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OUR ELECTRICITY TRANSMISSION NETWORK:

A VISION FOR 2020

A Report by the Electricity Networks Strategy Group

March 2009

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FOREWORD

by the Joint Chairs of ENSG

This report produced by the Electricity Networks Strategy Group (ENSG) is an important contribution to the ongoing work to identify solutions which will allow the creation of a network which facilitates the achievement of Government's energy and climate change policy in an economic and efficient manner. This includes the achievement of the 2020 renewable targets as well as ensuring that electricity supply remains secure and affordable.

During the Transmission Access Review (TAR), Government and Ofgem considered the changes that are required to facilitate the timely connection of new generation. The Review was conducted because network access is seen as a barrier to entry for new generators, particularly renewable ones. In June 2008, the TAR Final Report[1] made a number of recommendations on how to improve transmission access. At the same time, Government published its Renewable Energy Strategy consultation. In both documents, Ofgem and Government asked the transmission companies to initiate work to identify the transmission reinforcements needed to support the 2020 targets. Ofgem and Government also invited the Energy Networks Strategy Group to provide critical industry-wide input to this work.

We are pleased that all parties have delivered on their commitment to publish this 2020 study. The study, which is supported by technical and economic analysis, sets out options for reinforcing the transmission network that demonstrate the way in which the networks can facilitate achievement of our ambitious renewable energy targets.

From now until 2020 and beyond, the electricity transmission system will change significantly. Managing this change will require the electricity industry to tackle new legal, technical, commercial and regulatory challenges.

Government is working on a range of policy initiatives to help enable the electricity transmission network to develop to accommodate significant levels of generation from a range of different sources. A key step in ensuring that the projects identified by the Energy Networks Strategy Group can be built on time is the Government's further work on simplifying and streamlining the GB planning regime and integrating this process with the National Policy Statements.

1 http://www.ofgem.gov.uk/Networks/Trans/ElecTransPolicy/tar/Documents1/080626_TAR%20Final%20Report_FINAL.pdf

It is Ofgem's responsibility to determine the level of revenue that can be earned by the transmission companies, including the provision of appropriate funding for their investment activities. The 2020 study will be one of a number of important inputs to the process of developing and setting future funding allowances. Ofgem is working with the transmission companies to create new regulatory incentives which will create an environment to support timely investment in network assets.

Ofgem considers these new incentives will allow and encourage the transmission companies to anticipate and plan for future need. We expect the new incentive arrangements will apply to a number of the projects described in this report.

Finally, we wish to thank all of those who contributed to producing this report. It will serve as an important input into the debate going forward and a platform for taking forward the future work needed to ensure that our electricity networks support the delivery of the UK's climate change and energy goals.

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DEPARTMENT OF ENERGY & CLIMATE CHANGE

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Summary of the Report to the Electricity Networks Strategy Group on the Strategic Reinforcements required to Facilitate Connection of New Generation to the GB Transmission Networks by 2020

1 Overview

1.1 In June 2008, the Government published its consultation on a UK Renewable Energy Strategy[2]. Following on from this, the Electricity Networks Strategy Group[3] (ENSG), a cross industry group jointly chaired by the Department of Energy and Climate Change and Ofgem, asked the three GB Transmission Licensees, National Grid Electricity Transmission (NGET), Scottish Hydro Electric Transmission Ltd (SHETL) and Scottish Power Transmission (SPT) with the support of an Industry Working Group (ENSG – Project Working Group (PWG) to take forward a study to:

- Develop electricity generation and demand scenarios consistent with the EU target for 15% of the UK's energy to be produced from renewable sources by 2020; and
- Identify and evaluate a range of potential electricity transmission network solutions that would be required to accommodate these scenarios.

1.2 This is the summary report of that study the "Transmission Investment Option Study", which has been prepared by the PWG to discharge the actions requested by the ENSG. In taking the study forward the working group were also asked to identify potential technical, regulatory or commercial barriers[4] to the delivery of the proposed reinforcements. This report examines the technical issues associated with the network transmission reinforcements.

2 http://renewableconsultation.berr.gov.uk/
3 http://www.ensg.gov.uk/
4 Commentary on these potential barriers can be found in the report of the Chairman of the Working Group at www.ensg.gov.uk

1.3 The reinforcements identified in this report are based on a range of scenarios that take into account the significant changes anticipated in the generation mix between now and 2020. In particular, the scenarios examine the potential transmission investments associated with the connection of large volumes of onshore and offshore wind generation required to meet the 2020 renewables target, whilst, at the same time, facilitating the connection of other essential new generation, such as new nuclear that will be needed to reduce carbon emissions and maintain continued security of supply. The study concludes that, provided the identified reinforcements are taken forward in a timely manner and the planning consent process facilitates network development, the reinforcements can be delivered to the required timescales. Any necessary new transmission infrastructure works would require development consent under the Planning Act 2008 and/or planning permission from local planning authorities and would need to be the subject of comprehensive routeing and siting studies, consultations and detailed environmental impact assessment.

1.4 The total cost of the proposed reinforcements is £4.7bn and the resulting network can accommodate a further 45 GW of generation, of which 34 GW could be a combination of onshore and offshore wind generation. The opportunity has been taken to optimise the integration of onshore and offshore developments. This will facilitate a significant saving, estimated to exceed £850M, in developing offshore networks, which may be achieved by timely investment in the onshore network.

1.5 To ensure that the justifications for the identified reinforcements are sufficiently robust, they have been tested against a range of background scenarios, which take account of likely developments up to the year 2020. In identifying the potential transmission reinforcements, the opportunity was taken first to maximise the utilisation of the existing assets. Thereafter the options identified are based on new or replacement assets. In both circumstances consideration has been given to employing the latest technology, especially where additional economic and/or additional environmental benefits can be expected. In such cases, due account has been taken of the lead time required to develop robust engineering solutions and the need to obtain the necessary planning consents for each reinforcement.

1.6 The development of the potential reinforcements are phased to achieve a 2020 delivery date with the initial phase being delivered in 2015 based on the prospective growth of renewables in each region. It is recognised that there will continue to be a degree of uncertainty about the volume and timing of generation growth in any given area. It is therefore proposed to continue to monitor the developments of the market and update the scenarios accordingly. The proposed transmission reinforcements will be developed in such a manner as to ensure that the options are maintained at minimum cost. Undertaking pre-construction engineering work positions the delivery of each project such that construction can be commenced when there is sufficient confidence that the proposed reinforcements will be required. This is the least regret solution, i.e. the minimum commitment to secure the ability to deliver to required timescales.

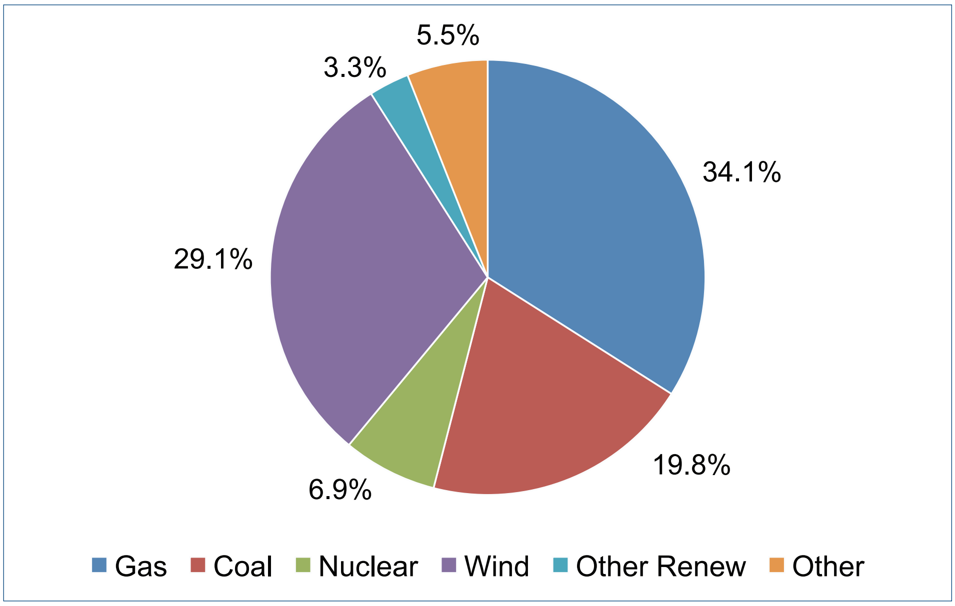
2 Approach to Developing Scenarios

2.1 A number of electricity generation and demand backgrounds have been developed. In their development, numerous factors have been taken into account; particularly in relation to ensuring that the UK and Scottish Government 2020 targets for renewable energy and the UK target for greenhouse gas emissions would be met. Such factors included the analysis of:

- closures of existing generating plants due to various legislation and age profile;
- contracted new connections for all types of generating plant;
- the potential for, and location of onshore and offshore wind generation; and
- the potential build rates for wind and new nuclear generating plant.

2.2 In developing a detailed background, issues such as security of supply, the ability of the supply chain to deliver and technological advances have been taken into consideration. The fuel mix in the scenario for 2020 (known as the 'Gone Green' scenario), which was endorsed by the ENSG and on which the study is based, is set out below:

Fuel mix in 2020 of the 'Gone Green' scenario Generation connected to transmission



2.3 The resulting generation background scenarios, upon which the studies are based, vary the capacity of renewable generation in Scotland from a minimum of 6.6 GW (this is the minimum required to meet the Scottish Government target on top of the existing hydro generation which is assumed to continue to contribute to the target), to 8 GW in a second scenario and a maximum of 11.4 GW by 2020 in a third scenario. All scenarios considered achieve a total UK renewable electricity contribution of 147 TWh by 2020; to achieve this the volume of offshore windfarm generation in England and Wales was increased to compensate for any volumes less than 11.4 GW in Scotland. These scenarios will be referred to throughout this report.

2.4 The total offshore windfarm capacity in England and Wales is assumed to be in the region of 21–25 GW by 2020. In considering how this offshore capacity could be achieved, it is assumed that some 8 GW of Round 1 and 2 wind generation projects will proceed to completion, with the remainder being made up from the proposed Round 3 development sites. In determining the timing and location of the potential projects in England and Wales, the report produced by the Crown Estate (Round 3 Offshore Wind Farm Connection Study[5]) and the report recently published by DECC (National Grid Input into UK Offshore Energy Strategic Environmental Assessment[6]) were used as the basis of the future analysis, together with appropriate sensitivity studies.

2.5 The generation scenarios assume two new nuclear installations with a combined capacity of 3.3 GW by 2020. The existing signed agreements identified in the 2008 GB Seven Year Statement (SYS)[7] and subsequent Quarterly Updates were used as a basis for determining possible future nuclear sites.

2.6 The developments in the generation market and the progress that Generators have made in obtaining planning permission and in construction of their projects will continue to be monitored and the scenarios updated accordingly.

2.7 The generation assumptions made for the purpose of this report are entirely independent from and in no way presuppose the outcome of individual planning decisions about projects on particular sites and, in the case of nuclear, the Strategic Siting Assessment (SSA) process.

5 http://www.thecrownestate.co.uk/round3_connection_study.pdf
6 http://www.offshore-sea.org.uk/site/scripts/consultation_download_info.php?downloadID=238
7 http://www.nationalgrid.com/uk/Electricity/SYS/

3 Findings – Power Flows and Existing Transmission Capacity

3.1 The predominant power flow on the GB transmission system is from the North towards the South. In the North of Scotland, local demand is, for the most part, adequately met by the portfolio of existing hydro generation, Peterhead power station and an increasing number of windfarm developments. Accordingly, there is a predominant net export of energy from the region to the Central Belt of Scotland. Additional power flows in the Central Belt of Scotland, within the SPT network, place a severe strain on the 275 kV elements of the network and, in particular, the north to south and east to west power corridors.

3.2 The circuits between Scotland and England are already operating at their maximum capability. Under all the generation scenarios considered, the power transfers from Scotland to England increase significantly. Reinforcements identified to relieve the boundary restrictions across these circuits result in power transfers on the Upper North network of the England and Wales transmission system exceeding the network's capability. South of the Upper North boundary the increased power flows south from Scotland and the North West of England progressively diminish as they are offset by the closure and displacement of existing conventional generation along the way. Accordingly, while there are transmission overloads in northern England the effects are greatly muted as the power flows travel towards the Midlands.

3.3 Offshore wind generation in England and Wales, together with the potential connection of new nuclear power stations, raises a number of regional connection issues, particularly in Wales (North & Central), the South West and along the English East Coast between the Humber and East Anglia. The increased power transfers across the North to Midlands boundary and/or the increased generation off the East Coast and/or Thames Estuary result in severe overloading of the transmission circuits north of London.

4 Analysis to Determine Transmission Reinforcement Requirements

4.1 The range of potential power flows on the GB transmission system have been determined on the basis of the currently authorised/planned GB transmission system (i.e. the existing GB transmission system together with all the approved or planned transmission system reinforcements assumed to be in place for the years 2015 and 2020). Such transmission reinforcements include:

- the proposed Beauly–Denny 400 kV line;
- the uprating of the transmission capacity between Scotland & England (TIRG[8]); and
- the additional transmission capacity around the North West and North East of England.

4.2 The current GB Security and Quality of Supply Standard (GB SQSS) was used in determining the reinforcements necessary under the scenarios. In determining wider infrastructure requirements we have assumed a high level of network sharing. By applying the GB SQSS against the scenarios and appropriate sensitivity studies, a range of potential power transfers can be determined at winter peak. These transfers are not necessarily the maximum transfers and may be significantly higher at off-peak times, particularly in areas where there are significant volumes of wind generation. The impact of our sharing assumptions and the potential for increased transfers is considered in more detail in the Cost Benefit Analysis (CBA) described below.

4.3 When considering local generation connections in areas which predominately contain wind and/or nuclear generation, given the high value associated with low carbon generation, developing a transmission network is generally more economic and efficient than curtailing low carbon production. If the local network was designed to accommodate only 90% of the output of a windfarm generator, the cost of constraints would be in the region £5–7M per annum per GW of installed wind generation. This level of constraint cost is generally higher than the marginal cost of providing transmission capacity.

8 http://www.ofgem.gov.uk/Networks/Trans/PriceControls/TPCR4/ConsultationDecisionsResponses/Documents1/9139-28804.pdf

4.4 Even with a high level of assumed sharing, there is concern that due to the relatively low utilisation of renewable intermittent generation together with the increased margin between installed generation capacity and demand, there may be opportunities for greater sharing of existing transmission capacity. A Fundamental Review of the GB SQSS[9] and a Transmission Access Review (TAR) are currently being conducted. Whilst this report did not undertake analysis against all variants under consideration by these two reviews, a CBA was undertaken in respect of proposals to reinforce major system boundaries. The level of transmission capacity identified by the CBA should be consistent with the conclusions of both the GB SQSS and TAR reviews, since it ensures that the GB transmission system is designed to give the most economic and efficient solution. Nevertheless, the proposals presented within this report will be subject to further examination in light of the conclusions of the two reviews. These reviews are due to be completed this year, and this re-examination will not impact on delivery of required network capacity.

4.5 The CBA has been fully developed for all reinforcements from the central zone of the SHETL system through the SPT system to the North of England. In undertaking a CBA the generation has been ranked. That is generation has been grouped according to fuel type (e.g. nuclear, wind, large coal, modern gas etc.) and ranked in accordance with perceived likelihood of operation based on historic information covering the last few years. The generation constraint prices (i.e. bid on/off) are based on the average price seen over the last few years. Data in respect of the current year is atypical and is influenced by unusual conditions which are not believed to be representative of the long-term outlook, which would result in higher constraint cost if utilised in future constraint analysis over a long period. The cost of carbon is assumed to be included within the energy cost used in the study. Whilst this assumption is unlikely to have a material impact on the future constraint cost, it is recognised that it is likely to lead to an underestimation of the cost of losses in future years and, as a consequence, underestimate benefits of future transmission upgrades, but these underestimations are not considered to be material.

4.6 A generic wind output distribution curve has been developed which reflects the intermittent nature of wind generation output. The model ensures that the different generation output over seasons is calculated (average utilisation of 38% and 30% respectively for winter and summer has been used) along with an appropriate diversity factor for windfarm generation across the GB system. The wind generation output at any given time is determined by Monte Carlo sampling. The CBA model then seeks to dispatch the most economic generation, whilst not violating transmission capacity limits. A series of sensitivity studies have then been undertaken to ensure that proposals arising are robust against a wide range of sensitivities discussed in the main report.

9 http://www.nationalgrid.com/uk/Electricity/Codes/gbsqsscode/reviews/

4.7 When identifying a shortfall in network capacity, consideration has been given to traditional solutions such as reconductoring circuits, upgrading to a higher voltage and constructing new lines. However, it is recognised that traditional methods of enhancing system capacity, particularly those which involve new overhead line routes, are difficult to achieve due to planning constraints and environmental concerns. Such difficulties can result in long delays in providing the required transmission capacity and consequential delays in facilitating the connection of sufficient volumes of renewable and other forms of generation needed to meet UK targets. As a result, the Transmission Licensees have investigated the potential for new or previously unused technologies on the GB transmission system in order to either enhance and maximise the use of existing assets, or provide new infrastructure with minimal environmental impact and an acceptable level of technological risk. Discussions have been taking place with equipment manufacturers regarding the use of series compensation, HVDC technologies and developments in subsea cables.

5 Proposed Transmission Network Reinforcements

5.1 Within the North Scotland (SHETL Licence area)

5.1.1 The proposed Beauly–Denny rebuild is an important step in developing a transmission system in the North of Scotland of sufficient capacity to accommodate renewable development proposals. With this upgrade in place, further reinforcement of the North of Scotland transmission system can be achieved by the strengthening of other elements of the existing system.

5.1.2 Further improvements on the mainland system are required to make maximum use of the existing infrastructure and overhead line routes to connect renewable generation developments on the Scottish mainland and the islands. This can be achieved by reconductoring and re-insulation work on existing tower routes, along with development of new substations or extensions to existing substations.

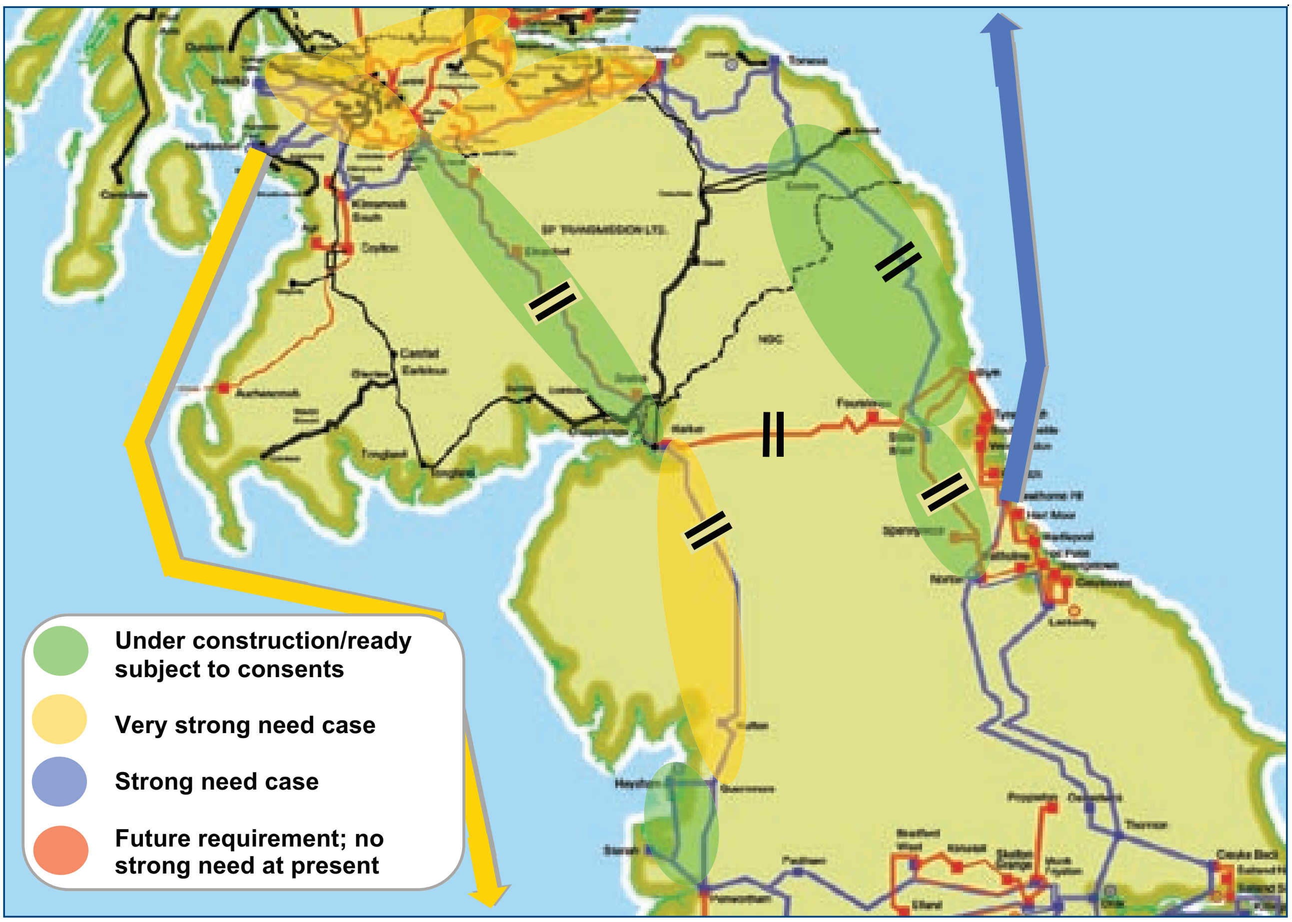
5.1.3 The first stage of upgrades will be required to reinforce North-West Scotland and transfer capability south to the Central Belt. This first phase consists of the Dounreay–Beauly–Kintore (DBK) 275 kV upgrade. Together with the East Coast reconductoring and re-insulation works included in 5.2.1 below this will provide a transmission system in SHETL's North of Scotland area capable of accommodating 5.5 GW of renewables (which is consistent with the 8 GW scenario). The total cost of the DBK reinforcement is estimated at £180M, and that of the East Coast work at £150M.

5.1.4 A second phase of upgrades would be required to accommodate 6.9 GW of renewables in the North of Scotland, contributing to the total figure of 11.4 GW for Scotland. These upgrades comprise an estimated additional £450M reinforcement between Caithness and Moray together with the Eastern HVDC Link described below in 5.2.3. The requirement for these upgrades would be assessed as generation develops, but pre-construction work should commence at the earliest opportunity.

5.1.5 The provision of connection capacity to the Scottish Islands via subsea links to the main interconnected system, together with the subsea link between the Kintyre peninsula and Hunterston, allows the connection and contribution of 1.5–2 GW of renewable generation from these areas. The capital cost of these connections has not been taken account of in this study.

5.2 The Scotland-England Interface

Scotland



Upgrading the main interconnected Scottish system from the North of Scotland to the Central Belt, and on to the North of England includes three main elements.

5.2.1 The 'Incremental' upgrade, which includes reconductoring and re-insulation work on existing tower routes, along with development of new and existing substations and the installation of series compensation, thus making maximum use of existing transmission routes. The total estimated cost of the reinforcements identified below is some £625M:

- SHETL East Coast reconductoring, re-insulation and substation works: £150M
- SPT East Coast reconductoring, re-insulation and substation works: £135M
- SPT East West Upgrades: £80M
- SPT/NGET Series compensation on the circuits connecting the Scottish and English Networks: £160M
- NGET Reconductoring Harker–Quernmore: £100M.

5.2.2 The Western subsea High Voltage Direct Current (HVDC) Link, a 1.8 GW HVDC link between Hunterston and Deeside. This provides additional capacity across the circuits between Scotland and England and additional capacity across the upper North of England The total cost of the reinforcement is estimate at £760M and the major elements of the reinforcements are summarised below:

- SPT – Western HVDC Link and associated works: £400M
- NGET – substation works at Deeside and HVDC Link: £360M

5.2.3 The Eastern subsea HVDC Link, a 1.8 GW HVDC between Peterhead and Hawthorne Pit. This provides additional capacity across B4, B5, B6 and limited additional capacity across the upper North of England. The total cost of the reinforcements is estimate at £700M and the major elements of the reinforcements are summarised below:

- SHETL onshore substation works & Eastern HVDC Link: £340M
- NGET onshore substation works & Eastern HVDC Link: £360M

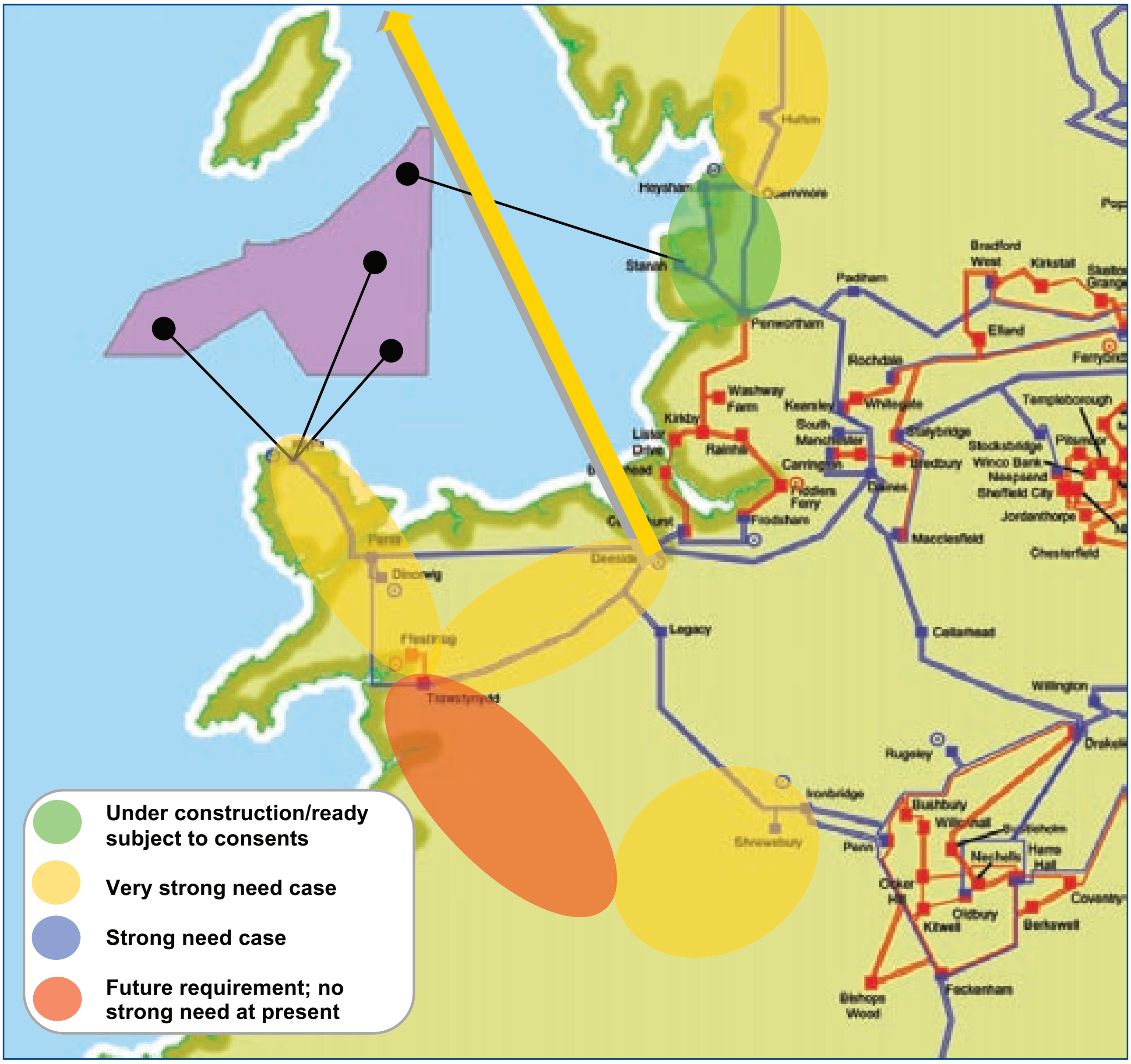
5.2.4 Whilst all three reinforcements identified above are required by 2020 in the 11.4 GW scenario (based on the deterministic requirements of the GB SQSS and supported by the CBA), only two of the reinforcements would be required to meet the 8 GW scenario in Scotland. In determining which of the two reinforcements should be taken forward first, the CBA did not demonstrate conclusively that any particular two reinforcements offered significant benefit over any other combination against the scenarios under consideration. When considering the generation sensitivities, particularly extending the life of the Hartlepool and Heysham 1 Nuclear power stations (scenario assumes they close around 2017/18), the western HVDC link reinforcement, along with the 'Incremental' upgrade, provides the most robust solution.

5.2.5 If the Scottish renewable generation contribution is limited to 6.6 GW of wind generation in total (i.e. the minimum required to meet the Scottish Government target if hydro is assumed to contribute), then any single reinforcement identified above provides sufficient transmission capacity.

5.2.6 A high level analysis has indicated that there is a high probability that at least 8 GW of wind generation will connect in Scotland. It is therefore proposed to proceed with the Western HVDC Link and the incremental upgrade immediately, with a target completion date of 2015 at an estimated cost of £1385M, but develop the incremental reinforcement in such a manner as to install a subset if necessary, and then proceed with the Eastern HVDC link with a target completion date of 2018 at an estimated cost of £700M. Although the Eastern HVDC link is not required until 2018, some preliminary engineering work will be necessary to ensure it can be integrated into the network.

5.3 North & Central Wales

North & Central Wales



5.3.1 The scenarios assume that up to 4 GW of offshore wind in the Southern Irish Sea may connect since the offshore generation in this area is expected to be among the least cost of the Round 3 sites. Round 3 windfarms in the area will seek to utilise the same capacity as the existing pumped storage plant, Round 2 developments, possible interconnections to Ireland and new nuclear replanting at Wylfa. When total generation, whether wind or nuclear generation, on Wylfa exceeds 1.8 GW[10] it will be necessary to construct a new circuit from Wylfa through to Pentir and establish the second circuit between Pentir and Trawsfyndd, together with some associated works further east. These works need to be undertaken in sequence and, in order to provide additional capacity by 2015, the engineering of some elements needs to commence early in 2009 if the timeline is to be retained.

10 GB SQSS Review Group, Review Request GSR007, 'Review of Infeed Loss Limits' refers. GSR007 is considering raising the threshold limits of the normal (currently 1000 MW) and infrequent (currently 1320 MW) in recognition of the likelihood that single units in excess of 1320 MW (possibly posing a loss of power infeed risk of up to 1800 MW) will connect to the GB transmission system.

5.3.2 To provide offshore network developers with sufficient confidence that they can connect to Wylfa, it may be necessary to seek consents for the new line prior to the development of the offshore networks. Commitment to full construction can then be adjusted as the build-up of generation materialises. This approach can achieve a potential saving of offshore network cost in the region of £500M by facilitating connections at Wylfa rather than a more remote site.

5.3.3 The proposed reinforcements are estimated at £400M, for completion by 2017.

5.4 Central Wales – Stage 1

5.4.1 The Welsh Assembly Government Technical Advice Note 8 identifies an onshore wind generation target of 800 MW. The majority of wind resource is in Central Wales, which has no immediate connection to the main interconnected transmission system.

5.4.2 New transmission assets including overhead lines and cable sections need to be commissioned in order to connect the new generation to the transmission network. As the generation is made up of a number of small to medium windfarms the current proposal is to create a hub substation to which all windfarms connect. A single transmission route will then be used to connect to the transmission network in the Legacy–Shrewsbury–Ironbridge circuits. Exact locations of both substation and transmission connection point are being evaluated.

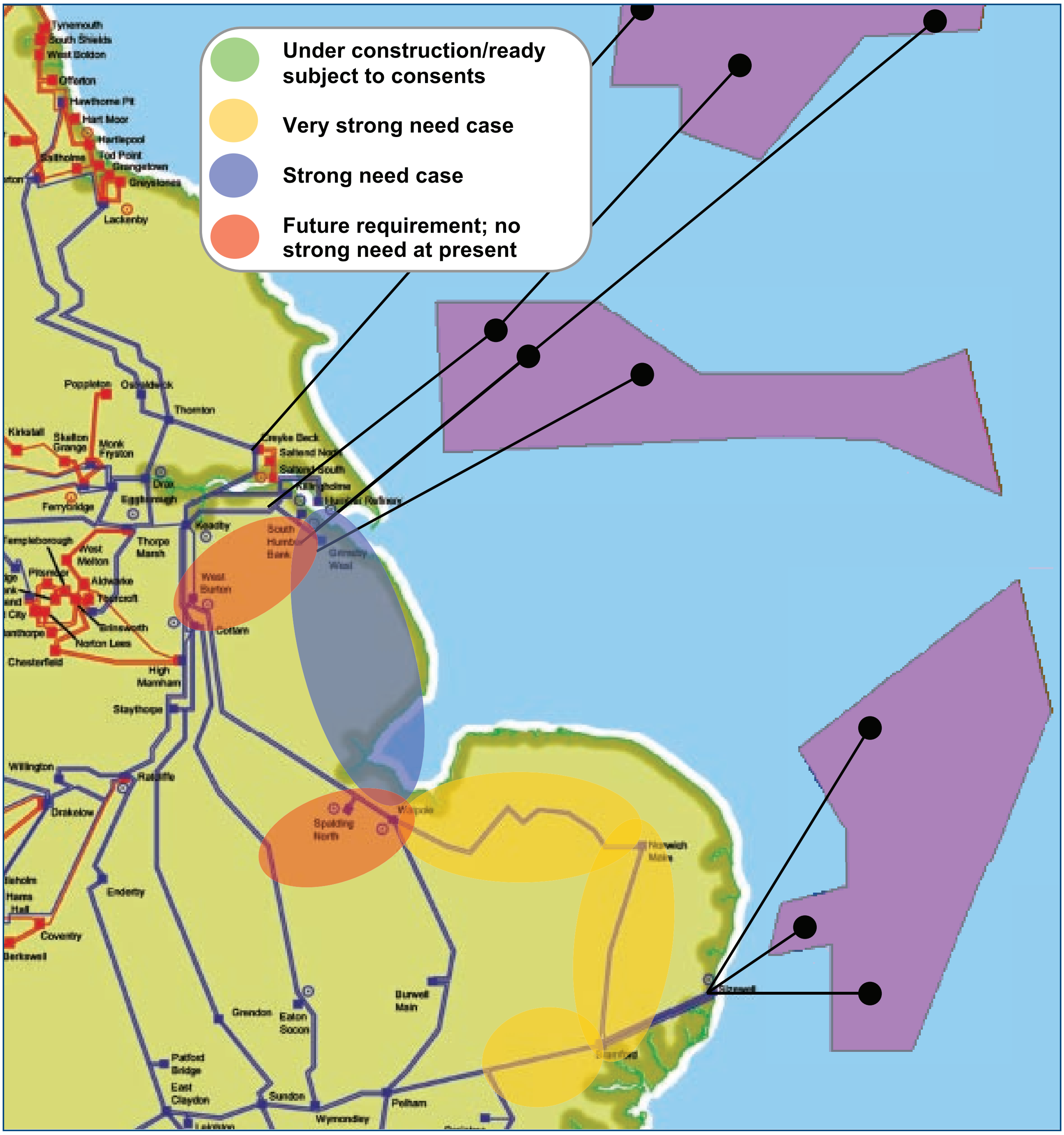
5.4.3 The cost of these works above is estimated to be £225M, for completion by 2015.

5.5 Combining North & Central Wales – Stage 2

5.5.1 The potential for further generation in Central Wales and significant new generation in the North Wales (combination of wind generation and nuclear on Wylfa) with the resulting pressure on the North Wales boundary has highlighted an opportunity for considering an additional development in Central Wales. The capacity of the connection to the main interconnected system will frequently be underutilised due to the typical load factor for wind generation. An additional connection from the Trawsfynydd area to the new substation in Central Wales would allow full utilisation of this circuit and provide additional capacity across the North Wales boundary. Furthermore, by connecting further south than the Legacy–Shrewsbury–Ironbridge circuit, for example, Ironbridge or Bishop's Wood substations, additional relief on heavily loaded circuits will be realised. Exploration of the transmission technology used is critical to making full use of this new through route. This will be considered further in the next stage of the project which will review network requirements for 2025 and 2030. The report on the findings of the final stage of the project will be completed April 2009.

5.6 English East Coast & Humber

English East Coast & Humber



5.6.1 Previously published investigations such as the Crown Estate Round 3 Offshore Wind Farm Connection Study and National Grid's input to the DECC Offshore Energy Strategic Environmental Assessment have considered a total of up to 12 GW of Round 3 offshore wind generation from the Dogger Bank and Hornsea areas connecting into the onshore transmission network in the Humber area. However, scenarios utilised in this study assume a maximum of between 4 and 8 GW by 2020 (dependent on the level of onshore wind assumed for Scotland). The conclusions from this study propose to optimise both onshore and offshore transmission networks by integrating the design of these networks in order to capture significant cost savings (potentially in the range £200–300M). This can be achieved by connecting some of the Round 3 windfarms in this region via direct tee connections into an onshore HVDC link connecting the Humber area to East Anglia.

5.6.2 Connecting these two areas affords the extra benefits of providing additional capacity for new generation connections to the north of the North to Midlands boundary as well as delaying, but not removing, the need for reinforcement in the East Anglia region. This comes as a result of the increased functionality and controllability of HVDC circuits relative to standard AC overhead lines.

5.6.3 In view of the novel nature of this development, pre-engineering works will be required to ensure that the proposed solution can be developed to required timescales. Otherwise, it may be necessary to develop an alternative solution involving new 400 kV overhead lines, thus negating the potential savings.

5.6.4 The cost of the onshore works is estimated to be £510M, for completion by 2017.

5.7 English East Coast Reinforcement, East Anglia Stage 1

5.7.1 It is anticipated that between 3 and 4 GW of Round 3 offshore wind generation will be developed in waters directly east of East Anglia. The nearest onshore substations for connection are either Norwich Main or Sizewell, which are both located on the same 400 kV route. Therefore Round 3 offshore wind projects will interact significantly with the potential for nuclear replanting at Sizewell (of up to an additional 3.3 GW) on this part of the network. Reinforcement of the network is required for either offshore wind generation and/or nuclear replanting at Sizewell.

5.7.2 The reinforcements proposed for this area of the network include reconductoring the double circuit route from Walpole to Norwich through Bramford, a new 400 kV substation at Bramford with all circuits from Norwich Main, Sizewell, Pelham and Rayleigh turned in and a new section of 400 kV double circuit overhead line, approximately 27 km in length from Bramford to the existing tee point down to Rayleigh (near Twinstead). This would then create two double circuit routes to the west out of Bramford.

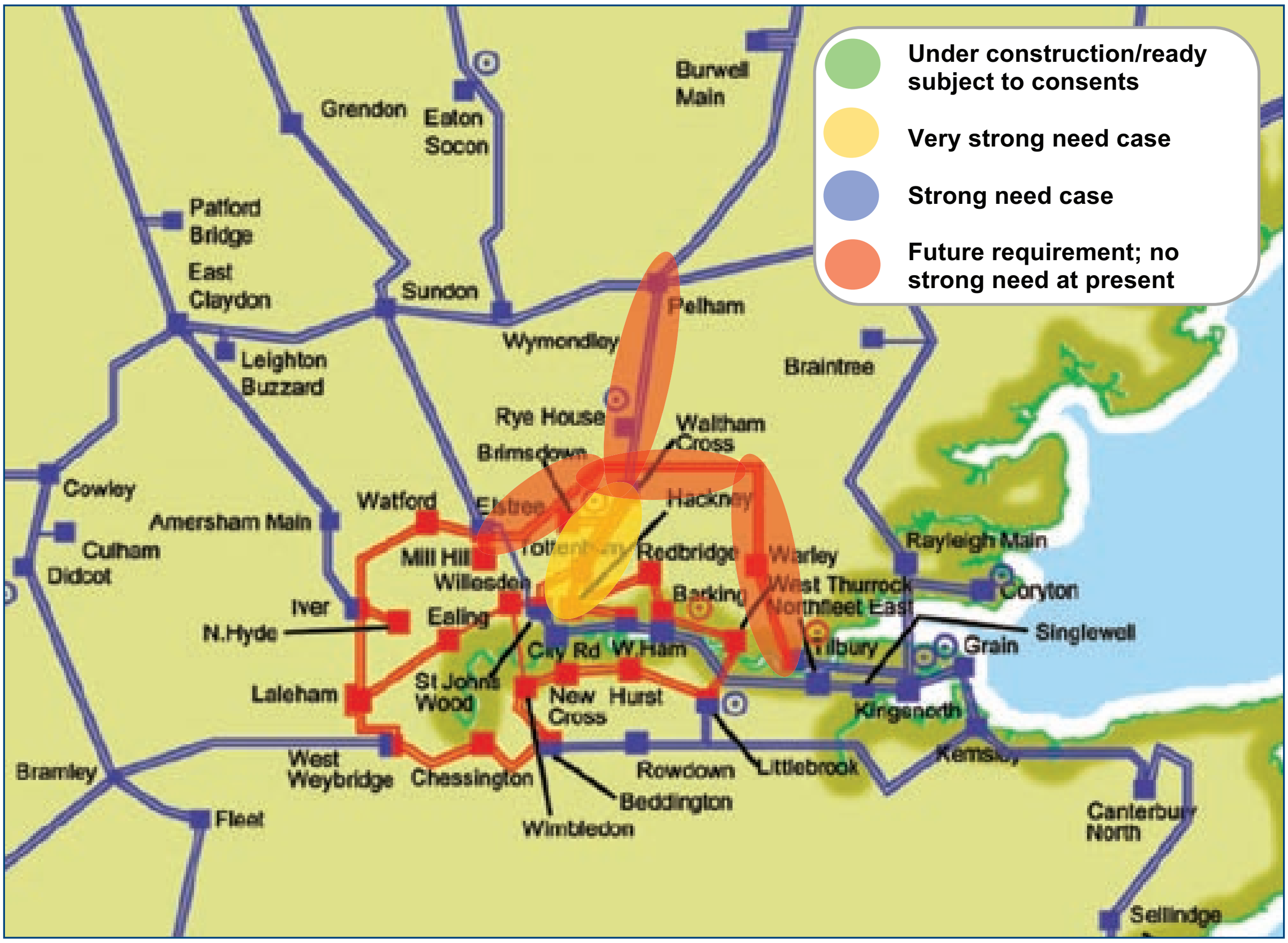
5.7.3 The cost of onshore works is estimated to be £400M, for completion in 2017.

5.8 English East Coast Reinforcements – Humber & East Anglia Stage 2

5.8.1 Should the volumes of offshore wind generation surpass the expected volumes of between 4 and 8 GW after 2020, new connections between Walpole and the Cottam–Eaton Socon line and/or Grimsby West and Keadby may be required. This will be considered further in the next stage of the project.

London

London



5.8.2 Historically, the network in and around London was developed to secure demand in the capital and its surroundings, when the major generation sources were the oil- and coal-fired plant in the Thames Estuary, or the coal-fired plant in the East and West Midlands. Additionally, it handled transfers to and from the interconnector at Sellindge.

5.8.3 However, several factors associated with the scenarios and sensitivities investigated, including the introduction of new low-carbon generation and liberalisation of European energy markets, drive a need for additional transmission capacity in the London area. These factors are increased generation in East Anglia and the Thames Estuary, a potential increase in interconnection with mainland Europe and the potential for future demand increases associated with the electrification of transport and/or the decarbonisation of space heat. As a consequence there will be a need for additional transmission feeding central London from the north-east, and ultimately a need to reinforce east–west ties.

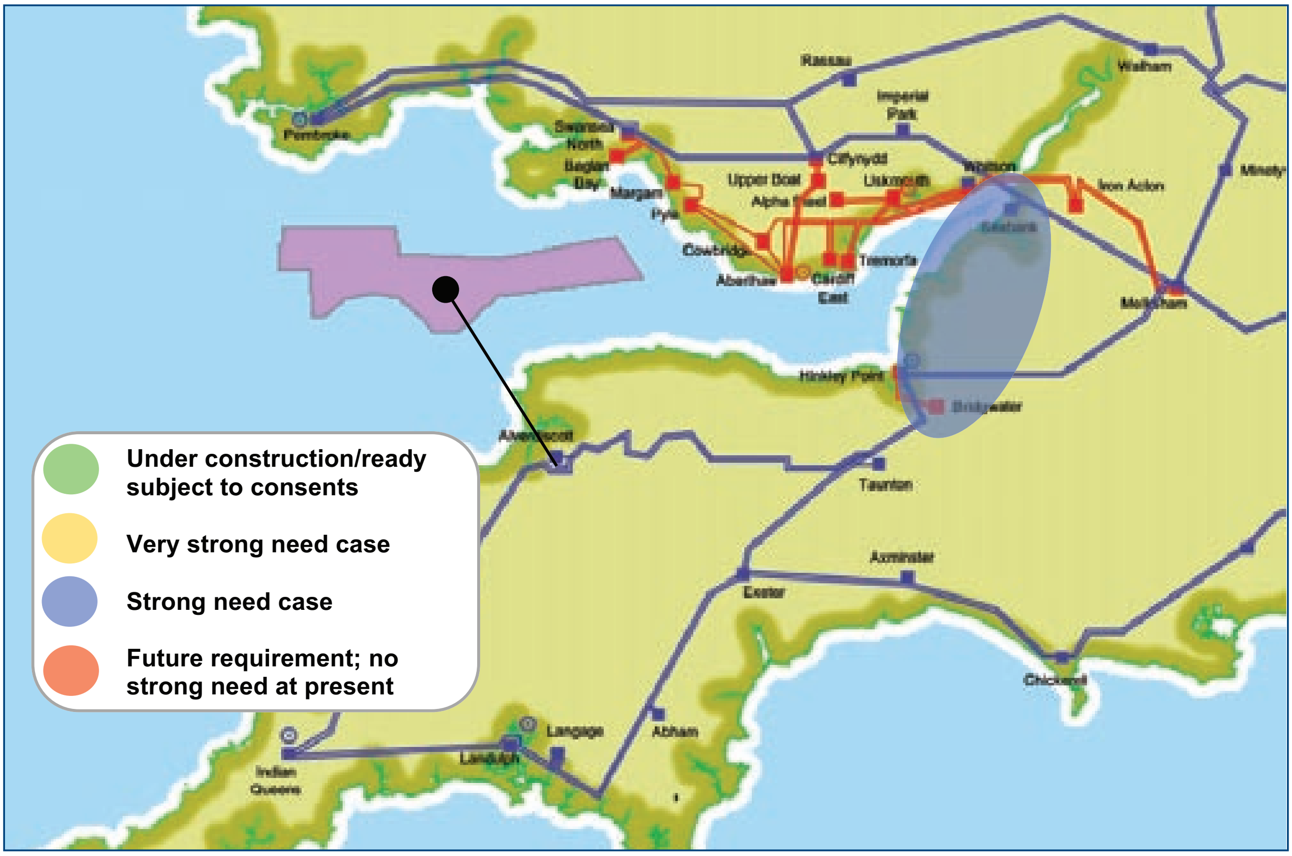
5.8.4 The proposed reinforcement is to uprate a 275 kV overhead line from Waltham Cross to Hackney via Brimsdown and Tottenham to 400 kV. The cost of these works is estimated to be £190M, with a completion date of 2015.

5.9 London – Stage 2

5.9.1 In the longer term, a section of the ‘middle’ 275 kV ring between Tilbury, Warley, Waltham Cross and Elstree may need to be uprated to 400 kV to provide additional capacity between the Estuary and North London. The cost of this additional work is estimated at £85M, with a notional completion date of 2022, subject to a future evaluation of need based on developments at that time.

5.10 South West

South West



5.10.1 This area of the network, around the Severn Estuary, is characterised by large volumes of localised generation, high demand levels and a limited export capacity. Future changes in the generation connected in this region, including the potential for large amounts of gas-fired generation and possible nuclear replanting at Hinkley Point and/or Oldbury-on-Severn, drive the need for additional transmission capacity. Planned offshore wind generation through future rounds of wind leasing in this area further add to this requirement.

5.10.2 Proposed reinforcements to accommodate the agreed 2020 scenarios and sensitivities investigated include a new 400 kV circuit between Hinkley Point and Seabank approximately 50 km in length. Reconductoring of existing circuits between Hinkley Point, Melksham and Bramley is also needed to provide the power generated in this area with a stronger electrical connection to the demand centre of London.

5.10.3 The cost of these works above is estimated to be £340M, with a completion date of 2017.

6 Capital Cost of Transmission Reinforcements

6.1 The estimated capex requirement to deliver the reinforcements identified above, the amount of generation which can be accommodated and the potential reduction in cost of delivering offshore networks is shown in the table below. The estimated capex requirement to deliver the reinforcements will be subject to a rigorous review as part of the pre-construction engineering stage.

<table>
<tr><th rowspan="2">Region</th><th rowspan="2">Reinforcement</th><th rowspan="2">Cost (£M)</th><th colspan="3">Capacity of generation which can be accommodated (GW)</th><th rowspan="2">Potential saving in offshore network costs (£M)</th><th rowspan="2">Net costs (£M)</th></tr>
<tr><th>Wind</th><th>Nuclear</th><th>Total</th></tr>
<tr><td rowspan="3">Scotland – Stage 1, 2015</td><td>North of Scotland Upgrade</td><td>180</td><td rowspan="3">8</td><td rowspan="3">0</td><td rowspan="3">8</td><td rowspan="3">NA</td><td rowspan="3">1565</td></tr>
<tr><td>Incremental Scottish Upgrade</td><td>625</td></tr>
<tr><td>Western HVDC Link</td><td>760</td></tr>
<tr><td rowspan="2">Scotland – Stage 2, 2018</td><td>North of Scotland Upgrade</td><td>450</td><td rowspan="2">4</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">NA</td><td rowspan="2">1150</td></tr>
<tr><td>Eastern HVDC Link</td><td>700</td></tr>
<tr><td rowspan="2">Wales – Stage 1</td><td>North Wales – 2017</td><td>350</td><td rowspan="2">4 – 6</td><td rowspan="2">0 – 3.3</td><td rowspan="2">4 – 7.2</td><td rowspan="2">500</td><td rowspan="2">75</td></tr>
<tr><td>Central Wales – 2015</td><td>225</td></tr>
<tr><td rowspan="2">English East Coast – Stage 1</td><td>Humberside</td><td>510</td><td rowspan="2">7 – 11</td><td rowspan="2">0 – 3.3</td><td rowspan="2">4 – 14.2</td><td rowspan="2">350</td><td rowspan="2">560</td></tr>
<tr><td>East Anglia</td><td>400</td></tr>
<tr><td>London</td><td>London</td><td>190</td><td>1 – 2</td><td>–</td><td>1 –2</td><td>–</td><td>190</td></tr>
<tr><td>South West</td><td>South West</td><td>340</td><td>2 – 3</td><td>3.3 – 3.3</td><td>5.3 – 6.3</td><td>–</td><td>340</td></tr>
<tr><td>Total</td><td></td><td>4730</td><td>26 – 34</td><td>3.3 – 9.9</td><td>29.3 – 44.9</td><td>850</td><td>3880</td></tr>
</table>

6.2 The above costs are for the upgrades to the main interconnected system and exclude the provision of subsea links to the Scottish Islands and offshore network costs for offshore wind. The offshore network costs will be of the order of £400/kW, as indicated in the Crown Estate report on offshore connection costs.

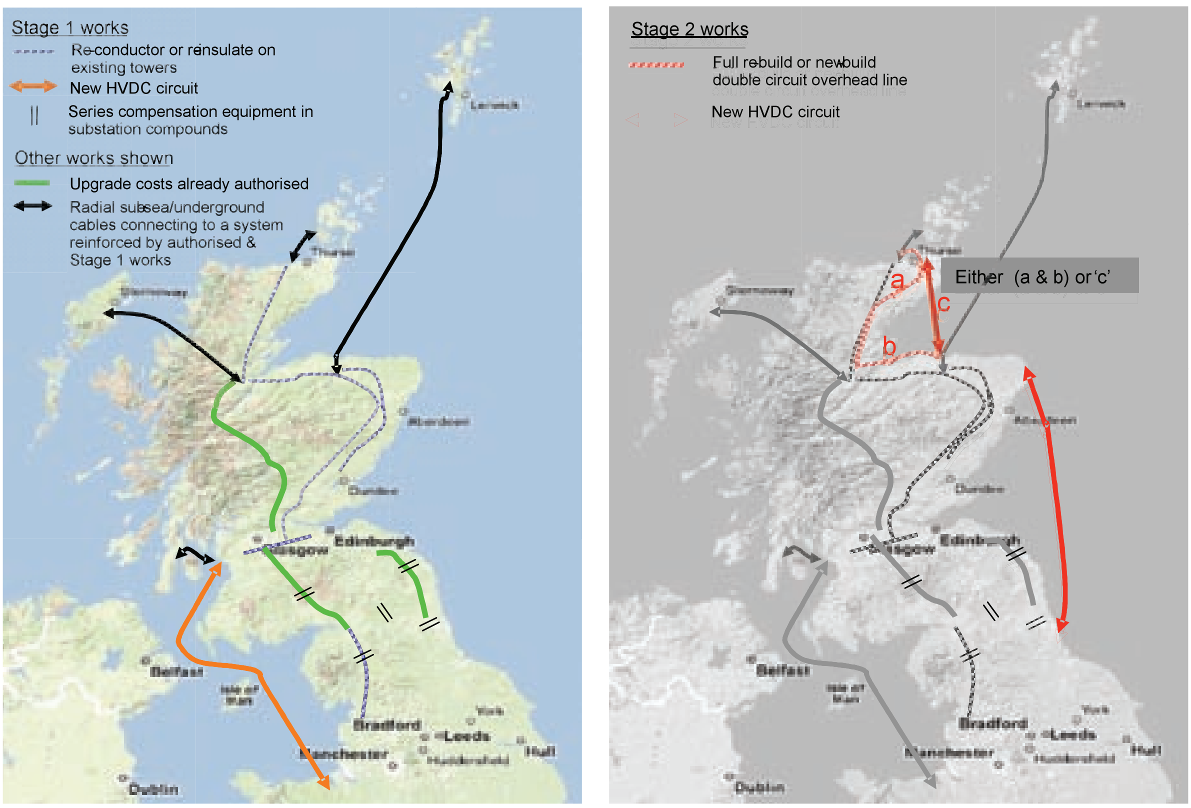
6.3 Timely investment on the onshore network can provide significant benefits in facilitating the connection of offshore networks with a potential saving of £850M. However, it should be noted that many of the proposals involve the use of new and novel solutions and the integration of these solutions into the existing transmission system needs to be carefully engineered. If the transmission network is to facilitate the connection of renewable generation in a timely manner it is essential that pre-construction work commence immediately. Because new technology is involved, it is difficult to determine the total cost of pre-construction engineering work, but for schemes of this complexity it would be normal to anticipate costs in the range of 2–5% of total scheme costs, with typically 0.25–0.5% of cost occurring in year 1. For the package of schemes identified above, it is estimated that the pre-construction cost will be in the order of £150M with a cost of some £10M to £20M occurring in the first year.

7 Transmission Investments, the Scottish National Planning Framework 2 (NPF 2) & National Policy Statements (NPS)

7.1 The Transmission reinforcement proposals are consistent with requirements to meet the UK Targets and in order to meet these challenging programmes of delivery dates it is essential that there are no significant delays in obtaining the necessary planning permissions. As part of the pre-construction engineering, it is proposed that planning applications will be taken forward ahead of commitment from any individual generator.

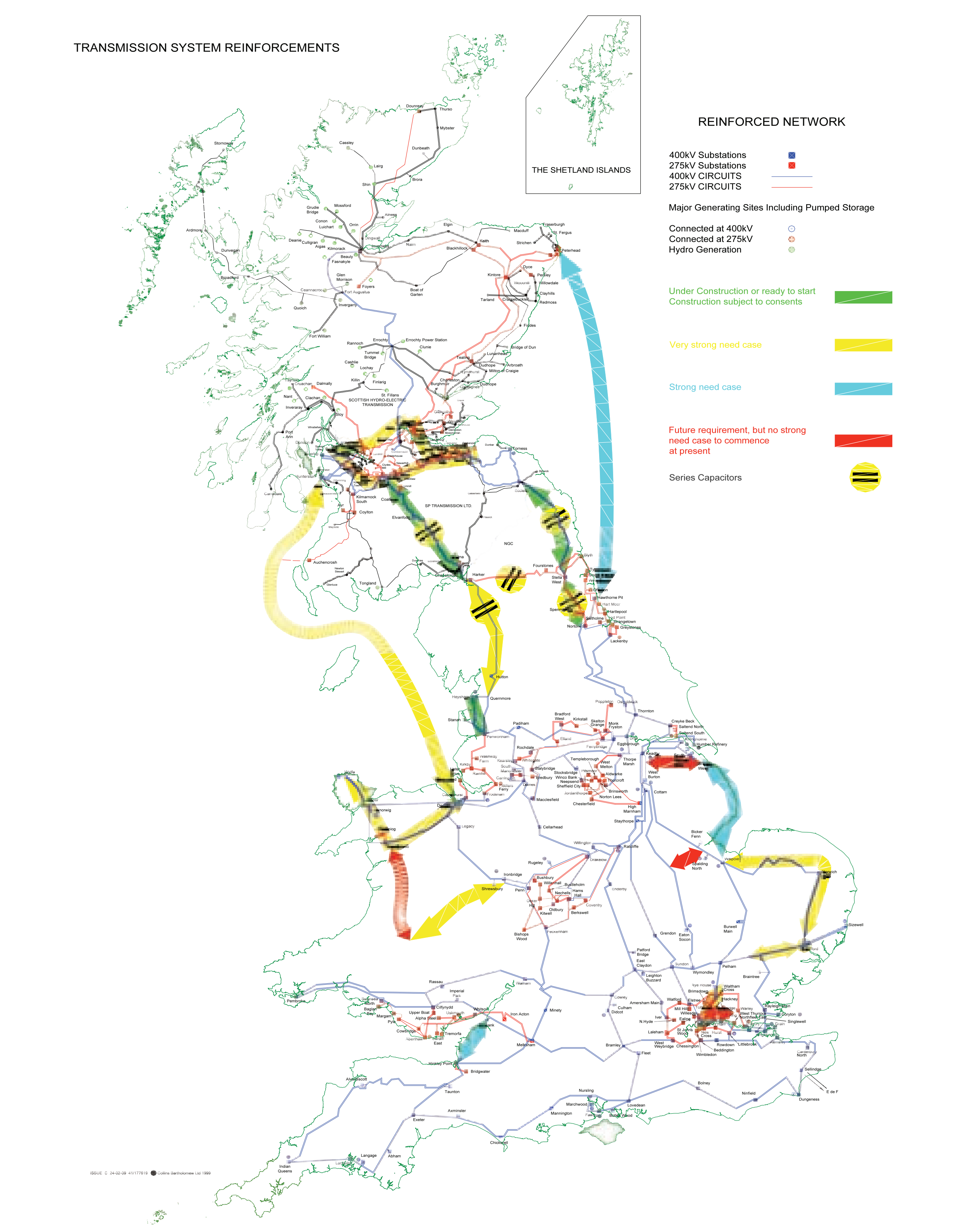
7.2 The Scottish Government's National Planning Framework 2 (NPF 2) prioritises a range of onshore and offshore strategic grid reinforcement in Scotland. These will help deliver Scotland's renewable energy potential and contribute to meeting UK and Scottish renewable energy targets. NPF 2 also recognises the potential of developing sub-sea routes to harness renewable energy. Importantly, while the successful completion of existing and planned transmission works is assumed in the ENSG study as a pre-requisite for all the analyses undertaken, in identifying the proposed grid reinforcements, no assumptions are made about the Beauly-Denny transmission reinforcement planning applications which are currently being considered by the responsible authorities. The high level diagram of the proposed ENSG reinforcements for Scotland are at Figure 1.

Figure 1: Stage 1 and 2 transmission reinforcements for Scotland



7.3 Figure 2, shows at high level, the proposed reinforcements for England & Wales, and it is anticipated that the need for such reinforcements will be discussed in the proposed National Policy Statement for Electricity Networks Infrastructure.

Figure 2: Proposed reinforcements NGET & SPT



Annex A

Electricity Networks Strategy Group – Terms of Reference 2008

The ENSG will:

- Develop and promote a vision of the UK electricity networks that will effectively and efficiently facilitate the increase in renewable and other low-carbon generation necessary to meet the EU 2020 renewables target and longer-term energy goals.
- Develop an understanding of the implications of policy for our electricity networks, identifying potential technical, commercial and regulatory barriers to meeting the UK renewables target and provide strategic advice on possible solutions.
- Maintain an overview of activities and developments that have potential to impact on realisation of the vision and advise on whether they provide a complete and coherent delivery and development path against the targets.
- Disseminate the results of its activities to the wider community ensuring engagement of the relevant stakeholders.

ENSG Membership

DECC	Chris Barton	Director, Renewable Energy and Innovation Directorate (Joint Chairman)
Ofgem	Steve Smith	Managing Director, Networks (Joint Chairman)
National Grid Electricity Transmission	Nick Winser	Executive Director
Scottish Hydro Transmission Ltd	Mark Mathieson	Board Member - SSE
Scottish Power Transmission	Jim Sutherland	Asset Strategy Director
EdF Energy	Barry Hatton	Director – Capital Programme
CE Electric UK	Phil Jones	President and Chief Operating Officer
E.ON	John Crackett	Managing Director
British Energy /Edf	David Love	Managing Director
RWE Npower	Kevin Akhurst	Executive Director
Renewable Energy Systems	Douglas Wright	Managing Director – Wind Energy
Centrica Energy	Sarwjit Sambhi	Director, Power Business
Vattenfall	David Hodgkinson	Managing Director
Renewable Energy Association/ BWEA/ Scottish Renewables Forum	Robert Longden	Trade Associations
Scottish Executive	Colin Imrie	Head of Energy & Telecommunications
Welsh Assembly	Ron Loveland	Head of Sustainable Energy & Industry
Department for Communities & Local Government	Peter Ellis	
Department for Environment, Food and Rural Affairs	Neil Witney	
DECC	John Overton	Deputy Director, Future Electricity Networks Team

Annex B

ENSG Transmission Project Working Group Terms of Reference

- Support National Grid and the transmission licensees in developing the likely capacity (renewable and conventional) deployment scenarios in GB needed to support delivery of the 2020 targets.
- Review the high-level transmission investment plans as they are developed and consider and comment on the scale, costs and associated timescales of investment that might be necessary throughout the GB transmission network to accommodate these scenarios in particular identifying those investments that are likely to be essential in any plausible scenario.
- Identify potential regulatory issues and obstacles that might arise in relation to the timely and efficient delivery of this investment.

In addition, the ENSG asked that:

The Project Working Group should take into account and build upon related work commissioned in support of the DECC Renewable Energy Strategy Consultation.

The Project Working Group should maintain awareness of, take into account and contribute to, other related ongoing activities that have the potential to affect the conclusions and outputs of the Group.

ENSG 2020 Transmission Study Terms of Reference

To identify and evaluate specific economic transmission investment options to accommodate electricity generation to meet the UK's 15% renewable energy target by 2020.

- Quantify level of renewables that can be accommodated on the existing networks (inc. approved reinforcements) by 2015 based on transmission upgrades with low consent and technology risks.
- Identify network to accommodate UK renewable targets for 2020 whilst maintaining sufficient transmission capacity ensure continued security of supply (appropriate generation can get access to demand).
- High level overview of Environmental considerations (final report).
- Final report by end January 2009 which identifies the optimum reinforcement strategy

Annex C

Members of Project Working Group

Membership of the ENSG Transmission Studies Project Working Group

John Overton (Chair)	BERR/DECC
John Spurgeon	BERR/DECC
Stuart Cook	Ofgem
Chris Bennett	National Grid
Mike Barlow	Scottish Hydro Transmission Ltd [Study Team]
Colin Bayfield	Scottish Power Transmission Ltd [Study Team]
Guy Phillips	E.ON
Dave Openshaw	EdF
Nic Rigby	RWE
Keith Maclean	SSE
Robert Longden	Trade Organisations
Richard Ford	RES
Rob Rome	BE
Floren Castro	SKM (Independent Expert)
Chris Naish	Secretariat, AEA Technology

List of attendees to the Working Group meetings over the course of the project

Andrew Hiorns	National Grid [Study Team]
David Paradine	National Grid [Study Team]
Min Zhu	Ofgem
David Hunt	Ofgem
Cheryl Mundie	Ofgem
Graham Knowles	Ofgem
Danielle Lane	Crown Estate
Aileen McLeod	Scottish & Southern Energy
Alan Michie	Scottish Power
Charles Ruffell	RWE
Tim Russell	Independent [Trade Associations]

Annex D

Glossary

Boundary capability	The post fault power a specified group of transmission circuits is capable of carrying while maintaining acceptable transmission system operating conditions.
CAPEX	Capital Expenditure
Constraints	The costs incurred through paying generators to vary their power output to prevent unacceptable post fault transmission system operating conditions.
Contracted plant	Generators with a valid connection agreement (agreement is often in place prior to construction of generation)
Demand	Sum of all electrical loads satisfied by power from the transmission system
Fuel mix	Range of generation primary energy sources (coal, oil, nuclear etc)
GB SQSS	Great Britain Security and Quality of Supply Standard; Provides the basic parameters and conditions to which the transmission network is designed.
GW	1,000,000,000 Watts
Hydro generation	Generation whose primary energy source is water
HVDC	High Voltage Direct Current (exceeding 650V)
Interconnector	Connection between the assets of different Transmission Owners
kV	1,000 Volts
Marginal cost	Cost of the most expensive generator connected at a particular point in time in £/MWhr

MW	1,000,000 Watts
Off-peak	Times of the year when the demand for electricity is substantially below the annual maximum
Plant	Fixed and moveable items used in the transmission and generation of electricity
Reconductoring	Replacing the conductors on a overhead line with those of a higher current carrying capacity
Re-insulation	Changing the fittings on an overhead line to enable the line to be operated at a higher voltage and hence carry more power
Scenario	A set of assumptions about future generation and its spatial disposition, demand and energy forecast
TWh	Tera Watt Hour; a measure of electrical energy used which is equal to 1,000,000,000,000 Watts for a period of one hour

Department of Energy & Climate Change
www.decc.gov.uk

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