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Yorkshire Green Project
Document control

Version History

Document	Version	Status	Description / Changes
01/11/2022	A	FINAL	First Issue

1. Introduction

1.1 This Updated Needs Case Report (this Report) has been prepared by National Grid Electricity Transmission plc (National Grid) to support an application to the Secretary of State for Business, Energy and Industrial Strategy (Secretary of State) for development consent for the Yorkshire Green Energy Enablement Project (the Yorkshire GREEN Project).

1.2 This Report provides an overview of the need case for the Yorkshire Green Project setting out the drivers for change, including the increase in electricity generation and how this affects the National Electricity Transmission System. The Report structure is as follows: -

- Background - An overview of National Grid's role and obligations (**Section 2**);
- The Yorkshire GREEN Need Case (**Section 3);** and
- Conclusions (**Section 4**)

2. Background

2.1 In 2019 the Committee on Climate Change (CCC) published its Net Zero report[1] setting out recommendations to the UK Government on long-term emissions targets for the UK. The Government subsequently adopted the Climate Change Act 2008 (2050 Target Amendment) Order 2019[2], which increased its pledge to 100% reduction in emissions by 2050. One of the ways this will be achieved is through decarbonisation, including moving away from fossil fuels providing energy to our homes and businesses. The vision for a transition to clean energy was set out in December 2020 with the publication of the Energy White Paper[3], which added further detail to the Prime Minister's Ten Point Plan for a Green Industrial Revolution. This requires the adoption of alternative sources of energy to power our homes, transport and businesses.

2.2 As a result, electricity production is now moving towards reducing greenhouse gas emissions, by increasing renewable and low carbon sources, such as offshore and onshore wind, solar energy and new nuclear generation. The National Infrastructure Commission (NIC) have recently published a report recommending to the UK Government that renewable generation[4] can be increased to 65% of supply by 2030 at no adverse cost to consumers, enabling the decarbonisation in part of sectors such as transport and heating via electrification.

2.3 Following the publication of the NIC Report, the UK Government published the British Energy Security Strategy[5] in April 2022 setting out a strategy for secure, clean and affordable British energy for the long term. This strategy sets out energy ambition across a number of sectors such as:

- Up to 8 Reactors of Nuclear energy being progressed reaching up to 24GW to be achieved by 2050;
- Up to 50GW of offshore wind connected by 2030 including 5GW of which will be offshore floating wind;
- Up to 10GW of low carbon hydrogen production capacity by 2030, doubling the previous ambition; and
- 600,000 heat pump installations a year by 2028 and improving housing stock insulation.

[1] Committee on Climate Change, Net Zero the UK's Contribution to stopping global warming (2019). Available at: [redacted] (Accessed: 1 November 2022)

[2] Climate Change Act 2008 (2050 Target Amendment) Order 2019. Available at: https://www.legislation.gov.uk/uksi/2019/1056/contents/made (Accessed 1 November 2022).

[3] HM Government (2020). Energy White Paper: Powering our Net Zero Future.

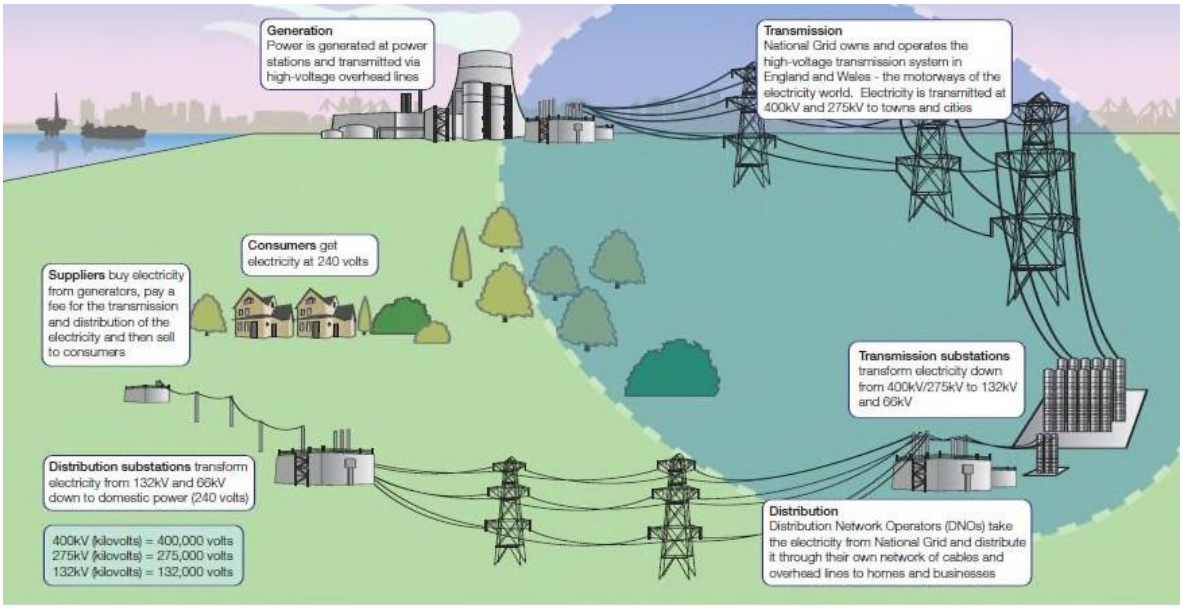
[4] National Infrastructure Commission, Operability of highly renewable electricity systems (2021). Available at [redacted] (Accessed 1 November 2022).

[5] HM Government (2022). Department for Business, Energy & Industrial Strategy. Policy paper: British energy security strategy. Available at: https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy (Accessed 1 November 2022)

2.4 To facilitate these ambitions, electricity network infrastructure is needed to ensure that energy can be transported from where it is generated to where it is used.

2.5 The existing transmission system operates at 400 kV and 275 kV and transports bulk supplies of electricity from generating stations to demand centres. Distribution systems operate at 132 kV and below in England and Wales and are mainly used to transport electricity from bulk infeed points (interface points with the transmission system) to the majority of end customers. See **Figure 2.1**, below**.**

Figure 2.1: The electricity system from generator to consumer



2.6 A single electricity market serves the whole of Great Britain. In this competitive wholesale market, generators and suppliers trade electricity on a half hourly basis. Generators produce electricity from a variety of energy sources, including coal, gas, nuclear and wind, and sell energy produced in the wholesale market. Suppliers purchase electricity in the wholesale market and supply to end customers.

2.7 Electricity can also be traded on the single market in Great Britain by generators and suppliers in other European countries. Interconnectors with transmission systems in France, Northern Ireland, Belgium, Denmark and the Netherlands are used to import electricity to and/or export electricity from the transmission system.

National Grid's Role

2.8 Transmission of electricity in Great Britain requires permission by a licence granted under Section 6(1)(b) of the Electricity Act 1989[6] (as amended) (the Electricity Act). National Grid has been granted a transmission licence (the Transmission Licence) and is therefore bound by legal obligations, which are primarily set out in the Electricity Act and the Transmission Licence

2.9 National Grid Electricity Transmission (NGET) which is part of the National Grid Group of companies is the licensed entity and owner of the high voltage transmission system in England and Wales and is referred to as "National Grid" within this report.

2.10 Part of National Grid's role is to provide the contractual interface with demand customers, generators and interconnectors that are seeking to connect to, or are connected to, the National Electricity Transmission System (NETS).

[6] *Electricity Act 1989,* c. 29. Available at: <https://www.legislation.gov.uk/ukpga/1989/29/contents> (Accessed: 20 October 2022).

National Grid's Existing Transmission System

2.11 The existing transmission system was developed to transport electricity in bulk from power stations to demand centres. Much of National Grid's transmission system was originally constructed in the 1960s. Incremental changes to the transmission system have subsequently been made to meet increasing customer demand and to connect new power stations and interconnectors with other transmission systems.

2.12 National Grid's transmission system consists of approximately 7,200 km of overhead lines and a further 700 km of underground cabling, operating at 400 kV and 275 kV. In general, 400 kV circuits have a higher power carrying capability than 275 kV circuits. These overhead line and underground cable circuits connect between around 340 substations forming a highly interconnected transmission system. Further details of the transmission system including geographic and schematic representations are published by the Electricity System Operator (National Grid ESO) annually as part of its Electricity Ten Year Statement (ETYS).

2.13 Circuits are those parts of the system used to connect between substations on the transmission system. The system is mostly composed of double-circuits (in the case of overhead lines carried on two sides of a single pylon) and single-circuits. Substations provide points of connection to the transmission system for power stations, distribution networks, transmission connected demand customers (e.g. large industrial customers) and interconnectors.

Requirement for Changes to the Transmission System

2.14 Under the terms of the Transmission Licence, National Grid is required to provide an efficient, economic and co-ordinated transmission system in England and Wales. The transmission infrastructure needs to be capable of maintaining a minimum level of security of supply and of transporting electricity from and to customers. National Grid is required to ensure that its transmission system remains capable as customer requirements change.

2.15 The transmission system needs to cater for demand, generation and interconnector changes. Customers can apply to National Grid for new or modified connections to the transmission system; National Grid is then required to respond to each customer application with an offer for new or modified connection.

2.16 Recently, a large volume of applications have been made to National Grid for connection at locations that are more remote from the existing transmission system or which are in the vicinity of parts of the transmission system that does not have sufficient capacity available for the new connection.

2.17 National Grid has a key role providing a transmission system which benefits all consumers in England and Wales. As a monopoly National Grid is regulated by the Office of Gas and Electricity Markets (Ofgem) on behalf of consumers and are required to operate in accordance with the Transmission Licence. This includes maintaining reliable electricity supplies and offering to connect new energy suppliers. Where the network needs to be developed to do that, National Grid must be efficient, co-ordinated and economical and have regard to the desirability of preserving amenity, in line with the duties under section 9 and 38 of the Electricity Act.

2.18 In developing new network infrastructure proposals, National Grid is therefore guided by the legislative and policy framework set by the UK Government.

Electricity System Operator role in development of the Transmission System

2.19 The Electricity System Operator (ESO) is independent of the transmission owner but as of 2022 is still part of the National Grid Group. The ESO facilitates several roles on behalf of the electricity industry which complement National Grid's strategic options appraisal process.

2.20 The ESO have annual processes to publish the Electricity Ten Year Statement (ETYS), which sets out the development of all transmission in Great Britain over the next 10 years.

2.21 The ESO have annual processes to publish the Future Energy Scenarios (FES) which takes a number of energy industry views as part of a consultation process and develops a set of possible energy growth scenarios.

2.22 The ESO have an annual process to evaluate the Network Options Assessment (NOA). This document takes into account the ETYS and FES to establish via a Cost Benefit Analysis (CBA) process when it is right to take forward options proposed by transmission owners to increase network capacity. This considers the capital cost of the proposal, delivery timescales and constraint costs (as explained further below) avoided by delivering the proposal. This establishes when a proposed reinforcement becomes the most economic, efficient and coordinated way to deliver value to Great Britain energy consumers.

2.23 The ESO have also launched the Offshore Transmission Network Review (OTNR), having published a resulting Holistic Network Design (HND) [7]document in summer 2022.

[7] National Grid ESO. (2022). Pathway to 2030. A holistic network design to support offshore wind deployment for net zero. (online) (Accessed October 2022).

3. Yorkshire GREEN Need Case

3.1 The electricity industry in Great Britain is undergoing unprecedented change. Closure of fossil fuel burning generation and end of life nuclear power stations means significant additional investment in new generating and interconnection capacity will be needed to ensure existing minimum standards of security and supply are maintained.

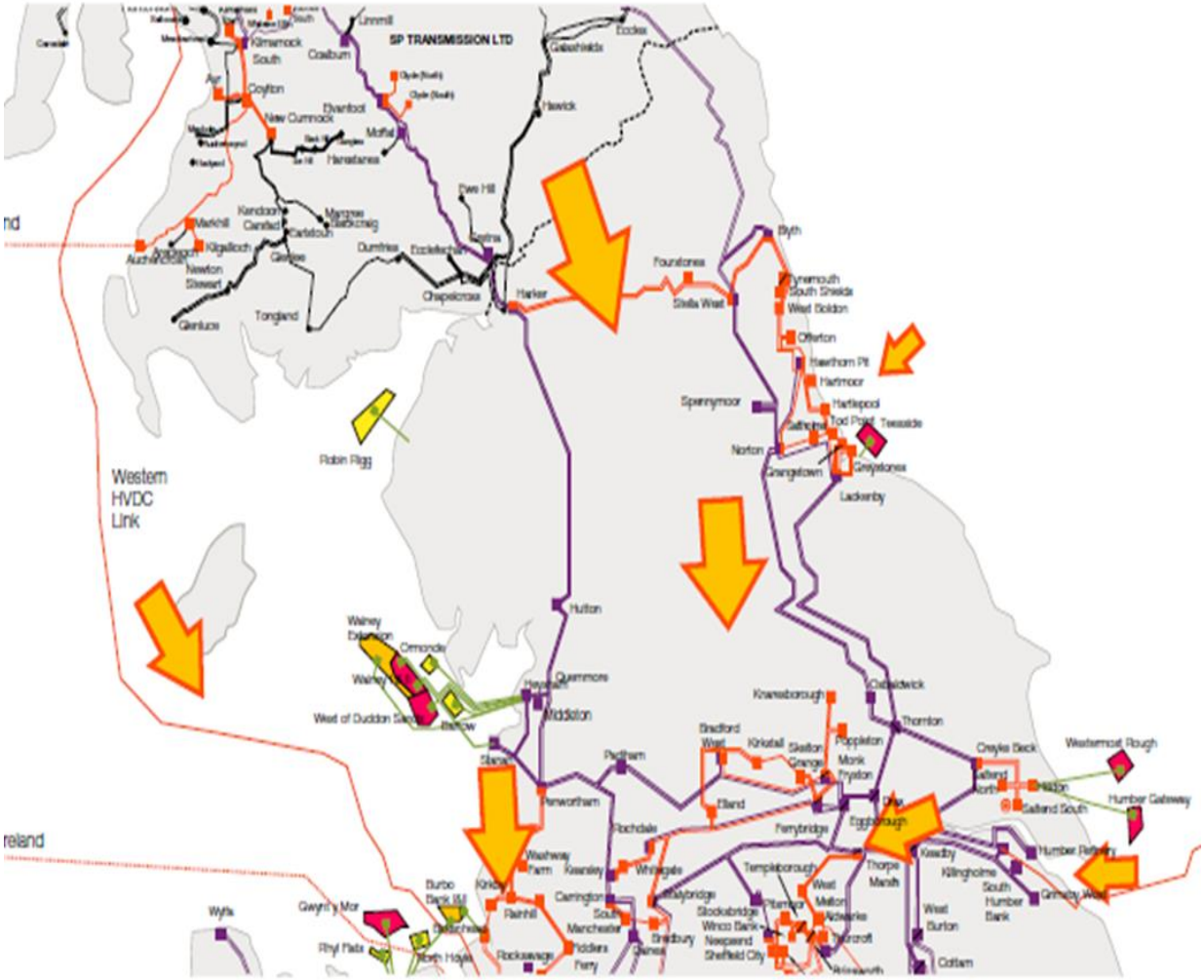
3.2 Growth in offshore wind generation and interconnectors to Europe have seen a significant number of connections planned in Scotland and coastal areas of the North of England. The Climate Change Act 2008 and Climate Change Act (2050 Target Amendment) Order 2019 commits the UK Government by law to reducing greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050, strengthening the likelihood of the majority of these connections progressing to delivery.

3.3 The existing transmission network infrastructure in the Yorkshire area was not originally designed to transfer the growing volumes of generation capacity from the North. The network will require significant reinforcements to provide capacity for these connections and customers to ensure that power can be transferred securely to the onshore demand centres to meet the needs of Great Britain electricity consumers.

Existing North of England transmission network

3.4 The North of England Transmission Region includes the transmission network between the Scottish border and the north Midlands. This is shown in **Figure 3.1** below:

Figure 3.1 North of England Transmission Systems and indicative Power flows



3.5 The indicative power flows in **Figure 3.1** show how the majority of flow is north to south, with high flows across the Scottish border combining with flows of power entering the system in the North of England. In times of good and high wind conditions across Scotland this power flow exceeds the capability of the transmission network.

3.6 The expected new connections which result in significant power flows in the northeast are shown in **Table 3.1** below. This forms part of the contracted generation background establishing the need set out in this document. A generator enters the contracted background once it has a signed an agreement for connection, with its contracted date being the date it can have full capacity access to the system.

Table 3.1 Contracted New Generation Connections in North-East area

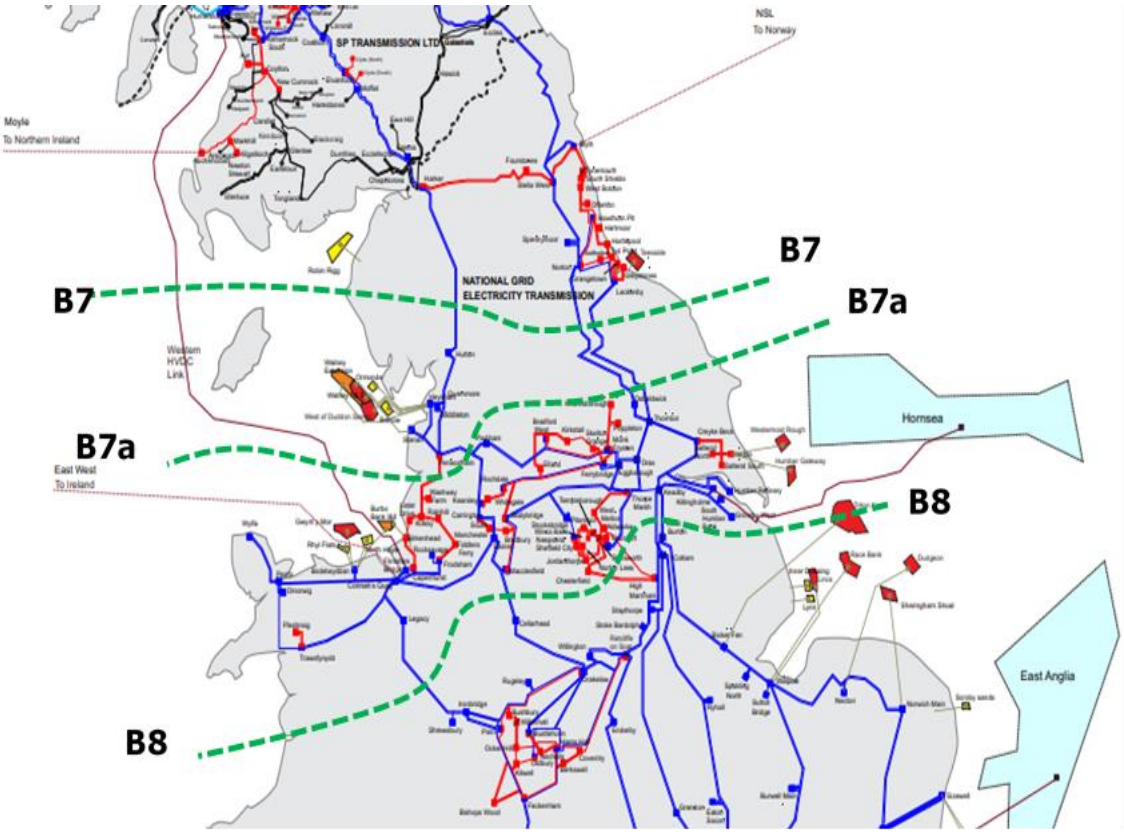
Description	Capacity(MW)	Contracted Date
EGL 2	2000	2027
Sofia Offshore Wind Farm	1320	2024
Tees CCCP 1	850	2023
Tees CCCP 2	850	2027
Dogger Bank P4	1200	2024
Dogger Bank A	1200	2023
Dogger Bank C	1200	2025
Continental link	1800	2027
Hornsea Power Station 3	2250	2026
Hornsea Power Station 3 pt2	750	2028
Hornsea Power Station 4	1500	2027
Hornsea Power Station 4 pt2	1100	2028
C gen Killingholme	540	2023
Atlantic Superconnector	1000	2027
Total	17560	

3.7 National Grid must remain compliant with Section 9 of the Electricity Act and Standard Condition D3 (Transmission system security standard and quality of service) of National Grid's Transmission Licence. This means that where boundary capacity of the Main Interconnected Transmission System (MITS) is exceeded against the standards, National Grid must resolve the capacity shortfall under the terms of its Transmission Licence. The standards against which National Grid assesses these shortfalls are set out in the MITS section of the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS).

3.8 Standard Condition D16 (Requirements of a connect and manage connection) of the Transmission Licence, allows for constraints to remain on the system until they can be resolved, however this should be achieved economically. The Electricity System operator can manage any shortfall in boundary capacity by reducing the power flows. This is achieved by constraining generation and paying for generators to reduce output. When this cost becomes larger than any required investment to resolve the capacity constraint, it is considered right to proceed with investment to remove the constraint.

3.9 The MITS Section of the NETS SQSS considers the concept of flows across defined boundaries set across the network. **Figure 3.1** shows the main boundaries affected by high power flows in the North of England namely B7, B7a and B8.

Figure 3.2 B7, B7a and B8 boundaries



3.10 A boundary is defined by an area which has demand greater than 1,500MW and must meet the criteria for design of the Main Interconnected Transmission System (MITS) set out in the NETS SQSS. Within boundaries the generation is scaled to levels set within the NETS SQSS and an interconnection allowance is applied to accommodate the variation of output between the boundary areas. The interconnection allowance stresses the boundary differently depending on if the boundary is importing or exporting. For the boundaries above, powers flows are always exported from north of the boundary to the south of the boundary.

3.11 The boundaries considered as part of the needs case shown in figure 3.2 for this Report are as follows

- B7 – Cutting across three 400kV double circuits and Western HVDC link;
- B7a – Cutting across three 400kV double circuits, one 275kV double circuit and Western HVDC link;
- B8 – Cutting across four 400kV double circuits and a 275kV double circuit connections to south Yorkshire.

3.12 When undertaking the boundary study, the flow is set to levels of generation that require to be accommodated across the intact network when all circuits are available, this is the pre-fault capacity. Then the post fault capacity is established by applying the worst-case fault to the network of two circuits being lost across the boundary. The future required transfer is considered and if the flow exceeds the post fault capacity the system will need reinforcement to remain compliant with the NETS SQSS by 2027.

3.13 For boundaries B7, B7a and B8, **Table 3.2** summarises:

- the existing capacity pre-fault, when the network is intact;
- the capacity post-fault, when the worst fault required to be considered by the NETS SQSS is applied;
- the future required transfer following the connection of new generation, demand or interconnectors shown in **Table 3.1**; and increased flows across the boundary;
- the difference between the future transfer and post fault capacity.

Table 3.2 Boundary Transfer requirements for B7, B7a and B8

Boundary or Group	Pre-fault Capacity (MW)	Post-Fault Capability (MW)	Future Transfer 2027 (MW)	Deficit between Post-fault capacity and Future transfer (MW)
B7	6,357 MW	6,060 MW	10,000 MW	**-3940 MW**
B7a	7,395 MW	6,060 MW	14,000 MW	**-7940 MW**
B8	13,900 MW	9,980 MW	15,000 MW	**-5020 MW**

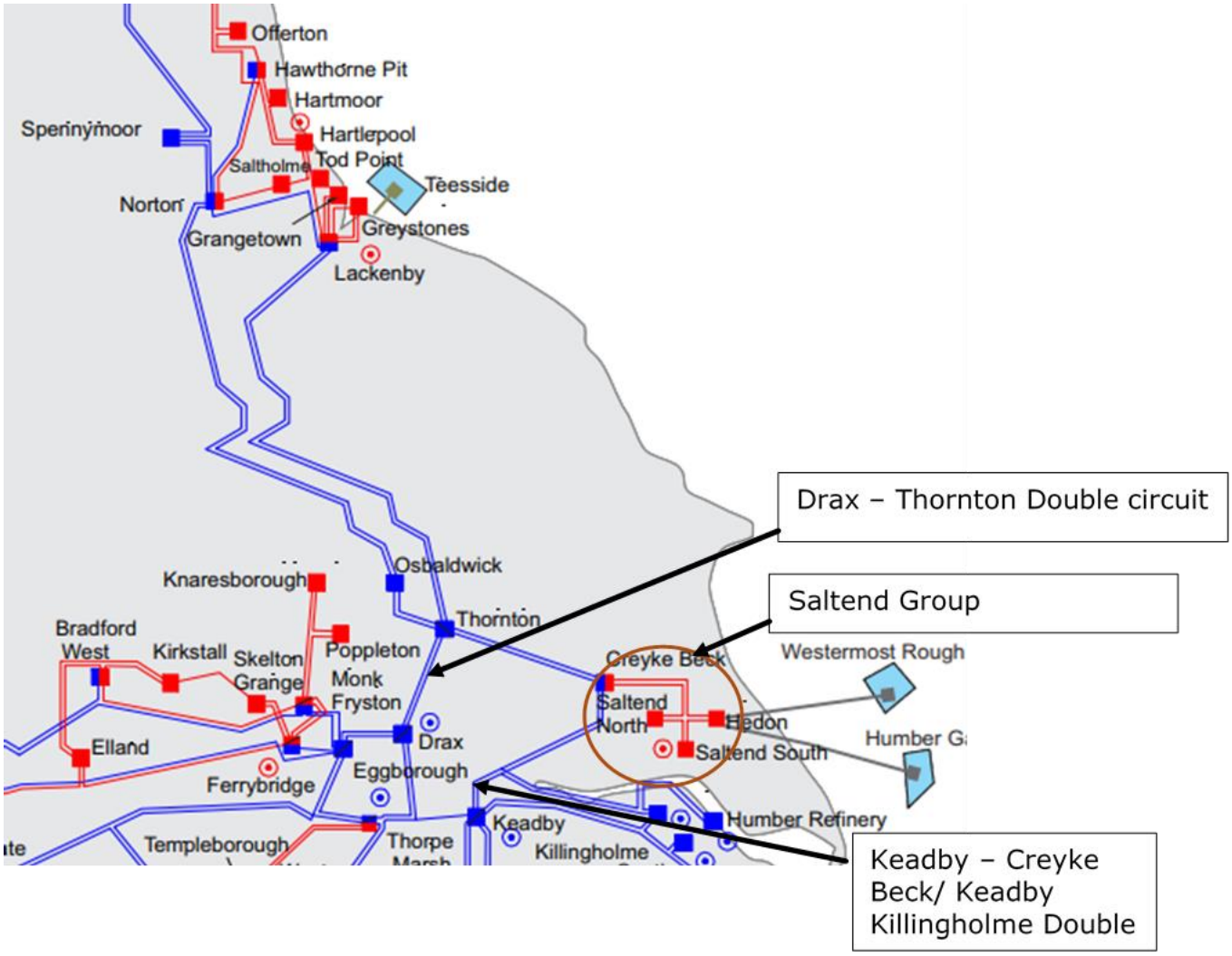
3.14 **Table 3.2** demonstrates the future transfer and shortfall across the B7, B7a and B8 boundaries by 2027. Boundaries B7, B7a and B8 exceed their post fault capacity by greater than circa 4,000 MW on every boundary. This means there can be no further unconstrained connections above boundary B8 until the shortfalls are resolved.

3.15 This NETS SQSS analysis, is further supported by the ESO Future Energy Scenarios (FES) document which indicates that for the four scenarios considered in the FES, from 10,000 MW to between 20,000 MW to 30,000 MW is required in increased capacity by 2040. This supports the urgent need to reinforce the transmission network in this area.

Impact upon the Local Yorkshire Network

3.16 **Figure 3.3** below depicts the Yorkshire network in detail, with two 400kV double circuits feeding into Thornton 400kV Substation from the north. A further two 400kV double circuits from Thornton 400kV Substation take power south towards the Humber and Drax.

Figure 3.3 Yorkshire Transmission Network



3.17 With the increase in boundary flows set out in **Table 3.2** above, the loss of any of the four circuits that feed Thornton 400kV would result in significant overloading of the remaining circuit.

3.18 The most onerous fault would be the loss of the Creyke Beck to Keadby / Keadby – Killingholme and Cottam to Keadby double circuit transmission line, which would leave the remaining Drax – Thornton Creyke to Humber Refinery to Keadby and Keadby to West Burton number 1 circuits as the only route for flows from the South Humber group. This would lead to the Keadby to West Burton number 1 circuit becoming the bottleneck with overloads of 3476 MW observed under this scenario which exceed the circuit rating of 3326 MW by 150 MW.

3.19 Conversely, a fault on the Drax – Thornton double circuit would result in overloading of the remaining circuits from Creyke Beck to Keadby, in particular the Creyke Beck to Keadby to Killingholme circuit. Operational actions can be taken to alleviate the constraint however, this moves the issue onto the Keadby to West Burton number 1 circuit. Overloads of 3396 MW have been observed under this scenario which exceed the circuit rating of 3326 MW by 70 MW.

3.20 As part of the ESO annual ETYS and FES assessment, the ESO have established that the constraints described in this Report would add constraint costs exceeding the costs of reinforcement of the network. These costs feed through ultimately to consumer and business energy bills.

3.21 Three of the contracted generators listed in **Table 3.1** are contributory to the overloads described in **Table 3.2** and have a requirement for reinforcement to be undertaken before they connect, with signed contracts in place to that effect. They are Continental Link, The Atlantic Superconnection and Hornsea Offshore Phase 4. These projects are described below:

- Continental Link – A 1.8GW Interconnector between England and Norway to connect in the Creyke Beck Substation, close to Hull, by 2027;
- The Atlantic Superconnection - A 1GW Interconnector from Iceland expected to connect in the Creyke Beck Substation, close to Hull, by 2027; and
- Hornsea Offshore P4 - 2 phased connection application for 2.6GW (1.5GW in 2027 and 1.1GW in 2028) of offshore wind generation with an offer to connect in the North East in April 2027 and October 2028 respectively.

3.22 Failure to deliver reinforcements to resolve the need set out in this Report would result in commercial restrictions for these contracted generators, and limit future flows from northern areas of Great Britain. This restriction is in conflict with National Grid's obligations to deliver connections and maintain the system to the requirements of the NETS SQSS.

4. Conclusions

4.1 In line with the UK government's legal commitment to reduce greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050, growth in offshore wind generation and interconnectors to Europe has seen a significant number of connections planned in Scotland and coastal areas of the North of England.

4.2 The existing electricity transmission network was not designed to transfer the current and increasing volume of generation capacity from the North to major centres of electricity demand which continue to exist in central and southern England. The network will require significant reinforcement in the Yorkshire area to provide capacity for these connections and customers to ensure that power can be transferred securely to onshore demand centres in the south to meet the needs of Great Britain electricity consumers.

4.3 National Grid Electricity Transmission (National Grid) has obligations under its Transmission Licence to provide an efficient, economic and co-ordinated transmission system in England and Wales. National Grid is required at all times to plan and develop the transmission system in accordance with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS) and to offer connections to and/or use of the transmission system via the National Grid Electricity System Operator (ESO).

4.4 The growth in generation and interconnectors to Europe and rising transfers of onshore and offshore wind from Scotland, alongside connections in the northern regions of England, means that by 2027, boundaries B7, B7a and B8 of the transmission system will exceed their current capacity.

4.5 This assessment is supported by both the Network Options Assessment (NOA) and the Future Energy Scenarios (FES) which are undertaken by the Electricity System Operator, independently of National Grid as the transmission owner. The FES identified that from 10,000 MW to between 20,000 MW to 30,000 MW is required in increased capacity by 2040 driven by generation to achieve net zero targets.

4.6 The National Grid (ESO) manages shortfalls in boundary capacity by reducing power flows and constraining generation. This is achieved by paying generators to reduce their outputs, known as 'constraint costs'. Ultimately, constraint costs are passed on to consumers and businesses through electricity bills. When constraint costs become higher than the cost of investment required to reinforce the network (and remove the need for constraint costs) it is considered right to proceed with investment for reinforcement. Without reinforcement by 2027 there can be no further unconstrained connections above boundary B8.

4.7 In addition, the following three contracted customers have connection offers which are reliant on reinforcement of the network:

- Continental Link – A 1.8GW Interconnector between England and Norway to connect in the Creyke Beck Substation, close to Hull, by 2027
- The Atlantic Superconnection - A 1GW Interconnector from Iceland expected to connect in the Creyke Beck Substation, close to Hull, by 2027
- Hornsea Offshore P4 - 2 phased connection application for 2.6GW (1.5GW in 2027 and 1.1GW in 2028) of offshore wind generation with an offer to connect in the North East in April 2027 and October 2028 for each phase respectively.

4.8 Therefore, there is an urgent need to reinforce the network in the Yorkshire area by 2027 in order to enable connection of three contracted customers; ensure future connections of renewable generation can be connected without incurring significant constraint costs; facilitate net zero ambitions; and meet National Grid's transmission licence obligations.

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