THURSO SOUTH GRID SUPPLY POINT: STRATEGIC DEVELOPMENT PLAN

Our network serving communities in North-East Caithness and Orkney

Draft for consultation

November 2024

Scottish & Southern Electricity Networks

CONTENTS

1. EXECUTIVE SUMMARY

SSEN is taking a strategic approach in the development of its distribution networks. This will help to enable the net zero transition at a local level to the homes, businesses, and communities we serve.

Our Net Zero strategic development plans take the feedback we have received from stakeholders on their future energy needs through to 2050 and translate these requirements into strategic spatial plans of the future distribution network needs of the future. Strategic spatial plans help us transparently present our future conceptual plans and facilitate discussion with Local Authorities and other stakeholders on how these could be translated in the local power systems of the future. To that end these are living plans reviewed as and when stakeholders tell us of changes to their future requirements.

These plans become blueprints for our future plans, shaped by stakeholder feedback. On an annual basis, or as parties seek to connect or change their power use, we will use the strategic development plans to guide our more detailed development works through the Distribution Network Options Assessment (DNOA)[1] process. Through the DNOA process, we typically look at detailed development of options for additional capacity up to seven years ahead of need. This approach ensures that our projects and flexibility opportunities are developed as part of an overall strategic design of our networks

To that end this, our strategic development plan carries a number of recommended interventions that we believe need to be progressed through the DNOA process. These will be further developed in 2024 and the detailed project proposals published in a forthcoming DNOA outcomes report. This report will also provide context on the timescale for delivery of infrastructure works or use of flexibility services.

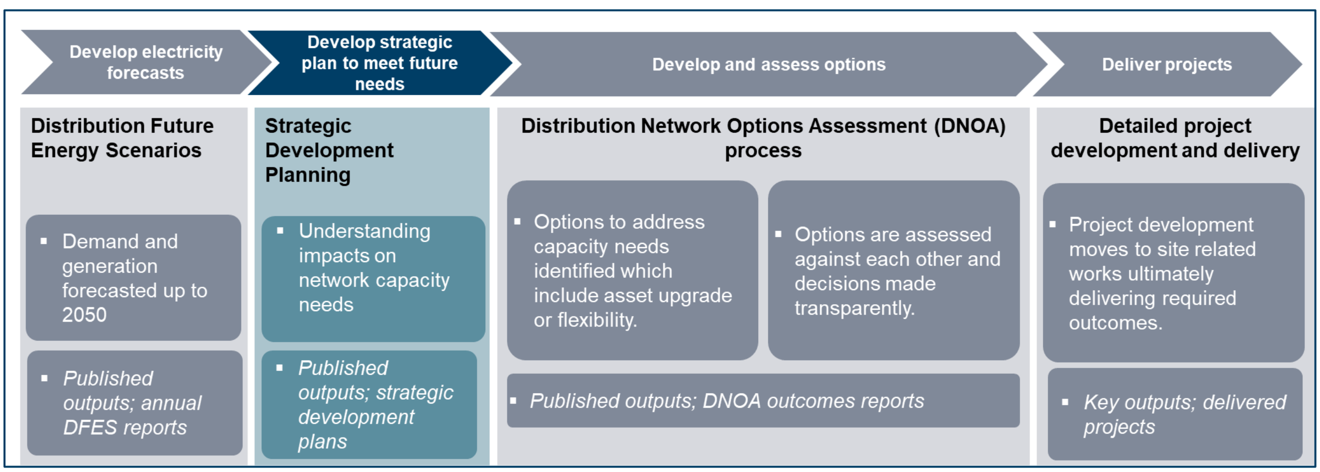

Figure 1 Overview of SSEN's Strategic Planning Process.

The overall strategic planning process is summarised above. We adopt a neutral facilitator role throughout our strategic planning process exploring flexibility options alongside network investment needs. Flexibility is a key component in the transition to Net Zero both assisting in earlier connection of customers as well as helping to optimise timing decisions around future investment needs.

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1 Earlier this year we published our first Distribution Network Options Assessment (DNOA) methodology describing how we are making transparent decisions over flexibility and network investment options. The DNOA methodology forms a key component of our Net Zero strategic planning process. https://www.ssen.co.uk/globalassets/about-us/dso/consultation-library/distribution-network-options-assessment-dnoa---making-decisions-on-the-future-use-of-flexibility.pdf

We operate our local networks across a range of differing voltage levels as power is transformed down to reach individual homes and businesses. Our Net Zero strategic plan considers networks at all these voltage levels and is tailored to the specific needs of each type recognising their different challenges.

This report focuses on the Thurso South Grid Supply Point (GSP), which supports the greater network around Orkney, Kirkwall, Twatt and Stromness. A GSP is an interface point with the national transmission system where SSEN then takes power to local homes and businesses within a geographic area. The specific geographic area is shown in Figure 2 below. It is predominantly rural and so relies on a combination of underground cables, overhead power lines and subsea cables to provide electrical supplies.

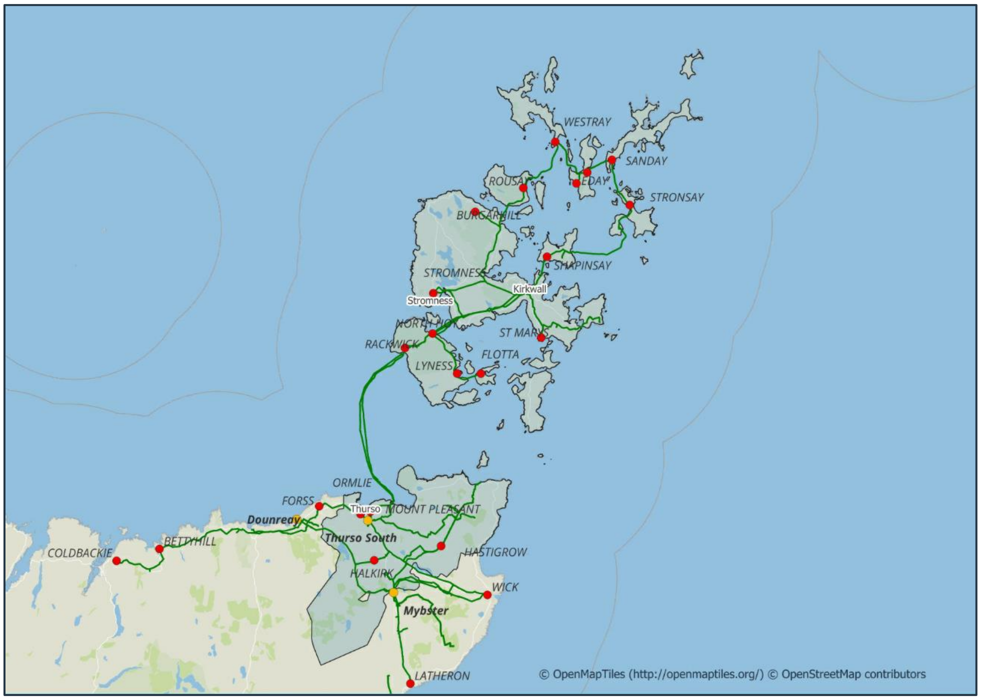

Figure 2 Geographic area covered by this report.

This geographic area of Orkney & Greater Thurso is within the scope of the ‘Hebrides and Orkney Whole System Uncertainty Mechanism’ (HOWSUM).. This is a regulatory mechanism, forming part of our current price control period agreement with Ofgem, which provides SSEN with a route to apply for additional funding to deliver whole system solutions for net zero and to support the security of supply in the Scottish Islands.

Key Areas of Focus in Strategic Development Plan

In the report, we provide an overview of critical aspects that will shape our future network development and planning. This includes an analysis of the evolving demand and generation requirements, as well as the impacts on our electricity networks:

The future demand and generation requirements for the Thurso South GSP area. Much of this information is drawn from our work with Regen to develop the 2023 Distribution Future Energy Scenarios (DFES). However, we also consider additional information from connection request activities in the area and local stakeholder insight. This includes insights gained from our recent islands focused work with Regen[2] as well as subsequent engagement with the whisky industry.

The impacts of these requirements on our electricity networks. In this report we describe how future requirements affect both our higher voltage networks and also the lower voltage circuits feeding individual homes and businesses. From this we develop spatial plans of future network needs at key time intervals through to 2050.

The 2050 spatial plan for our EHV network is shown below in Figure 3. This shows us, potential areas of capacity needed around Eday, Kirkwall, Sanday and St Marys primaries.

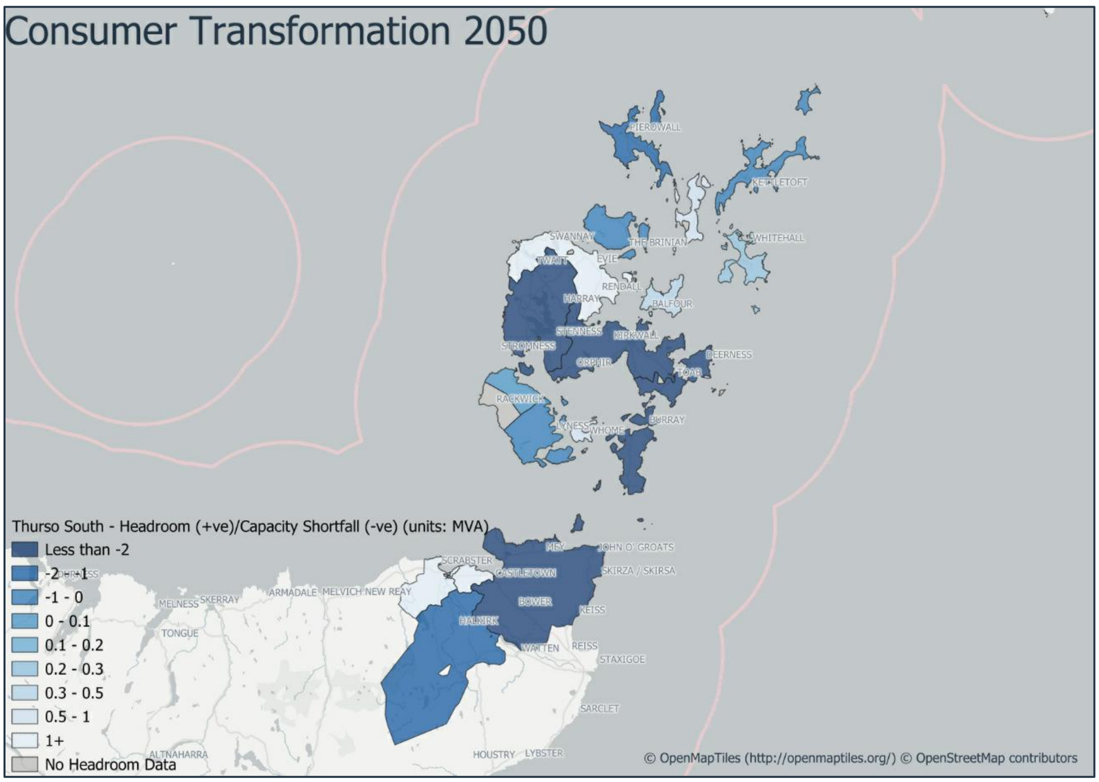

Figure 3 Thurso South GSP 2050 EHV network spatial plan.

The 2050 spatial plan for our High Voltage/Low Voltage (HV/LV) networks is shown in figure 4**Error! Reference source not found.**. This plan shows the specific load driven requirements of different local communities and a need to take a bespoke approach to reinforcement of these networks and/or use of flexibility.

2 [Whole system energy solutions for the Scottish Islands - SSEN]

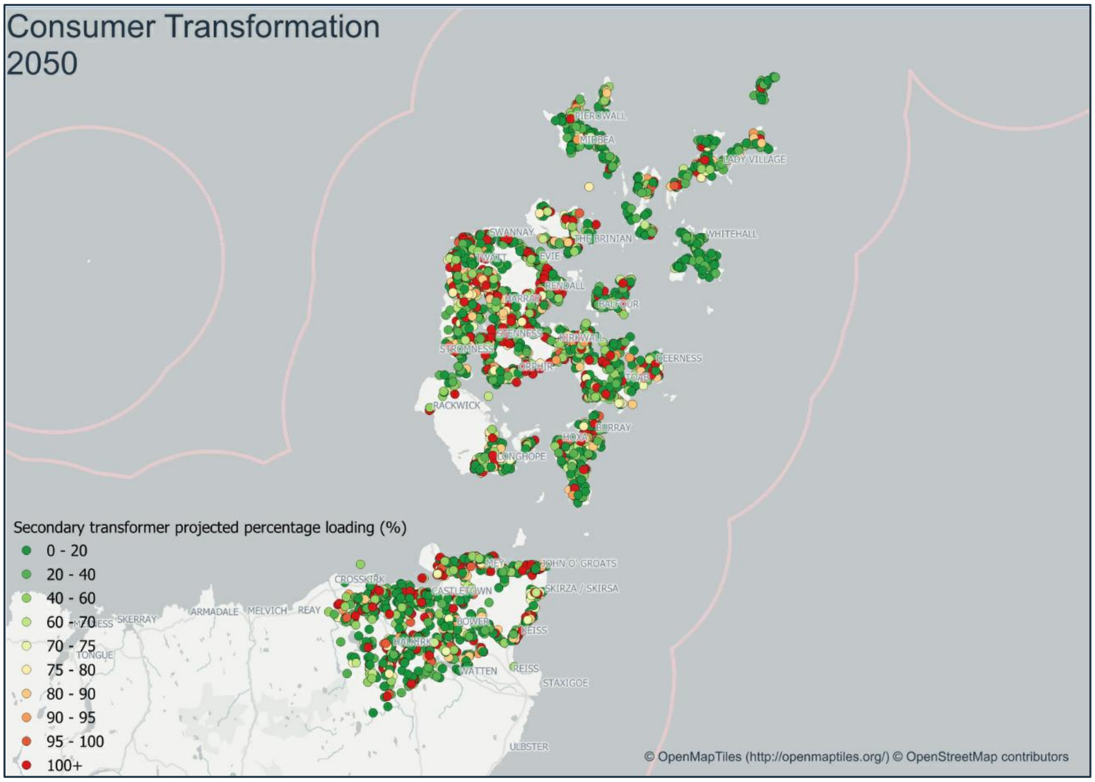

Figure 4 Thurso South GSP 2050 HV/LV network spatial plan.

Proposed activities to resolve the system needs highlighted in the spatial plans. In the report we provide an overview of work that we have already progressed through the DNOA process and initial proposals for projects that we recommend are developed further through the DNOA process. These are generally projects that we believe are needed within the next seven years. We also provide outline thoughts on longer term needs to 2050 with a view to further discussions with local stakeholders.

The pathways to decarbonisation and Net Zero are not always clear and our use of four DFES backgrounds in the report recognises these future uncertainties. Whilst the Thurso South GSP strategic development plan provides a best view of both our spatial needs and required activities, this is subject to change. This plan is therefore a living document that we will update annually reflecting changes from our updated DFES as well as insights gathered from local stakeholders.

This Strategic Development Plan is published as a draft report, and we welcome your feedback to shape both the form and content. We will use your feedback to inform both our final published Strategic Development Plan and also future publications. Please submit any feedback to us through our inbox at: Whole.System.Distribution@sse.com

2. INTRODUCTION

The goal of this report is to demonstrate how local, regional, and national targets link with stakeholder views in the area to provide a robust evidence base for load growth out to 2050 across the Thurso South GSP area. Further context for the area this represents is shown above in **Figure 2**.

To identify the future requirements of the electricity network, SSEN commissioned Regen to produce the annual Distribution Future Energy Scenarios (DFES). The DFES analysis is based off the National Grid Energy System Operator (ESO) Future Energy Scenarios (FES) while accounting for more granular stakeholder insights and new demand and generation connection applications. The DFES provides a forward-looking view of how demand and generation may evolve under four different scenarios as we move towards the national 2050 net zero target. These scenarios are summarised in Figure 5. SSEN use Consumer Transformation as the central case scenario following stakeholder feedback during the RIIO-ED2 development process. This position is reviewed annually.

Where new customer connection information has not been captured in the DFES, we aim to consider it as part of our studies to ensure that the projected load more accurately reflects what we expect to see in the future.

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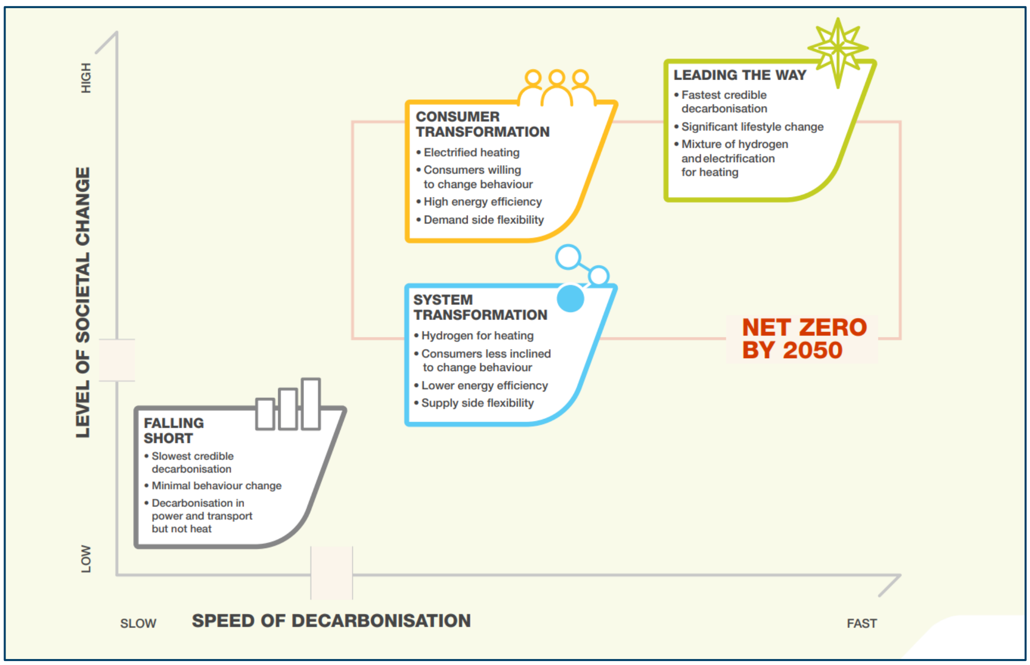

Figure 5 The 4 Future Energy Scenarios adopted for the DFES. *Source: ESO FES*

Using the DFES, power system analysis has been carried out to identify the future system needs of the electricity network. These needs are summarized by highlighting the year the need is identified under each of the four scenarios, and the projected 2050 load. Here, system needs are identified through power system analysis using the Consumer Transformation (CT) scenario (aligning with our RIIO-ED2 business plan), with sensitivity analysis carried out as part our high-level analysis on the other three scenarios to ensure we capture when these needs arise.

Once the preliminary system analysis is completed, and a list of reinforcement options to resolve the system needs is identified, our strategic plans are shared with stakeholders for review. After this, we begin the DNOA process which will provide more detailed optioneering for each of these reinforcements, improving stakeholder visibility of the strategic planning process. Opportunities for procurement of flexibility will also be highlighted in the DNOA, to cultivate the flexibility markets, and to align with SSEN's flexibility first approach.

Further details on our strategic development planning process can be found in our published methodology document

3. STAKEHOLDER ENGAGEMENT AND WHOLE SYSTEM CONSIDERATIONS

3.1. Local Authorities and Local Area Energy Planning

The main local authorities that are supplied by Thurso South GSP are Orkney Islands Council and Highland Council, as shown in **Figure 6.** The development plans for these local authorities will have a significant impact on the potential future electricity load growth on SSEN's distribution network. As such, it is vital for SSEN to engage with these plans when carrying out strategic network investment.

SSEN has strong working relationships with the local authorities and other key stakeholders in Highland and the Orkney Islands. We have regular engagement with Highland Council and Orkney Islands Council through their use of the Local Energy Net Zero Accelerator (LENZA) platform3, which allows them to keep SSEN up to date on their future energy plans in the area. We also have regular engagement with Highlands and Islands Enterprise's Net Zero Transition and Carbon Neutral Islands teams, as well as the Island Centre for Net Zero through which we maintain a 2-way flow of information on respective plans for the area.

This engagement, along with engagement with local businesses and groups, has helped SSEN stay informed about planning and development in the region that will impact local communities' use of the network.

3.https://www.orkney.gov.uk/Files/Council/Council-Plans/Council_Plan_Delivery_Plan

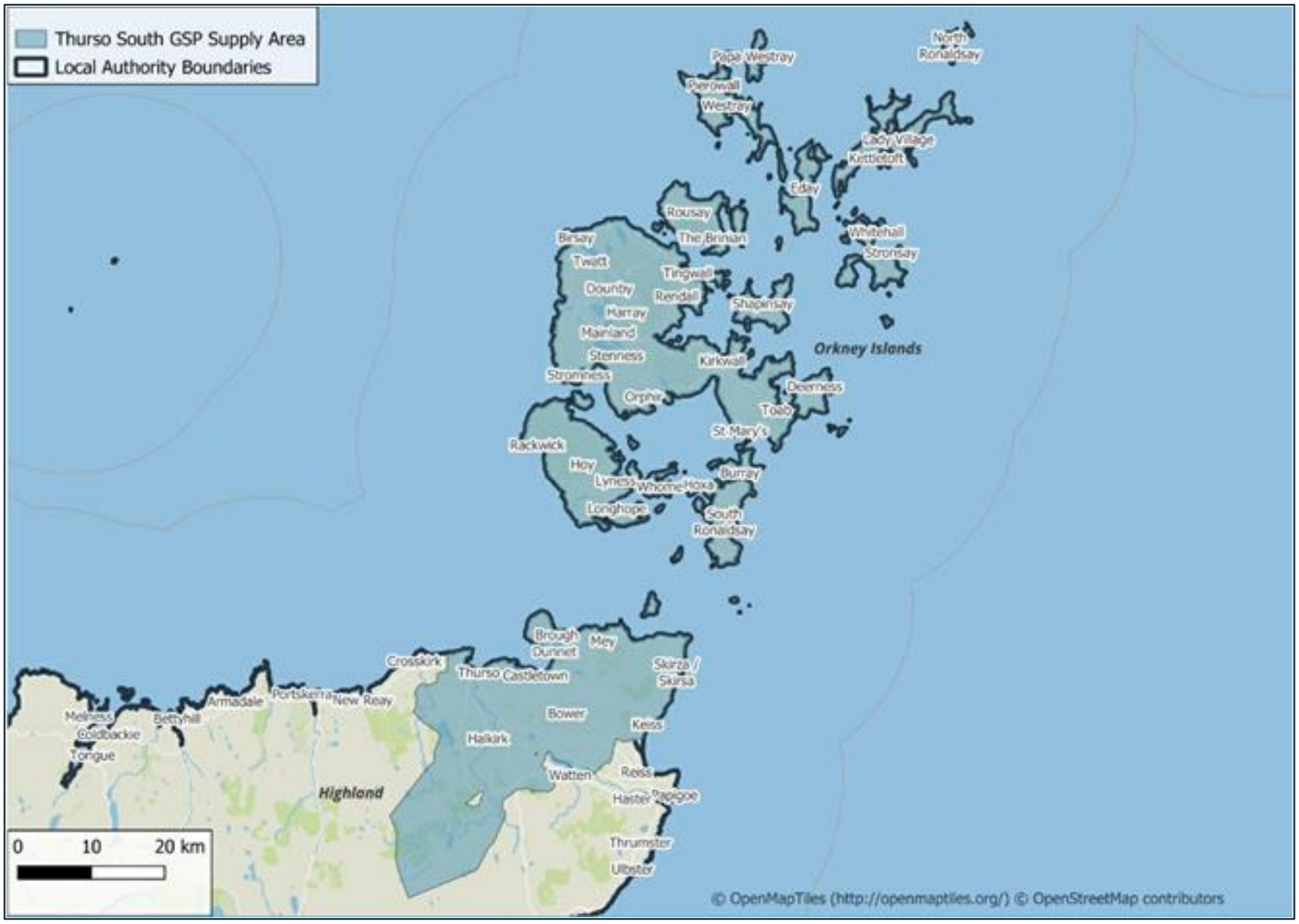

Figure 6 Thurso South GSP Supply Area and Local Authority Boundaries.

3.1.1. Orkney Islands Council

Orkney is made up of more than 70 islands and skerries, with a total land area of 1,000km2. Orkney's estimated population in mid-2020 was 22,400, making up 10,635 households. The Orkney Mainland population has increased in recent years, but the Isles population is slowly reducing.

The Orkney community energy sector is represented by Community Power Orkney and is made up of five community groups. These five groups own a total of 5.4MW of onshore wind projects.

Orkney is also well known for innovative community energy models. These innovative projects highlight the enthusiasm and determination of Orkney's residents to utilize their large renewable resources to help their communities thrive and lead the way in decarbonizing their islands. Grid constraints ae forcing local community groups to choose between repowering existing wind turbines or installing new onshore wind capacity.

Orkney Islands council has a net zero carbon vision: A secure, sustainable low carbon island economy driven uniquely by innovation and collaboration, enabling the community to achieve ambitious carbon reduction targets, address fuel poverty and provide energy systems solutions to the world. The Orkney Renewable Energy Forum

has published the Orkney Sustainable Energy Strategy 2017-2025[4] which presents a vision of the Islands development of its energy sector.
This revisit of the strategy however reconfirms those 3 high levels aims which have informed the following vision statement:

- The achievement of ambitious carbon reduction targets.
- The reduction and eradication of fuel poverty in Orkney.
- Position Orkney as the globally recognised innovation region for energy.
- Ensure a secure energy supply during transition to a low carbon future.

In order to achieve these outcomes, the strategy defines an activity framework based around 5 key thematic pillars:

- Maximum local value and efficiency (from local resources).
- Smart low carbon transport and heat.
- Secure transition to renewable and low carbon energy systems.
- Smart, supportive infrastructure investment.
- Develop and influence policy: delivering access to energy markets.

Orkney Islands Council is currently working on their Local Heat and Energy Efficiency Strategy (LHEES) and Delivery Plan with a view to publishing later this year.

3.1.2. Highland Council

The total land area including all islands at low water is 26,484 square kilometres. This is 33 percent of the land area of Scotland and 11.4 percent of Great Britain. The length of coastline including islands at low water is 4,905 kilometres, 21 per cent of the Scottish total, and excluding islands is 1,900 kilometres (49 per cent of Scotland). Argyll and Bute has the next longest coastline with 3,723 kilometres, then Western Isles with 3,716 kilometres.

The population of Highland Council Area in Mid 2021 – 238,060 - 7th largest of 32 Council areas in Scotland. Between 2001 and 2021, the population has increased by 13.9 per cent (Scotland-wide increase of 8.2 per cent).

Highland Council has published their Net Zero Strategy which includes a route map to net zero by 2045, with key interim targets to reduce emissions by at least 75% by 2030 and at least 90% by 2040[5].

Areas of focus from this strategy that are of particular interest to SSEN include:

- Improving energy efficiency across their estate.
- Identifying and developing opportunities arising from renewable energy generation.
- Rationalising the fleet and replacing vehicles with low-emission alternatives.

Highland Council has also published their LHEES and Delivery Plan which sets out their ambition for a place based approach to planning and delivery of heat decarbonisation in the region.

4.Orkney Sustainable Energy Strategy 2017/2025

5 https://www.highland.gov.uk/info/1210/environment/321/climate_change/2

3.2. Whole System Considerations

We have worked closely with local stakeholders, customers, market participants government bodies and transmission organisations to build on our engagement prior to RIIO-ED2 and develop an enduring Whole System solution to meet the future energy needs of the areas supplied from Thurso South GSP and to enable the region to support the transition to net zero through its extensive natural resource potential.

We are supported in this process by the Hebrides and Orkney Whole System Uncertainty Mechanism (HOWSUM). This regulatory mechanism facilitates exploration of the long-term strategies for decarbonisation and future resilience requirements for relevant island groups and the strategic development plans form a key stage in HOWSUM. We will be using high level options generated from this report and stakeholder feedback to produce detailed proposals that will be submitted to the Regulator in January 2025.

Through our whole system considerations, several options have been identified for future use in the local area, some based on specific feedback from island stakeholders. It should be noted that some of these elements are not sufficiently mature today, however, potentially form part of our longer-term strategic plans:

1. **Traditional Distribution elements:** We have considered how future network needs could be met with additional Distribution investment. It is generally recognised that all islands will need to remain connected to the mainland GB system so there is a definite need for continued Transmission and / or Distribution circuitry and capacity.
2. **Traditional Transmission elements:** We have worked closely with SSEN Transmission to understand their future requirements and considered the potential for a second connection to the islands in the future.
3. **Use of new technologies:** We have discussed and will assess the use of new technologies such as hydrogen and other forms of storage to help resolve some of the drivers for change.
4. **Use of flexibility:** We see flexibility as potentially being required as part of all the developed options. For load related drivers, it can help optimise the timing of future investment needs.
5. **Repowering of diesel generators:** The potential to repower our diesel generators at Kirkwall with green alternatives is being considered as an option to help decarbonise the Scottish islands.

3.2.1. Network resilience for island groups connected by subsea cables

SSEN own and operate 446.5km of Distribution (33kV & 11kV) Submarine Cables, across 60 Islands with Scottish Hydro Electric Power Distribution (SHEPD) licence area covering the north of Scotland. As part of SHEPD's distribution Standard Licence Condition (SLC) 24 and the Distribution Code there is an obligation on SSEN to ensure that certain levels of security are in place as per Engineering Recommendation P2 (ER P2). SLC 24 also requires SHEPD to demonstrate that the requirements of ER P2 are being met to provide demand centres with resilience in the event of network faults.

Subsea cable faults are rare events but can have a big impact on our island communities. Due to the nature of the environment in which they operate, fault location and repair on a subsea cable can take significant periods of time. Therefore, there is an understanding within the SSEN business that island communities served by our subsea cable assets require additional levels of resilience due to these prolonged outage times.

Given the uniqueness of the SSEN subsea network to the UK, Engineering Recommendation P2/8 [6] does not account for the operational realities of faults on the subsea cable networks and as such, a different resilience standard is required. This enhanced resilience standard takes the form of SSEN's newly developed Resilience policy for island groups connected by subsea cables which is explained further below.

Achieving these future resilience levels is the long-term ambition for our island groups and will be considered in any strategic planning of the island networks. Please note, this is an enhancement to the existing P2 planning requirements and does not have retrospective application to our existing network.

We have assessed the level of resilience we currently provided to each of our island groups fed from sub-sea cables and developed this policy based on the demand group sizes stated within P2/8.

Table 1 below summarises the enhanced resilience standard developed for our Resiliency policy for Island Groups connected by subsea cables:

Forecasted 2050 group demand (CT)*	Relevant 2050 P2-8 Category	Net Zero Resilience Policy for Island groups fed via subsea cables
Over 60MW and up to 300MW	D	Group demand secured for sustained long duration N-2 condition through a combination of network assets and local generation (including third party).
Over 4MW And up to 60MW	C	
Over 1MW And up to 4MW	B	Group demand secured for sustained long duration N-1 condition through a combination of network assets and local generation (including third party). N-2 condition managed through use of portable generation or use of existing generation on island if available.
<1MW	A	

Table 1 – SSEN Group Demand sizes for Island Groups fed via subsea cables

3.2.2. Diesel Embedded Generation (DEG) Decarbonisation

SSEN currently has 16.3MW of Diesel Embedded Generation available at Kirkwall Power Station, to provide network resilience in the unlikely event of a subsea cable fault or planned outages.

SSEN has developed a 2050 strategy for the decarbonisation of its Diesel Embedded Generation (DEG) fleet. This will contribute to SSEN achieving its Science Based Targets (SBTs) by 2033 and our Net Zero ambition by latest 2045 as outlined in the RIIO-ED2 business Plan. Further details can be found in our Sustainability Strategy[7].

The application of this strategy will be tailored to each island group, recognizing both the needs of the island communities and also the status of the existing DEG infrastructure. We will consider how DEG decarbonization can be most efficiently enacted for that island group which could be through;

- Bringing forwards additional network resilience from our 2045 vision to reduce probability of operation (e.g. advancement of investment/reinforcement project delivery to provide additional network resilience);
- Use of flexibility solutions as an alternative to running DEG;
- Repowering DEG with alternative fuel sources such as Hydrotreated Vegetable Oil (HVO);
- Full review of the impact and management of our NOx emissions

3.2.3. Transmission interactions

We have seen a significant increase in generator connection applications in Orkney and Thurso South, predominantly in renewable generation supporting the country's drive towards Net Zero.

Finstown new GSP (2x120MVA) is proposed to be installed due to the contracted generation and the ongoing applications in Orkney. The project scope is to design and install a high voltage alternating current (HVAC) transmission system between Finstown in Orkney and Dounreay in Caithness, capable of transmitting up to 220MW of power. The project includes approximately 14km onshore HVAC cable and 53km subsea HVAC cable.

Currently there are a number of grid constraints preventing the development of new renewable projects and on-island consumption of community-owned wind projects. The new Finstown GSP will enable generation customers on the Orkney to export the electricity they produce to the wider GB network. This scheme should also increase network resilience with an additional transmission link/presence on the Orkney archipelago. The Finstown GSP is expected to be commissioned and energised in 2028.

3.3. Flexibility Considerations

Through its innovative Constraint Managed Zone (CMZ) initiative in 2016, SSEN was the first UK DNO to introduce Flexibility Services in their current commercial format. We are continuing to lead the way in this development resulting in over 700MW of Flexibility Services being procured in the 23/24 Financial Year.

SSEN uses of Flexibility Services to manage areas on our network that would otherwise have power flow that exceeded the network capacity. Flexibility Services is a key tool in the design and operation of the network and is used to support our network investment programme by enabling outages to go ahead; optimising the build programme and delaying reinforcement where economical to do so.

SSEN procures Flexibility Services from owners, operators, or aggregators of Distributed Energy Resources (DERs), which can be generators, storage, or demand assets. Services are typically needed at specific locations and times of day where high power flows are expected to occur.

7 SSEN Sustainability Strategy

In September 2024, we launched a Request for Information (RFI) to identify new Flexibility Service Participants in a selection of island communities and establish routes to market in this geographical location. The consultation closed on the 20th September and we are continuing conversations with participants as we develop our procurement strategy in these locations.

In addition there are a number of generators on Orkney connected via flexible connection to the distribution system. An Active Network Management (ANM) scheme in place to manage the flows on the two existing onshore OHL and subsea cables from Thurso South Grid substation. This scheme has enabled the connection of 24 generators.

4. EXISTING NETWORK INFRASTRUCTURE

4.1. Thurso South Grid Supply Point Context

The Isle of Orkney is supplied from Thurso South GSP via two 33kV subsea cables via Scorradale substation. There are fourteen 33/11kV primary substations at Orkney, as shown in Table 2, supplying approximately 14,058 customers

Diesel generators at Kirkwall provide back-up power supplies to the islands in the event of an interruption to the subsea cable supplies.

The Thurso South mainland network is made up of 33kV, 11kV and LV circuits. In total, the mainland network supplies four primary substations via three 33kV feeders and approximately 8,651 customers.

Substation Name	Site Type	Number of Customers Served	Transformer number / MVA rating	2024 Substation Maximum MVA
Orkney Area				
BURGARHILL	Primary Substation	898	Single 4/8MVA transformer	1.79
EDAY	Primary Substation	126	Single 1MVA transformer	0.83
EDAY TIDAL	Primary Substation	2	Single 8MVA transformer	0.18
FLOTTA	Primary Substation	78	Single 2.5MVA transformer	0.12
KIRKWALL	Primary Substation	6,630	Double 12/24MVA transformer	19.13
LYNESS	Primary Substation	286	Single 1MVA transformer	0.41
NORTH HOY	Primary Substation	39	Single 0.2MVA transformer	0.05
ROUSAY	Primary Substation	229	Single 2.5MVA transformer	0.44
SANDAY	Primary Substation	429	Single 1MVA transformer	0.61
SHAPINSAY	Primary Substation	207	Single 2.5MVA transformer	0.29
ST MARYS	Primary Substation	1,604	Single 4MVA transformer	2.50
STROMNESS	Primary Substation	2,829	Double 7.5/15MVA transformer	6.93
STRONSAY	Primary Substation	222	Single 2.5MVA transformer	0.31
WESTRAY	Primary Substation	479	Single 4MVA transformer	0.67
Thurso South Area				
HALKIRK	Primary Substation	1,142	Single 2.5MVA transformer	1.99
HASTIGROW	Primary Substation	1,864	Single 5MVA transformer	2.48
MOUNT PLEASANT	Primary Substation	1,594	Double 7.5/15MVA transformer	3.81
ORMLIE	Primary Substation	4,051	Double 7.5/15MVA transformer	4.11

Table 2 Customer number breakdown and substation peak demand readings (2024)

4.2. Current EHV Network Topology

Two subsea cables connect Thurso South substation with Scorradale substation. There are four 33kV circuits which supply the rest of the Orkney demand from Scorradale substation.

Thurso GSP supplies four primaries (Halkirk, Hastigrow, Mount Pleasant and Ormlie) on the.

The existing 33kV network topology is shown in Figure 8 and Figure 8.

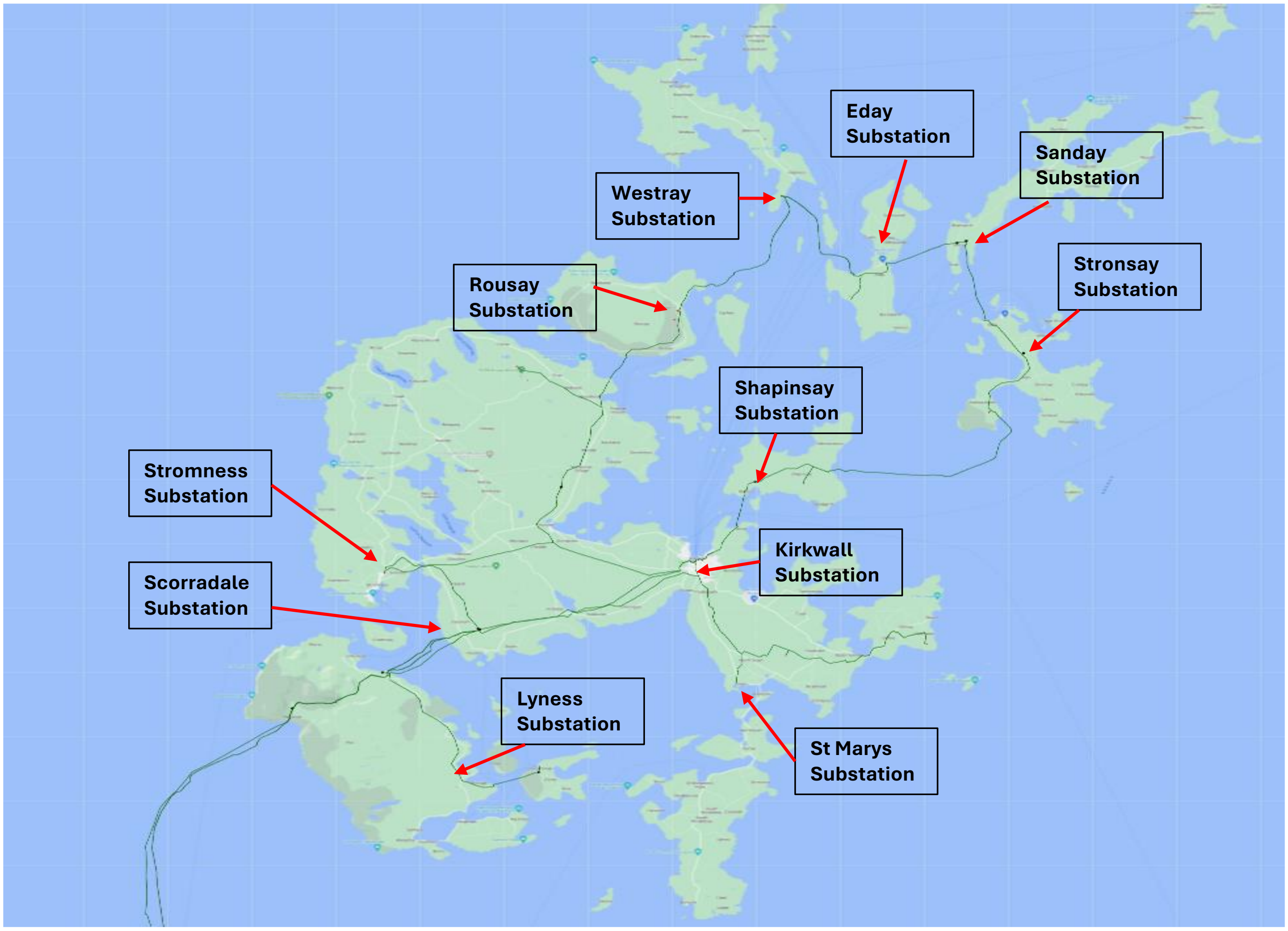

Figure 7 The Existing Orkney Network Topology.

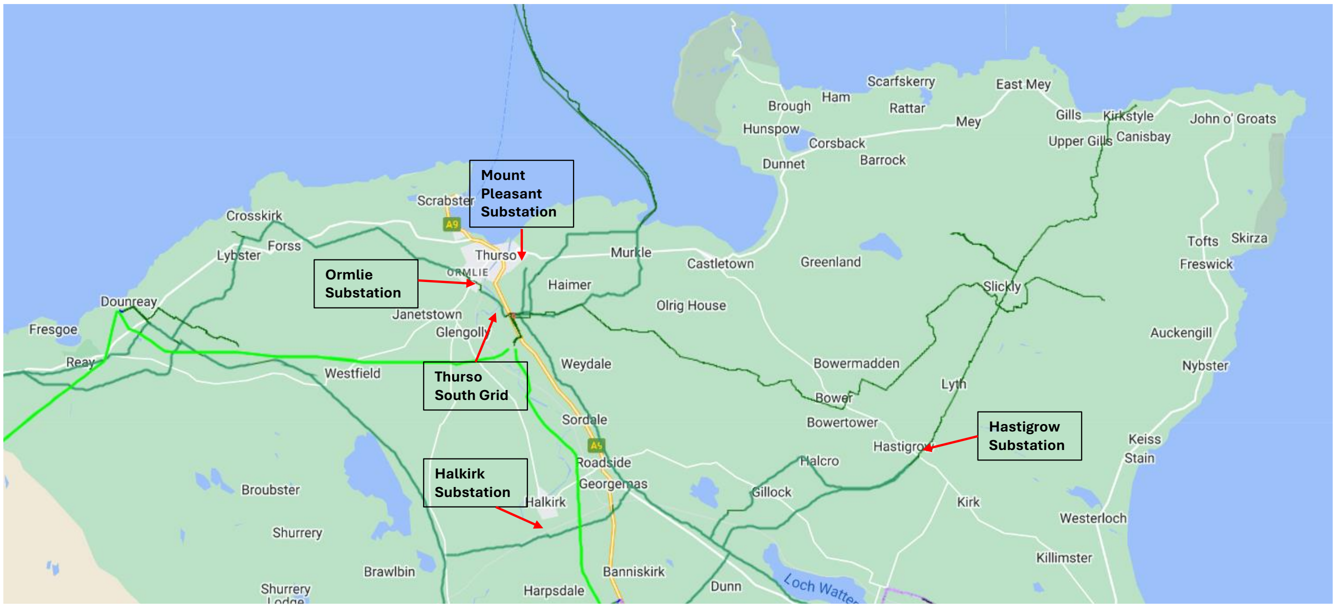

Figure 8 The Existing Thurso South Mainland Network Topology.

4.3. Current Network Schematic

The existing 33kV network is shown in **Figure 9** and Figure 10.

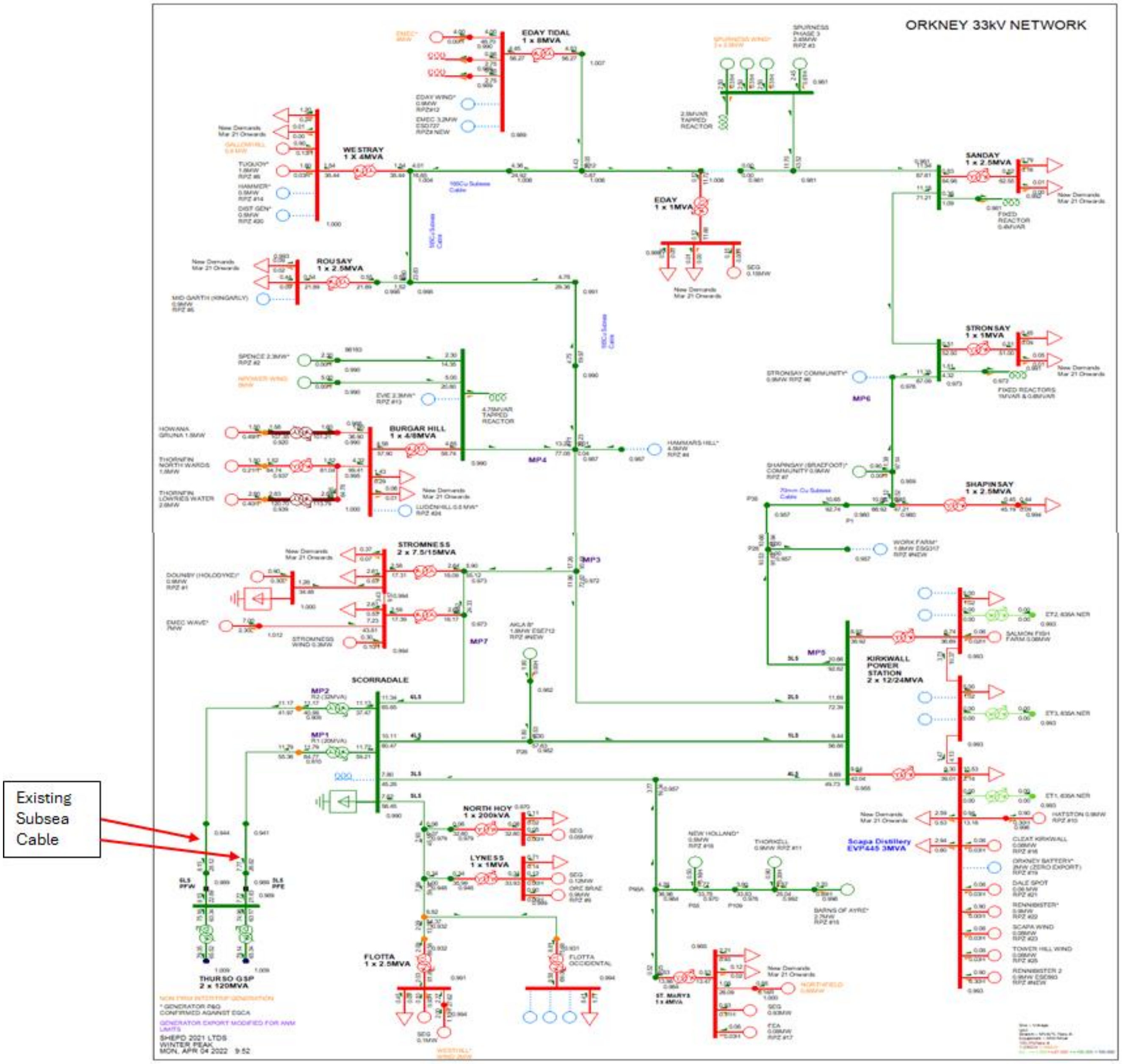

Figure 9 Existing Orkney Network.

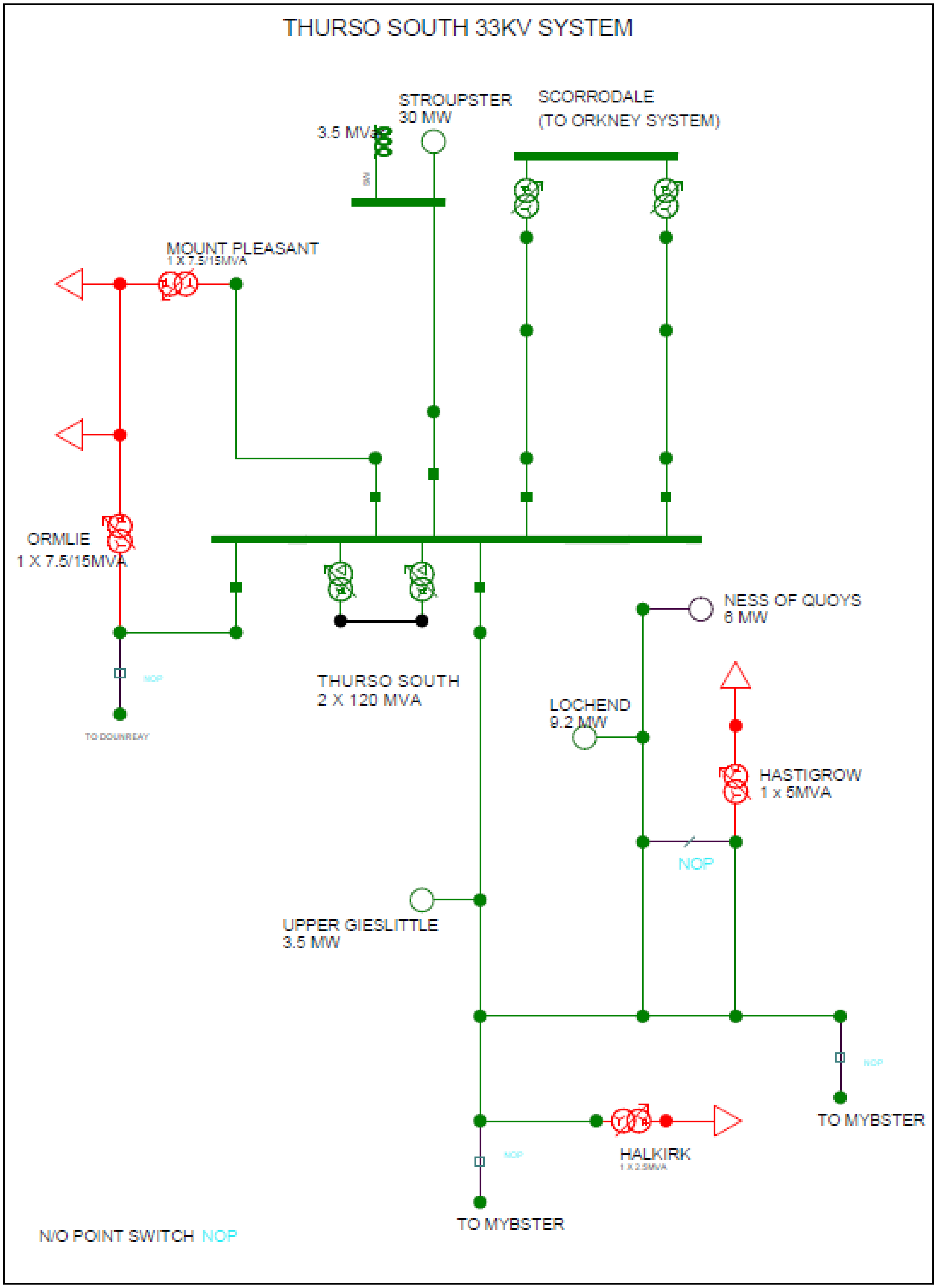

Figure 10 Existing Thurso South Network.

5. FUTURE ELECTRICITY LOAD AT THURSO SOUTH GSP

5.1. Distributed Energy Resource

5.1.1. Orkney

5.1.1.1. Generation

Based on the DFES projections, distributed connected renewable generation across Orkney will increase significantly from 52MW in the currently connected baseline to 409MW in 2040 and 493MW in 2050 (in **Figure 11**). We see onshore wind and marine accounting for much of the distributed generation from 2025 onwards and hydropower maintaining at current levels.

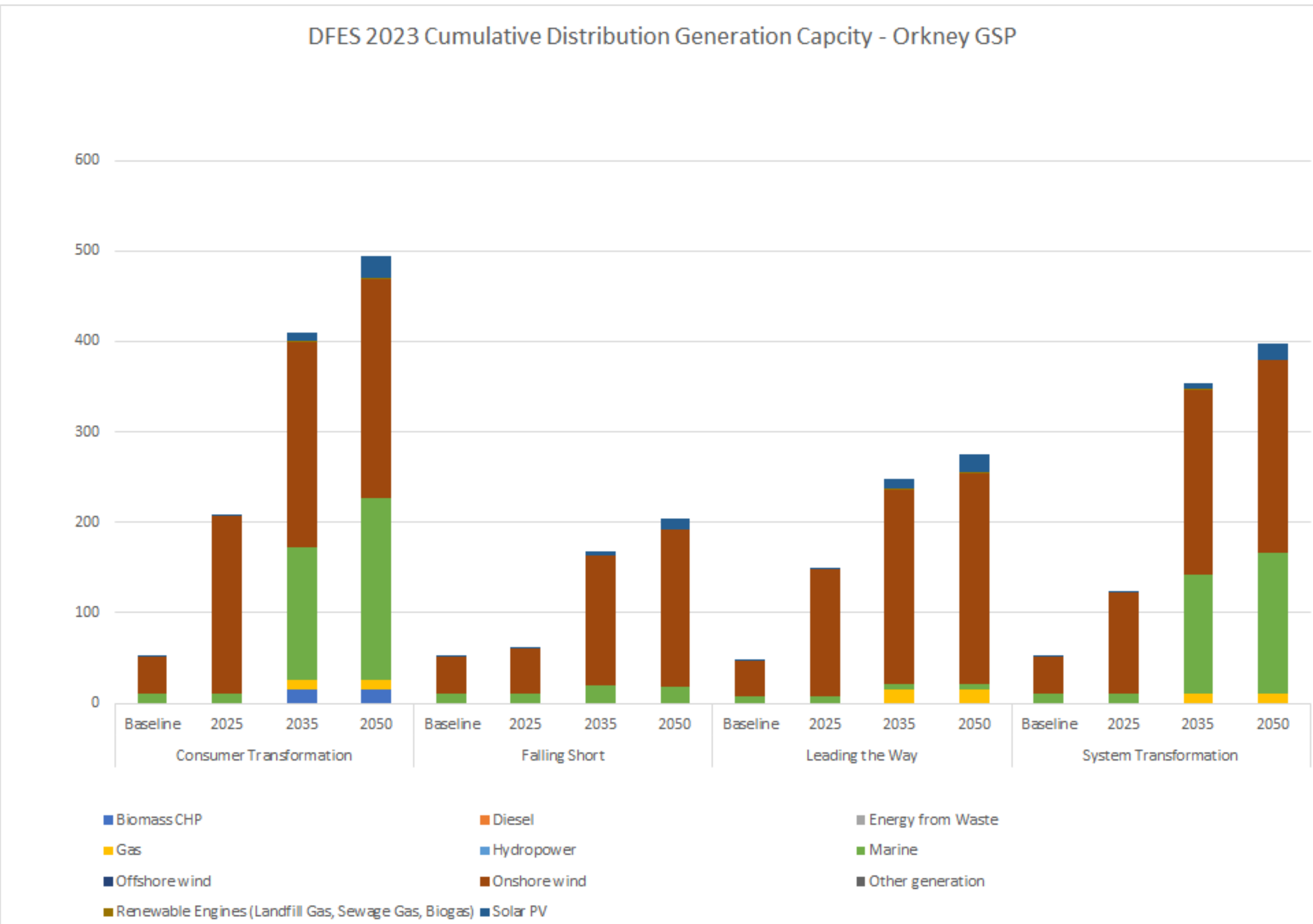

Figure 11 Projected Cumulative Distributed Generation Capacity Orkney (MW). Source: SSEN DFES 2023

5.1.1.2. Storage

While multiple storage technologies have projected uptake modelled in the DFES, in the Orkney supply area we only see a significant increase in the installation of domestic batteries (shown in **Figure 12**). This refers to those 1-15kW in scale, designed to enable households to increase the self-consumption of domestic solar PV, as well as acting as a backup power supply households in more rural locations. A cumulative storage capacity of between 1MW and 9.9MW is projected by 2050 under 4 scenarios.

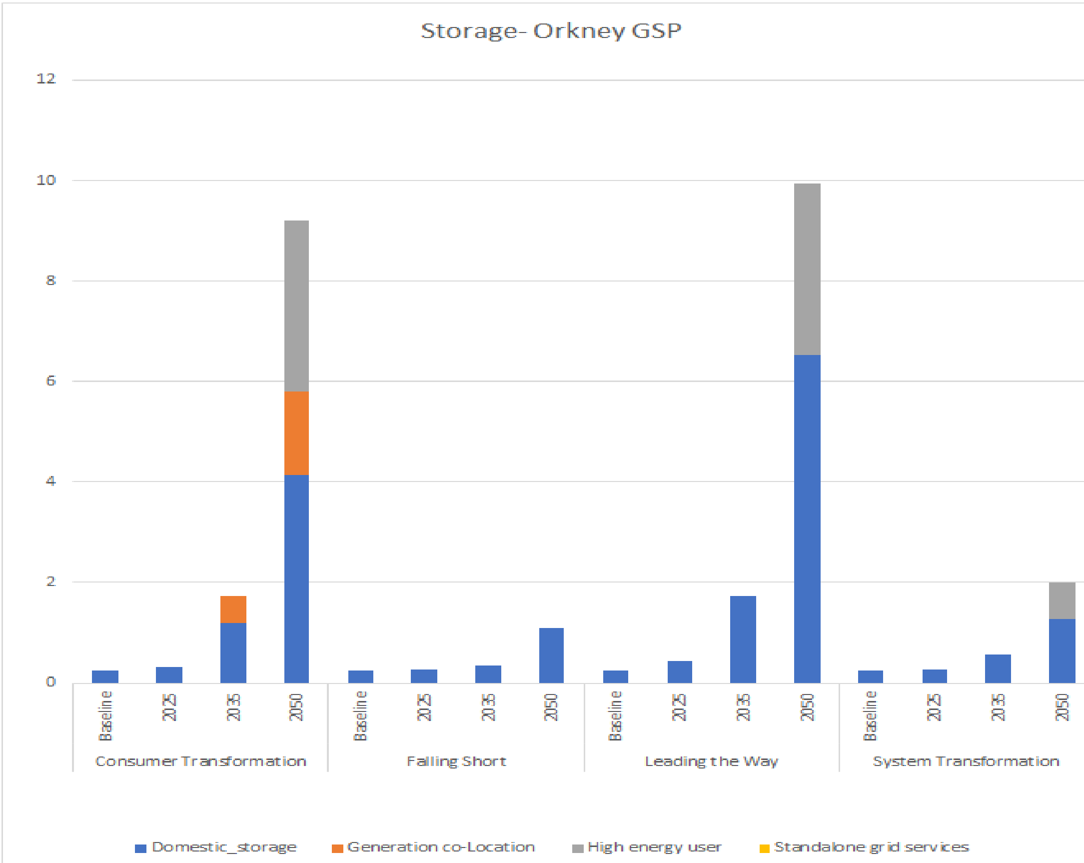

Figure 12 Projected Cumulative Storage Capacity Orkney (MW). Source: SSEN DFES 2023

5.1.2. Thurso South Mainland

5.1.2.1. Generation

Based on the DFES projections, distributed connected renewable generation across Thurso South mainland will increase significantly from 72MW in the currently connected baseline to 194MW in 2040 and 273MW in 2050 (in **Figure 13**). We see onshore wind accounting for much of the distributed generation from 2025 onwards and hydropower maintaining at current levels.

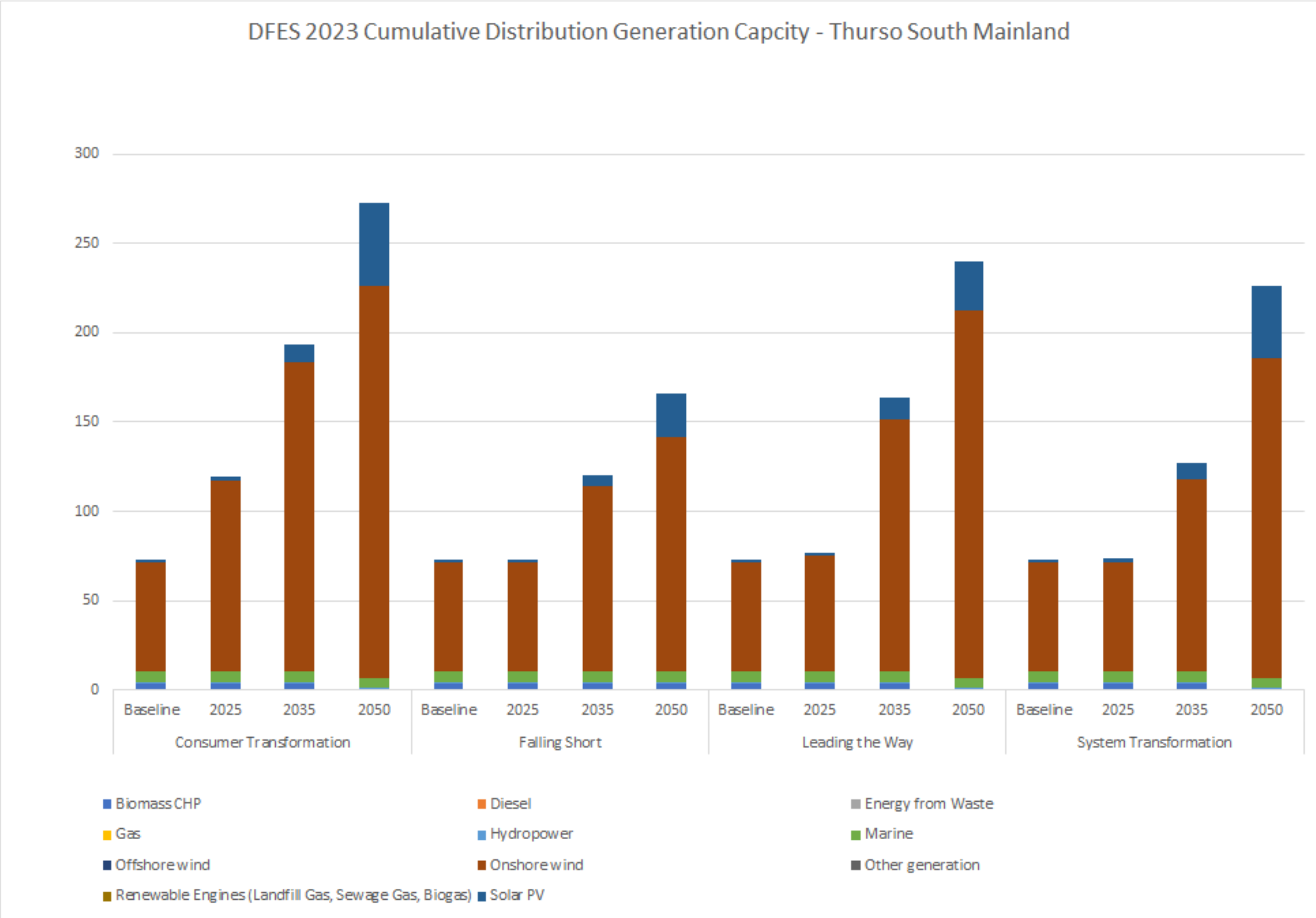

Figure 13 Projected Cumulative Distributed Generation Capacity Orkney (MW). Source: SSEN DFES 2023

5.1.2.2. Storage

While multiple storage technologies have projected uptake modelled in the DFES, in the north of Scotland we see a notable increase in applications to connect new battery storage projects with the total pipeline of contracted or quoted-issued connections now reaching 7.7GW (4.1GW is active in planning). But only a small proportion of this 4.1GW pipeline was due to connect to the Thurso South mainland Network by 2035.

This comes mostly in the form of the installation of large commercial-scale batteries (standalone grid assets and batteries co-located with renewable generation sources), which accounts for 100MW to connect in the area by 2050 (shown in **Figure 14**).

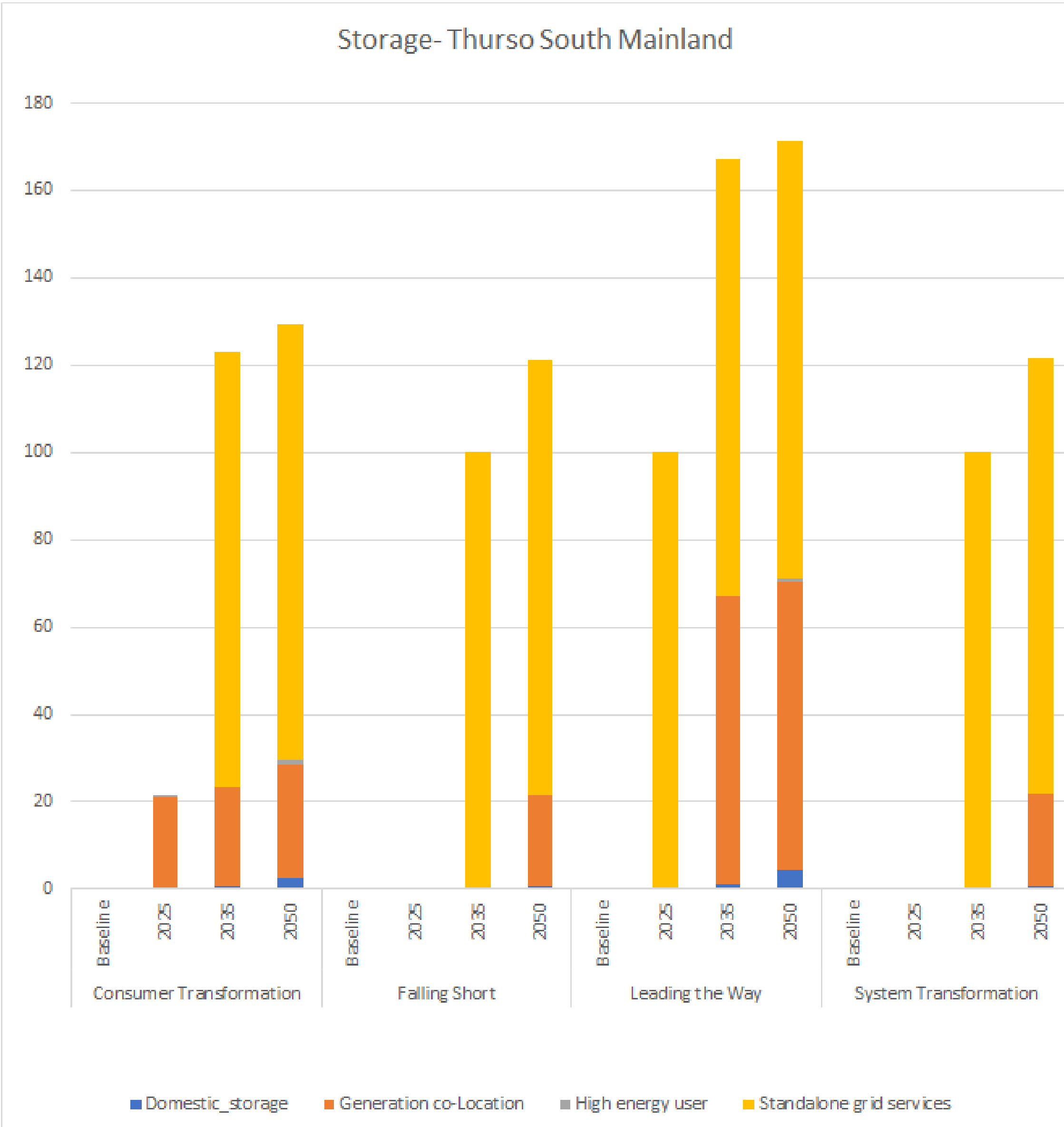

Figure 14 Projected Cumulative Storage Capacity Thurso South mainland (MW). Source: SSEN DFES 2023

5.2. Transport Electrification

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.

5.2.1. Orkney

SSEN's 2023 DFES analysis, there could be just over 24,906 (2023 DFES) EV cars and light goods vehicles (LGVs) registered in the Thurso South GSP area by 2050. At Orkney, this number will be 17,637 by 2050.

As the network operator, it is important for SSEN to understand the network facing demand of EVs. To do this we can use the projected EV charger capacity (MW) from SSEN's DFES analysis. The SSEN DFES project that the total connected EV charge point capacity under Thurso South GSP, excluding off-street domestic chargers, could total over 14MW for Orkney (as shown in Figure 15). It is important to note that this value represents the total installed capacity and does not consider diversity. In our studies for future system needs diversity is taken into consideration so the studied capacity across Orkney is not equivalent to 14MW.

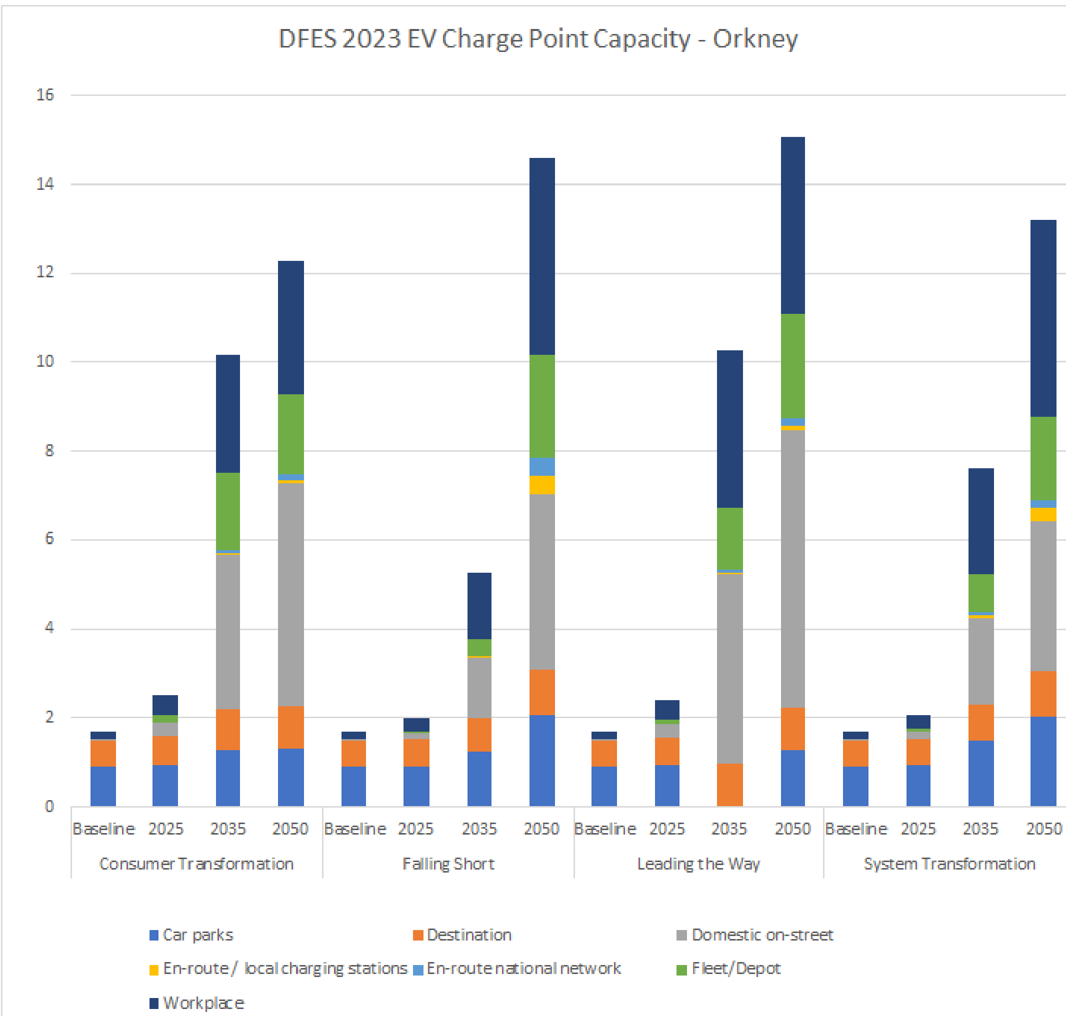

Figure 15 Projected EV Charge Point Capacity across Orkney. Source: SSEN DFES 2023

5.2.2. Thurso South Mainland

The SSEN DFES project that the total connected EV charge point capacity will be more than 12MW for Thurso South mainland by 2050 (as shown in Figure 16).

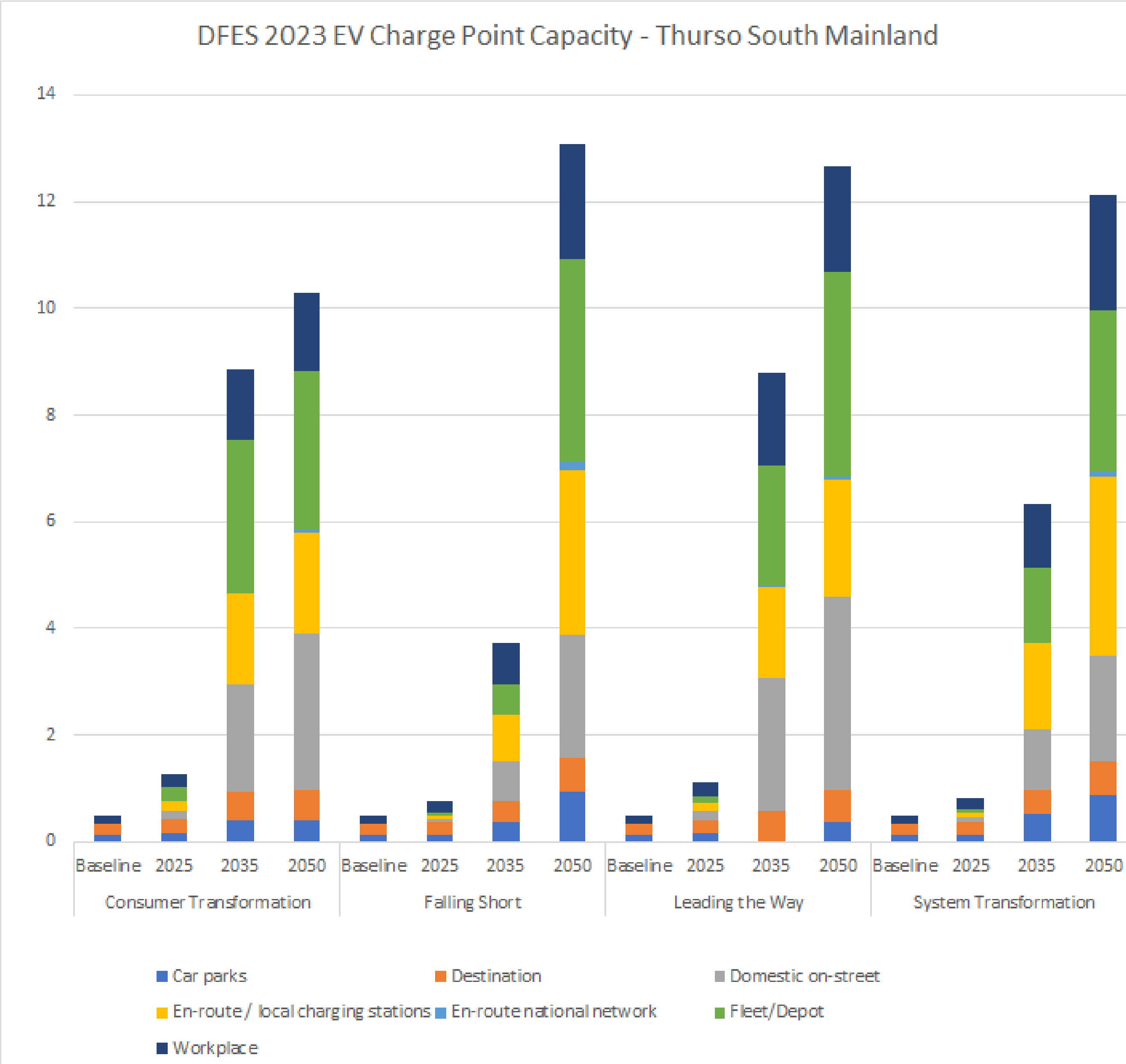

Figure 16 Projected EV Charge Point Capacity across Thurso South mainland. Source: SSEN DFES 2023

5.3. Electrification of heat

The decarbonisation of space heating technologies in homes and businesses will have a significant impact on the future energy system. Government legislation, including the publication of local authorities' Local Heat and Energy Efficiency Strategies (LHEES)[8], and consumer behaviour are just two of many factors that will impact the future electricity demand arising from space heating.

8 Local heat and energy efficiency strategies and delivery plans: guidance - gov.scot (www.gov.scot)

5.3.1. Orkney

Under all scenarios, we see an increase from a baseline of 459 heat pumps to between 11,988 & 14,534 by 2050 connected to the network under Orkney (as shown in Figure 17). Decarbonising space heating technologies in homes and businesses could be a significant consideration for future electricity load in the Orkney. The islands currently haves no mains gas connection and so households rely on direct electric heaters (radiant and night storage), oil and solid fuels for heating. In addition, the Orkney' relatively older housing stock results in households using more fuel for space heating over the year.

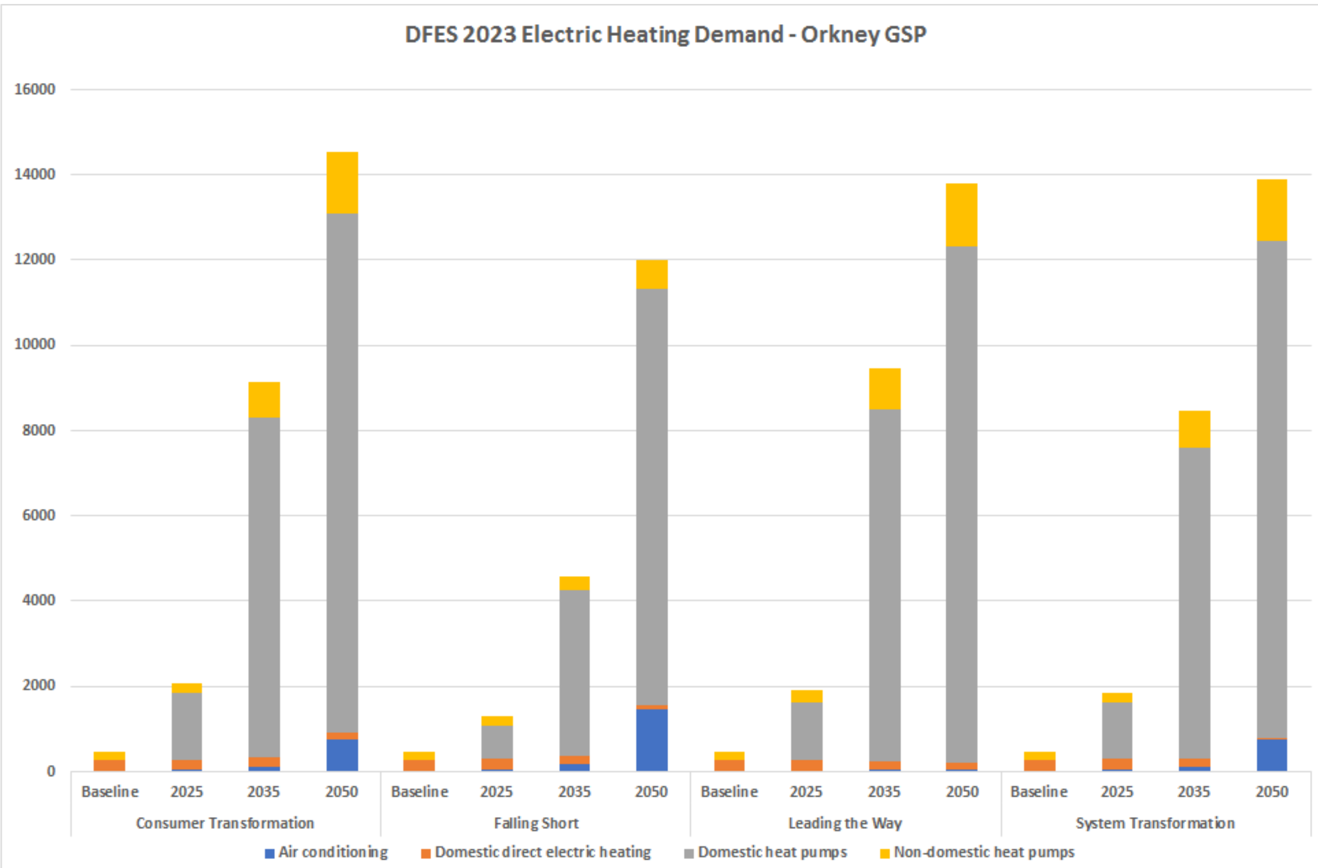

Figure 17 Projected number of Heat Pumps across Orkney. Source: SSEN DFES 2023

5.3.2. Thurso South Mainland

The heat pump at Thurso South mainland increases from a baseline of 2,142 heat pumps to between 6,917 & 8814 by 2050 connected to the network under Orkney (as shown in Figure 18).

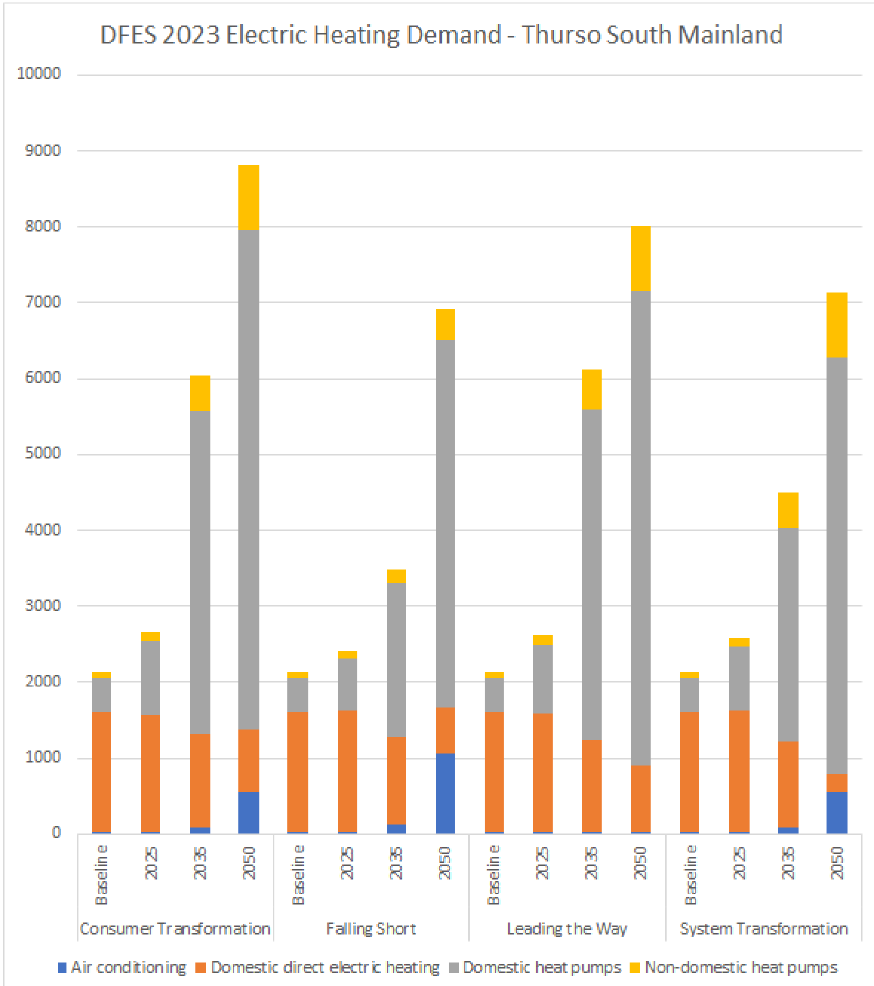

Figure 18 Projected number of Heat Pumps across Thurso South mainland. Source: SSEN DFES 2023

5.4. New building developments

To produce the SSEN DFES, Regen undertook engagement with local authorities to understand local authority development plans across our licence areas.

5.4.1. Orkney

For Orkney, the DFES projects the cumulative floorspace of non-domestic new developments. **Figure 19** shows that the two building classifications contributing to the largest floorspace growth are university, and new office space.

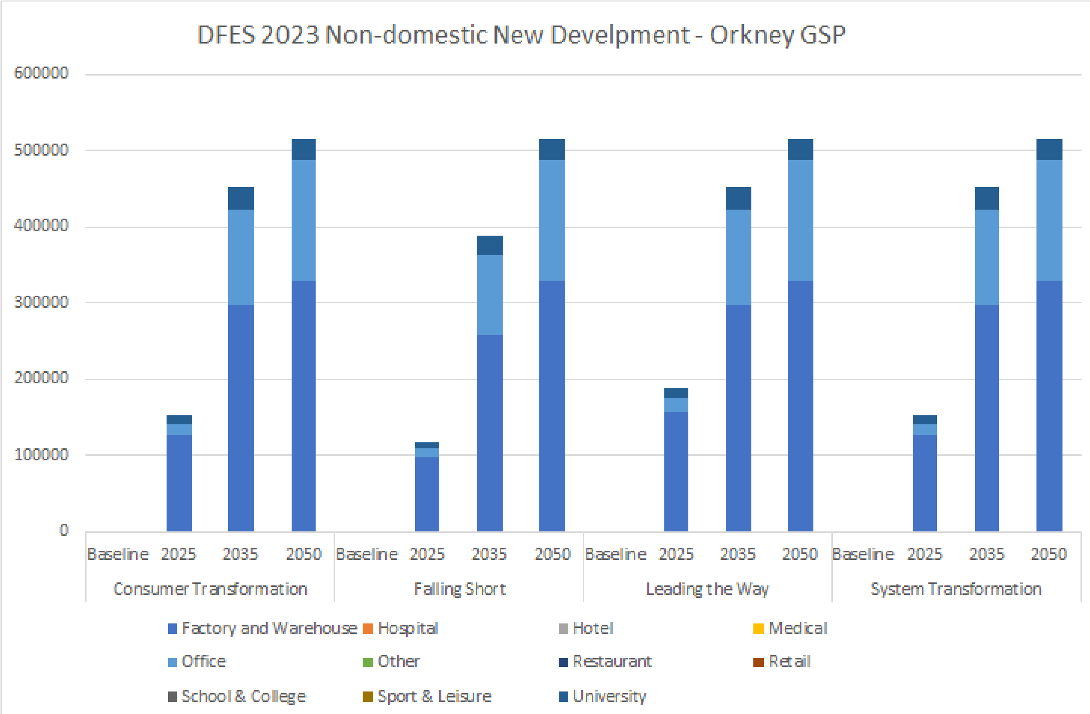

Figure 19 Projected new non-domestic development across Orkney. Source: SSEN DFES 2023

5.4.2. Thurso South Mainland

For Thurso South mainland, the main classification contributing to the largest floorspace growth is new office space (see Figure 20).

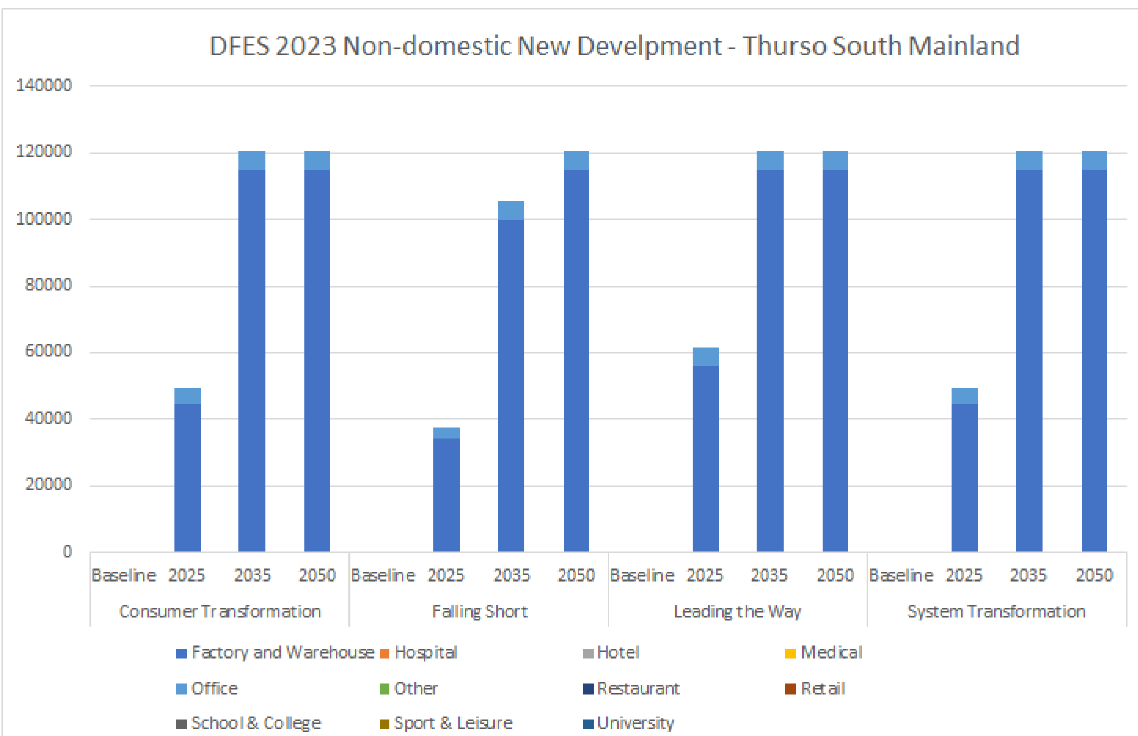

Figure 20 Projected new non-domestic development across Thurso South mainland, *Source: SSEN DFES 2023*

5.5. Commercial and industrial electrification

We recently commissioned Regen to explore more deeply the decarbonisation of demand on Scottish Islands. The detailed analysis conducted by Regen regarding the decarbonization of industries specific to Northern Scotland (i.e. whisky distilleries, fish and seaweed farming) and broader industries (e.g. agriculture and other commercial businesses) indicate there could be a range of potential electrification outcomes affecting Thurso South GSP. We have identified distilleries and the port industry in particular as areas of significant future demand growth for the Thurso South. Below we summarize these findings and the impacts on our analysis work.

5.5.1. Distilleries

Whisky distilleries are a key part of the Scottish economy, accounting for 74% of all Scottish food and drink exports and 22% of all UK food and drink exports in 2023. More than 41,000 people are employed in the Scotch Whiskey industry in Scotland and over 25,000 more jobs across the UK are supported by the industry[9].

Orkney currently hosts seven operational whisky and gin distilleries. Thurso South mainland has several whiskey distilleries. Whisky is one of the most energy intensive products to produce in the food and drink industry, which accounts for a significant proportion of energy demand on many islands.

The distilling process has significant and constant high-temperature heat demand which is largely met by fossil fuel combustion at present. The wider whisky industry has made progress towards decarbonization, with non-fossil fuels making up 20% of its energy use in 2018, up from only 3% in 2008[10]. Regen engagement with the Scotch Whisky Association (SWA) highlighted that their 2023-25 strategy includes commitments to achieving net zero emissions in their own operations by 2040[11]. A Ricardo report commissioned by the SWA in 2019 investigated how carbon reduction in the distillery industry could be achieved[12]. The Regen analysis provided qualitative information on the distilleries. However, we are in the process of developing a methodology to forecast the electrical demand for distilleries which will form part of the system needs in future analysis.

5.5.2. Maritime Transportation

Three main ferry companies operate frequent external and internal ferry routes around Orkney and Thurso South mainland. All three ferry operators have committed to decarbonizing their vessel fleets, with initiatives ranging from electrifying propulsion system and associated fuel to installing energy-efficient measures on board.

Ferries are one of the primary modes of maritime transportation across Orkney and Thurso South mainland, and their shore power requirements, charging profile and ability to charge EVs will be major considerations for any network reinforcement. 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** – within the fishing industry, Orkney has a strong commercial inshore fishing fleet across the islands and is home to Europe's largest crab processing plant.

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9 Scottish whisky association, 2023. Facts and figures

10 Heriot Watt University, 2021. Distilleries need blend of green energy and storage for net zero.

11 Scotch Whisky Association, 2021. The Scotch Whisky Industry Sustainability Strategy.

12 Scotch Whisky Association (Ricardo), 2020. Scotch whisky pathway to net zero.

- **Cargo** – dedicated freight vessels operate between Aberdeen and Kirkwall six days a week, catering to all types of traffic including project cargoes for renewable energy, construction and the oil and gas sector.
- **Cruises** – as a popular location, the Orkney receives over 132,000 cruise passengers[13] in 2019 and this number also increases in recent years. Several organisations in Orkney were recently awarded funding through the Clean Maritime Demonstration Competition (CMDC) – Round 4 to develop a solution for cold-ironing at Kirkwall port, capable of sustaining hotel loads of cruise ships at anchorages. This could become a significant source of future electricity demand at key port locations.

5.6. Generation and Demand Forecast Summary

The data presented in sections 5.1-5.5 of this report is utilized in the development of profiled forecasts of demand and generation on our networks. These are shown in further detail in Appendices A and B whilst in this section we summarise the information presented.

5.6.1. Forecast Generation Capacity for Thurso South

Appendix A shows the forecast generation capacity relate to the cumulative capacity (MW) of distribution connected generation projects across Thurso South GSP. The charts are broken down into technology types expected to connect across the network and do not relate to coincident peaks for each technology.

Table 3 below summarises the cumulative forecast generation capacity from today to 2050 for Thurso South GSP.

Substation	CT Scenario (in MW)				LW Scenario (in MW)			
	2024	2028	2040	2050	2024	2028	2040	2050
Orkney	**150.46**	**254.39**	**423.64**	**493.78**	**146.84**	**182.49**	**264.15**	**275.86**
Thurso South Mainland	**73.69**	**172.85**	**209.76**	**270.93**	**74.27**	**126.11**	**196.99**	**238.14**
TOTAL (MW)	**224.14**	**427.23**	**633.40**	**764.72**	**221.11**	**308.60**	**461.15**	**514.00**
Substation	**ST Scenario (in MW)**				**FS Scenario (in MW)**			
	2024	**2028**	**2040**	**2050**	**2024**	**2028**	**2040**	**2050**
Orkney	**53.24**	**124.32**	**197.58**	**204.35**	**61.70**	**156.70**	**375.53**	**396.98**

13 Orkney Tourism Strategy 2020-2030

Thurso South Mainland	**73.07**	**110.57**	**133.53**	**165.80**	**73.14**	**112.23**	**183.14**	**225.21**
TOTAL (MW)	**126.31**	**234.89**	**331.11**	**370.15**	**134.84**	**268.92**	**558.66**	**622.20**

Table 3 - Thurso South Group Generation Capacity to 2050
Source: SSEN DFES 2023 (PowerBI)

5.6.2. Demand Forecast

.
Appendix B shows forecast demands for each DFES scenario through to 2050. These forecasts are taken as winter peak demand at each primary with any effect of embedded generation netted off. Information relating to industrial decarbonization impacts will be added to these values in any detailed analysis undertaken.

This information is summarized for the demand at Thurso South, within the Island of Orkney in Table 4 below.

Substation	**CT Scenario (in MW)**				**LW Scenario (in MW)**			
	2024	**2028**	**2040**	**2050**	**2024**	**2028**	**2040**	**2050**
Orkney	32.1	44.51	69.53	76.86	33	47.7	75.85	88.73
Thurso South Mainland	12.39	18.04	27.8	30.19	12.39	18.06	28.43	30.68
TOTAL (MW)	44.49	62.55	97.33	107.05	45.39	65.76	104.28	119.41
Substation	**ST Scenario (in MW)**				**FS Scenario (in MW)**			
	2024	**2028**	**2040**	**2050**	**2024**	**2028**	**2040**	**2050**
Orkney	32.7	43.16	69.35	82.93	32.14	38.13	58.55	69.65
Thurso South Mainland	12.35	16.5	25.31	28.19	12.27	14.94	22.06	27.86
TOTAL (MW)	45.05	59.66	94.66	111.12	44.41	53.07	80.61	97.51

Table 4 - Thurso South Group Demand Forecast to 2050
Source: SSEN DFES 2023 (PowerBI)

6. PROJECTS IN PROGRESS

6.1. Ongoing works in Thurso South GSP

Network interventions can be caused by a variety of different drivers. Examples of common drivers are load-related growth, specific customer connections, and asset health. Across Thurso South GSP these drivers have already triggered network interventions that have now progressed to detailed design and delivery. For this report, these works are assumed to be complete, with any resulting increase in capacity considered to be released.

For this report, there are some capital works are undergoing to meet the demand requirements in Orkney. These are summarised in Table 5 below:

Substation	Description	Driver	Forecast completion [14]	Fully resolves future strategic needs to 2050?
Orkney Area				
Finstown GSP and associated 33kV reinforcements	New GSP	Transmission and DNOA process	2028	
Orkney - Shapinsay	33kV Cable Reinforcement	DNOA process	2024	
Burgar Hill	Resilience (WSC Scheme)	Resilience (WSC Scheme) s	2027	
Sanday	Transformer Replacement to 2.5MVA	Asset Condition	2027	
Lyness	Transformer Replacement to 2.5MVA	Asset Condition	2028	
Eday	Transformer Replacement to 2.5MVA	Asset Condition	2025	
Kirkwall Transformer or new Kirkwall Primary	Replace T1/T2 transformers or install a third transformer or install a new primary near Kirkwall	DNOA process	2030	
St Mary P2 Compliance and new primary at Ronaldsay	33kV second infeed and 11kV P2 reinforcement works	DNOA process	2028	

14 These dates are best view at the time of publication and subject to change during the delivery process.

Thurso South Mainland				
Ormlie and Mount Pleasant	Intall the second transformer at both primaries	Green Recovery Scheme	2025	
Halkirk	Transformer Replacement to two 6.3MVA	DNOA process	2030	

Table 5 Works already triggered through customer connections and the DNOA process.

Where the above works are marked as not providing sufficient capacity for 2050 peak demands, it is important to note that this relates to the individual primary substation's firm capacity. When considering the further works identified in this report, the holistic plans provide capacity across the GSP for 2050.

Alongside these asset solutions being deployed, flexibility solutions are also being used to release additional capacity. Due to the existing and future availability of renewable energy within Orkney, we are assuming 23MW of the renewable energy could be used to flexibility solutions that is dependent on the flexible market prices and the required flexible volumes.

6.2. Network Schematic (following completion of above works)

The network considered for long-term modelling is shown in Figure 21.

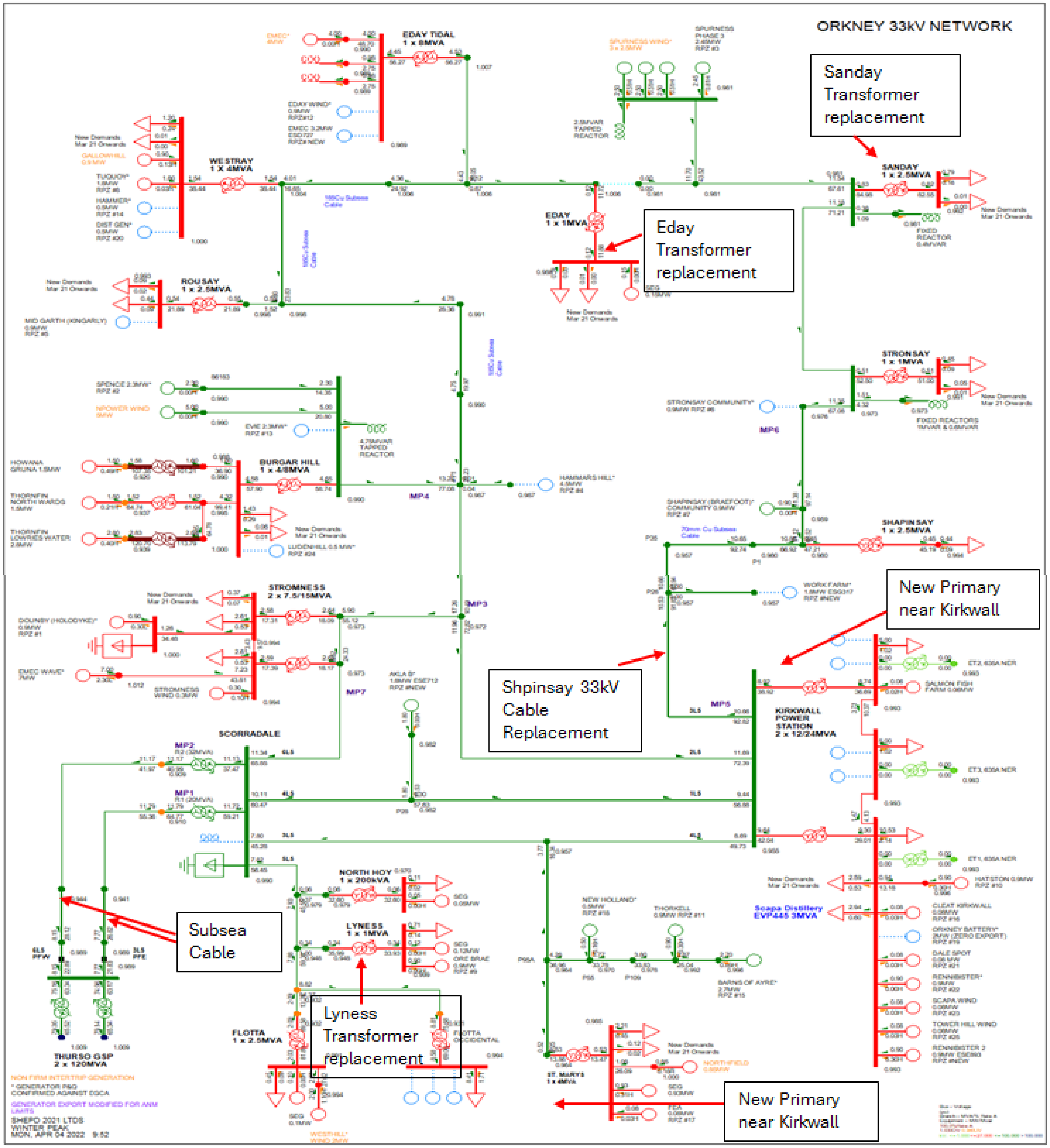


Figure 21 Schematic network with works in progress at Orkney.

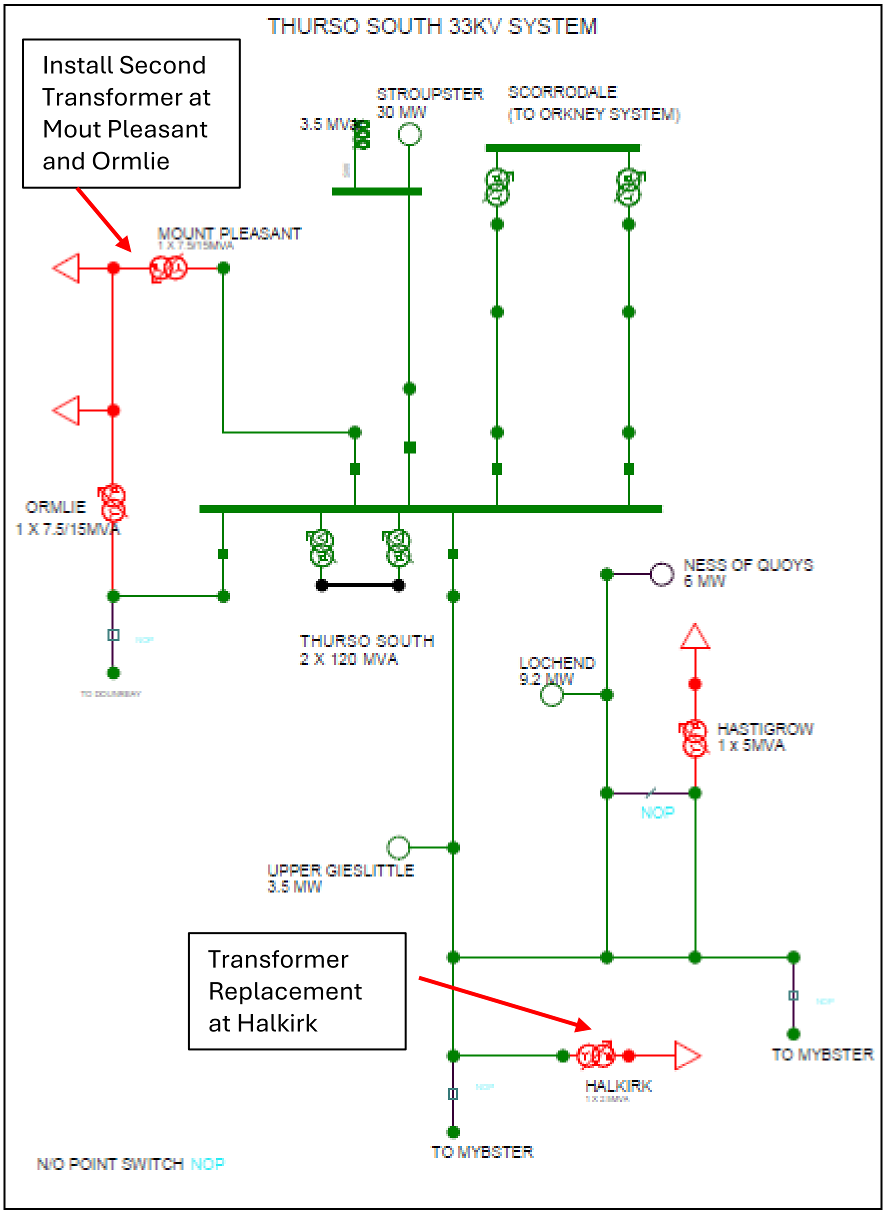


Figure 22 Schematic network with works in progress at Thurso South Mainland.

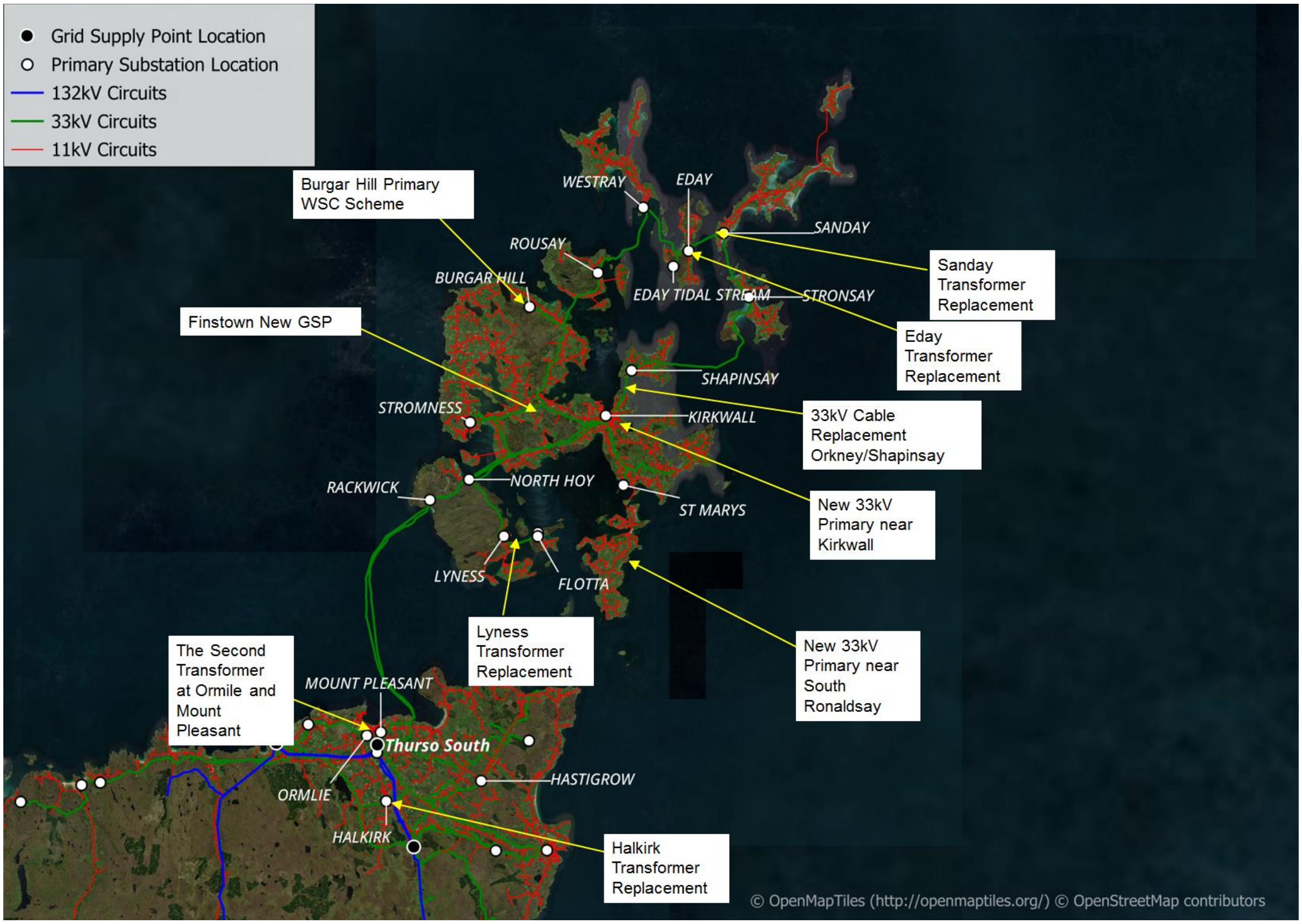


Figure 23 GIS view of network with works in progress and system needs annotated.

7. FUTURE SYSTEM NEEDS

In the previous sections we discussed the Regen DFES Demand and Generation forecasts for Orkney and Thurso South mainland. We have used this information to understand what this means for the local networks. Initially this is developed through the creation of a spatial plan of future system demand needs looking at periods of maximum demand with minimum generation. These will be augmented in the future to include spatial plans of low demands with high generation output.

We have created spatial plans at a primary substation level (33/11kV) and secondary substation level (11kV/LV). Snapshots are provided for 2028, 2033, 2040, and 2050 enabling clear visualisation of future distribution system needs beyond the current network capacity. They are currently based on 2023 DFES.

These spatial plans consider the distribution network requirements to capacity requirements. They do not account for the enhanced network resilience policy for island groups fed by sub-sea cables nor do they account for any needs arising from the transmission system.

7.1. Extra High Voltage Spatial Plan for Demand Future Needs

The EHV spatial plans for the four DFES 2023 scenarios are highlighted in figure 24, figure 25, figure 26 & figure 27 for CT, LW, FS and ST respectively.

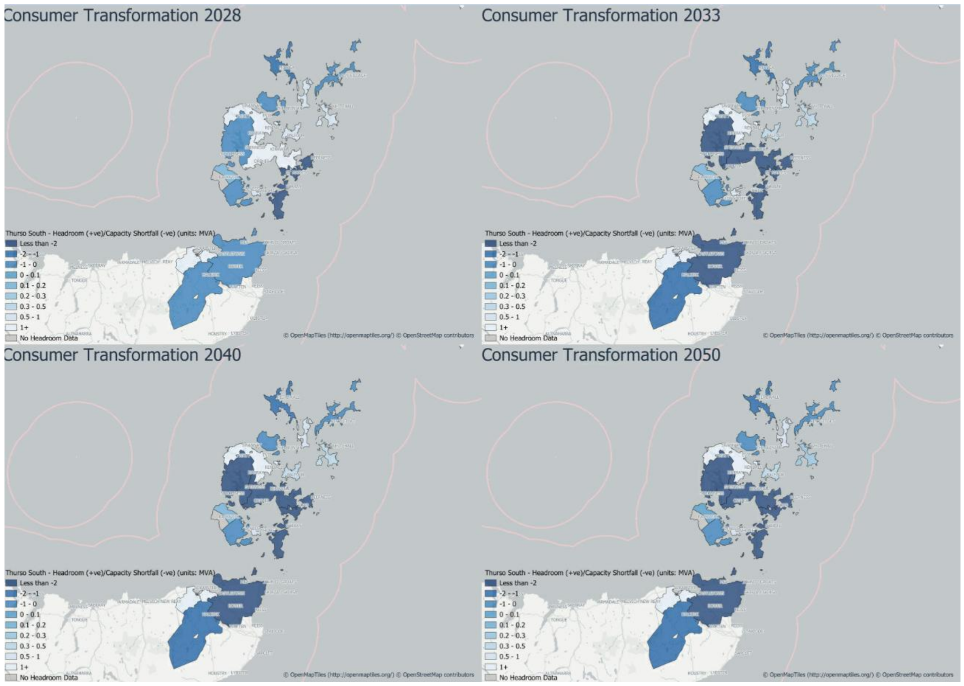


Figure 24 **Thurso South GSP EHV** spatial plans for CT 2028, 2033, 2040, and 2050.

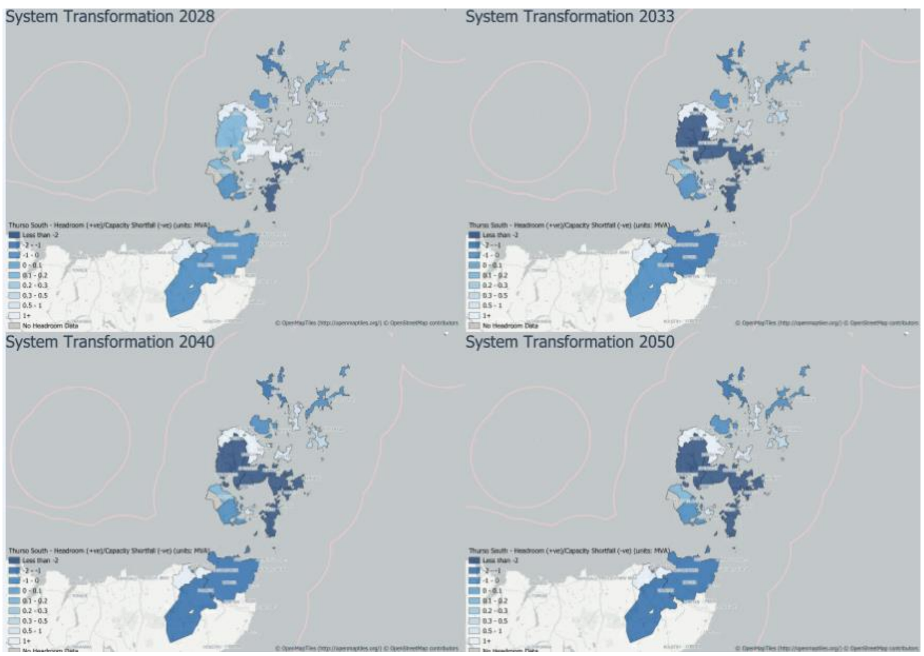


Figure 25 **Thurso South GSP EHV** spatial plans for ST 2028, 2033, 2040, and 2050.

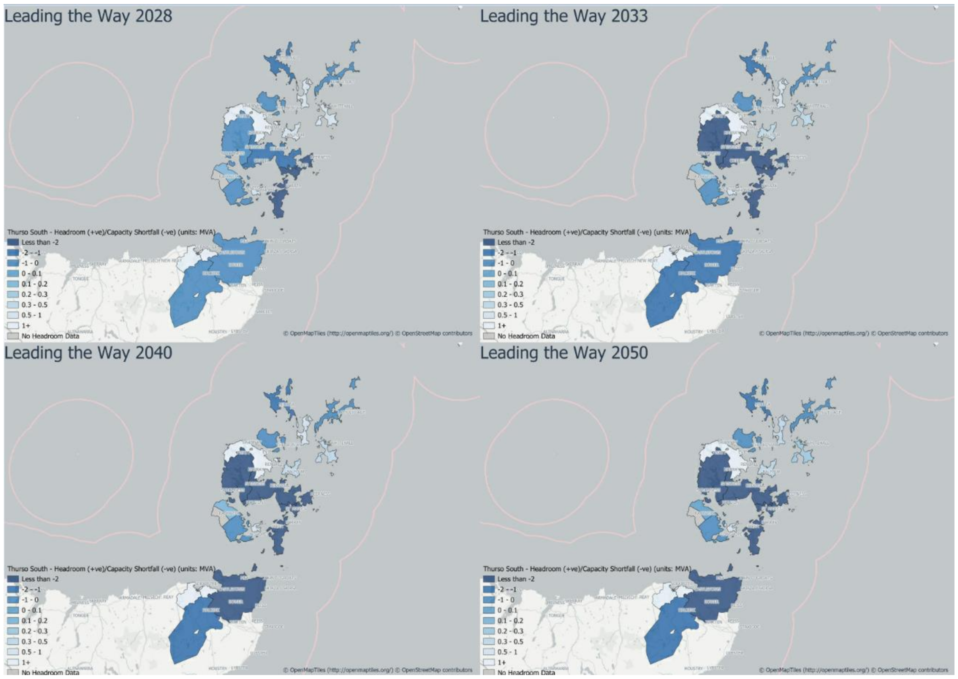


Figure 26 Thurso South GSP EHV spatial plans for LW 2028, 2033, 2040, and 2050.

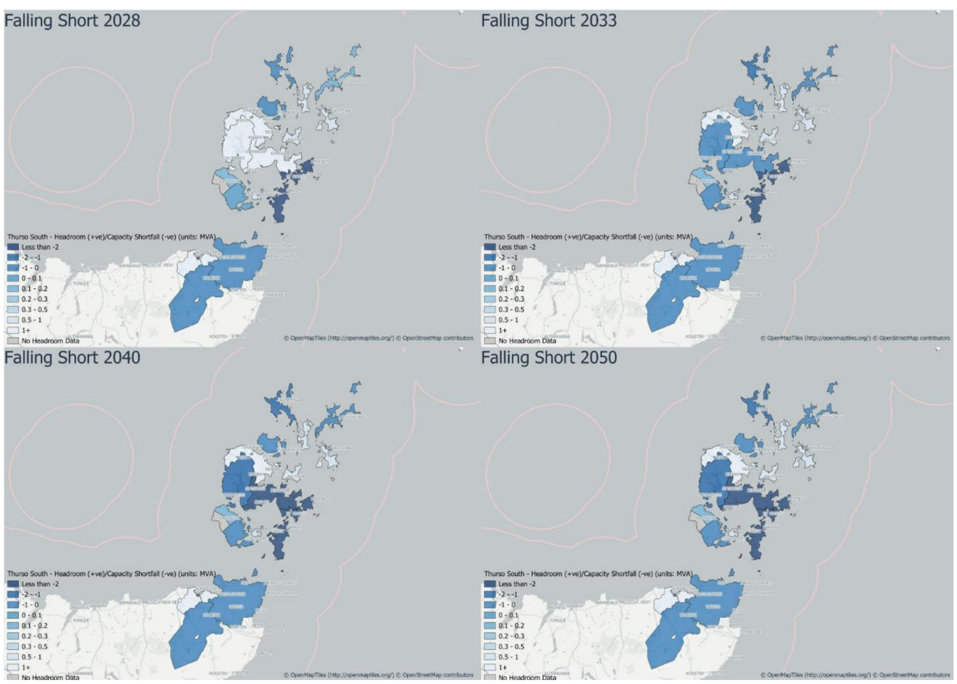


Figure 27 Thurso South GSP EHV spatial plans for FS 2028, 2033, 2040, and 2050.

7.2. Extra High Voltage Specific System Generation Needs

7.2.1. Orkney Generation Needs

The renewable generation potential of the Orkney is widely documented. This is due to the area benefiting from the high wind sources making it a suitable area for onshore wind and the potential for tidal generation schemes. The existing and projected generation mix on the Orkney has been described in the future electricity demand and generation forecasts section of this report.

Previous efforts to release capacity on the Island have been successful with Active Network Management and the Distributed Generation Automatic Disconnection (DGAD) schemes having enabled more generation to connect to the distribution network. However, the ANM scheme is also now at capacity. As a result, further network and non-network options will be required to relieve generation constraints on the Orkney. There are three key potential development areas that could facilitate further generation capacity on the island.

The most significant of these is the need for additional capacity between the Orkney and the mainland by the late 2040s. This could be delivered through a new subsea cable to Finstown GSP; however other 66kV or 33kV options may allow this to be deferred or even avoided. We recommend that further work is done to understand generator behavior (historical and forecast) to further establish credible scenarios. Outcome of these to be further developed through the DNOA process as required.

7.2.2. Thurso South Mainland Generation Needs

For Thurso South mainland, the 132kV/33kV transformers at Thurso South could be close to full capacity due to the ongoing generation applications in this area

7.3. Extra High Voltage Specific System Demand Needs

7.3.1. Orkney Demand Needs

The current subsea cables running from the Thurso South grid to the Scorradale primary substation are 500mm2 cable, rated at 29.3MVA. The eastern circuit is running at 23.4MVA (limited by the onshore 33kV overhead line). Presently, the demand at Orkney has exceeded the ratings of these subsea cables and it is managed by ANM scheme.

From the resilience requirements for Orkney, existing network will be constrained due to the demand growth in 2030s. We have identified some potential options that could be used to mitigate both demand constraints.

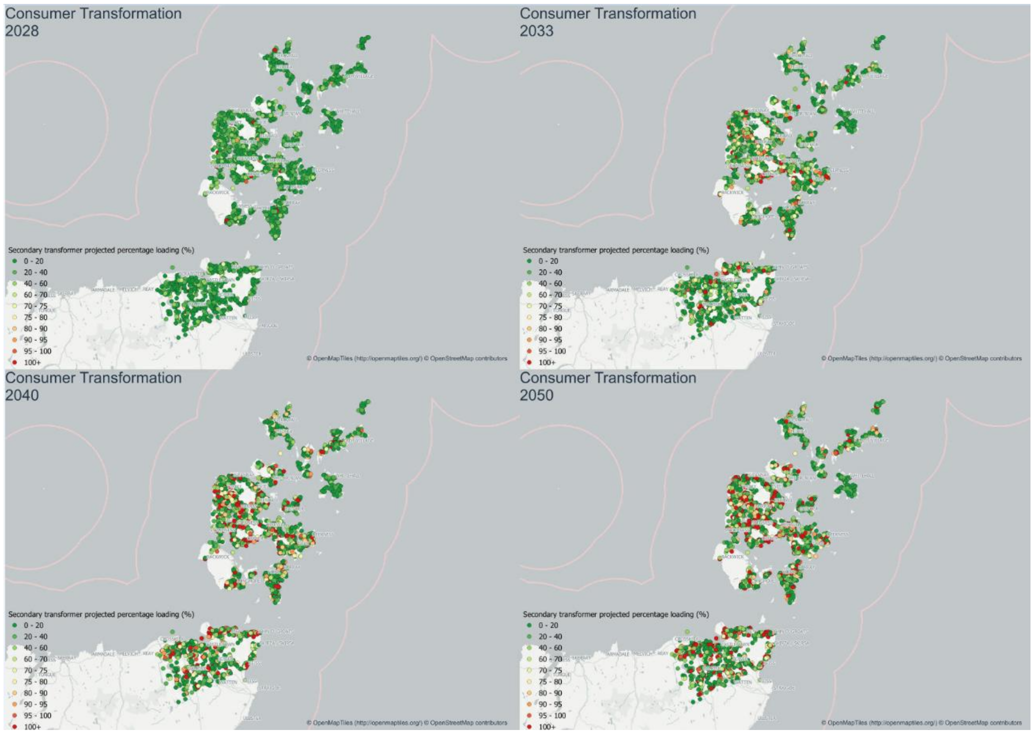
Reinforcement of existing assets (transformers and circuits): For Orkney network, the future demands grow mainly at Kirkwall and St Marys. These demands will be supplied by Finstown GSP. To meet these demand growth, new primary substations near Kirkwall and South Ronaldsay have been considered. The 33kV circuits between Finstown and Kirkwall/St Marys will be reinforced to guarantee the demand requirements. However, the existing interconnecting circuit sections between Scorradale and Finstown haven't been included in the reinforcement plan. To keep the supply resilience for Orkney, these existing 33kV interconnecting circuits shall be reinforced.

7.3.2. Thurso South Demand Needs

With the proposed capital works at Thurso South mainland, the Thurso South mainland network meets the future demand needs in 2050.

7.4. HV/LV demand spatial plans

To understand, where load is growing at a lower granularity, we have used information from the SSEN load model. The secondary transformer projected percentage loadings for each of the four DFES scenarios are highlighted in figure 28 for CT, LW, FS and ST respectively. As shown in the legend, the points are coloured based on their percentage loading with green being low percentage loading and darker reds being higher percentage loading (see legend for detail on loading bands and colouring).


Consumer Transformation 2028
Consumer Transformation 2033
Consumer Transformation 2040
Consumer Transformation 2050
Secondary transformer projected percentage loading (%)
0 - 20
20 - 40
40 - 60
60 - 70
70 - 75
75 - 80
80 - 90
90 - 95
95 - 100
100+
© OpenMapTiles (http://openmaptiles.org/) © OpenStreetMap contributors

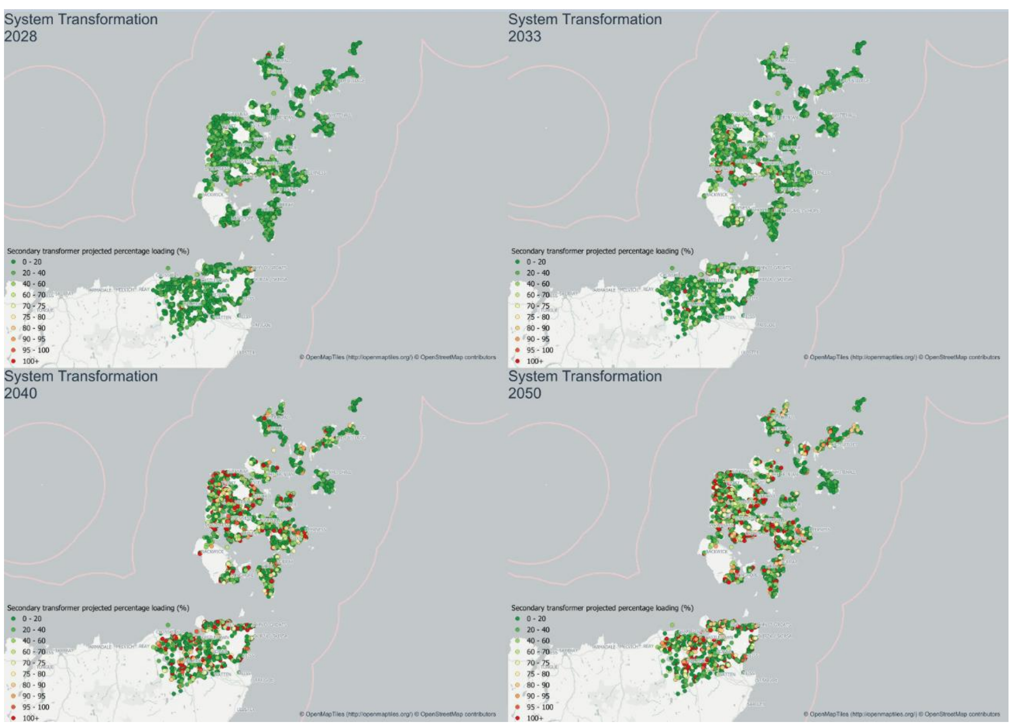

System Transformation 2028
System Transformation 2033
System Transformation 2040
System Transformation 2050
Secondary transformer projected percentage loading (%)
0 - 20
20 - 40
40 - 60
60 - 70
70 - 75
75 - 80
80 - 90
90 - 95
95 - 100
100+
© OpenMapTiles (http://openmaptiles.org/) © OpenStreetMap contributors

Figure 28 Thurso South HV/LV demand spatial plans for 2028, 2033, 2040, and 2050.

8. OPTIONS TO RESOLVE

8.1. Options Consideration

The relevant spatial plans provide us with a strategic view of future system needs. We have reviewed this through thermal power system analysis to understand the specific requirements of our EHV networks through to 2050. This analysis has been based on the insights developed from the 2023 DFES alongside other information including known connection applications. Initial needs have been identified using the DFES Consumer Transformation background with sensitivity analysis undertaken against the other three DFES backgrounds.

The options consider scenarios for both summer and winter to ensure the varying demand and support from local generation combinations were all accounted for. Contingency N-2 considerations for islands supplied by subsea cables will also be undertaken.

In this section we propose initial options to resolve these needs. These will be further developed through the HOWSUM and DNOA processes, where they will be considered alongside the potential for flexibility.

The section is split into Three parts.

- Network dependencies, risks and mitigations – These summarise the overall dependencies between works proposed and different criteria such as network output delivery and flexible network services. It also includes the potential risks and mitigation measures in relation to the dependencies identified.
- 2050 high level options for EHV network – There is a greater degree of uncertainty of outcomes in this time frame. This also provides more opportunity to work with stakeholders to develop a strategic plan and our outline solutions reflect this initial phase of the work as we look to engage with interested parties. For needs within the next seven years we will recommend these are progressed through the DNOA process. These needs are more certain and therefore we have more clearly defined options to meet the requirements. In all cases we are proposing solutions that meet the projected requirements for 2028. We also provide a summary of more strategic elements that also need to be considered in these timeframes. For EHV system needs to 2040, we are proposing solutions that meet the projected requirements for 2040. We also provide a summary of more strategic elements that also need to be considered in these timeframes. For EHV system needs between 2040 - 2050, we have highlighted these areas of reinforcement to be considered.
- Specific options required for all four scenarios – These summarise the specific options that is required through the DNOA process. These specific options combined with the HOWSUM options will improve the whole network resilience and system security up to 2050.

8.2. Overall dependencies, risks, and mitigations

There are a number of overarching risks to the delivery of our strategic plan. Below we list these alongside proposed mitigating actions. We will work with stakeholders to develop these mitigating actions further.

Dependency: The ANM scheme has existed for a number of years facilitating the connection of many embedded generators. Enhancements to the scheme could allow for further optimisation which in turn could allow for more generators connecting on the Orkney ahead of or in lieu of reinforcing or adding new 33kV or 66kV assets.
Risks: There is a risk with present technology that insufficient future generators are able to connect via the ANM scheme.

Mitigation: Enhancements to the scheme could allow for further optimisation which in turn could allow for more generators connecting on the Orkney ahead of or in lieu of reinforcing or adding new 33kV or 66kV assets.

Dependency: Works proposed here are dependent on the supply chain required to deliver the project. It has been tested through delivery of RIIO-ED1 projects. This has shown that the supply chain is able to provide the capacity and skills required to deliver these projects. As we move into RIIO-ED2 with the increased amount of capital delivery required it is important for us to ensure that the supply chain can continue to deliver.
Risks: Works delay potential interventions downstream and/or cannot deliver the subsea cable on time.
Mitigation: In response to this we have commenced early market engagement with subsea cable installation contractors to ensure that the capacity and skills to deliver this project are available.

Dependency: Procurement of flexible services to defer reinforcement where possible and economically viable.
Risks: Insufficient flexibility in the relevant area to resolve system need.
Mitigation: Flexible service procurement carried out ahead of time with signposting of future needs. Last build date identified to allow time for traditional reinforcement if flexibility not viable.

8.3. 2050 high level options for EHV network

This section provides more detail on the high-level options to resolve in the period through to 2050. Additional system needs have been identified here which our forecasts have indicated need addressing ahead of 2050. These have been identified through thermal power system analysis and the impact on all four DFES scenarios has been considered.

Section 8.3.1 summarises high level options developed through the HOWSUM process that will facilitate the requirements of island communities in the Inner Hebrides. The remaining tables show more specific options that fall outside the HOWSUM process and will be progressed through the DNOA process.

The options listed in Table 6 outline potential approaches to address individual constraints on the network through 2050.A combination of these options will be required to meet system needs out to 2045. Going forward, detailed analysis of these proposed options will be required to ensure that there is a comprehensive and cost-effective solution, which aligns with a whole-system approach to ensure maximum value for our customers whist meeting the demand and generation needs of the network.

8.3.1. EHV Options Consideration

Table 7 below summarises the system options we have identified through the HOWSUM process. These are needs relating to future requirements for the infrastructure from Port Ann GSPs to the relevant Inner Hebridean islands. The options shown form alternative potential solutions that will be tested further through detailed system analysis as part of the HOWSUM process. Sections 8.3.2-8.3.4 break these options down further into the potential time periods for their need.

Option Number	Option	Description	Driver	System Needs being resolved
1	Augment existing 33kV circuits	Establish 75MVA rated interconnector from Thurso South GSP to Scorradale.	Demand	Secures N-2 resilience for Island Group. Does not require

	with 66kV upgradation			replacement on Failure of 33kV.
2	Augment existing 33kV circuits with new 33kV	Establish additional 35MVA rated interconnector from Thurso South GSP to St Marys via Flotta.	Demand	Secures N-2 resilience for Island Group. Will require replacement on failure. Need to upgrade St Marys – Kirkwall 33kV OHL/cable.
3	Augment existing 33kV circuits with new 66kV	Establish additional 75MVA rated interconnector from Thurso South GSP to St Marys via Flotta.	Demand	Secures N-2 resilience for Island Group. Does not require replacement on Failure of 33kV. Need to upgrade St Marys – Kirkwall 33kV OHL/cable.
4	Additional 132/33kV transformers at Thurso South	Install new 132/33kV transformers at Thurso South	Generation	Meet the generation export requirements
5	Augment existing 33kV circuits with new 33kV	Establish additional 35MVA rated interconnector from Thurso South GSP to new primary near South Ronaldsay via Flotta.	Demand	Secures N-2 resilience for Island Group.
6	Augment existing 33kV circuits with new 33kV	Establish additional 35MVA rated interconnector from Thurso South GSP to Scorradale.	Demand	Secures N-2 resilience for Island Group.
7	Augment existing 33kV circuits with new 33kV	Establish additional 35MVA rated interconnector from Thurso South GSP to Kirkwall Via Scapa.	Demand	Secures N-2 resilience for Island Group.
8	Additional infeed at Finstown	Establish and additional HV AC link to Finstown GSP.	Generation	Secures N-2 resilience for Island Group. May allow for relaxation of ANM to support connections.
9	Augment existing 33kV circuits with new 66kV	Establish additional 75MVA rated interconnector from Thurso South GSP to Kirkwall	Demand	Secures N-2 resilience for Island Group. Does not require replacement on Failure of 33kV.
10	Augment existing 33kV circuits with new 66kV	Establish additional 75MVA rated interconnector from Thurso South GSP to to new primary near South Ronaldsay via Flotta.	Demand	Secures N-2 resilience for Island Group. Does not require replacement on Failure of 33kV.

Table 7 Options for system needs to 2050.

8.3.2. EHV Options 2024-2028 within HOWSUM Scope

This section provides more detail on the specific system needs and initial options to resolve in the period through to 2040. The options are shown in Table 8 and Figures 29 – 32.

Option	CT Year of need	ST Year of need	LW Year of need	FS Year of need	**Description**	**System Needs being resolved**	**Schematic Reference**
Augment existing 33kV circuits with 66kV upgradation			2028		Establish 75MVA rated interconnector from Thurso South GSP to Scorradale.	Secures N-2 resilience for Island Group and meets demand growth to 2040. Does not require replacement on failure of 33kV.	①
Augment existing 33kV circuits with new 33kV	2028	2028	2028	2028	If option ① is not adopted, establish additional 35MVA rated interconnector from Thurso South GSP to St Marys via Flotta.	Secures N-2 resilience for Island Group and meets demand growth to 2028. Will require replacement on failure of 33kV.	②
Augment existing 33kV circuits with new 66kV			2028		Alternative option for option ② to establish additional 75MVA rated interconnector from Thurso South GSP to St Marys via Flotta.	Secures N-2 resilience for Island Group and meets demand growth to 2040. Does not require replacement on Failure of 33kV. Need to upgrade St Marys – Kirkwall 33kV OHL/cable.	③
Additional 132/33kV transformers at Thurso South	2028	2028	2028	2028	Install new 132/33kV transformers at Thurso South	Meet the generation export requirements.	④

Table 8 Options for system needs 2024-2028.

Figure 29 Geographic maps with system needs 2024-2028 Option 1.

Figure 30 Geographic maps with system needs 2024-2028 Option 2.

Figure 31 Geographic maps with system needs 2024-2028 Option 3.

Figure 32 Geographic maps with system needs 2024-2028 Option 4.

8.3.3. EHV Options 2029-2040 within HOWSUM Scope

This section provides more detail on the specific system needs and initial options to resolve in the period through to 2040. The options are shown in Table 9 and figures 33 – 35.

Option	CT Year of need	ST Year of need	LW Year of need	FS Year of need	Description	System Needs being resolved	Schematic Reference
Augment existing 33kV circuits with new 33kV	2040	2040	2040		If 33kV option ② is adopted during 2025-2028, establish additional 35MVA rated interconnector from Thurso South GSP to new primary near South Ronaldsay via Flotta.	Secures N-2 resilience for Island Group and meets demand growth to 2040.	⑤

Augment existing 33kV circuits with new 33kV	2040	2040	2040		Alternative option for option ⑤ to establish additional 35MVA rated interconnector from Thurso South GSP to Kirkwall via Scapa.	Secures N-2 resilience for Island Group and meets demand growth to 2040. Will require replacement on failure of 33kV.	⑥
Augment existing 33kV circuits with new 33kV	2040	2040	2040		Alternative option for option ⑤ to establish additional 35MVA rated interconnector from Thurso South GSP to Scorradale.	Secures N-2 resilience for Island Group and meets demand growth to 2040. Will require replacement on failure of 33kV.	⑦

Table 9 Options for system needs 2029-2040.

Figure 33 Geographic map with system needs 2029-2040 Option 5.

Figure 34 Geographic map with system needs 2029-2040 Option 6.

Figure 35 Geographic map with system needs 2029-2040 Option 7.

8.3.4. EHV Options 2041-2050 within HOWSUM Scope

This section provides more detail on the specific system needs and initial options to resolve in the period through to 2040. The options are shown in Table 10 and figures 36 – 38.

Option	CT Year of need	ST Year of need	LW Year of need	FS Year of need	Description	System Needs being resolved	Schematic Reference
Additional Infeed at Finstown	2050	2050	2050	2050	Establish and additional HV AC link to Finstown GSP.	Secures N-2 resilience for Island Group and meet the generation export requirements. Does not require replacement on failure of 33kV.	⑧

Augment existing 33kV circuits with new 66kV	2050	2050	2050	2050	Alternative option for option ⑧ to establish 66kV 75MVA rated interconnector from Thurso South GSP to Kirkwall via Scapa.	Secures N-2 resilience for Island Group and meets the demand growth to 2050. Does not require replacement on failure of 33kV.	⑨
Augment existing 33kV circuits with new 66kV	2050	2050	2050	2050	Alternative option for option ⑧ to establish 66kV 75MVA rated interconnector from Thurso South GSP to new primary near South Ronaldsay via Flotta.	Secures N-2 resilience for Island Group and meets the demand growth to 2050. Does not require replacement on failure of 33kV.	⑩

Table 10 Options for system needs 2041-2050.

Figure 36 Network schematic with system needs 2041-2050 Option 8.

Figure 37 Network schematic with system needs 2041-2050 Option 9.

Figure 38 Network schematic with system needs 2041-2050 Option 10.

8.4. Specific Options Required Outside HOWSUM Scope

This section focuses on the specific needs of Thurso South GSP which are outside the geographic scope of the HOWSUM process but will improve network resilience and system security of supply up to 2050. This includes both system needs on the mainland of Scotland and also those limited to on-island networks.

As stated in Section 7, the future demands growth on Orkney is mainly centred around Kirkwall and St Marys. These demands will be supplied by Finstown GSP. To meet these demand growth, new primary substations near Kirkwall and South Ronaldsay have been considered. The associated 33kV circuits between Finstown and Kirkwall/St Marys will be reinforced to meet the demand requirements. However, the existing interconnecting circuit sections between Scorradale and Finstown haven't been included in the reinforcement plan.

The list in table 11 refers to high level options that can be implemented in the future to resolve forecast network constraints and ensure the network remains compliant as distribution grid transitions to net zero.

Option	Description	Driver	System Needs being resolved
33kV circuit sections between Finstown and Scorradale	Upgrade the 33kV circuit sections between Finstown and Scorradale	Demand	Improves N-1 resilience for Loss of Finstown GSP
33kV circuit sections between Kirkwall and St Marys	Upgrade the 33kV circuit sections between Kirkwall and St Marys	Demand	Improves N-1 resilience for Loss of Finstown GSP
33kV circuit sections between Kirkwall and South Ronaldsay	Upgrade the 33kV circuit sections between Kirkwall and South Ronaldsay	Demand	Improves N-1 resilience for Loss of Finstown GSP
Grid Transformer reinforcement at Thurso South GSP	Upgrade the existing GT1 and GT2 to higher capacity transformers	Generation	Additional generation connection capacity

Table 11 Options for specific system needs 2029-2050 outside of the HOWSUM scope.

8.5. Future requirements of the High Voltage and Low Voltage Networks

Our HV/LV spatial plans indicate that there is no clear pattern to future demands on these lower voltage networks. We are therefore planning on a forecast volume basis and this section provides further context on this work for both the Thurso South high voltage and low voltage network needs to 2050.

8.5.1. High Voltage Networks

As well as the EHV system needs identified in the previous section, increased penetration of low carbon technologies (LCTs) connecting to the distribution network will result in system needs on the High Voltage (HV) and Low Voltage (LV) networks. To provide a view on the impact of these technologies on the distribution network here we have used the load model that is produced by SSEN's Data and Analytics team.[15]

The load model is a machine learning product which estimates a half-hourly annual demand profile for each household based on a series of demographic, geographic and heating type factors. This enables us to estimate capacity on the electricity network while protecting individual customers data privacy by using modelled data. These views are then aggregated up the network hierarchy based on the combinations of customers associated with each asset. This view is supplemented with the DFES to highlight the projected impact of LCTs on the network.

For the 18 primary substations supplied by Thurso South GSP, the percentage of secondary substations where projected peak loading exceeds the nameplate rating of the secondary transformer was taken from the load model data. Figure 40 demonstrates how this percentage changes under each DFES scenario from now to 2050.

To satisfy these requirements a variety of solutions will need to be investigated. It is likely that a combination of flexibility and asset replacement will be employed to resolve the projected HV system needs. It is important to

15 SSEN Open Data Portal, 2023, SSEN Secondary Transformer – Asset Capacity and Low Carbon Technology Growth.

note that for HV needs, flexibility is likely to be provided through Distributed Energy Resources (DER), Consumer Energy Resources (CER), and domestic/commercial Demand Side Response (DSR). One of the challenges associated with procuring flexibility to High Voltage and Low Voltage system needs is that only a small number of customers can provide a flexible service due to the requirement to be supplied by a specific secondary transformer. As the role of aggregators develops, we may see a shift in the potential for flexibility in an area. Where the magnitude of an overload is too large for flexibility to be feasible, addition of new assets or asset replacement will be necessary.

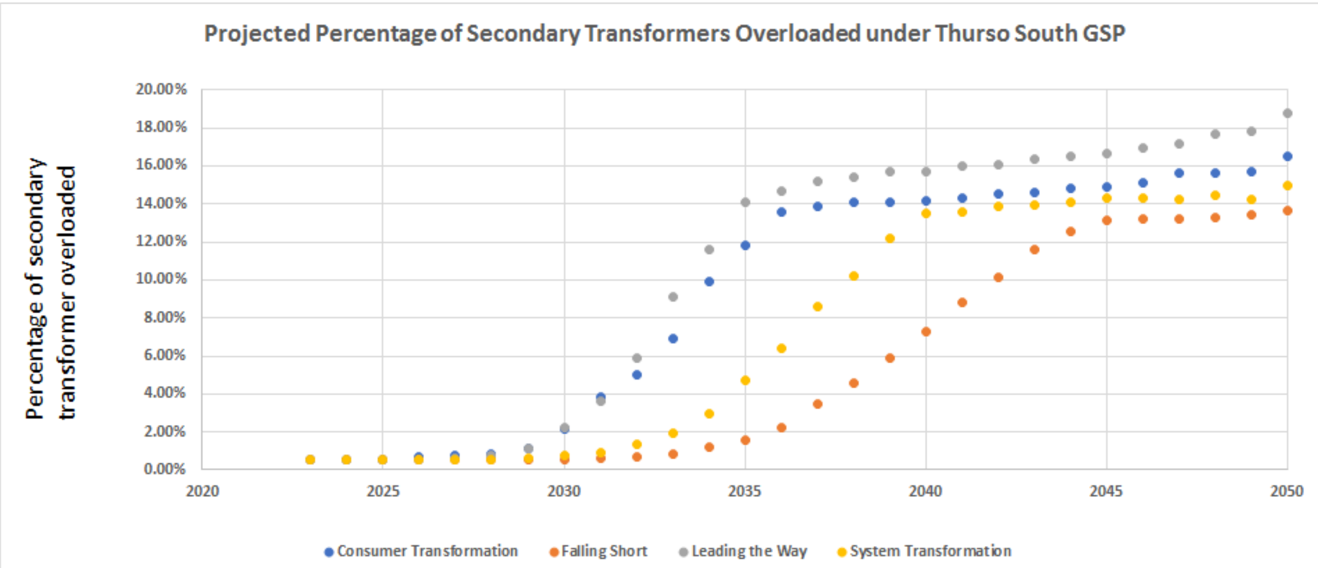


Figure 39 Thurso South Projected Secondary Transformer Loading. Source: SSEN Load Model

8.5.2. Low Voltage Networks

Drivers for interventions in low voltage networks may be either capacity related or be driven by voltage requirements. We are progressing options to resolve both of these drivers. From a network perspective the solution typically involves upgrading the number of LV feeders to split/ balance the load and improve voltage or to install another substation at the remote end of the LV network to balance load and improve voltage. In both instances, flexibility at a local level, especially voltage management products linked to battery export and embedded generation such as solar is likely to be required alongside traditional reinforcement.

We are leveraging recent innovation work through Project LEO (Local Energy Oxfordshire) and My Electric Avenue to inform this strategy. Enhanced network visibility through Smart meter data analytics and low-cost substation feeder monitoring is also necessary to enable appropriate dispatch of services and network reconfiguration.

Capacity driven needs – Thermal constraints tend to materialise in the sections of cable leading to the substation (transformer) where multiple customer loads join together. We are modelling requirements out to 2050 leveraging low voltage monitoring and metering equipment combined with analytical techniques. This will demonstrate how the magnitude of LV system need changes for remote rural communities including those on Scottish Islands across scenarios and years out to 2050.

Voltage driven needs – Generally, connection of Low Carbon Technology and large loads such as heat pumps is limited by voltage constraints before thermal constraints when located more than around 150m from the local secondary transformer. Increased loading on our low voltage networks can reduce the voltages to consumer premises. This is a non-liner relationship and as such requires more complex analysis. We are currently undertaking analysis to better understand the extent of this future need.

Initial analysis indicates that 3.2% of low voltage feeders may need intervention by 2035 and around 4% by 2050 under the CT scenario as shown in Figure 41. This is based on data from remote rural areas across the North of Scotland. The need is unlikely to be triggered until 2028 onwards. However, due to the timeline to grow workforce, with jointing skills taking typically 4 years to be fully competent, it is necessary to start recruitment and initiate programmes ahead of need to be able to deliver the required volumes from 2028 onwards.

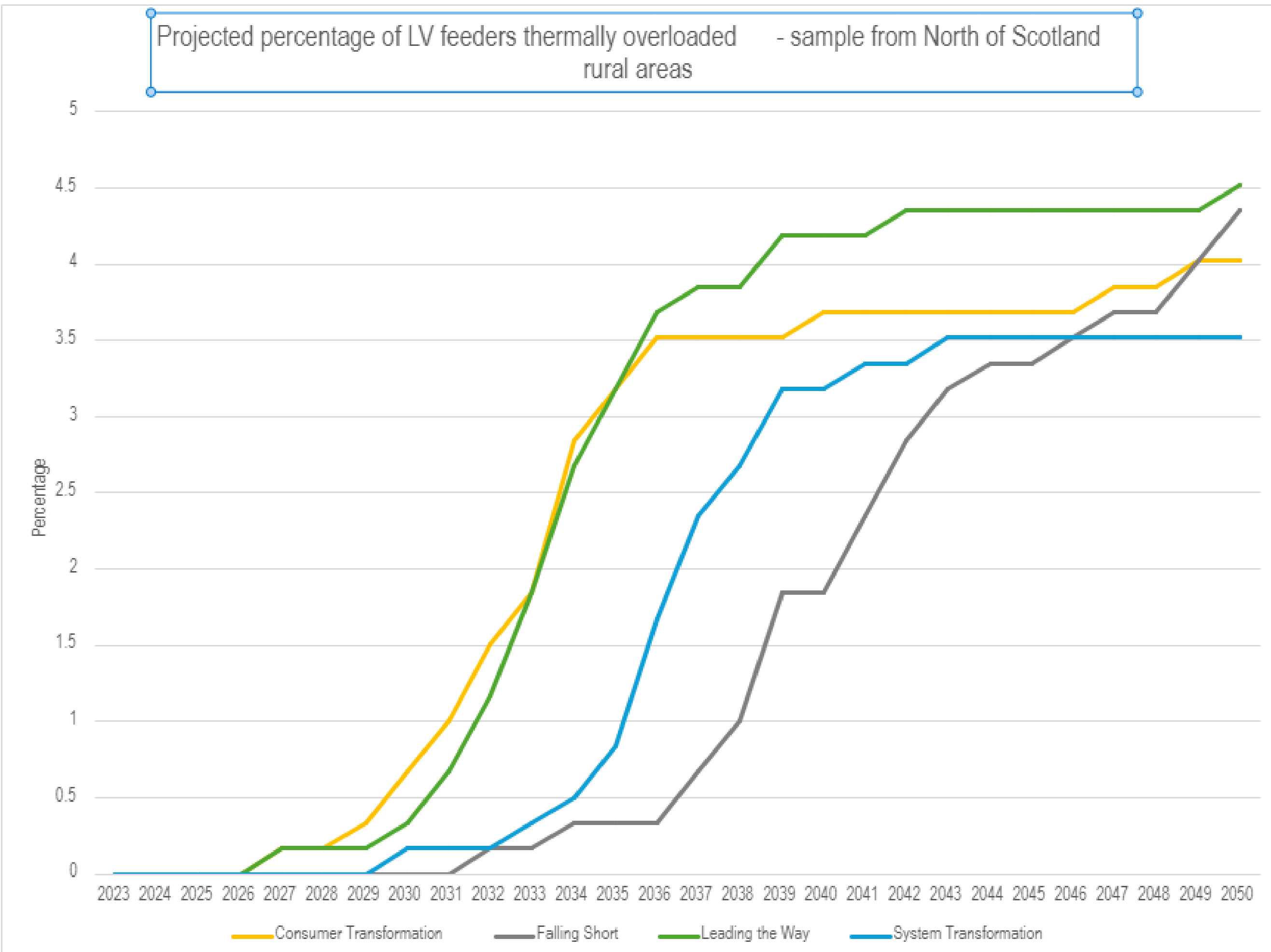


Figure 40 Percentage of LV feeders projected to be overloaded in Northern Scotland remote rural areas

9. RECOMMENDATIONS

The review of stakeholder engagement and the SSEN 2023 DFES analysis provides a robust evidence base for load growth across Thurso South GSP group in both the near and longer term. Drivers for load growth across Thurso South GSP arise from multiple sectors and technologies. These drivers impact not only our EHV network but will drive system needs across all voltage levels. They are driven by both demand and generation needs and detailed optioneering will need to consider both scenarios.

Across Thurso South GSP group, a variety of works have already been triggered through the DNOA process and published in the DNOA Outcomes Report. These are driven by customer connections and system needs that will arise this decade but are being developed to meet 2050 needs.

The findings from this report have provided evidence for 6 key recommendations

- Proposed works to resolve the system needs projected in the short and medium term should be assessed through the DNOA methodology.[16] This will allow for a variety of solutions to be considered and the viability of flexibility solutions to be assessed. The DNOA process will then provide insight on the solution to the system need that provides the most benefit to customers;
- The 2050 EHV high level plans affecting the Orkney Isles should be developed and refined further through the HOWSUM process. This can allow for a robust case for works to be undertaken in the near future to improve the infrastructure to this island group to facilitate decarbonisation. Given the whole system nature of HOWSUM this needs to include a wide range of drivers including asset condition and future resilience, particularly given the increasing reliance of the island communities on electricity for heating, transport and industry. A wide range of solutions should also be considered including the use of flexibility;
- The connection of low carbon technologies across the HV and LV networks will result in significant demand growth. Where it has been identified that there are overloads projected, mitigations will need to be put in place. There is no clear pattern to low voltage load growth in Thurso South GSP, so we are taking a volume driver approach. This needs to be based on strategic modelling of LV networks to understand the volume of work needed;
- SSEN should proactively engage with key stakeholders to scope longer term works that have been signposted in this document including plans to decarbonise operations. This could take the form of input from Local Area Energy Plans (LAEPs), or more specific engagement on the details of individual projects. This needs to include discussions on related activities such as land availability and usage;
- SSEN should also actively engage with specific large customers in Thurso South GSP with the aim of refining its demand forecast methodology for industries such as distillery and ports which will play a major role in both local decarbonisation and driving future network needs
- ;

16 https://www.ssen.co.uk/globalassets/about-us/dso/consultation-library/distribution-network-options-assessment-dnoa---making-decisions-on-the-future-use-of-flexibility.pdf

- SSEN should keep its ANM system and technology under review to understand if any enhancements could support the connection of additional generation and/or the reduction of limitations on existing flexible connections.

Actioning these recommendations will allow SSEN to develop a network that supports local net zero ambitions. By doing so, contributing to net zero targets at a national level.

APPENDIX A – DEFINITIONS AND ABBREVIATIONS

ACRONYM	DEFINITION
ANM	Active Network Management
BAU	Business as Usual
CER	Consumer Energy Resources
CMZ	Constraint Managed Zone
CT	Consumer Transformation
DEG	Diesel Embedded Generation
DER	Distributed Energy Resources
DFES	Distribution Future Energy Scenarios
DGAD	Distributed Generation Automatic Disconnection
DNO	Distribution Network Operator
DNOA	Distribution Network Options Assessment
DSR	Demand Side Response
EHV	Extra High Voltage
EJP	Engineering Justification Paper
ER P2	Engineering Recommendation P2
ESO	National Grid Energy System Operator
EV	Electric Vehicle
FES	Future Energy Scenarios
FS	Falling Short
GSPs	Grid Supply Points
HV/LV	High Voltage/Low Voltage
HOWSUM	Hebrides and Orkney Whole System Uncertainty Mechanism
HVO	Hydrotreated Vegetable Oil
LAEP	Local Area Energy Planning
LENZA	Local Energy Net Zero Accelerator
LW	Leading the Way
OHL	Overhead Line
PV	Photovoltaic

MW	Megawatt
MVA	Mega Volt Ampere
NRS	National Records of Scotland
RIIO-ED1/2	RIIO Electricity Distribution Price Control periods 1 and 2
SBTs	Science Based Targets
SDP	Strategic Development Plan
SHEPD	Scottish Hydro Electric Power Distribution
SLC	Standard Licence Condition
SSEN	Scottish and Southern Electricity Network
ST	System Transformation
SWA	Scottish Whisky Association
WSC	Worst Served Customers

APPENDIX B – GENERATION CAPACITY FORECASTS

This annex shows aggregated forecast generation capacity of distribution connected projects within Thurso South GSP.

Orkney – Generation Capacity Forecast

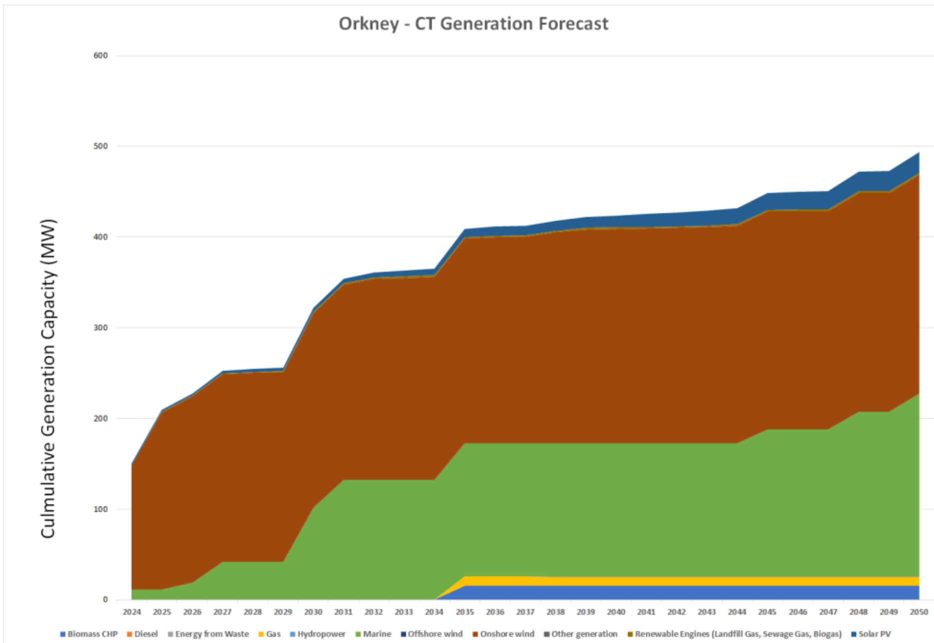


Figure 42 Generation Capacity Forecast by Technology for Orkney – CT. Source: SSEN DFES 2023

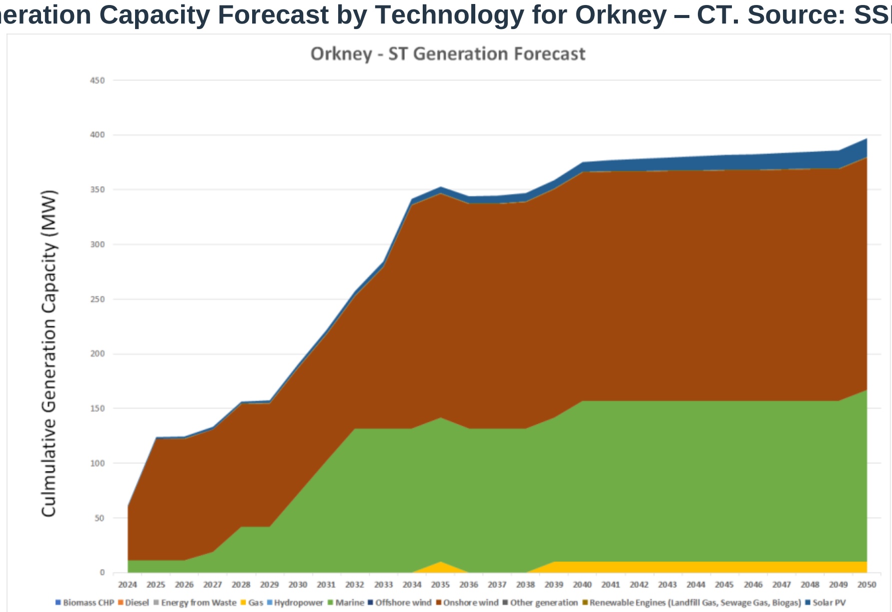


Figure 41 Generation Capacity Forecast by Technology for Orkney – ST. Source: SSEN DFES 2023

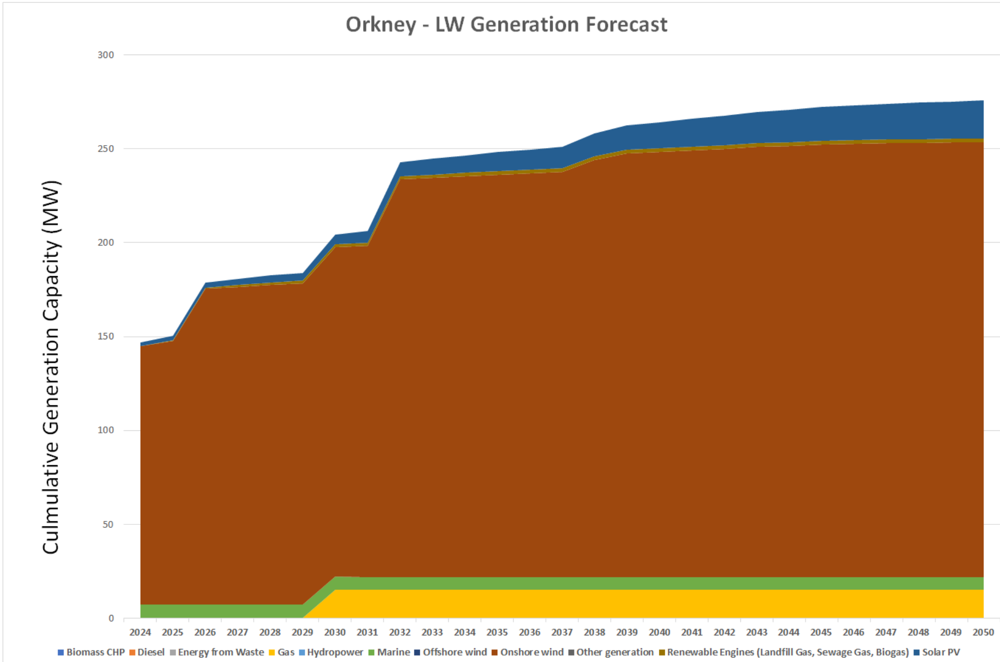


Figure 42 Generation Capacity Forecast by Technology for Orkney – LW. Source: SSEN DFES 2023

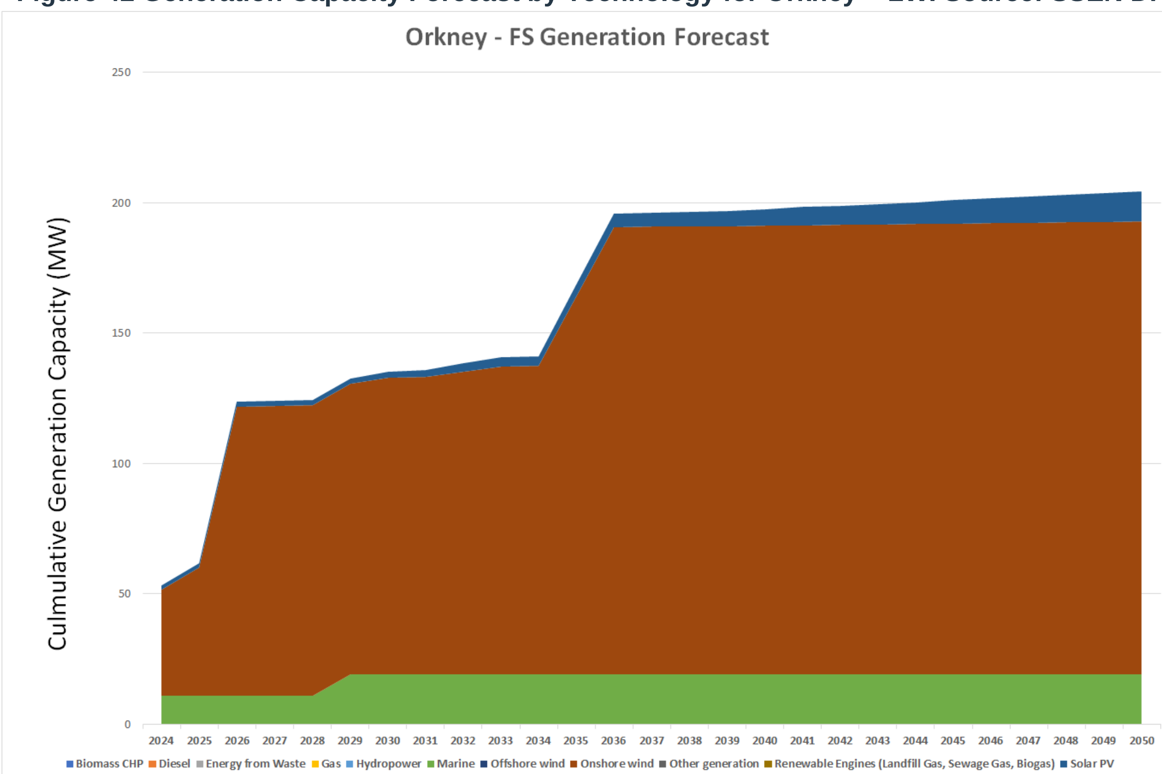


Figure 43 Generation Capacity Forecast by Technology for Orkney – FS. Source: SSEN DFES 2023

Thurso South Mainland – Generation Forecast

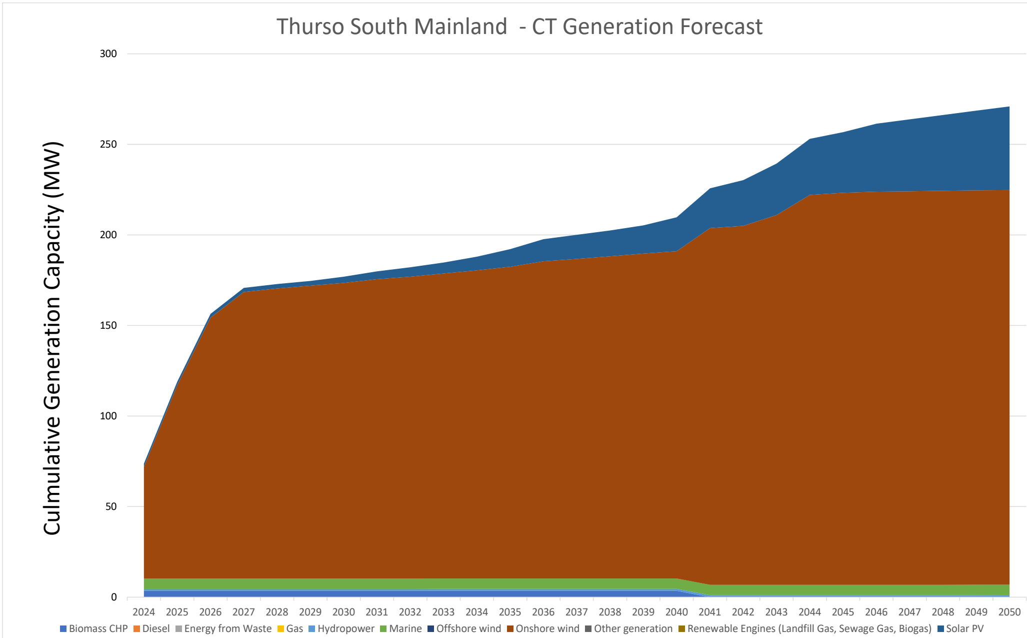


Figure 44 Generation Capacity Forecast by Technology for Thurso South Mainland – CT. Source: SSEN DFES 2023

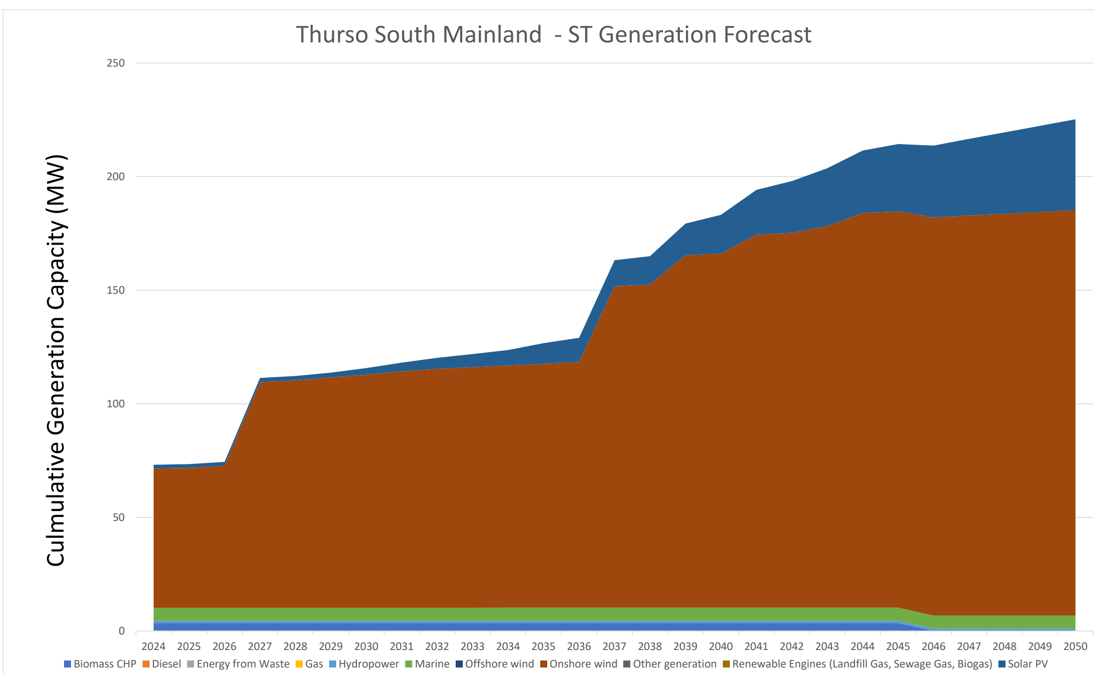


Figure 45 Generation Capacity Forecast by Technology for Thurso South Mainland – ST. Source: SSEN DFES 2023

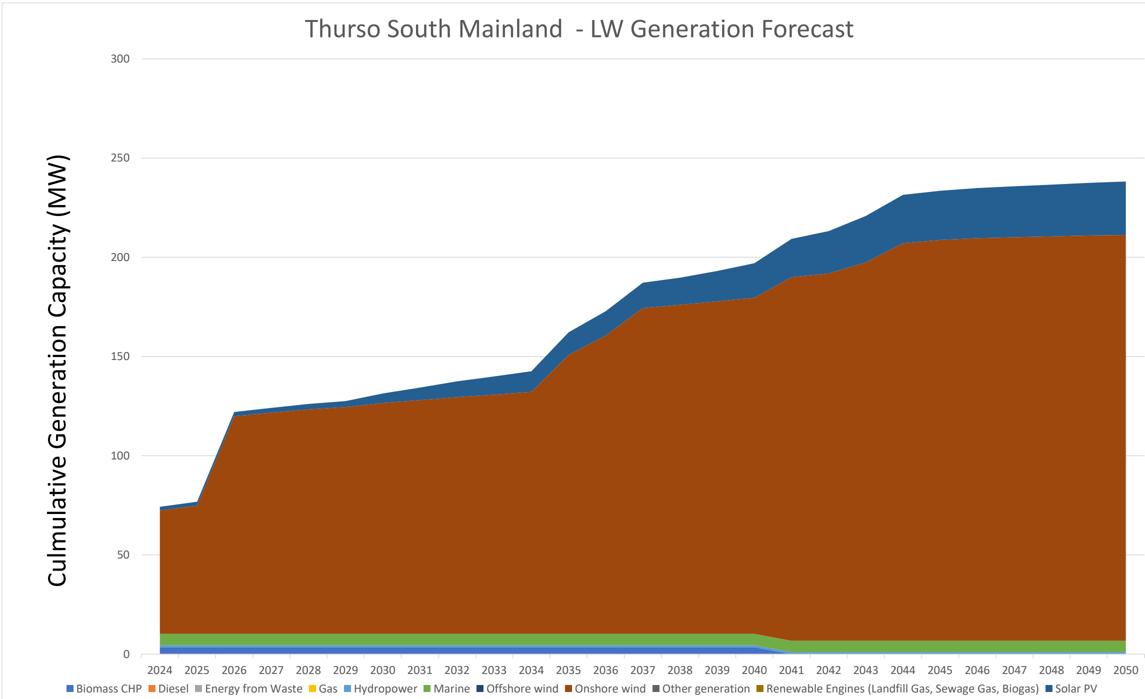


Figure 46 Generation Capacity Forecast by Technology for Thurso South Mainland – LW. Source: SSEN DFES 2023

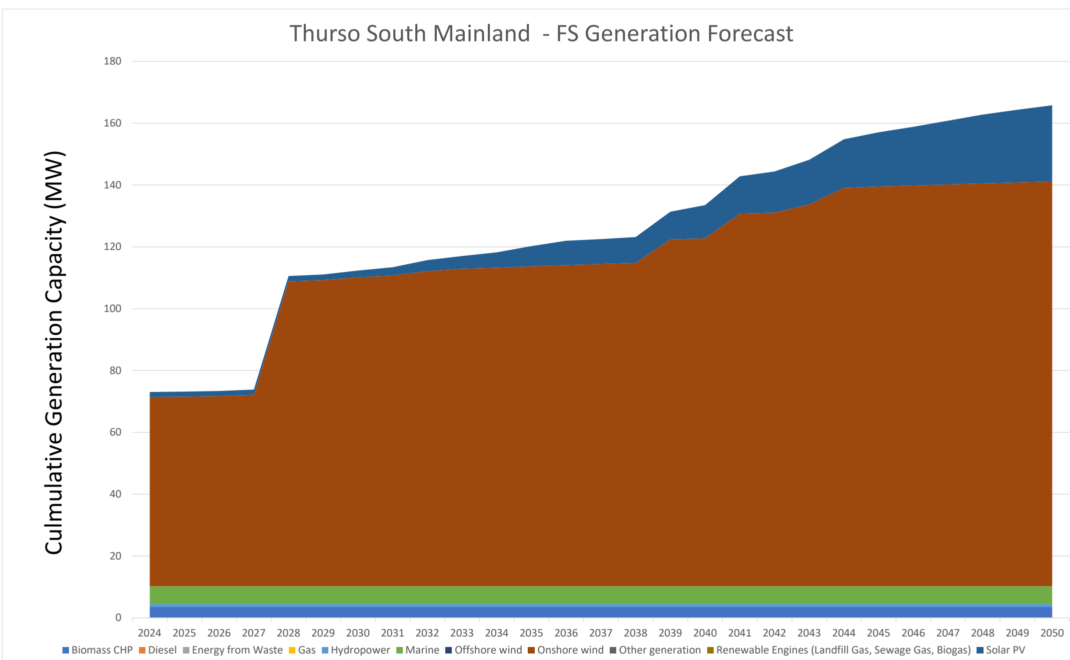


Figure 47 Generation Capacity Forecast by Technology for Thurso South Mainland – FS. Source: SSEN DFES 2023

APPENDIX C – DEMAND FORECASTS

This annex shows the winter peak forecast demand for primary substations within Thurso South GSP. This data is forecast demand net of embedded generation output.

Orkney

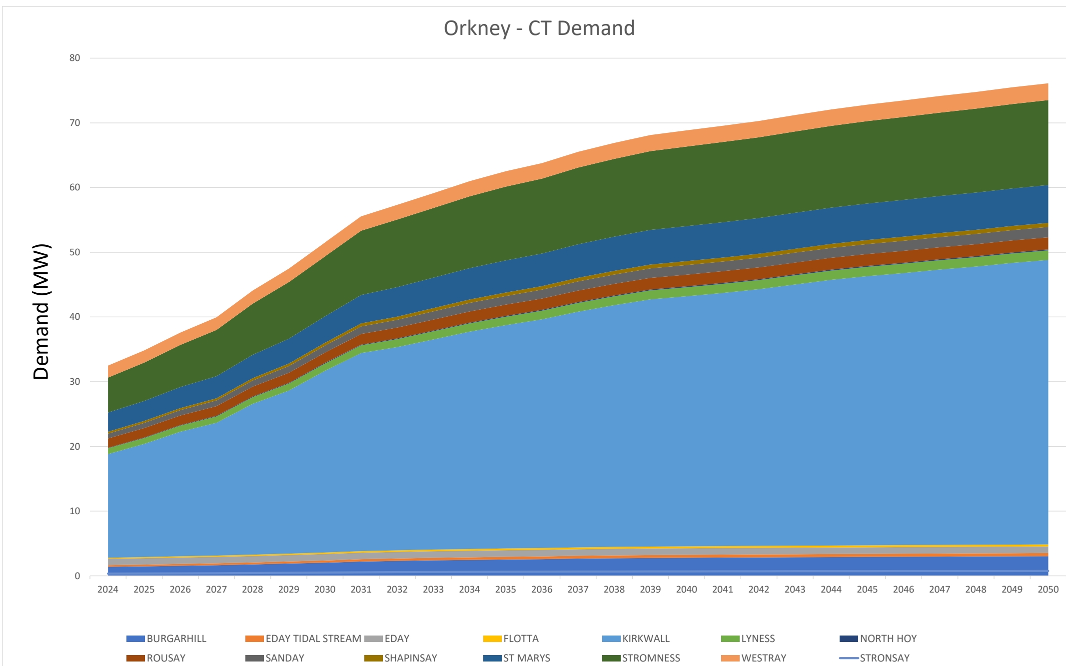


Figure 48 Demand Forecast for Orkney – Breakdown by Primaries – CT. Source: SSEN DFES 2023

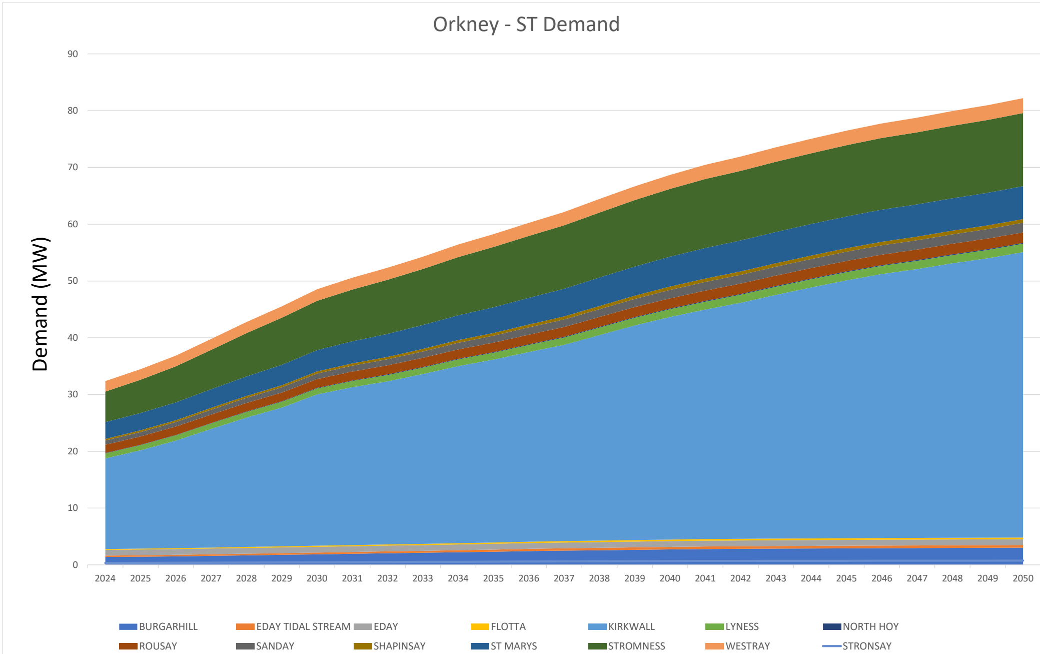


Figure 49 Demand Forecast for Orkney – Breakdown by Primaries – ST. Source: SSEN DFES 2023

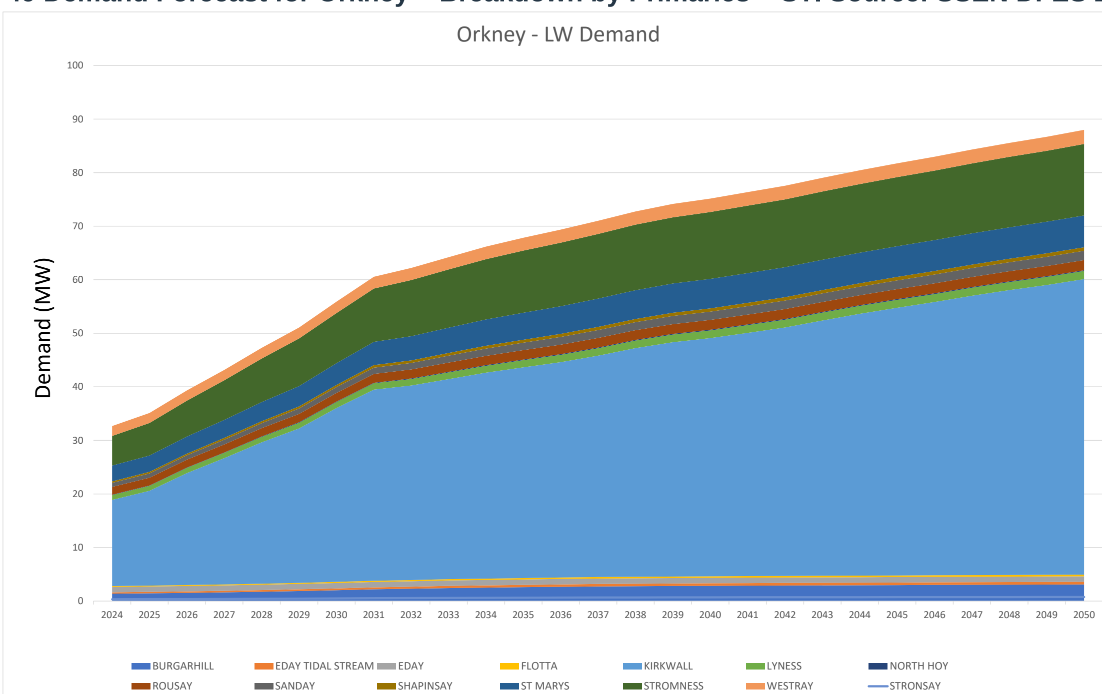


Figure 50 Demand Forecast for Orkney – Breakdown by Primaries – LW. Source: SSEN DFES 2023

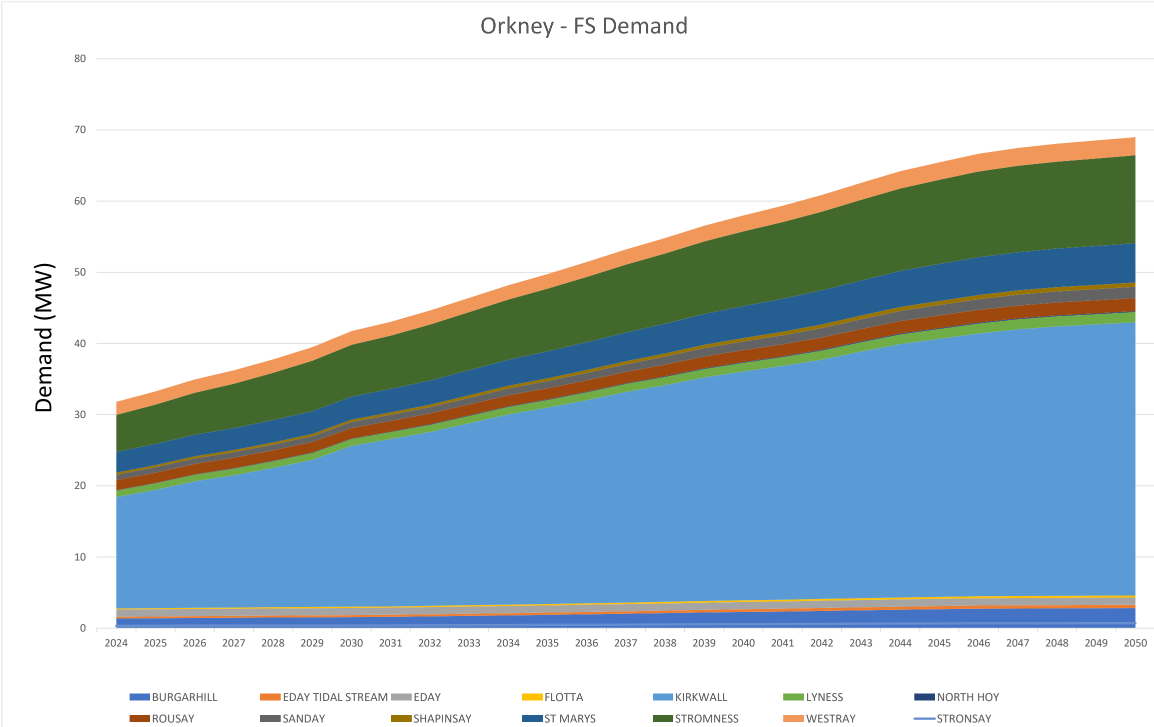


Figure 51 Demand Forecast for Orkney – Breakdown by Primaries – FS. Source: SSEN DFES 2023

Thurso South Mainland

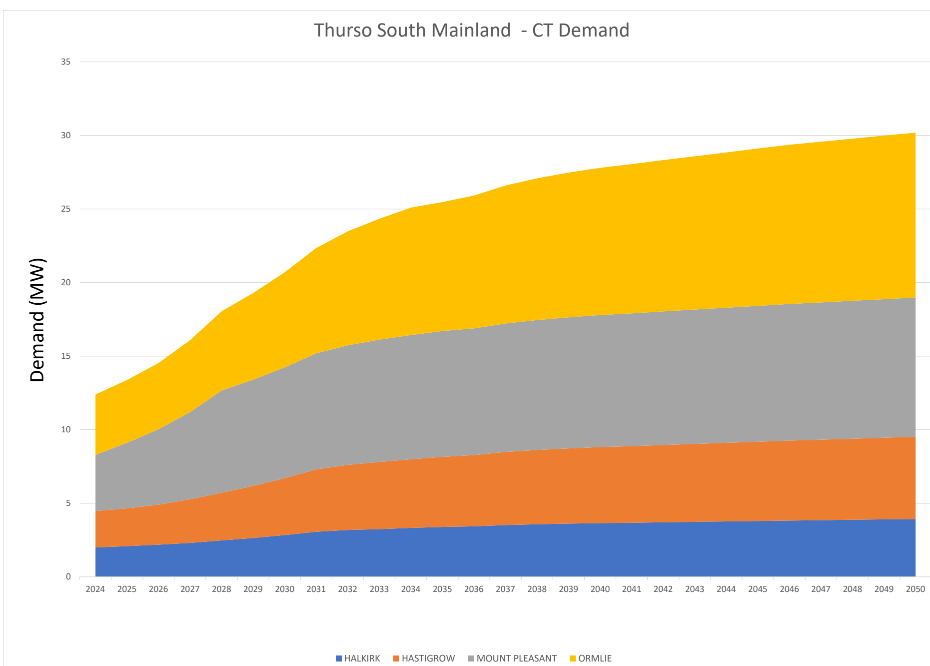


Figure 52 Demand Forecast for Thurso South Mainland – Breakdown by Primaries – CT. Source: SSEN DFES 2023

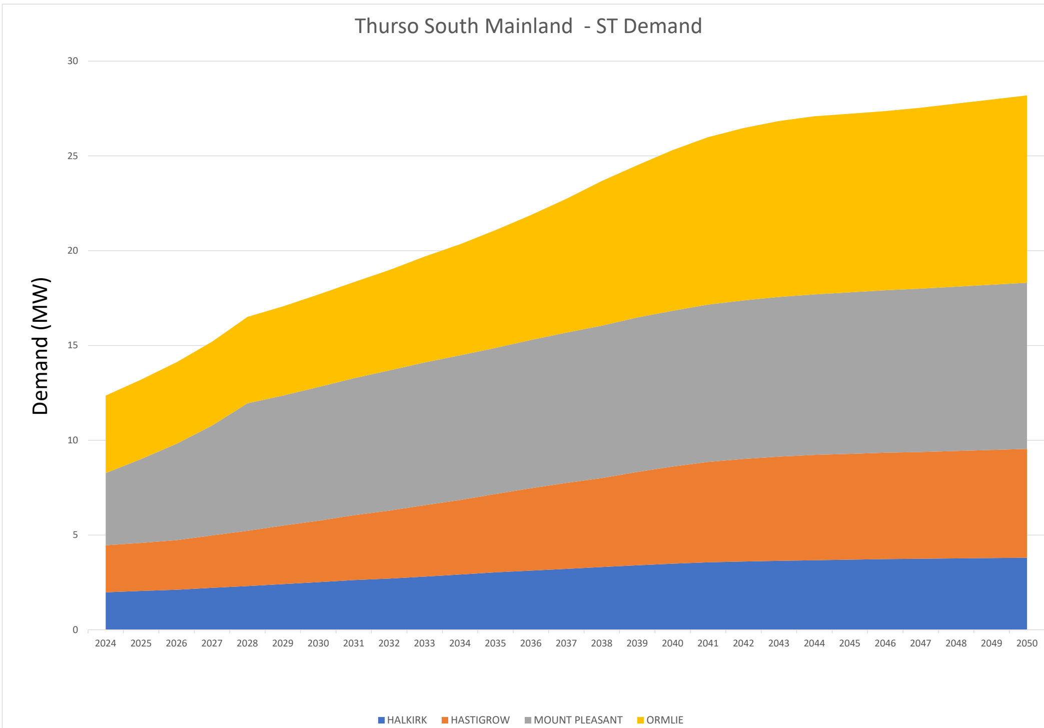


Figure 53 Demand Forecast for Thurso South Mainland – Breakdown by Primaries – ST. Source: SSEN DFES 2023

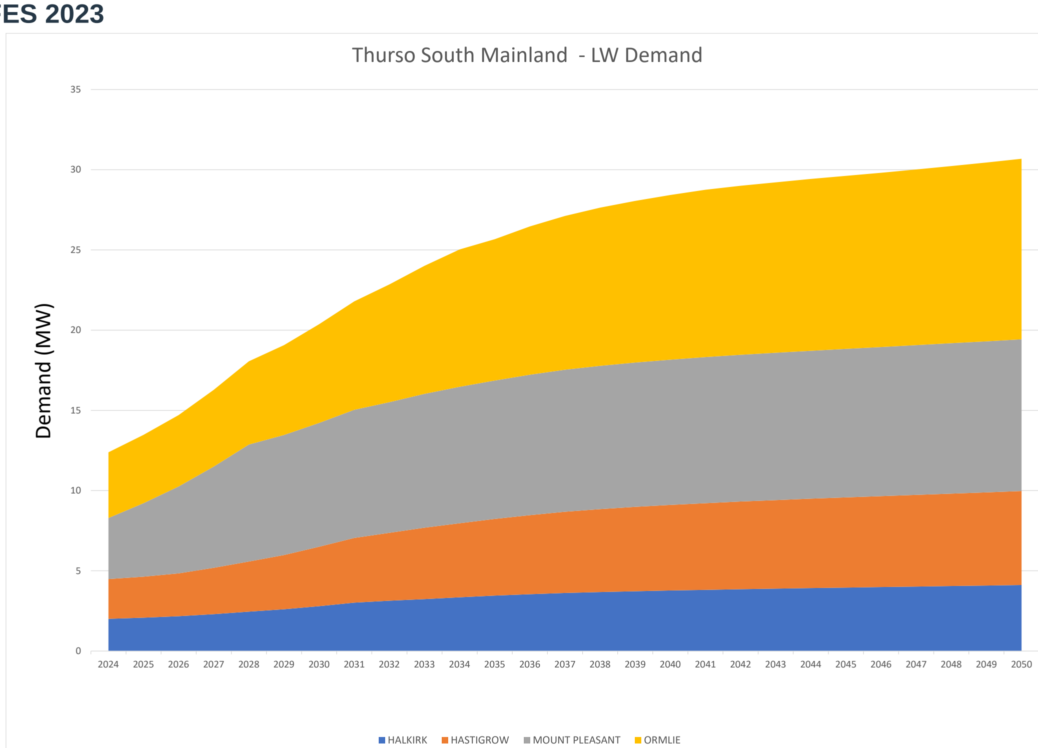


Figure 54 Demand Forecast for Thurso South Mainland – Breakdown by Primaries – LW. Source: SSEN DFES 2023

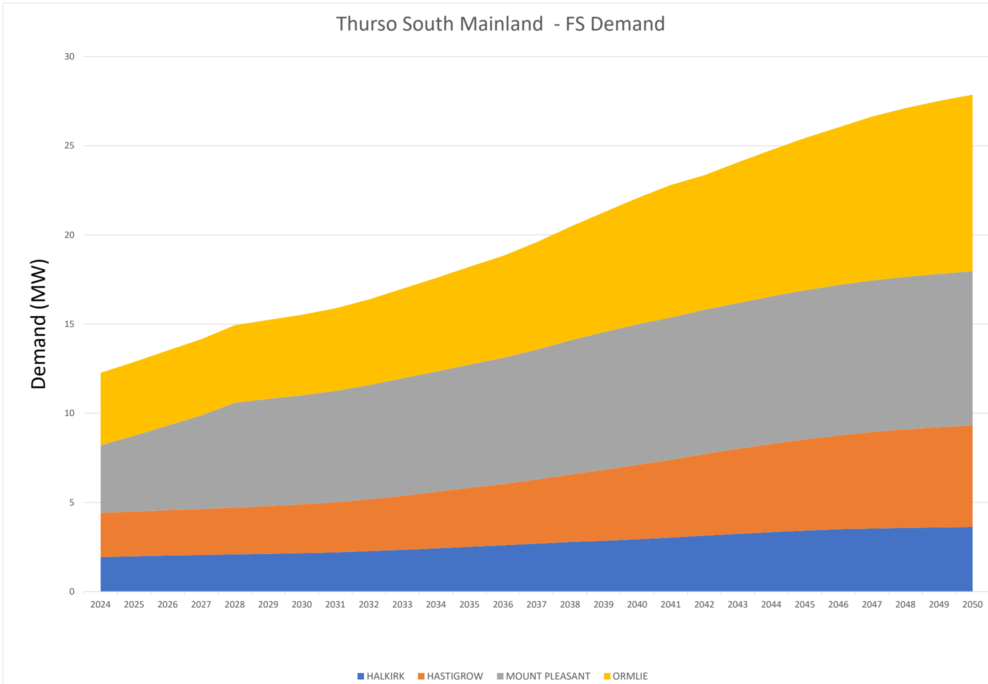


Figure 55 Demand Forecast for Thurso South Mainland – Breakdown by Primaries – FS. Source: SSEN DFES 2023

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