Electricity Ten Year Statement

#ETYS2024

Contents

Foreword

Paul Wakeley
Head of Strategic Network Development
National Energy System Operator

Welcome to our Electricity Ten Year Statement (ETYS). The ETYS represents the National Energy System Operator's (NESO) perspective on future transmission requirements and the capabilities of Great Britain's National Electricity Transmission System (NETS) based on our latest Future Energy Scenarios (FES). The ETYS 2024 enables us to understand the investment and development required to maintain a safe and reliable operational network, while achieving our zero-carbon ambition.

The ETYS provides an assessment of the capability and needs of the network over the next 10 years. Through our analysis we can identify areas of the transmission network which require more transfer capacity to be added through network reinforcement, to reduce constraints and allow the connection of more network participants. This year, we have identified some emerging voltage issues and a requirement for an acceleration of network reinforcement in order to reduce network constraint costs for consumers as we transition to clean power.

Britain's electricity needs are set to rise substantially over the coming years – up to 15% by 2030 and 40% by 2035 – as we move towards more electrified heating and transport options. Additionally, HM Government has an ambition for Great Britain to be supplied with clean power by 2030.

National Energy System Operator (NESO) was commissioned by the Government to provide independent advice on the pathway towards the 2030 ambition. The Clean Power 2030 report, published in November 2024, presents our advice and analysis on the foundations for clean power, the core elements of a clean power system, our pathways, critical enablers, and the benefits and costs. Following this advice, the UK Government published their Clean Power Action Plan in December 2024.

The wider transmission network build programme to 2030 was set out in the Pathway to 2030 report in 2022 and revised in the Beyond 2030 report in 2024. The Clean Power 2030 report concluded that the current programme would be able to deliver the clean power pathways in an efficient way with only 3 (out of 80) critical projects needing to be accelerated to 2030 delivery.

Offshore wind will be vital to achieving this clean power ambition and to sustaining a clean power system beyond 2030 to enhance energy security and achieve net-zero greenhouse gas emissions by 2050. Following the publication of Beyond 2030, the NESO has continued to collaborate with stakeholders to build on the network plan and recommendations; conducting impact assessments to review potential design changes, producing a recommended design for Innovation and Targeted Oil and Gas (INTOG) Recommended Design, and making final recommendations for the Celtic Sea offshore leasing round.

In October 2024, the Electricity System Operator transitioned into the National Energy System Operator, taking a broader, whole-system view on how Great Britain can deliver on its Net Zero ambitions while maintaining a reliable and affordable energy supply. As part of this transition, we are moving to our enduring Centralised Strategic Network Plan (CSNP) process. This process will integrate offshore design, system requirements, and options assessment to provide a holistic network plan which can accelerate the delivery of network solutions, support net-zero ambitions, and deliver consumer value.

The first CSNP publication is expected in Q4 2027. In the interim, to allow for further development of some of the early maturity options which were recommended in Beyond 2030, Ofgem have proposed a refresh of the Beyond 2030 recommendations. By reassessing options, the needs case can be reconfirmed and Ofgem will then be able to provide pre-construction funding for continued option development. The Refresh will also establish a funnel of potential projects which can form the delivery pipeline of the first CSNP.

You can read more about the CSNP high-level and Refresh methodologies and find details about future stakeholder engagement here. On behalf of Strategic Network Development, I would like to thank all stakeholders who have taken the time to engage in the development of these processes.

ETYS 2024 / Foreword 3

Key Messages

NESO
National Energy
System Operator

Key Message 1

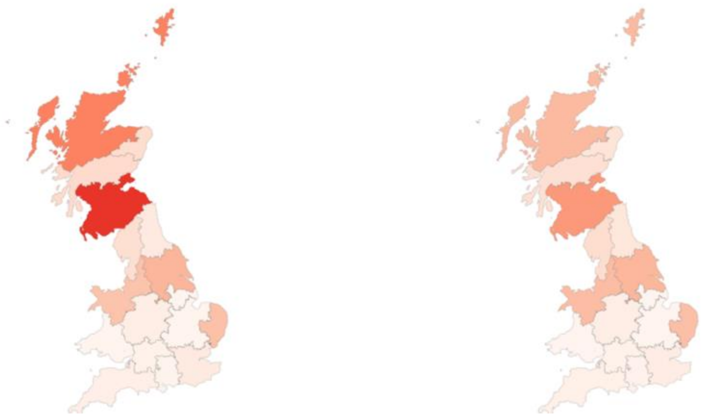
Our Clean Power 2030 report emphasises a rapid need to reinforce the network across Great Britain

NESO is collaborating with industry partners and the UK government to accelerate the decarbonisation of the electricity network. In November 2024, after being commissioned by the Secretary of State, NESO published its Clean Power 2030 report which provides advice to the government on a range of pathways to achieving clean power by 2030. Our advice indicates that this goal will require a once-in-a-generation shift in both approach and pace of delivery.

In December 2024, the UK Government published their Clean Power Action Plan.

The implementation of the network plan set out in the Pathway to 2030 report in 2022 will be crucial to these clean power ambitions. Of the 88 projects recommended in Pathway to 2030, 80 were identified as being critical to achieving clean power in 2030 under the Clean Power 2030 pathways. Three of these projects will need to be accelerated to 2030 delivery. Further reinforcement of the network is needed after 2030, as detailed in Beyond 2030, published in March 2024.

Our analysis of the CP30 pathways has reemphasised the need for rapid action in the deployment of additional boundary capability, through new projects.



Anticipated network constraint regions in 2030 under the Clean Power pathways, Further Flex & Renewables (left) and New Dispatch (right).

ETYS 2024 / Key Messages 5

Key Message 2

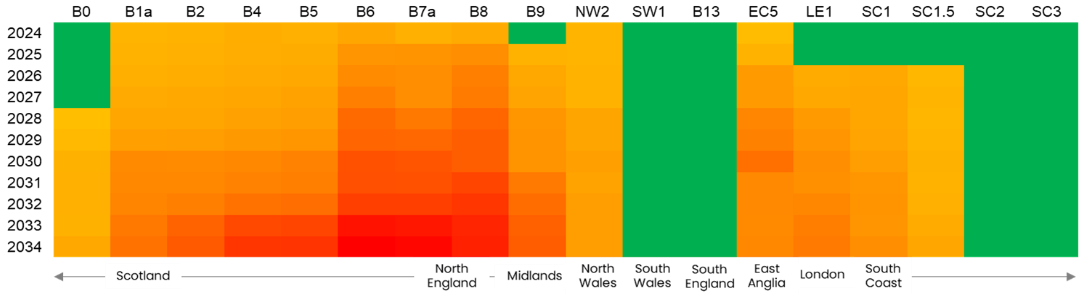
Timely and coordinated network reinforcements will significantly help reduce network constraints up to and after 2030

The ETYS describes the network capability by looking at the maximum secured power transfer between two regions or the power transfer across a boundary. To operate the network safely, we must make sure that the power flow across the boundary does not exceed the capability of the system between the two regions. When capability does become exceeded, we must take actions to constrain generation which can incur significant costs.

The two heatmaps below illustrate the impact of the network reinforcement options recommended in the Beyond 2030 report on the "Holistic Transition" FES 2024 pathway, showing how these options can significantly reduce constraints by increasing the power transfers across boundaries.

The NESO are also proactively developing market-based solutions to reducing network constraint costs. Constraint Management Intertrip Services (CMIS) are being developed for the EC5 boundary (with an interim service already in place and the full service expected in Q2 2026) and one covering Central Scotland (B2 – B5), following the success of the B6 CMIS. More market-based solutions may be required in future to reduce constraint costs and allow the connection of more customers.

Excess flows beyond boundary capability **if no action is taken** to reinforce the system



Excess flows beyond boundary capability **with the Beyond 2030 report's recommended options applied***

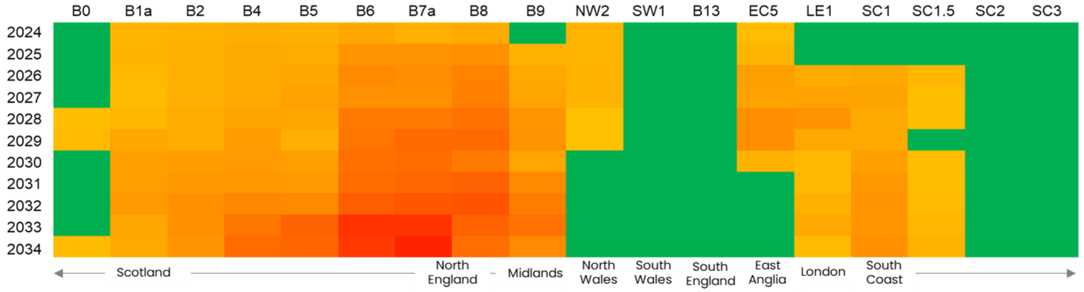


*Chart uses the boundary capability following the recommendations from the *Beyond 2030* report against *Leading the Way* FES 2023 required transfers.

ETYS 2024 / Key Messages 6

Key Message 3

We will continue to focus on implementing our plans for managing voltage on the GB Electricity Transmission System over the next decade

Voltage is a local system issue driven by changes in local generation, demand, and the evolving network. High voltage issues primarily arise in low load conditions while low voltage issues arise in high flow conditions. In recent years we have seen limited voltage issues around the network and our analysis shows a growing requirement for voltage support over the coming years. We will continue to explore options to address these needs, including through the NESO's Network Services Procurement efforts.

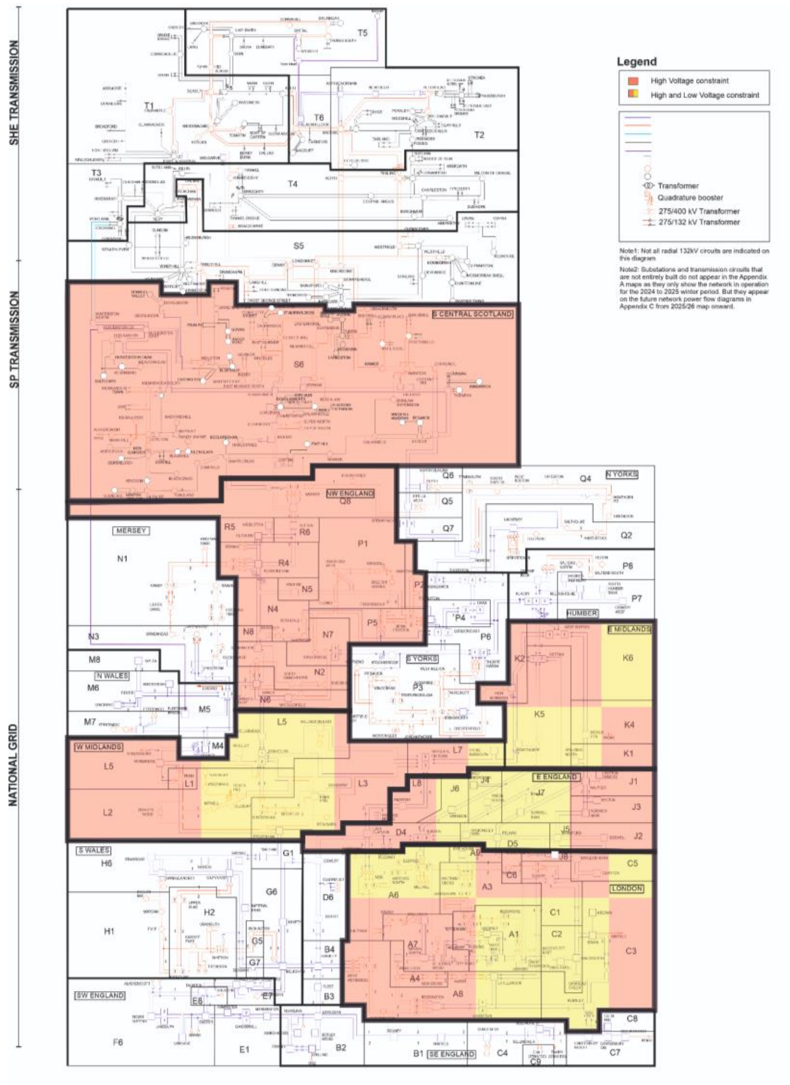
Potential voltage issues have been identified in a number of regions over the next 10 years:

Regions with high voltage issues:

- Southern & Central Scotland
- North West England
- East of England
- The Midlands
- London

Regions with low voltage issues:

- East England
- The Midlands
- London



ETYS 2024 / Key Messages 7

Key Message 4

The Centralised Strategic Network Plan (CSNP) will expand our network planning to address a broader range of system requirements and speed up the delivery of infrastructure.

The CSNP is a coordinated, long-term plan for energy network planning in Great Britain looking out to 2050. Initially, this will focus on the electricity transmission network - onshore, offshore and interconnectors. Gas transmission and any proposals for a hydrogen system are expected to be included in future iterations.

Through the CSNP – alongside the established boundary analysis previously communicated in the ETYS – we will expand our view of system requirements, including across a longer-term horizon, and lead on additional year-round thermal analysis, as well as identify wider residual stability and voltage needs.

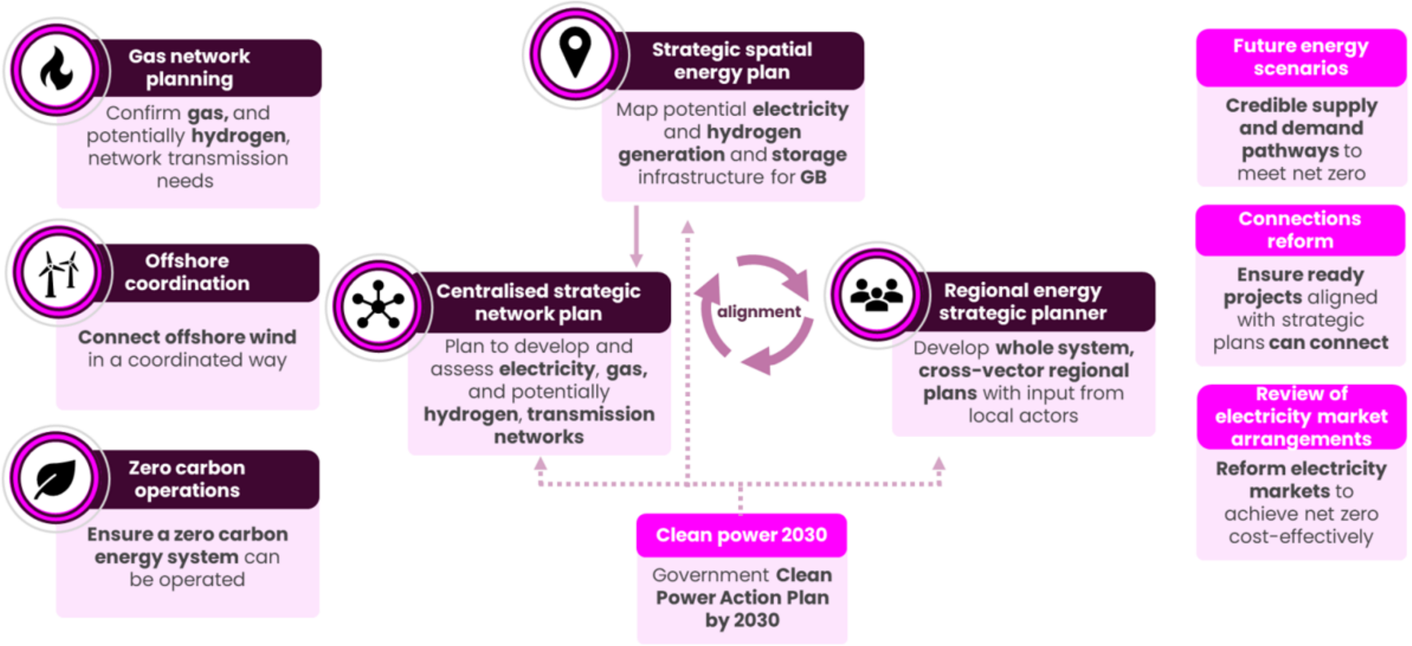
Our current network planning process will see two critical changes:

- The ability to fix projects within a delivery pipeline to provide certainty on network investments required for net zero and enable focus on detailed design.
- A move to a three-year cycle, in alignment with the Strategic Spatial Energy Plan (SSEP), to provide decisive investment signals and allow additional time for option development.

The SSEP will spatially map the optimal mix and location of clean generation and storage to meet forecast demand, net zero targets, and security of supply for all consumers. These will be optimised against high-level network needs as well as against cost, environment and community impact, economic growth, and other agreed objectives.

The single view provided by the SSEP will drive investment decisions across the entire 25-year horizon of the CSNP. This will ensure alignment with government policy and help consider combinations of energy system and network options to maximise utilisation of existing networks.

You can read the CSNP high-level methodology, SSEP methodology, and find details about future stakeholder engagement here.



ETYS 2024 / Key Messages 8

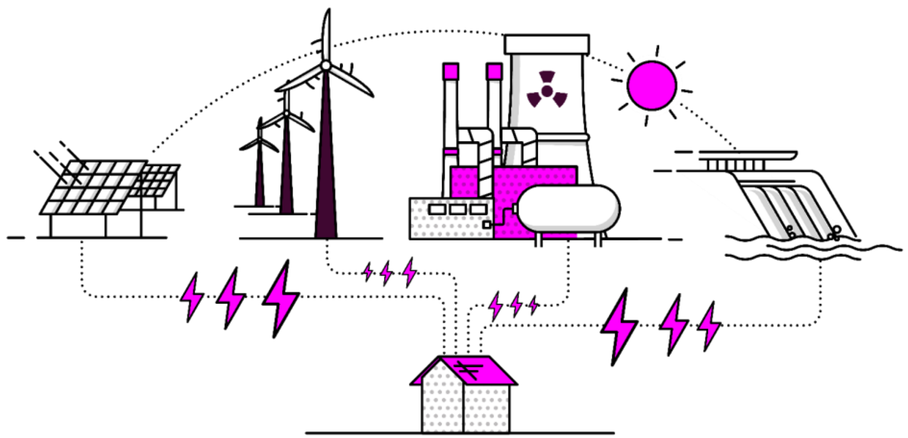
Our ETYS analysis

Introduction

The ETYS is the NESO view of future transmission requirements and the capability of Great Britain's National Electricity Transmission System (NETS) over the next 10 years.

The 2024 Future Energy Scenarios (FES24) present a range of credible pathways to decarbonise our energy system as we strive towards net zero. The ETYS uses data from the FES pathways to describe how system requirements will evolve over time, which helps us identify areas of the NETS where investment and development are required for us to continue delivering electricity reliably and achieve Great Britain's net-zero ambitions.

Our key messages explain the most important insights of our system needs, based on our analysis of FES24, as well as our Clean Power 2030 pathways.



About the ETYS

The ETYS is a well-established network development publication and sits at the heart of our network planning process. Using the data from our FES, points on the transmission network are identified where more transfer capacity is required (through reinforcing the network) to continue delivering electricity reliably. Once we have assessed these network requirements, we invite stakeholders to propose solutions.

These proposals were traditionally assessed through our Network Options Assessment (NOA) process, where the most economic and efficient solutions were identified and given a recommendation to proceed, whilst others are put on hold or stopped.

Transitioning to the CSNP

We're currently transitioning from the NOA & ETYS, to a new Centralised Strategic Network Plan (CSNP). The CSNP aims to ensure a holistic development of the NETS, incorporating key aspects of our existing network planning process while providing a more granular approach to future inputs and outputs.

Our most recent investment plan, the Beyond 2030 report, was released in March 2024. This transitional plan serves as a stepping-stone before we fully develop and publish the CSNP.

Once the CSNP is published, it will take over in outlining the transmission network requirements, meaning some key information from ETYS will be integrated into the CSNP. The CSNP methodology will include changes to how system needs are assessed, in line with Ofgem's CSNP decision. We aim to have a single set of system needs for both the short and long term as part of the CSNP.

Key to our ambitions for the CSNP is the continued development of the NESO's bespoke tools for year-round analysis on thermal, voltage, and stability analysis.

ETYS 2024 / Our ETYS analysis 10

National Electricity Transmission System (NETS)

As the NESO, we are responsible for the system operation of the transmission networks in England, Wales, Scotland and in the surrounding offshore waters.

The National Electricity Transmission System (NETS) spans Great Britain and is comprised of overhead lines as well as underground and subsea cables, at 132 kV, 275 kV and 400 kV voltage levels.[1]

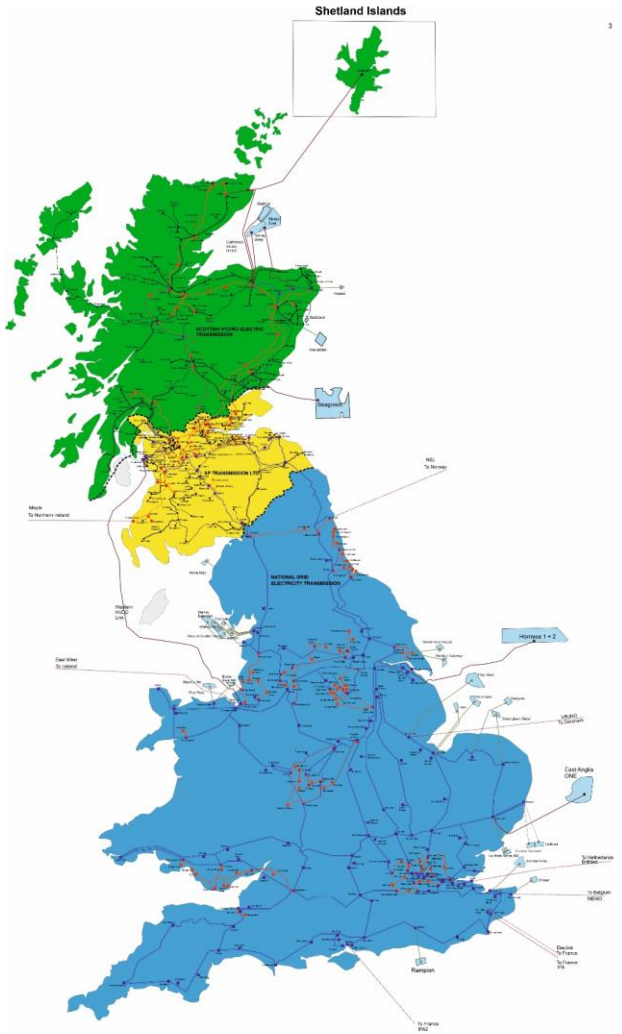
These are all linked together via substations across the country which connect separately owned generators, interconnectors, large demands, and distribution systems. Electricity Distribution comprises of network below 275 kV in England and Wales and below 132 kV in Scotland respectively. It transports electricity from transmission "highways" to the end consumer.

Great Britain has three onshore Transmission Owners that separately own the network. These are:

- Scottish & Southern Energy Networks Transmission - owning the network in the north of Scotland.
- Scottish Power Transmission - owning the network in the south of Scotland.
- National Grid Electricity Transmission – owning the transmission network in England and Wales.

There are also 27 licenced offshore transmission owners (OFTOs) appointed through Ofgem's competitive tendering process. They own the assets that connect operational offshore wind farms to the transmission or distribution network.

Together with the Transmission Owners, we regularly assess and model network behaviour under different conditions to test its resilience. We assess where the network may be under strain for various reasons and this analysis accumulates into the ETYS. This ensures we portray an accurate representation of the current transmission capabilities and identify future requirements.



[1] Some of the transmission network in SSEN-T consists of 220kV subsea cables.

ETYS 2024 / Our ETYS analysis 11

What is a boundary?

A boundary splits the system into two parts, crossing critical circuit paths that carry power between the areas where power flow limitations may be encountered.

Defining the boundaries has evolved over many years of planning and operating the transmission system. When significant changes occur, new boundaries may be defined and some boundaries either removed or amended and we communicate any changes with our stakeholders.

We do not study all boundaries, specifically those where no significant changes are identified in the FES generation and demand data compared to previous years. We assume the same capability as the previous year for these boundaries.

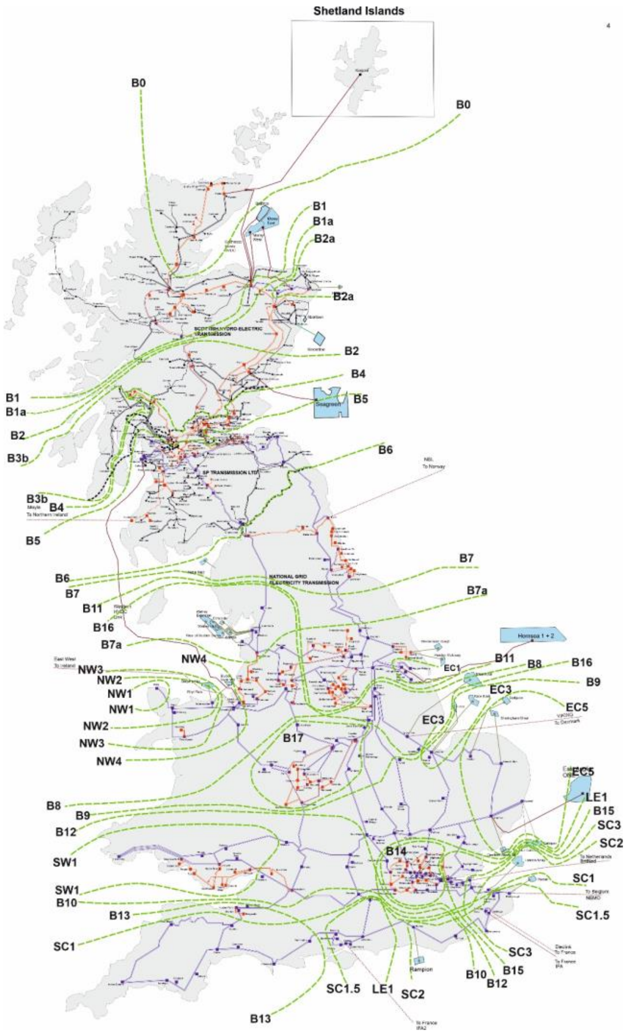
The boundaries used by ETYS can be split into two different types:

Local boundaries

Small areas of the NETS with a high concentration of generation. These small power export areas can give high probability of overloading the local transmission network due to too much generation operating simultaneously.

Wider boundaries

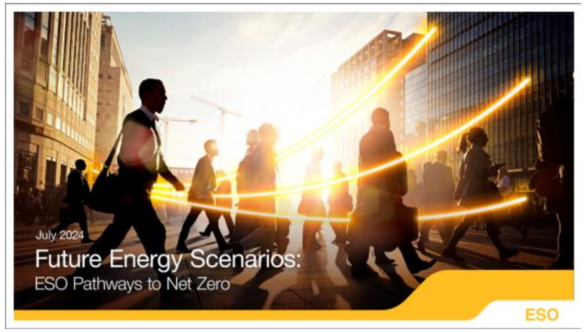
Large areas containing significant amounts of both generation and demand. The System Security and Quality of Supply Standard (SQSS) boundary scaling methodologies assess the capability of the wider boundaries. These consider both the geographical and technological effects of generation, allowing for a consistent capability and requirements assessment.



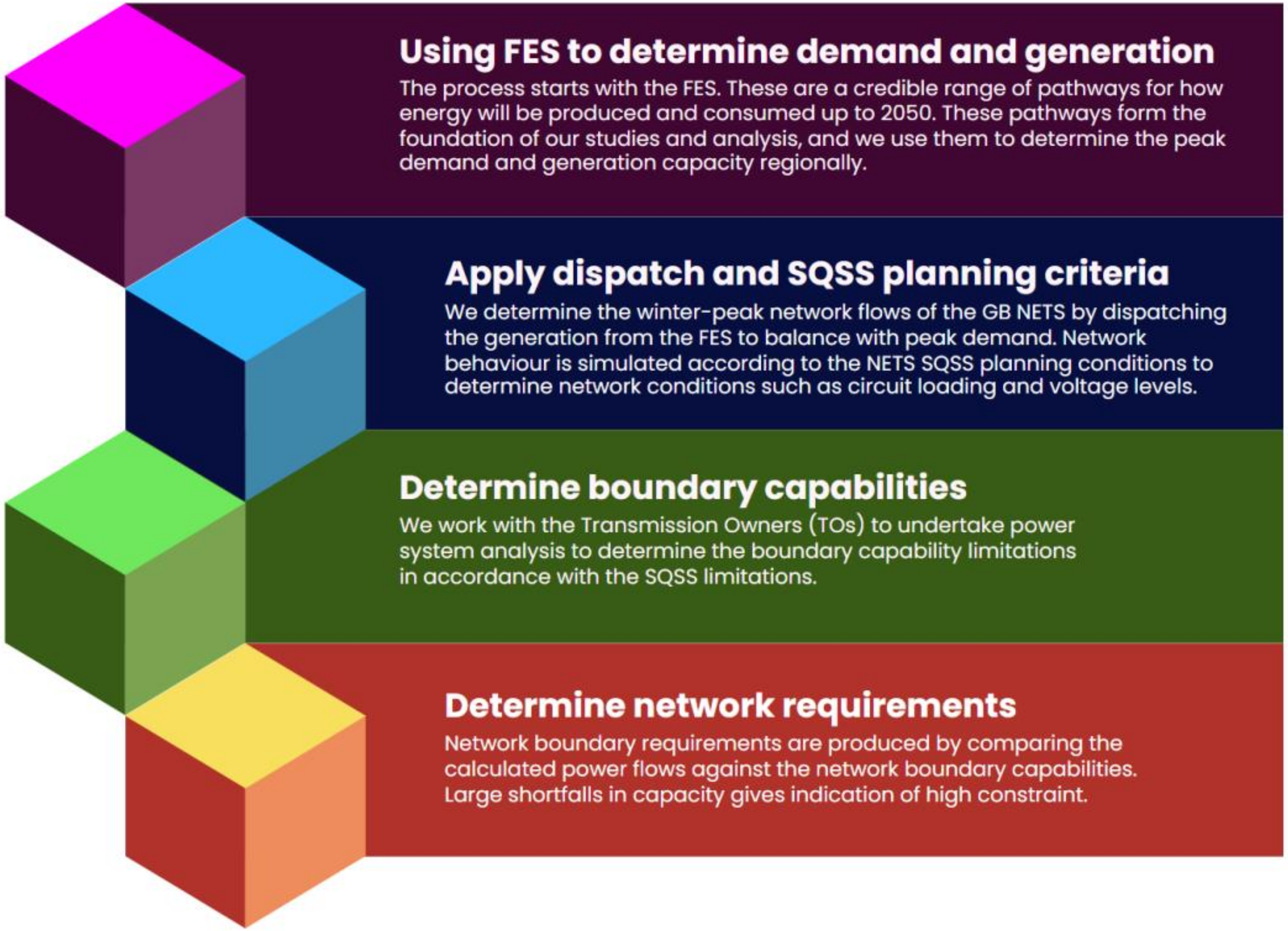
ETYS 2024 / Our ETYS analysis 12

How we assess the network

To identify the future transmission requirements of the GB NETS there are several inputs that are fed into the planning process and at various stages.



You can find more details on the NESO's FES 2024 Pathways on the FES webpages and the FES2024 report.



ETYS 2024 / Our ETYS analysis 13

Determining boundary capability

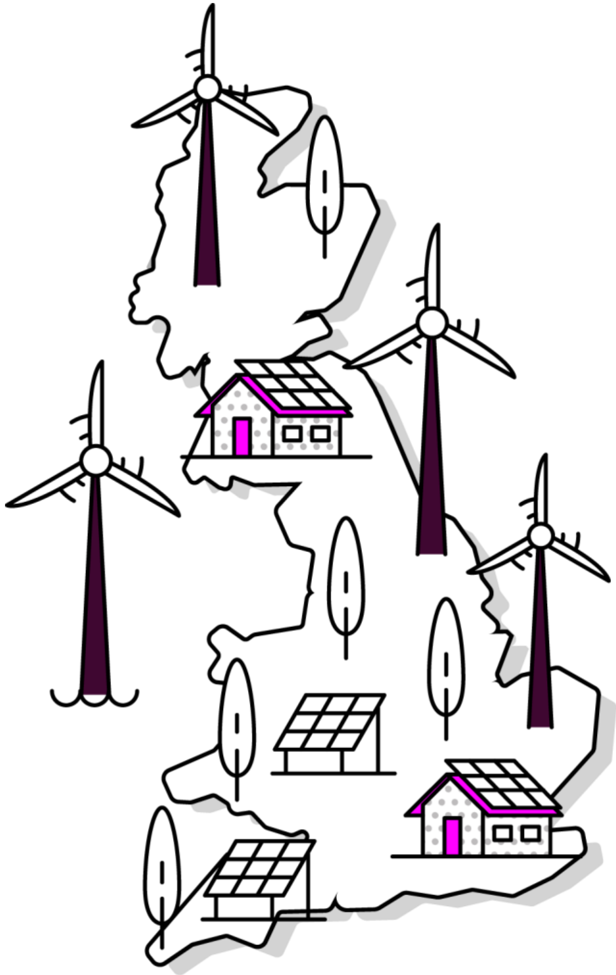
Boundary Capability is the maximum power flow that can be securely transferred across the boundary while maintaining compliance with the NETS SQSS.

The SQSS has fixed rules for planning and operating the MITS. The MITS has to be kept secure against credible events such as network faults and loss of generation; while making sure circuits are not overloaded, voltages and frequency are kept within limits.

For each boundary, we work with the transmission owners to undertake power system analysis, determining the boundary capability. Limiting factors on transmission capacity include:

- Thermal circuit rating
- Voltage constraints
- Dynamic stability

For the ETYS network assessment, contingencies are applied, and the most severe SQSS limitation is used to determine the network boundary capability. The base capability of each boundary can be seen in the Electricity Transmission Network Requirements section.



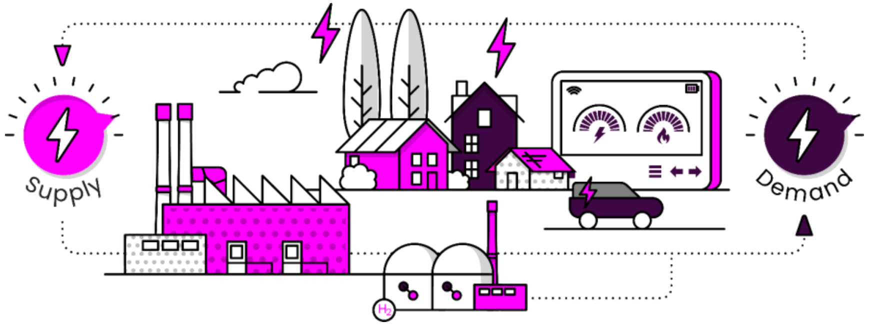
ETYS 2024 / Our ETYS analysis 14

Our voltage analysis

How do the NESO manage voltage?

To keep voltage stable and within SQSS limits, it can be increased it by injecting reactive power or decreased by absorbing reactive power. Generators on the system can provide reactive power control when they are generating electrical power. The MITS network itself can also be controlled to manage reactive power; this could come from reactive compensation equipment, such as Synchronous condensers, Static VAR compensators, STATCOM, Mechanically Switched Capacitors or Shunt Reactors. Voltage can also in some cases be controlled from the electrical properties of cables and overhead lines.

In the past, the NESO mainly used to take action to manage low voltage but now that there are fewer industrial processes and spinning turbines, we often have to manage higher than normal voltages. Similar to last year – voltage needs on the NETS will be communicated at a high level in our 'Regional Drivers' sections, within Electricity Transmission Network Requirements.



Why do we see voltage requirements on the NETS?

We're committed to communicating network needs to the industry so that essential action can be taken to secure the NETS. Over the last decade, the regulation of voltage by controlling reactive power has become particularly demanding due to issues such as:

The new shape of our energy landscape – compared with the historic abundance of synchronous power plants providing the flexibility of dispatching both active and reactive power output on the system. Reactive power delivery is now increasingly relying on assets such as capacitors, shunt reactors, Static Var Compensators (SVCs), as well as renewable generation. Depending on an asset's physical location on the network, they can be far away from where voltage issues are and may be less effective in correcting voltage levels.

Decreasing minimum demand (typically during summer) - due to consumer behaviour, an increase in embedded generation such as solar and battery, improved efficiency in electrical goods year on year and a decrease in industrial demand – lines are now less loaded in times of minimum demand. This results in a high gain on the system, leading to higher voltages. Particular challenges arise in regions with cable circuits or long overhead lines. It is also worth noting that the power output from renewables does not follow demand - it follows the weather - low demand in the evening coinciding with high wind, could result in a lower proportion of synchronised plant running on the system leading to limited voltage support available from online generation.

Fault events - Conversely to minimum demand, the annual peak electricity demand has been increasing. During a fault on the network, the number of circuits that transfer power from one area to another can reduce. This increases the power flow on remaining circuits which could lead to voltage depression. Therefore, voltage support is required following faults to ensure that voltage remains within compliance limits. During a period of minimal generation, faults on the system can lead to issues with high voltage step change and potentially risk breaching high voltage limits.

Local phenomena - The closure of power stations can cause a reduction in voltage support on the system. The screening process explores if locations have a reliance on local assets as well. It is important to monitor these issues as part of our routine planning and operation activities, as well as identifying further issues that could emerge in the future.

ETYS 2024 / Our ETYS analysis 15

Our voltage analysis

When do we see voltage requirements on the NETS?

The power flow behaviour on our system causes a significant difference to voltage characteristics. Issues seen during summer are entirely different to those seen in winter as explained below.

Summer minimum periods – Peak solar output causes localised high voltage on sunny days in areas with substantial solar generation connected to the grid. This, coupled with reduced synchronous generation in our baseload, causes challenges and requires reactive compensation. If essential reactive equipment is out of service due to faults or should a fault coincide with a planned outage, it can become increasingly challenging to operate the system efficiently and economically. Managing voltage overnight is even more onerous, especially in areas with a lot of underground cable networks as they present different reactive behaviour to overhead lines. The gain produced from the cables exacerbate high voltage issues, requiring us to take circuits out of service for voltage control. Given that maintenance season tends to be in the summer, additional circuits could be out of service for planned outage works making it complex to switch out circuits for voltage control as this might affect demand security.

Winter peak periods – voltage management can be challenging during periods of high power flow. During this peak, high power flows can be seen when for example offshore/far away generation must meet demand which is predominantly located in the centre of the country. This stresses the transmission system to its capacity limits. Typically, if a fault occurs, it will reduce the number of routes for power to flow, leading to low voltage on the network during high flows. For such secured events we must ensure that there is an adequate level of static and dynamic reactive power to keep the voltage within the limits detailed in the SQSS.

High interconnector power flows – Since interconnector flows are dictated by the energy price differential between GB and the European continent, the flows on the interconnector can switch from importing into Great Britain to exporting. This can stress network assets and could result in a change from high to low voltage and vice versa. Voltage Source Converter (VSC) interconnectors on the system do have a reactive power range which can help in such situations.

Reactive power output from generation – Penetration of renewables is increasing at both distribution and transmission network level, which has led to a decline in national demand seen at the transmission level. Generators play a key role in regulating voltage by dispatching reactive power at the request of the Electricity National Control Centre (ENCC).

Outages which weaken the network – When circuits are on outage, switching further circuits out for voltage control becomes difficult and compromises on other priorities such as demand security. As a result, we must carefully assess outages on voltage control equipment which also tend to be requested in the summer.

Faults on voltage control equipment – These faults can be temporary, long term or even permanent requiring replacement. This limits the maintenance that can be carried out on remaining assets, making it more unreliable and susceptible for faults.

ETYS 2024 / Our ETYS analysis 16

Our stability analysis

Stability needs in the ETYS

Our ambition is to communicate a long-term view of year-round stability needs in future ETYS/CSNP publications with more specific procurement needs communicated through our stability market, which is still under development.

Further work is still ongoing to develop tools and techniques to allow year-round long-term stability analysis (via automation). Once our tools and processes mature, we will integrate a long-term view of stability needs within the CSNP's annual cycle.

Stability Market

The Stability Markets allow NESO to secure operation of the network at lowest cost to consumers. These will replace the previous Stability Pathfinders, through which we had procured long-term stability network services. However, all units from Stability Pathfinder Phase 1 are now operational and assets contracted under phases 2 and 3 will come online from 2024.

We are actively implementing three enduring stability markets to meet our stability needs more effectively. As recommended by the Stability Market Design Network Innovation Allowance project which concluded in 2023, we are implementing new stability markets:

- Long-term (Y-4),
- Mid-term (Y-1), and
- Short-term (D-1).

These will allow us to signal new investment when and where we need it, and more immediately provide a route to market for assets capable of delivering stability services in the present, and those which could do so in the future with additional investment. The first tender round under the mid-term (Y-1) stability market was launched in 2023 procuring stability services for delivery from 1st October 2025 until 30th September 2026. You can find more detail on this and other balancing services markets in the Markets Roadmap 2024.

Innovation Projects

STARTZ - Stability Requirements Calculation Toward Net-Zero

Current stability calculation methods use a number of assumptions and approximations and there may be room to make the process more accurate. This project reviews the NESO's stability requirement calculations and explores the potential for new methodologies, machine learning and automation to enhance accuracy and efficiency to inform procurement market activities and future network planning. Suggested improvements to the methodology will be tested and validated against detailed system modelling.

This project will support the energy transition by ensuring the grid remains stable while more renewable generation is integrated into the network. It will provide value for money for consumers, as there is less variance in our estimates so the balancing services required will be more accurately predicted and procured. The potential to use automation and machine learning to calculate stability needs will make the process more efficient and reduce the risk of human error which could affect the results. Further details available here.

Enhanced RMS (e-RMS) Models for Stability Assurance

Developing an enhanced RMS (e-RMS) modelling framework that can provide dynamic stability assurance in planning studies and at operation timescale without carrying the cost of being overly conservative.

Existing models struggle to anticipate instability issues caused by inverter-based resources (IBRs). The project's development of an enhanced RMS (e-RMS) model for IBRs, functioning as digital twins of high-fidelity IBR models, addresses these challenges. It enables a more thorough analysis of IBR-dominated systems, effectively allowing for greater renewable integration without compromising grid stability. Further details available here.

ETYS 2024 / Our ETYS analysis 17

Electricity Transmission Network Requirements

NESO
National Energy System Operator

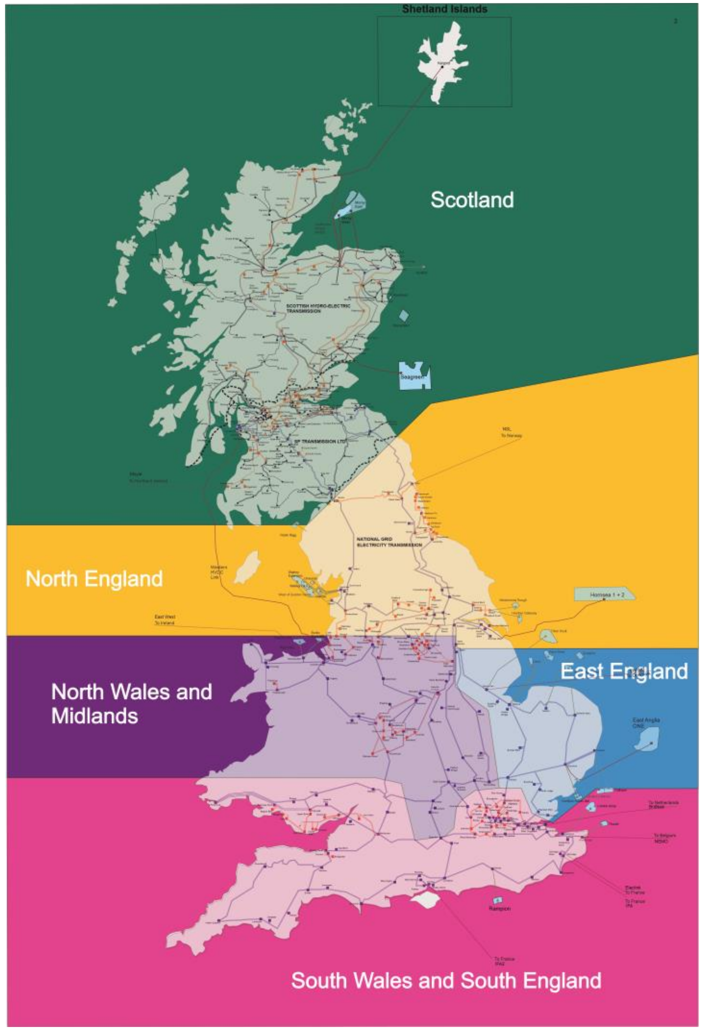
Introduction

Great Britain's National Electricity Transmission System (NETS) must continue to adapt and be developed so power can be transported from source to demand, reliably and efficiently.

In this chapter, we:

- Describe the thermal and voltage characteristics of the NETS – On a regional basis.
- Discuss the thermal characteristics of the NETS boundaries.
- Provide analysis to show how and when, the NETS could potentially face growing future network needs in several regions.
- Provide a comparison of the requirements from the Clean Power 2030 pathways and the FES 2024 pathways.

This chapter is broken into regions as shown on the map to the right:



ETYS 2024 / Electricity Transmission Network Requirements 19

Communicating our thermal needs

Each pathway indicates differing levels of generation and demand across the NETS which project boundary power flow expectations. From applying the methodology in the NETS SQSS for wider boundary planning requirements (as discussed in the previous chapter), we determine for each pathway:

- The economy criteria - solid coloured line
- Security criteria - dashed coloured line
- Current and future capability (where available) - solid red line

The purpose and modelling conditions of the economy and security criteria are detailed in the NETS SQSS appendices E & C, respectively.

The capability line (red line) is based on the recommendations from our Beyond 2030 report. This is the best information available at the time of publication and will change over time as the network, generation, demand and more importantly - the optimal path of reinforcements recommended - changes.

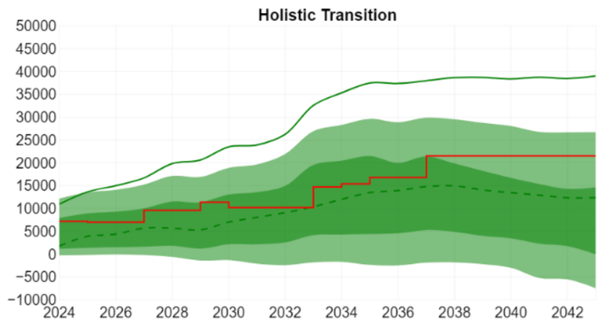
More information about the NOA methodology can be found here. The 50%, 90%, Economy required transfer (RT) and Security RT are calculated from the 2024 FES and ETYS processes. Where the NOA transfer capability is not available, there is a red line that provides the most recent available boundary capability.

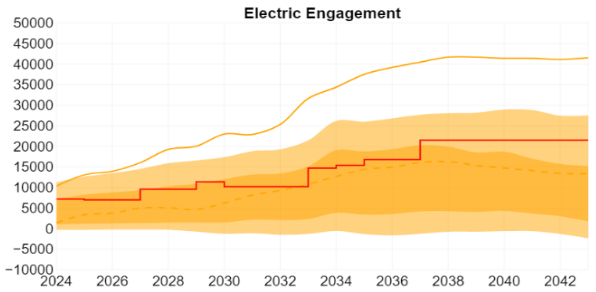
The calculations of the annual boundary flow are based on unconstrained market operation, meaning network restrictions are not applied. This way, the minimum cost generation output profile can be found. We can see where the expected future needs could be by looking at the power flows in comparison with boundary capability.

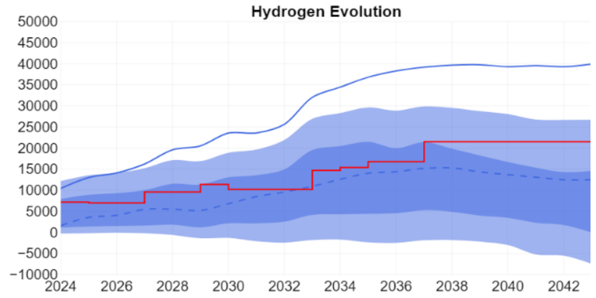
On each graph, the two shaded areas provide confidence as to what the power flows would be across each boundary:

- The darker region shows 50% of the annual power flows
- The lighter region shows 90% of the annual power flows

From the regions, we can show how often the power flows expected in the region split by the boundary are within its capability. If the capability of the boundary is lower than the two regions over the next 20 years, there might be a need for reinforcements to increase the capability. However, if the line is above the shaded regions, it shows that there should be sufficient capability here and that potentially no reinforcements are needed from an unconstrained power flow perspective until the shaded regions exceed the capability.







ETYS 2024 / Electricity Transmission Network Requirements 20

Clean Power 2030 Requirements

The two Clean Power 2030 pathways presented in the Clean Power 2030 report describe two possible pathways for how Great Britain can achieve a clean power system by 2030.

These pathways were developed from the analysis set out in FES 2024, with adjustments based on the greater challenge of clean power, our deeper assessment of the 2030 pipelines, and our stakeholder engagement for this report.

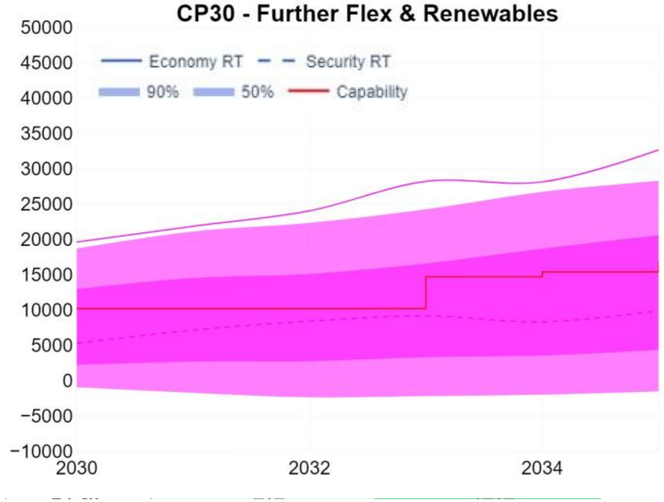
Our clean power pathways push the limits of what is feasibly deliverable, but there are some flexibilities at the margin. For example, onshore wind and solar could substitute for offshore wind; more demand-side response could substitute for batteries; more hydrogen or CCS could substitute for most other supply options.

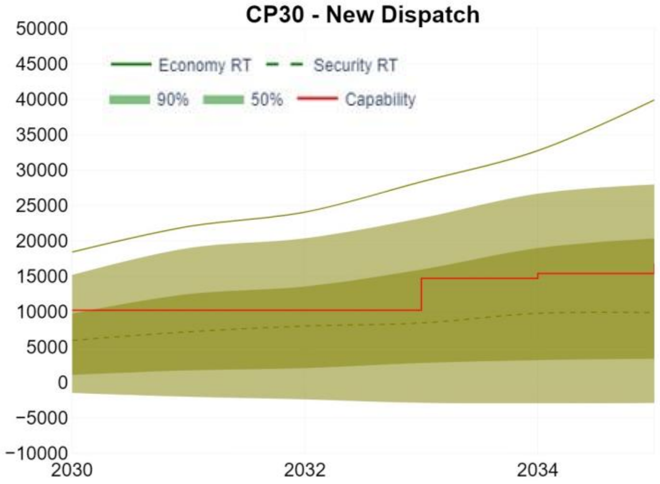
One pathway, Further Flex and Renewables, sees 50 GW of offshore wind and no new dispatchable plants. The other, New Dispatch, has 43 GW of offshore wind and new dispatchable plants (totalling 2.7 GW, using either hydrogen from low carbon sources or carbon capture and storage [CCS]).

Across both pathways, there is a slight reduction in the expected north-south transfer, from Scotland to Northern England, across the B0 – B7a boundaries, more so in New Dispatch where the total wind capacity in the north is lower than in FES24.

In contrast, expected flows along the south coast and south-east of GB slightly increased due to the additional dispatchable generation capacity introduced in the New Dispatch and the increased storage capacity in Further Flex & Renewables. Overall, the Clean Power pathways are very close in their requirements across GB as the most ambitious pathway from FES 2024, Holistic Transition.

Informed by NESO's Clean Power 2030 pathways, DESNZ have developed their own 'Clean Power Capacity Range', for each technology type in 2030. These are the ranges which will be used to inform NESO's Connection Reforms and determine strategic alignment of future new generation projects needed to achieve clean power by 2030. Details on DESNZ's Clean Power Capacity Range can be found in their Clean Power 2030: Action Plan.





ETYS 2024 / Electricity Transmission Network Requirements 21

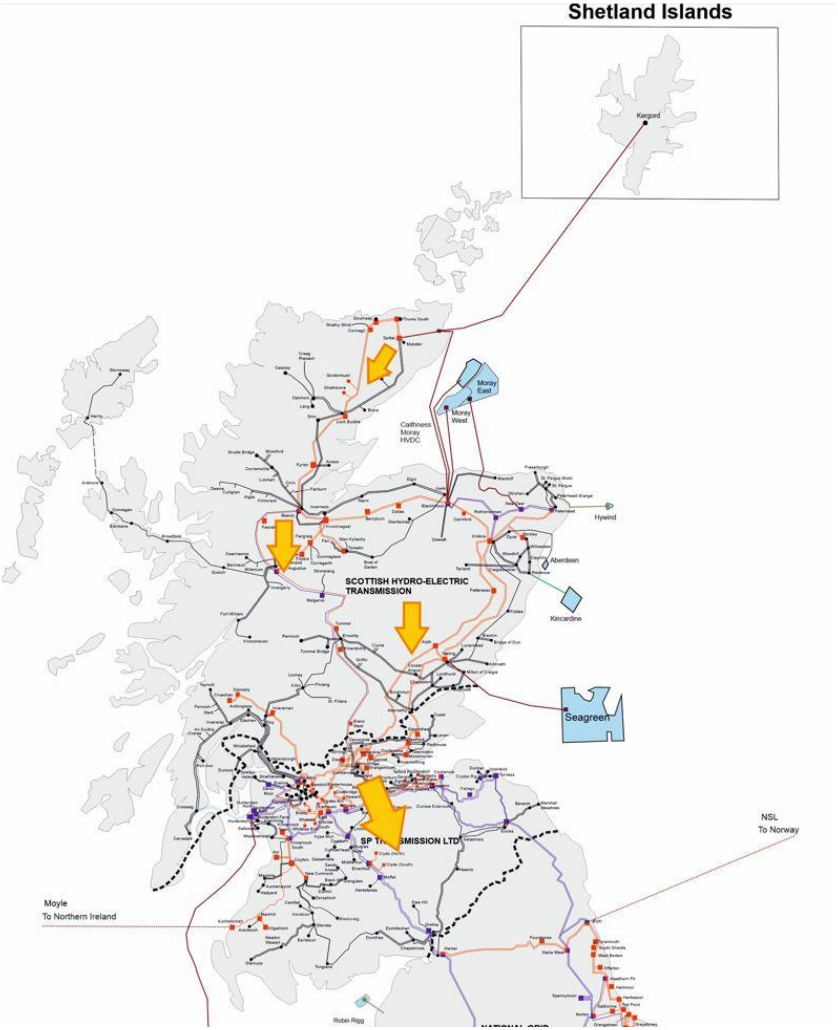
Scotland

The onshore transmission network in Scotland is owned by SSEN Transmission and SP Transmission.

The Scottish NETS is divided into 7 boundaries:

- B0 – Upper North SSEN Transmission
- B1a – North West SSEN Transmission
- B2 – North to South SSEN Transmission
- B3b – Kintyre and Argyll SSEN Transmission
- B4 – SSEN Transmission to SP Transmission boundary (shared by SSEN Transmission and SP Transmission)
- B5 – North to South SP Transmission
- B6 – SP Transmission to NGET (shared by SP Transmission and National Grid Electricity Transmission)

The figure to the right shows the general pattern of power flow directions expected to occur most of the time in the years to come up to 2036, i.e. power will generally flow from north to south. The arrows in the diagram illustrate power flow directions and are approximately scaled relative to the winter peak flows.



ETYS 2024 / Scotland 22

Scotland – Regional Drivers

Scotland has vast natural resources meaning there's a steep projected increase in renewable-generated electricity. The transmission system must therefore develop to facilitate this increase in many areas where it's currently limited.

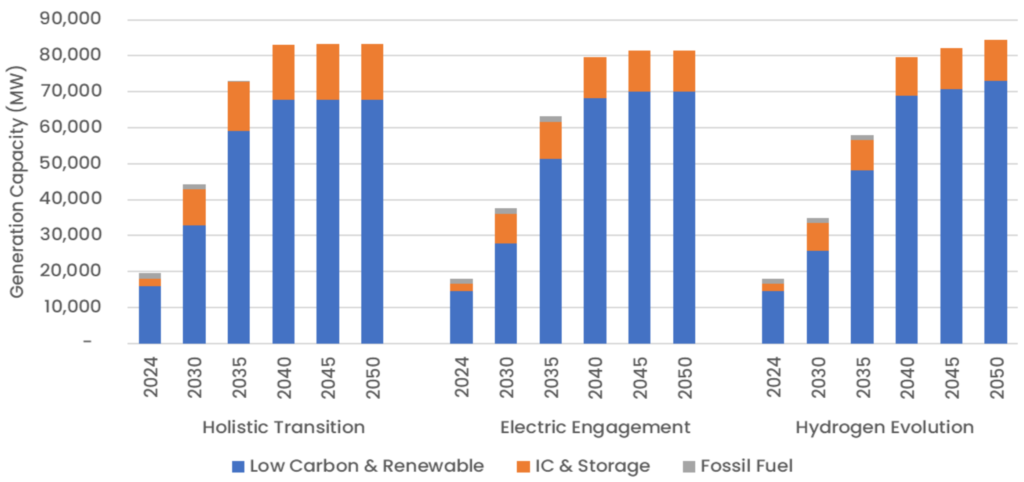
Over the next 10 years, rapid growth in renewable-generated electricity in Scotland will mainly be attributed to offshore wind. This will cause far greater power transfer requirements across the Scottish boundaries, increasing the network reinforcement needs in some areas. Generation capacity in Scotland heavily exceeds demand, thus Scotland will be expected to export power into the rest of Great Britain most of the time except during periods of prolonged low wind, where the reverse may occur.

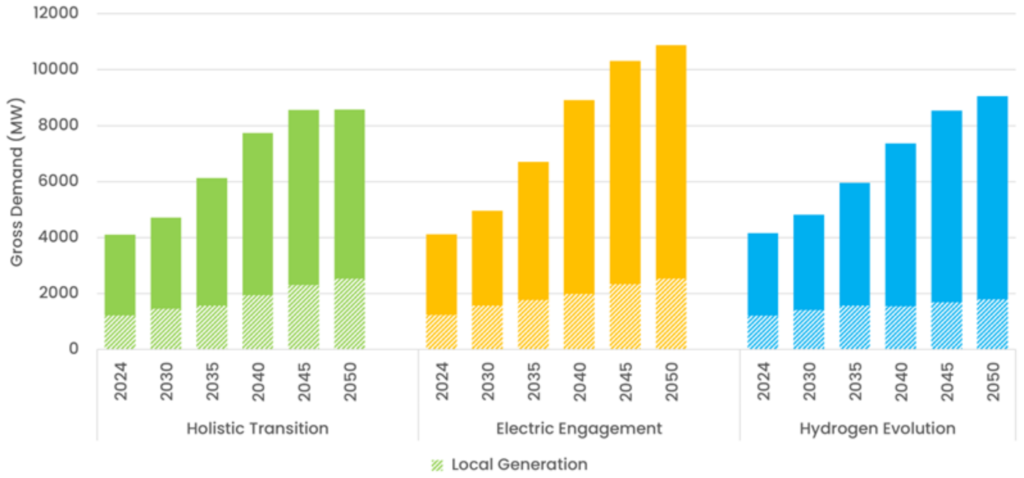
Scotland's current winter peak gross demand is just over 4 GW and remains below 5GW in 2030 across all FES pathways. The generation capacity in Scotland today is just under 20 GW, this is set to more than double - rising to approximately 45 GW in the Holistic Transition pathway by 2030. Across all three FES pathways, the generation capacity of fossil fuel in Scotland reaches zero between 2035 - 2040.

As Scotland's renewable generation over the next 10 years increases, so too does the power transfer requirements across the Scottish boundaries (the Scottish NETS boundaries are B0, B1a, B2, B3b, B4 and B5 and B6).

The decline in synchronous generation and prevalence of long transmission lines in Central Scotland can lead to high-voltage issues under light-load conditions. New renewable generation in Scotland will be connecting at the periphery of the network, leading to limited voltage support locally, new solutions may be required in future to ensure we are able to manage high voltage issues in Central Scotland.

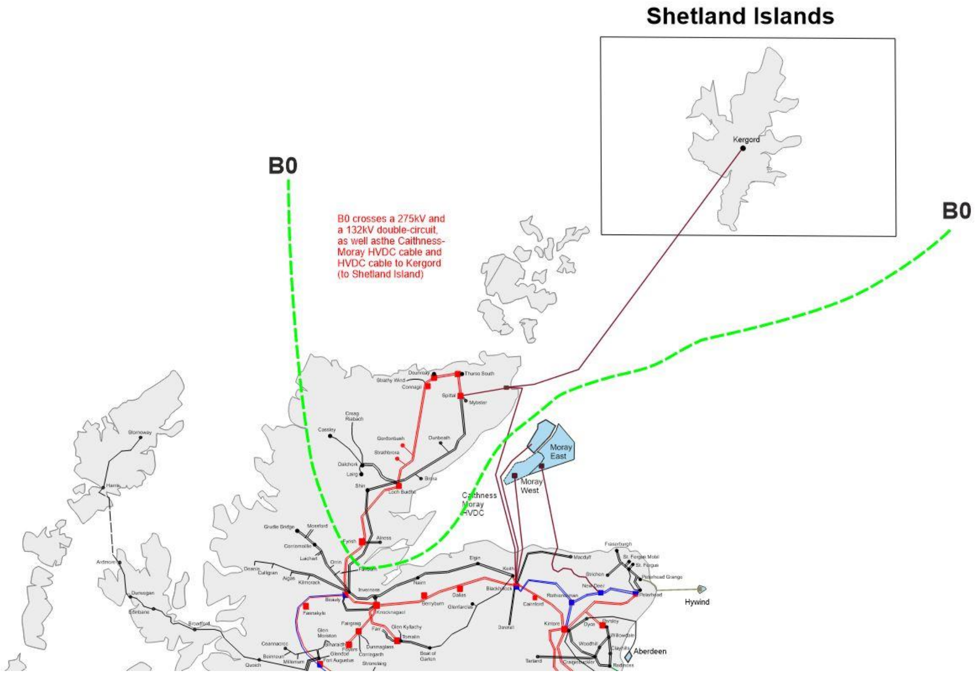
NESO has been running the Constraints Collaboration Project over the past year, where we've been working with industry to develop short-term solutions for reducing constraint costs, in addition to more network and wider market reform coming in the longer-term. One option we're considering is how to avoid curtailing wind in Scotland through increasing the availability of flexible demand in the constrained area. This is still in the initial assessment phase and we're working closely with industry and government to assess the best way to incentivise new demand sources in locations beneficial for operability. For more information, please look at our webpages.



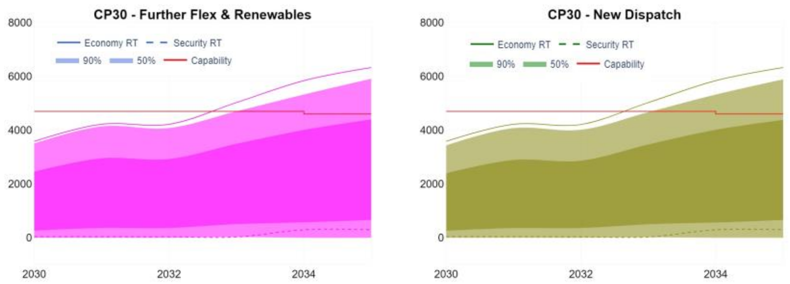


ETYS 2024 / Scotland 23

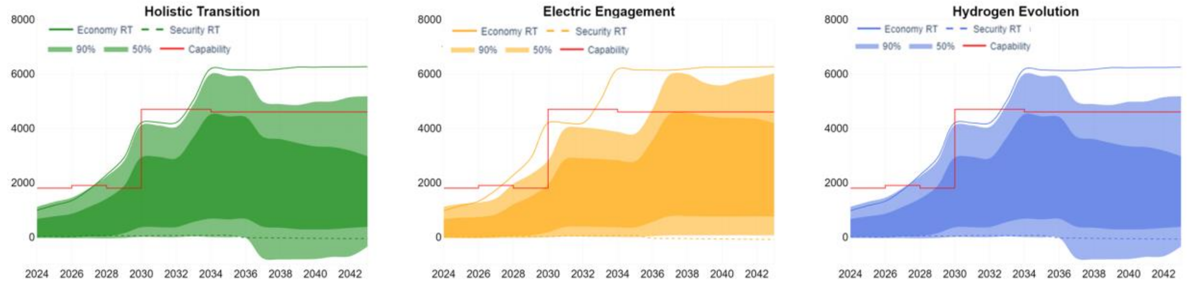
Boundary B0 – Upper North SSEN Transmission



The power transfer through B0 is increasing due to the substantial growth of renewable generation north of the boundary. This generation is primarily centred around both onshore and offshore wind. There is also the prospect of new marine generation resource in the Pentland Firth and Orkney waters in the longer term.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.

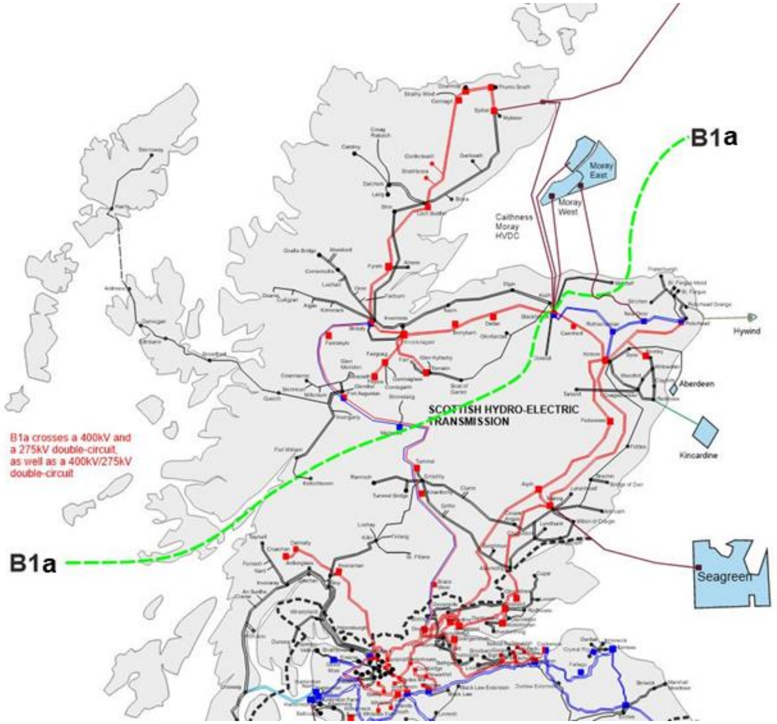


The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 1.1 GW due to a thermal constraint on Beauly – Shin 132kV circuit

ETYS 2024 / Scotland 24

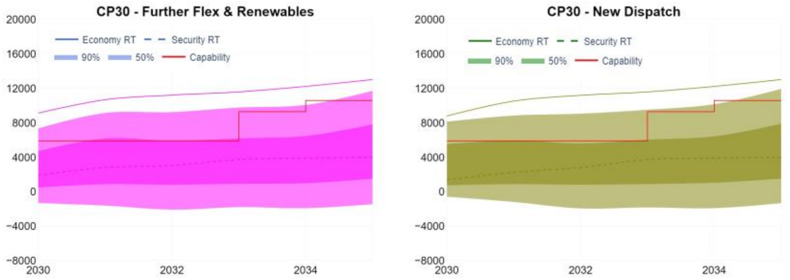
Boundary B1a – North West SSEN Transmission



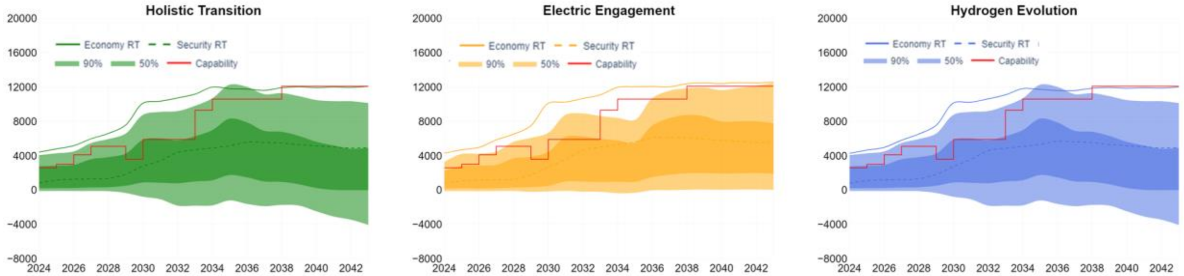
New renewable generation connections north of the boundary are expected to result in a significant increase in export requirements across the boundary, especially along the Beauly – Denny circuit.

In all FES, there is an increase in the power transfer through B1a due to the large volume of renewable generation connecting north of this boundary. Contracted generation behind boundary B1a includes the renewable generation on the Western Isles, Orkney and the Shetland Isles with a considerable volume of large and small wind developments both onshore and offshore. Future connection of new pumped storage assets in the North-West of the country is planned.

Beyond 2035, we see a decrease in expected transfers in the Holistic Transition and Hydrogen Evolution pathways. This is due to increasing demand in the north of Scotland whilst generation capacity remains relatively flat post-2035.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.

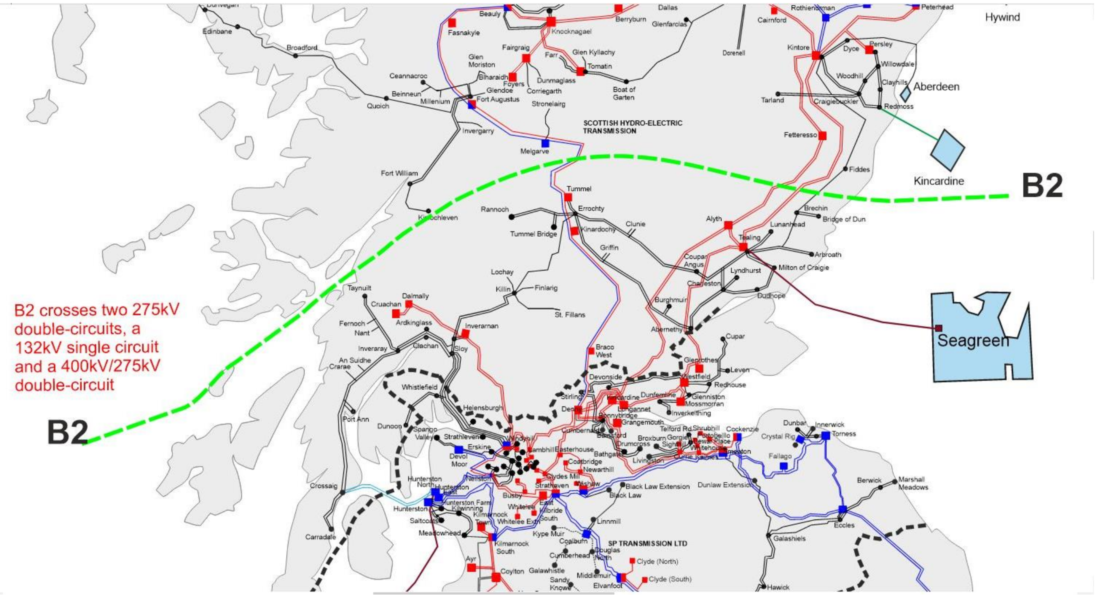


The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 2 GW due to thermal constraint on the Tummel - Errochty 132kV circuit

ETYS 2024 / Scotland 25

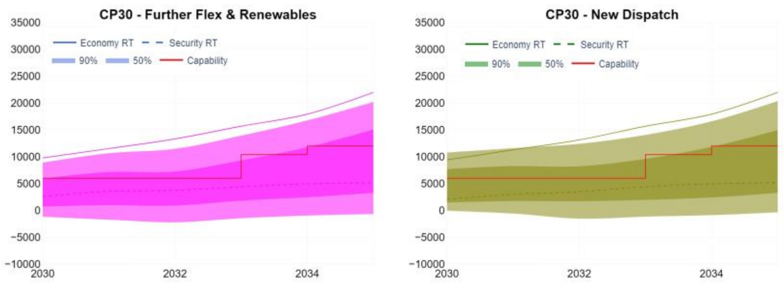
Boundary B2 – North to South SSEN Transmission



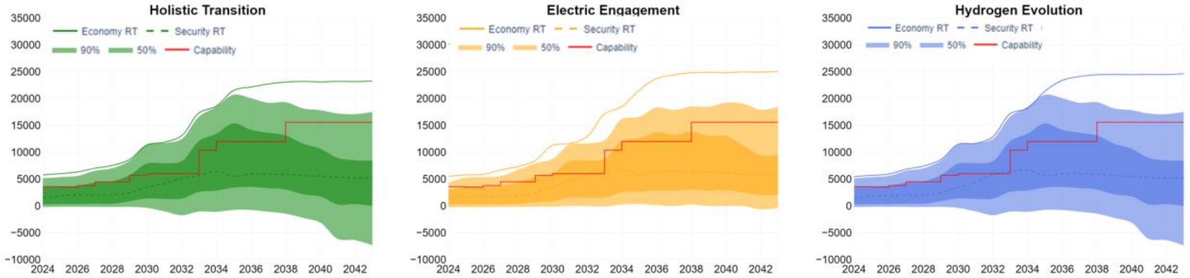
The generation behind boundary B2 includes both onshore and offshore wind, with the potential for additional pumped storage. Thermal generation lies between boundaries B1a and B2, as do several offshore windfarms.

The potential future boundary transfers for boundary B2 are increasing at a significant rate because of the high volume of renewable generation to be connected to the north of the boundary. This increased generation capacity will drive increasing power flows down the east coast 275kV circuits.

The increase in the required transfer capability for this boundary across all generation scenarios, with expected flows being above capability, indicates the strong potential need to reinforce the transmission system.



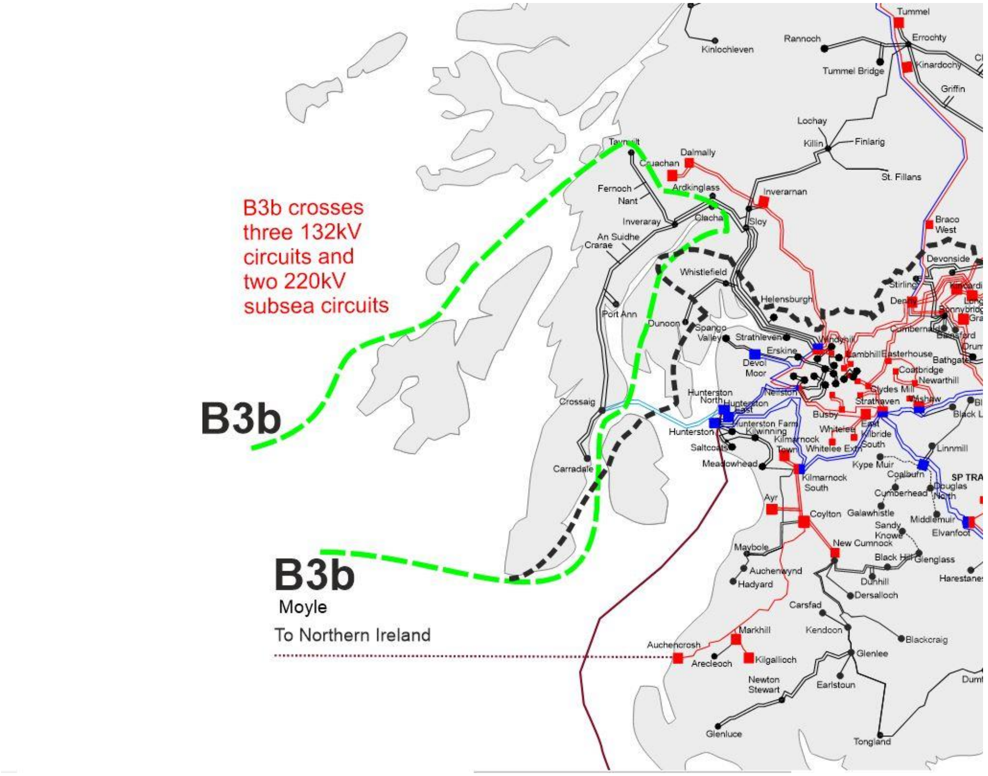
The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 2.9 GW due to thermal constraint on the Tummel - Errochty 132kV circuit

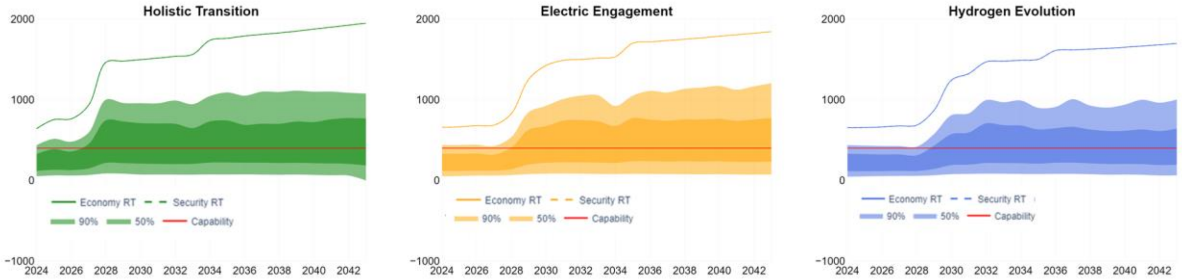
Boundary B3b – Kintyre and Argyll SSEN Transmission



The generation within boundary B3b includes both onshore wind and hydro generation, with the prospect of further onshore wind generation being connected in B3b in the future, triggering the requirement for future reinforcement of this network.

B3b is not currently subject to NOA reinforcement options as current contracted enabling works for customer connections will increase the ability to export power from this region, effectively splitting the network in the south west and altering the boundary.

Boundary B3b flows were not analysed in the Clean Power 2030 studies.

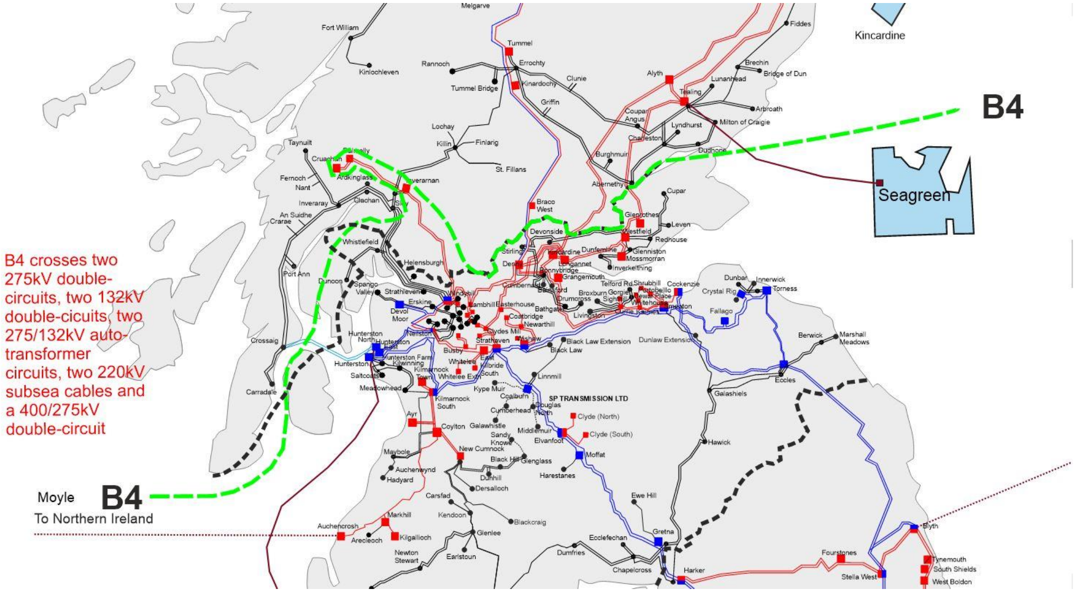


The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 0.45 GW due to thermal constraint on the Crossaig – Hunterston 220kV circuit

ETYS 2024 / Scotland 27

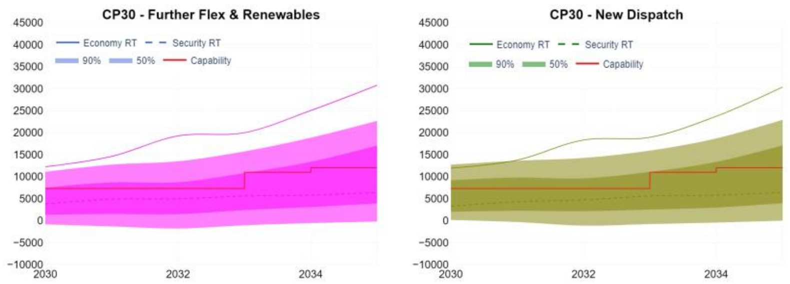
Boundary B4 – SSEN Transmission to SP Transmission



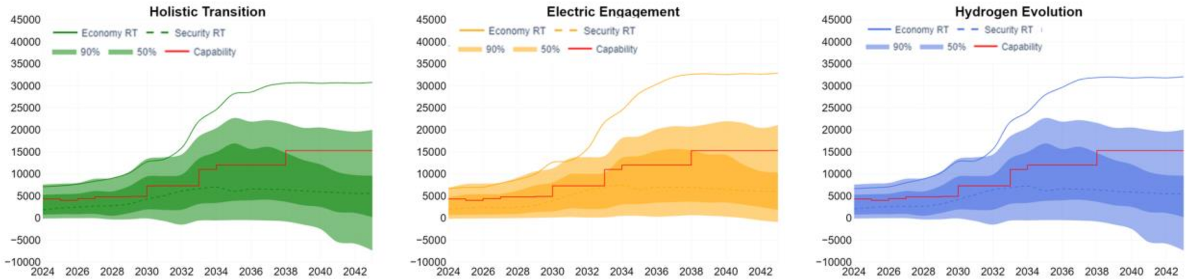
With increasing generation and potential interconnectors in the SSEN Transmission area for all scenarios, the required transfer across boundary B4 is expected to increase significantly over the next decade.

Across all FES, power transfer through B4 boundary increases due to significant generation connecting north of the boundary, including all generation above boundaries B0, B1a, B2, and B3b. This is primarily onshore and offshore wind generation, with the prospect of significant further offshore wind and storage being connected in the longer term.

Boundary B4 has a range of planned reinforcements as recommended by Beyond 2030 which will increase boundary capability; significant constraint costs have been incurred in the past year in this area of the network due to ongoing asset outages as some of these works take place. A potential opportunity for a new Constraint Management Intertrip Service has been identified for Central Scotland and NESO is working with Transmission Owners to understand the potential value for consumers.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.

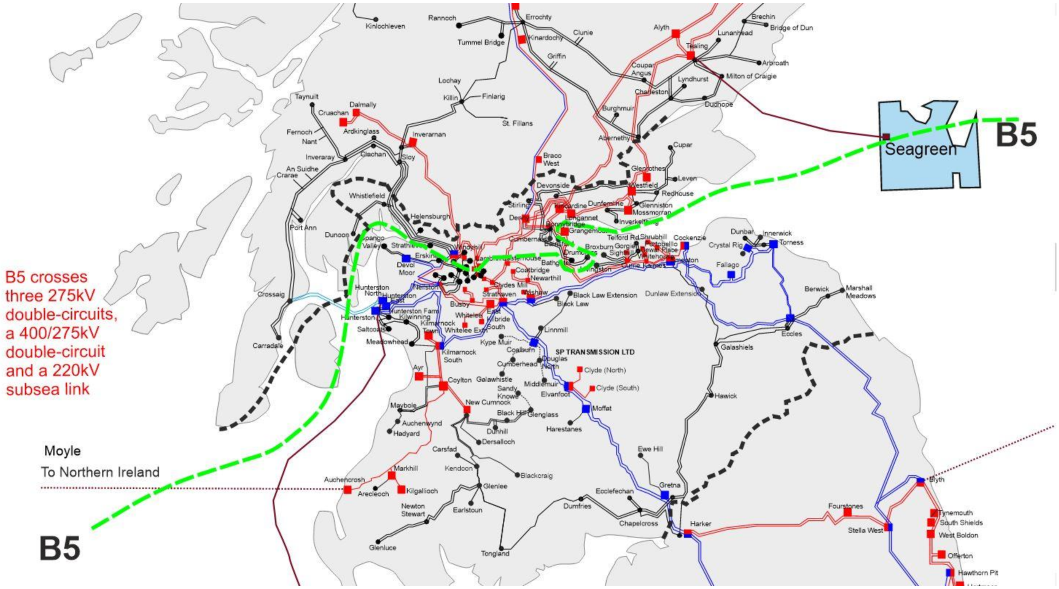


The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

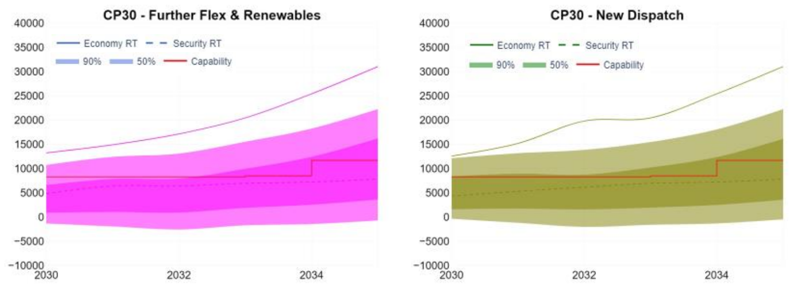
The boundary capability is limited to 4 GW due to thermal constraint on the Tealing - Westfield 275kV circuit

ETYS 2024 / Scotland 28

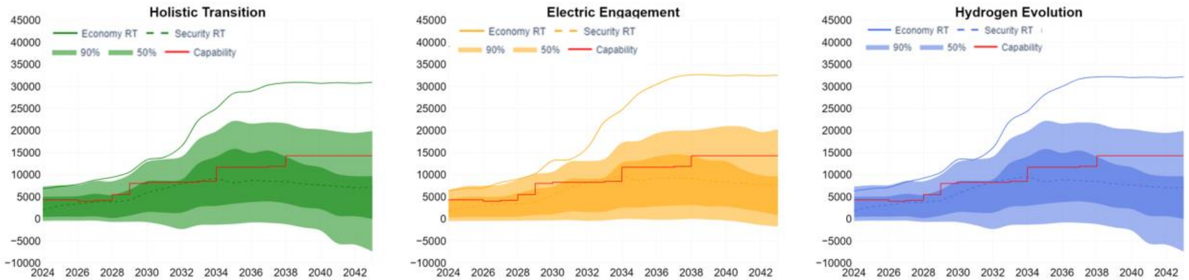
Boundary B5 – North to South SP Transmission



Across all FES, the power transfer through boundary B5 increases because of the significant volumes of generation connecting north of the boundary, including all generation above boundaries B0, B1a, B2 and B4. This is primarily onshore and offshore wind generation.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.

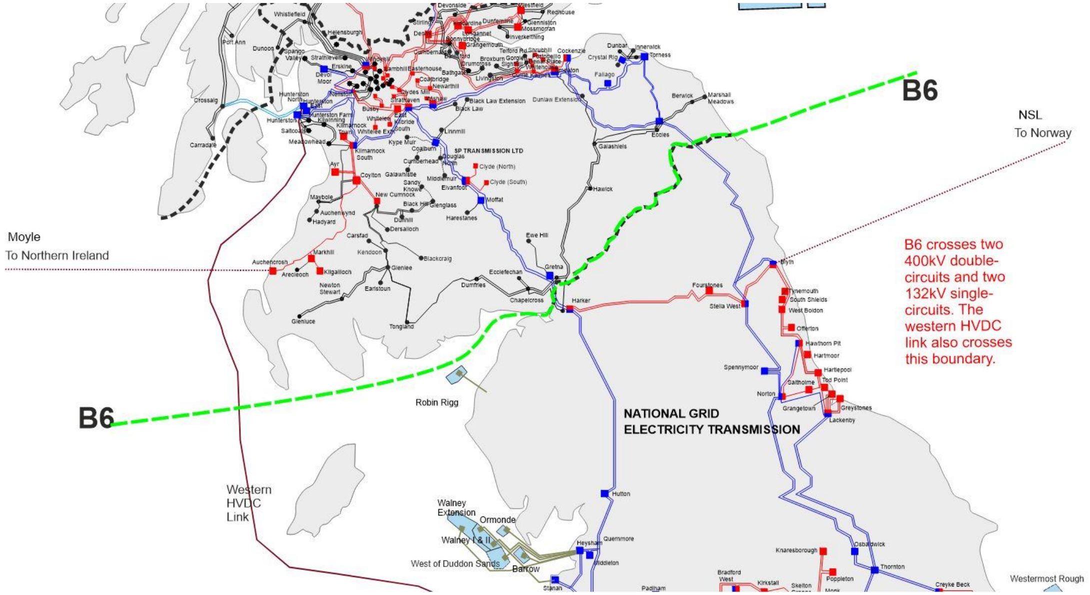


The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 3.9 GW due to thermal constraint on the Denny North-Lambhill 275kV circuit

ETYS 2024 / Scotland 29

Boundary B6 – SP Transmission to NGET

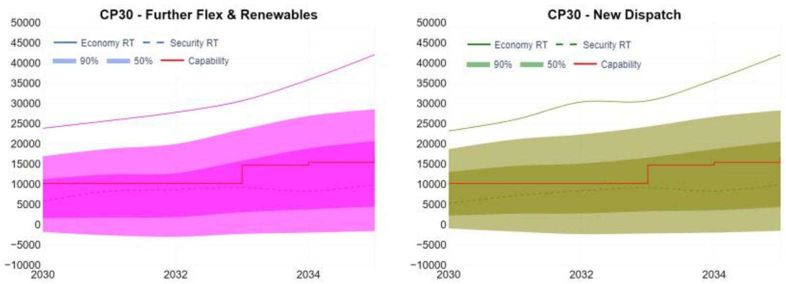


Across all FES, there is an increase in the power transfer requirements from Scotland to England due to the connection of additional generation in Scotland, primarily onshore and offshore wind.

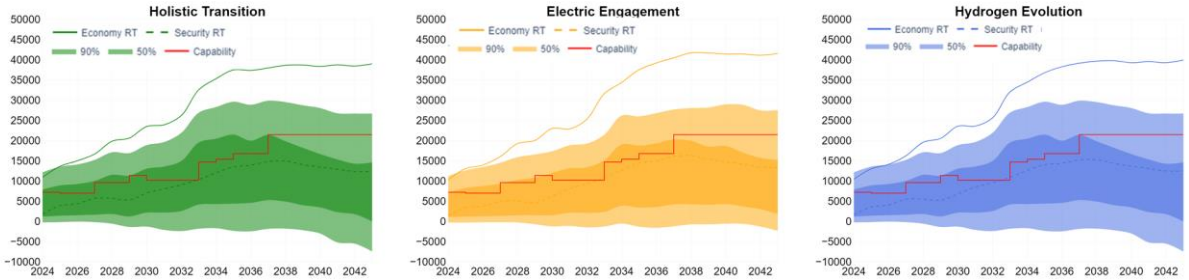
With the FES including many wind farms in Scotland, the spread of boundary power flows is very wide due to the variable nature of wind generation. During periods of low generation output in Scotland, it is credible to have power flowing from south to north feeding Scottish demand.

The magnitude of the south to north power flows is low compared to those in the opposite direction so network capability is sufficient to support those conditions. While the south to north transfer capability is enough to meet demand in Scotland, it is still necessary for synchronous plant capability to remain in service in Scotland to maintain year-round secure system operation.

A sub-component of the project WCN2, one of the network reinforcements crossing B6 and recommended in Beyond 2030, was recently requested by NESO to be the first project to be competitively tendered through onshore early competition.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 6.7 GW due to thermal constraint on the Harker-Moffat 400kV circuit

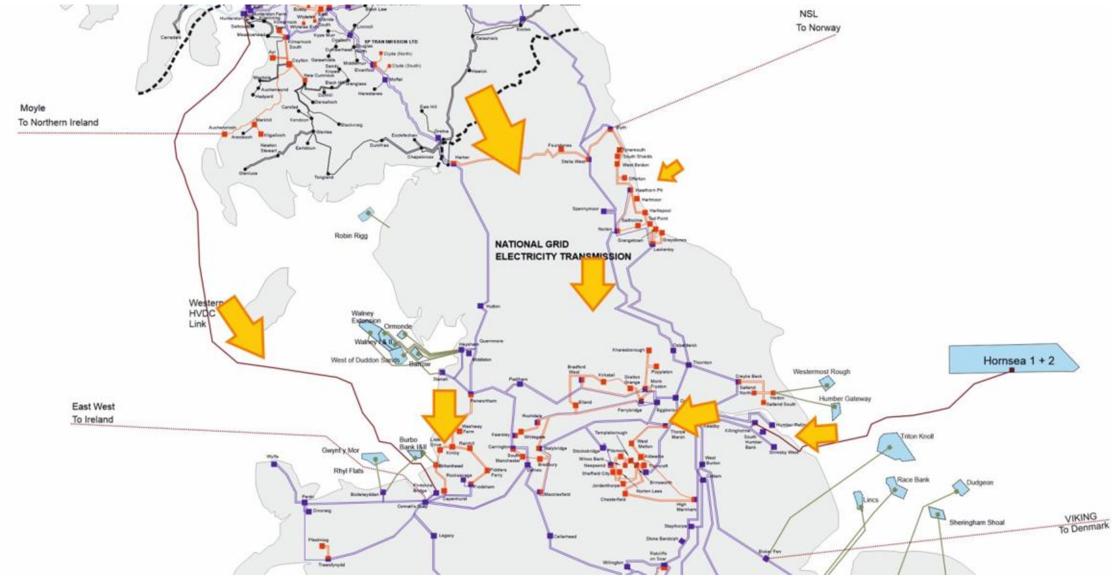
ETYS 2024 / Scotland 30

North of England

The North of England transmission region includes the network between the Scottish border and the North Midlands.

Boundaries B7a and B8 are in this region.

The figure to the right shows the general pattern of power flow directions expected to occur most of the time in the years to come up to 2036, i.e. power will generally flow from north to south. The arrows in the diagram illustrate power flow directions and are approximately scaled relative to the winter peak flows.



ETYS 2024 / North of England 31

North of England – Regional Drivers

Presently, most of the transmission network in the North of England is oriented for GB-wide North-South power flows. The significant projected increase of generation capacity in Scotland - is expected to drive transmission network requirements in the North of England.

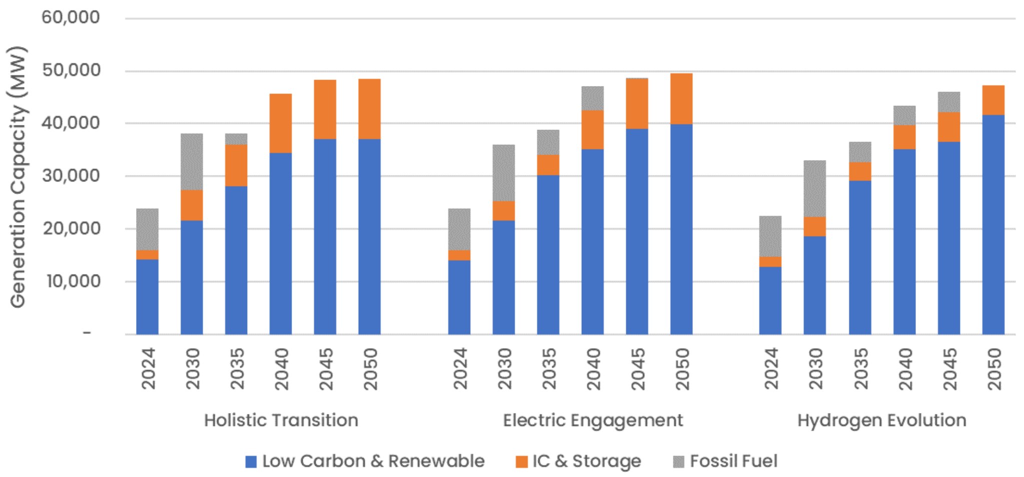
The North of England is a heavily power-exporting region (the generation capacity far outstrips demand) and must also manage power flows from Scotland to demand centres in the Midlands and South. When wind generation is high, power will travel North to South, mostly coming from internal boundary generation and generators in Scotland.

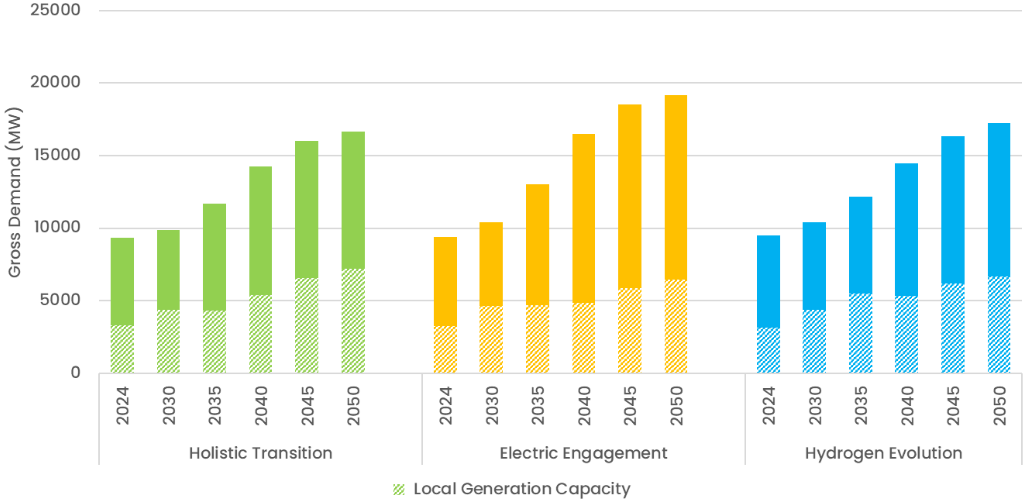
When most of this area and Scotland is generating power, the transmission network can become highly overloaded. The loss of one of the north-to-south routes can lead to constraints on the remaining circuits here. Low-carbon and renewable generation is expected to increase across all 3 FES pathways while fossil fuel generation could see sustained decline, but it wouldn't be phased out in the region until 2040 at the earliest, in the Holistic Transition pathway.

Overall, by 2030, the generation capacity in the region could increase to a total of over 33GW across all pathways. Gross demand in the North of England is expected to increase to a total of 10GW or more by 2030. All three pathways show a steady increase in the gross demand and a further 3-4GW of local embedded generation by 2050, with 3.5GW currently connected.

More local generation in this region would result in a reduction in net demand causing even less of the North-South power flows through this region being absorbed by demand. This will lead to higher through flows from the North of England and Scotland to demand centres in the midlands and south, resulting in more transmission capacity requirements.

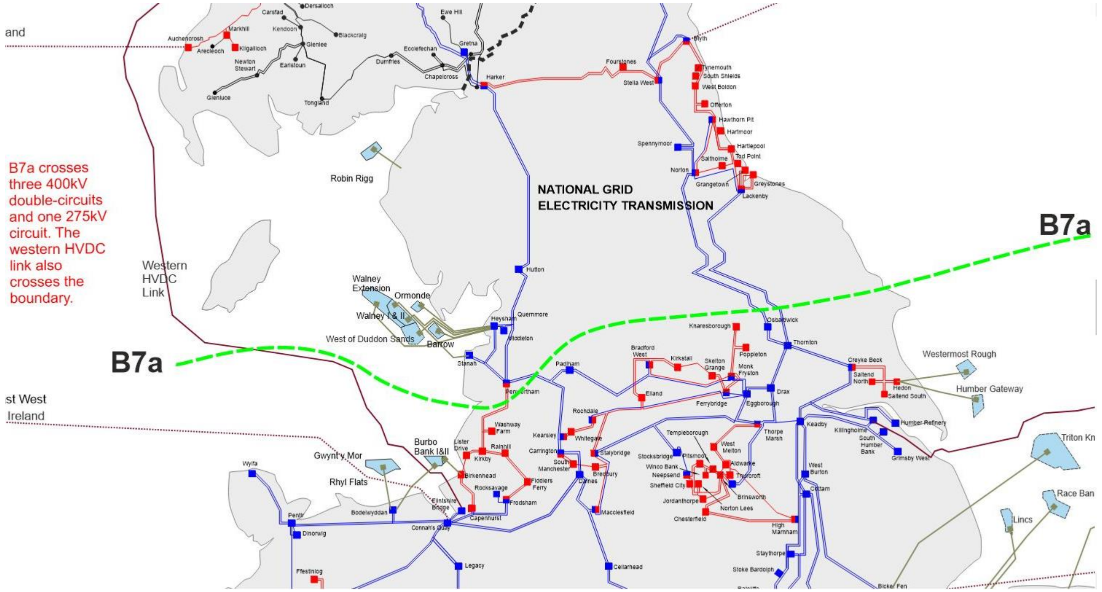
High voltages issues, due to the closure of traditional generators and prevalence of long transmission lines in the region, can occur under light-load conditions. The NESO's Voltage 2026 tender recently procured significant capability to manage high-voltage issues, with delivery from 2026. During periods of high flows (especially during high-winds), South Yorkshire could also experience low voltage issues





ETYS 2024 / North of England 32

Boundary B7a – Upper North of England

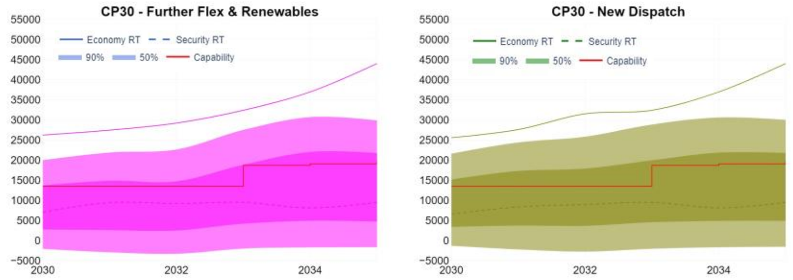


Across all FES, the SQSS economy required transfer and expected power flows are already beyond the present boundary capability. This suggests a strong need for network development to manage the increasing power flows.

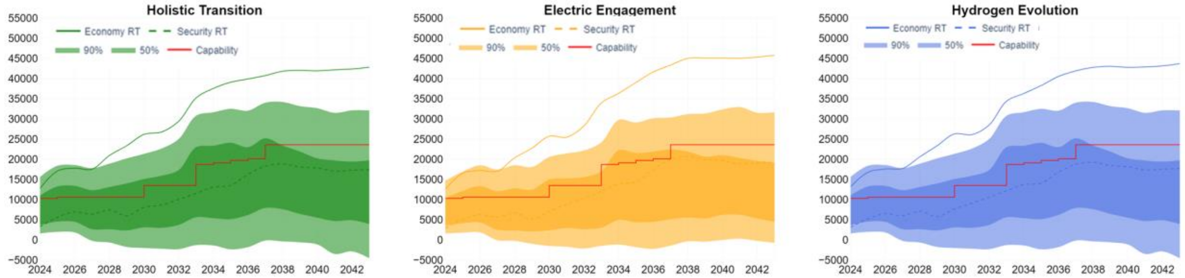
The FES show a lot of variable renewable generation in the north, meaning the spread of boundary power flows is very wide. During periods with low northern generation output it is credible to have power flowing from south to north feeding northern demand.

Offshore wind contribute heavily to the increase in flows across B7a, multiple offshore developments are expected to connect onshore in Northern England - above B7a.

The Clean Power 2030 scenarios saw a decrease in expected transfers post-2030 when compared to the Holistic Transition scenario, with transfers around 2GW lower across both CP30 scenarios.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.

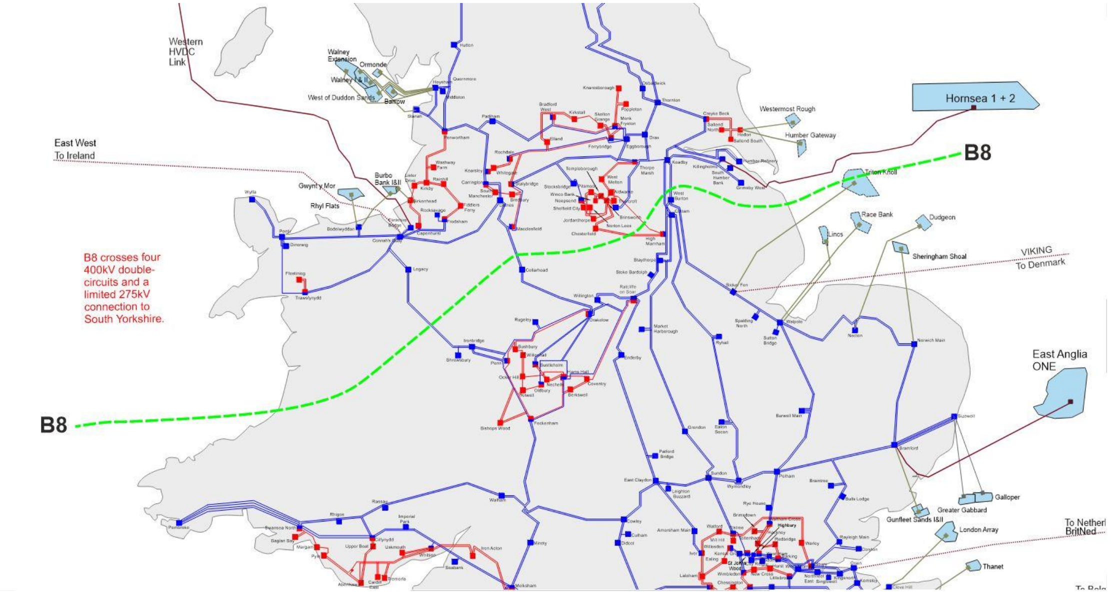


The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 9.4 GW due to thermal constraint on the Penwortham – Washway Farm 275kV circuit

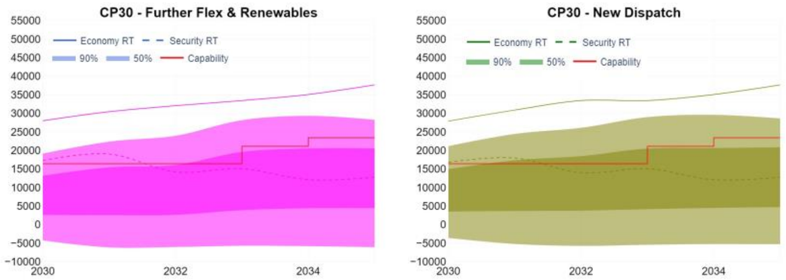
ETYS 2024 / North of England 33

Boundary B8 – North of England to Midlands

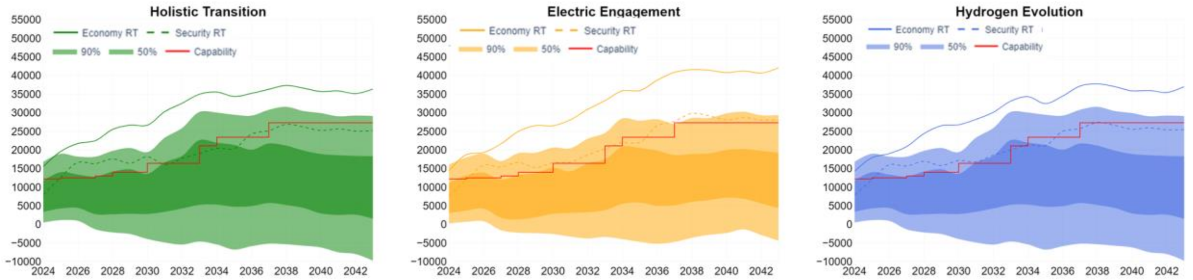


For all scenarios in the FES, the SQSS economy required transfer and expected power flows quickly grow to beyond the present boundary capability. This suggests a strong need for network development to manage the increasing power flows.

Compared to the expected transfers calculated for ETYS 23, transfers are lower in ETYS 24 due to changing assumptions around the delivery dates for multiple offshore wind projects. Transfers across B8 from 2030 onwards are around 4GW lower in ETYS 24 than in ETYS 23, whilst expected flows are still higher than the capability.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 11 GW due to thermal constraint on the Keadby – West Burton 400kV circuit

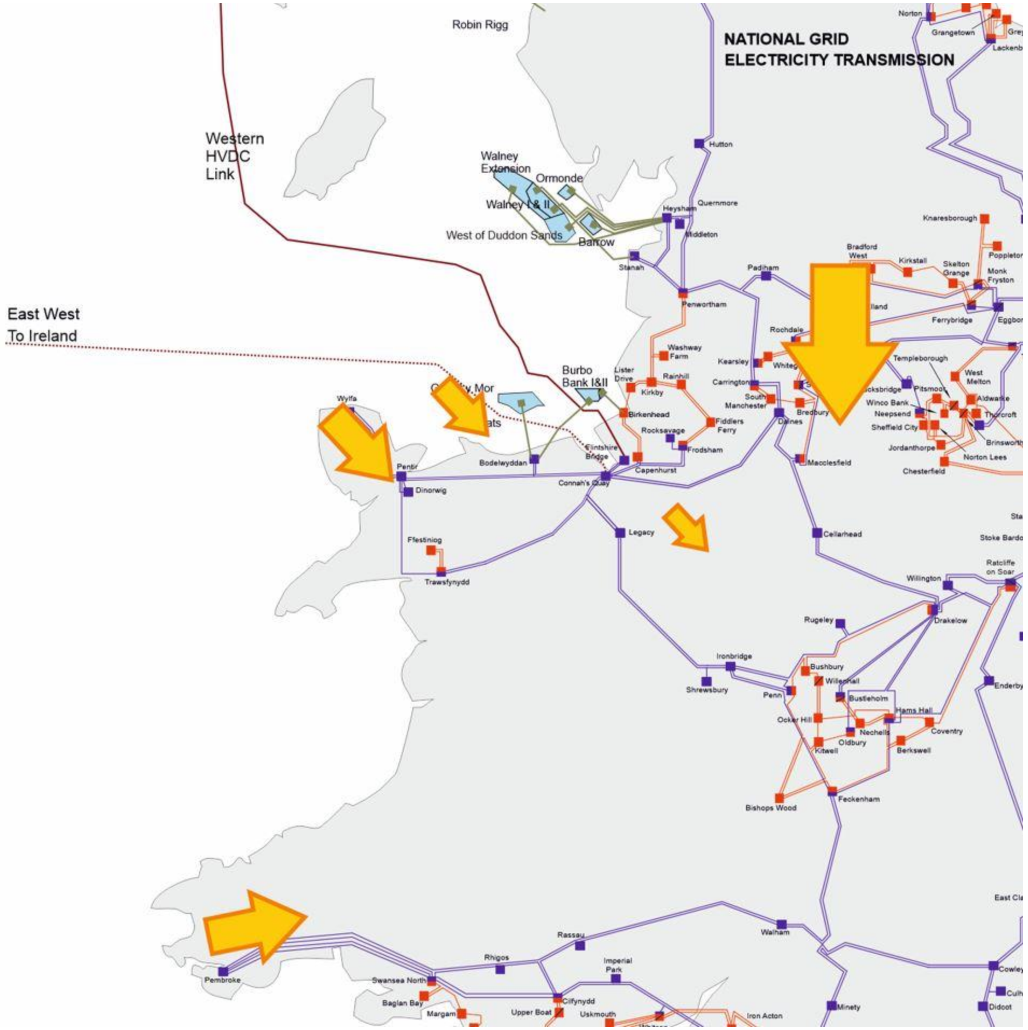
ETYS 2024 / North of England 34

North Wales & Midlands

The Western transmission region includes boundaries in the Midlands and the north of Wales.

This includes the lower midlands boundary B9 and the north Wales boundaries NW1, NW2 and NW3.

The figure to the right shows the general pattern of power flow directions expected to occur most of the time in the years to come up to 2036, i.e. power will generally flow from north to south. The arrows in the diagram illustrate power flow directions and are approximately scaled relative to the winter peak flows.



ETYS 2024 / North Wales & Midlands 35

North Wales & Midlands – Regional Drivers

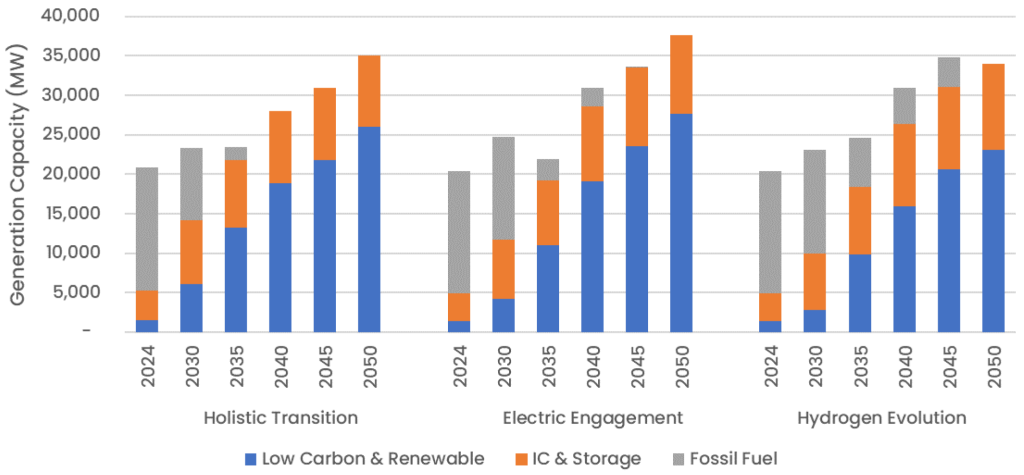
Power plant closures are set to occur in the Midlands with demand set to remain fairly high, driving increased power flows eastwards from future generation connecting to North Wales.

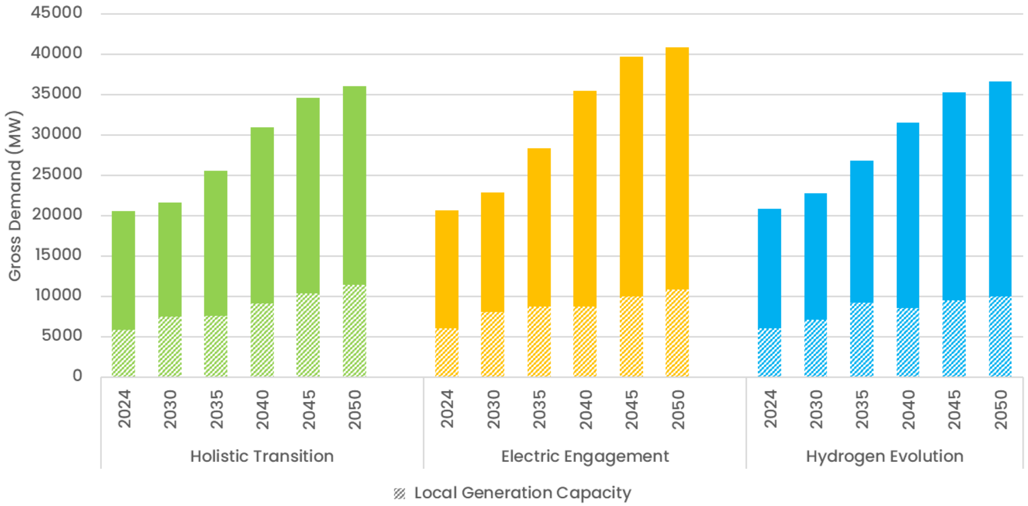
Presently, this region's generation capacity has a significant volume of fossil fuel, however all pathways show this declining by 2035. The region shows a largely similar growth in both gross demand and generation capacity. Following 2035, North Wales and the Midlands is expected to generally export power, facilitated by the recommendations of the Beyond 2030 report.

The FES pathways suggest a total amount of transmission-connected generation capacity to be between 23GW to 25GW by 2030, from the current 20.5GW.

A major increase in low-carbon and renewable generation capacity is accompanied by a slight growth in interconnectors and storage. The gross demand as seen from the transmission network in the region will increase across all scenarios, levelling out at around 2045 for Holistic Transition and Electric Engagement. For all pathways, fossil fuel generation is not present in the region by 2050.

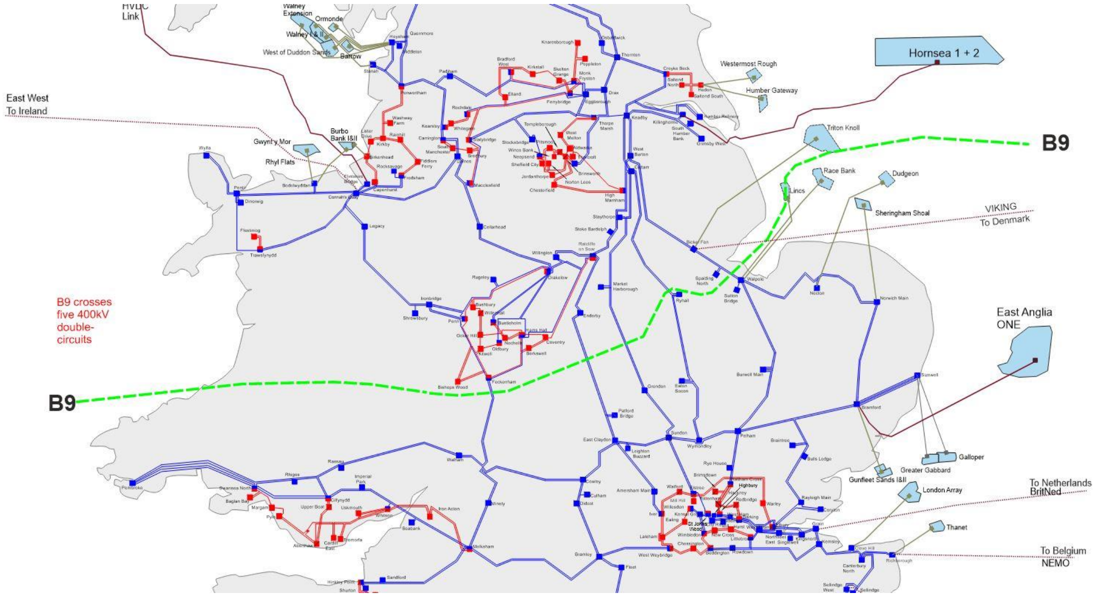
The Midlands could experience significant low-voltage issues over future years with the expected closure of much of the traditional generation in the region and the increase in transfer volumes across the region. In future years, during high loading conditions, especially during high winds, we could require additional local solutions to manage low voltages on the north-to-south transmission routes across B9.





ETYS 2024 / North Wales & Midlands 36

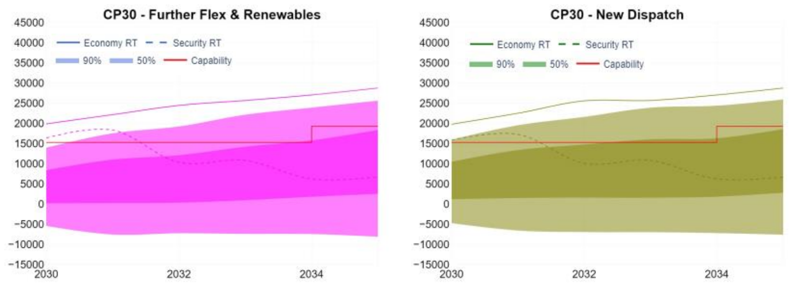
Boundary B9 – Midlands to South of England



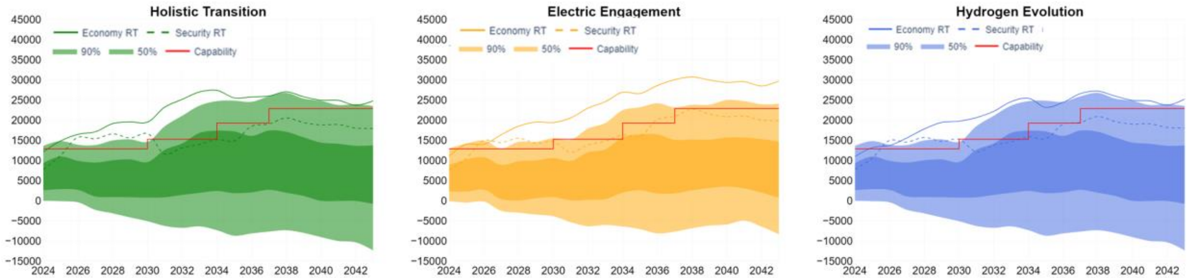
Developments in the east coast and the East Anglia regions, such as the locations of offshore wind generation connection and the network infrastructure requirements, will affect the transfer requirements and capability of boundary B9.

In all FES, the expected flows increase to above the boundary capability for B9 after 2030. Expected flows have fallen compared to ETYS 23, similar to B7a & B8.

The FES show a lot of variable renewable generation in the north, meaning the spread of boundary power flows is very wide. During periods with low northern generation output it is credible to have power flowing from south to north feeding northern demand.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 12 GW due to a voltage constraint for a fault on the Spalding North – Walpole – Bicker Fen 400kV circuits

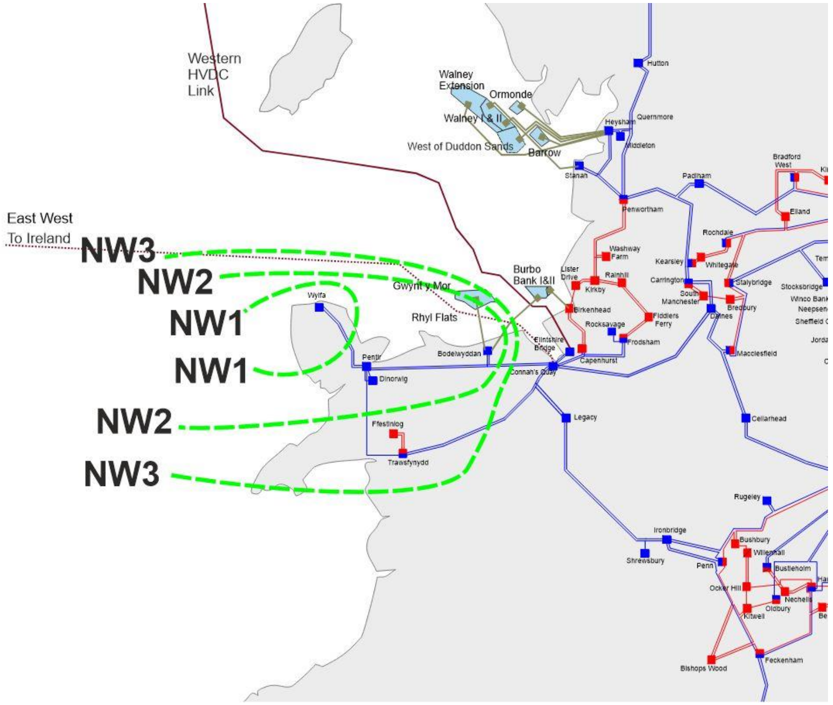
ETYS 2024 / North Wales & Midlands 37

North Wales

The onshore network in North Wales comprises a 400kV circuit ring that connects Pentir, Connah's Quay and Trawsfynydd substations.

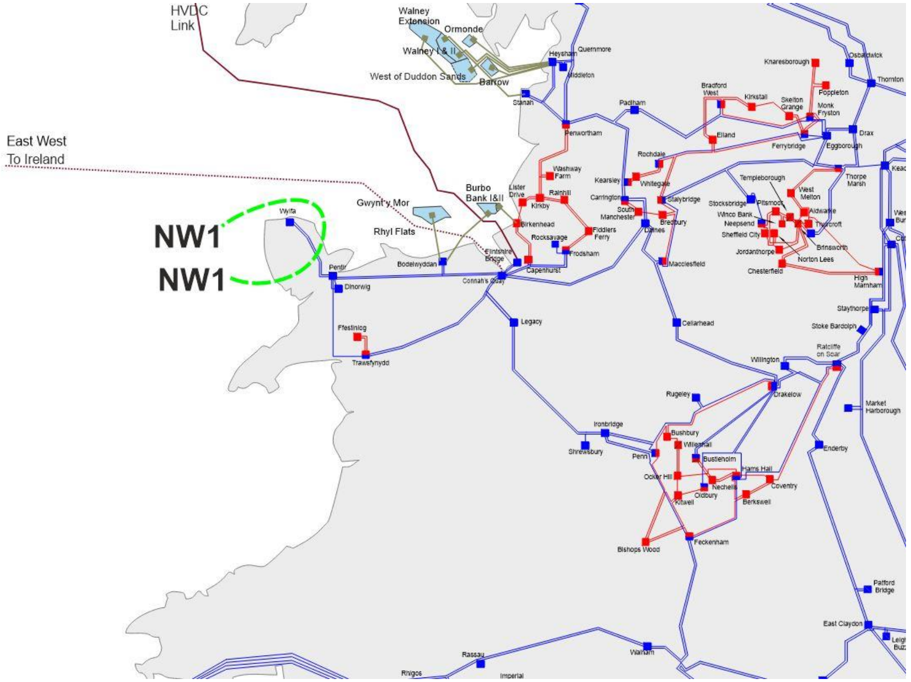
A 400kV double-circuit spur crossing the Menai Strait and running the length of Ynys Mon connects the now decommissioned nuclear power station at Wylfa to Pentir. A short 400kV double -circuit cable spur from Pentir connects Dinorwig pumped storage power station. In addition, a 275kV spur traverses north of Trawsfynydd to Ffestiniog pumped storage power station.

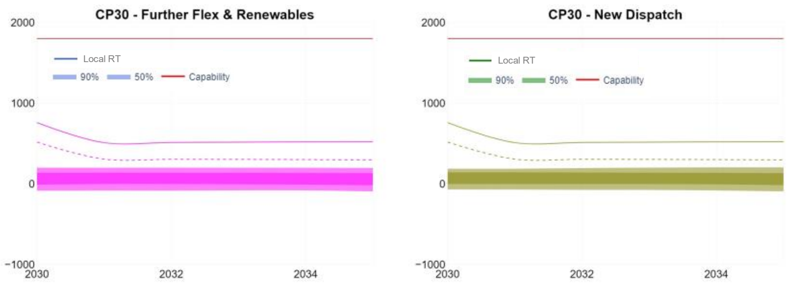
Most of these circuits are of double circuit tower construction. However, Pentir and Trawsfynydd within the Eryri National Park are connected by a single 400kV circuit, which is the main limiting factor for capacity in this area. The area is studied by analysing the local boundaries NW (North Wales) 1 to 3.



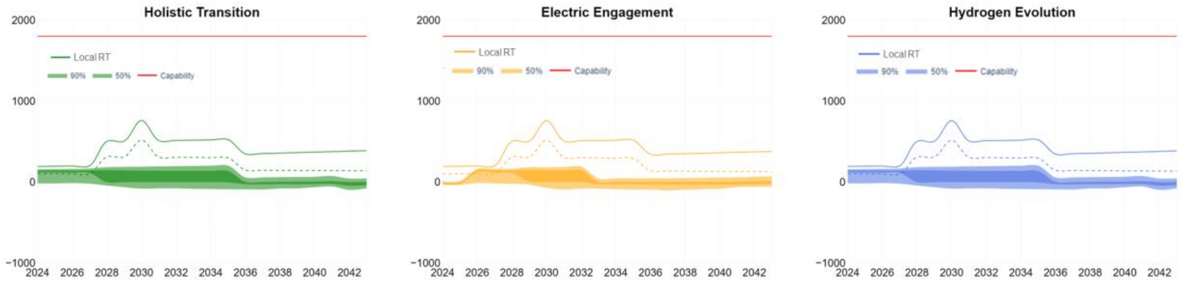
ETYS 2024 / North Wales & Midlands 38

Boundary NW1 – Ynys Mon





The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



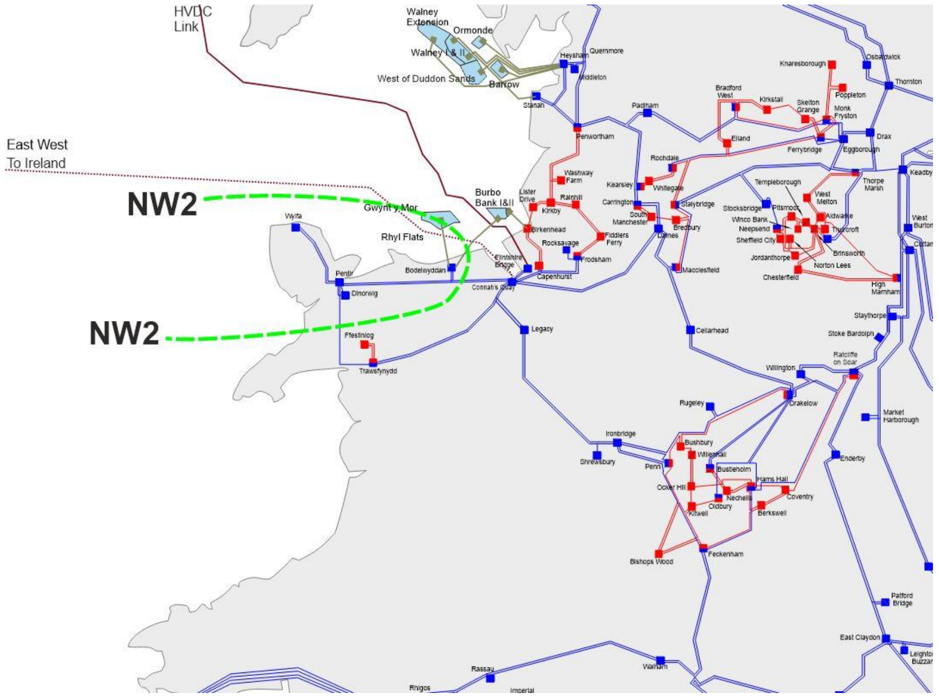
There is currently very low amounts of transmission-connected generation behind NW1 following the closure of Wylfa power station in 2015. However, there is some renewable and storage plant. Due to this low generation behind the boundary - it is expected within the later years for NW1 to become predominantly importing.

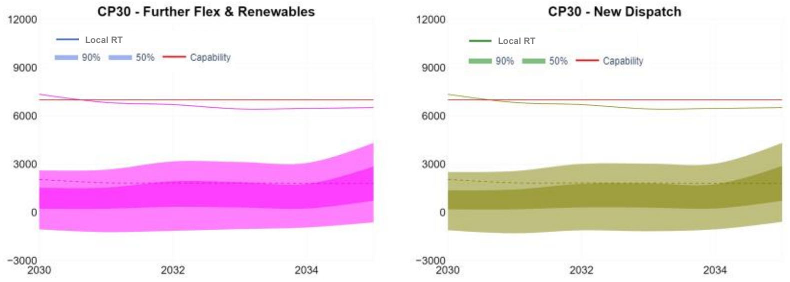
The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited by the infrequent infeed loss risk criterion set in the SQSS, currently 1.8GW

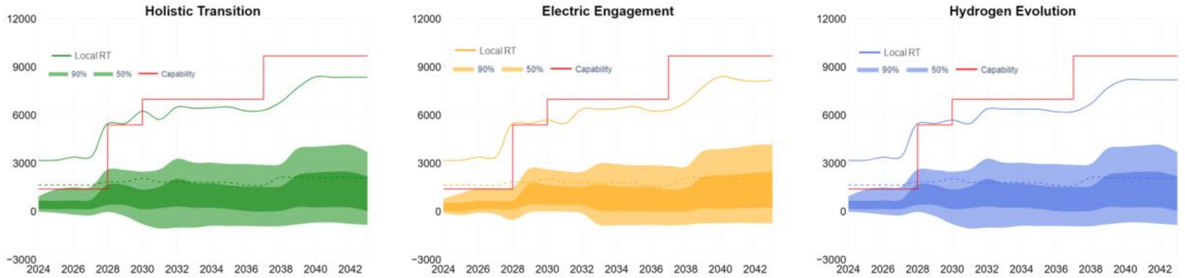
ETYS 2024 / North Wales & Midlands 39

Boundary NW2 – Ynys Mon and Caernarvonshire





The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

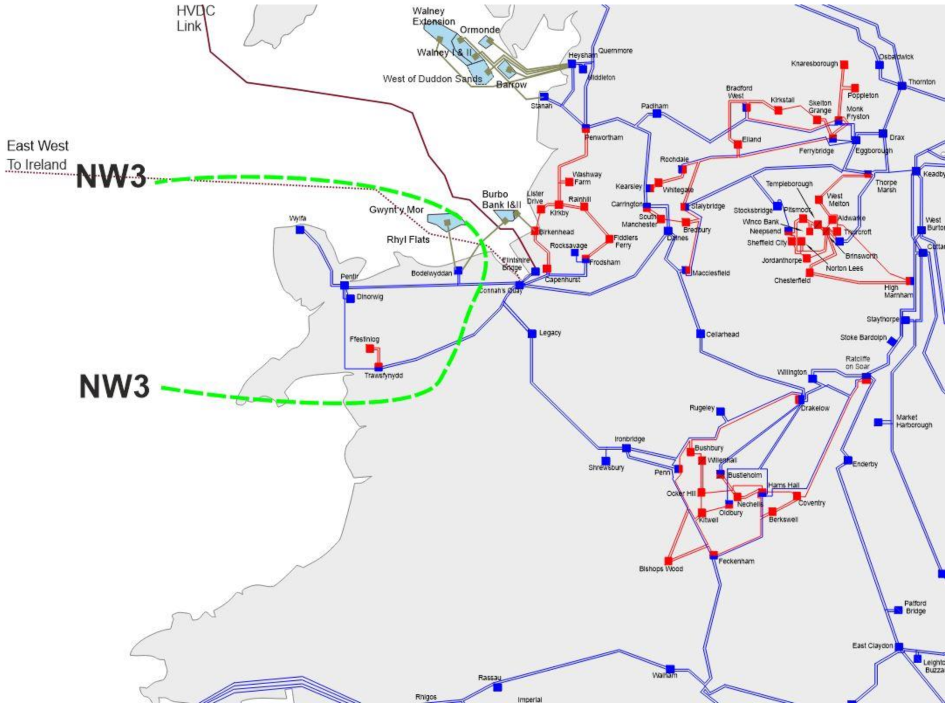
Currently, there is not a significant amount of generation behind NW2, mainly pumped storage and offshore wind projects.

Expected transfers across NW2 post-2028 will rise due to the additional offshore wind generation projects landing within the boundary, planned reinforcements in the area will facilitate this new generation capacity.

The boundary capability is limited to 1.4GW due to a thermal constraint on the Pentir – Trawsfynydd 400kV circuit

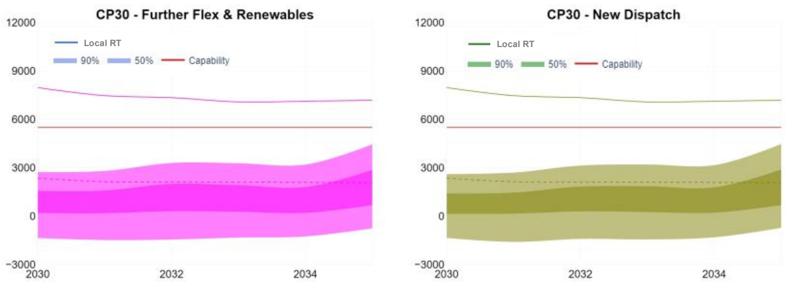
ETYS 2024 / North Wales & Midlands 40

NW3 – Ynys Mon, Caernarvonshire and Meirionnydd

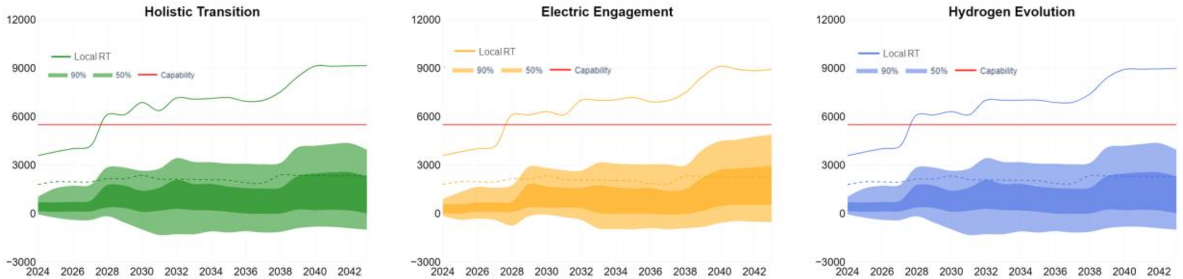


The profile of NW3 is largely similar to that of NW2.

Expected transfers across NW3 post-2028 will rise due to the additional offshore wind generation projects landing within the boundary, planned reinforcements in the area will facilitate this new generation capacity.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 5.5GW due to a thermal constraint on the Connah's Quay - Bodelwyddan - Pentir 400kV circuit

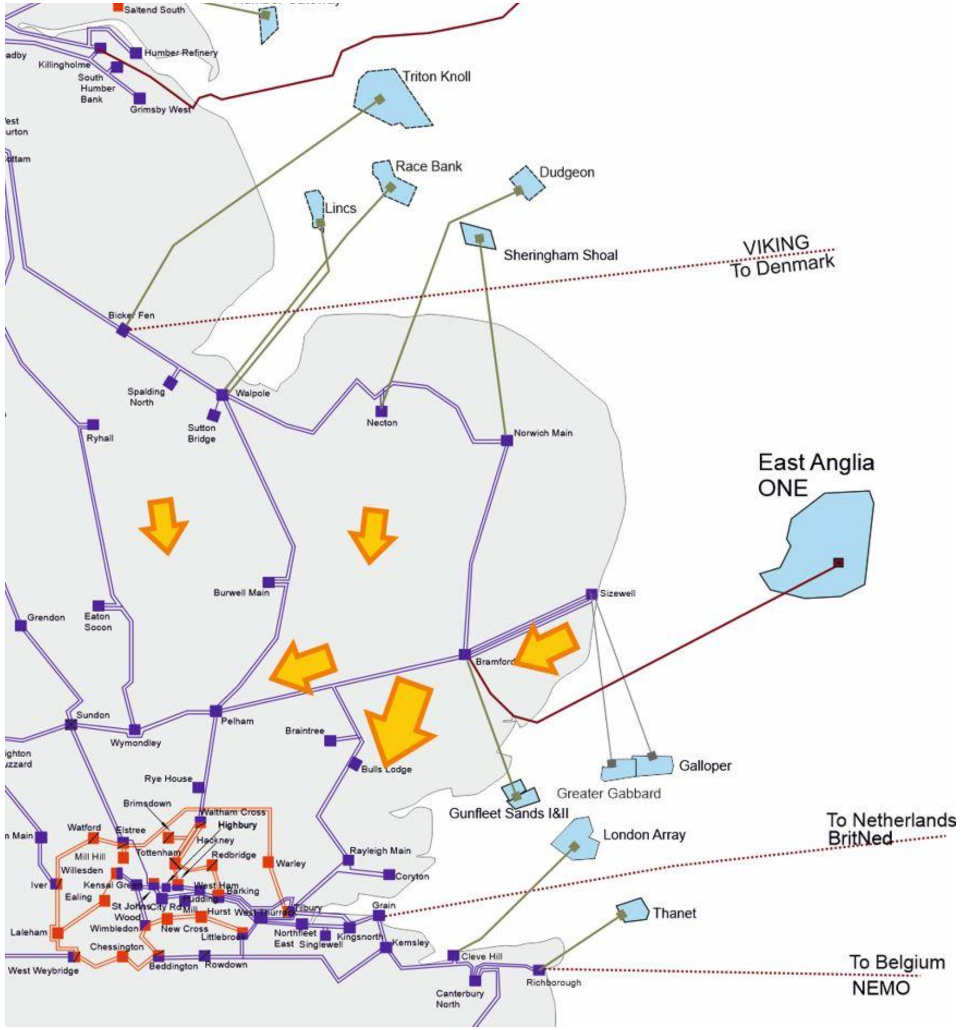
ETYS 2024 / North Wales & Midlands 41

East of England

The East of England region includes the counties of Norfolk and Suffolk.

EC5 is the only boundary within this region.

The figure to the right shows the general pattern of power flow directions expected to occur most of the time in the years to come up to 2036, i.e. power will generally flow from north to south. The arrows in the diagram illustrate power flow directions and are approximately scaled relative to the winter peak flows.



ETYS 2024 / East of England 42

East of England – Regional Drivers

Peak gross demand in the East of England region is expected to remain steady with limited growth over the same timeframe. The FES pathways show that growth in low-carbon and renewable generation will primarily drive the system needs in this region.

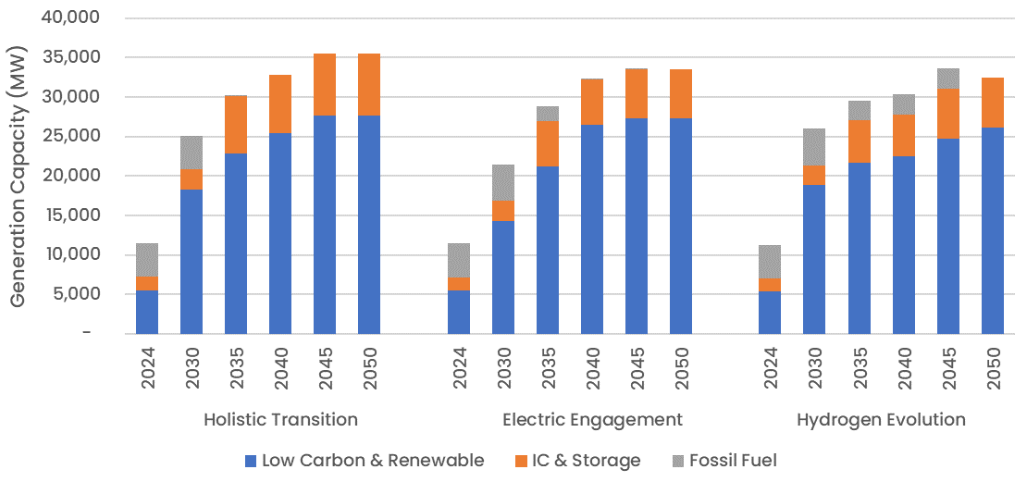
Over the next decade, this region could see growth in generation primarily from low carbon and renewable generation.

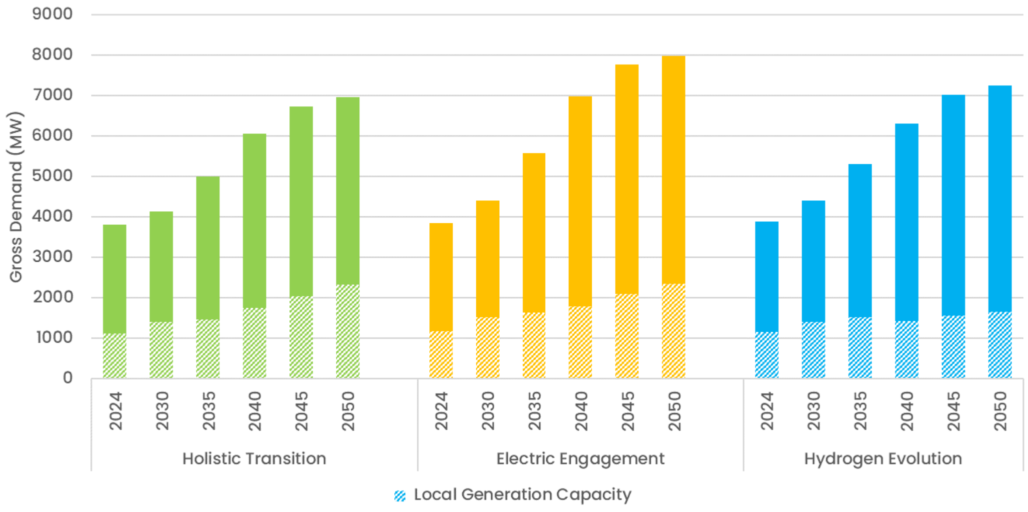
From 2030, there could be further interconnector and storage connections in this region. Demand is steady in the short term with growth expected from 2030 out to 2050.

As the total generation will likely exceed the local demand, this region will be a net power exporter. There is work ongoing to coordinate the network infrastructure in this region to facilitate greater coordination of offshore generation and interconnectors connecting into this region. This follows the 2024 publication of NESO's East Anglia Network Study which reviewed the upcoming generation connections and network reinforcement planned in the area.

In order to manage the constraints across the East Coast boundaries, the NESO is also proactively developing a commercial non-build solution, the EC5 Constraint Management Intertrip Service (CMIS). This will contract with generators in the region to provide a more economical method of managing constraints than actions through the balancing mechanism. An interim service is now operational with over 900MW of generation contracted, with the launch of the enduring EC5 CMIS expected in 2026.

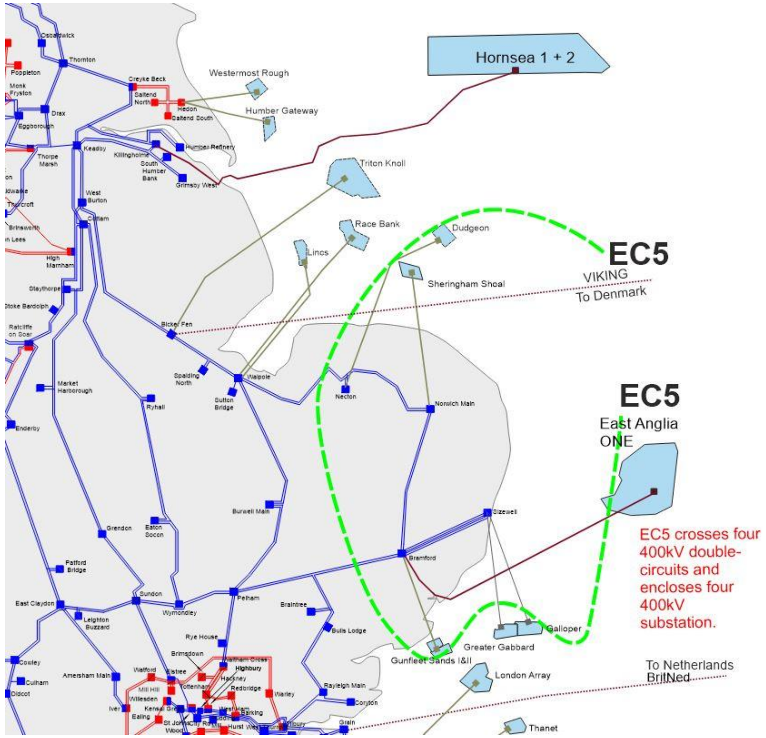
Increasing renewable generators connecting combined with low demand in the region could lead to issues managing high voltages, especially during transmission circuit outages. Further closures of the existing synchronous generation could exacerbate these issues. Additionally, during periods of high north to south flows across GB this region experiences low voltage issues on the transmission routes heading towards the south-east.





ETYS 2024 / East of England 43

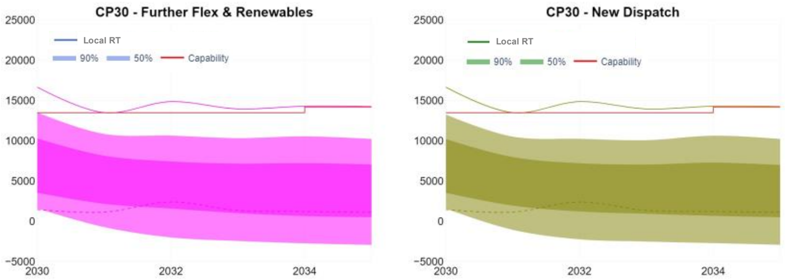
Boundary EC5 – East Anglia



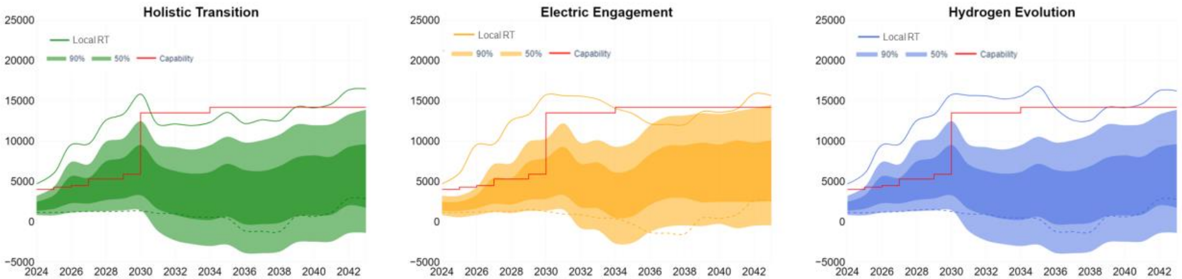
There are several offshore wind projects connecting into the region.

The growth in low carbon and renewable generation connecting behind this boundary greatly increase the power transfer requirements. The present boundary capability is sufficient for today's needs but could be significantly short of the future capability requirements.

Work is ongoing to coordinate the network infrastructure in this region to facilitate greater coordination of generation connecting into this region.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 3.3 GW due to a voltage constraint for a fault on the Pelham-Bramford-Braintree 400kV circuits

ETYS 2024 / East of England 44

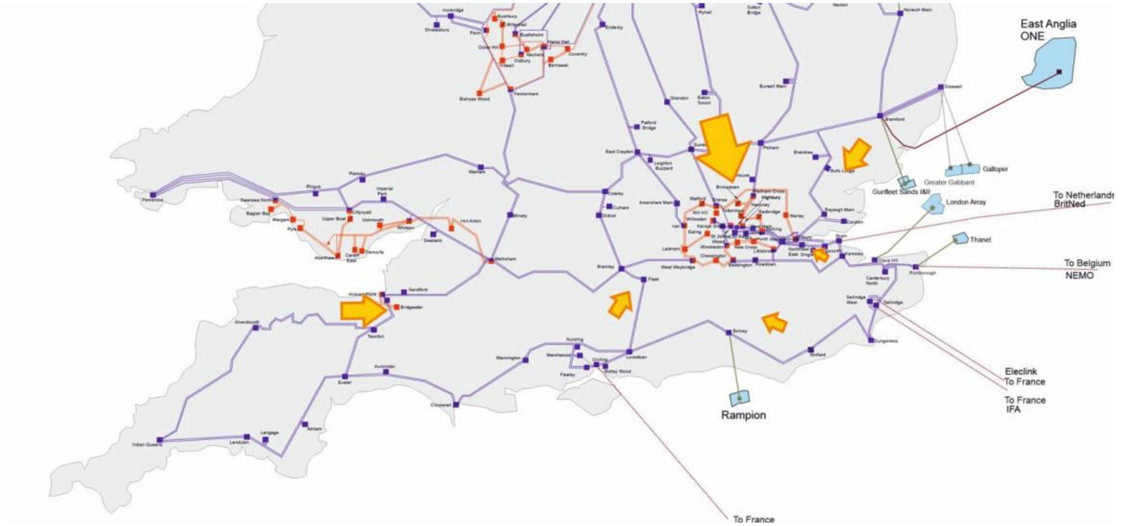
South Wales & South of England

The region includes the high demand area of London, generation around the Thames estuary and the long set of circuits that run around the south coast and South Wales.

Interconnection to Central Europe is connected along the south east coast and this interconnection has significant influence on power flows in the region by being able to both import and export power with Europe.

The South of England transmission region includes boundaries B13, B14, LE1, SC1, SC1.5, SC2, SC3 and SW1.

The figure to the right shows the general pattern of power flow directions expected to occur most of the time in the years to come up to 2034, i.e. power will generally flow from north to south. The arrows in the diagram illustrate power flow directions and are approximately scaled relative to the winter peak flows.



ETYS 2024 / South Wales & South of England 45

South Wales & South of England – Regional Drivers

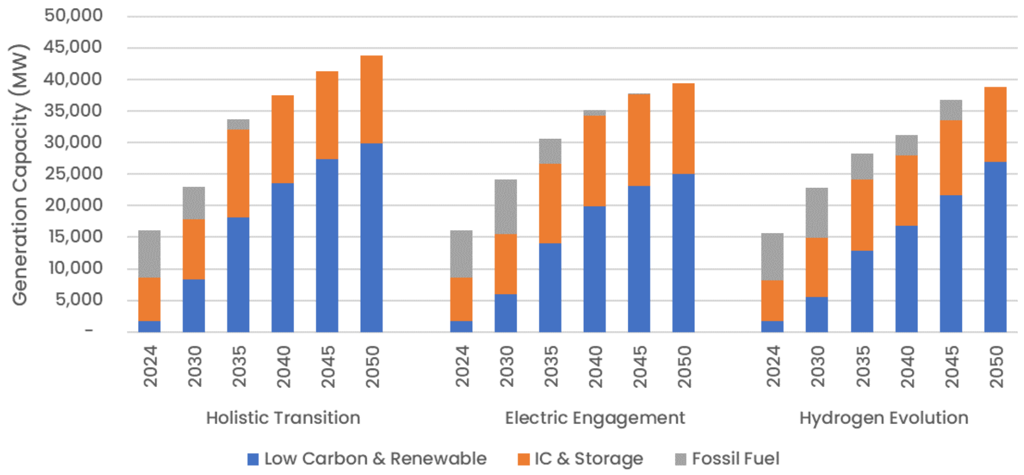
Network management will be critical in this region due to European interconnection developments and contrasting network topology, causing potential high circuit flows leading to overloading, voltage management and stability issues.

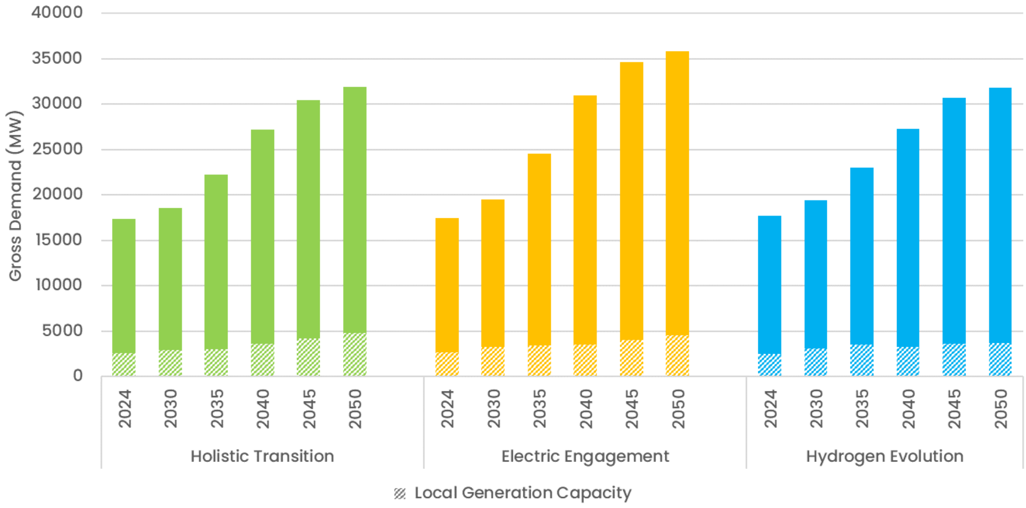
The transmission network in the south is densely meshed in and around the London boundary B14 and the Thames estuary, but moving South and towards the West, the network is much more radial with longer distances between each substation. Most interconnectors will be connected south of boundary SC1, the impact of these will be discussed later in the chapter in the SC1, SC1.5 and SC2 requirements sections.

All pathways suggests that a total of around 9GW of interconnectors and energy storage capacity will be connected by 2030, up from about 6.5GW to date. Interconnectors and storage are bidirectional, meaning that the south could see their capacity provide almost 9GW power injection or 9GW increased demand, placing a heavy burden on the transmission network.

With new interconnector and generation connections, boundaries SC1, SC1.5, SC2, SC3, LE1 and B13 will need to be able to support large power flows in both directions. The South will be expected to fulfil a lower portion of its demand from local embedded generation than other regions are. With future additional interconnector connections, in the south region it will be challenging to support all interconnectors importing or exporting simultaneously without network reinforcement.

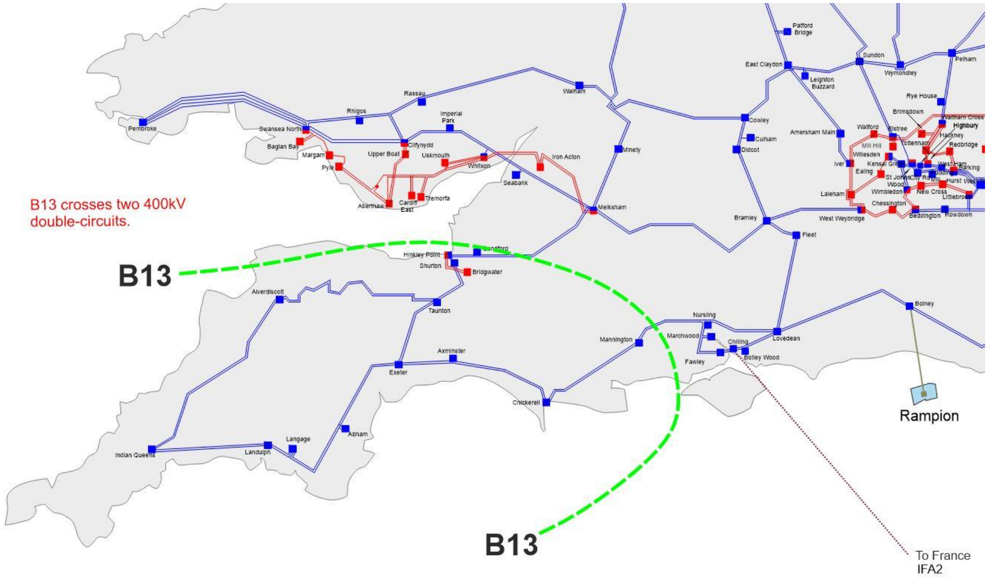
High-voltages in London arises from the high gain from the numerous cable circuits, particularly overnight when demand is low. The Voltage 2026 tender has also procured capability in this region to manage these high-voltage issues in future. In future years, low-voltage issues are expected to become more prevalent around London during high-flow periods, especially when the south-coast interconnectors are exporting power.





ETYS 2024 / South Wales & South of England 46

Boundary B13 – South West

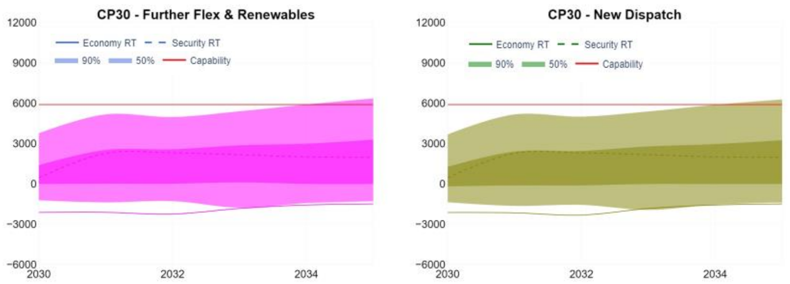


The southwest peninsula is a region with a high level of localised generation and demand. Until new generation or interconnectors connect there is very little variation in boundary requirements for B13, and that the current importing boundary capability is sufficient to meet the short-term needs.

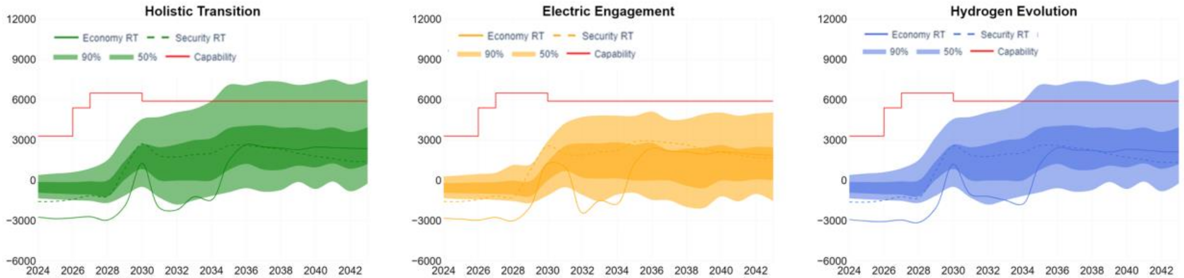
The large size of the potential new generators wishing to connect close to boundary B13 is likely to push it to large exports but the current network plan in raises boundary capability to a sufficient level. Further reinforcements may be required post-2030, following the connection of offshore wind projects in the south west.

The NESO's final recommended design for the Celtic Sea, facilitating the connection of The Crown Estate's Floating Offshore Wind Leasing Round 5, sees up to 1.5GW of offshore wind connecting into South West England, behind B13, by 2035.

The Crown Estate's Marine Delivery Routemap identified the Celtic Sea region to have potential for up to 12GW of additional offshore wind capacity, of which 4-10GW could be leased by 2030 and in operation from 2035 to 2040. This could see an acceleration of the system requirements in the South West.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.

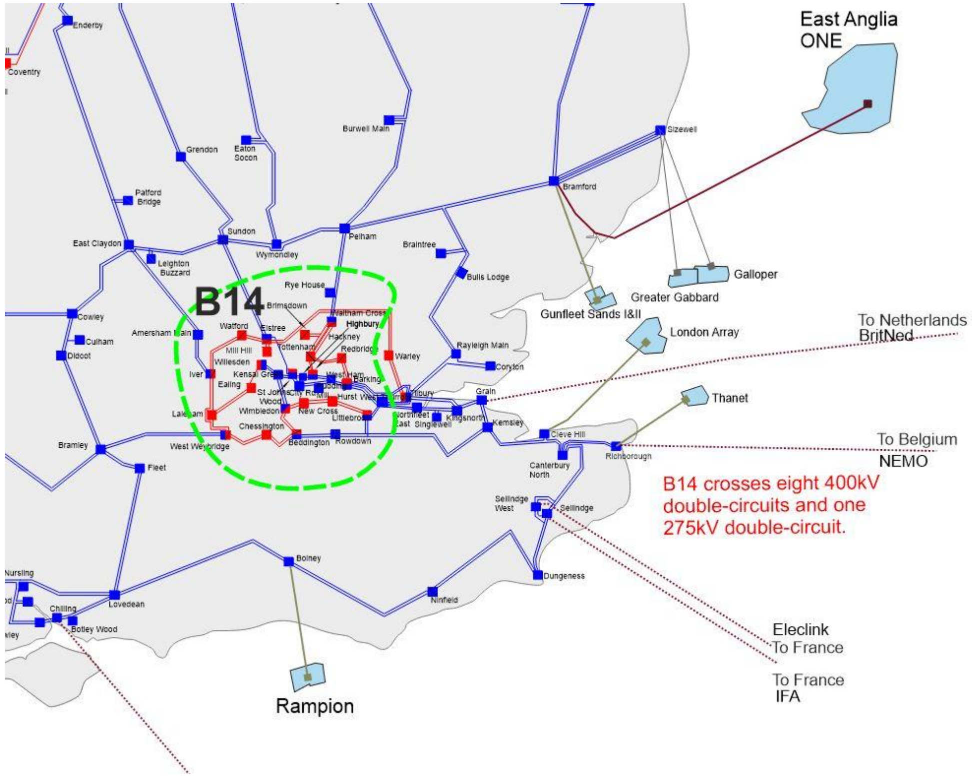


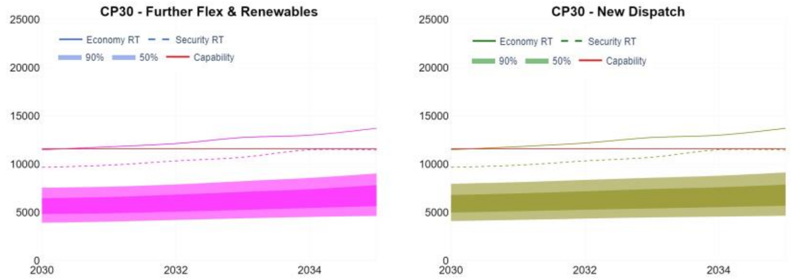
The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 3.5 GW due to a voltage constraint for a fault on the Landulph – Langage 400kV double circuit

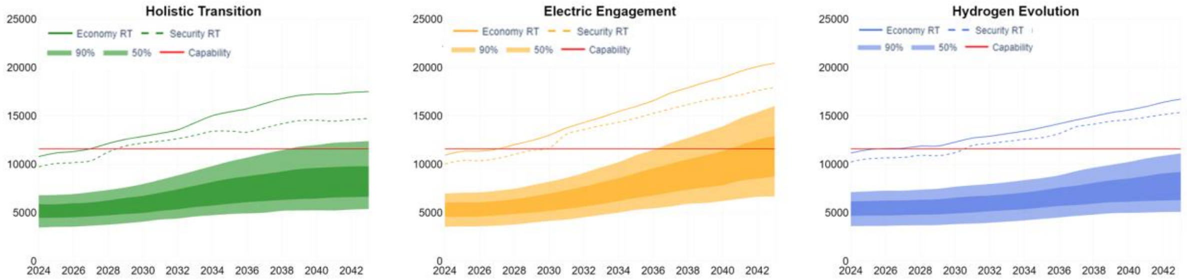
ETYS 2024 / South Wales & South of England 47

Boundary B14 – London





The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The circuits entering from the north can be particularly heavily loaded at winter peak conditions. The circuits are further overloaded when the European interconnectors export to mainland Europe as power is transported via London to feed the interconnectors along the south coast.

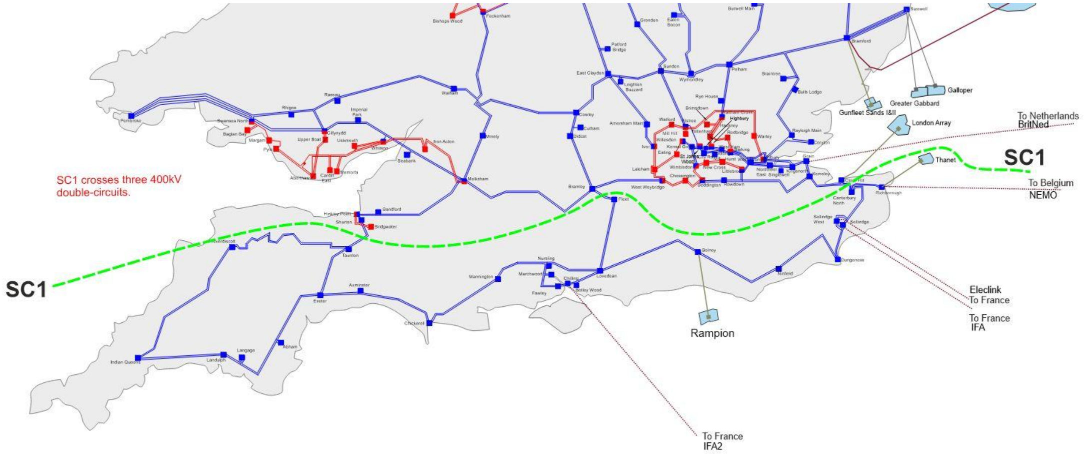
As the transfer across this boundary is mostly dictated by the contained demand, the scenario requirements mostly follow the increasing demand with little deviation due to generation changes.

The boundary requirements are close to each other across all scenarios for security and economy required transfer. In both criteria, the required transfer is significantly above the 95th percentile flows.

The boundary capability is limited to 11.6GW due to a thermal constraint on the Grain - Kingsnorth & Grain - Tilbury circuits

ETYS 2024 / South Wales & South of England 48

Boundary SC1 – South Coast

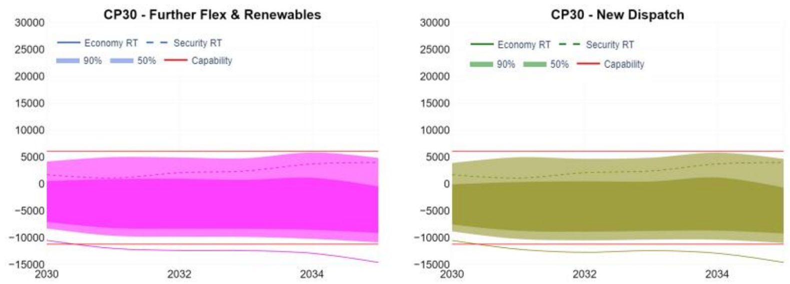


During winter peak demand, the power typically flows from north to south across the boundary due to the low volumes of local generation on the south coast.

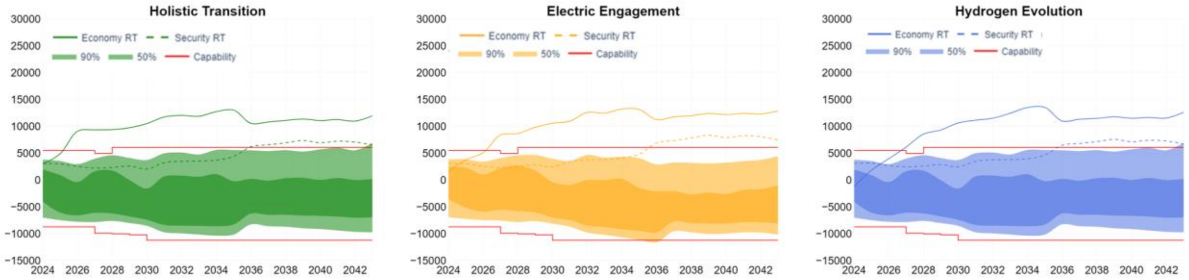
Interconnector activity significantly influences this boundary power flow. Currently, interconnectors to France, the Netherlands, and Belgium connect at Sellindge, Grain, and Richborough, respectively. The most significant driver for future requirements across SC1 will continue to be the connection of new continental interconnectors.

These interconnectors have a substantial impact on power transfers across SC1 and can, at times, complicate the management of network flows & constraints in real-time. For instance, a 2GW interconnector like IFA can cause a 4GW difference on the boundary, switching from full export to full import mode or vice versa.

Across all FES, the expected flows move further into the importing region over future years. Capability is expected to be sufficient for both importing and exporting cases.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



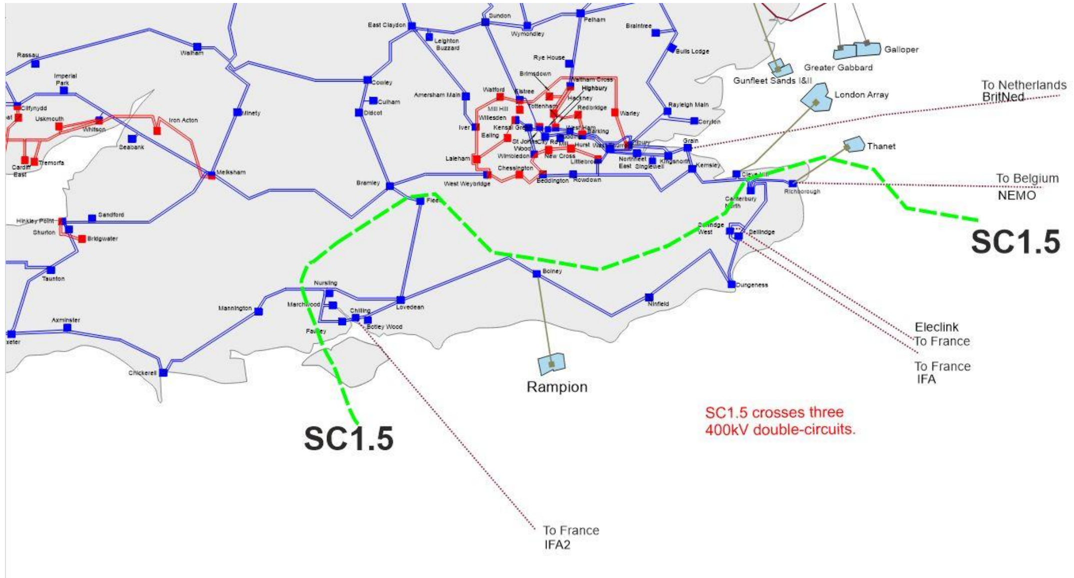
The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

A reverse boundary capability has also been provided for this boundary (the boundary capability identified under scenarios where SC1 is importing power from the rest of GB) as this boundary is expected to import power for significant periods of time either now or in the future.

The boundary capability is limited to 3.9 GW due to a voltage compliance constraint at the Dungeness 400kV substation

ETYS 2024 / South Wales & South of England 49

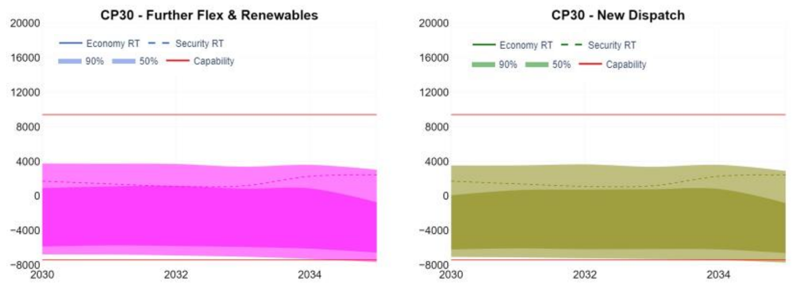
Boundary SC1.5 – South Coast



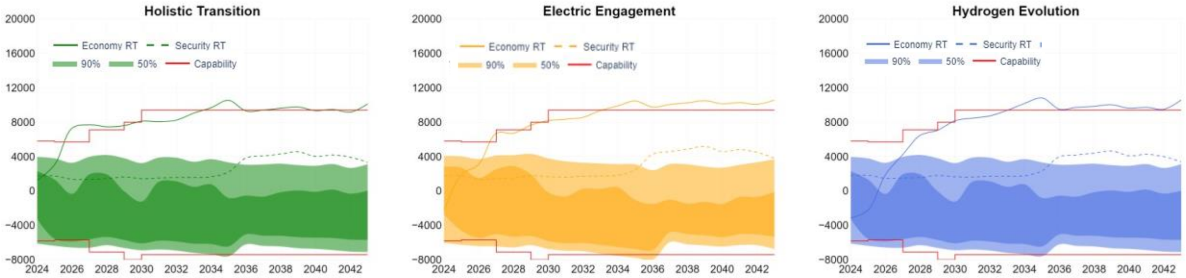
During peak winter demand in, power typically flows from north to south across the boundary due to the low volumes of local generation on the south coast.

The volatility of interconnector activity can be seen in the wide spread of expected boundary flows depicted by the shaded areas on the boundary charts.

Across all FES, the expected flows move slightly more toward importing on average, over future years. Capability is expected to be sufficient for both importing and exporting cases.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



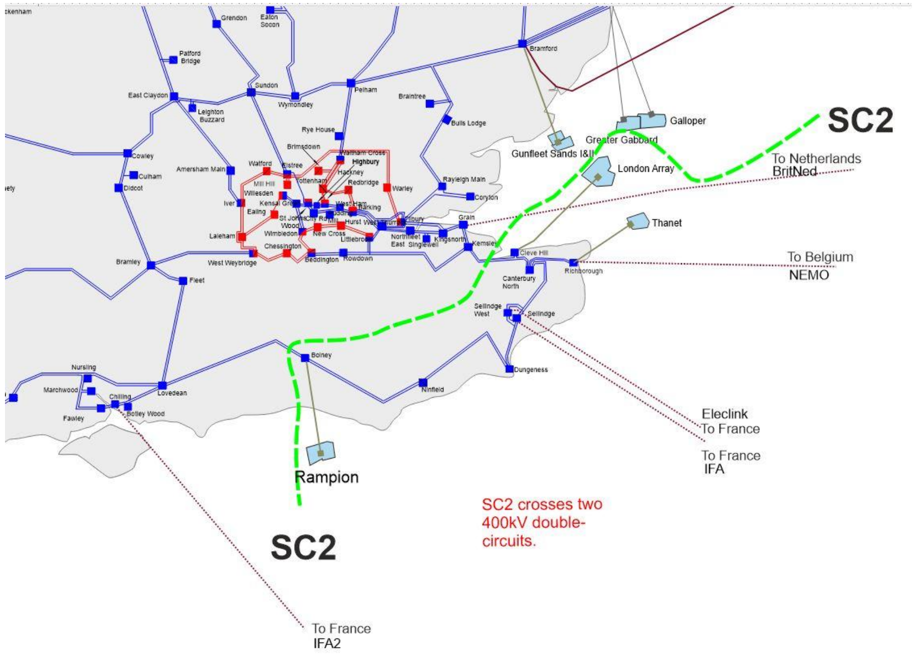
The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

A reverse boundary capability has also been provided for this boundary (the boundary capability identified under scenarios where SC1.5 is importing power from the rest of GB) as this boundary is expected to import power for significant periods of time either now or in the future.

The boundary capability is limited to 5.4 GW due to a voltage constraint for a fault on the Cleve Hill – Canterbury North – Kemsley 400kV circuits

ETYS 2024 / South Wales & South of England 50

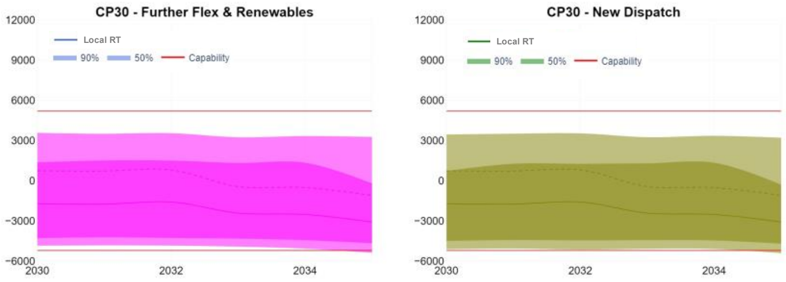
Boundary SC2 – South Coast



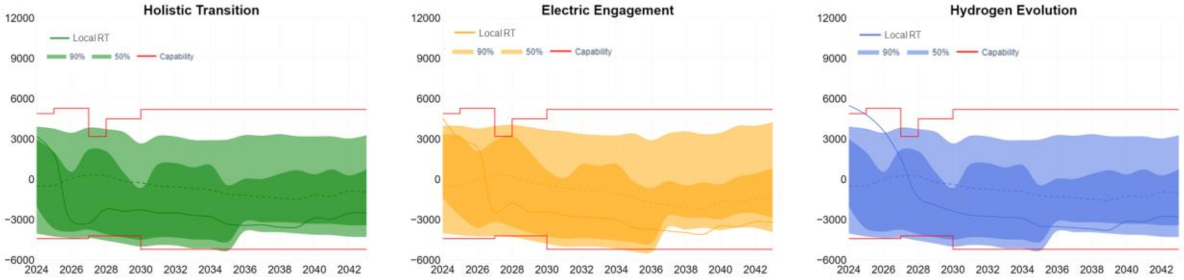
The 400kV route between Kemsley and Lovedean is relatively long and serves significant demand while connecting large generators and interconnections to Europe. A fault at either end can turn it into a long radial feeder, placing all the load on the remaining two circuits. This can be restrictive due to circuit ratings and may cause voltage issues.

Additional generation and interconnectors contracted for connection below SC2 could lead to some constraints when windy periods occur in combination with outages around the south east coast.

Across all FES, expected flows are projected to shift slightly more towards importing on average over the coming years. However, the capability is expected to be sufficient for both importing and exporting cases.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



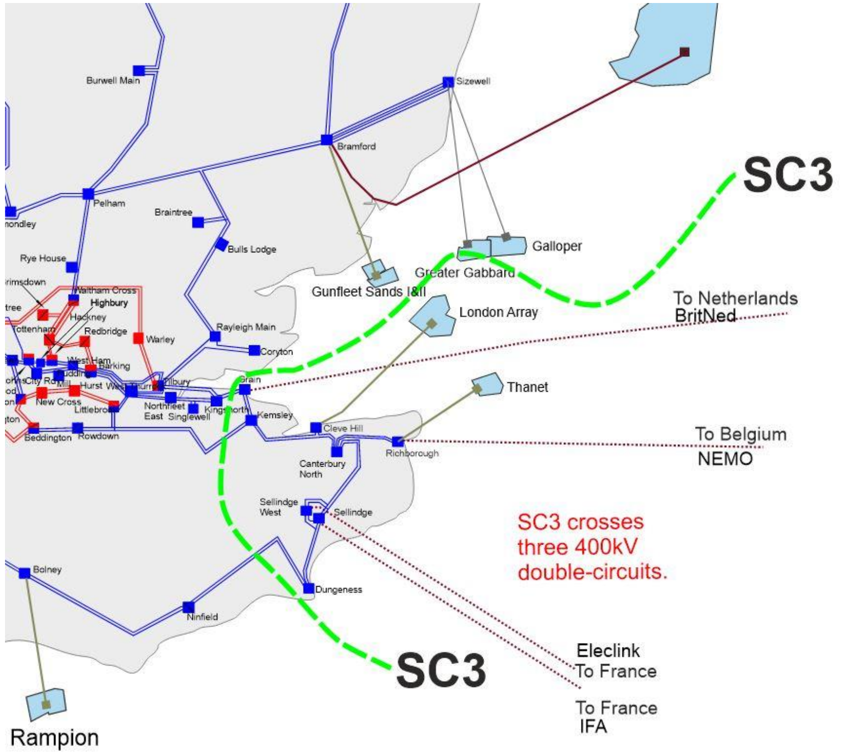
The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

A reverse boundary capability has also been provided for this boundary (the boundary capability identified under scenarios where SC2 is importing power from the rest of GB) as this boundary is expected to import power for significant periods of time either now or in the future.

The boundary capability is limited to 3.8GW due to voltage compliance constraints

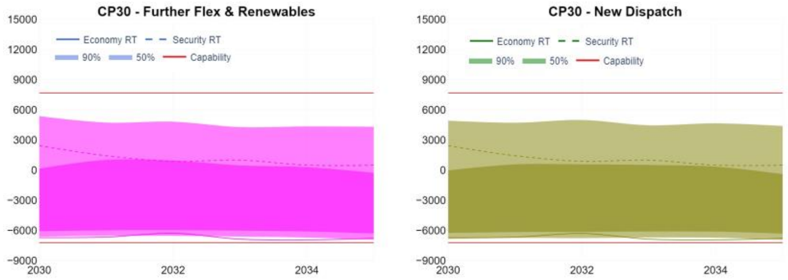
ETYS 2024 / South Wales & South of England 51

Boundary SC3 – South Coast

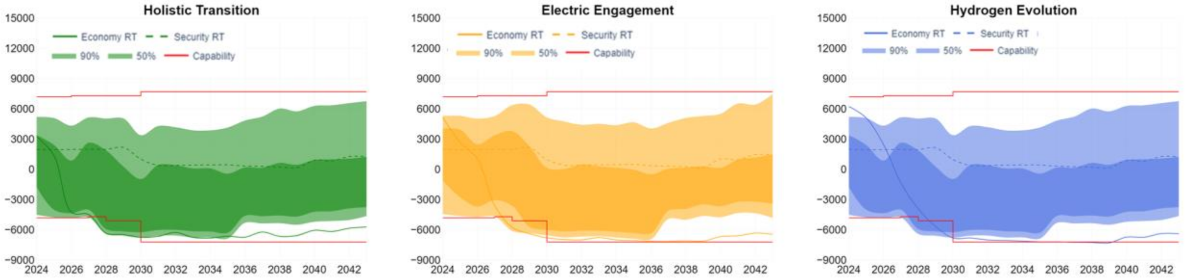


The current and future interconnectors to Europe have a significant impact on the power transfers across SC3. The current interconnectors to France, the Netherlands and Belgium connect at Sellindge, Grain and Richborough respectively.

Across all FES, the expected flows move slightly more toward importing on average, whilst still expected to regularly export power for limited periods, in future years. Capability is expected to be sufficient for both importing and exporting cases.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



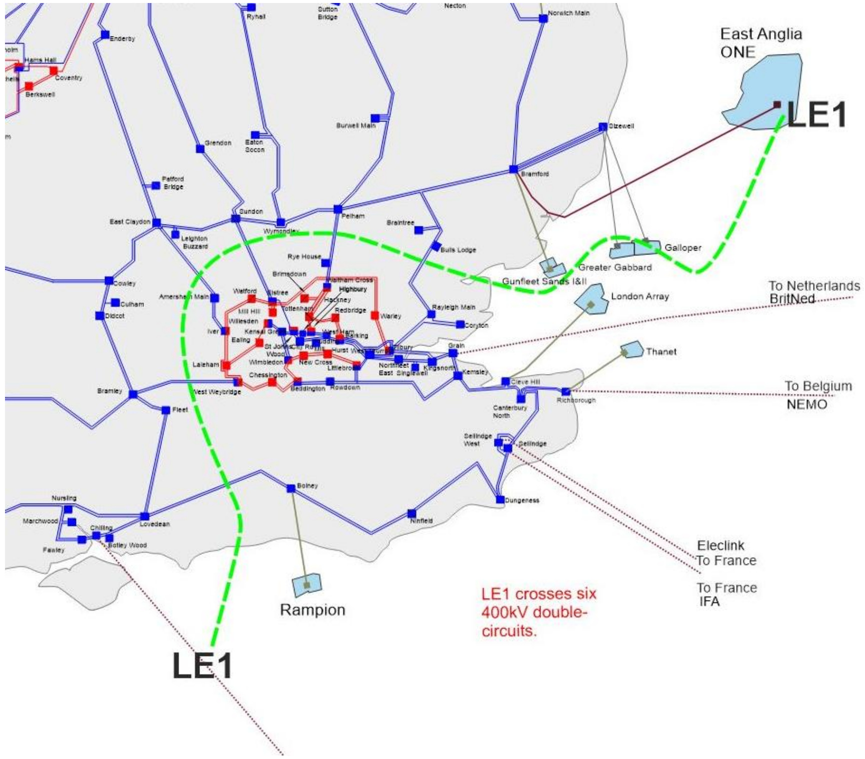
The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

A reverse boundary capability has also been provided for this boundary (the boundary capability identified under scenarios where SC3 is importing power from the rest of GB) as this boundary is expected to import power for significant periods of time either now or in the future.

The boundary capability is limited to 6.7GW due to a thermal constraint on the Grain – Tilbury 400kV circuit

ETYS 2024 / South Wales & South of England 52

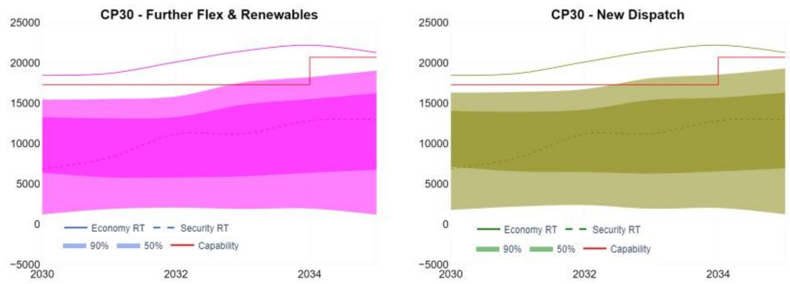
Boundary LE1 – South East



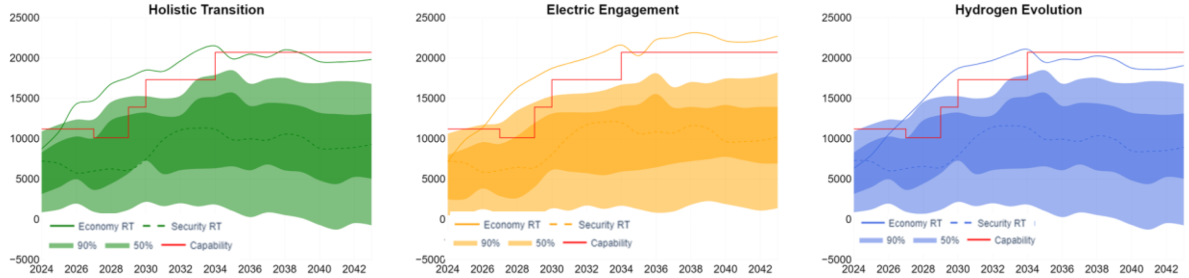
LE1 is characterised by two distinct areas. Within London, there is high local demand and little generation. The remainder of the area contains both high demand and high levels of generation.

LE1 almost exclusively imports power from the north and west into the south-east, and the purpose of the boundary is to monitor flows in this direction. Due to this and for ease of reading, LE1 is defined in the reverse manner, positive flows on the boundary charts indicate power flowing into LE1 (importing).

Increasing interconnector exports to Europe drive an increase in power flows and a need for network reinforcements in the area over the coming years. By 2030 capability rises above the 95th percentile of expected flows in all pathways which will reduce constraints in the south east.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.

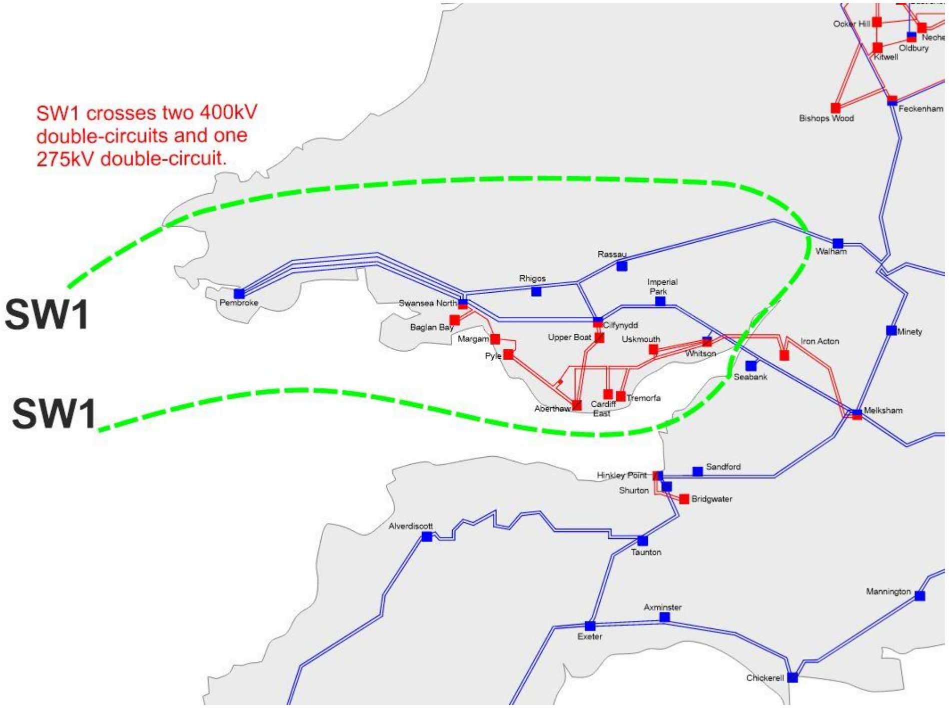


The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 10.2 GW due to a voltage constraint for a fault on the Pelham-Bramford-Braintree 400kV circuits

ETYS 2024 / South Wales & South of England 53

Boundary SW1 – South Wales

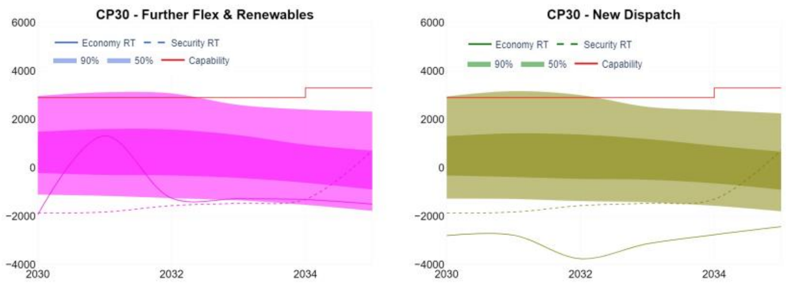


Contained within the boundary is a mixture of generation types including renewable generation and fossil fuel generation which are expected to close.

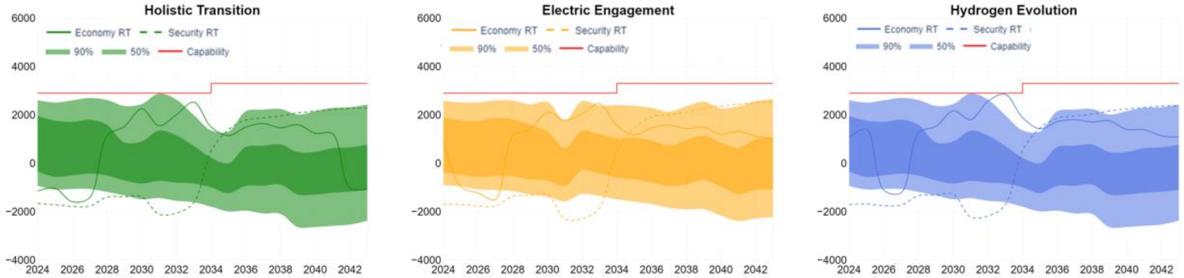
South Wales includes demand consumptions from the major cities, including Swansea and Cardiff, and the surrounding industry.

The boundary requirements are within the boundary's present capability, and we expect this to remain the case for the foreseeable future, as seen in the boundary chart.

The NESO's final recommended design for the Celtic Sea offshore sees up to 3GW of floating offshore wind connecting into South Wales, behind SW1, by 2035.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on the Clean Power 2030 pathways.



The capability line (in red) is based on the recommendations from the Beyond 2030 optimal path which uses the 2023 FES and ETYS data as inputs. The 50%, 90%, Economy RT and Security RT lines are based on FES 2024. The ETYS and NOA methodologies for this boundary are different and can result in different transfer capabilities.

The boundary capability is limited to 3.8 GW due to a thermal constraint on the Imperial Park – Melksham 400kV circuit

ETYS 2024 / South Wales & South of England 54

Further Information

NESO
National Energy
System Operator

Meet the Team

Supporting Parties

Producing the ETYS requires support and information from a range of stakeholders and internal teams. Parties who provide support and information that makes our work possible include:

- The GB electricity Transmission Owners
- The NESO Energy Insights team who provides us with FES
- Our customers

Don't forget you can email us with your views on ETYS at: Transmission.ETYS@nationalenergyso.com. You can also stay up to date with our latest developments from Strategic Network Development by signing up to the NESO's monthly newsletter.

Network Operability and Data Modelling

In our Network Operability department, we are responsible for studying a variety of power system issues including generator and HVDC compliance. We develop and produce the System Operability Framework publications.

From our Data and Modelling department we produce power system models and datasets for network analysis. We also manage the technical aspects of the GB and European electricity frameworks, codes and standards that are applicable to network development.

Network Requirements and the Electricity Ten Year Statement
Paul Obanor
GB System Capability Manager
Transmission.ETYS@nationalenergyso.com

Cost-benefit analysis for the NOA & TCSNP
Griffin John
Technical and Economic Assessment Manager
NOA@nationalenergyso.com

Head of Strategic Network Development
Paul Wakeley

System Capability Manager
Paul Obanor

Strategic Network Development

In addition to publishing the ETYS, we are responsible, together with the transmission licence holders, for developing a holistic strategy for the NETS. This includes performing the following key activities:

- The management and implementation of the Options Assessment process, which assesses the need to progress wider transmission system reinforcements.
- Producing recommendations on preferred options for NETS investment and publishing results annually.

Our most recent set of network recommendations is in the Beyond 2030 report.

NESO
National Energy System Operator

ETYS 2024 / Further Information 56

Thank you for your time

Continuing the Conversation

In terms of next steps, we welcome stakeholder engagement for our ETYS process, using your comments and questions about ETYS 2024 to inform our future analysis and insights.

Ways to connect and stay in touch

Keep an eye out for any surveys, energy articles and engagement opportunities on our NESO website www.neso.energy

You can also contact us through our ETYS email address at transmission.ETYS@nationalenergyso.com and one of our team members will be in touch.

Access our current and past ETYS documents, data, and media at the ETYS archive.

Write to us at

GB System Capability
National Energy System Operator
Faraday House
Warwick Technology Park
Warwick CV34 6DA

ETYS 2024 / Further Information 57

NESO National Energy System Operator

Glossary

NESO
National Energy
System Operator

Glossary – 1/6

Acronym	Phrase	Explanation
	Ancillary services	Services procured by a system operator to balance demand and supply and to ensure the security and quality of electricity supply across the transmission system. These services include reserve, frequency control and voltage control. In GB these are known as balancing services and each service has different parameters that a provider must meet.
ACS	Average cold spell	Average cold spell is defined as a particular combination of weather elements which gives rise to a level of winter peak demand which has a 50% chance of being exceeded as a result of weather variation alone. There are different definitions of ACS peak demand for different purposes.
	Boundary allowance	An allowance in MW to be added in whole or in part to transfers arising out of the NETS SQSS economy planned transfer condition to take some account of year-round variations in levels of generation and demand. This allowance is calculated by an empirical method described in Appendix F of the Security And Quality of Supply Standards (SQSS).
	Boundary transfer capacity	The maximum pre-fault power that the transmission system can carry from the region on one side of a boundary to the region on the other side of the boundary while ensuring acceptable transmission system operating conditions will exist following one of a range of different faults.
ASTI	Accelerated Strategic Transmission Investment	In December 2022, Ofgem published their decision to introduce a new Accelerated Strategic Transmission Investment (ASTI) framework to both assess and fund large strategic onshore electricity transmission projects and incentivise the timely delivery of these projects.
CBA	Cost-benefit analysis	A method of assessing the benefits of a given project in comparison to the costs. This tool can help to provide a comparative base for all projects to be considered.
CCS	Carbon capture and storage	Carbon capture and storage is a process by which the CO2 produced in the combustion of fossil fuels is captured, transported to a storage location and isolated from the atmosphere. Carbon capture and storage can be applied to large emission sources like power plants used for electricity generation and industrial processes. The CO2 is then compressed and transported for long-term storage in geological formations or for use in industrial processes.
	Climate change targets	Targets for share of energy use sourced from renewable sources. The 2020 UK targets are defined in the Directive 2009/28/EC of the European Parliament and of the Council of the European Union, see http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0028&from=EN#ntc1-L_2009140EN.01004601-E0001
CCGT	Combined cycle gas turbine	Gas turbine that uses the combustion of natural gas or diesel to drive a gas turbine generator to generate electricity. The residual heat from this process is used to produce steam in a heat recovery boiler which, in turn, drives a steam turbine generator to generate more electricity.
CHP	Combined heat and power	A system whereby both heat and electricity are generated simultaneously as part of one process. Covers a range of technologies that achieve this.
CT	Consumer Transformation	This scenario achieves the 2050 decarbonisation target in a decentralised energy landscape.
	Contracted generation	A term used to reference any generator who has entered into a contract to connect with the National Electricity Transmission System (NETS) on a given date while having a transmission entry capacity (TEC) figure as a requirement of said contract.
	Deterministic	A deterministic system is a system in which no randomness is involved in the development of future states of the system.
	Double-circuit overhead line	In the case of the onshore transmission system, this is a transmission line which consists of two circuits sharing the same towers for at least one span in SSEN Transmission's system or NGET’s transmission system or for at least two miles in SP Transmission’s system. In the case of an offshore transmission system, this is a transmission line which consists of two circuits sharing the same towers for at least one span.
DC	Direct current	An electric current flowing in one direction only.

ETYS 2024 / Further Information 59

Glossary – 2/6

Acronym	Phrase	Explanation
DSR	Demand side response	A deliberate change to an industrial and commercial user's natural pattern of metered electricity or gas consumption, brought about by a signal from another party.
DNO	Distribution Network Operator	Distribution Network Operators own and operate electricity distribution networks.
ENTSO-E	European Network of Transmission System Operators	Electricity ENTSO-E is an association of European electricity TSOs. ENTSO-E was established and given legal mandates by the EU's Third Legislative Package for the Internal Energy Market in 2009, which aims at further liberalising electricity markets in the EU.
ESO	Electricity System Operator	An entity entrusted with transporting electric energy on a regional or national level, using fixed infrastructure. Unlike a TO, the ESO may not necessarily own the assets concerned. For example, National Grid ESO operates the electricity transmission system in Scotland, which is owned by Scottish Hydro Electricity Transmission and Scottish Power Transmission.
EU	European Union	A political and economic union of 28 member states that are located primarily in Europe.
FACTS	Flexible alternating current transmission system	FACTS devices are static power-electronic devices that utilise series and/or shunt compensation. They are installed in AC transmission networks to increase power transfer capability, stability, and controllability of the networks.
FES	Future energy scenarios	The FES is a range of credible futures which has been developed in conjunction with the energy industry. They are a set of scenarios covering the period from now to 2050, and are used to frame discussions and perform stress tests. They form the starting point for all transmission network and investment planning, and are used to identify future operability challenges and potential solutions.
	FLOP Zone	To simplify the description and analysis of the transmission network, it is mapped to a set of zones, known as FLOP zones. Each zone contains the nodes and circuits within a defined area of the transmission network. The zones have been created in such a way that our ETYS boundaries can be defined using a list of the zones on one side of the boundary. Note that these zones are defined electrically, meaning that they are defined by the circuits that they cross rather than a specific geographical area.
GEP	Grid entry point	A point at which a generating unit directly connects to the National Electricity Transmission System. The default point of connection is taken to be the busbar clamp in the case of an air insulated substation, gas zone separator in the case of a gas insulated substation, or equivalent point as may be determined by the relevant transmission licensees for new types of substation. When offshore, the GEP is defined as the low voltage busbar on the platform substation.
GSP	Grid supply point	A point of supply from the GB transmission system to a distribution network or transmission-connected load. Typically only large industrial loads are directly connected to the transmission system.
GTYS	Gas Ten Year Statement	The GTYS illustrates the potential future development of the (gas) National Transmission System (NTS) over a ten year period and is published on an annual basis.
GW	Gigawatt	1,000,000,000 Watts, a measure of power.
GWh	Gigawatt hour	1,000,000,000 Watt hours, a unit of energy.
GB	Great Britain	A geographical, social and economic grouping of countries that contains England, Scotland and Wales.
HND	Holistic Network Design	The Holistic Network Design (HND) is a first of its kind, integrated approach for connecting 23GW of offshore wind to Great Britain. By considering future offshore generation out to 2030, infrastructure can be planned to bring power to the grid cohesively, ensuring maximum benefit for consumers, local communities and the environment.

ETYS 2024 / Further Information 60

Glossary – 3/6

Acronym	Phrase	Explanation
HVAC	High voltage alternating current	Electric power transmission in which the voltage varies in a sinusoidal fashion, resulting in a current flow that periodically reverses direction. HVAC is presently the most common form of electricity transmission and distribution, since it allows the voltage level to be raised or lowered using a transformer.
HVDC	High voltage direct current	The transmission of power using continuous voltage and current as opposed to alternating current. HVDC is commonly used for point to point long-distance and/or subsea connections. HVDC offers various advantages over HVAC transmission, but requires the use of costly power electronic converters at each end to change the voltage level and convert it to/from AC.
	Interconnector	Electricity interconnectors are transmission assets that connect the GB market to Europe and allow suppliers to trade electricity between markets.
LCPD	Large Combustion Plant Directive	The Large Combustion Plant Directive is a European Union directive which introduced measures to control the emissions of sulphur dioxide, oxides of nitrogen and dust from large combustion plant.
LW	Leading the Way	A scenario from the Future Energy Scenarios (FES) where net zero is achieved at the fast pace with a high level of societal change and a rapid speed of decarbonation
	Load factor	The average power output divided by the peak power output over a period of time.
	Marine technologies	Tidal streams, tidal lagoons and energy from wave technologies (see http://www.emec.org.uk/).
MW	Megawatt	1,000,000 Watts, a measure of power.
MWh	Megawatt hour	1,000,000 Watt hours, a measure of power usage or consumption in 1 hour.
	Merit order	An ordered list of generators, sorted by the marginal cost of generation.
MITS	Main Interconnected Transmission System	This comprises all the 400kV and 275kV elements of the onshore transmission system and, in Scotland, the 132kV elements of the onshore transmission system operated in parallel with the supergrid, and any elements of an offshore transmission system operated in parallel with the supergrid, but excludes generation circuits, transformer connections to lower voltage systems, external interconnections between the onshore transmission system and external systems, and any offshore transmission systems radially connected to the onshore transmission system via single interface points.
NETS	National Electricity Transmission System	The National Electricity Transmission System comprises the onshore and offshore transmission systems of England, Wales and Scotland. It 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. It is owned and maintained by regional transmission companies, while the system as a whole is operated by a single Electricity System Operator (ESO).
NETS SQSS	National Electricity Transmission System Security and Quality of Supply Standards	A set of standards used in the planning and operation of the National Electricity Transmission System of Great Britain. For the avoidance of doubt, the National Electricity Transmission System is made up of both the onshore transmission system and the offshore transmission systems.
NGET	National Grid Electricity Transmission plc	National Grid Electricity Transmission plc (No. 2366977) whose registered office is 1-3 Strand, London, WC2N 5EH.

ETYS 2024 / Further Information 61

Glossary – 4/6

Acronym	Phrase	Explanation
	Network access	Maintenance and system access is typically undertaken during the spring, summer and autumn seasons when the system is less heavily loaded, and access is favourable. With circuits and equipment unavailable, the integrity of the system is reduced. The planning of system access is carefully controlled to ensure system security is maintained.
NOA	Network Options Assessment	The NOA is the process for assessing options for reinforcing the National Electricity Transmission System (NETS) to meet the requirements that the Electricity System Operator (ESO) finds from its analysis of the Future Energy Scenarios (FES).
OFGEM	Office of Gas and Electricity Markets	The UK's independent National Regulatory Authority, a non-ministerial government department. Their principal objective is to protect the interests of existing and future electricity and gas consumers.
	Offshore	This term means wholly or partly in offshore waters.
	Offshore transmission circuit	Part of an offshore transmission system between two or more circuit breakers which includes, for example, transformers, reactors, cables, overhead lines and DC converters but excludes busbars and onshore transmission circuits.
	Onshore	This term refers to assets that are wholly on land.
	Onshore transmission circuit	Part of the onshore transmission system between two or more circuit breakers which includes, for example, transformers, reactors, cables and overhead lines but excludes busbars, generation circuits and offshore transmission circuits.
OCGT	Open cycle gas turbine	Gas turbines in which air is first compressed in the compressor element before fuel is injected and burned in the combustor.
	Peak demand	The maximum power demand in any one fiscal year: Peak demand typically occurs at around 5:30pm on a week-day between December and February. Different definitions of peak demand are used for different purposes.
PA	Per annum	per year.
PV	Photovoltaic	A method of converting solar energy into direct current electricity using semi-conducting materials.
	Planned transfer	A term to describe a point at which demand is set to the National Peak when analysing boundary capability.
	Power supply background (aka generation background)	The sources of generation across Great Britain to meet the power demand.
	Probabilistic	Model or approach where there are multiple possible outcomes, each having varying degrees of certainty or uncertainty of occurrence. This is based on the idea that you cannot be certain about results or future events but you can judge whether or not they are likely, and act on the basis of this judgment.
QB	Quadrature booster	A quadrature booster is a type of transformer also known as a phase shifting transformer and it is used to control the amount of real power flow between two parallel lines.
	Ranking order	A list of generators sorted in order of likelihood of operation at time of winter peak and used by the NETS SQSS.

ETYS 2024 / Further Information 62

Glossary – 5/6

Acronym	Phrase	Explanation
	Reactive power	Reactive power is a concept used by engineers to describe the background energy movement in an alternating current (AC) system arising from the production of electric and magnetic fields. These fields store energy which changes through each AC cycle. Devices which store energy by virtue of a magnetic field produced by a flow of current are said to absorb reactive power; those which store energy by virtue of electric fields are said to generate reactive power.
	Real power	This term (sometimes referred to as "Active Power") provides the useful energy to a load. In an AC system, real power is accompanied by reactive power for any power factor other than 1.
	Seasonal circuit ratings	The current carrying capability of circuits. Typically, this reduces during the warmer seasons as the circuits' capability to dissipate heat is reduced. The rating of a typical 400kV overhead line may be 20% less in the summer than in winter.
SCADA	Supervisory control and data acquisition	A control system architecture comprising computers, networked data communications and graphical user interfaces for high-level supervision of machines and processes.
	SSEN Transmission	Scottish Hydro-Electric Transmission (No.SC213461) whose registered office is situated at Inveralmond HS, 200 Dunkeld Road, Perth, Perthshire PH1 3AQ.
SP	Steady Progression	This scenario makes progress towards decarbonisation through a centralised pathway, but does not achieve the 2050 target.
	SP Transmission	Scottish Power Transmission Limited (No. SC189126) whose registered office is situated at Ochil House, 10 Technology Avenue, Blantyre G72 0HT.
	Summer minimum	The minimum power demand of the transmission network in any one fiscal year. Minimum demand typically occurs at around 06:00am on a Sunday between May and September.
	Supergrid	That part of the National Electricity Transmission System operated at a nominal voltage of 275kV and above.
SGT	Supergrid transformer	A term used to describe transformers on the NETS that operate in the 275–400kV range.
	Switchgear	The term used to describe components of a substation that can be used to carry out switching activities. This can include, but is not limited to, isolators/disconnectors and circuit breakers.
	System inertia	The property of the system that resists changes. This is provided largely by the rotating synchronous generator inertia that is a function of the rotor mass, diameter and speed of rotation. Low system inertia increases the risk of rapid system changes.
	System operability	The ability to maintain system stability and all of the asset ratings and operational parameters within pre-defined limits safely, economically and sustainably.
SOF	System Operability Framework	The SOF identifies the challenges and opportunities which exist in the operation of future electricity networks and identifies measures to ensure the future operability
	System stability	With reduced power demand and a tendency for higher system voltages during the summer months, fewer generators will operate and those that do run could be at reduced power factor output. This condition has a tendency to reduce the dynamic stability of the NETS. Therefore network stability analysis is usually performed for summer minimum demand conditions as this represents the limiting period.

ETYS 2024 / Further Information 63

Glossary – 6/6

Acronym	Phrase	Explanation
	System stability	With reduced power demand and a tendency for higher system voltages during the summer months, fewer generators will operate and those that do run could be at reduced power factor output. This condition has a tendency to reduce the dynamic stability of the NETS. Therefore network stability analysis is usually performed for summer minimum demand conditions as this represents the limiting period.
ST	System Transformation	Scenario from the Future Energy Scenarios (FES) where the target of reaching net zero is achieved by a moderate level of societal change and a low-moderate level of decarbonisation
	Thermal Constraint	The maximum power transfer achievable without exceeding the heat dissipation limitations of the circuits.
	Transmission circuit	This is either an onshore transmission circuit or an offshore transmission circuit.
TEC	Transmission entry capacity	The maximum amount of real power deliverable by a power station at its grid entry point (which can be either onshore or offshore). This will be the maximum power deliverable by all of the generating units within the power station, minus any auxiliary loads.
	Transmission losses	Power losses that are caused by the electrical resistance of the transmission system.
TO	Transmission Owners	A collective term used to describe the three transmission asset owners within Great Britain, namely National Grid Electricity Transmission, Scottish Hydro–Electric Transmission Limited and SP Transmission Limited.
TSO	Transmission System Operators	An entity entrusted with transporting energy in the form of natural gas or electricity on a regional or national level, using fixed infrastructure.
	Voltage Constraint	The transmission operation limitation to maintain transmission assets within statutory limits. The limits are to keep assets witing safe and secure voltage ranges.

ETYS 2024 / Further Information 64

NESO
National Energy
System Operator