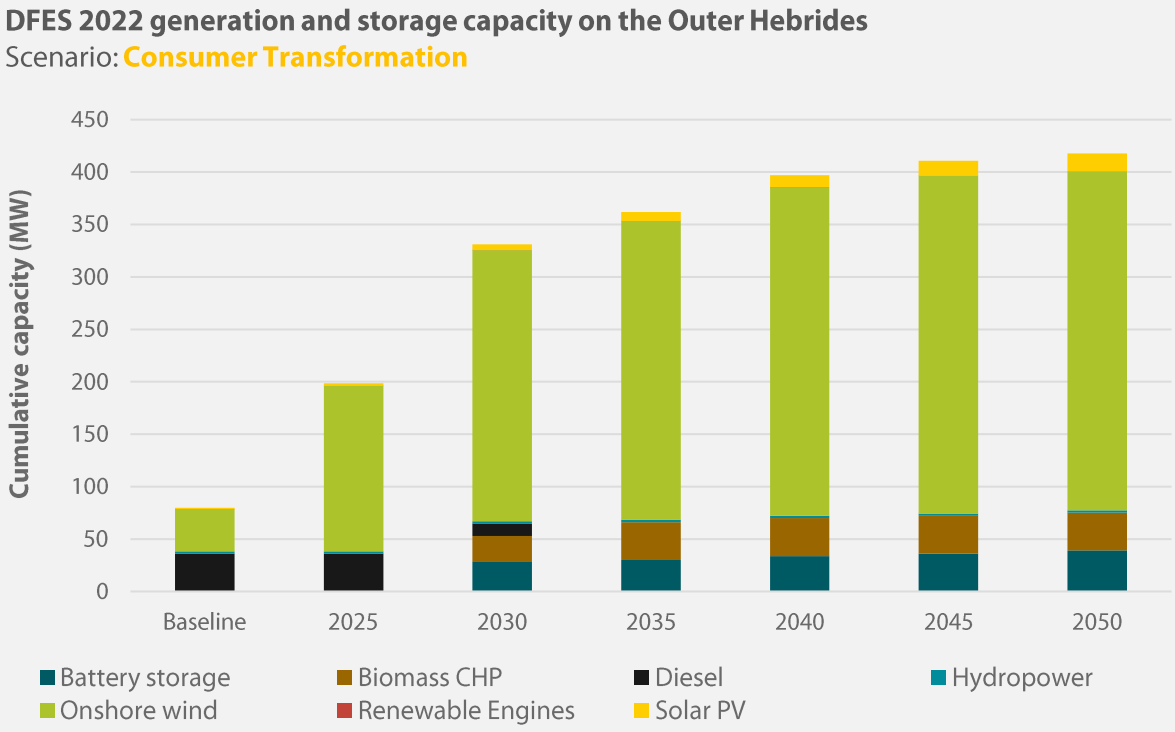

Figure 2

Cumulative distributed generation and storage capacity on the Outer Hebrides, Consumer Transformation scenario

Source: SSEN DFES 2022 projections.

The electrification of transport, heat and other commercial decarbonisation activities will also drive an increase in electricity demand on the Outer Hebrides in the future. Under a Consumer Transformation scenario, there could be >250 MW of additional demand capacity from heating, transport and electrolysis, compared to c.60 MW of equivalent demand today. See Figure 3.

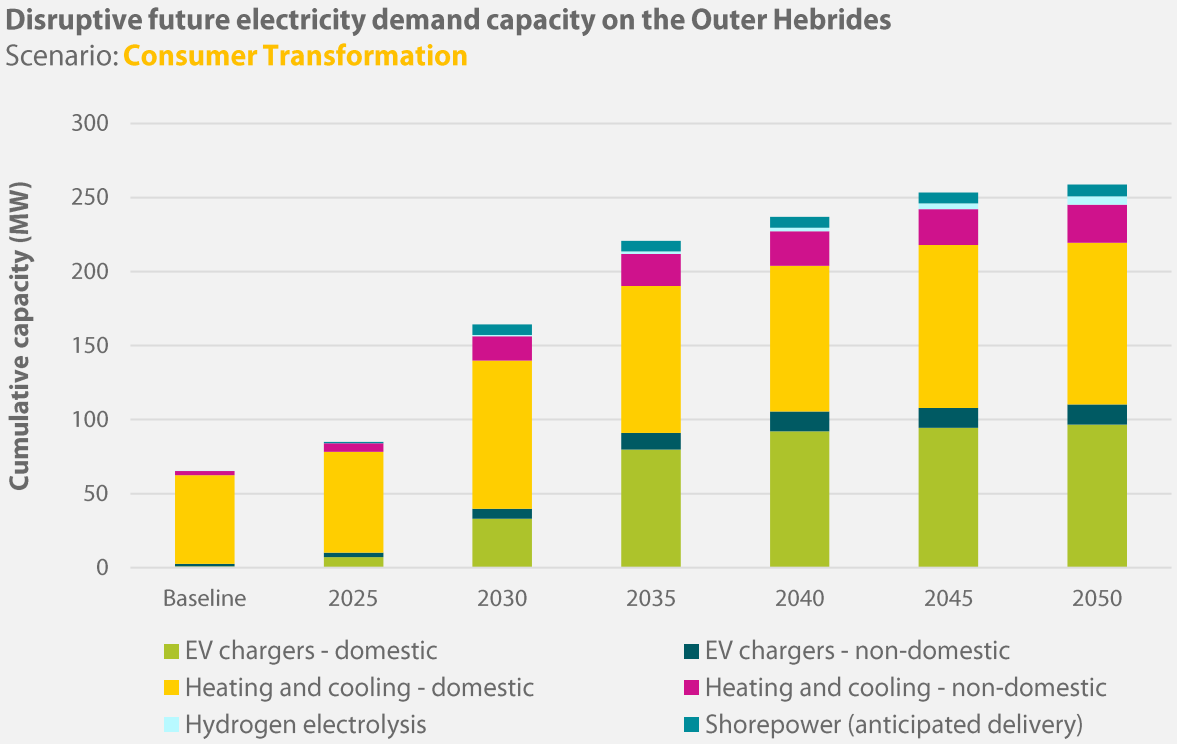

Figure 3

Cumulative disruptive electricity demand capacity on the Outer Hebrides, Consumer Transformation scenario

Sources: SSEN DFES 2022 projections. SSEN connections data.
Note this does not include all sources of domestic or commercial and industrial demand.

Communities and industries across the Outer Hebrides 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.

SSEN will need to ensure that future reinforcement of the Scottish Islands network is able to unlock near-term generation capacity, whilst preparing island infrastructure for the increased level of electricity demand that the net zero transition will bring for residents, businesses and island industries.

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, will remain a significant source of future generation load growth on the Outer Hebrides. Additional distribution network capacity and the fulfilment of the proposed transmission link to Stornoway may drive further wind and solar projects to come online in the future.
Battery storage	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 on the Outer Hebrides, this could change as use cases and business models constantly evolve. SSEN's replacement of existing diesel backup engines may also include longer duration electricity storage as part of a future solution.
Hydrogen	Both as a source of electricity demand from electrolysis and as a potential offtake of local wind generation for local usage, green hydrogen could see notable development on the Outer Hebrides, under some scenarios. SSEN should continue engaging with SGN and hydrogen innovation projects developing on the islands and across Scotland.
Transport	Future electricity demand from transport could come from three different transport sectors that are on very different timelines. EV charging is likely to see rapid adoption to meet demand from residents and visitors. The development of shore power capacity for ferries is already being explored with SSEN at key port locations; other vessels may increase future capacity requirements at these locations. Commitments from Loganair, who operate flights at three island airports are pushing for the electrification of on-ground assets, vehicles, and a longer-term view for aircraft.
Heating	Space heating could be a significant source of electricity demand in the future on the islands. With the Outer Hebrides being identified as a hydrogen development hub, there could be a pathway that hydrogen is considered for space heating in more areas of the island, including specifically in Stornoway. However, the lack of existing gas network infrastructure and low viability for hydrogen heating in homes in general makes this unlikely, so electrification remains the primary low carbon heating technology option for the Outer Hebrides.
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, 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, and SSEN is in the process of engaging 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

Off the back of 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 is a high-level summary of the approach taken and the evidence collected across the latter half of 2023, for future electricity load growth on the Outer Hebrides. 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 2024.

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 input from a number of industry stakeholders in order to inform future load growth on the Outer Hebrides.

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 the purpose of 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.

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 that are not currently included in the DFES technology scope.

This included 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.

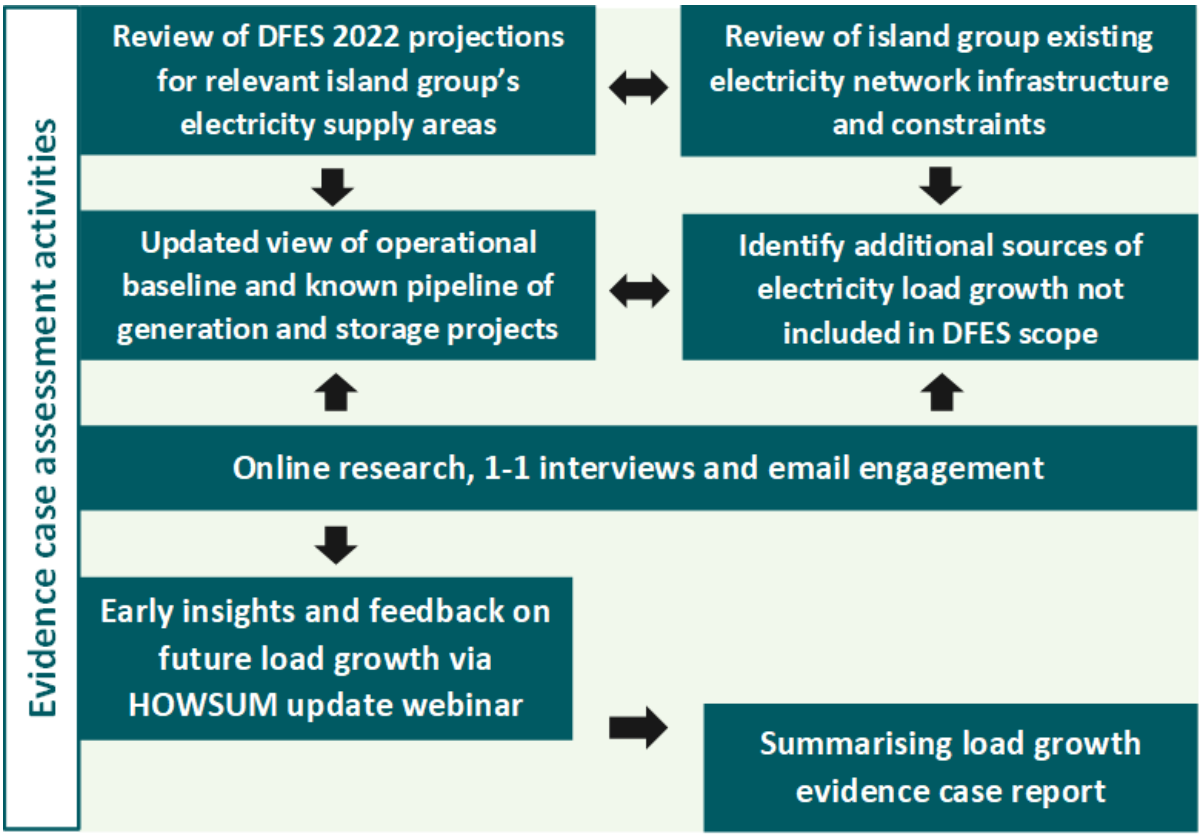

Figure 5

Overview of load growth evidence case methodology

Section 2:

The Outer Hebrides island group

This section provides some context around the Outer Hebrides island group itself, 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

The Outer Hebrides, also known as the Western Isles, is a collection of over 70 islands located off the west coast of Scotland, stretching over 100 miles from north to south. The archipelago currently inhabits c. 26,200 people[2] (an estimated 5.5% decrease since the 2011 Census), of which the five major islands – Lewis and Harris, North Uist, Benbecula, South Uist and Barra – account for 98% of the population. Stornoway on the Isle of Lewis, is the main settlement with a population of c. 7,000 people (2016 estimates)[3].

Figure 6
Outer Hebrides island group

[2] Scotland's Census, 2023. Scotland's Census 2022 – Rounded estimates.
[3] Outer Hebrides Housing Land Audit, 2021. Outer Hebrides Land Audit 2021.

Table 2

Population change in the Outer Hebrides by island group

Island	Population 2011	% change 2011-2018
Lewis and Harris	19,918	-3%
North Uist	1,271	-4%
Benbecula	1,219	-1%
South Uist	1,818	-7%
Carra	1,078	-1%
Scalpay	322	-2%
Great Benera	233	-3%
Eriskay (Causeway)	143	-15%
Vatersay	90	-3%

Source: Adapted from Outer Hebrides Local Transport Strategy 2020-30.

There are around 15,000 residential properties across the Outer Hebrides, primarily situated on the Isle of Lewis and Harris. Although long-term demographics show a 5.5% reduction in population across the last decade, the number of households has increased by 1.1%, with one-person households now the most prevalent household type across the Outer Hebrides.

Transport infrastructure

Public transport within the Outer Hebrides is dominated by road, with an active bus fleet (Figure 7) and road network spanning the islands; the majority of which are connected by causeway or bridge. The future electrification of road transport is discussed in section 3.4 of this report.

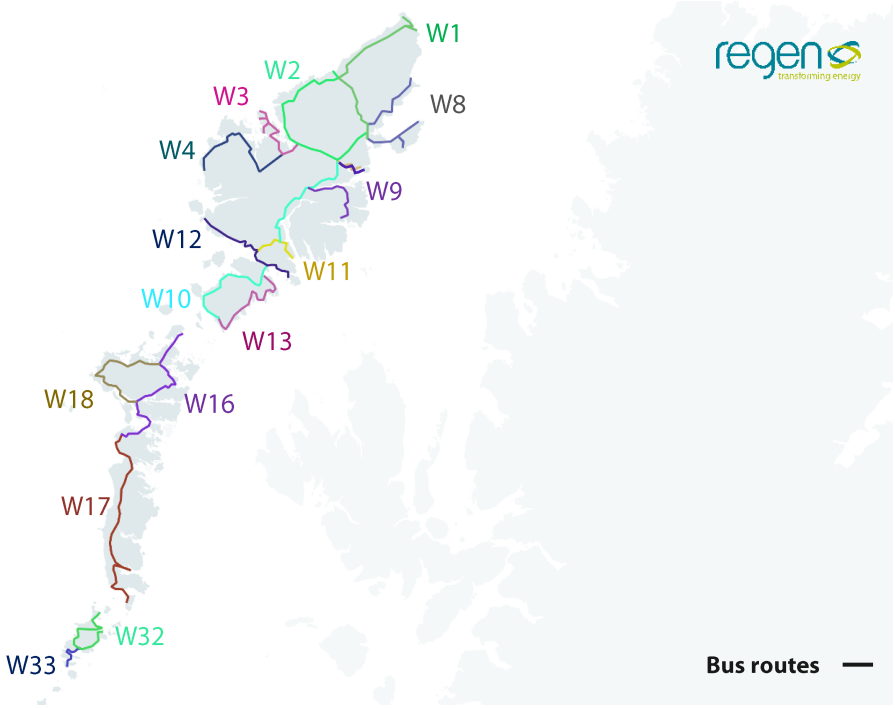

Figure 7
Outer Hebrides bus route map

Source: Visit Outer Hebrides

For islands not linked by causeway or bridge, ferries are the primary mode of inter-island transport. As a group of island communities and prime tourist destination, transport within the Outer Hebrides is also heavily linked to the ferry services that connect the islands with both the Inner Hebrides and the Scottish mainland. Businesses, residents and tourists rely heavily on these ferry services on a daily basis. As such, maritime transport and its associated infrastructure is arguably the most significant transport sector in the Outer Hebrides.

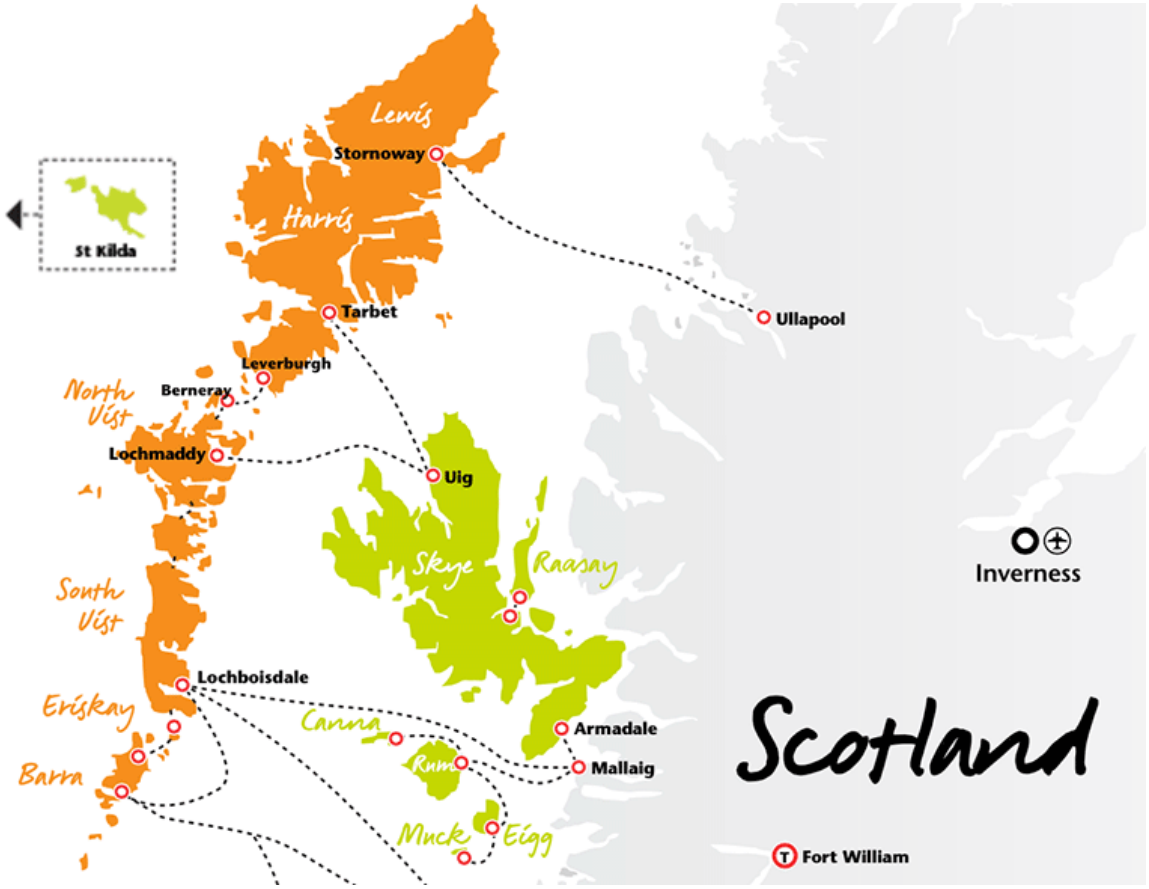

Figure 8
Outer Hebrides ferry links

Source: CalMac Ferries

The potential for future electrification of both the inter-island ferries and the ferries connecting the Outer Hebrides to other parts of the Scottish Isles is explored in more detail in section 3.4.

The potential electrification of the maritime sector considers future propulsion technology and fuels alongside the introduction of shore power infrastructure at key ports, which could be a notable source of future electricity load growth at specific coastal points of the Outer Hebrides.

In addition to maritime transport, there are three airports on the Outer Hebrides located at Stornoway, Benbecula and Barra. These airports operate direct flights to three airports in mainland Scotland (Glasgow, Edinburgh and Inverness), as well as connecting flights from other UK airports. See Figure 9.

Future electrification of aviation on the islands is also discussed in section 3.4, which considers future thrust/drive technology and associated fuel usage, alongside a shift towards all-electric aircraft turnaround by electrifying ground infrastructure, vehicles and equipment.

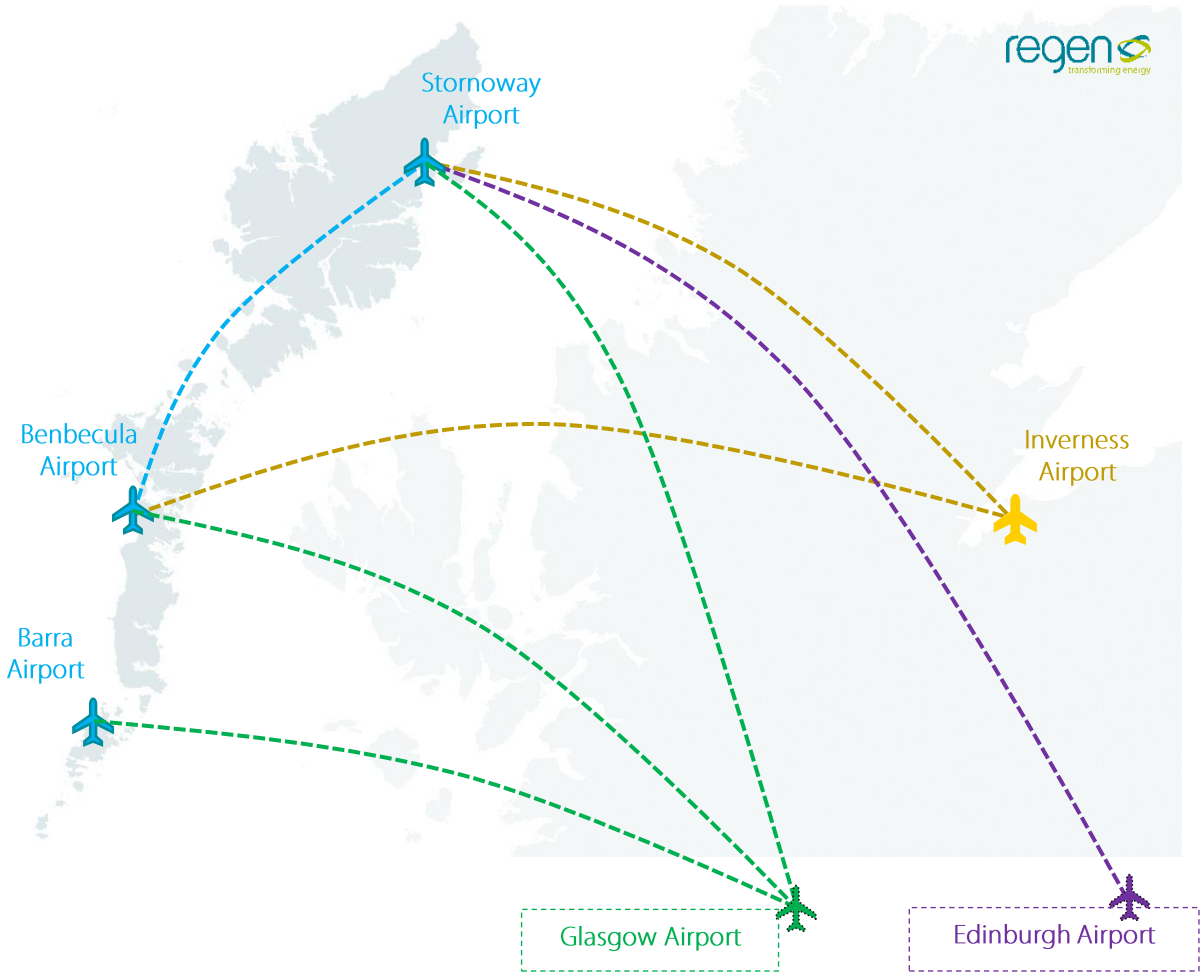

Figure 9
Airports and direct flights to/from the Outer Hebrides

2.2. Existing network infrastructure

The Outer Hebrides are currently supplied by SSEN-Transmission's network via a single circuit fed from the 132 kV busbar at the Fort Augustus Grid Substation. From Fort Augustus, the radial circuit primarily consists of a 132 kV overhead line to Ardmore Grid Substation located on the Isle of Skye. This is then stepped down, and a section of 33 kV overhead line, land and a subsea cable connects an Ardmore GSP 33 kV busbar to the Harris Grid Substation on the Isle of Harris. Once at Harris, the voltage is stepped up to 132 kV and runs across an overhead transmission line to Stornoway Grid Substation.

The Isles of North Uist, South Uist, Benbecula, Eriskay, Barra and Vatersay – the Southern group of islands – are connected to Ardmore GSP via a 33 kV subsea cable to Loch Carnan 33 kV Switching Station (Figure 10).

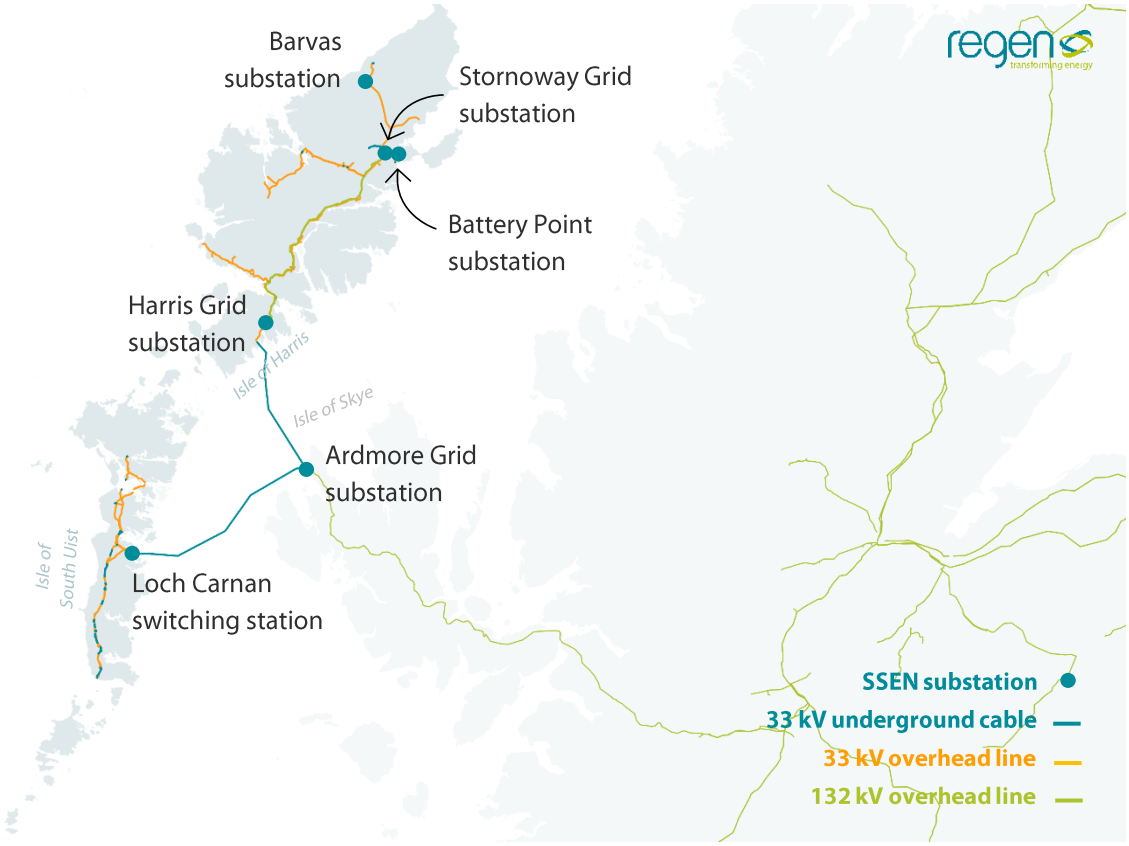

Figure 10
Existing network infrastructure in the Outer Hebrides

Source: SSEN distribution network mapping data

The on-island 33 kV electricity network then distributes power across the islands to 14 primary substations spread across the Isles of Harris, Lewis, North Uist, Benbecula, Barra and South Uist. These substations step down from 33 kV to 11 kV for local distribution. The associated 11 kV and low-

voltage network then distributes electricity to connected homes and businesses across the Outer Hebrides.

Four diesel-fuelled power stations are in-place across the Islands, acting as a backup supply to the islands in the event that subsea cables are tripped or taken offline for maintenance.

Table 3
Diesel generation operating on the Outer Hebrides

Power station	Location	Installed capacity (MW)	Primary fuel	Year commissioned
Arnish	Lewis	10	Diesel/Gas oil	2000
Barra Power Station	Barra	2.5	Diesel/Gas oil	1986
Battery Point (Stornoway)	Lewis	23	Diesel/Gas oil	1952
Loch Carnan	South Uist	11	Diesel/Gas oil	1972

Source: Digest of UK Energy Statistics (2023), Department of Energy Security and Net Zero.

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.

The transmission network that supplies the island group is also being looked at extensively, with both an upgrade to the Fort Augustus to Sky 132kV network and the Western Isles 1.8 GW HVDC link between Beauly on the Scottish mainland and Stornoway on the Isle of Lewis.

2.4. Comhairle nan Eilean Siar net zero strategy

Comhairle nan Eilean Siar (CnES) is the local authority responsible for the Outer Hebrides. CnES has published a range of strategies and supporting documents detailing its vision and aims around climate change, local transport, local heat and energy efficiency, waste, wind energy and green hydrogen.

As part of their Corporate Strategy 2022-2027[4], CnES identified a number of core values to guide the delivery of their business plans to the local community. These values include the delivery of sustainable services and the reduction of their carbon footprint, see Figure 11.

To work in partnership.	To deliver efficient and sustainable services.	To be ambitious for the Outer Hebrides.
To listen and empower our communities.	To promote fairness and equality for all.	To be open and transparent.
To protect our natural environment and reduce our carbon footprint.	To promote community resilience and safety.	To support those in our community who are in need.

Figure 11
Comhairle nan Eilean Siar Core Values

Source: CnES Corporate Strategy 2022-2027

Building on this strategy, CnES also published a separate Climate Change Strategy covering the same period 2022-2027[5]. This strategy outlined a number of commitments to reducing carbon emissions for the Council's own estate/operations, as well as developing policies and targets to enable a net zero transition and to increase climate-resilience for the Outer Hebrides.

The strategic priorities outlined in this strategy document include:

- Carbon Neutral Comhairle – zero direct emissions and minimal indirect by 2038
- Net Zero Islands – supporting the Outer Hebrides islands towards net zero by 2045
- Climate Resilient Islands - supporting improved climate resilience for the Outer Hebrides

These priorities demonstrate a range of sectoral commitments around buildings, vehicles, low carbon heat, electricity, waste, energy efficiency, green hydrogen production and wind power.

Within the Carbon Neutral Comhairle aims, there are a number of specific objectives:

- The development of an Assets Strategy, assessing what buildings CnES will require in the medium and long term.

[4] Comhairle nan Eilean Siar, 2022, Corporate Strategy 2022-2027
[5] Comhairle nan Eilean Siar, 2022, *Climate Change Strategy 2022-2027* (not currently available online)

- Completion of an assessment of the CnES estate, to inform prioritisation of energy efficiency measures and investment in reducing carbon emissions in buildings.
- Introduction of a policy to ensure all new CnES buildings see improvements to energy efficiency and low-carbon heating technologies, taking a 'zero-emissions first' approach to the replacement of heating systems where feasible.
- The development of a Fleet Decarbonisation Plan, to outline how CnES will expand EV charging stations across the islands and procure more EVs.
- Undertake a review of current leased ULEVs to maximise their use and expand EVs in CnES' fleet, aiming to increase the amount of business travel that is carried out in EVs.
- Continue to make a pool of EVs available and promoted to CnES staff to use.
- Introduce an Electric Refuse Collection Vehicle to the CnES fleet, using funding secured from the Scottish Government Recycling Improvement Fund.
- Consider the potential to expand the use of green hydrogen for other refuse vehicles.
- Aim to increase the amount of renewable electricity supplied to CnES premises, by conducting a review of the CnES estate. This will identify potential sites for renewable energy generation, including the expansion of PV arrays and wind turbines on site.
- Implement further energy efficiency measures to reduce electricity use through staff training and a review of the existing energy demand of buildings and street lighting.

Improve energy efficiency across the estate	Support staff to engage in energy and resource efficient behaviours
Decarbonise heating across the estate	Minimise emissions from business travel
Decarbonise the Comhairle's fleet	Minimise emissions from waste
Make Electric Vehicles available for employees to use	Minimise environmental impact and emissions from the Comhairle's supply chain
Empower staff to choose active transport	Improve measurement and reporting of greenhouse gas emissions

Figure 12
Carbon Neutral Comhairle commitments

Source: CnES Climate Change Strategy 2022-2027

Within the Net-Zero Islands targets, there are a number of commitments and objectives:

- A commitment to work with partners to address grid constraints, currently preventing the development of new renewable projects and on-island consumption of community-owned wind projects.
- Pushing electricity network operators for upgrades to the electricity network to enable the strong renewable energy resources to be exploited effectively. Maximising the potential of wind, solar, marine generation and green hydrogen on the Outer Hebrides.
- Produce an updated Outer Hebrides Energy Strategy, focusing on shared ownership of wind projects and investigating the potential for green hydrogen production.
- Development of a Local Heat and Energy Efficiency Strategy and action plan.
- Continue to improve energy efficiency, reduce fuel poverty and decarbonise heating in homes, workplaces and community buildings across the Outer Hebrides.
- Work with partners, including the Outer Hebrides Net Zero Hub, to explore the potential for green hydrogen to decarbonise the Stornoway Town Centre propane gas network.
- Explore options to supply low-cost electricity to off-gas areas of the islands, to enable a switch away from other fossil fuel heating.
- Identify potential opportunities and applications of heat networks across the islands.
- Work with partner organisations to expand the rollout of EV charging infrastructure across the Outer Hebrides for residents and visitors.
- Explore potential applications of green hydrogen for transport decarbonisation.
- Work with partner organisations to identify opportunities to decarbonise public transport on the islands, including buses, ferries and aviation.
- Assess applications for green hydrogen to support industrial businesses to decarbonise.
- Support communities to minimise waste and leverage circular economy opportunities.
- Ensure the carbon sequestration potential of the natural landscape is maximised.
- Empower Outer Hebrides communities to take climate mitigation actions.

Maximise the renewable energy and green hydrogen production potential of our islands	Ensure buildings in our communities are energy efficient and use low carbon heating systems
Increase the availability of low-carbon transport options are available throughout the islands	Support our communities to minimise waste and seize circular economy opportunities
Ensure the carbon sequestration potential of our natural landscape is maximised	Empower communities to take climate mitigation action

Figure 13
Comhairle nan Eilean Siar Net Zero Islands commitments

Source: CnES Climate Change Strategy 2022-2027

Section 3:

Baseline & future electricity load on the Outer Hebrides

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

3.1. Distributed electricity generation

As a coastal island group, the Outer Hebrides have some of the best wind resources in the UK. This has led to the development of a number of onshore wind projects on the islands. Building on this baseline and developments in Scotland's energy policy, there is likely to be additional development of distributed electricity generation across the Outer Hebrides. Some of the relevant recent policy developments include:

- UK government's annual Contracts for Difference rounds as part of the 2022 Energy Security Strategy[6], providing financial support for low carbon projects. This includes specific support for Remote Island Wind. Many projects will target the transmission network, but smaller-scale wind and solar sites may connect to the distribution network.
- The creation of the Onshore Wind Strategic Leadership Group (OWSLG) in February 2023 to oversee the delivery of the Scottish Government's target of 20 GW onshore wind capacity by 2050[7] - as stated in Scotland's Onshore Wind: policy statement 2022.
- Ofgem's Access and Forward-Looking Significant Code Review [8] (SCR) has reduced connection charges and introduced non-firm contracts which enable projects to connect in congested areas of the network.
- Scottish Government's Draft Energy Strategy and Just Transition Plan[9] has targeted 20 GW of additional onshore and offshore renewable energy capacity by 2030.
- Scottish Government's Carbon Neutral Islands programme is supporting six islands (including Barra in the Outer Hebrides) to become carbon neutral by 2040.

[6] HM Government, 2022. British Energy Security Strategy.
[7] Scottish Government, 2022. Onshore wind: policy statement 2022.
[8] Ofgem, 2022. Access and Forward-Looking Charges Significant Code Review: Decision and Direction.
[9] Scottish Government, 2023. Draft Energy Strategy and Just Transition Plan.

DFES 2022 projections

Based on SSEN's DFES 2022 projections, under the Consumer Transformation scenario, distributed renewable generation across the Outer Hebrides could increase significantly over the next two decades, from a 2022 baseline of around 43 MW to over 330 MW by 2035 and increasing further to c.380 MW by 2050 (see Figure 14).

Onshore wind is the primary contributor to this potential increase in renewable capacity, seeing a 600% uplift from the 2022 baseline (40 MW) to 284 MW by 2035 and 320 MW by 2050. This reflects significantly strong wind resources and policy support for onshore wind in the region.

Also under this scenario, some small-scale biomass CHP generation could also be developed on the islands, and 17 MW of solar PV (primarily rooftop) could be deployed across the island group. The Consumer Transformation scenario also assumes that the existing diesel backup power stations at Barra and Stornoway will be decommissioned within the next decade, potentially replaced by alternative technologies such as longer-duration batteries or bioenergy.

It is noted that solar PV will have a limited role in the Outer Hebrides energy generation mix due to very low irradiance levels. However, 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. Overall, significant growth of onshore wind demonstrates the Outer Hebrides as a strong area for renewable energy development if additional grid capacity is made available.

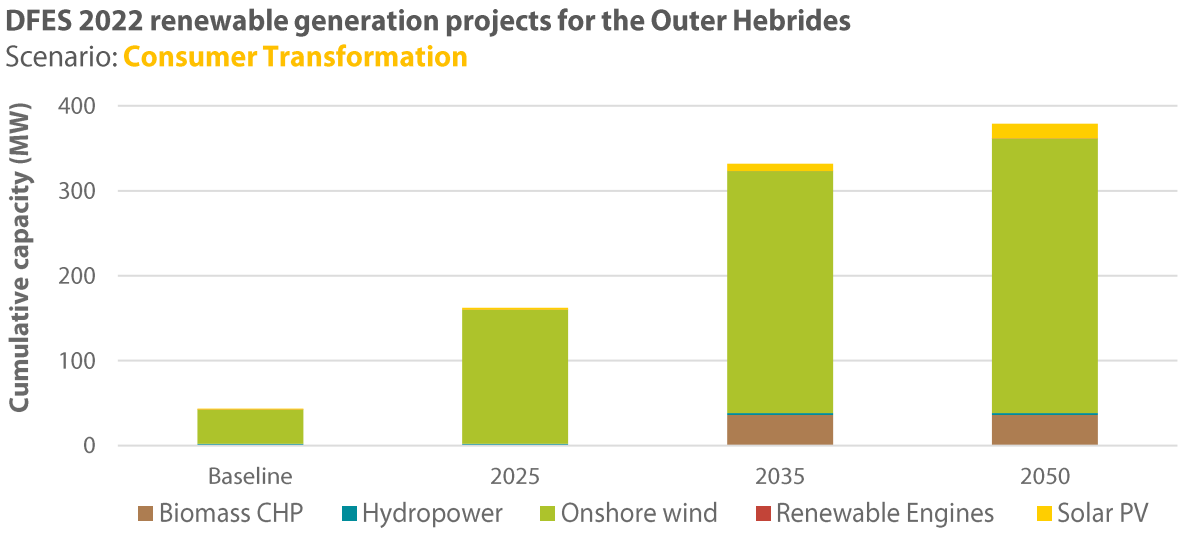

Figure 14

Projected cumulative distributed generation capacity in the Outer Hebrides

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

Baseline and pipeline distributed generation as of 2023

As of August 2023, there is 87.3 MW of existing distributed generation operating on the Outer Hebrides (see Table 4 and Figure 15). Although the generation mix is currently dominated by 15 onshore wind sites, over half of the currently connected baseline capacity comes from four fossil fuel diesel backup sites located at Arnish (10 MW), Barra (2 MW), Loch Carnan (11 MW) and Stornoway (22.3 MW). The island also hosts two small hydropower plants located on the Isle of Harris and the Isle of Lewis.

In addition to the 87.3 MW baseline, there is a pipeline consisting of 76.2 MW of distributed generation sites that hold accepted connection agreements with SSEN in the Outer Hebrides – this is based on analysis of SSEN's connection data as of October 2023.

This pipeline is entirely new onshore wind projects, see Table 4 and Figure 16.

- Three sites totalling 61 MW have been approved in planning between 2019 and 2022
- The largest site is the 49.7 MW Druim Leathann wind farm on the north east of the Isle of Lewis, which was granted planning permission in June 2022
- A 7.5 MW development on the Isle of Harris is currently in pre-planning.

Table 4

Baseline and pipeline distributed electricity generation connected and accepted to connect

Generation technology	Number of installed sites	Installed capacity (MW)	Number of pipeline sites	Pipeline capacity (MW)
Fossil fuel diesel backup	4	45.3	0	0
Hydropower	2	1.9	0	0
Onshore wind	15	40.1	7	76.2
Total	29	87.3	7	76.2

Source: SSEN 2023 connections data

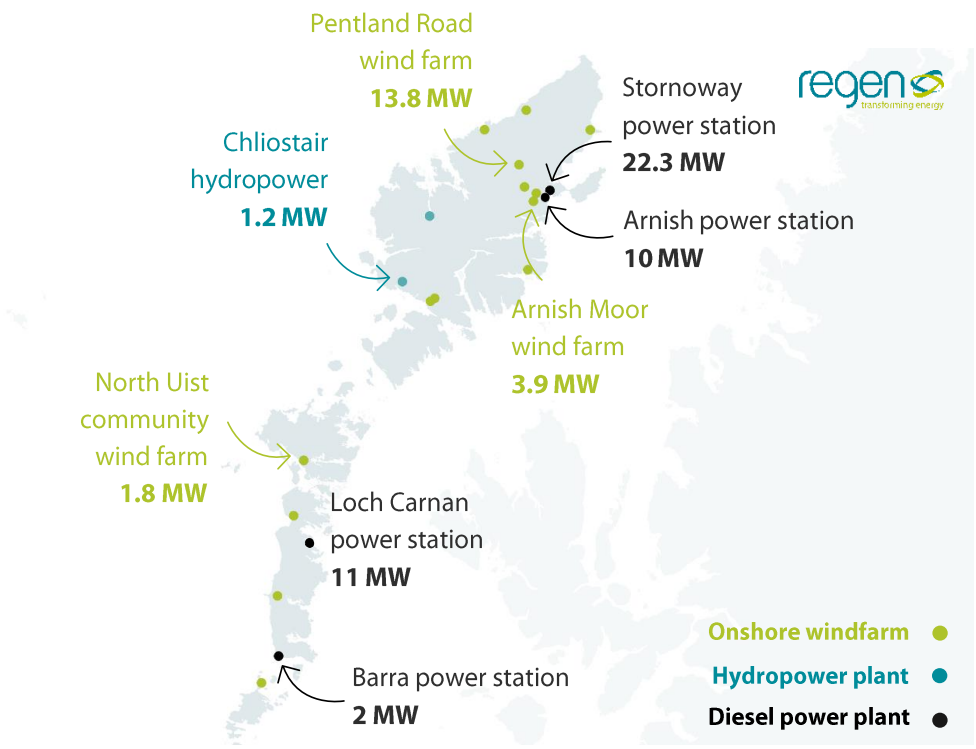

Figure 15

2023 baseline of distributed generation projects

Source: SSEN connections data

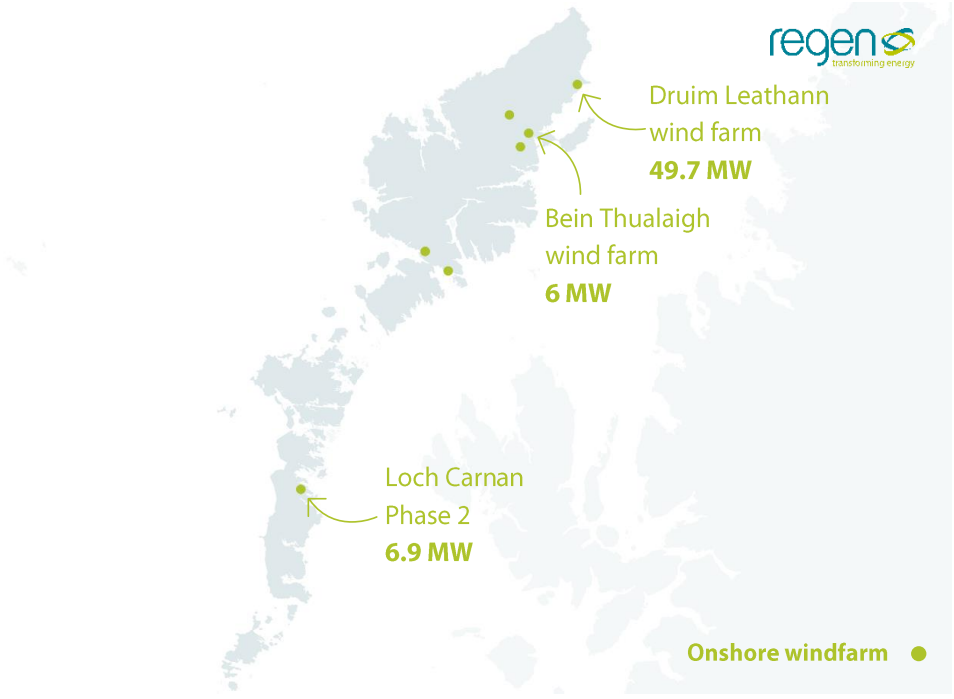

Figure 16

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 the location, size, age etc., but an estimated range is between 15-20 years[10], with some operators already seeking to repower legacy sites with more efficient, higher yield, higher capacity turbines on existing site footprints.

The 15 operational onshore wind sites on the Outer Hebrides range in age (Table 5), but some are ten years old, and Arnish Moor Wind Farm on Lewis has been in operation since 2007. Scottish Government and CnES both support the repowering of existing wind farms, with repowering schemes being treated as new planning applications. CnES has published specific guidance on this as part of their local development supplementary planning guidance[11].

Table 5

Operational lifetimes of existing onshore wind projects on the Outer Hebrides

Project Name	Capacity (MW)	Date Connected	Age (yrs)
Arnish Moor Wind, Lewis	6.9	2007	16
Barra Wind Generating Stn, Barra	0.9	2013	10
Beinn Greadaig	9	2015	8
Liniclate Wind Generation, Benbecula	0.9	2014	9
Bunavoneadar, Harris	0.15	2016	7
Creed Business Park, Stornoway, Lewis	0.225	2013	10
Galson, Lewis	2.7	2013	10
Bornish (Hebridean Energy Food), Lewis	0.33	2016	7
Horshader, Lewis	0.9	2015	8
Lemreway, Lewis	0.05	2018	5
Monan	1.5	2015	8
North Uist Community Wind	1.8	2019	4
Pentland Road Wind, Lewis	13.8	2013	10
Tolsta Community Wind Farm, Lewis	0.9	2013	10

Source: SSEN connections data

Repowering is factored in to the DFES projections, but engagement with existing operators could provide more detail to the scale and intention of repowering at specific locations.

[10] SIA Partners | Climate Analysis Centre, 2022, Repowering existing wind farms will help reach renewable electricity targets faster

[11] Comhairle nan Eilean Siar, 2021, *Supplementary Guidance for Wind Energy Development (not online)*

Transmission network development

SSEN Transmission is currently consulting[12] on the development of a High Voltage Direct Current (HVDC) link between the Scottish mainland to the Outer Hebrides. This significant new connection includes a number of proposed elements, see below and Figure 17:

- An HVDC Converter Station and an Alternating Current (AC) substation located near Stornoway on the Isle of Lewis.
- c. 4 km of underground HVDC cable from the new HVDC converter station and AC substation to the landfall at Arnish Point, Stornoway.
- 81 km of HVDC subsea cable from Arnish Point, Stornoway to Dundonnell on the Scottish mainland.
- c. 80 km of onshore underground HVDC cable from Dundonnell to a mainland HVDC converter station near Beauly.
- A mainland HVDC Converter Station near Beauly.

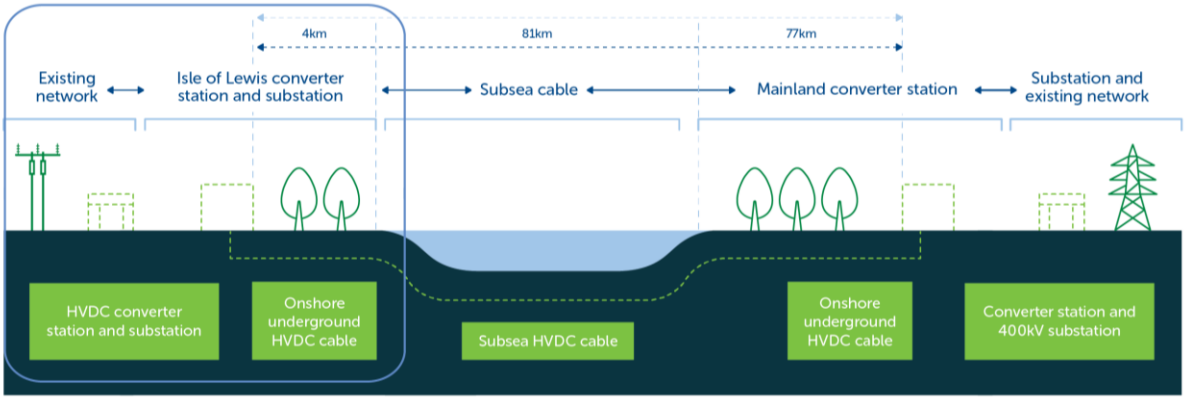

Figure 17
Western Isles Connection Project infrastructure elements

Source: SSEN Transmission

Alongside offshore wind developments (discussed further in section 0) that will leverage this new transmission link, in the Allocation Round 4 of the Contracts for Difference programme, the 200 MW Stornoway Wind Farm project[13] successfully secured a strike price of £46.39/MWh under the Remote Island Wind (onshore wind) technology category.[14]

This is in addition to an in-flight investment for an upgrade to the Fort Augustus to Skye 132kV network, which could impact the Ardmore GSP connection to North and South Uist.

These works are part of SSEN Transmission's broader Pathway to 2030[15] network investment programme, which is being progressed under Ofgem's Accelerated Strategic Transmission

[12] SSEN Transmission, Nov 2023, Western Isles Connection Project
[13] Lewis Wind Power, Stornoway Wind Farm developer website
[14] Department for Energy Security and Net Zero, 2022, Contracts for Difference Allocation Round 4: results
[15] SSEN Transmission, Pathway to 2030 projects

Investment (ASTI) framework[16]. These investments are aiming to prepare the transmission network for significant levels of future offshore wind.

See map in Figure 18 showing in-flight and proposed pathway to 2030 network investments.

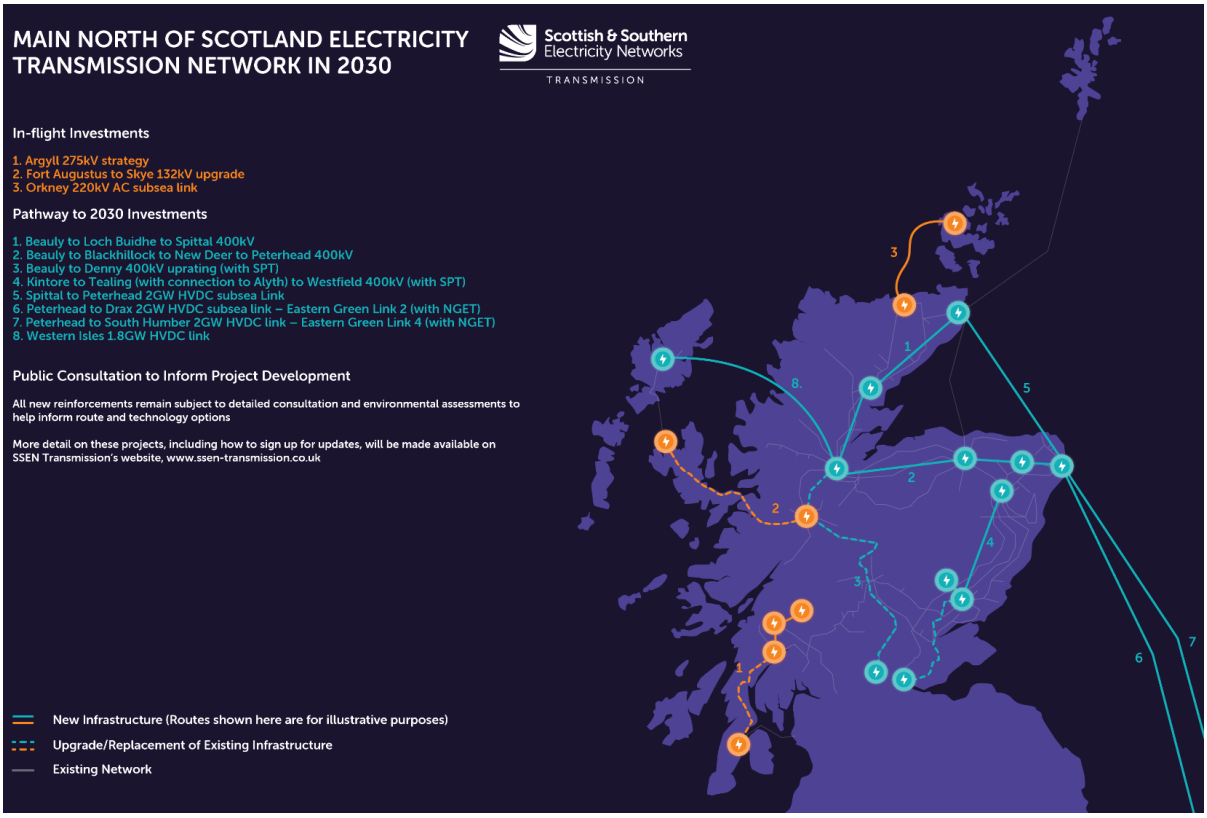

Figure 18
Proposed transmission network investments in North Scotland

Source and credit: SSEN Transmission

[16] Ofgem, August 2023, Decision to modify the special licence conditions in the electricity transmission licences: Accelerated Strategic Transmission Investment

3.2. Offshore wind development

As part of the Scotwind leasing round[17], 2.9 GW of offshore wind capacity has been awarded option agreements from Crown Estate Scotland to generate electricity off the coast of the Western Isles. Magnora Offshore Wind is currently developing the Talisk 500 MW floating offshore wind farm, and Northland Power is developing two projects - Spiorad na Mara (900 MW) and Haybredey (1,500 MW). Due to the scale of electricity generation, any offshore wind projects awarded through Scotwind will connect directly to the transmission network. However, the proximity of the island group to the proposed areas of seabed can make the Outer Hebrides an attractive location for the development and ongoing maintenance of a windfarm.

As part of the Scotwind process, both developers demonstrated clear intentions to develop local capabilities across the Highlands and Islands, to ensure skills development and transfer is well structured to a level sustainable for the long-term operation of windfarms beyond Scotwind [18] [19]. As such, localised distributed electricity demand on the islands could be impacted throughout the lifetime of these offshore wind farms, namely the construction, operation and maintenance (O&M) and decommissioning phases.

The distribution network will need to support the upfront build-out and use of port laydown facilities and turbine integration infrastructure for the windfarm construction, increasing electricity demand for necessary development and use of port facilities. The continual use of these facilities for the O&M phase of the project – which could be in excess of 20 years – will also necessitate electricity demand through the use of transfer vessels and heavy machinery, alongside housing and accommodating operations teams.

Stornoway Port is a significant opportunity for the development of offshore wind, having already supported the delivery of components to local windfarms and assisted in the export of related renewable components from the Arnish Fabrication facility. The port authority has already designated heavy load assembly areas and extensive storage for renewable equipment [20] in preparation for involvement in the construction and maintenance of future offshore wind farms. Further to this, the introduction of low-carbon operational maritime vessels could also add to the potential electricity load growth on the islands, as offshore wind developers look to decarbonise the entire project lifecycle.

All of these projects were awarded through the Scotwind leasing round, a key step in reaching the Scottish Government's target of 11 GW by 2030[21]. As such, increased electricity demand for these projects could be expected by 2028 at the earliest – subject to current policies – where a lack of distribution grid reinforcement could significantly impact their build-out and put the Scottish Government's target at risk.

[17] Crown Estate Scotland, 2022. Scotwind leasing round.
[18] Crown Estate Scotland, 2023. Spiorad Na Mara SCDS Outlook.
[19] Crown Estate Scotland, 2023. Magnora Talisk SCDS Outlook.
[20] Stornoway Port Authority, nd. Commercial
[21] Scottish Governmennt, 2020. Increased offshore wing ambition by 2030.

3.3. Flexibility technologies

As significant levels of variable renewable energy generation connects to the electricity system, a diverse range of flexibility technologies will be required to enable system operability and balance supply and demand. Regen's analysis[22], working in partnership with National Grid ESO, suggested that across GB 80-100 GW of flexibility capacity will be needed by 2035. In a net zero electricity system, unabated fossil fuel generation will be unable to provide this flexibility. Instead, other forms of flexible energy technologies will be required, which could include electricity storage, and hydrogen (both as a source of flexible electricity demand through electrolysis and electricity generation through hydrogen fuelled peaking plants).

Battery storage

Electricity storage could be a significant source of flexibility in a net zero electricity system. Regen's analysis suggests that 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], the most dominant technology being developed and leveraging flexibility markets is lithium-based battery storage. Thousands of battery storage projects are being developed at various scales across the UK, with the pipeline capacity in the region of 200 GW.

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 1-15kW scale, designed to enable households to increase the self-consumption of domestic solar PV, as well as acting 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.

[22] Bridging the gap to Net Zero – a Day in the Life 2035 report, carried out by Regen and the ESO
[23] See Longer Duration Energy Storage Demonstration competition funding, managed by DESNZ

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. Only a small proportion of this large pipeline, up to 30 MW, was projected to connect on the Outer Hebrides, growing to 39 MW by 2050. This included 33 MW of large commercial-scale batteries (standalone grid assets and batteries co-located with renewable generation) and 5 MW of domestic batteries located in homes that have rooftop PV installed. See Figure 19.

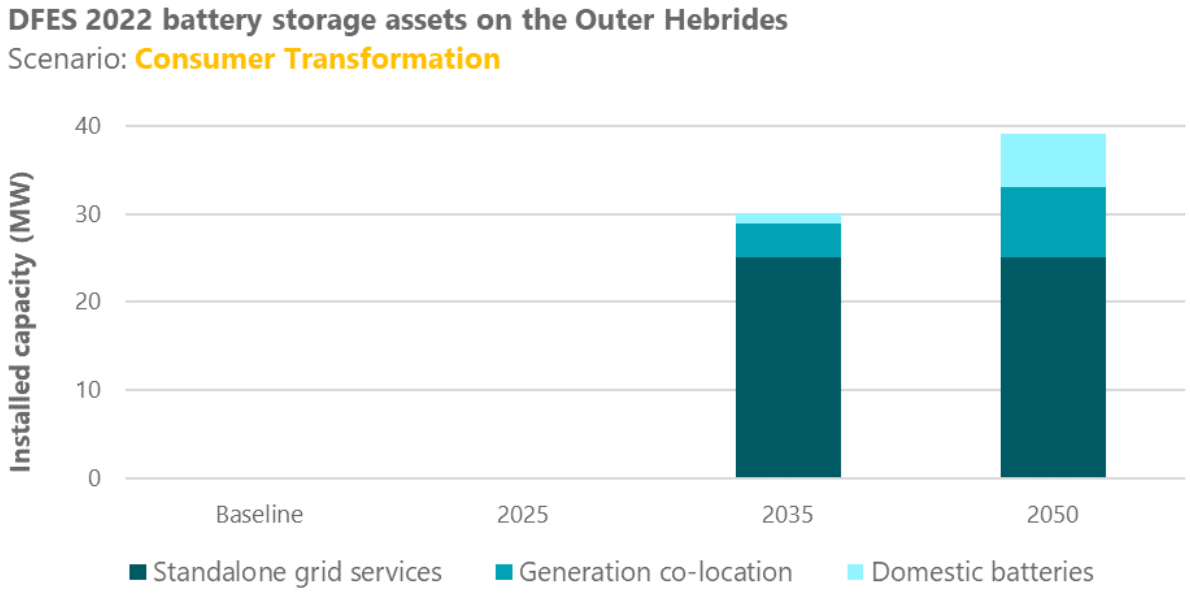

Figure 19

Projected cumulative battery storage capacity in the Outer Hebrides 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 active in planning.

[24] Regen analysis completed for Energy Storage Summit 2023

However, to date, no large-scale battery projects have come online in the Outer Hebrides, and only a single 25 MW battery, proposed to be located at Battery Point Power Station on Stornoway, holds an accepted connection agreement. See Table 6. This has attained planning permission and could be developed as part of a broader transition away from unabated fossil fuels at Battery Point.

Table 6

Baseline and pipeline distributed flexibility technologies connected and expected to connect

Generation technology	Number of installed sites	Installed capacity (MW)	Number of pipeline sites	Pipeline capacity (MW)
Battery storage	0	0	1	25

Source: SSEN 2023 connections data

Further industry insights

The likelihood of additional battery storage sites connecting on the Outer Hebrides in the future will largely be developer-led. With the current network constraints and logistical limitations of the island itself, battery developers are currently prioritising the mainland and other parts of the UK to develop projects. However, with onshore wind and solar capacity set to further increase, businesses and homes on the island looking to maximise the self-consumption of onsite generation and potentially install backup power supplies, there could be a number of use cases for battery storage to be developed on the Outer Hebrides.

Hydrogen electrolysis

The production of green hydrogen through the use of electrolysis plants could be a potentially significant source of future electricity demand. However, as an emerging technology, there is a level of uncertainty around the scale of development of green hydrogen production that could be seen nationally, regionally and locally. This uncertainty stems from a number of areas. There is no clarity as to 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). Also, the degree to which electrolysers will need to be located near storage facilities for distribution versus located near to potential end-user sectors is unclear. However, the British Energy Security Strategy[25] 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[26] 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.

[25] UK Government, 2022, British Energy Security Strategy
[26] Scottish Government, 2022, Hydrogen Action Plan

The Outer Hebrides itself is already seeing the development of low carbon hydrogen projects, including initiatives led by the Comhairle nan Eilean Siar Net Zero Hub, Outer Hebrides Local Energy Hub and the North Uist Distillery Company.

13. Western Isles
The Outer Hebrides Energy Hub aims to maximise the area's abundant onshore and offshore wind resources, producing enough renewable hydrogen to power the islands, as well as for export to the UK domestic and international markets.

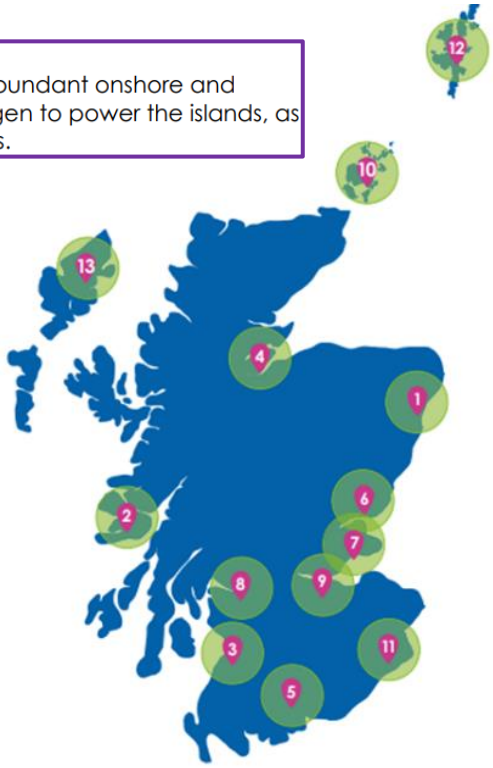

Figure 20
Map of potential regional hydrogen hub locations

Source: Scottish Government Hydrogen Action Plan

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 (namely 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 small amount of capacity is modelled to operate on the Outer Hebrides, totalling just under 6 MW by 2050. This reaches 9 MW under Leading the Way.

This is partly related to some hydrogen innovation projects not directly connecting to the distribution network, but with hydrogen being produced and directly supplied onsite and not requiring a dedicated electricity network connection.

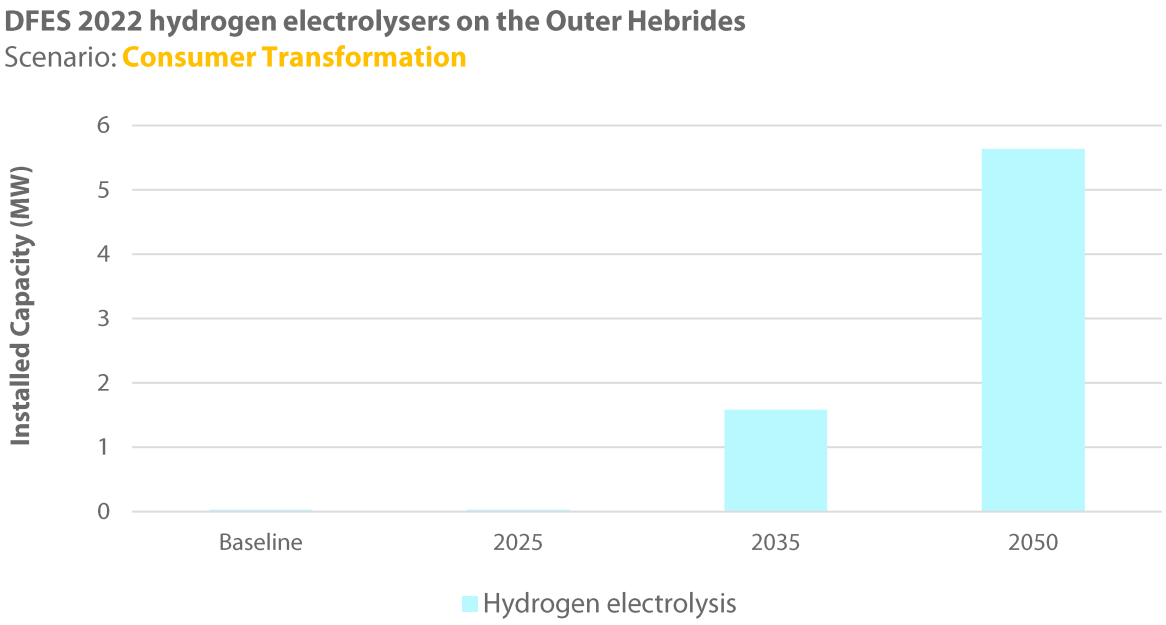

Figure 21

Projected cumulative hydrogen electrolysis electricity demand capacity in the Outer Hebrides

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

Baseline and pipeline as of 2023

One of the few operational electrolyser projects in the licence area is located south of Stornoway, a 30 kW plant which came online in 2019 as part of a wider multi-technology Outer Hebrides Local Energy Hub initiative[27].

Beyond this small installation, there are currently no pipeline electrolysis projects seeking to connect to SSEN's distribution network on the Outer Hebrides.

However, there are initiatives and trial projects currently being pursued on the islands that could lead to future grid applications for electrolysers:

- Grant funding was awarded to a consortium of PlusZero, CnES and UHI Outer Hebrides to increase green hydrogen production at Creed Park in Stornoway, using surplus generation from future onshore wind projects.[28]
- The North Uist Distilling Company secured funding from the Green Distilleries Fund to use hydrogen to heat thermal oil to replace steam in their distillation process.[29]

[27] Community Energy Scotland, 2019, Outer Hebrides Local Energy Hub
[28] Scottish Construction Now, 2021, Western Isles set for green hydrogen future thanks to match-funded grant
[29] Locogen, 2021, Using Hydrogen to Heat Thermal Oil to Replace Steam in Distillation Process

Figure 22
Outer Hebrides Local Energy Hub hydrogen store and refuel

Source: Community Energy Scotland OHLEH project page.

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. At present, the predominant fuel type for both private and public transportation across the Outer Hebrides is fossil fuels. However, as policies start to initiate a technological and industrial shift away from petrol and diesel-based fuels, the network must be ready to take on the potentially significant increase in electricity demand. Being able to travel by road/ferry between the islands and the Scottish mainland will remain critical for residents, businesses and tourists.

The Outer Hebrides Local Transport Strategy[30] has determined five Transport Planning Objectives, of which one includes the "need and requirement to decarbonise transport to support reduction in carbon emissions". In line with the Scottish Government's 2045 net zero target, CnES have recognised the decarbonisation of transport as a key priority and has continuously promoted the uptake and use of low-carbon vehicles (both hydrogen and electric) across a variety of sectors.

[30] Comhairle nan Eilean Siar, 2019. Outer Hebrides Local Transport Strategy (*not available online).*

Electric vehicles

Investment in EVs across the Outer Hebrides has resulted in an increased coverage of EV charging infrastructure, which has been financially supported by Transport Scotland since 2012. This has seen a phased implementation of domestic and non-domestic EV charging points at key locations across the island group, and CnES are currently in the process of identifying sites which would benefit from the introduction of rapid charging capability.

As charging capacity has increased, the Outer Hebrides has seen a notable increase in the use and ownership of EVs. This can be attributed to a greater public sector commitment (Comhairle has purchased EVs for staff), an increase in private EV ownership and 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 in excess of 12,000 EV cars and light goods vehicles (LGVs) on the Outer Hebrides by 2035 (Figure 23). 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 post-2035, increasing to over 13,000 by 2050, which is likely due to increased use and deployment of public transport and active travel. All of the road vehicles considered in this scenario are projected to be fully-electric – no hybrids are expected – due to policies favouring fully electric battery EVs.

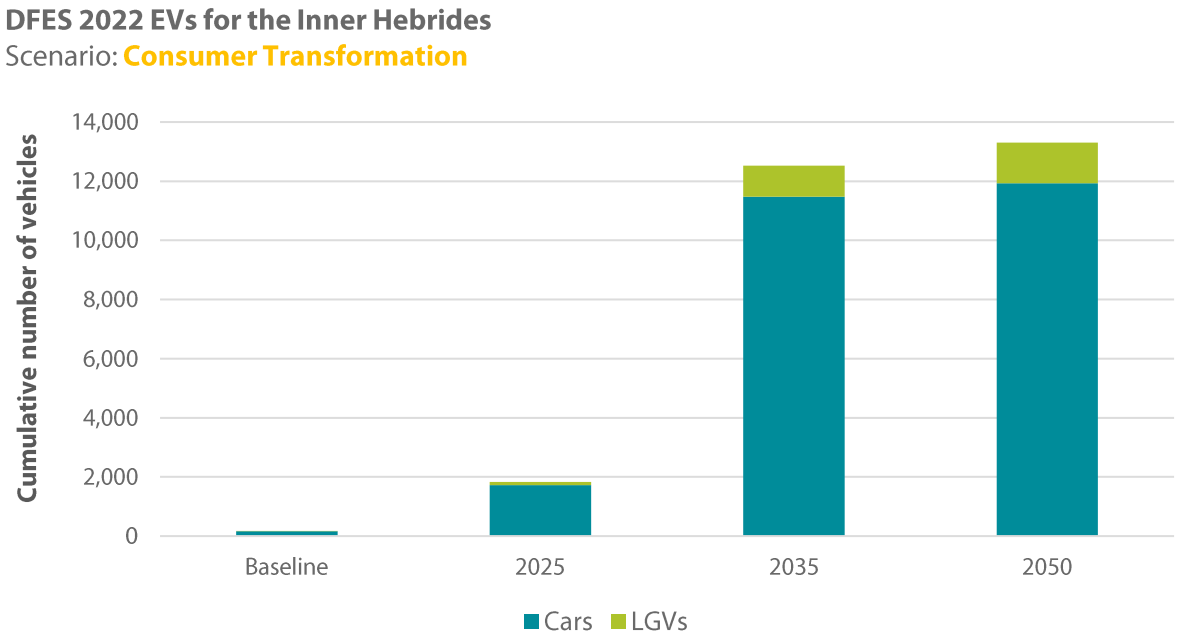

Figure 23

Projected cumulative number of EV cars and LGVs

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

The additional electricity demand that this uptake of EVs could create on the Outer Hebridean network 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 considerations and a selection of different EV charger archetypes, the total connected EV charger capacity across the Outer Hebrides could total 11.7 MW by 2035, increasing to 14.5 MW by 2050 (Figure 24). This capacity is purely for non-domestic EV archetypes, such as chargers located at car parks, workplaces, fleet depot locations and en-route/local charging stations.

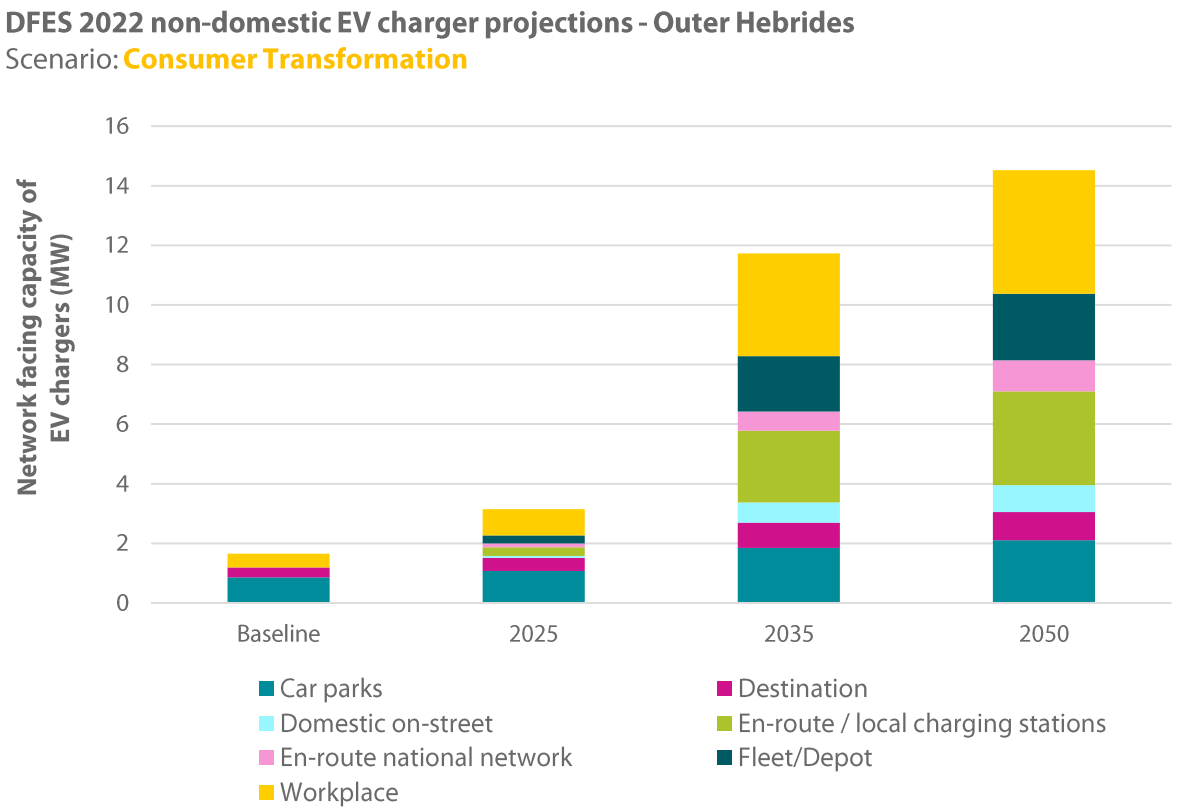

Figure 24

Projected cumulative EV charger capacity in the Outer Hebrides

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

In addition to the non-domestic demand, there is expected to be a significant uptake in the number of domestic EV chargers installed in households. In the Outer Hebrides, projections show over 11,000 off-street domestic chargers by 2035 under Consumer Transformation, increasing to over 13,500 by 2050 (Figure 25).

This is in line with the Building (Scotland) Regulations[31] – 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 obviously be

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

concentrated in more populated areas such as Stornoway and Newmarket on Lewis and Loch Maddy and Balivanich on the North Uist and Benbecula.

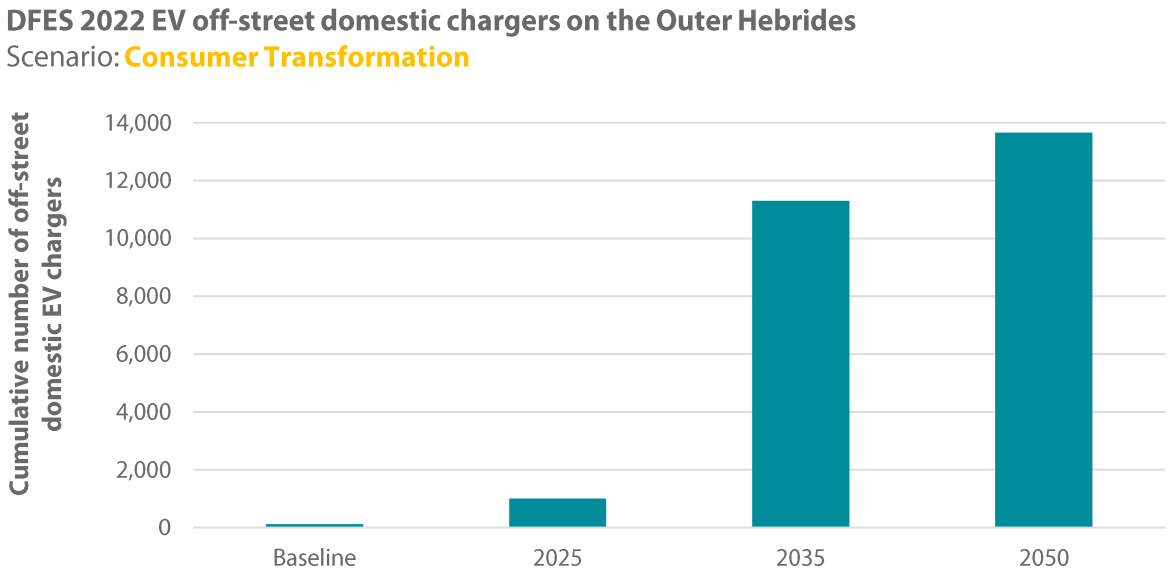

Figure 25

Cumulative domestic off-street chargers on the Outer Hebrides

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

When considering the various potential EV charging behaviours that could be adopted by drivers on the Outer Hebrides, 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. This said, it is clear from the DFES projections that the electricity demand from road transport on the Outer Hebrides will increase significantly between 2025 and 2035.

Further industry insights

A key consideration for the Outer Hebrides' future transport load growth is the number of tourists that visit the islands each year. In 2017 (the year of the last visitor survey), the Outer Hebrides welcomed 219,000 visitors[32], almost ten times the number of permanent residents.[33]

[32] Outer Hebrides Tourism, 2023. Tourism insights in the Outer Hebrides.
[33] Highland and Islands Enterprise, 2019. Outer Hebrides Key Statistics.

A 2020 report[34] undertaken for SSEN looked into the projected impact of tourist EV charging demand on the 2032 distribution network across several Scottish tourist hotspots, including the Outer Hebrides. Analysis of the impact of tourists on the Outer Hebrides was centred around the ferry services between Uig on the Isle of Skye to Tarbert on the Isle of Harris, which modelled no network constraints for the Tarbert Pier secondary substation. This analysis assumed a maximum 50 kW charging demand on the substation, which has a current demand of 119 kW and a rated capacity of 309 kW. With a focus on the charging infrastructure at the main port, this report demonstrates that a worst-case scenario would not cause constraints on the secondary substation located at the pier. This may however depend on other future loads that may connect to this substation.

Public transport should also be considered. Industry engagement suggested that the island's bus network is heavily used – all year by school children and particularly by visitors in the summer months. With a shift towards electrifying bus transportation, current range considerations alongside the necessary number of vehicles and their associated network charging profiles could be a significant source of load growth. Engagement with the commercial sector also suggested that the current grid is a potential barrier to the installation of EV chargers for local businesses and depots. Several large organisations across the Scottish islands have already installed EV charging points for either staff or visitors; however, the installation of additional chargers may challenging be due to constraints in the network. This could impact businesses on the Outer Hebrides from reaching their own net zero targets.

Maritime transportation

Inter-island ferries and crossings between the Outer Hebrides and other Scottish Isles are operated by Caledonian MacBrayne (CalMac Ferries), who run 33 vessels spanning 30 routes across the north and south of the island group. Baseline analysis from CalMac's Environmental Strategy[35] estimated their 2019 – 2020 carbon emissions to be in the region of 126,000 tCO_2e (approximately 2% of the UK's domestic shipping total).

Many of the islands' ferries, including lifeline services, are reaching the end of their operational lifespan – if not already exceeding their estimated lifespan[36]. As such, ferries are currently in the process of being replaced. Caledonian Maritime (who own infrastructure and vessels for CalMac Ferries) have committed to decarbonising their ferry fleet. This includes electrifying the current propulsion systems on all small ferries by 2027 and increasing the number of hybrid vessels from three to eight. These changes could result in a range of expected power requirements of at each port location, potentially in the realm of 1-5 MVA.

The timeframe of possible electricity load growth is heavily linked to the timeline of individual vessel propulsion systems being changed/replaced. This timeline is currently difficult to quantify due to uncertainties around technology readiness. However, partial/hybrid or full electrification at some

[34] Element Energy, 2020. E-tourism: charging demand by electric vehicles in Scottish tourist hotspots.
[35] Caledonian MacBrayne, 2020. CalMac Environmental Strategy.
[36] BBC News, 2023. CalMac's race to keep its ageing fleet afloat.

scale (as opposed to ammonia or biomethane) is being considered, particularly for smaller-scale roll-on/roll-off ferries.

The associated use of shore power – to charge these vessels – could equate to a significant load at each of the relevant ferry terminals. This could be in the range of 8 MW of additional future demand capacity across the islands group through 'cold ironing' – shore power to berthed ferries[37].

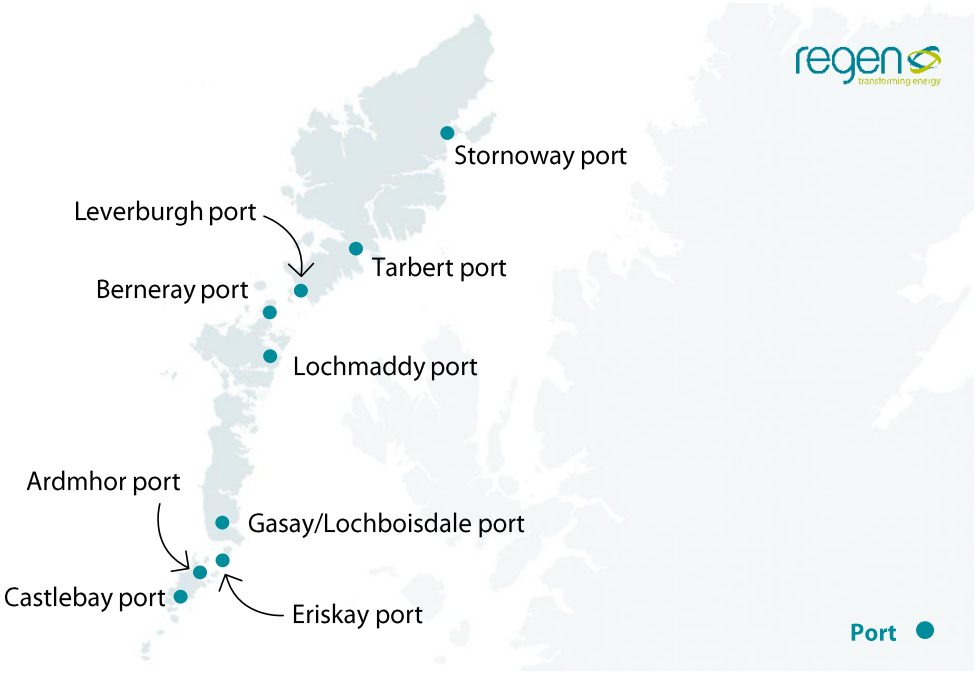

Figure 26
Ports within the Outer Hebrides

Source: CalMac ferry destinations

Ferries are one of the primary modes of maritime transport across the Outer Hebrides, 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 to be installed at marinas and harbours.
- Fishing – the fishing industry has stabilised in recent years with Stornoway Port now used primarily for shellfish landings[38], and crew changes due to the proximity to the airport.
- Aquaculture – the Outer Hebrides accounts for over one-fifth of Scottish fish farming production[39], which is distributed by ferry to the mainland once processed.

[37] SSEN, 2023. Stakeholder engagement.
[38] Stornoway Port, nd. Commercial sectors.
[39] Highlands and Islands Enterprise, 2023. The Blue Economy in the Highlands and Islands.

- Cargo – Stornoway Port handles a variety of general cargo throughout the year. This includes fuel deliveries (critical to the islands) as well as road salt, coal and cement.
- Cruises – as a popular location, the Outer Hebrides receive c. 15,000 cruise ship passengers each year. A new deep-water terminal in Stornoway is set to become operational in 2024 which will give the islands capacity to cater for the majority of the world's cruising fleet[40].

An estimate of the electricity load requirements from these industries would require a more detailed assessment. However, most of these industries have acknowledged that the implementation of shore power for their vessels is part of the current route to reach net zero.

Aviation

Electrification is likely to play a large role in the future Outer Hebridean aviation sector. Both the Scottish Government and Highlands and Islands Airports Limited (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[41].

Inter-island flights and flights between the Outer Hebrides and the Scottish mainline are served primarily by Loganair, the UK's largest regional airline.

In October 2021, Loganair launched its GreenSkies initiative with an aim to be carbon neutral by 2040[42] - five years earlier than the Scottish Government's net zero target. The GreenSkies initiative will see a multi-million-pound investment in the development of fuel-efficient aircraft and thrust systems, alongside a shift towards all-electric ground equipment for the aircraft turnaround across the three island airports – Barra, Benbecula and Stornoway.

As of 2023, Loganair has already achieved its first all-electric aircraft turnaround at Stornoway Airport[43], with over £2 million invested in new ground handling technology. This included electric baggage trucks, solar-powered aviramps, hybrid ground-power units and on-ground EVs. There is ambition to establish this technology across all of their Highlands and Islands airports, mitigating 70,000 litres of diesel annually.

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

- Ground power unit – c.200 kW.
- Electric Tug (for towing aircraft) – c.400 kW.

In addition to the electrification of on-ground infrastructure and vehicles, the decarbonisation of future thrust/drive systems for aircraft themselves is difficult to quantify due to:

[40] British Ports Association, nd. Scottish Ports: Gateways for Growth 2023.
[41] Highlands and Islands Airports Limited, 2022. Sustainability Strategy 2023-33.
[42] Loganair, 2023. GreenSkies Initiative
[43] Loganair, 2023. Loganair (…) cleaner greener ground operations after first all-electric turnaround.

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

These challenges are pertinent to aircraft operating on the Outer Hebrides, e.g. no fuelling system currently exists in Benbecula, forcing aircraft to undertake round trips with demanding fuel requirements. It is anticipated that most aircraft fleets will electrify, although whether aircraft will fully electrify or use hybrid thrust 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.

3.5. Electrification of heat

The decarbonisation of space heating technologies in homes and businesses could be a significant consideration for future electricity load in the Outer Hebrides. Currently, 89% of domestic properties across the Outer Hebrides are off-gas[44], with a small gas grid in Stornoway Town Centre providing LPG to around 1,600 properties. Across domestic properties, oil is the primary fuel-type, used by 46% of houses, with around one-third currently using electricity as the main heating source. Oil is also the main source of heating for non-domestic properties.

Therefore, the transition to heat pump systems in homes and businesses could notably increase the number of properties with electrified heating but may not equivalently increase overall electricity demand due to heat pumps using 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. Areas where solid fuels are currently more heavily used could see a more disruptive increase in electricity demand from a significant future heat pump uptake.

DFES 2022 projections

Under the Consumer Transformation scenario, there could be around 7,100 heat pumps operating in homes and businesses by 2035 on the islands – including hybrid, standalone domestic and non-domestic variants. This could increase to over 9,000 by 2050 (Figure 27). 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[45] and a target peak installation rate of 200,000 new heat pump systems per annum in Scotland in the late 2020s[46].

In addition to these targets, the Scottish Government have recently provided additional support by amending the Home Energy Scotland Scheme[47] in 2022, making it easier for households to access

[44] Comhairle Nan Eilean Siar, 2023. Local Heat and Energy Efficiency Strategy. (*not available online).*
[45] Scottish Government, 2021. Heat in Buildings strategy.
[46] Scottish Government, 2023. Housing/Net Zero Freedom of Information release
[47] Scottish Government, 2022. Enhanced support to make homes warmer and greener

funding for heat and energy efficiency measures. This scheme also brings additional support for rural areas, such as parts of the Outer Hebrides, by increasing the maximum funding to £9,000 per household. Engagement with the Scottish Government in 2020 and 2021 also highlighted that heat pump deployment would seek to prioritise new homes, social housing and properties with off-mains gas fossil fuel heating.

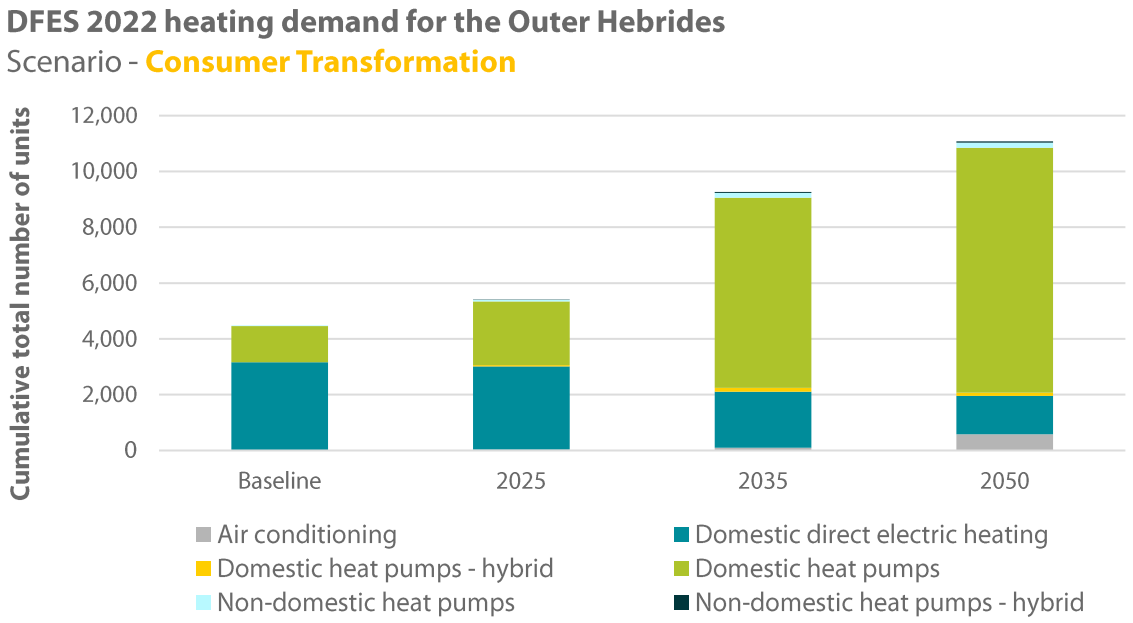

Figure 27

Projected cumulative number of heat pump types

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

The Consumer Transformation scenario does not prioritise hydrogen-fuelled space heating and, as such, heat pumps are the dominant technology under this scenario. Using local 100% green hydrogen has been identified as a priority option to decarbonise heating for the 1,600 properties currently on-gas in Stornoway town centre[48].

However, this is partially reliant on strategic decisions by the UK Government and the Scottish Government on the use of hydrogen for home heating. The Governments' views of hydrogen heating for homes need to be solidified before strategic decisions can be made. CnES have also stated that other heat decarbonisation solutions for on-gas properties will be assessed in the event that hydrogen is deemed unsuitable or unavailable.

[48] Comhairle Nan Eilean Siar, 2023. Local Heat and Energy Efficiency Strategy. (*not available online).*

3.6. New building developments

DFES 2022 projections

Based on an analysis of a register of new developments supplied by CnES, there are projections for new housing on the Outer Hebrides, totalling 280 homes by 2035, see Figure 28.

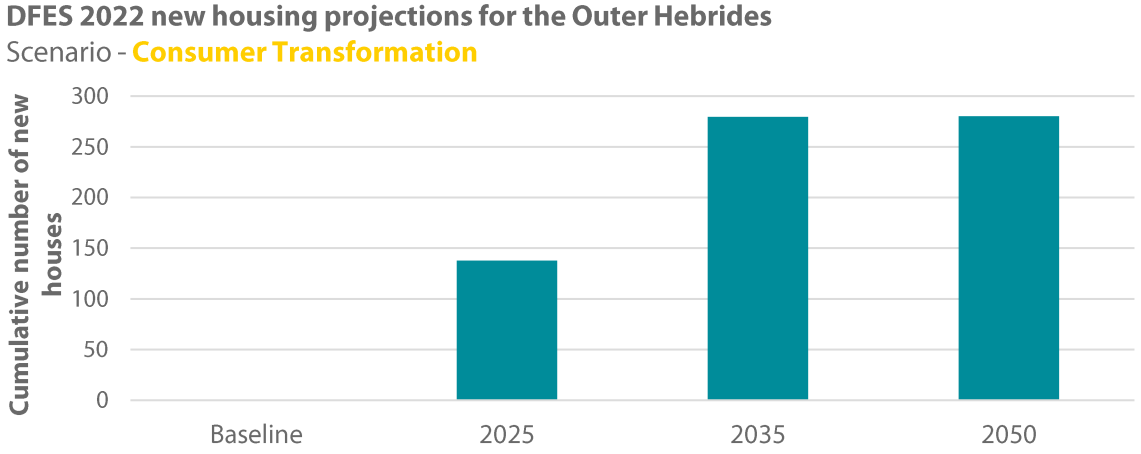

Figure 28
Projected cumulative number of new houses developed

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

In addition to domestic properties, CnES have also shared data for non-domestic developments. By 2035, it is projected that new non-domestic developments on the Outer Hebrides could exceed 850,000 m^2 of floorspace (Figure 29). This includes c. 59,000 m^2 of new factories and warehouses, c.28,000 m^2 of new office floorspace and 422 m^2 of new school developments. The majority of this increase in floor space is projected to stem from "other" developments that do no naturally fit into specific building classifications. Part of the significant development floorspace captured could be attributed to the proposed Spaceport potentially being developed in Scolpaig[49]. This has been modelled to occupy 1,091 m^2 of new operational floorspace – a significant decrease from the 278 hectares (2,780,000 m^2) originally provided by CnES. This is to align more with the expected electricity load requirement from the Spaceport site, where a large proportion of the development is expected to consist of open land/launch pads, which do not necessitate a large electricity demand. Planning permission for the space port has been upheld by the Scottish Government[50] and is expected to be completed in 2028.

[49] Islands Deal article, Spaceport 1
[50] The Guardian, July 2023, Scottish spaceport approved despite local opposition

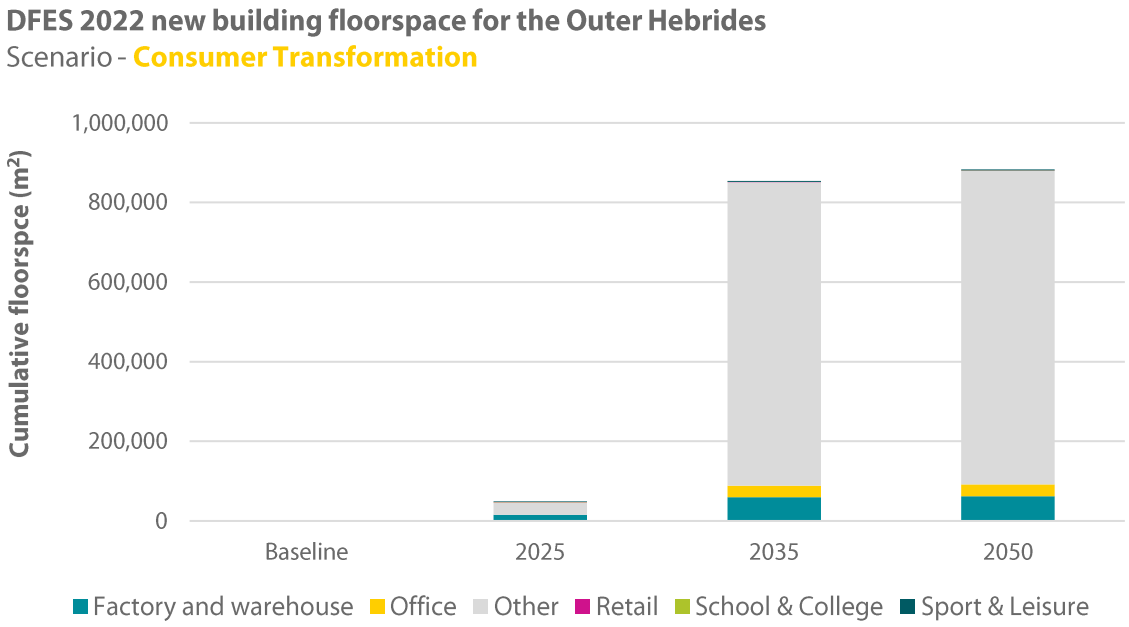

Figure 29

Cumulative floorspace for new non-domestic buildings

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

3.7. Commercial and industrial electrification

Outside of the electrification of transport and space heating, the Outer Hebrides is home to a range of commercial businesses and industry organisations. These typically focus on primary industries (including crofting, agriculture, fishing and aquaculture) but also encompass tourism, construction and the public sector. The future decarbonisation pathways and resultant electricity requirements from these businesses are rapidly evolving areas. Engagement with a number of businesses and island representatives provided some insight into several areas of energy-intensive sectors operating on the Outer Hebrides. 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.

Distilleries

Whisky distilleries are a key part of the Scottish economy, accounting for 77% of all Scottish food and drink exports and 1.5% of all UK goods exports in 2022. The Scotch Whisky industry provided £5.5 billion in gross value added (GVA) to the UK economy in 2018, and directly employs c. 11,000 people across Scotland[51].

[51] Scotch Whisky Association, 2022. Facts & Figures.

The Outer Hebrides currently hosts four operational whisky and gin distilleries[52] (see Figure 30). Whisky is one of the most energy intensive products to produce in the food and drink industry[53], resultantly accounting for a significant proportion of energy demand on many islands.

Figure 30
Distilleries currently operating on the Outer Hebrides

Compared to other island groups, distilling is not as significant a proportion of overall energy use as e.g. Islay/Inner Hebrides. However, as a sector in Scotland, distillery decarbonisation could be a significant source of future electricity demand, and the four operational sites are likely to pursue decarbonisation activities, impacting demand on Harris, North and South Uist.

The distilling process requires high-temperature heat, which is mostly provided by solid and liquid fossil fuels (e.g. oil, LPG, natural gas or diesel-fuelled boilers). The 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.[54] The Scotch Whisky Association (SWA) announced in their 2023-25 strategy that they are committed to achieving net zero emissions in their own operations by 2040[55]. A Riccardo report commissioned by the SWA in 2019 investigated how carbon reduction in the distillery

[52] Visit Outer Hebrides, Distilleries.
[53] Heriot Watt University, 2021. Distilleries need blend of green energy and storage for net zero.
[54] Heriot Watt University, 2021. Distilleries need blend of green energy and storage for net zero.
[55] Scotch Whisky Association, 2021. The Scotch Whisky Industry Sustainability Strategy.

industry could be achieved[56]. This included a range of options and technologies to reduce emissions, from energy efficiency to onsite renewables and hydrogen, see Figure 31.

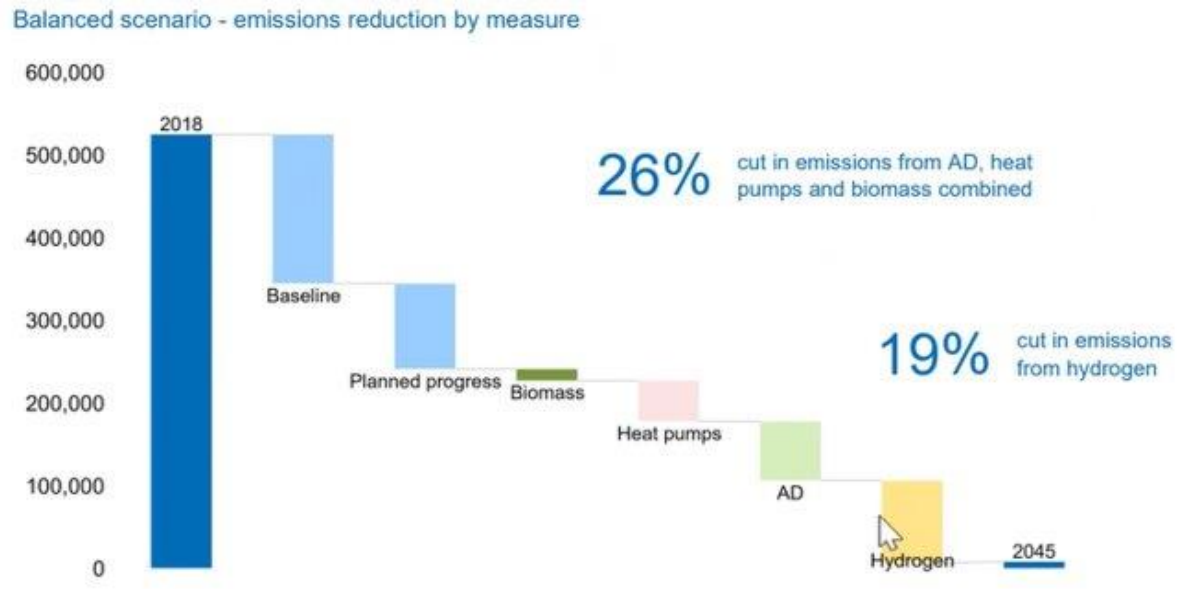

Figure 31

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

Source: Scotch Whisky Pathway to Net Zero report, Riccardo, 2019

For one site specifically, The North Uist Distilling Company, based on Benbecula, there are plans to make use of a grant from the Green Distilleries Fund to use hydrogen to heat thermal oil to replace steam in their current distillation process[57]. There is intention to produce hydrogen onsite through purchasing surplus power from existing operational wind farms. This will involve the installation of a thermal oil heater and a 1.3 MW alkaline electrolyser.

Alongside replacing fossil fuels for the distilling process, companies are looking to decarbonise all aspects of the business, 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 whisky industry 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-temperature process heating for distilling could bring down energy use by up to half[58]; however, the lack of grid capacity is forcing some companies to explore alternative options, such as biofuels, first.

[56] Scotch Whisky Association (Ricardo), 2020. Scotch whisky pathway to net zero.
[57] Locogen, 2021, Using Hydrogen to Heat Thermal Oil Replacement Steam in the Distillation Process
[58] Based on engagement with Diageo, 2023.

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 as a way 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.

Agriculture

Agriculture, forestry and fishing accounted for 28.1% of the workforce in the Outer Hebrides in 2019[59]. In addition to this, over two-thirds of the land in the Outer Hebrides is held in crofting tenure (a land tenure system of small-scale food producers unique to the Scottish Highlands and Islands[60]), with around 6,318 individual crofts[61]. Most of this land is used for small-scale, low-impact farming with minimal use of large-scale farm machinery.

Barra and Vatersay, islands chosen by the Scottish Government to be part of the Carbon Neutral Islands project, see only around 18,882 litres of red diesel (gas oil) and petrol attributed to agriculture, largely for quad bikes and light machinery. This is minimal when compared to the c. 315,000 litres of fuel consumed in the local fishing industry[62].

There is, however, a considerable amount of livestock across the islands, with Barra and Vatersay seeing 76% (883 tCO2e)[63] of their agricultural emissions coming directly from livestock through enteric fermentation. The main current energy use comes from the transport and processing of livestock to be sold. The potential electrification of processing centres and heavier livestock transportation vehicles could see an increase in demand load growth. However, as a fairly specialist subset of HGV electrification, the potential is unclear. Further engagement with the National Farmers Union and livestock transportation companies (such as WM Armstrong and Gilders Transport) would be recommended to explore the direction of travel for these vehicles.

[59] Highlands and Islands Enterprise, 2019. Outer Hebrides Key Statistics.
[60] Scottish Crofting Federation, n.d. About Crofting.
[61] Nature Scot, 2019. Landscape Character Assessment: Outer Hebrides Landscape Evolution and Influences.
[62] Carbon Neutral Islands, 2023. Stakeholder Engagement.
[63] Carbon Neutral Islands, 2023. Barra & Vatersay: Community Climate Action Plan.

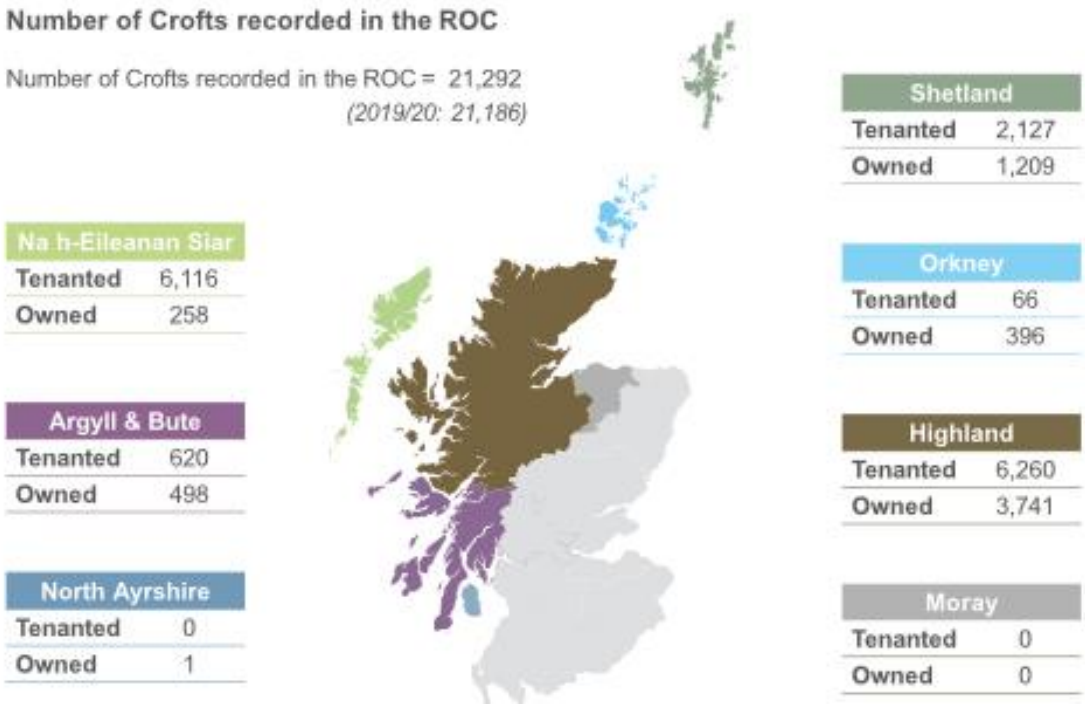

Figure 32
Map of the number of crofts in Scotland per region

Source: Crofting Commission Facts & Figures 2021/22

Aquaculture

The Highlands and Islands are the largest aquaculture production region in the UK[64], with the Outer Hebrides accounting for a fifth of all Scottish fish farming production. The fish are largely farmed, landed and processed on the islands before being distributed via ferry to the mainland[65]. A 2030 growth strategy is in place to double the sector's economic contribution in Scotland to £3.6 billion and support job growth to 18,000[66]. The processing and transportation of this predicted growth in aquaculture (finfish, shellfish and seaweed) could significantly increase electricity demand.

Another notable existing energy demand is the drying of seaweed, which is currently heavily fuelled through burning kerosene. Whilst a small industry compared to fishing, with five wild seaweed harvesting businesses located on the Outer Hebrides, conclusions from the Scottish Government suggested that there is potential for growth in the harvesting and export of seaweed in Scotland in 2022, due to increasing market demand[67].

Grid constraints are currently a barrier to the development of new aquaculture projects. Several local innovation projects have attempted to match local energy generation and demand to combat such

[64] Highlands and Islands Enterprise, 2023. The Blue Economy in the Highlands and Islands.
[65] Stornoway Port Authority, Commercial
[66] Highlands and Islands Enterprise, 2021. Aquaculture Growth to 2030.
[67] Scottish Government, 2022. Understanding the potential scale for seaweed-based industries in Scotland

constraints, including the Outer Hebrides Local Energy Hub (OHLEH) on the Isle of Lewis. This innovation project attempts to utilise fish waste from Bakkafrost's (formerly the Scottish Salmon Company) processing plant, alongside other local household and garden waste, in an anaerobic digester (AD). The AD produces biogas that feeds the Combined Heat and Power Plant, which generates electricity both to the local grid and a hydrogen electrolyser that can be used to supply Bakkafrost's hatchery with green hydrogen and oxygen, alongside power a local hydrogen bin lorry[68,69].

3.8. Community energy initiatives

The Outer Hebrides community energy sector is represented by Community Power Outer Hebrides and is made up of six community groups: Horshader Community Development, Point and Sandwick Trust, Urras Oighreachd Ghabhsainn (Galson Estate Trust), Tolsta Community Development, Stòras Uibhist, and Coimhearsnachd Bharraidh agus Bhatarsaidh (Barra & Vatersay Community)[70]. These six groups own a total of 21.3 MW of onshore wind projects, almost two-thirds of the current wind capacity on the islands[71].

Point and Sandwick Trust have a 9 MW wind farm consisting of three turbines and is the largest community-owned wind farm in the UK[72]. Despite strong appetite from the community, there was a considerable struggle to get a grid connection. The original offer, received in 2010, was awarded on the condition of the new HVDC undersea cable from Lewis to Skye. However, through discussions with SSE and Ofgem were the community successful in delinking the project from this condition.

The turbines were installed and operational in 2015, and the £14 million project still generates around £900,000 in net income for the local community to this day – the project is expected to generate up to £2 million a year to support local people and projects once capital costs have been repaid.

There is considerable appetite across the Outer Hebrides to generate community-owned electricity, yet there is also a considerable need to increase capacity on the local grid in order to facilitate such projects. Further to this, two islands, Barra and Vatersay, are part of the Scottish Government's Carbon Neutral Island project, providing them with extra support and funding to decarbonise their island communities by 2040 and act as guides for other island communities.

[68] Community Energy Scotland, 2021. Outer Hebrides Local Energy Hub Completion Report.
[69] FishFocus, 2019. Top Environmental Award for Outer Hebrides Project.
[70] Community Energy Scotland, nd. Community Power Outer Hebrides.
[71] The Wind Power, nd. Outer Hebrides.
[72] Point and Sandwick Trust, nd. Our Wind Farm.

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 on the Outer Hebrides will notably evolve in both the near and longer term.

DFES analysis suggest that distributed generation capacity is expected to increase from an 80 MW baseline to c. 420 MW by 2050. Most of this generation capacity will consist of onshore wind, which is expected to see an additional 200 MW deployed between the 2022 baseline and 2030. Electricity generation from diesel is expected to cease by 2035 from a 36.1 MW baseline. This could bring about an increase in electricity generation from biomass CHP and an increase in the use of battery storage facilities on the Outer Hebrides distribution network.

DFES 2022 generation and storage capacity on the Outer Hebrides
Scenario: **Consumer Transformation**

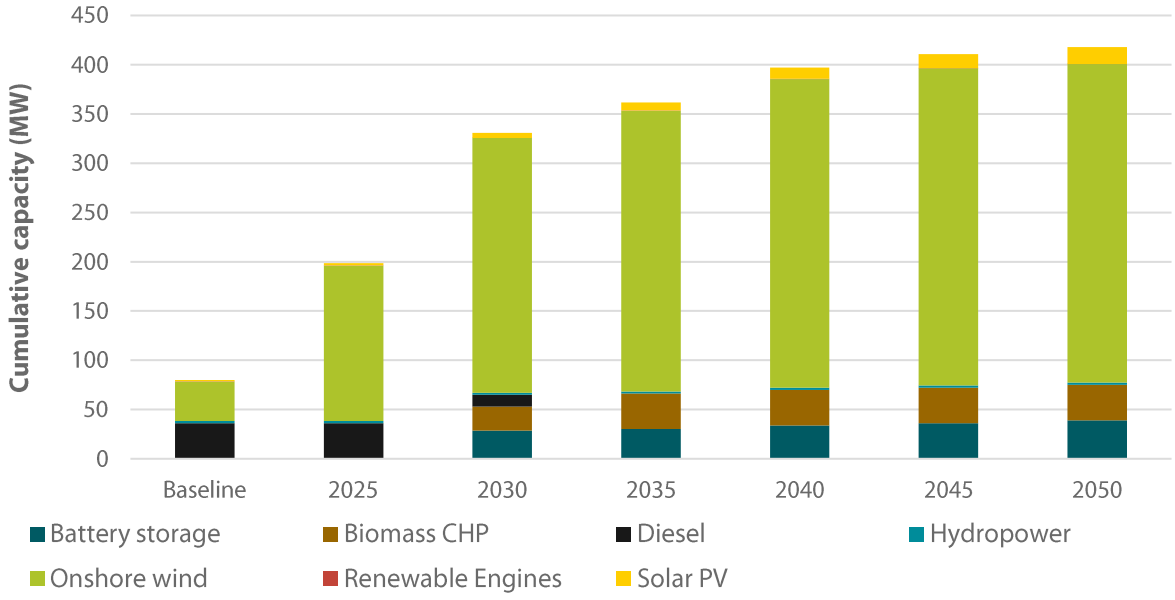

Figure 33

Cumulative distributed generation and storage capacity on the Outer Hebrides, Consumer Transformation scenario

Source: SSEN DFES 2022 projections – Consumer Transformation scenario

Distributed electricity demand on the Outer Hebrides is projected to follow a similar trend to that of distributed generation capacity. The DFES 2022 baseline depicts a 65 MW demand, where around 60 MW is 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 100 MW by 2030 where it them plateaus to 2050 as direct electric heating demand is replaced with domestic heat pumps.

Although the electricity demand from domestic and non-domestic EV chargers – and the assumed uptake of EVs – remains slow by 2025 with just 10 MW of demand, this is expected to increase to around 90 MW by 2035 and to 110 MW by 2050. This is alongside the 8 MW of shore power expecting to connect by 2050 and the 5.6 MW of hydrogen electrolysis.

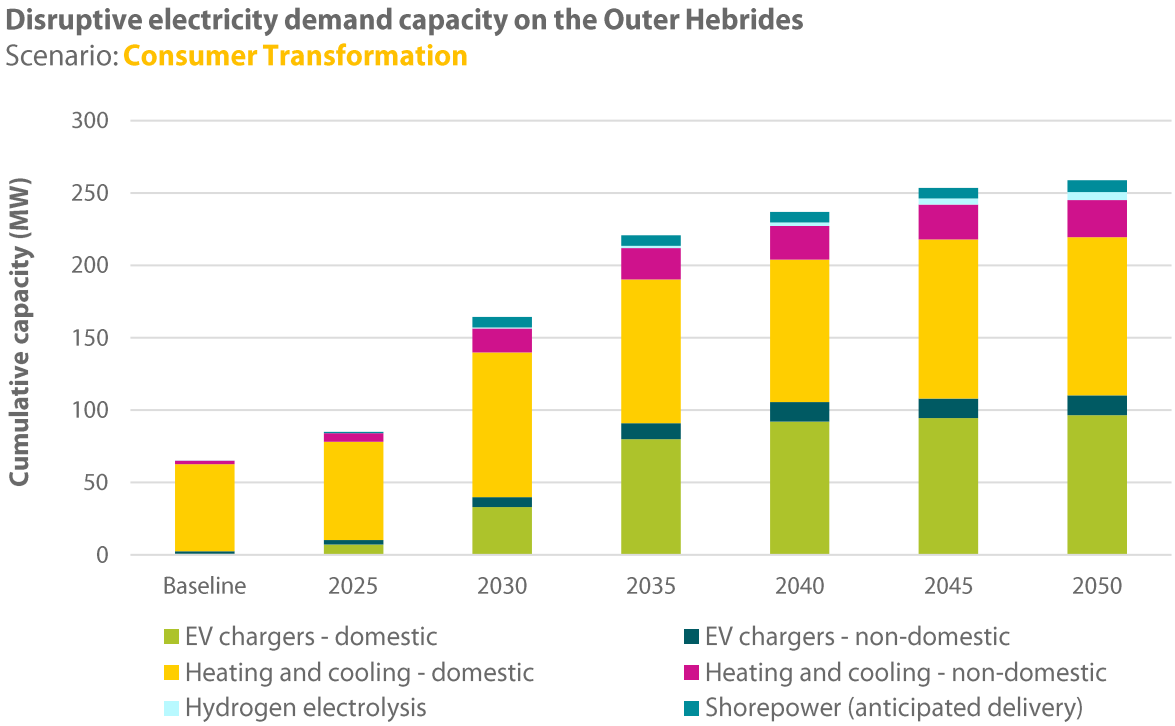

Figure 34

Cumulative disruptive electricity demand capacity on the Outer Hebrides, Consumer Transformation scenario

Sources: SSEN DFES 2022 projections – Consumer Transformation scenario. Shore power estimates from Caledonia Maritime's ferry terminal tracker – provided by SSEN.

The graphs above detail quantifiable projections as to the potential electricity load growth and demand on the Outer Hebrides. Although this data alone demonstrates the need to reinforcement in the distribution network, engagement with stakeholders and industry experts have brought forward additional distributed electricity supply and demand needs on top of these quantified measures. As such, an overall position on future electricity load growth across the sectors covered in this evidence case report is outlined in Table 7 and Figures below.

Table 7

Summary of potential future load growth on the distribution network on the Outer Hebrides by sector

Energy Sector	Summary of future load growth on the distribution network
Renewable energy	The Outer Hebrides have some of the strongest wind resource in Europe. This has enabled the existing onshore wind baseline of 40 MW and a near-term pipeline of 76 MW of prospective new onshore wind projects. This could expand even further in the future to upward of 300 MW under some scenarios. Whilst the Outer Hebrides have very low irradiance levels compared to other parts of the UK, there is potential for a moderate level of 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 Stornoway and the Scottish mainland will support the development of offshore wind adjacent to the island. Whilst this will not directly impact the distribution network on the Outer Hebrides, coordination between SSEN's distribution network reinforcement and this major new HVDC transmission link to Stornoway will be essential. **Renewable energy, particularly onshore wind, will remain a significant source of future generation load growth on the Outer Hebrides. Additional distribution network capacity and the fulfilment of the proposed transmission link to Stornoway may drive further wind and solar projects to come online in the future.**
Battery storage	There are currently no commercial battery storage assets operating on the Outer Hebrides. Despite a very large, growing pipeline of new projects seeking to connect to the wider SHEPD network, there is currently only a single 25 MW project with an accepted connection offer. As a result, under some scenarios, battery storage capacity has been projected to be 30-50 MW by 2050. However, with the development of more onshore wind sites and some rooftop solar installations, the potential for co-location as a business model could drive the development of more battery storage projects on the islands further. In addition to this, the replacement of the existing backup diesel power stations supporting the islands could include, in-part, the installation of longer-duration batteries. **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 on the Outer Hebrides, this could change as use cases and business models constantly evolve. SSEN's replacement of existing diesel backup engines may also include longer duration battery storage as part of a future solution.**
Hydrogen	One of the few operational hydrogen electrolysers in the UK is located on the Outer Hebrides, a small (30 kW) plant located just south of Stornoway at the Outer Hebrides Local Energy Hub. The Outer Hebrides has been identified as one of the hubs for future hydrogen development by the Scottish Government. Grant funding has been awarded to increase green hydrogen production at Creed Park in Stornoway, using surplus generation from future onshore wind projects. One of the whisky distilleries also secured funding from the Green Distilleries Fund to look to use hydrogen to heat thermal oil to replace steam in their distillation processes.

	There are proposals to supply green hydrogen to a 100% conversion of SGN's 1,400 consumer Stornoway Town Centre Gas Network from propane to hydrogen – the only on-gas area of the Outer Hebrides. Both as a source of electricity demand from electrolysis and as a potential offtake of local wind generation for local usage, green hydrogen could see notable development on the Outer Hebrides under some scenarios. SSEN should continue engaging with SGN and hydrogen innovation projects developing on the islands and across Scotland.
Transport	There are currently c.180 EV cars and LGVs registered on the Outer Hebrides. Under some scenarios, this is set to significantly increase in the future, reaching over 12,000 by 2035. Comhairle nan Eilean Siar have plans to develop a Fleet Decarbonisation Plan for their own fleet and public vehicles, including the introduction of an electric refuse collection vehicle. The Outer Hebrides welcomed 219,000 visitors in 2017. Tourism will continue to have a significant impact on the local economy and infrastructure, including EV charging requirements for tourists who are travelling to the islands via vehicle ferry routes. Under some scenarios, non-domestic EV charger capacity reaches over 14 MW, and the number of domestic EV chargers totals over 13,500 by 2050. Marine vessels could also be a significant source of future electricity demand at particular locations on the islands. The local ferry operator (CalMac) operates a number of routes both intra-island and between the island and the mainland and is currently looking to a number of options to decarbonise its fleet, including electrification. There are three airports on the Outer Hebrides, with a number of flights operated by Loganair to the mainland and between airports. Both the electrification of on-the-ground assets and future flight thrust/drive systems are being investigated by the operator and other consulting organisations. The airports could consequently become a further source of electricity demand. Future electricity demand from transport could come from three different transport sectors that are on very different timelines. EV charging is likely to see rapid adoption to meet demand from residents and visitors. The development of shore power charging for ferries is already being explored with SSEN at key port locations; other vessels may increase future capacity requirements at these locations. Commitments from Loganair, who operate flights at the three island airports are pushing for the electrification of on-ground assets, vehicles, and a longer-term view for aircraft.
Heating	Currently, 89% of domestic properties across the Outer Hebrides are off-gas. Most properties are heated by direct electric heaters, fossil fuel boilers or burners. Some parts of Stornoway are on a propane-fuelled gas network. Under some scenarios, the amount of homes with electric heating is set to increase to c.11,000 across the Outer Hebrides by 2050, 75% of all homes. SGN is currently pursuing 100% hydrogen conversion of the Stornoway town propane network, which currently supplies c.1600 homes. Space heating could be a significant source of electricity demand in the future on the islands. With the Outer Hebrides being identified as a hydrogen development hub, there could be a pathway that hydrogen is considered for space heating in more areas of the island. However, the lack of existing gas network infrastructure and low viability for hydrogen heating in homes in general makes this unlikely, so electrification remains the primary low carbon heating technology option for the Outer Hebrides.

Commercial and Industrial	There are a number of specific commercial businesses and industries operating on/around the Outer Hebrides. There are four whisky/gin distilleries located across the islands, looking to decarbonise their high-temperature processes. This could include the use of 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. The Outer Hebrides account for a fifth of all Scottish fish farming. The potential for electrification or alternative fuels requiring electricity (fuel cells) for fishing vessels and fish farming operations is being explored. In addition to fishing, there is a moderate amount of energy consumed by the harvesting and drying of seaweed, which currently uses fossil fuels/kerosene. Projected growth in this industry is currently being limited by electricity network constraints. The decarbonisation of industries specific to northern Scotland (i.e. whisky distilleries, fish and seaweed farming) and broader industries (e.g. agriculture, commercial businesses) could involve a range of potential electrification outcomes.

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