SP ENERGY NETWORKS

Denny to Wishaw Network Upgrade

Background to need case

May 2021

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Purpose of this document

SP Energy Networks is embarking on a project of significant scale and importance in the Falkirk and North Lanarkshire local authority areas of the central belt of Scotland to reinforce the electricity transmission network.

The transmission network throughout Scotland has evolved over the past 100 years to allow the transfer of power to customers from smaller, more local power stations in the early twentieth century to large fossil fuel power stations that were often located in coastal areas in the mid to late 20th century. This network is no longer suitable for the needs of today and the move to a net zero emissions economy where generators are smaller and more remote from large population centres.

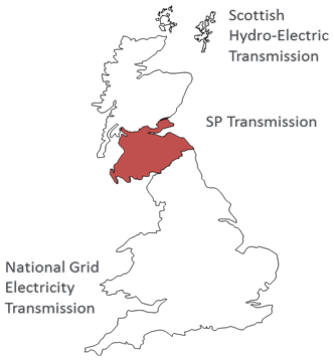
This document sets out at a high level the reasons why the Denny to Wishaw 400kV Upgrade is required and the options considered in developing the network.

It describes the main project drivers and why this investment is needed, along with a summary of the significant work that has been carried out to date. It will explain why the transmission network in the central belt of Scotland needs to be developed to provide an increase in capacity to enable the power produced by renewable generation in the north of the UK to be transported to the demand centres in central and southern Scotland, and further south, helping both Scotland and the UK meet their net zero emissions targets.

SPEN & SPT

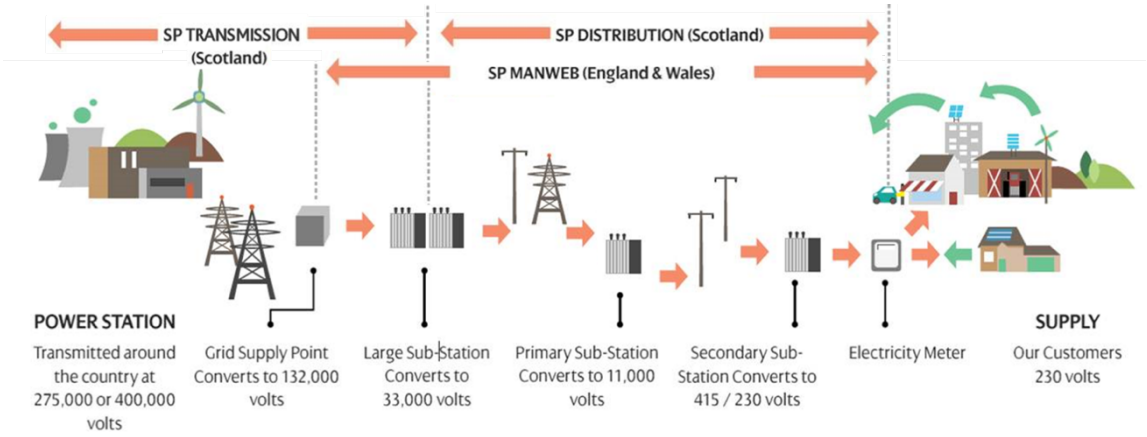
SP Energy Networks (SPEN) is the trading name for Scottish Power Energy Network Holdings Limited. SPEN owns and operates the electricity transmission and distribution networks in central and southern Scotland through its wholly-owned subsidiaries SP Transmission plc (SPT) and SP Distribution plc (SPD). These businesses are 'asset-owner companies' holding the regulated assets and Electricity Transmission and Distribution Licenses. SP Transmission plc is the transmission licensee.

In addition, SPEN's Manweb business operates the distribution business in Cheshire, Merseyside and North Wales.



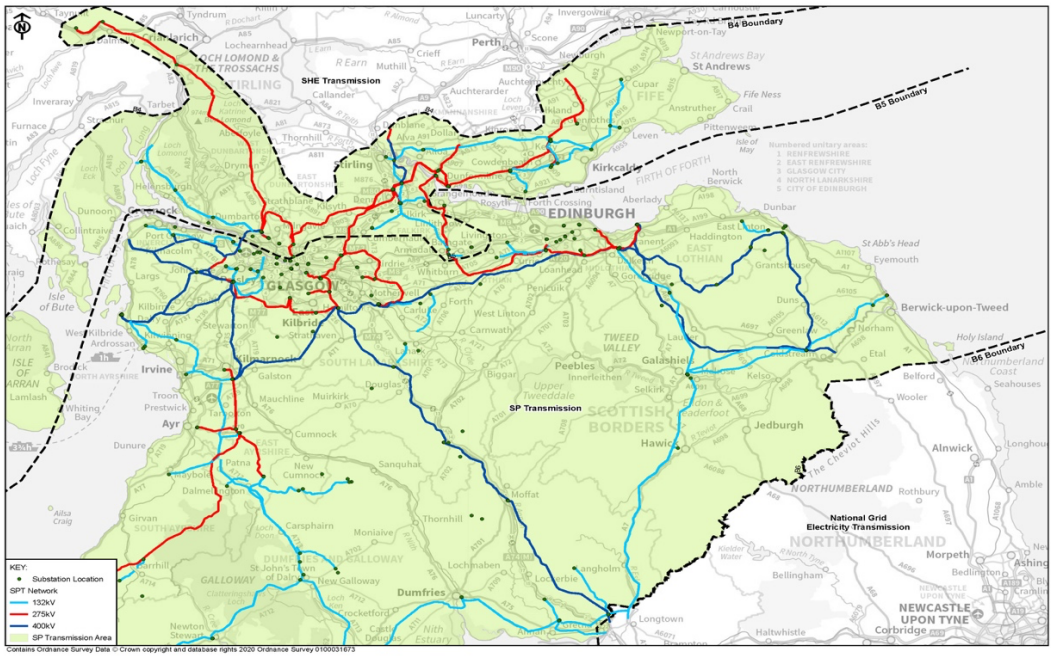
Across each of its license areas SPEN's role is to maintain, operate and invest in its transmission and distribution networks to secure a safe, reliable, and economic service for current and future consumers (See Fig.1).

Figure 1 "Generation to plug" – SPEN's area of responsibility



SPT's transmission network consists of approximately 4,000 circuit kilometres of overhead line and underground cable and 154 substations operating at 400 kilovolts (kV), 275kV and 132kV serving 2.01 million customers and covering an area of 22,950 square kilometres. It is connected to the Scottish Hydro Electric (SHE) Transmission System to the north, the National Grid Electricity Transmission (NGET) System to the south and the Northern Ireland Transmission System via an HVDC subsea cable. Reference should be made to the illustration showing the license areas and further details on the GB Transmission system below (See Fig.2).

Figure 2 – SPT transmission network



Ofgem is the Office of Gas and Electricity Markets. It regulates the monopoly elements of the electricity market primarily through price controls. The current prince control is RIIO T2 and runs from April 2021 to March 2026. RIIO stands for 'Revenue = Incentives + Innovation + Outputs'. It's a framework used by Ofgem to ensure that network companies, like SPEN, provide a safe and reliable service, value for money, maximise performance, operate efficiently, innovate and ensure the resilience of their networks for current and future customers.

Price controls are a method of setting the amount of money (allowed revenue) that can be earned by the network companies over the length of a price control. The companies recover their allowed revenues from their charges to suppliers who in turn pass these costs through to customers. The revenues must be set at a level which covers the companies' costs and allows them to earn a reasonable return subject to them delivering value for consumers, behaving efficiently and achieving the targets set by Ofgem.

Great Britain's electricity transmission system transmits high-voltage electricity from where it is produced to where it is needed throughout the country. The system is made up of high voltage electricity wires that extend across Britain and nearby offshore waters.

The transmission system is owned, maintained and improved by each of the three regional transmission companies under the direction of the system operator. SPT is the Transmission Owner (TO) in the central belt of Scotland. SHE Transmission is the TO in the north of Scotland. In England and Wales the TO is NGET. The GB transmission system as a whole is operated by National Grid ESO (NGESO).

NGESO evaluates what reinforcements will be required in the future and where these should take place. This is informed by the Network Options Assessment, which is carried out annually by NGESO with support from the TOs.

Under the current transmission price control, SPT is delivering an investment plan of transmission infrastructure totaling £1.2 billion pounds over the 5-year regulatory price control period from April 2021 to March 2026. Along with the other TOs, this continues the most significant investment in the transmission system in the last 70 years.

Background

The electricity system in the UK is going through a transformational change as it moves towards a net zero emissions economy. Traditional large fossil fuel power stations are being replaced by a large number of renewable generating stations such as wind farms that are geographically more spread out.

The current network was designed and built to take power from those traditional large power stations, often coal fueled (such as Kincardine and Longannet) and take it to demand centres throughout the central belt of Scotland and beyond. However, now smaller, renewable generators are connecting to the system in areas where historically there was very little demand or generation, such as in the north of Scotland. To allow the electricity to be carried from where it is now produced in the north to the large demand centres in the south of the UK, where it is required, there is a need for modernisation and reinforcement of the transmission system across Scotland and Great Britain.

The SPT's network is crucial to the delivery of the UK Government's renewable energy objectives due to its location in an area of outstanding renewable resource and its position between the SHE Transmission and NGET areas. SPT has a unique role in connecting renewable generation and bulk transfer of renewable energy from its area and from the SHE Transmission area into England and Wales. SPT's activities therefore benefit stakeholders throughout Great Britain.

The Network Options Assessment (NOA)[1] is carried out every year by NGESO to work out what, if any, additional capacity will be required to ensure current and future generation can flow from where it is produced to where it is needed. This assessment has identified that the Denny to Wishaw 400kV Upgrade hereafter also referred to as 'the Project' should proceed. The Project will enhance the transmission infrastructure in the central belt of Scotland while helping Scotland and the United Kingdom achieve its net-zero carbon emissions targets by 2045 and 2050 respectively. This Project will assist in increasing the transfer capacity of the SPT network by approximately 1,000 megawatts.

As a result, SPT have included the development of the Project in its RIIO-T2 plan (and beyond). This is the plan of works that will be undertaken within the price control period between April 2021 and March 2026 to modernise and enhance the transmission network in the central belt area of Scotland.

[1] The Network Options Assessment (NOA) is carried out annually by NGESO and evaluates proposed system reinforcement projects against several future generation and demand scenarios to determine what reinforcement will be required in the GB System and when this should take place. When this is done, each proposed project is either approved for progression, put on hold for a period or rejected as not being required at that point in time. The output of this process is to determine the most efficient way of reinforcing the GB System within the time period allowed.

The Project consists of a number of key components, including reinforcement of existing transmission overhead lines and substations and the construction of a new transmission overhead line. These components are set out below:

- Uprating of one side of the existing 275kV overhead line (known as ZG route) between Denny North and Bonnybridge substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV

- Denny North 400kV / 275kV Substation works. Works to move the uprated 400kV circuit from the 275kV substation to the 400kV substation at Denny.

- Construction of a new double circuit 275 / 400kV overhead line circuit (known as the Bonnybridge to Glenmavis 400kV Overhead Line) that will run from Bonnybridge 275kV Substation in the north to a point on an existing 275kV overhead line (known as XX route), near Glenmavis in North Lanarkshire, that runs between the Easterhouse and Newarthill 275kV Substations in the south.

- Bonnybridge 275kV Substation works. Works to terminate the new Bonnybridge to Glenmavis overhead line.

- Uprating of the existing 275kV overhead line (known as ZD route) between Longannet and Clydesmill substations that runs past Easterhouse substation. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV on one side. The existing overhead lines around the Easterhouse substation will be deviated to provide a 275kV overhead line between Clydesmill and Newarthill and a 400kV overhead line between the Longannet area and Wishaw.

- Uprating of the existing 275kV overhead line (known as XX route) between the Easterhouse and Newarthill substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV on one side. Uprating of the existing 275kV overhead line (known as XR route) between Newarthill and Wishaw substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV.

- Uprating of the existing 275kV overhead line (known as XR route) between Newarthill and Wishaw substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV.

- Wishaw 400kV Substation works. Works to connect the uprated 400kV circuit to the Wishaw 400kV GIS Substation.

The uprating of the existing transmission overhead lines from 275kV to 400kV will require new conductors (wires) and electrical insulators on the existing towers. It is proposed that these existing overhead line routes will remain in situ, however it may be necessary to undertake deviations of these lines where they enter the existing substation sites.

The proposed new Bonnybridge to Glenmavis 400kV overhead line will be routed with a strong focus on minimising effects on the local population and environmental sensitivities, including visual amenity.

The Network in Central Scotland

The electricity transmission network in the central belt of Scotland has undergone continuous evolution since it was first built in the late 1920s. The first section of the 132kV network was, in fact, energised in the Bonnybridge area in 1929 to connect it to Dalmarnock Power Station in the East End of Glasgow. The network continued to expand in both size and capacity through the 1950s and 1960s, when most of the existing 275kV network was constructed. This has continued to the present day with the introduction of new sections of network similar to that proposed as part of the Project, and new technologies, such as the High Voltage Direct Current undersea cables between Scotland and Northern Ireland.

Today, the existing electricity network in the Falkirk and north Lanarkshire local authority areas encompasses both 132kV and 275kV overhead line infrastructure. It allows both the through flow of generation from other parts of the GB system to the wider network beyond the SPT area and the supply of power more locally via Grid Supply Points (GSPs) at Bonnybridge, Cumbernauld, Newarthill, Coatbridge and Wishaw.

The network in this area is made up of double circuit 132kV and 275kV overhead lines as shown in Figure 3. A 132kV double circuit, such as the overhead line between Bonnybridge and Cumbernauld (known as 'CB route') has a circuit on either side of a lattice steel tower and is lower in height than a 275kV overhead line. Figure 4 shows a photograph part of the double circuit 132kV transmission overhead line between Bonnybridge and Cumbernauld. The circuit between Newarthill and Wishaw operates at 275kV and is also shown on Figure 3. A photograph of the existing Denny North to Bonnybridge 275kV double circuit tower line (ZG route) is included in Figure 5.

The customer base of around 242,000 customers in the Bonnybridge, Cumbernauld, Easterhouse, Newarthill, Coatbridge and Wishaw areas that are supplied by this network of 132kV and 275kV transmission lines is a typical mix of:

- Strategic Community Services – NHS facilities, water and sewerage facilities, cell phone/communications infrastructure, public lighting and traffic control systems;
- Local Amenities - Health centres, schools, medical practices, dental surgeries;
- Tourism – the Falkirk Wheel, hotels, local shops and restaurants throughout the area;
- Domestic - a typical mix of domestic dwellings covering urban, rural, private sector and social;
- Renewable energy – such as wind farms and biomass generators; and
- Large-scale commercial customers – such as Liberty Steel and British Oxygen Company (BOC)

Figure 3 – Existing transmission network in the Cumbernauld and Wishaw areas

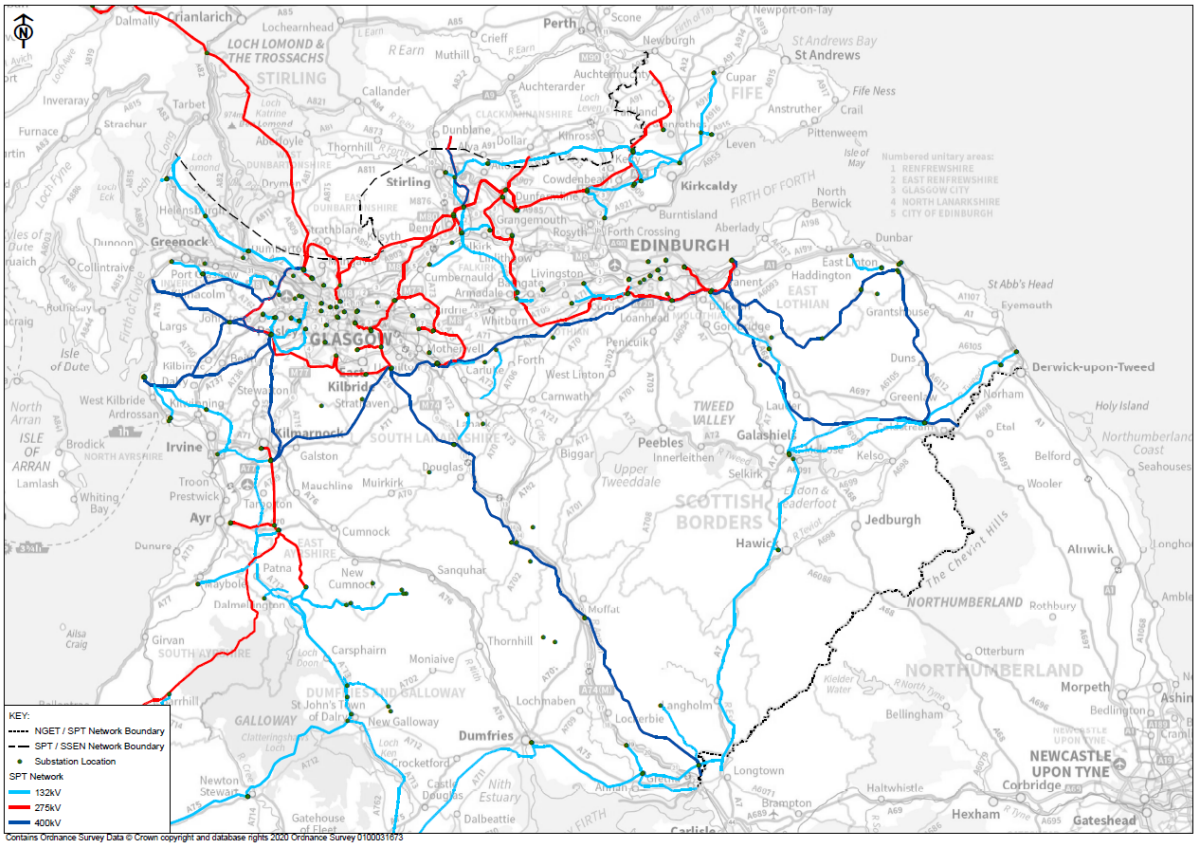


Figure 4 – The double circuit 132kV transmission overhead line between Bonnybridge and Cumbernauld

Figure 5 – A typical double circuit 275kV transmission overhead line

Connection of Renewable Generation within the UK

Within the UK, the pace of connection of renewable generation and volume of electricity produced increases year on year. This rise will only continue as Scotland moves to achieve net zero emissions of all greenhouse gases by 2045 at the latest and the UK by 2050[2]. As a large amount of the renewable resource, both realised and potential, within the UK is located in the northern part of Scotland, SPT needs to increase its ability to transport the power produced through its licence area to the larger demand centres in the south of the UK.

In order to increase the amount of electricity that can be carried by SPT's network, it needs to invest in new and uprated infrastructure to provide additional capacity. Should this additional capacity not be delivered then the already connected, contracted and potential future generation will be severely constrained.

In addition to being obliged to design and maintain an economic, efficient and coordinated transmission system, SPT's transmission licence obliges it to make its transmission system available for generators wishing to connect to it. Offers to connect must be compliant with system security standards in which the minimum requirements are for the renewable generators such as wind farms to be able to export their output under intact system conditions. SPT must also ensure that the system is fit for purpose through appropriate reinforcements to accommodate the contracted capacity. Therefore, the transmission network needs to be appropriately sized to meet the needs of existing users and also take cognisance of future capacity and wider system connectivity to allow the transfer of this renewable energy.

[2] In April 2021 UK government announced a new target to cut emissions by 78% by 2035 compared to 1990 levels

Network Development and Options

As previously mentioned, a Network Options Assessment (NOA) is carried out every year by the NGESO to determine what, if any, enhancements to the GB electricity system are required to increase capacity in the coming years. This assessment has shown that to support the achievement of the UK net zero emissions targets, the SPT network needs significant development to allow the transfer of renewable generation from areas in the north of Scotland to those areas where demand is highest, in the towns and cities in the south.

A number of different options have been developed and considered to achieve this goal. These all aim to make the best use of the existing transmission network and have been tested as alternatives to, and in combination with, the preferred option. These are as follows:

1. Windyhill-Lambhill-Denny North 400kV Reinforcement - Uprating[3] of the existing Windyhill-Lambhill-Denny 275kV overhead line circuit, construct a new 400kV substation at Windyhill and install new 400/275kV transformers[4] at the existing substation Grid Supply Points (GSPs) at Windyhill and Lambhill. The aim of this proposal was to allow a greater flow of generation output from the SHE Transmission network into the SPT network and onto the wider GB Transmission System. This was submitted as part of the NOA 2020/21, with a recommendation from the NGESO to delay the delivery of this project. To provide most benefit to the wider GB transmission system it will need to be delivered after the main components of the Project (Denny to Wishaw 400kV Reinforcement) have been brought into service on the SPT network. The situation will continue to be reviewed via the ongoing NOA process.

2. Eastern Scotland B55 400kV Reinforcement - Formation of a new 400kV overhead line circuit by uprating and reconfiguring existing 275kV overhead line circuits between Longannet in Fife and Cockenzie to the south of Edinburgh area, via existing substation GSPs at Kincardine, Currie, Smeaton and Kaimes. Again, the aim of this proposal was to allow a greater flow of generation output from the SHE Transmission network into the SPT network and onto the wider GB Transmission System. This was submitted as part of the NOA 2020/21. NGESO recommended that it did not proceed at this time as it would conflict with other works to be brought forward on the SPT network during the RIIO-T2 price control period of April 2021 to March 2026. This option will continue to be reviewed via the ongoing NOA process.

3. Establish Denny North-Clydesmill-Wishaw 400kV circuit from existing 275kVcircuits – Construct a new 400kV overhead line circuit between the existing substation GSPs at Denny North, Clydesmill and Wishaw by reconfiguring the existing 275kV circuits between Longannet, Easterhouse and Clydesmill and Wishaw and uprating of the overhead line to operate at 400kV. This was proposed as part of the NOA 2020/2021 and was recommended to proceed by the GBESO. It is described in further detail below.

[3] The term 'uprating', or 'uprated' refers to increasing the operating voltage of an existing circuit or circuits. In this instance from 275kV to 400kV. It should be noted that this is only feasible where the overhead line supports (steel lattice towers) can support both larger / heavier conductors (wires) and maintaining statutory safety clearance distances to the ground and objects underneath the overhead lines e.g. roads, trees and buildings.

[4] A transformer is a piece of electrical plant which is used to either 'step up' or 'step down' voltage between electrical 'circuits' (either overhead line or underground cable).

[5] The GB Transmission System is divided up into areas by several boundaries. The SPT area is associated with three boundaries - the B4 boundary between SHE Transmission and SPT, the B5 boundary that splits the SPT area into two sections and the B6 boundary between SPT and NGET. These boundaries are shown in Figure 1.

4. Denny to Wishaw 400kV Upgrade Project - Upgrade6 of the SPT network by uprating several existing overhead line circuits between Denny in the north and Wishaw in the south and building approximately 17km of new 400kV overhead line to increase the transfer capacity for renewable generation. This was proposed under the NOA 2020/21 and was recommended to proceed by the NGESO. It is described in further detail below.

Denny to Wishaw 400kV Upgrade Details

The aim of the Project is to increase the capacity of the SPT network by increasing the operating voltage of the existing overhead lines between Denny and Bonnybridge, known as 'ZG route' from 275kV to 400kV[7] and building a new double circuit overhead line to connect the existing overhead line that runs between Easterhouse, Newarthill and Wishaw [8].

The Project consists of a number of key components, including reinforcement of existing transmission overhead lines and substations and the construction of a new transmission overhead line. The Project will need to proceed in two stages. The first is the uprating of the existing overhead line circuits from between Denny North to Easterhouse, Newarthill and Wishaw from 275kV to 400kV. These works will provide some additional capacity for the network and will also facilitate connection of the proposed new 400kV overhead line from Bonnybridge to Glenmavis. The key components of the Project are set out below:

Stage 1

- Uprating of the existing 275kV overhead line (known as ZD route) between the Denny North, Easterhouse and Clydesmill substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV.

- Uprating of the existing 275kV overhead line (known as XX route) between the Easterhouse and Newarthill substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV.

- Uprating of the existing 275kV overhead line (known as XR route) between Newarthill and Wishaw substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV.

- Wishaw 400kV Substation. Works to connect the new 400kV circuit to the Wishaw 400kV GIS Substation.

Stage 2

- Uprating of the existing 275kV overhead line (known as ZG route) between Denny North and Bonnybridge substations. This uprating will increase the capacity and voltage level of the overhead line, allowing it to operate at a voltage of 400kV.

[6] The project is described as an 'Upgrade' rather than 'Reinforcement' to reflect the enhancement as well as strengthening of the network.
[7] This overhead line currently carries two circuits, one of which would be 'uprated' to 400kV.
[8] Separate to this, the final aspect of these works will be to turn the existing Torness to Strathaven 400kV circuit into the Wishaw 400kV substation to form a Torness to Wishaw and a second Wishaw to Strathaven 400kV circuits. The latter will allow an increase power flow onto the 400kV network in the south of the SP Transmission area and further afield.

- Denny North 400kV / 275kV Substation works. Works to move the uprated 400kV circuit from the 275kV substation to the 400kV substation.

- Construction of a new double circuit 275 / 400kV overhead line circuit (known as the Bonnybridge to Glenmavis 400kV Overhead Line) that will run from Bonnybridge 275kV Substation in the north to a point on an existing 275kV overhead line (known as XX route), near Glenmavis in North Lanarkshire, that runs between the Easterhouse and Newarthill 275kV Substations in the south.

- Bonnybridge 275kV Substation works. Works to terminate the new Bonnybridge to Glenmavis overhead line at Bonnybridge Substation.

Summary

Investing in new infrastructure is driven by Scottish and UK Energy policy and customer needs such as security of supply, demand growth or connecting new generation.

SPT is subject to a statutory duty to develop and maintain an efficient, coordinated and economical electricity transmission system for existing and future consumers. It is also subject to licence conditions which require it to make its transmission system available for generators wishing to connect to it and to ensure that the system is fit for purpose through appropriate reinforcements to accommodate the contracted capacity.

SPT, supported by the NGESO economic assessment (via NOA), considers that the network in the central belt of Scotland needs to be reinforced to provide additional capacity (approximately 1,000 megawatts) for new generation connecting in the north to flow to demand centres elsewhere in the UK.

In order to achieve this, there is a need to reinforce the transmission network through the central belt of Scotland to ensure that the additional capacity can flow through the GB transmission system from north to south, support the move to a net zero emissions economy and help Scotland and the UK meet net zero emissions targets by 2045 and 2050 respectively. The expected connection of over 14.2GW[9] in the North of Scotland will be helped when all components of the Project are completed and energised by allowing more power to flow through SPT's network[10].

[9] Each year the ESO looks at possible pathways for what the future of energy may be and how we could decarbonise our energy system, this is described in the Future Energy Scenarios Report and includes the amount of generation that is expected to be connected in each area.
[10] This is contingent on other works being undertaken on SPT's network, north of the Firth of Forth, during the RIIO-T2 and T3 periods.