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GB Seven Year Statement 2009

Introduction to Chapter 4

Generation presents information on all the sources of generation which are used to meet the ACS Peak GB Demand as defined in the Glossary and presented in **Electricity Demand**. Accordingly, Chapter 3 presents information on Large power stations (directly connected or embedded), Medium and Small power stations that are directly connected to the GB transmission system and directly connected External Interconnections with External Systems.

Embedded generation may be Large but is more likely to be either Medium or Small. Large embedded power stations are reported in Chapter 3 as explained above. Medium and Small embedded power stations and embedded External Interconnections with External Systems are reported in this chapter.

Much of the existing and future embedded generation is either in the form of combined heat and power (CHP) projects or in the form of renewable projects. This chapter considers these two types of generation source and, in so doing, also reports on non-embedded renewable sources of generation (e.g. Wind farms).

The Benefits of an Interconnected Transmission System

Superficially, it may seem reasonable to assume that growth in embedded generation could eventually lead to a position of zonal self-sufficiency rendering the GB transmission system redundant in whole or in part. However, this is not the case and, to understand why, it is first helpful to remind ourselves of the role of the interconnected transmission system and its history.

Until the 1930s, electricity supply in Britain was the responsibility of a multiplicity of private and municipally owned utilities, each operating largely in isolation. The Electricity (Supply) Act (1926) recognised that this was a wasteful duplication of resources. In particular, each authority had to install enough generating plant to cover the breakdown and maintenance of its generation. Once installed, it was necessary to run more plant than the expected demand to allow for possible sudden plant failure.

By interconnecting separate utilities with the high voltage transmission system, it is possible to pool both generation and demand. The interconnected transmission system not only provides for a consistent high quality of supply (e.g. in terms of frequency variations, voltage level, voltage waveforms, voltage fluctuations and harmonic levels) across the system but it also provides a number of economic and other benefits including those outlined in this chapter.

Bulk Power Transfers

A number of factors influence the decision to construct a power station at a particular location. These include fuel availability, fuel price, fuel transport costs, financing, cooling water, land availability and the level of transmission system charges. For combined heat and power (CHP) stations a local market for the heat output would also be a consideration.

It can be very difficult, particularly for large power stations, to obtain sites close to demand centres for environmental and other reasons. Similarly, some renewable energy generation technologies such as wind or wave are unlikely to be located near demand centres. The interconnected transmission system provides for the efficient bulk transfer of power from remote generation to demand centres irrespective of the actual connection voltage of the generation. Transmission of electricity at high voltage is more efficient than transfer at lower voltage due to the lower capital cost per unit transmitted and the lower losses (the 400kV and 275kV GB transmission system losses are approximately 1.5% of energy transmitted).

Economic Operation

The interconnected transmission system provides the main national electrical link between all participants (generation and demand) and by linking them via the transmission system it is then possible to select the cheapest generation available. Market participants can thus choose to trade with the most competitive counter party and National Grid, in its role as GBSO (Great Britain System Operator), is able to accept the most attractive ‘bids’ and ‘offers’ in the Balancing Mechanism to meet the demand, irrespective of location.

Security of Supply

Security in this context means providing the demand customer with a supply of electricity that is continuous (i.e. uninterrupted except in exceptional circumstances) and is of the required quantity and of defined quality (e.g. in terms of voltage, waveform and frequency). This means that the transmission system, and for that matter the generation and distribution systems, must be sufficiently robust to maintain supplies under conditions of plant breakdown or weather induced failures for a wide range of demand conditions.

Interruption of supply can result from insufficiency or unavailability of generation, transmission or distribution capacity. The former is a function of the electricity market. The latter is the concern of the distribution network operators. For transmission, the system is planned and operated in accordance with strict standards laid down in the Transmission Licence.

It may at first seem that security of supply is potentially at its greatest when the source of power is close to the demand it supplies. However, transmission circuits tend to be far more reliable than individual generating units. Accordingly, enhanced security is delivered by providing sufficient transmission capacity between customers and the national stock of generation. The transmission system is able to exploit the diversity between individual generation sources and demand.

Reduction in Plant Margin

In an ideal world it would simply be necessary to install generation capacity to meet the forecast maximum average cold spell (ACS) demand. In practice, additional capacity is required for security purposes to cover for one or more of the following reasons: the fact that plant becomes unavailable due either to routine maintenance or breakdown; or plant under construction may not be commissioned on time; the weather may be colder than ACS conditions; or the ACS peak demand forecast may simply be underestimated.

The integrated transmission system enables surplus generating capacity in one area to be used to cover shortfalls elsewhere on the system. The requirement for additional installed generating capacity, to provide sufficient generation security for the whole system, is therefore smaller than the sum of individual zonal requirements.

As a point of interest, before privatisation the Central Electricity Generating Board (CEGB) in England & Wales used a planning margin of 24% to provide generation security when planning the need for future generation installed capacity. Under the pre-NETA electricity "Pool" trading arrangements in England & Wales, capacity payments were paid in respect of available generation capacity. These capacity payments, which were a function of Loss of Load Probability (LOLP), were intended to provide a signal of capacity requirements. Under NETA/BETTA market forces determine the plant margin.

Reduction in Frequency Response

National Grid as GBSO has a statutory obligation to maintain frequency between certain specified limits save in exceptional circumstances (see the Electricity Supply Regulations 1989). Large deviations in frequency can lead to widespread demand disconnections and generation disruptions. System frequency is a continuously changing variable and is determined and controlled by a careful balance between demand and generation. If demand is greater than generation, frequency falls and, if generation is greater than demand, frequency rises.

With the arguable exception of pumped storage power stations, electricity, unlike other commodities, cannot be stored in significant quantities. Therefore, in order to avoid an unacceptable fall in frequency in the event of the failure of one or more sources of generation, it is necessary to have available additional generation, that can be called upon at very short notice (i.e. within seconds or minutes). This is referred to as 'frequency response'.

Without transmission interconnection, each separate system would need to carry its own frequency response. With interconnection the net response requirement is the highest of the individual system requirements to cover for the largest potential loss of power (generation) infeed, rather than the sum of them all.

Embedded Generation

Types of Embedded Generation

The output of most embedded Medium and Small power stations falls into two main categories that are not mutually exclusive, namely that generated primarily for own use, normally in the form of combined heat and power (CHP), and that generated for supply to third parties, mainly from renewable sources (e.g. wind).

A CHP plant is an installation where there is simultaneous generation of usable heat and electrical power in a single process. CHP schemes are generally fuelled by gas, coal or oil although some are also partially fuelled by fossil fuels and partially fuelled by renewable sources of energy (e.g. biofuels such as sewage gas). The latter are referred to as ‘Co-firing’ generating stations. CHP schemes tend to be located in close to customers (e.g. large industry) wishing to take the heat output.

Renewable generation technologies cover a range of energy sources including hydro, biofuels, wind, wave and solar. In output terms, the largest contributions currently come from biofuels, which include landfill gas, waste combustion, sewage sludge digestion and coppice wood and straw burning. UK figures show that in 2006 biofuels accounted for about half (51%) of renewable generation, with the other half mainly shared between hydro (25%) and wind (23%). Three years earlier the equivalent percentages were 58%, 30% and 12%.

Embedded Small and Medium Power Stations

Electricity Demand considers, amongst other things, the forecast peak demand on the GB transmission system in average cold spell (ACS) conditions, which is based on the projections provided by the system 'Users' and by National Grid. ACS peak demand relates to the demand met by directly connected power stations, imports across directly connected External Interconnections from External Systems and embedded Large power stations, all of which are the subject of **Generation**.

Network operators are required under the Grid Code to net off their own allowances for the output from embedded Medium and Small power stations when submitting their forecasts of demand to be supplied at the Grid Supply Points. They are also required to net off their own allowances for any forecast imports across embedded External Interconnections from External Systems. Accordingly, the output of embedded Medium and Small power stations is taken into account when planning the development of the transmission system. However, this output is not directly seen by the transmission system operator, although its overall effect on the GB transmission system and its operation is.

In responding to previous customer surveys, many readers have requested detailed information on embedded generation to be included in the Seven Year Statement. In response to these requests, we have included **Table 4.1**, which contains a range of information on Small and Medium power stations embedded within distribution networks. The information in this table is based on information kindly provided by the relevant distribution network operators even though the provision of such detail currently goes beyond their Week 24 Grid Code obligations. Please note that a number of the smaller wind farms, listed in **Table 4.1**, have yet to connect.

The information in respect of the Scottish distribution companies (i.e. SHEPD and SP Distribution Ltd) has been updated this year. However, updated information in respect of the distribution companies in England and Wales was not available in time for publication in this Statement and, for those DNOs, last year's data has been re-used. Accordingly, the information contained in **Table 4.1** is not necessarily complete and, as such, should not be relied upon. If the reader requires further information they are advised to contact the relevant distribution network operator.

In view of the relatively high volume of data relating to the distribution systems in England and Wales, a cut-off point of 5MW has been adopted to reduce the data collection burden on the distribution network operators (i.e. embedded plant of less than 5MW located in England and Wales is not included). However, the information relating to the Scottish distribution systems provided by the Scottish network operators does not have a lower cut-off level. For some User Systems, the information is provided on an individual power station basis while for others the information is provided on a GSP basis.

There is a current Grid Code requirement (PC.A.3.1.4 of the Planning Code refers) for distribution network operators to inform NGET of, inter alia, the summated capacity of embedded Medium and Small power stations within their area and the allowances made for these in their demand forecasts projected for the time of the GB peaks. This information is summarised in **Table 4.2** . Please note that the 'Zone Number', referred to in **Table 4.2**, iis the 'Demand TNUoS Tariff Zone' rather than the 'SYS Study Zone', both of which are introduced in **Use of System Tariff Zones**.

Notwithstanding the fact that the information contained in the above two tables may, in some respects, be incomplete, they do nevertheless provide an initial useful insight into the types of embedded generation (**Table 4.1**) and into the total demand in the system (i.e. demand on the GB transmission system plus embedded generation capacity 'netted off ' the distribution network operators Grid Code demand submissions).

Inspection of the two tables indicates that the distribution network operators assume that, overall, around forty seven percent of the installed capacity of embedded generation is considered to be contributing at the time of the GB peak. The contribution assumed by network operators to be firm at other times, including the time of the local peak demand for which the Grid Supply Point is chiefly designed, rather than the time of GB peak demand, is not reported. On the basis of the information provided in **Table 4.2**, the total installed capacity of embedded Medium and Small generation is 7454MW in 2009/10. Of this, some 769MW is located in Scotland (zones 1 & 2), 3344MW is located in northern zones of England and Wales (zones 3, 4, 5 & 6) and 3341MW is located in southern zones (zones 7 to 14).

Government Targets and Obligations

As part of its policy to reduce carbon emissions in 2010 by 20% of their 1990 level in order to help deliver the UK's Climate Change Programme, the government set a target of increasing the electrical capacity of combined heat and power in the United Kingdom to 10GW by 2010.

In addition to this CHP objective, the government also set a target for 2010 for the proportion of electricity sold by suppliers to be sourced from renewable fuels through the Renewables Obligation. The introduction of these instruments, together with the trading arrangements for the Renewables Obligation (RO) certificates, has provided a significant boost to the economics of renewables. However, it is important to also have the successful introduction of an appropriate planning framework in order to facilitate the speedy development and construction of renewable generation in line with the Climate Change Programme and targets.

In presenting our own view of projected peak demand and electricity requirements our assumptions about future growth in embedded CHP and renewable generation are outlined in **Electricity Demand**.

Renewables Obligation

The main instrument for encouraging the development of renewable generation prior to April 2002, was the Non-Fossil Fuel Obligation (NFFO) in England & Wales and the Scottish Renewable Order (SRO) in Scotland. Under these schemes the Department of Trade and Industry selected and approved renewable generating projects following a tendering process. Electricity suppliers were then obliged to purchase power from these generators, the extra cost of doing so being reimbursed from the Fossil Fuel Levy imposed on customers' bills.

A government aim is for renewable energy to make an increasing contribution to energy supplies in the UK, with renewable energy playing a key role in the wider climate change programme. The Renewable Obligation, the Renewable Obligation (Scotland) and the Renewable Obligation (Northern Ireland) are designed to incentivise renewable generation in the electricity generation market. These schemes were introduced by the Department of Trade and Industry, the Scottish Executive and the Department of Enterprise, Trade and Investment respectively and are administered by Ofgem.

Since 2002 Ofgem has published annual reports on the Renewables Obligation and readers are advised to consult these for more detail on the subject. The annual reports are available on the Ofgem website. The latest issue is in respect of the period 2007-08.

The first Renewable Obligation Order came into force in April 2002 as did the first Renewable Obligation Order (Scotland). These Orders were subject to review in 2004, 2005, 2006 and 2007. The first Renewables Obligation Order (Northern Ireland) came into force in April 2005. New Orders came into force on 1 April 2006 and 1 April 2007. The Renewables Obligation Order (Northern Ireland) 2007 was amended on 19 October to allow for its continued effective operation within the new Single Electricity Market arrangements for Ireland with effect from 1 November 2007.

These Orders place an obligation on licensed electricity suppliers in Great Britain and Northern Ireland to source an increasing proportion of electricity from renewable sources. In 2007-08, this was 7.9% in Great Britain and 2.8% in Northern Ireland. The size of these obligations increases year on year such that for Great Britain they reach 10% of electricity sales in 2010 and 15% in 2015.

Suppliers meet their obligations by presenting sufficient Renewable Obligation Certificates (ROCs), also referred to as 'Green Certificates', to cover their obligations. These certify that a generating station has generated an amount of electricity from renewable sources and that this electricity has been supplied to customers in Great Britain. Where suppliers do not have sufficient ROCs to meet their obligation, they must pay an equivalent amount (referred to as the buy-out price) into a fund. An obligation period runs from 1 April to 31 March each year. The buy-out price for the 2007-08 obligation period was £52.95 per megawatt hour. In February this year, Ofgem published a buy-out price for the RO of £37.19 per megawatt hour for the period 1 April 2009 to 31 March 2010. The money accrued from the fund is redistributed to all suppliers in proportion to the amount of renewable power they actually buy, as defined by the number of certificates they hold. The government intends that suppliers will be subject to a Renewables Obligation until 31 March 2027.

When the RO was first introduced, the most prevalent technology type (in terms of the number of accredited generating stations) was landfill gas with 202 accredited stations at 1st April 2002. The number of landfill gas stations being accredited has reduced significantly and, in 2007-08, 12 landfill gas generating stations were accredited.

The most prevalent technology in the 2006-07 obligation period, in terms of the number of stations becoming accredited, was photovoltaic with 662 stations being accredited. The most prevalent technology, in terms of capacity becoming accredited, in this period was on-shore wind. On-shore wind stations made up approximately 47% of the total renewable capacity installed and accredited under the RO in the 2007-08 obligation period.

In May 2007 BERR issued a consultation on a number of proposed changes to the Renewables Obligation. In their response, the government decided upon a number of changes to be implemented from 1 April 2009. These include:

- Banding the RO so that different levels of support are provided to different technologies;
- Extending obligation levels up to 20% on a “guaranteed headroom” basis;
- A change to the treatment of generators supplying through private wire networks;
- Publishing annual sustainability reporting for Biomass; and
- Deeming energy from waste at 50% renewable content and allowing a higher percentage where adequate sampling procedures are in place.

Further to this, BERR launched a second consultation in June 2008 outlining how the government proposed to enact the changes proposed in the 2007 consultation. These proposals would be implemented from 1 April 2009 and include the following

- Grandfathering generation in existence prior to 11th July 2006, with the exception of co-firing without CHP and microgeneration stations.
- Band the RO to provide more support to certain technologies over others.
- Establish processes for settling the obligation, allowing suppliers to calculate their obligation.
- Require biomass generators to report on sustainability
- Fund Ofgem’s administrative costs from the buyout fund
- Set a separate Combined Heat and Power Quality Assurance (CHPQA) efficiency criteria for renewable Combined Heat and Power (CHP) schemes.

Environmental Targets for Renewables & Emissions

The UK Government has recently signed up to two environmental targets one relating to renewable energy and one to green house gas (GHG) emissions. The former relates to the EU renewable target of 20% of energy to come from renewable sources by 2020 which translates for the UK to 15% due its low starting point. The latter was recently confirmed in the 2009 Budget statement when the Government announced the first three carbon budgets at levels leading to a 34% reduction in GHG emissions by 2020, which will put the UK on the flight path to the 80% reduction target by 2050. To see what potential power station developments and network reinforcements are required to enable these 2020 targets to be met please refer to the section on the Electricity Networks Strategy Group (ENSG) report in **Indicative Reinforcements required to meet Environmental Targets**.

Climate Change Levy

Another instrument of the government's policy to reduce environmental emissions is the Climate Change Levy (CCL). This is an energy tax payable by all industrial and commercial businesses since April 2001. It is levied on energy supplies, the rate varying depending on the fuel. The levy initially set for electricity was 0.43p/kWh. From April 2007 the CCL has been increased in line with RPI, and the rate for electricity for 2008/09 is 0.456p/kWh, up from 0.441p/kWh in 2007/08. Energy intensive businesses can receive up to 80% discount on the levy if they enter into agreements with the government to undertake significant energy efficiency improvements.

Electricity generated from renewables is exempt from the CCL, thus currently benefiting developers of renewable electricity by an extra 0.456p/kWh. As a result, developers of qualifying renewable schemes could receive a minimum support of 4.032p/kWh in 2008/09, (i.e. the buy-out price of 3.576p/kWh under the RO plus 0.456p/kWh under the CCL). This is in addition to the value of the share-out of the buy-out kitty among those suppliers who have bought green energy under the Renewables Obligation.

Growth and Location of Wind Farms

There are clear indications of significant activity associated with the development of wind generation and, accordingly, future activity in this area is worthy of further consideration.

Wind farms may, of course, be embedded or non-embedded and may be classified as Large, Medium or Small power stations. Accordingly, relevant information can be found from two sources of data within this Statement.

The first is **Table 4.1**, which presents information on embedded Medium and Small power stations. As explained previously, the information contained in Table 4.1 is not necessarily complete and, as such, should not be relied up on. Much of the information contained in Table 4.1 has been voluntarily sourced by the distribution network operators and NGET cannot therefore guarantee its accuracy. Nevertheless, the information it contains does provide a useful initial indicator to the types and capacity of embedded Medium and Small generation connected to distribution networks.

The second source is **Table 3.5** of (Chapter 3), which presents information on directly connected power stations and Large embedded power stations. Accordingly, **Table 3.5** includes information on all Large wind farms, whether directly connected or embedded, and Medium and Small wind farms, that are directly connected to the GB transmission system.

On the basis of the information contained in **Table 4.1**, the installed capacity of embedded Medium and Small wind farms in 2008/09 is 2.072GW. Of this 1.146GW is located onshore and 0.927GW is located offshore. Some 64MW of the onshore wind farms are located in the SHETL area and 280MW of the onshore wind farms are located in the SPT area. The remainder (onshore and offshore) is located in the NGET area.

On the basis of the information contained in **Table 3.5**, the installed capacity of wind farms, that are either classified as Large or are directly connected to the GB transmission system, grows from some 2.9GW in 2009/10 to 13.9GW by 2015/16. This is made up of a growth in offshore capacity from some 0.8GW in 2009/10 to 6.1GW by 2015/16. Onshore wind capacity is projected to grow from 2.1GW in 2009/10 to 7.9GW by 2015/16. The disposition of this wind farm capacity is included in **Table 3.13**.

Overall, wind farm capacity, both embedded and directly connected is projected to grow from 5.0GW in 2009/10 to 16.0GW by 2015/16. (2.1GW embedded and 2.9GW large/transmission connected) in 2009/10 to 16.0GW by 2015/16 with all the growth (11.1GW) coming from large/transmission connected. Embedded wind is seen by National Grid as negative demand and as a consequence is netted of the demand within the distribution networks.

Effect on Power Transfers

General Considerations

One effect of an increasing proportion of embedded generation will be to reduce the flow across the interface between the transmission and distribution networks. This will tend to delay the need for reinforcement of parts of the transmission network but it is unlikely to remove the need for the substations that exist at the interface between the transmission and distribution systems (i.e. the Grid Supply Points). These will continue to be required to balance the fluctuations between generation and demand in that specific part of the distribution network from minute to minute.

In a few areas it is possible that embedded generation may increase to a level where there could be electricity exports from distribution networks to the transmission system. Provided such transfers are within the capacity of the super grid transformers, this is not expected to lead to major technical difficulties. The general reduction in the power flow from the transmission to distribution networks does not necessarily lead to a similar reduction in the bulk power transfer across the transmission system. These bulk transfers, and therefore the need for system reinforcements, are a function of the size and geographical location of both generation and demand.

Power stations, particularly Large Power Stations, tend to be located in clusters near fuel sources. This, coupled with their size (i.e. capacity) relative to that of individual demands, means that generation developments (openings or closures) tend to exert the greater influence on the need for transmission reinforcements. Demand changes are normally less localised and are subject to a more even rate of change. Having said that, in some areas (e.g. where demand exceeds local generation) demand can exert the greater local influence and as such there remains a need for accurate demand forecasts in terms of both level and location.

Transmission System Performance, which considers the performance of the GB transmission system against the 'SYS background', includes two figures (**Figure 7.3** and **Figure 7.4**) which provide a simplistic overview of the power flow pattern at the time of ACS peak demand for the years2009/10 and 2015/16 respectively. For ease of reference these figures have been reproduced here as **Figure 4.1** and **Figure 4.2**.

Figure 4.1

Click to load a larger version of Figure4.1 image

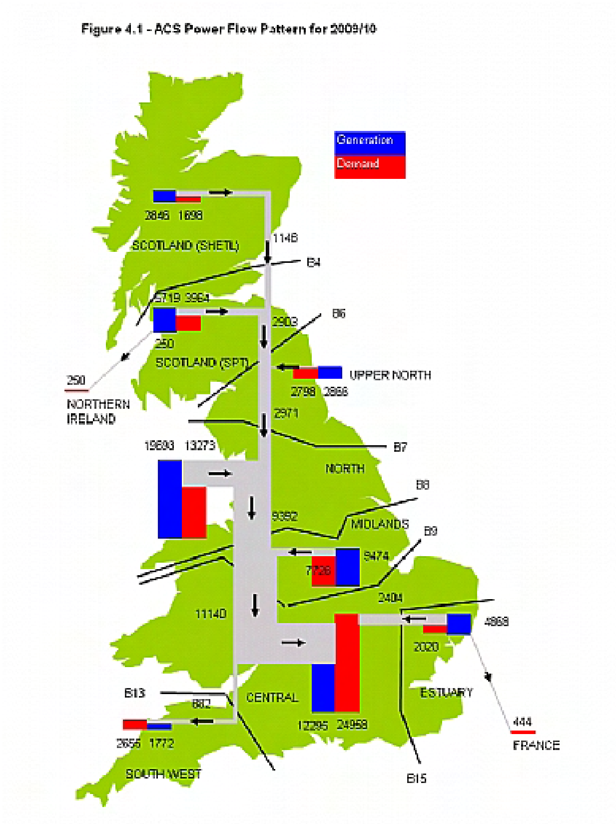
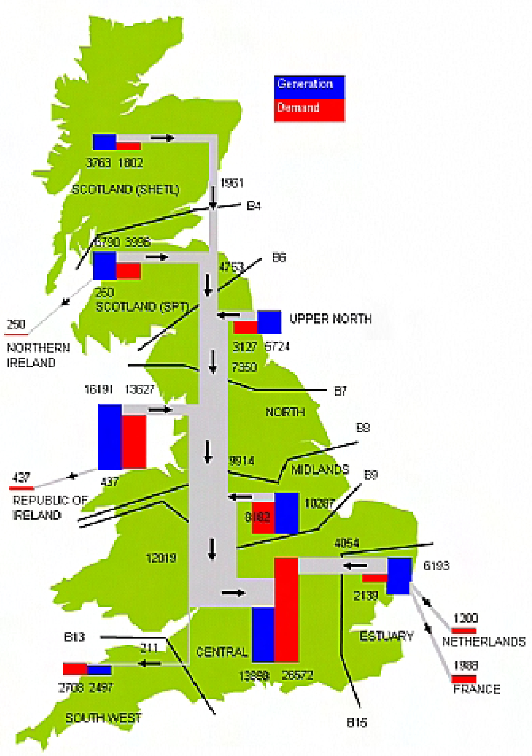


Figure 4.2

Click to load a larger version of Figure4.2 image

Figure 4.2 - ACS Power Flow Pattern for 2015/16



Power transfers across the system at any given time are a function of the output of the power stations actually operating at that time rather than of their installed capacity. The disposition of such plant changes as the overall demand level changes throughout the year. The predominant north to south power flows illustrated in **Figure 4.1** and **Figure 4.2** reflect the fact that whilst around 50% of the peak demand is located in the south (i.e. south of the midlands to south border), much of the less expensive generation is located in the north. These heavy transfers from the north to the south prevail throughout most of the year since, as demand falls, less of the relatively more expensive generation in the south is used.

Power transfers across the GB transmission system depend on the disposition of generation and demand regardless of whether it is directly connected to the GB transmission system or embedded within a distribution system. To reduce bulk flows would require a general movement of economic generation (directly connected or embedded) nearer to the major load centres (e.g. the south). Even then it would not necessarily follow that the north to south power transfers would reduce. For instance, if new embedded generation were to be located in the south its operation could displace the operation of less economic plant also in the south, in which case transfers would be unchanged. Alternatively, if new embedded generation were to be located in the north of the system it is more likely that north to south transfers would increase.

Growth in Wind Farms

Table 4.1 (on embedded generation) and **Table 3.5** collectively imply that the installed capacity of wind farms (embedded and directly connected) could reach some 6.95GW by 2010/11, 9.7GW by 2011/12 growing to 16.0GW by 2014/15. However, it has to be borne in mind that not all prospective future projects will necessarily proceed to completion.

Transmission Network Use of System Charges (TNUoS)

The Balancing and Settlement Code (BSC) and TNUoS charges, including to whom they apply, are explained in **Market Overview**.

Generators that are not registered within the BSC are exempt from TNUoS charges and payments. Relevant power stations would be Licence exempt, embedded and registered within a Supplier BM Unit. The output of these power stations will have already been accounted for in the supplier's demand figures upon which TNUoS charges are based.

Under the above circumstances an embedded power station which is both licence exempt and not party to the BSC will not be charged TNUoS and may be able to reduce the TNUoS charges payable by the host supplier (i.e. the supplier in whose BM Unit the power station is registered) by generating on the Triad legs.

Fluctuating Unpredictable Output and Standby Capacity

The output of some renewable technologies, such as wind, wave, solar and even some CHP, is naturally subject to fluctuation and, for some renewable technologies, unpredictability relative to the more traditional generation technologies. Analyses of the incidence and variation of wind speed, the expected intermittency of the national wind portfolio would not appear to pose a technical ceiling on the amount of wind generation that may be accommodated and adequately managed. However, increasing levels of such renewable generation on the system would increase the costs of balancing the system and managing system frequency.

It is a property of the interconnected transmission system that individual and local independent fluctuations in output are diversified and averaged out across the system. Moreover, the interconnected system permits frequency response and reserves to be carried on the most cost effective generation or demand side service provider at any particular time. These properties of the transmission network permit intermittent/ variable generation to be used with lower standby and frequency control costs than would otherwise be the case.

Given the variable and unpredictable nature of some renewable technologies such as wind, the proportion of conventional generation needed to be retained in the electricity market so that current levels of security of supply are not eroded is the subject of recent research that has been recently published. The report "Growth Scenarios for the UK Renewable Generation and Implications for future Developments and Operation of electricity Networks" (BERR Publication URN 08/1021 June 2008) indicates that in the future "the probability of having low wind output at times of peak demand is considerable. There is a 10% probability that wind output will be below about 20% of installed capacity at times of peak demand in winter and a 5% probability of output being below about 15%."

This implies that, for larger wind penetrations, the wind capacity that can be taken as firm is not proportional to the expected wind energy production. It follows that the electricity market will need to maintain in service a larger proportion of conventional generation capacity despite reduced load factors. Such plant is often referred to as "standby plant".

Balancing Mechanism Participation

Users registered within the Balancing and Settlement Code (BSC) may volunteer to participate in the Balancing Mechanism (BM) regardless of whether they are directly connected to the transmission system or embedded within a distribution system. The minimum offer size in the BM is 1MW.

National Grid's responsibility in the BM is limited to balancing generation and demand and to resolving transmission constraints. This includes a duty and financial incentive under the System Operator Incentive Scheme to purchase Balancing Services economically. The Grid Code requires all embedded participants on the BM to ensure that their physical notifications, bids and offers are feasible with respect to their host network.

The persistence effect of wind (i.e. its output is naturally subject to fluctuation and unpredictability relative to the more traditional generation technologies) coupled with the expected significant diversity between regional variations in wind output means that, while the balancing task will become more onerous, the task should remain manageable. Provided that the necessary flexible generation and other balancing service providers remain available, there is no immediate technical reason why a large portfolio of wind generation cannot be managed in balancing timescales.

It is anticipated that balancing volumes and costs will increase as the wind portfolio increases. National Grid estimation of these volumes and costs will be highlighted via a separate consultation report on future system operations which is due to be published in May 2009.

In the longer term, we do not think it likely that there will be a technical limit on the amount of wind that may be accommodated as a result of short term balancing issues but economic and market factors will become increasingly important.

Ancillary Services

Balancing Services (which include Ancillary Services) and Balancing Services Use of System (BSUoS) charges (including to whom they apply) are explained in **Market Overview**.

National Grid has actively encouraged and facilitated market arrangements for the provision of ancillary services. Whilst BSUoS charges are levied on all BSC signatories, the provision of ancillary services is not limited to those signatories. Accordingly, the provision of such services is open to any party who can provide a service, including embedded generation, cost-effectively.

System operators at the national control centre use ancillary services. They are only able to call-off a limited number of service blocks in the short period of time available. Thus, for practical reasons, de-minimis sizes are specified for control use. These are:

- frequency response : 3MW each despatch instruction
- reserve : 3MW each despatch instruction
- reactive : $^{+}$/- 15Mvar at station terminals
- black start : must be capable of charging circuit

However aggregators/agents are encouraged as this facilitates the provision of practical service blocks, enhances the dependability of service provision and reduces costs due to simplified communication requirements.

Prior to NETA, much experience was gained with a significant number of embedded service providers (generation and demand). However, whilst National Grid now specifies service levels at station terminals rather than at the National Grid/service provider interface, to date it has not been successful in entering into a reactive contract with embedded generation not registered within the BSC. This illustrates the difficulties and costs faced by small reactive providers acting through an intermediate network/distribution system.

Licence exempt embedded generation not registered within the BSC may receive benefits from the host Supplier in recognition of the consequent reduction to that Supplier's obligation to pay BSUoS charges. However, if the embedded generation were to choose to participate in the Balancing Mechanism, then registration within the BSC would be necessary and appropriate BSUoS charges would be levied.

Technical and Data Requirements

All Generators with Large power stations are obliged to sign onto the Connection and Use of System Code (CUSC). This includes signatories to the Balancing and Settlement Code (BSC). In addition parties who are not holders of a Licence but who have registered within the BSC are also required to sign the CUSC.

The CUSC places a number of obligations on signatories, which includes compliance with the Grid Code. Amongst other things, the Grid Code sets out technical requirements for the various classes of generation (e.g. Large, Medium, Small, embedded and directly connected External Interconnections) as well as requirements for data to be supplied to National Grid as GBSO.

Some of the earlier technologies used in wind turbines were very sensitive to voltage depressions, even where such depressions lasted for very short periods of time, such as the 140 milliseconds that protective equipment on the GB transmission system typically take to remove a line fault caused by lightning. Such faults can result in voltage depressions over an extensive area of the system potentially causing a large number of wind turbines to trip as a result of a common cause. In recognition of this the Grid Code has now been revised to include revised minimum technical characteristics for such generation technologies.

Medium and Small embedded generation which is Licence exempt and which is not registered within the BSC, is not required to sign on to the CUSC and, in consequence, is not obliged to comply with the Grid Code. Nevertheless, it is recognised that such embedded generation does impact on the overall performance of the transmission system and its operation.

Embedded Medium power stations are most likely to have a material effect. Small power stations may also be important particularly if connected at the first voltage transformation level of the Grid Supply Point.

To enable the Transmission Owners to meet their obligations with regard to planning the transmission system and National Grid, acting as GBSO, to further meet its obligations with regard to operating the GB transmission system it is important that Users submit sufficient and timely information on all embedded generation, that may have a material effect on the transmission system. Amongst other things, the following are required:-

- technical and other information in respect of any new embedded generation which may be material to the design and operation of the transmission system in order that any necessary works can be evaluated and initiated in a timely fashion; and
- sufficient notification to enable any necessary works to be completed and ensure the transmission network is safe and secure before the embedded generation is energised.

It is also important that relevant embedded generation meets, where appropriate, certain minimum technical requirements (e.g. so that they are able to participate in the provision of ancillary services).

At the time of writing, power stations which are capable of exporting between 50MW and 100MW to the total system in Great Britain, connecting since 30 September 2000 may apply to apply to the Department of Trade and Industry (DTI) to seek a Licence Exemption. The DTI then consults all interested parties including National Grid. Power stations, which are not capable of exporting 50MW or more to the total system, are automatically exempt from the requirement to hold a generation licence. On receipt of the consultation documents from the DTI, we consider the need for:

- any transmission system works including timing;
- Grid Code data requirements (e.g. Planning Code data);
- technical requirements (e.g. as specified under the Grid Code Connection Conditions);
- metering requirements

The above information is included in our response to the DTI consultation document and at the same time we offer an agreement, also containing the above information, where appropriate. Such agreements would not automatically subject the Generator to TNUoS charges, but would provide for any necessary data exchange.

It is recognised that some Generators with embedded generation would not want to have a contract or any other commercial arrangement with National Grid. The longer term solution to these interface issues with embedded generation is for National Grid to work with the host distribution network operators to obtain the necessary information, ensure co-ordination of developments and also to pass across certain technical responsibilities, currently in the Grid Code, to the network operator. This approach would facilitate a single contract relationship between the embedded generation and the host distribution network operator.

Summary

National Grid recognises the importance of climate change issues and that the government's targets for growth in CHP and renewable generation are likely to lead to continuing increases in embedded generation. It is important for National Grid to play its part in facilitating this by ensuring that any transmission issues arising are appropriately addressed. At present, no insurmountable transmission problems associated with accommodating new embedded generation projects are foreseen. Indeed, the properties of the interconnected transmission system are such as to facilitate embedded generation growth regardless of location.

Nevertheless, this does not preclude the potential need for reinforcements to the GB transmission system, the extent of which would be a function of the system location of the new plant. For example, the extent, and therefore cost, of GB transmission reinforcement would be a function of the volume of offshore wind located off the England and Wales coast or onshore wind located in Scotland. . There is considerable ongoing work in this area which is published by the Electricity Networks Strategy Group (ENSG): **http://www.ensg.gov.uk/index.php?article=126**

The persistence effect of wind (i.e. its output is naturally subject to fluctuation and unpredictability relative to the more traditional generation technologies) coupled with the expected significant diversity between regional variations in wind output, means that, while the balancing task will become more onerous, the task should remain manageable. Provided that the necessary flexible generation and other balancing service providers remain available, there is no immediate technical reason why a large portfolio of wind generation cannot be managed in balancing timescales.

It is anticipated that balancing volumes and costs will increase as the wind portfolio increases. National Grid estimation of these volumes and costs will be highlighted via a separate consultation report on future system operations which is due to be published in May 2009.

Figure 4.1 - ACS Power Flow Pattern for 2009/10

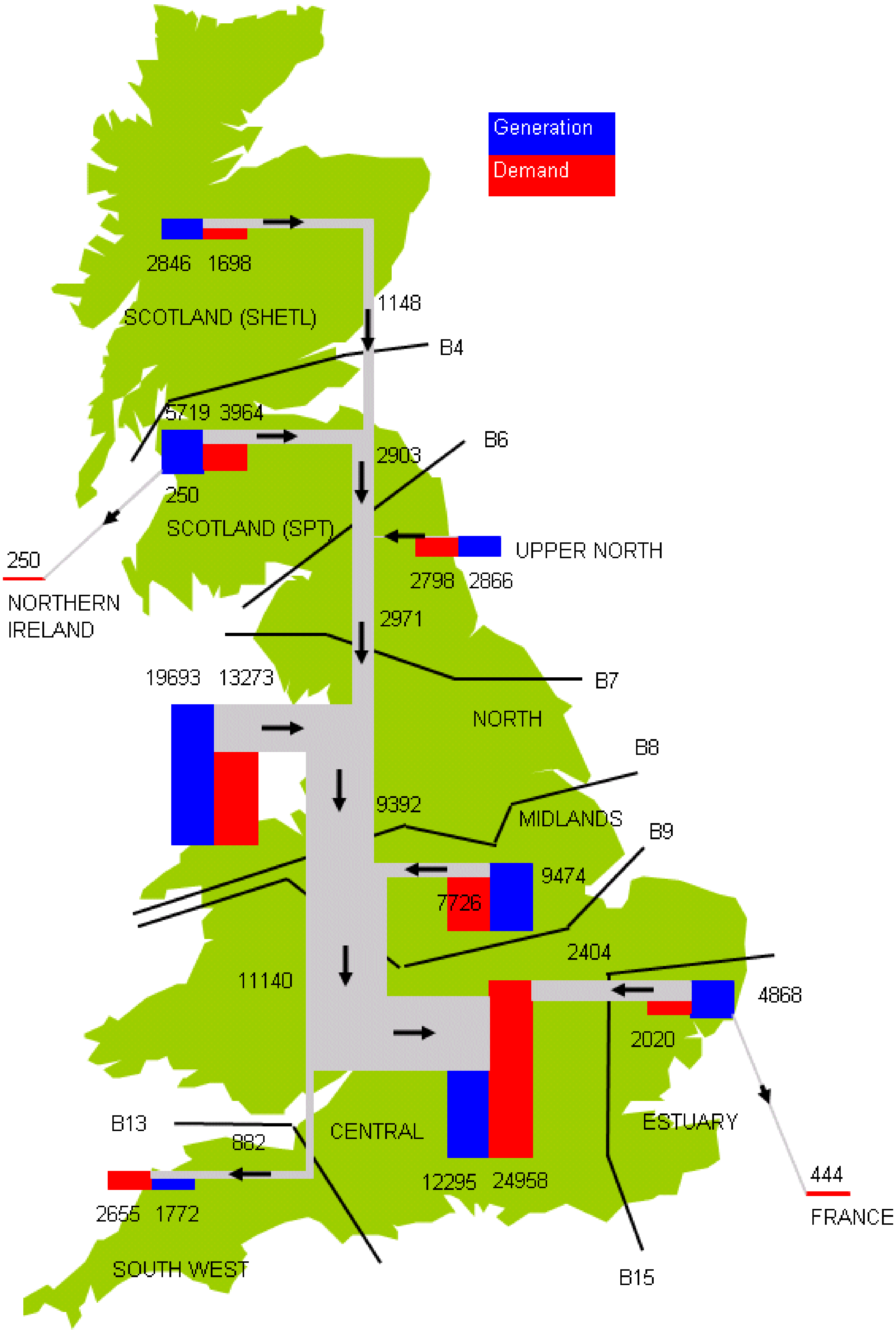


Figure 4.2 - ACS Power Flow Pattern for 2015/16

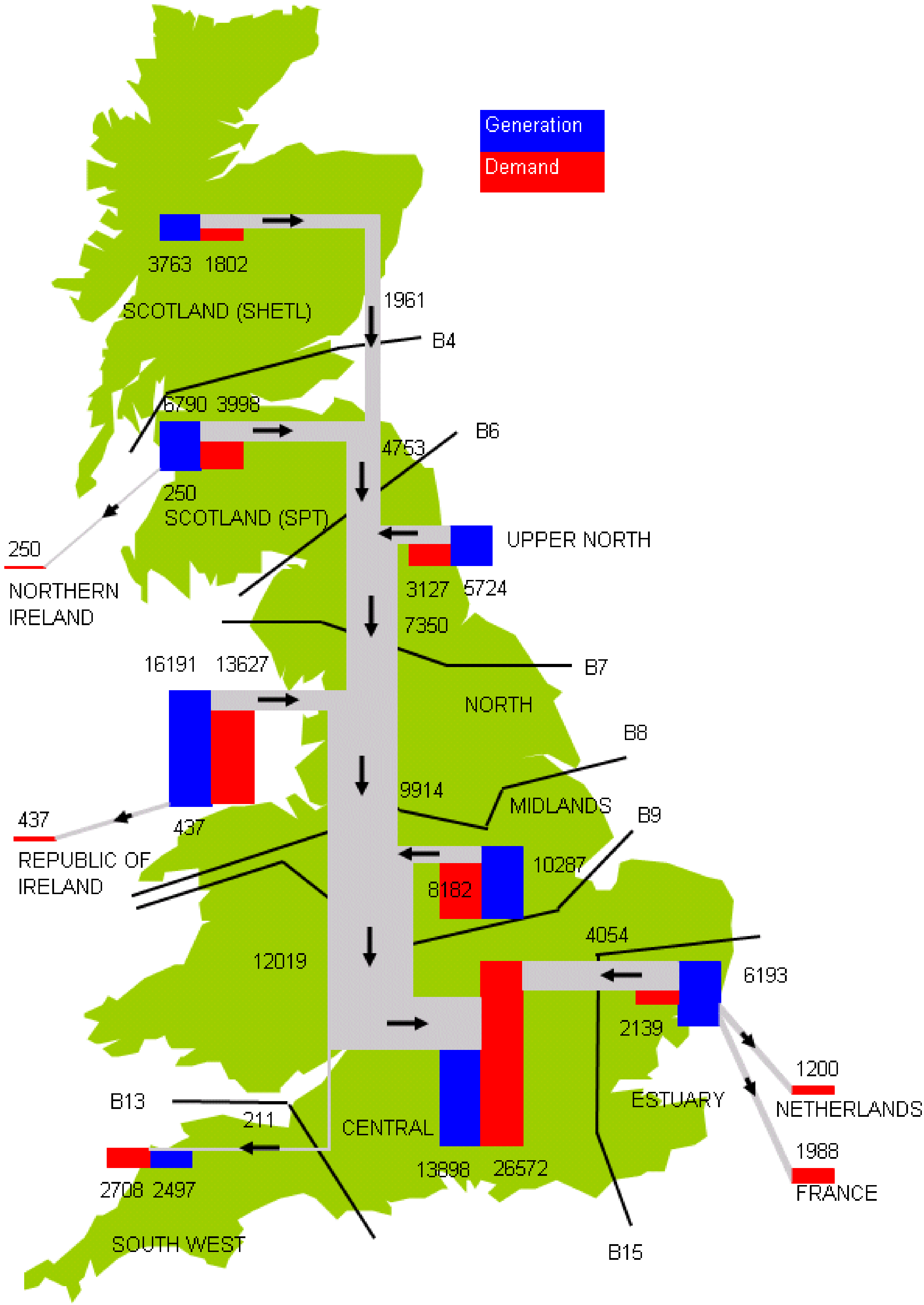


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Table 4.1 - Installed Capacity of Medium and Small Generation Embedded within Distribution Networks

DNO Network	Power Station Name	Grid Supply Point	Installed Capacity (in MW)	Fuel/Plant Type
SHEPD	Binn Landfill, Glenfarg	Abernethy	4	Waste
SHEPD	Cauldron Linn	Abernethy	0.4	Hydro
SHEPD	Stormontfield	Abernethy	0.1	Hydro
SHEPD	Arbroath Sports Centre CHP Phase 1	Arbroath	0.1	Thermal
SHEPD	Arbroath Sports Centre CHP Phase 2	Arbroath	0.2	Thermal
SHEPD	Mitchells of Letham	Arbroath	1	Waste
SHEPD	Arnish Moor Wind, Lewis	Ardmore	3.9	Wind
SHEPD	Arnish, Stornoway	Ardmore	3	Diesel
SHEPD	Barra	Ardmore	2	Diesel
SHEPD	Chliostair, Stornoway	Ardmore	1.2	Hydro
SHEPD	Gisla, Stornoway	Ardmore	0.7	Hydro
SHEPD	Liniclate Wind Generation, Benbecula	Ardmore	0.9	Wind
SHEPD	Beannachran Dam	Beauly	0.2	Hydro
SHEPD	Falls of Conis	Beauly	0.9	Hydro
SHEPD	Little Wyvis	Beauly	0.6	Hydro
SHEPD	Luichart Dam	Beauly	0.1	Hydro
SHEPD	Meig Dam	Beauly	0.1	Hydro
SHEPD	Misgeach	Beauly	0.4	Hydro
SHEPD	Orrin Dam	Beauly	0.3	Hydro
SHEPD	River Glass	Beauly	0.9	Hydro
SHEPD	Ardverickie	Boat of Garten	1.2	Hydro
SHEPD	Cuaich	Boat of Garten	2.6	Hydro
SHEPD	Ashfield Mill, Dunblane	Braco	0.2	Hydro
SHEPD	Deanston Distillery	Braco	0.5	Hydro
SHEPD	Glen Finglass	Braco	0.5	Hydro
SHEPD	Glen Turret	Braco	2	Hydro
SHEPD	Monzie	Braco	0.2	Hydro
SHEPD	Inverbain	Broadford	0.9	Hydro

SHEPD	Nostie Bridge	Broadford	1.2	Hydro
SHEPD	Cromwell Park	Burghmuir	0.1	Hydro
SHEPD	Kinnaird Hydro	Burghmuir	0.3	Hydro
SHEPD	Stanley Mills	Burghmuir	1	Hydro
SHEPD	Claddoch	Carradale	0.2	Hydro
SHEPD	Gigha	Carradale	0.7	Wind
SHEPD	Lussa	Carradale	2.4	Hydro
SHEPD	Duchally	Cassley	0.4	Hydro
SHEPD	Maldie Burn Hydro	Cassley	4.5	Hydro
SHEPD	Merkland Hydro	Cassley	1.4	Hydro
SHEPD	Cluanie Dam	Ceannacroc	0.3	Hydro
SHEPD	Dundreggan Dam	Ceannacroc	0.2	Hydro
SHEPD	Loyne Tunnel	Ceannacroc	0.6	Hydro
SHEPD	Allt na Lairige	Clachan	6	Hydro
SHEPD	Balliemeanoch	Clachan	1	Wind
SHEPD	Douglas Water Hydro, near Inveraray	Clachan	2.5	Hydro
SHEPD	Douglas Water Hydro, near Inveraray (Additional)	Clachan	0.5	Hydro
SHEPD	Drimsynie	Clachan	0.4	Hydro
SHEPD	Glen Kinglas, Cairndow	Clachan	1	Hydro
SHEPD	Sron Mor	Clachan	5.2	Hydro
SHEPD	Newton Dee Camphill Village Trust	Craigiebuckler	0	Wind
SHEPD	Dunbeath Beatrice Wind (Pilot)	Dunbeath	9.9	Offshore Wind
SHEPD	Striven	Dunoon	7.8	Hydro
SHEPD	Storr Lochs	Dunvegan	2.7	Hydro
SHEPD	Findhorn Wind Generators	Elgin	0.9	Wind
SHEPD	Fasnakyle P/Stn Compensation hydro	Fasnakyle	7.5	Hydro
SHEPD	Mullardoch	Fasnakyle	2.5	Hydro
SHEPD	Mains of Haulkerton Biodiesel, Laurencekirk	Fiddes	0.1	Biodiesel
SHEPD	Garry Dam	Fort Augustus	0.3	Hydro
SHEPD	Garry Gualach	Fort Augustus	0.9	Hydro
SHEPD	Invergarry Dam	Fort Augustus	0.3	Hydro
SHEPD	Quoich Dam	Fort Augustus	0.4	Hydro
SHEPD	Ardtornish	Fort William	0.7	Hydro
SHEPD	Callop Hydro, Glenfinnan	Fort William	1.4	Hydro

SHEPD	Conaglen House Hydro, Ardgour	Fort William	0.3	Hydro
SHEPD	Glen Tarbert	Fort William	0.8	Hydro
SHEPD	Gorton	Fort William	0.1	Hydro
SHEPD	Kingairloch	Fort William	3.5	Hydro
SHEPD	Morar	Fort William	0.8	Hydro
SHEPD	Mucomir	Fort William	1.8	Hydro
SHEPD	Silverhill House, Glenborrodale	Fort William	0.1	Hydro
SHEPD	Dundee University CHP	Glenagnes	3	Thermal
SHEPD	Achanalt Hydro	Grudie Bridge	2.6	Hydro
SHEPD	Culleig Hydro (SRO)	Grudie Bridge	3	Hydro
SHEPD	Garbhaig	Grudie Bridge	1	Hydro
SHEPD	Kerry Falls	Grudie Bridge	1.3	Hydro
SHEPD	Loch Dubh	Grudie Bridge	1.2	Hydro
SHEPD	Loch Poll Hydro	Grudie Bridge	0.2	Hydro
SHEPD	Vaich Tunnel	Grudie Bridge	0.3	Hydro
SHEPD	Corriegarth	Inverness	3	Hydro
SHEPD	Dunmoglas	Inverness	0.6	Wind
SHEPD	Foyers Falls	Inverness	5	Hydro
SHEPD	Garrogie	Inverness	2	Hydro
SHEPD	Inverness Sports Centre CHP	Inverness	0.2	Gas
SHEPD	Gask Turriff Biomass Generation	Keith / Macduff	0.5	Waste
SHEPD	Acharn Burn	Killin	0.4	Hydro
SHEPD	Lochay Comp Set	Killin	2.1	Hydro
SHEPD	Lochay Fish Pass	Killin	0.5	Hydro
SHEPD	Lubreoch	Killin	4.2	Hydro
SHEPD	Stronuich Dam	Killin	0.2	Hydro
SHEPD	Balquhindachy Phase 1	Kintore	0.9	Wind
SHEPD	Inverurie (Taits) Paper Mill	Kintore	7.5	Thermal
SHEPD	Mackies Phase 2	Kintore	1.7	Wind
SHEPD	Rothienorman	Kintore	0.6	Wind
SHEPD	Lairg	Lairg	3.7	Hydro
SHEPD	Shin Diversion Weir	Lairg	0.1	Hydro
SHEPD	Lintrathen Water Works	Lunanhead	0.3	Hydro
SHEPD	Lunanhead Landfill	Lunanhead	2	Waste
SHEPD	Rottal Estate Hydro, Kirriemuir	Lunanhead	0.5	Hydro

SHEPD	Clatto Water Works	Lyndhurst	0.2	Hydro
SHEPD	Baldovie Incinerator (SRO)	Milton of Craigie	8.7	Waste
SHEPD	Knowehead, Dundee (SRO)	Milton of Craigie	1	Waste
SHEPD	Michelin Wind, Dundee	Milton of Craigie	4	Wind
SHEPD	Berriedale	Mybster	0	Wind
SHEPD	Berriedale Farm	Mybster	0.1	Hydro
SHEPD	Bilbster (Flex Hill), Caithness	Mybster	4.2	Wind
SHEPD	Pultneney Distillery CHP, Wick	Mybster	1.6	Thermal
SHEPD	Hazlehead Academy CHP, Aberdeen	Persley	0.3	Thermal
SHEPD	Seaton Estate CHP, Aberdeen	Persley	1.4	Thermal
SHEPD	Tarbothill	Persley	2.1	Wind
SHEPD	Wester Hatton Landfill	Persley	0.3	Waste
SHEPD	Ashfield Farm	Port Ann	0.3	Hydro
SHEPD	Bowmore	Port Ann	6.2	Diesel
SHEPD	Clachbreck Farm	Port Ann	0.1	Hydro
SHEPD	Claddach Wave, Islay	Port Ann	0.2	Wave
SHEPD	Gartnatra, Islay	Port Ann	0	PV
SHEPD	Loch Gair	Port Ann	6	Hydro
SHEPD	Ormsary Estate	Port Ann	0.6	Hydro
SHEPD	Twin Lochs Hydro Generator, Achnamara	Port Ann	0.5	Hydro
SHEPD	Auchtertyre Hydro	Rannoch	0.6	Hydro
SHEPD	Gaur Hydro, Rannoch Station	Rannoch	7.5	Hydro
SHEPD	Loch Ericht	Rannoch	2.2	Hydro
SHEPD	Burradale (1) Wind, Shetland 2MW	Shetland	2	Wind
SHEPD	Burradale (2) Wind, Shetland 1.7MW	Shetland	1.7	Wind
SHEPD	Dalchonzie	St Fillans	4.2	Hydro
SHEPD	Lednock	St Fillans	3.2	Hydro
SHEPD	Auchencarroch	Strathleven	3	Waste
SHEPD	Auchencarroch Landfill Phase 3	Strathleven	1.1	Waste
SHEPD	Stoney Hill Landfill	Strichen	3.2	Waste
SHEPD	Stoneyhill Landfill Phase 2	Strichen	2.1	Waste

SHEPD	Invergelder, Balmoral	Tarland	0	Hydro
SHEPD	Strathdon, Forbestown	Tarland	0.1	Hydro
SHEPD	Auchindarroch	Taynuilt	0.7	Hydro
SHEPD	Awe Barrage	Taynuilt	0.5	Hydro
SHEPD	Beinn Ghlass Wind (SRO)	Taynuilt	8	Wind
SHEPD	Beochlich (Balliemeanoch)	Taynuilt	1	Hydro
SHEPD	Blarghour Farm	Taynuilt	0.5	Hydro
SHEPD	Braevallich, Lochaweside	Taynuilt	3	Hydro
SHEPD	Esragan Hydro Project, Ardchattan, Loch Etive	Taynuilt	1	Hydro
SHEPD	Glenmore	Taynuilt	0.1	Hydro
SHEPD	Kilmelford	Taynuilt	2.1	Hydro
SHEPD	Luing	Taynuilt	0.1	Wind
SHEPD	Marine Resource	Taynuilt	0.4	Hydro
SHEPD	Tiree	Taynuilt	2.8	Diesel
SHEPD	Tobermory	Taynuilt	0.3	Hydro
SHEPD	Tralaig Dam	Taynuilt	0.1	Hydro
SHEPD	Bu Farm , Stronsay	Thurso	2.7	Wind
SHEPD	Burgar Hill (NWP), Orkney	Thurso	5	Wind
SHEPD	European Marine Energy Centre (Eday) Phase 1	Thurso	4	Wave
SHEPD	Forss	Thurso	3.6	Wind
SHEPD	Forss II, Caithness	Thurso	5.3	Wind
SHEPD	Isle of Burray, Orkney	Thurso	0.9	Wind
SHEPD	Marine Energy Test Centre	Thurso	7	Wave
SHEPD	Salmon Fish Farm	Thurso	0.1	Hydro
SHEPD	Sigurd	Thurso	1.5	Wind
SHEPD	Spurness, Orkney	Thurso	7.5	Wind
SHEPD	Thornfinn	Thurso	4.3	Wind
SHEPD	Camserney	Tummel Bridge	0.9	Hydro
SHEPD	Clunie Dam	Tummel Bridge	0.2	Hydro
SHEPD	Dirnanean	Tummel Bridge	0.2	Hydro
SHEPD	Glen Lyon Estate	Tummel Bridge	1	Hydro
SHEPD	Keltney Burn	Tummel Bridge	2.2	Hydro
SHEPD	Lude Estate	Tummel Bridge	0.1	Hydro
SHEPD	Pitlochry Dam	Tummel Bridge	0.1	Hydro
SHEPD	Tombuie, Kenmore	Tummel Bridge	0.4	Hydro
SHEPD	Trinafour	Tummel Bridge	0.6	Hydro

SHEPD	Stockethill CHP	Woodhill	0.2	Thermal
SHEPD			287.5	TOTAL (MW)
SP Distribution Ltd	Patersons Landfill	Carntyne	4.3	Waste to Energy
SP Distribution Ltd	Carsfad	Carsfad	12	Hydro
SP Distribution Ltd	Craig	Chapelcross	8	Wind
SP Distribution Ltd	Greenoakhill Landfill	Clydes Mill	4	Waste to Energy
SP Distribution Ltd	Braiden Hill Farm	Coatbridge	0.8	Wind
SP Distribution Ltd	Garlaff Landfill	Coylton	3.2	Waste to Energy
SP Distribution Ltd	Harehill	Coylton	13.2	Wind
SP Distribution Ltd	Windy Standard (Gallow Rigg)	Coylton	10.8	Wind
SP Distribution Ltd	Windy Standard (Polwhat Rigg)	Coylton	10.8	Wind
SP Distribution Ltd	Greendykeside	Cumbernauld	4	Wind
SP Distribution Ltd	Greengairs II - VI	Cumbernauld	10.4	Waste to Energy
SP Distribution Ltd	Greengairs Power Station	Cumbernauld	4.6	Waste to Energy
SP Distribution Ltd	Lower Melville Wood Landfill	Cupar	1.1	Waste to Energy
SP Distribution Ltd	Greenknowes	Devonside	27	Wind
SP Distribution Ltd	Lochar Moss Landfill	Dumfries	0.8	Waste to Energy
SP Distribution Ltd	Wetherhill	Dumfries	18	Wind
SP Distribution Ltd	Dunbar Works	Dunbar	5.3	Waste to Energy
SP Distribution Ltd	Lochhead Landfill	Dunfermline	2.3	Waste to Energy
SP Distribution Ltd	Earlstoun	Earlstoun	13	Hydro
SP Distribution Ltd	Invento A/S	Earlstoun	1.2	Hydro
SP Distribution Ltd	Cathkin Landfill	East Kilbride South	5.3	Waste to Energy
SP Distribution Ltd	Blackhill	Eccles	28.6	Wind
SP Distribution Ltd	Dun Law	Galashiels	17.2	Wind
SP Distribution Ltd	Myreshill	Giffnock	1.9	Wind
SP Distribution Ltd	Glenlee	Glenlee	23	Hydro
SP Distribution Ltd	Artfield Fell	Glenluce	19.5	Wind
SP Distribution Ltd	Avondale	Grangemouth	4.6	Waste to Energy
SP Distribution Ltd	Avondale Landfill Phase 2	Grangemouth	6.6	Waste to Energy
SP Distribution Ltd	Bowbeat (Emly Bank)	Kaimes	15	Wind
SP Distribution Ltd	Bowbeat (Roughsidehill)	Kaimes	15	Wind
SP Distribution Ltd	Melville Landfill	Kaimes	1.2	Waste to Energy
SP Distribution Ltd	Drumjohn	Kendoon	2.2	Hydro
SP Distribution Ltd	Kendoon	Kendoon	23	Hydro
SP Distribution Ltd	Summerston Landfill	Killermont	2.9	Waste to Energy
SP Distribution Ltd	Summerston Landfill 2	Killermont	2.1	Waste to Energy

SP Distribution Ltd	Shewalton Landfill	Kilmarnock South	1.8	Waste to Energy
SP Distribution Ltd	Craignaught Landfill	Kilmarnock Town	0.7	Waste to Energy
SP Distribution Ltd	DSM Nutritional Products (Roche Site 1)	Kilwinning	15	CHP
SP Distribution Ltd	Bonnington	Linnmill	11	Hydro
SP Distribution Ltd	Hagshawhill	Linnmill	15.6	Wind
SP Distribution Ltd	Hagshawhill Extension	Linnmill	27	Wind
SP Distribution Ltd	Stonebyres	Linnmill	6	Hydro
SP Distribution Ltd	Kaimes Landfill	Livingston	2.6	Waste to Energy
SP Distribution Ltd	Girvan Distillery	Maybole	5	CHP
SP Distribution Ltd	Auchenlea	Newarthill	2.3	Waste to Energy
SP Distribution Ltd	Dalmacoulter	Newarthill	0.7	Waste to Energy
SP Distribution Ltd	Greengairs I	Newarthill	2	Waste to Energy
SP Distribution Ltd	Diageo Distilling Ltd (United Distillers)	Port Dundas	5.1	CHP
SP Distribution Ltd	Drummond Moor Landfill	Portobello	0.8	Waste to Energy
SP Distribution Ltd	Oatslie Landfill	Portobello	2.3	Waste to Energy
SP Distribution Ltd	Barkip Landfill	Saltcoats	1.1	Waste to Energy
SP Distribution Ltd	Hauplandmuir	Saltcoats	29.4	Wind
SP Distribution Ltd	Wardlaw Wood	Saltcoats	18	Wind
SP Distribution Ltd	Westfield CL	Westfield	12.5	Biomass
SP Distribution Ltd			481.8	TOTAL (MW)
CE Electric (NEDL)	BASF	Saltholme	82.3	CHP
CE Electric (NEDL)	Bran Sands	Lackenby	10	Waste Gas
CE Electric (NEDL)	British Sugar	Poppleton	10	Crop
CE Electric (NEDL)	Cleveland Incinerator	Norton	35	Waste
CE Electric (NEDL)	Cleveland Potash	Lackenby	22.4	Gas
CE Electric (NEDL)	Kelt	Osbaldwick	50	Gas
CE Electric (NEDL)	Nestlé	Osbaldwick	9	CHP
CE Electric (NEDL)	Northallerton	Norton	6.4	Diesel
CE Electric (NEDL)	Phillips	Saltholme	80	CHP
CE Electric (NEDL)	RVI	Stella North	8.5	CHP
CE Electric (NEDL)	Viking	Saltholme	52	Gas
CE Electric (NEDL)	Holmeside Windfarm	Stella South	5.5	Wind
CE Electric (NEDL)	ICI Billingham Synthetic	Saltholme	40	
CE Electric (NEDL)	Norsk Hydro (Hydro Polymers)	Norton	5	CHP
CE Electric (NEDL)	High Volts Windfarm	Hartmoor	8.2	Wind
CE Electric (NEDL)	Harehills Windfarm	Hawthorn Pit	5.5	Wind
CE Electric (NEDL)	Kielder Hydro Power	Spadeadam (United Utilities)	5	Hydro

CE Electric (NEDL)	Blyth		4	Offshore Wind
CE Electric (NEDL)			438.8	TOTAL (MW)
United Utilities (Norweb)	Mirrless Blackstone	Bredbury	6.4	Diesel
United Utilities (Norweb)	Cerestar	Carrington	14	Gas
United Utilities (Norweb)	Partington	Carrington	6.8	Diesel
United Utilities (Norweb)	Davyhulme ETW-	Carrington	6.2	Bio-gas
United Utilities (Norweb)	Shell	Carrington	60	Gas CHP
United Utilities (Norweb)	Silver Lane	Fiddlers Ferry	12	Bio-gas
United Utilities (Norweb)	Workington	Harker	50	Gas CHP
United Utilities (Norweb)	Albright & Wilson	Harker	16	Gas CHP
United Utilities (Norweb)	British Sidac	Harker	10	Oil
United Utilities (Norweb)	Kielder Hydro	Harker	5.6	Hydro
United Utilities (Norweb)	Winscales	Harker	7.2	Wind
United Utilities (Norweb)	Wharrels Hill	Harker	12.4	Wind
United Utilities (Norweb)	Talentire	Harker	12	Wind
United Utilities (Norweb)	Brownrigg Hall	Harker	12.5	Wind
United Utilities (Norweb)	Hallburn Farm	Harker	20	Wind
United Utilities (Norweb)	Westfield Point	Hutton	24	Gas
United Utilities (Norweb)	J Cropper	Hutton	8	Gas CHP
United Utilities (Norweb)	Ulverston	Hutton	12	Oil
United Utilities (Norweb)	Vickers North	Hutton	6	Oil
United Utilities (Norweb)	Kirkby Moor Windfarm	Hutton	5	Wind
United Utilities (Norweb)	Lambrigg	Hutton	7.8	Wind
United Utilities (Norweb)	Askam Wind Farm	Hutton	5	Wind

United Utilities (Norweb)	Lamonby	Hutton	12.5	Wind
United Utilities (Norweb)	Shap	Hutton	24	Wind
United Utilities (Norweb)	Caton Moor	Heysham	16	Wind
United Utilities (Norweb)	Bolton Waste	Kearsley Local	11.1	Waste
United Utilities (Norweb)	Astra Zeneca	Macclesfield	15	Gas
United Utilities (Norweb)	Leyland Vehicles	Penwortham W	7.6	Diesel
United Utilities (Norweb)	Salwick	Penwortham W	15.5	Gas CHP
United Utilities (Norweb)	Clifton Marsh	Penwortham W	6.4	Landfill Gas
United Utilities (Norweb)	Manchester Airport	S.Manchester	10	Gas
United Utilities (Norweb)	Moss Nook	S.Manchester	10	Gas
United Utilities (Norweb)	Hillhouse	Stanah	9.3	Diesel
United Utilities (Norweb)	West Quarry Landfil	Washway Farm	5	Landfill Gas
United Utilities (Norweb)	AM Paper	Wasway Farm	8	Gas
United Utilities (Norweb)	Mirror Colour Print	Whitegate	6.6	Diesel
United Utilities (Norweb)	Denshaw WF	Whitegate	10.5	Wind
United Utilities (Norweb)	Solway off shore (twin)	Harker	99	Offshore Wind
United Utilities (Norweb)	Eon off shore (twin)	Harker	99	Offshore Wind
United Utilities (Norweb)	Moresby Moss	Harker	65	Wind
United Utilities (Norweb)	Ormonde Energy Wind	Heysham	99.9	Offshore Wind
United Utilities (Norweb)	Ormonde Energy Gas	Heysham	99.9	Gas
United Utilities (Norweb)	Barrow Off Shore	Heysham	99.9	Offshore Wind
United Utilities (Norweb)	Cliviger	Rochdale	9.6	Wind
United Utilities (Norweb)	Sappi	Rochdale	60	Gas

United Utilities (Norweb)	Scout Moor	Rochdale	64	Wind
United Utilities (Norweb)	Burbo Bank		90	Offshore Wind
United Utilities (Norweb)			1272.7	TOTAL (MW)
CE Electric (YEDL)	Allied Colloids Bradford	Skelton Grange	7.4	Gas
CE Electric (YEDL)	Appleby Froddingham	Keadby	80	Steam Turbine
CE Electric (YEDL)	Barugh	West Melton	6.4	Diesel Engine
CE Electric (YEDL)	Brighouse	Elland	6.4	Diesel Engine
CE Electric (YEDL)	Caythorpe	Creyke Beck	10.5	Gas CHP
CE Electric (YEDL)	Ciba-Geigy South Humberside	Grimsby West	8	Gas
CE Electric (YEDL)	City Energy	Ferrybridge B	13.5	Steam Turbine
CE Electric (YEDL)	Commonside Lane	Ferrybridge B	6.4	Diesel Engine
CE Electric (YEDL)	Courtaulds Fibres	Grimsby West	32	Gas/Steam
CE Electric (YEDL)	Easington	Creyke Beck	10.8	Gas
CE Electric (YEDL)	Ecclesfield	West Melton	6.4	Diesel Engine
CE Electric (YEDL)	Fibrogen	Keadby	10	Waste
CE Electric (YEDL)	Grimsby	Grimsby West	25	Gas
CE Electric (YEDL)	Halifax Building Society	Elland	8	Diesel
CE Electric (YEDL)	Harworth Colliery Notts	Thurcroft	30	Steam
CE Electric (YEDL)	Hedon Salads Burstwick	Saltend North	16.5	Gas
CE Electric (YEDL)	Hickson & Welch	Ferrybridge	56	Steam
CE Electric (YEDL)	Huddersfield Incinerator	Skelton Grange	12.1	Waste
CE Electric (YEDL)	Hydro Agri (UK) Ltd	Grimsby West	12.2	Steam Turbine
CE Electric (YEDL)	Lindsey Oil Refinery South Humberside	Grimsby West	31	Gas CHP
CE Electric (YEDL)	Mill Nurseries	Creyke Beck	15	Gas
CE Electric (YEDL)	Monkton Coke & Chemicals	Ferrybridge A	11.7	Steam Turbine
CE Electric (YEDL)	Out Newton Windcluster	Creyke Beck	9.1	Wind Turbine
CE Electric (YEDL)	Ovenden Moor Windfarm	Bradford West	9.2	Wind Turbine
CE Electric (YEDL)	Project Arbre	Ferrybridge A	8	Waste
CE Electric (YEDL)	Rigid Paper Products Selby	Drax	8.6	Steam
CE Electric (YEDL)	SCM Chemicals Grimsby	Grimsby West	19.2	Gas
CE Electric (YEDL)	Sheffield Heat & Power	West Melton	6.9	Steam Turbine
CE Electric (YEDL)	Sheffield Heat & Power	West Melton	22.5	Steam Turbine
CE Electric (YEDL)	Sonoco Board Mills	Elland	6	NULL
CE Electric (YEDL)	Tate & Lyle Citric Acid	Drax	12.6	NULL
CE Electric (YEDL)	Thornhill	Elland	52.2	Gas

CE Electric (YEDL)	Thurnscoe Generation	W Melton/Thpe Marsh	5	NULL
CE Electric (YEDL)	Trumfleet Independant Energy	W Melton/Thpe Marsh	8.6	Gas
CE Electric (YEDL)	United Leeds Teaching Hospital	Kirkstall	17.8	Steam Turbine
CE Electric (YEDL)	Wakefield	West Melton	20.4	Diesel
CE Electric (YEDL)	Warren Lane	Ferrybridge B	6.4	Diesel Engine
CE Electric (YEDL)	Wheldale Colliery	Ferrybridge B	10.5	Gas
CE Electric (YEDL)	YWA/Royd Moor Windfarm	Elland	6.5	Wind Turbine
CE Electric (YEDL)	Zeneca Fine Chemicals Ltd	Skelton Grange	16.8	Steam Turbine
CE Electric (YEDL)	St James' Hospital	Skelton Grange	6.1	Gas
CE Electric (YEDL)	Pentex (East Midlands) Ltd	Keadby	9	
CE Electric (YEDL)	Winterton Landfill	Keadby	3.9	Gas
CE Electric (YEDL)	Roxby Quarry Landfill	Keadby	4.8	Gas
CE Electric (YEDL)	Levitt Hagg Waste Recycling	Thurcroft	7.6	
CE Electric (YEDL)	Immingham Landfill	Grimsby West	4.1	Gas
CE Electric (YEDL)			697	TOTAL (MW)
SP MANWEB	Arpley	Fiddlers Ferry	19	Landfill
SP MANWEB	BHP Petroleum	Connahs Quay	5	CHP
SP MANWEB	Bridgewater Paper	Capenhurst	64	CHP
SP MANWEB	Cabot Carbon	Frodsham	4.8	CHP
SP MANWEB	Carno	Legacy	35.6	Wind
SP MANWEB	Cefn Croes Wind Farm	Swansea North	58.5	Wind
SP MANWEB	Cemmaes	Trawsfynydd	16	Wind
SP MANWEB	Cowleyhill Works	Rainhill	10	CHP
SP MANWEB	Cwm Dyli	Trawsfynydd	10.2	Hydro
SP MANWEB	Dolgarrog	Pentir	37	Hydro
SP MANWEB	Eli Lilly (ex Dista)	Rainhill	10	CHP
SP MANWEB	Flexsys Rubber Chemicals	Legacy	5.4	CHP
SP MANWEB	Greengate Works	Rainhill	10	CHP
SP MANWEB	Hays Chemicals	Carrington	60	CHP
SP MANWEB	Huntington	Capenhurst	12	Diesel
SP MANWEB	Kronospan	Legacy	12	CHP
SP MANWEB	Llangwyryfon	Swansea North	6	Wind
SP MANWEB	Llidiartywaun	Legacy	20	Wind
SP MANWEB	Llyn Alan	Wylfa	20.4	Wind
SP MANWEB	Maentwrog	Trawsfyndd	30	Hydro

SP MANWEB	Mynydd Gorddu	Swansea North	12	Wind
SP MANWEB	North Hoyle Wind Farm	Connahs Quay	90	Offshore Wind
SP MANWEB	Penrhyddlan	Legacy	12.9	Wind
SP MANWEB	Rheidol	Swansea Nth	56	Hydro
SP MANWEB	Rhyd-y-Groes	Wylfa	7.2	Wind
SP MANWEB	Royal Liverpool Univ Hospital	Lister Drive	8	CHP
SP MANWEB	Salt Union	Frodsham	48	CHP
SP MANWEB	Strand Gate CHP	Kirkby	35	CHP
SP MANWEB	Thornton	Frodsham	94	Stm/Wste/Diesel
SP MANWEB	Trysglwyn	Wylfa	6.7	Wind
SP MANWEB	U G Ravenhead	Rainhill	10	CHP
SP MANWEB	Watson St Works	Rainhill	10	CHP
SP MANWEB	Winnington CHP	Carrington	98	Gas/CHP
SP MANWEB			935.2	TOTAL (MW)
Central Networks (East)	ABR Foods Corby	Grendon	11.5	Gas-CHP
Central Networks (East)	Boots plc Beeston Nottm	Ratcliffe on Soar	14	Gas-CHP
Central Networks (East)	British Sugar Newark	Staythorpe	10	Oil
Central Networks (East)	Britisih Sugar Bardney	West Burton	14	Oil
Central Networks (East)	Calvert Landfill Site	East Claydon	15	Waste
Central Networks (East)	Courtalds Acetate Spondon	Willington	30	Coal
Central Networks (East)	Coventry Waste Incineration	Coventry	10	Waste
Central Networks (East)	Derby Cogeneration	Willington	63.4	Gas-CHP
Central Networks (East)	EPR Corby	Grendon	38	Crop
Central Networks (East)	Goosy Lodge Power Plant	Grendon	15	Waste
Central Networks (East)	Inner Dowsing Offshore Wind	Walpole	90	Offshore Wind
Central Networks (East)	Lynn Offshore Wind	Walpole	90	Wind
Central Networks (East)	Nottingham District Heating	Ratcliffe on Soar	11.2	Waste
Central Networks (East)			412.1	TOTAL (MW)

Central Networks (West)	Alstom Stafford	Cellarhead	5.5	Oil
Central Networks (West)	Birmingham University	Kitwell	7	Gas
Central Networks (West)	British Sugar Kidderminster	Bishops Wood	8	Coal
Central Networks (West)	British Sugar Leaton	Ironbridge	9	Coal
Central Networks (West)	Crown Street Incinerator	Willenhall	7	Waste
Central Networks (West)	Elm Energy	Willenhall	28	Waste
Central Networks (West)	Fort Dunlop (1)	Nechells	99	Gas
Central Networks (West)	GCHQ	Walham	6.6	Gas
Central Networks (West)	Holditch Colliery	Cellarhead	10.5	Gas
Central Networks (West)	Kappa SSK	Nechells	8.8	Gas
Central Networks (West)	Kraft General Foods	East Claydon	12.2	Gas
Central Networks (West)	Land Rover	Hams Hall 400kV	12	Gas
Central Networks (West)	Lister Road Incinerator	Penn	7.4	Waste
Central Networks (West)	Packington	Hams Hall 400kV	11	Bio-gas
Central Networks (West)	Quatt Waterworks	Bishops Wood	8	Diesel
Central Networks (West)	Sideway Incinerator	Cellarhead	13	Waste
Central Networks (West)	Stoke CHP	Cellarhead	63	Gas/CHP
Central Networks (West)	Tyseley EFW	Nechells	28	Waste
Central Networks (West)			344	TOTAL (MW)
EdeF Energy (EPN)	Aveley Landfill	Warley	7.6	Landfill
EdeF Energy (EPN)	BG Data Hemel	Elstree	8.1	CHP
EdeF Energy (EPN)	Brogborough	Sundon	19.5	Landfill
EdeF Energy (EPN)	BSCBury St Edmunds	Bramford	53.9	CHP

EdeF Energy (EPN)	BSC Wissington	Walpole	47.5	CHP
EdeF Energy (EPN)	BSC Cantley	Norwich	17.6	Oil
EdeF Energy (EPN)	BSC Sproughton	Bramford	15.1	Oil
EdeF Energy (EPN)	BT Mill Hill	Mill Hill	5.7	Oil
EdeF Energy (EPN)	Coldham Windfarm	Warley	15	Wind
EdeF Energy (EPN)	Cromer Windfarm	Norwich	95	Offshore Wind
EdeF Energy (EPN)	Deephams	Tottenham	28.5	Waste Incineration
EdeF Energy (EPN)	Eye Airfield	Bramford	13.8	Waste Incineration
EdeF Energy (EPN)	Fibrowatt Thetford	Bramford	13.3	Waste Incineration
EdeF Energy (EPN)	Glaxo Warren Springs	Wymondley	7.1	Diesel
EdeF Energy (EPN)	Hanson Landfill	Warley	5.7	Landfill
EdeF Energy (EPN)	Kodak Harrow	Elstree	17.8	Oil
EdeF Energy (EPN)	MCP Watford	Elstree	5.7	Gas
EdeF Energy (EPN)	Mobil (Coryton)	Tilbury	19	CHP
EdeF Energy (EPN)	Mucking	Tilbury	19.9	Landfill
EdeF Energy (EPN)	NEI Bedford	Eaton Socon	19	Oil
EdeF Energy (EPN)	Ockendon Landfill	Warley	10.1	Landfill
EdeF Energy (EPN)	Purfleet Board Mills	Warley	14	CHP
EdeF Energy (EPN)	RAE Bedford	Grendon	38	Oil
EdeF Energy (EPN)	RAF Neatishead	Norwich	6.8	Oil
EdeF Energy (EPN)	RAF High Wycombe	Amersham	6.6	Oil
EdeF Energy (EPN)	Rainham Landfill	Warley	23.8	Landfill
EdeF Energy (EPN)	Sainsbury Waltham Abbey	Rye House	5.7	Gas

EdeF Energy (EPN)	Sarah Jane Windfarm	Norwich	77	Wind
EdeF Energy (EPN)	Scroby Sands	Norwich	60	Offshore Wind
EdeF Energy (EPN)	Shellhaven	Tilbury	25.1	Oil
EdeF Energy (EPN)	Stags Holt Windfarm	Warley	7.6	Wind
EdeF Energy (EPN)	Stewartby	Eaton Socon	11.4	Landfill
EdeF Energy (EPN)	Sutton	Burwell	31.3	Straw
EdeF Energy (EPN)	Vandenburgh Oils Purfleet	Warley	8.5	CHP
EdeF Energy (EPN)			760.7	TOTAL (MW)
Western Power Distribution (South Wales)		Aberthaw/Cardiff East	5	Other Generation
Western Power Distribution (South Wales)		Aberthaw/Cardiff East	2.5	Other Generation
Western Power Distribution (South Wales)		Aberthaw/Cardiff East	2.6	CHP
Western Power Distribution (South Wales)		Aberthaw/Cardiff East	2	Landfill Gas (Sewage)
Western Power Distribution (South Wales)		Aberthaw/Cardiff East	1.3	Landfill Gas (Sewage)
Western Power Distribution (South Wales)	Dow Corning	Aberthaw/Cardiff East	34	CHP
Western Power Distribution (South Wales)		Grange	11.2	CHP
Western Power Distribution (South Wales)		Grange	44	CHP
Western Power Distribution (South Wales)	Ffynnon Oer	Grange	32	Onshore Wind
Western Power Distribution (South Wales)		Pembroke	3.5	Other Generation
Western Power Distribution (South Wales)		Pembroke	26.6	Other Generation

Western Power Distribution (South Wales)		Pyle	1	Other Generation
Western Power Distribution (South Wales)		Pyle	9.6	Other Generation
Western Power Distribution (South Wales)		Pyle	1.2	Landfill Gas (Sewage)
Western Power Distribution (South Wales)	Mynydd Gorddu	Rassau	10.6	Onshore Wind
Western Power Distribution (South Wales)		Rassau	2.6	Landfill Gas (Sewage)
Western Power Distribution (South Wales)		Rassau	4	Hydro
Western Power Distribution (South Wales)		Rassau	3.5	Hydro
Western Power Distribution (South Wales)		Swansea North	4.8	Other Generation
Western Power Distribution (South Wales)	Parc Cynog	Swansea North	3.7	Onshore Wind
Western Power Distribution (South Wales)		Swansea North	4.4	Landfill Gas (Sewage)
Western Power Distribution (South Wales)		Swansea North	5	Waste Incineration (Not Chp)
Western Power Distribution (South Wales)		Swansea North	6.9	Onshore Wind
Western Power Distribution (South Wales)	Blaen Bowi	Swansea North	3.9	Onshore Wind
Western Power Distribution (South Wales)	Llynbrianne	Swansea North	5.6	Hydro
Western Power Distribution (South Wales)	Tower Colliery	Swansea North	8.1	Other Generation
Western Power Distribution (South Wales)		Swansea North	3.6	Landfill Gas (Sewage)

Western Power Distribution (South Wales)		Upperboat 132	3.1	Other Generation
Western Power Distribution (South Wales)		Upperboat 33	1.3	Other Generation
Western Power Distribution (South Wales)		Upperboat 33	1.3	Other Generation
Western Power Distribution (South Wales)		Upperboat 33	2.6	Landfill Gas (Sewage)
Western Power Distribution (South Wales)		Upperboat 33	2	Landfill Gas (Sewage, Biogas)
Western Power Distribution (South Wales)	Taff Ely	Upperboat 33	9	Onshore Wind
Western Power Distribution (South Wales)		Upperboat 33	10	Other Generation
Western Power Distribution (South Wales)		Uskmouth	1.5	CHP
Western Power Distribution (South Wales)	Solutia District Energy	Uskmouth	10	Other Generation
Western Power Distribution (South Wales)	Whitbread Brewery Magor	Uskmouth	8.4	CHP
Western Power Distribution (South Wales)			292.4	TOTAL (MW)
EdeF Energy (SPN)	Aylesford	Northfleet East	101.3	Gas - CHP
EdeF Energy (SPN)	Grovehurst	Kemsley	80.4	Gas - CHP
EdeF Energy (SPN)	Isle of Grain	Northfleet East	14	Diesel
EdeF Energy (SPN)	Kentish Flats		90	Offshore Wind
EdeF Energy (SPN)	Medway S&S	Kingsnorth	56	Gas - CHP
EdeF Energy (SPN)	NOT KNOWN	Bolney	10.8	Biogas
EdeF Energy (SPN)	NOT KNOWN	Canterbury	7	Biogas
EdeF Energy (SPN)	NOT KNOWN	Sellindge	10	Gas

EdeF Energy (SPN)	NOT KNOWN	Sellindge	6.5	Gas-CHP
EdeF Energy (SPN)	Stangate	Northfleet East	5.5	Biogas
EdeF Energy (SPN)	TWA Hampton	Laleham	5.6	Diesel
EdeF Energy (SPN)	VHB	Canterbury	10	Gas - CHP
EdeF Energy (SPN)	Windmill Quarry	Bolney	5.1	Biogas
EdeF Energy (SPN)			402.2	TOTAL (MW)
EdeF Energy (LPN)	Abbeymills	West Ham	6.4	Diesel
EdeF Energy (LPN)	BBC TV Centre Wood Lane	Willesden	5	Gas CHP
EdeF Energy (LPN)	Beckton Sewage Works	Barking West	20	Steam/Gas
EdeF Energy (LPN)	Charterhouse St.	City Road	31.6	Gas CHP
EdeF Energy (LPN)	Church Manor Way Erith Works	Littlebrook	14.8	Gas CHP
EdeF Energy (LPN)	Coppermills	Hackney	5.6	Diesel
EdeF Energy (LPN)	Crossness	Barking West	10.4	Steam/Gas
EdeF Energy (LPN)	Dartford Paper Mills	Littlebrook	5.2	Gas CHP
EdeF Energy (LPN)	Factory Road Tate & Lyle	West Ham	16.5	Gas CHP
EdeF Energy (LPN)	Glaxo Wellcome Dartford	Littlebrook	10.4	Gas CHP
EdeF Energy (LPN)	Imperial College	Lodge Road	9	Gas CHP
EdeF Energy (LPN)	Landmann Way	Wimbledon	31	Waste
EdeF Energy (LPN)	LUL Greenwich Gen. Station	City Road	22	Dual Fuel
EdeF Energy (LPN)	LUL Greenwich Gen. Station	West Ham	33	Dual Fuel
EdeF Energy (LPN)	Nat West Bank	City Road	17.1	Diesel
EdeF Energy (LPN)	Royal Free Hospital	St John's Wood	5	Gas CHP
EdeF Energy (LPN)	Tunnel Avenue	Hurst	18.6	Gas CHP

EdeF Energy (LPN)			261.6	TOTAL (MW)
Southern Electric Power Distribution	Aldsershot Military P.S.	Fleet	11.5	Diesel
Southern Electric Power Distribution	Arreton Nurseries	Fawley	24	Gas
Southern Electric Power Distribution	BP Wytch Farm	Mannington	9.5	Gas
Southern Electric Power Distribution	Burghfield	Burghfield	44	Gas
Southern Electric Power Distribution	Carless	Fleet	10	Private Gas
Southern Electric Power Distribution	Chickerell	Chickerell	48	Gas
Southern Electric Power Distribution	Chippenham	Melksham	12	Gas
Southern Electric Power Distribution	Fawley	Fawley	102	Various
Southern Electric Power Distribution	Five Oaks	Fleet	9.6	Diesel
Southern Electric Power Distribution	Heathrow Airport	Iver	16	Gas/CHP
Southern Electric Power Distribution	Heathrow New Generation	Laleham	110	NULL
Southern Electric Power Distribution	Lucy Ltd	Cowley	7	Diesel/Gas
Southern Electric Power Distribution	New Set'	Nursling	7	Geothermal
Southern Electric Power Distribution	Overton	Fleet	8	Gas -CHP
Southern Electric Power Distribution	Shanks Waste	Fawley	11.5	Gas
Southern Electric Power Distribution	Slough	Iver	94	Various
Southern Electric Power Distribution	Slough NFF04	Iver	13	NULL
Southern Electric Power Distribution	Southampton General Hospital	Nursling	6	CHP
Southern Electric Power Distribution	Sutton Courtney	Cowley	7.5	Landfill Gas
Southern Electric Power Distribution	Tangmere (Export)	Lovedean	10	Gas
Southern Electric Power Distribution	Thames Water Mogden	Ealing	24.6	Methane
Southern Electric Power Distribution	Thatcham	Bramley	9.6	Diesel

Southern Electric Power Distribution	Wapseys Wood	Iver	6	Methane
Southern Electric Power Distribution	White's Pit	Mannington	7.5	Various
Southern Electric Power Distribution			608.3	TOTAL (MW)
Western Power Distribution (South West)	Bears Down	Alverdiscott / Indian Queens	9.6	Onshore Wind
Western Power Distribution (South West)	Cold Northcott	Alverdiscott	6.6	Onshore Wind
Western Power Distribution (South West)			2	Other
Western Power Distribution (South West)	Carland Cross	Indian Queens	6	Onshore Wind
Western Power Distribution (South West)			1.1	Other
Western Power Distribution (South West)			7.2	Onshore Wind
Western Power Distribution (South West)			4	Onshore Wind
Western Power Distribution (South West)	Drinnick	Indian Queens	7.2	Other
Western Power Distribution (South West)	Forest Moor		3	Onshore Wind
Western Power Distribution (South West)			4.5	Onshore Wind
Western Power Distribution (South West)			1.2	Other
Western Power Distribution (South West)			2.9	Biomass
Western Power Distribution (South West)			3	Diesel
Western Power Distribution (South West)			2	Diesel

Western Power Distribution (South West)	Goonhilly Downs	Indian Queens	5.6	Onshore Wind
Western Power Distribution (South West)	Carbon Black	Seabank	1.6	Other
Western Power Distribution (South West)	Par Harbour	Indian Queens	10.5	Medium CHP
Western Power Distribution (South West)			1.1	Other
Western Power Distribution (South West)			2.1	Landfill
Western Power Distribution (South West)			2.4	Landfill Gas
Western Power Distribution (South West)			3	Landfill Gas
Western Power Distribution (South West)			2.8	Landfill
Western Power Distribution (South West)		Axminster	1	Other
Western Power Distribution (South West)		Exeter / Abham / Landulph	1	Landfill Gas
Western Power Distribution (South West)			2.6	Landfill Gas
Western Power Distribution (South West)			2	Other
Western Power Distribution (South West)			2.2	Landfill Gas
Western Power Distribution (South West)	Filton	Iron Acton	49.9	OCGT
Western Power Distribution (South West)			1.5	Other
Western Power Distribution (South West)			1	Landfill Gas

Western Power Distribution (South West)			2.2	Landfill Gas
Western Power Distribution (South West)			1	Landfill Gas
Western Power Distribution (South West)			2.9	Hydro
Western Power Distribution (South West)			2.8	Other
Western Power Distribution (South West)		Iron Acton	4	Other
Western Power Distribution (South West)	Marsh Barton	Exeter	50	OCGT
Western Power Distribution (South West)		Seabank / Bridgewater / Taunton	1.2	Other
Western Power Distribution (South West)			1.2	Other
Western Power Distribution (South West)			2.6	Landfill Gas
Western Power Distribution (South West)	Isles of Scilly	Indian Queens	5	Other
Western Power Distribution (South West)			1.2	Other
Western Power Distribution (South West)			3	Other
Western Power Distribution (South West)			3	Other
Western Power Distribution (South West)	Bradon Farm	Bridgwater	9.7	Medium CHP
Western Power Distribution (South West)			1.2	Other
Western Power Distribution (South West)	Huntworth	Bridgwater	10	Other

Western Power Distribution (South West)			3	Other
Western Power Distribution (South West)			4.5	Other
Western Power Distribution (South West)			259.4	TOTAL (MW)
			7453.8	GRAND TOTAL (MW)

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Table 4.2 - Embedded Medium and Small Generation Capacity Netted off Demand Forecast Submissions by DNOs

DNO Network	Zone Number	Zone Name	Installed Capacity (MW) from Table 4.1 2009/10	Generation Netted Off at Time of GB Peak (MW) 2009/10	Generation Netted Off at Time of GB Peak (MW) 2010/11	Generation Netted Off at Time of GB Peak (MW) 2011/12	Generation Netted Off at Time of GB Peak (MW) 2012/13	Generation Netted Off at Time of GB Peak (MW) 2013/14	Generation Netted Off at Time of GB Peak (MW) 2014/15	Generation Netted Off at Time of GB Peak (MW) 2015/16
SHEPD	1	Northern Scotland	287.5	122.6	135.3	136.5	138	139.6	139.6	139.6
SP Distribution Ltd	2	Southern Scotland	481.8	218	230	246	266	287	309	332
CE Electric (NEDL)	3	Northern	438.8	175	175	175	175	175	175	175
United Utilities	4	North West	1272.7	885.1	885.1	885.1	885.1	885.1	885.1	885.1
CE Electric (YEDL)	5	Yorkshire	697	257.5	257.5	257.5	257.5	257.5	257.5	257.5
SP Manweb	6	North Wales & Mersey	935.2	767	797	797	797	797	797	797
Central Networks East	7	East Midlands	412.1	61	61	62	62	63	63	63
Central Networks West	8	Midlands	344	12	12	12	12	12	12	12
EDF Energy Networks (EPN)	9	Eastern	760.7	284	284	383	383	448	448	448
Western Power Distribution South Wales	10	South Wales	292.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4
EDF Energy Networks (SPN)	11	South East	402.2	252	252	252	252	252	252	252
EDF Energy Networks (LPN)	12	London	261.6	44	44	44	44	44	44	44
Southern Electric Power Distribution	13	Southern	608.3	142	143	144	145	146	147	147
Western Power Distribution South West	14	South Western	259.4	178.3	178.3	178.3	178.3	178.3	178.3	178.3
GB Total			7453.8	3462.9	3518.6	3636.8	3659.3	3748.9	3771.9	3794.9

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GB Seven Year Statement
2009

Introduction to Chapter 5

This chapter brings together information on generation capacity from **Generation Capacity** forecast ACS (average cold spell) unrestricted peak demand from **Electricity Demand** and examines the overall plant/demand balance on the GB transmission system by evaluating a range of potential future plant margins.

However, it is emphasised that none of the plant margins presented in this chapter is intended to represent our forecast or prediction of the future position. The primary purpose is rather to provide sufficient information to enable the readers to make their own more informed judgements on the subject. Indeed National Grid believes that the relatively high margins presented in the various tables and figures of this chapter are unlikely to occur in practice for a number of reasons that are discussed in the main text.

The plant margins presented have been evaluated on the basis of a range of different backgrounds. These backgrounds take some account of the uncertainties relating to future generation, which include: the relative likelihood of prospective new future generation projects proceeding to completion; as yet un-notified future generation disconnections (closures), e.g. LCPD closures; and the possible return to service of previously decommissioned plant (or the return to service of plant with TEC currently set at zero). The appropriate contribution towards the plant margin of generation output from wind farms is also considered, as is the potential effect on the plant margin of exports (rather than imports) across External interconnections and the sterilisation of generation capacity by virtue of its location behind a transmission constraint.

There are a number of definitions of plant margin in current usage; and each definition is appropriate to a particular purpose. Naturally, the calculated value of plant margin also varies along with the definition. A discussion of two of the most useful definitions is included in the section headed **Plant Margin Terminology**. That section also contains other related explanatory information and readers, who are unfamiliar with current terminology, are advised to first read that section before returning to the main body of the chapter.

The chapter concludes with a brief report on the related issue of gas and electricity market interaction.

Plant Margins on Different Generation Backgrounds

Generation Commissioning Backgrounds

Unless otherwise stated the network analyses (e.g. the illustrative power flows, the loading on each part of the GB transmission system and the fault levels) presented in this Statement are based on the SYS background. Amongst other things, the SYS background includes existing generation projects and those proposed new generation projects for which an appropriate Bilateral Agreement is in place. Accordingly, most of the studies and analyses presented assume that the full 26.2GW of generating plant planned for commissioning over the period from the 2009/10 winter peak to the 2015/16 winter peak, will commission.

However, unless plant is already under construction there can be only limited certainty that any particular project will proceed to completion and, accordingly, there are a number of areas of uncertainty relating to the future generation position and consequently the future plant/demand position. These include:

•the possibility of termination or modification of longer term connection agreements before construction or commissioning;

• additional new connection agreements being signed;

• as yet un-notified plant closures;

• possible retention of generation assets by the owner for commercial reasons or the return to service of plant currently held in reserve. Table 3.11 identifies some 2.9GW of plant which, on the face of it, has the potential to return to service. However, in practice, the greater potential is for, say, 500MW to 1GW of this plant to return to service; and

• the possibility that some transmission contracted generation may not in the event be granted Section 36 consent.

In view of these uncertainties, three generation backgrounds have been considered. Each has been selected in recognition of the different level of certainty relating to whether the proposed new transmission contracted plant will, in the event, proceed to completion. These are illustrated in **Figure 5.1**.

Figure 5.1

Click to load a larger version of Figure5.1 image

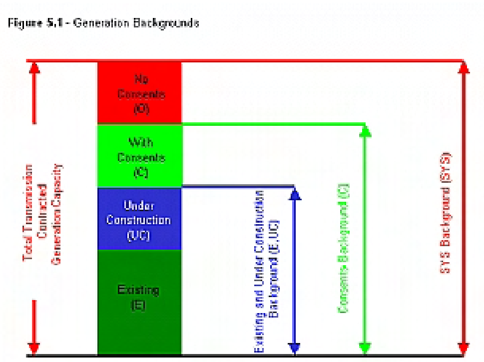


Figure 5.1 - Generation Backgrounds

- Background 1: 'SYS Background' (SYS)

This background includes the existing generation and that proposed new generation for which an appropriate Bilateral Agreement is in place. The fact that a generation project may be classified as 'contracted' does not mean that the particular project is bound to proceed to completion. Nevertheless, the existence of the appropriate signed Bilateral Agreement does provide a useful initial indicator to the likelihood of this occurring.

- Background 2: 'Consents Background' (C)

A second useful indicator is whether plant has already been granted the necessary consents under Section 36 (S36) of the Electricity Act 1989 and Section 14 (S14) of the Energy Act 1976 (see **Market Overview**). This background includes all existing plant, that portion of plant under construction that has obtained both S36 and S14 consent where relevant, and planned future plant that has obtained both S36 and S14 consent where relevant. Any 'contracted' generation not already existing that requires S36 and S14 consent but has not obtained both is excluded from this background.

- Background 3: 'Existing or Under Construction Background' (E, UC)
  This background is essentially the same as background 2 but excludes all future generation plant not yet under construction.

Table 5.1 , **Table 5.2** and **Table 5.3** set out the plant/demand balances for each of the three generation commissioning backgrounds on the basis of the customer based unrestricted demand forecasts given in **Electricity Demand**. The forecast demand streams utilised in each of these tables exclude station demand as that element of demand is excluded from the station TEC.

Table 3.7 and **Table 3.8** of Chapter 3 identify, amongst other things, which new 'transmission contracted' generation since 2005/06 is either existing by 2008/09 (3.6GW) or under construction (8.3GW). The tables also show how much of the remaining new 'transmission contracted' generation has, where relevant, obtained the necessary S36 and S14 consents (5.7GW) and how much has yet to obtain consent (17.6GW).

Table 5.4 and **Figure 5.2** compare plant margins derived from the customer based demand forecast with those derived from our own base view of future demand growth given in **Table 2.3**. This is repeated for each of the above backgrounds to give six sensitivities in all.

Figure 5.2

Click to load a larger version of Figure5.2 image

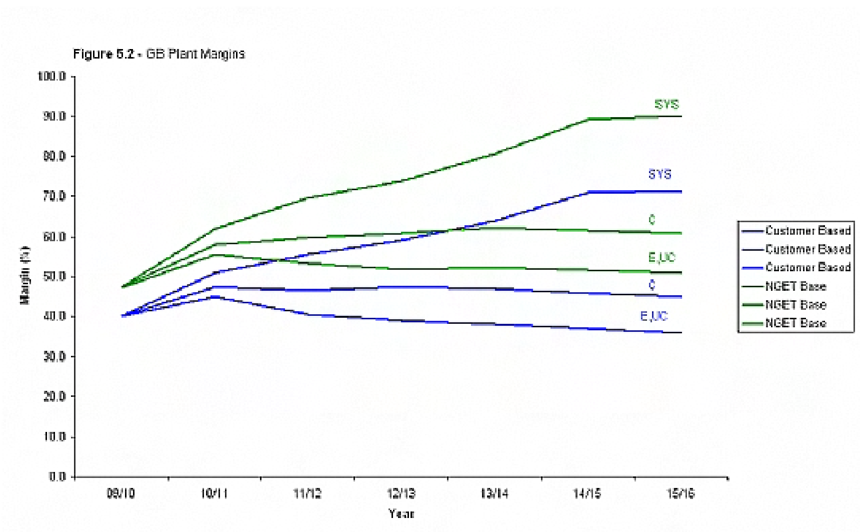


Figure 5.2 - GB Plant Margins

Generation Disconnection (Closure)

Generators are only required to give 6 months notice of closure of existing plant, which means that it is possible for us to receive formal notice of closure of plant within the first year of this Statement. It is important to read the Quarterly Updates to this Statement to identify any changes since the data was frozen for this GB SYS on 31 December 2008.

The effect on the potential future plant margin of a particular assumption on future generating closure may, of course, be readily assessed. For example, if it were assumed that say 1GW of additional generating plant were to decommission (close) by the year 2015/16 (i.e. when the demand less station demand is some 63.5GW as presented in row 3 of **Table 2.1**), the Plant Margin in that year would obviously reduce by around 1.6 percentage points (i.e. 100*1GW/63.5GW = 1.6%) relative to the margins shown in Tables 5.1 to 5.4 and the related figures.

Decommissioning

Table 3.11 lists generating units, that have either been formally notified by the owner as decommissioned (effectively TEC=0) or simply notified zero TEC covering the seven year period of this Statement; the total capacity of this plant is just over 2.9GW. Some, or all, of this plant has been retained by its owners for commercial reasons (e.g. placed in reserve or mothballed) and may under certain circumstances be returned to service at some future date (see **Decommissionings**).

However it is unlikely that all this capacity could be returned to service. Of the 2.9GW, perhaps some 500MW to 1GW has the greatest potential to return to service. Even then, it should also be borne in mind that, were individual plants to be re-commissioned/returned to service, the full previous capacities may not necessarily be realised.

The effect on the potential future plant margin of a particular assumption on re-commissioning generating units may again be readily assessed. For example, if it were assumed that say a 500MW unit were to re-commission by the 2015/16 winter peak, the plant margin in that year would obviously increase by around 0.79 percentage points (i.e. 100*0.5GW/63.5GW) relative to the margins shown in Tables 5.1 to 5.4 and the related figures.

The broad system effect of recommissioning mothballed plant is a function of the size and location of the particular plant or tranche of plant. The effects of returning individual plant to service must necessarily be considered on an individual basis both in terms of the overall system impact and on a site specific basis.

Wind Farm Contribution to Plant Margin

The section headed **Plant Margin Terminology** presented later in this chapter explains that the definition of Plant Margin, used for the purposes of this Statement, is such that no allowance is made within its calculation for the intermittent nature of the output and the level of output that, in consequence, can be relied upon from wind power plants at the time of system peak. This is unlike the assumptions on wind plant output underlying the system analyses, which are presented and discussed in **Modelling of the Planned Transfer** and in **GB Transmission System Capability**.

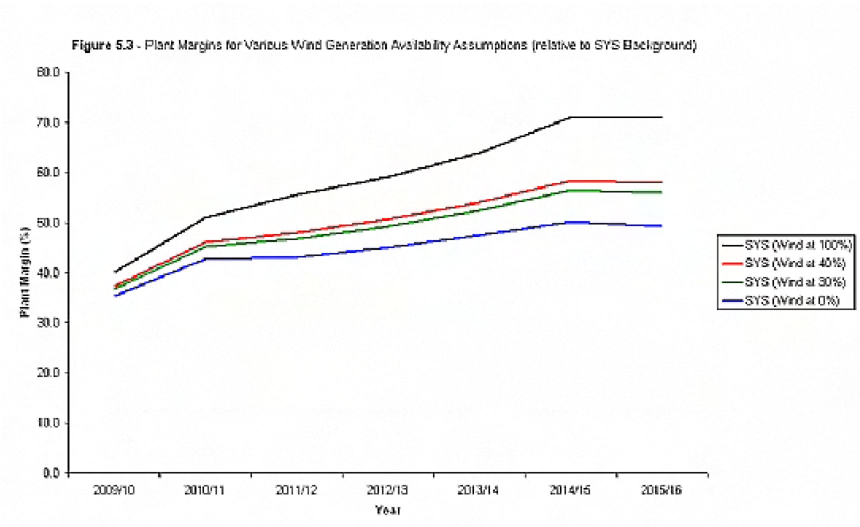
However, to enhance transparency and promote greater understanding within this chapter, additional plant margins have been calculated for a range of assumptions on the availability of wind generation capacity at the time of the winter peak as per customer based forecasts. Nevertheless, it should be remembered that such a range is quite arbitrary in this plant margin context.

Table 5.5 and **Figure 5.3** display plant margins for wind capacity availability assumptions of 40%, 30% and 0%. The SYS background (i.e. with an inherent 100% wind capacity assumption), as given in **Figure 5.2** and **Table 5.1**, is also included for ease of comparison.

An alternative way to look at margins would be to look at the two lowest scenarios for each demand and generation background combination in 2015/16, i.e. the Existing & Under Construction backgrounds with firstly the customer based demand forecasts and then National Grid's demand forecasts, and then incorporate wind at zero capacity and the LCPD closures. Then these plant margins would fall from 36% to 13% and 51% to 26% respectively. Hence if the customer based demand forecasts did materialise then the current portfolio of generation and those under construction wouldn't be enough to meet margin requirements and some additional new plant would be required; whereas, if National Grid's demand forecasts did materialise then margins would be sufficient.

Figure 5.3

Click to load a larger version of Figure5.3 image



Import and Export Assumptions Across Interconnections with External Systems

Table 3.12 of **Generation** sets out the notional import and export capabilities across the External Interconnections at the time of our ACS Peak Demand. The table shows that the Cross Channel link provides a nominal import/export capability of 1988MW each way; although the link is normally used for imports. Similarly the Netherlands link will provide an import/export capability (from 2010/11 onwards) of 1320MW import and 1390MW export and again the link will normally be used for imports. The two links to the Republic of Ireland will provide a combined import/export capability (from 2011/12 onwards) of 875MW import and 875MW export, and the link will normally be used for exports. The link with Northern Ireland has a nominal export/import capability of 500MW export and 80MW import. In this case the link will normally export. For the purpose of evaluating plant margins, import capabilities across External Interconnections are treated as generation and exports are treated as demand. This is explained in the section headed Plant Margin Terminology.

However, it is also explained in **GB Transmission System Performance** that, when ranking generating plant in order of likelihood of operation at peak, for the purpose of power flow analyses, the level of imports and exports across External Interconnections is subject to special treatment. That treatment recognizes that, notwithstanding the export capability, the actual level of exports and imports is, itself, a function of the prevailing plant/demand balance.

The methodology is described in more detail in **Modelling of the Planned Transfer** but, in brief, the margin of installed generation over demand is calculated without imports or exports across the Cross Channel Link or the Netherlands Interconnector for the peak of each year. The resultant margin is then used to determine an assumed level of imports or exports across the two Interconnectors for the peak of each year. For margins up to and including a nominal 25%, the full import is assumed. For margins of 45% or over, the full export is assumed. For margins between 25% and 45% a linear reduction in exports/increase in imports is assumed such that at a margin of 35% there are no imports or exports across the Cross Channel Link or the Netherlands Interconnector.

Throughout this methodology a pragmatic assumption of 250MW export to Northern Ireland and 437.5MW export to the Republic of Ireland from 2011/12 onwards, is used and this is represented as negative generation. This approach differs from the methodology used to evaluate Plant Margins in this chapter, which also uses the pragmatic 250MW export to Northern Ireland and 437.5MW export to the Republic of Ireland from 2011/12 onwards, but treats this as demand in accordance with the definition of Plant Margin in the section headed Plant Margin Terminology presented later in this chapter. For the avoidance of doubt, the actual import capabilities of the Cross Channel Link (1988MW) and the Netherlands Link (1320MW) at peak have been used for Plant Margin evaluation. These are represented as generation; again in accordance with the definition of Plant Margin.

A particular result of the application of the approach used in **Modelling of the Planned Transfer** for ranking plant in order of likelihood of operation at peak is that there may be exports (rather than imports based on nominal capabilities) to France and the Netherlands at peak, the level of which would be a function of the prevailing plant/demand balance.

However, as previously mentioned, the Plant Margins discussed in the previous sections of this chapter have been calculated on the basis of the methodology of this chapter (i.e. based on the definition of plant margin given in the section headed Plant Margin Terminology presented later) rather than the methodology outlined above, which is used in **Modelling of the Planned Transfer** for a different purpose. Accordingly, the Plant Margins presented are based on calculations which treat the nominal import capability at peak across the Cross Channel Link of 1988MW and across the Netherlands Link (from 2010/11) of 1320MW as equivalent to generation. The pragmatic assumption of a 250MW export at peak to Northern Ireland and a 437.5MW export to the Republic of Ireland is, as previously mentioned, treated as demand. Should the transfers across both the Cross Channel Link and Netherlands Interconnector be reversed to give, say, a net export (rather than import) of 3378MW (1988MW + 1390MW), this would be treated as demand in the calculation of plant margin.

As an example, the impact of this in year 2010 would be to reduce total generation capacity for the peak of that year from 90904MW to 87526MW (a reduction of 3378MW) and increase peak demand from 60236MW to 63614MW (an increase of 3378MW). This would reduce the calculated margin from 50.9% to 37.6% (or 13.3 percentage points).

Transmission Congestion

Transmission congestion exists on certain parts of the GB transmission system and this is considered in **GB Transmission System Capability**. Congestion occurs when the transfer capability of certain parts of the transmission system is insufficient to carry the power transfers arising from the unconstrained operation of generating plant. In such circumstances, generation is either constrained on or constrained off to avoid violation the Licence Standard in relation to system operation. Plant, which is constrained off, may be considered to be 'sterilised' in that it is unable to contribute to meeting the demand and may therefore be regarded as non contributory towards the overall GB plant margin.

Recent and forecast growth in generation in Scotland is significant, partly due to the high volume of new renewable generation seeking connection in the area. Until sufficient transmission reinforcement works are in place to enhance transmission capability across the boundaries between the SHETL system, the SPT and the NGET system the very low opportunities for the connection of new generation in the northern parts of the system will remain.

Amongst other things, **GB Transmission System Capability** explains that the 'planned transfer' from Scotland to England exceeds the expected capability of that transmission boundary in all years even with the planned transmission reinforcements to enhance that capability. Accordingly, some of the generating capacity in Scotland will need to be constrained off and, consequently, may be regarded as 'sterilised'. The level of plant required to be constrained off varies through the period. However, as a generalised illustration, if it were assumed that say 1GW of generating plant in Scotland were constrained off at, say, the time of the 2009/10 peak to limit the power flows from Scotland into England to within acceptable levels, then this would effectively reduce the overall GB plant margin, in that year, by around 1.7 percentage points (i.e. 100*1GW/59.6GW).

Interpretation

Broad Overview

It is worth repeating that, while plant margins based on several backgrounds have been considered, we do not attach any probability to the likelihood of occurrence of any particular background, including the SYS background. The range of backgrounds has been considered to enable readers to form their own view on potential future plant margins and do not represent our predictions of the future outcome.

The later section of this **Plant Margin Terminology** explains that a margin of installed generation capacity over peak demand is necessary for security of electricity supply and is not surplus or excess capacity. That section also explains that, for the purpose of calculating plant margins, power station TEC has been used. Power station TEC is net of station demand. Accordingly, the demand used in the calculation of plant margin also excludes station demand.

As a general observation, in all cases plant margins are higher than the equivalent margins published in last year's Statement. This is largely due to the reduced demand forecasts, which are explained in **Electricity Demand**. In addition, while generation capacity at peak is lower in the first three years relative to last year's Statement, it is higher in the remainder of the period.

National Grid do not believe that the relatively high margins shown in **Figure 5.2** and **Table 5.4** will occur in practice; particularly in respect of the later years. Amongst other things, those margins do not assume any plant is removed from service through disconnection or added through the return to service of currently unavailable (or decommissioned) plant. Nor do they take any account of additional new connection agreements being signed or the possibility that some transmission contracted plant may not, in the event, proceed to completion. As a point of interest, the relatively high level of generation commissioning activity in 2010/11 and 2011/12, previously discussed in **Generation Capacity Additions**, is a common feature in all backgrounds.

In particular the margins of **Figure 5.2** and **Table 5.4** take no account of wind farm intermittency. When reduced availability in wind farm output is taken into account, the apparent margins are naturally reduced significantly as illustrated in **Figure 5.2** and **Table 5.5** Similarly, exports rather than imports across the Cross Channel Link and the Interconnection with the Netherlands at times of peak would also reduce the effective margin. The potential for transmission congestion to 'sterilize' portions of installed generating capacity provides further scope for reduced margins.

The National Grid based forecast demands are lower than their equivalent User-based demands and this is reflected in the higher plant margins calculated using the National Grid based forecast demands.

The margins for 2009/10 should be viewed against the background of higher certainty (e.g. relating to demand forecasts and plant availability) associated with the earlier years. Thus, a lower margin in the earlier years may provide the same level of generation security as a higher apparent margin in later years.

Finally, it is stressed that none of the margins presented can, at this stage, be said to be 'correct'. However, the most probable margins are considered to be captured by the wide range given. This range of backgrounds, qualified by the comments on the potential for closures, the possibility of terminations, the possible return to service of plant that is currently unavailable, the possibility that there may be exports to, rather than imports from, External Systems at the time of peak, and the potential sterilisation of generating plant, may assist readers in formulating their own views on the subject. Table 5.6 attempts to give an indication of margins that have actually occurred in recent years.

Generation Market Drivers

As a result of the various uncertainties, not all of which have been reported in this chapter, there is the potential for a wide range of possible outcomes relating to generation. As a consequence, we have developed our own view of the likely developments into the future, which is considered alongside the SYS based backgrounds when undertaking our investment planning processes.

In developing our own view of available generation capacity going forward, we have made an assessment of the potential impact of a number of physical, environmental and commercial drivers. The physical drivers include the ageing population of certain classes of generating plant. Environmental drivers include the impact of the introduction of the EU Emissions Trading Scheme (ETS) from 2005, the Large Combustion Plant Directive (LCPD) from 2008 and the development of large scale (i.e. greater than 100MW) offshore wind farms. Commercial factors, which are entwined with the drivers outlined above, include the impact of forward prices, generator rationalisations, mothballing of plant and ancillary services. In addition, developments in the commercial framework would influence the generation capacity available.

Gas and Electricity Market Interaction

The interconnected electricity transmission system in Great Britain provides for the efficient bulk transfer of power from sources of electricity generation to the demand centres. The main benefits of the GB transmission system are outlined in **The Benefits of an Interconnected Transmission System**.Amongst other things, the transmission system provides for power stations to be located remote from the demand centres. The choice of power station location would take account of a wide range of considerations including financing, environmental factors, land availability, fuel availability and cost, potential savings in fuel transportation costs as well as taking account of our Transmission Network Use of System (TNUoS) charges which we levy on our customers for making use of our transmission system. Transmission Network Use of System charges are described in **Market Overview**.

Amongst other things, **Generation Capacity** reports on both the growth in capacity and disposition of Large power stations and the import capability of directly connected External Interconnections. The installed capacity of such plant is set to rise from 83.6GW in 2009/10 to 109.8GW by 2015/16. By 2015/16 it is projected that CCGT capacity will exceed coal capacity by 6.5GW and will account for 35.3% of the total installed transmission contracted generation capacity.

Gas is transported from producer to gas consumer (e.g. CCGT power station) via National Grid's gas transmission network for which transportation charges are levied. Thus, CCGT power stations could be viewed as a producer on the electricity transmission system and a consumer on the gas transmission network. This dual role gives rise to a degree of interaction between the electricity and gas markets. In particular, there are two elements in the gas market that have the potential to affect the level of available generation capacity: 'interruptible gas services' and 'CCGT arbitrage'.

Interruptible Gas Arrangements & Off Peak Capacity Product

The current interruptible arrangements apply until 30th September 2012. This is a service National Grid Gas offers to its customers which provides for lower gas transportation charges but, at times of high gas demand, allows it to shut off some or all of the gas supplied to the supply point for a specified maximum number of days within a year.

Gas supply could be interrupted by National Grid when there are transportation constraints on the National Gas Transmission network. In addition Shippers or Suppliers of gas can commercially interrupt their customers (e.g. CCGT station) either to balance their demand and supply portfolios or to sell gas onto the open market.

However, many of the power stations that would be affected (i.e. those with interruptible gas supplies) have back up supplies of distillate oil. Thus, providing there are no technical problems relating to switching to and from distillate oil, and providing adequate distillate capacity is available, then electricity generation can be maintained.

New market arrangements have been introduced which are effective from 1st October 2012 where the current NTS (National Transmission System) interruption arrangements are replaced by an off peak capacity product available via a day ahead pay-as-bid auction. National Grid NTS will be able to scale back such capacity holdings to manage constraints on the system.

CCGT Arbitrage

Gas-fired stations have the potential to respond to market price signals, decreasing their gas consumption when the electricity price is lower than the price of burning gas. This ability to arbitrage between gas and power is not restricted to power stations with National Grid gas interruptible contracts. In recent experience some firm CCGT power stations have self-interrupted over the winter for commercial reasons.

The willingness of the CCGTs to commercially interrupt themselves will be determined by the spark spread, which is itself influenced by the ability of the power generation sector to switch to other fuels and the level of electricity demand. Given the within-day profile of electricity demand, there is more scope for gas-fired generators to reduce their gas demand outside the peak half-hours of the day, as well as at other times of low electricity demand, such as at weekends and during holiday periods and either burn alternative fuel or switch generation to another station, burning coal or oil, within their portfolio of stations.

National Grid have carried out a detailed analysis to estimate the potential extent of CCGT arbitrage/demand side response within England and Wales, the results of which can be found in our 2008/09 Winter Consultation Report published in June 2008.

http://www.ofgem.gov.uk/Markets/WhlMkts/CustandIndustry/WinterOutlook/Documents1/WCR June 07 final.pdf

Looking forward, we think that there is a strong case for all prospective new CCGTs to fit alternative fuel capability in order to provide additional flexibility to deal with periods of gas-electricity interactions, especially given the projected increase in gas' share of the electricity generation market.

Plant Margin Terminology

Introduction

In simple terms, the 'plant margin' is the amount by which the installed generation capacity exceeds the peak demand. Thus a system with a peak demand of 100MW and 120MW of installed generation has a 20MW plant margin, which represents 20% of the peak demand.

Some commentators assume that the plant margin is surplus or excess generation, which is not necessary to the power system. This is incorrect since generating units are subject to breakdown and need to be taken out of service from time to time for maintenance and repair. Generating units are not available to generate 100% of the time.

If it is assumed that only 85% of the total stock of generating plant could be predicted to be available at the time of winter peak demands several years ahead, then it would be necessary to plan to meet that peak demand (100%) with only 85% of the generation. This would mean that an installed generating capacity equivalent to about 118% of the peak demand (i.e. 100 ÷ 0.85) would be needed in order to meet the peak. Further allowances would also have to be made for other factors such as the risk that the weather might be colder than the Average Cold Spell (ACS) conditions on which demand forecasts are based.

It was for reasons such as these that, in the past, large integrated power system utilities (e.g. the Central Electricity Generating Board in England and Wales) sought to achieve a plant margin of some 24% several years ahead of the event. This margin was referred to as the 'planning margin' rather than 'plant margin' (i.e. the planning margin was the value of plant margin used for planning the need for future generation).

An appropriate minimum value of 'plant margin' is therefore necessary for the security of electricity supply and does not represent surplus or excess generation. The actual required value of plant margin will be a function of the characteristics of the power system to which it applies.

The higher certainty associated with short term forecasts of say demand and generating unit availabilities means that the same level of security of electricity supply can be achieved with lower plant margins. Accordingly, the required margin for the earlier years would be much lower and the operational planning margin requirement for real time generation is generally around 10% depending on prevailing circumstances.

This chapter focuses on the planning time phase and relates to the security of supply provided by the generation capacity that is either already installed or is planned to be installed. The operational time phase, which relates, amongst other things, to the actual availability of the installed generation on the day, has not been specifically addressed.

In the privatised electricity supply industry within England and Wales and Scotland, there is no set standard for the planning margin and the need for new plant is determined by market forces.

Plant Margin Definitions

Plant Margin is defined in different ways in different documents.

The term "Plant Margin" is used in the License Standard, GB Transmission System Security and Quality of Supply Standard (SQSS). In Appendix C of that document, its value is used to determine whether the Straight Scaling and/or the Ranking Order technique should be used in the evaluation of the Planned Transfer Condition. The SQSS definition of Plant Margin is:

"The amount by which the total installed capacity of directly connected Power Stations and embedded Large Power Stations exceeds the net amount of the ACS Peak Demand minus the total imports from External Systems. This is often expressed as a percentage (e.g. 20%) or as a decimal fraction (e.g. 0.2) of the net amount of the ACS Peak Demand minus the total imports from External Systems".

Whilst this definition is considered appropriate for the License Standard, it is not necessarily appropriate for other uses. When considering the Plant Margin of a particular Utility or group of Utilities it is more appropriate to consider the simple relationship between total installed generation capacity and peak demand. The current GB SYS definition is given in the Glossary but is repeated below for ease of reference:

"The amount by which the total installed capacity of directly connected Power Stations and embedded Large Power Stations and imports across directly connected External Interconnections exceeds the ACS Peak Demand. This is often expressed as a percentage (e.g. 20%) or as a decimal fraction (e.g. 0.2) of the ACS Peak Demand".

The difference between the above two definitions lies in the fact that, the License Standard definition treats imports as negative demand but the GB SYS definition treats imports as generation. Whilst the plant margin in MW terms remains the same, in percentage terms the GB SYS margins are lower than would be the case using the License Standard definition. Please note that, whilst the wording of the GB SYS definition of plant margin does not mention exports to External Systems, it is implicit that such exports should be treated as positive demand.

Accordingly basic Plant Margins presented in this chapter have been calculated on the basis of:

the forecast ACS peak demand given in row 3 of **Table 2.1** of **Electricity Demand** which includes the assumed 250MW export at peak across the External Interconnection between Scotland and Northern Ireland, and the assumed 437.5MW export from 2011/12 onwards at peak across the two External Interconnections between Wales and the Republic of Ireland as part of the demand on the GB transmission system; and

the power station TEC values given in **Table 3.5** of **Generation** but with the 80MW TEC value for the export across the External Interconnection between Scotland and Northern Ireland, and the 875MW combined TEC value for the export from 2011/12 onwards across the two External Interconnections between Wales and the Republic of Ireland removed.

Finally, it is also worth noting that the above underlying demand and generation assumptions used in the calculation of Plant Margin, as defined in this GB SYS, differ from the demand and generation assumptions used in **GB Transmission System Performance** . For instance in **Table 7.1** of **GB Transmission System Performance**, which is used for ranking generating plant in order of likelihood of operation at peak, different more pragmatic import/export assumptions may be used in recognition of prevailing circumstances.

Wind Farm Generation Availability

The question arises as to whether the installed generation capacity used for the purpose of the plant margin calculations in this Statement should be reduced in recognition of the high levels of future renewable generation which have inherently low availability (e.g. wind farms).

It has already been explained that the plant margin relates to the security of supply provided by the level of generation installed on the system to meet the demand. The "planning margin" is the value of plant margin calculated to be required several years ahead of the event to achieve the desired level of security at the time of the forecast winter peak demand. The chosen value of "planning margin" stochastically takes account of: the average winter peak availability of all generation; variations in the assumed average generation availability; variations in forecast peak demand due to weather; and basic forecasting error.

The selected value of the planning margin does not influence the definition or the calculation of the plant margin but rather the level of security it provides (derived from stochastic calculations). In view of this, for the purposes of this Statement, the installed generation capacity has not been reduced to compensate for low availability of renewable generation when calculating the basic plant margins.

However, to enhance transparency and promote greater understanding within this chapter, additional plant margins have been calculated for a range of assumptions on the availability of wind generation capacity at the time of the winter peak.

Use of TEC, CEC or RC

It may be argued that the "total installed capacity of a power station" is the aggregate of the Registered Capacities (or CEC) of all the individual Generating Units at that Power Station. However:

TEC reflects the maximum power the Generator can export across the system from a Grid Entry Point or a User System Entry Point;

The level of use of system rights for a Power Station is expressed in terms of the amount of TEC; and

Transmission infrastructure is designed on the basis of TEC.

Although TEC of a power station does not strictly fall within the definition of "total installed capacity", to the intents and purposes of this 2008 GB SYS it is reasonable to take TEC as being equal to the "total installed capacity" of a power station. Accordingly, the plant margin has been calculated on the basis of TEC.

Station Demand

By definition, TEC is a gross-net-net quantity. That is it is net of power supplied through the Generating Unit's unit transformer and net of the auxiliary demand supplied through the station transformers. However, the "ACS Peak GB Demand" includes station transformer demand.

Accordingly, to avoid double counting in the calculation of plant margin, the demand to be used should be "ACS Peak GB Demand" less "station demand" at peak.

Accordingly, for the purposes of this Statement, the plant margin has been calculated on the basis of:

summated TEC of directly connected power stations, embedded Large power stations and imports to the GB transmission system from External Systems: and

"ACS Peak GB Demand" less "station demand" at peak since TEC is also net of "station demand".

Figure 5.1 - Generation Backgrounds

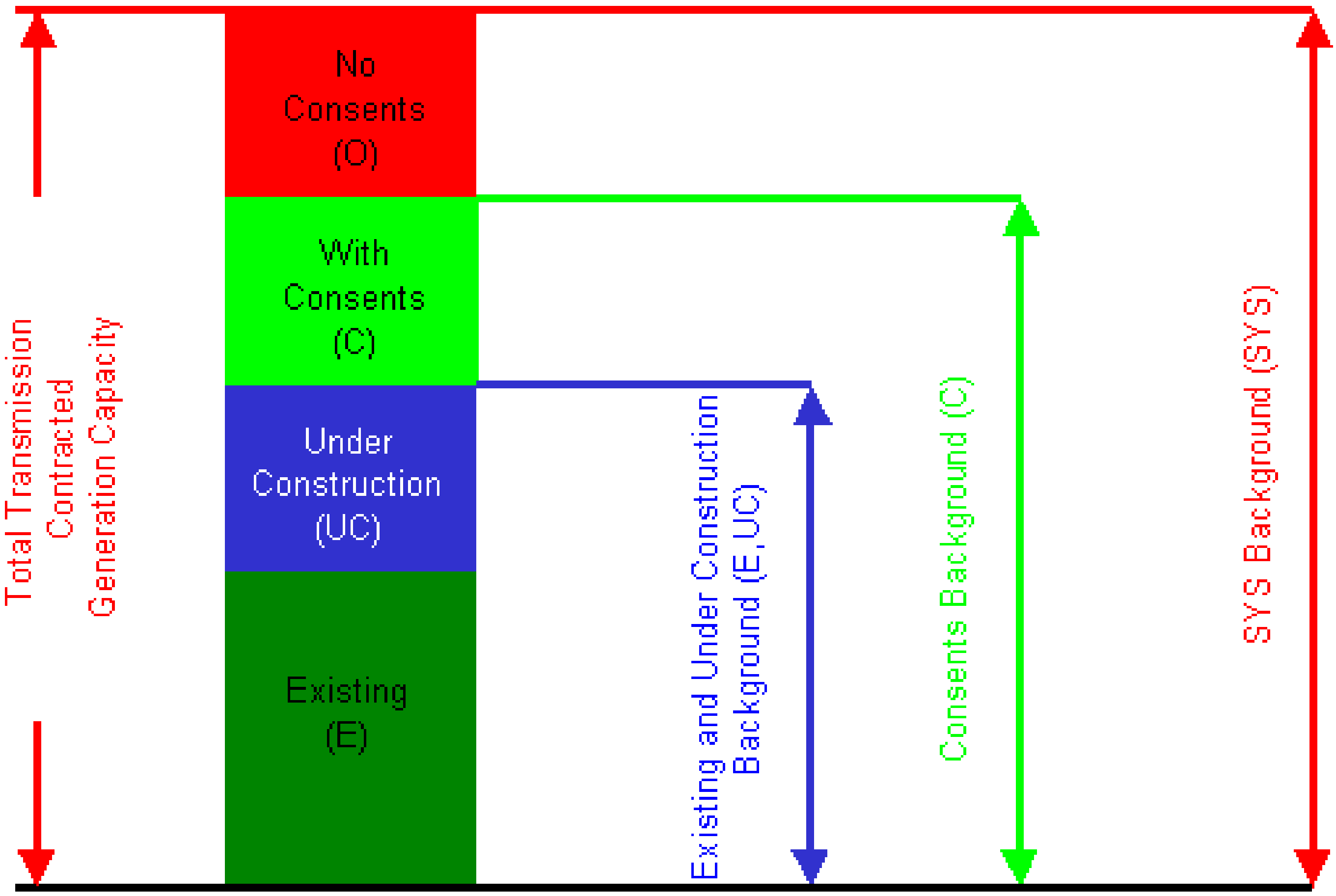


Figure 5.2 - GB Plant Margins

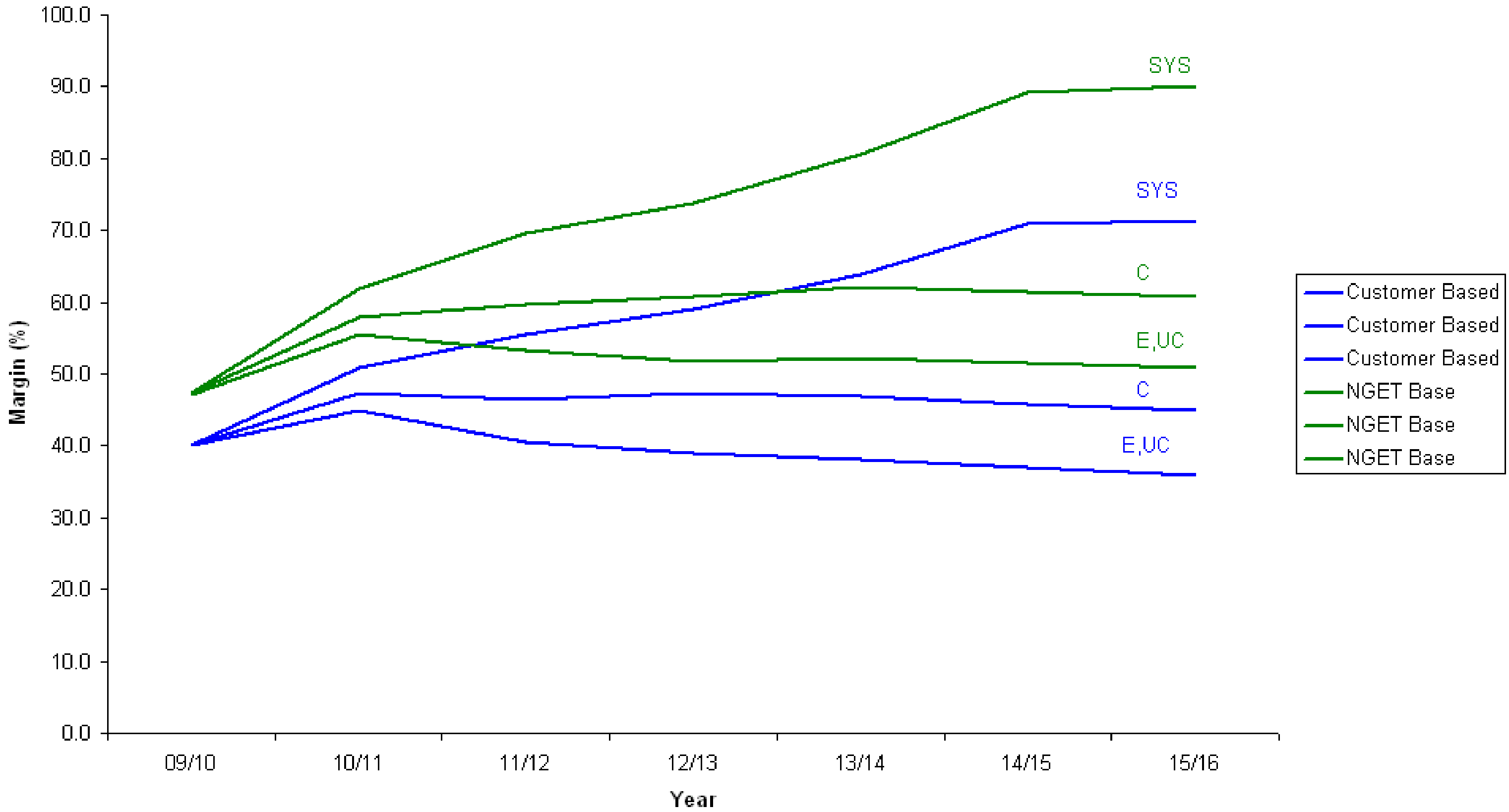
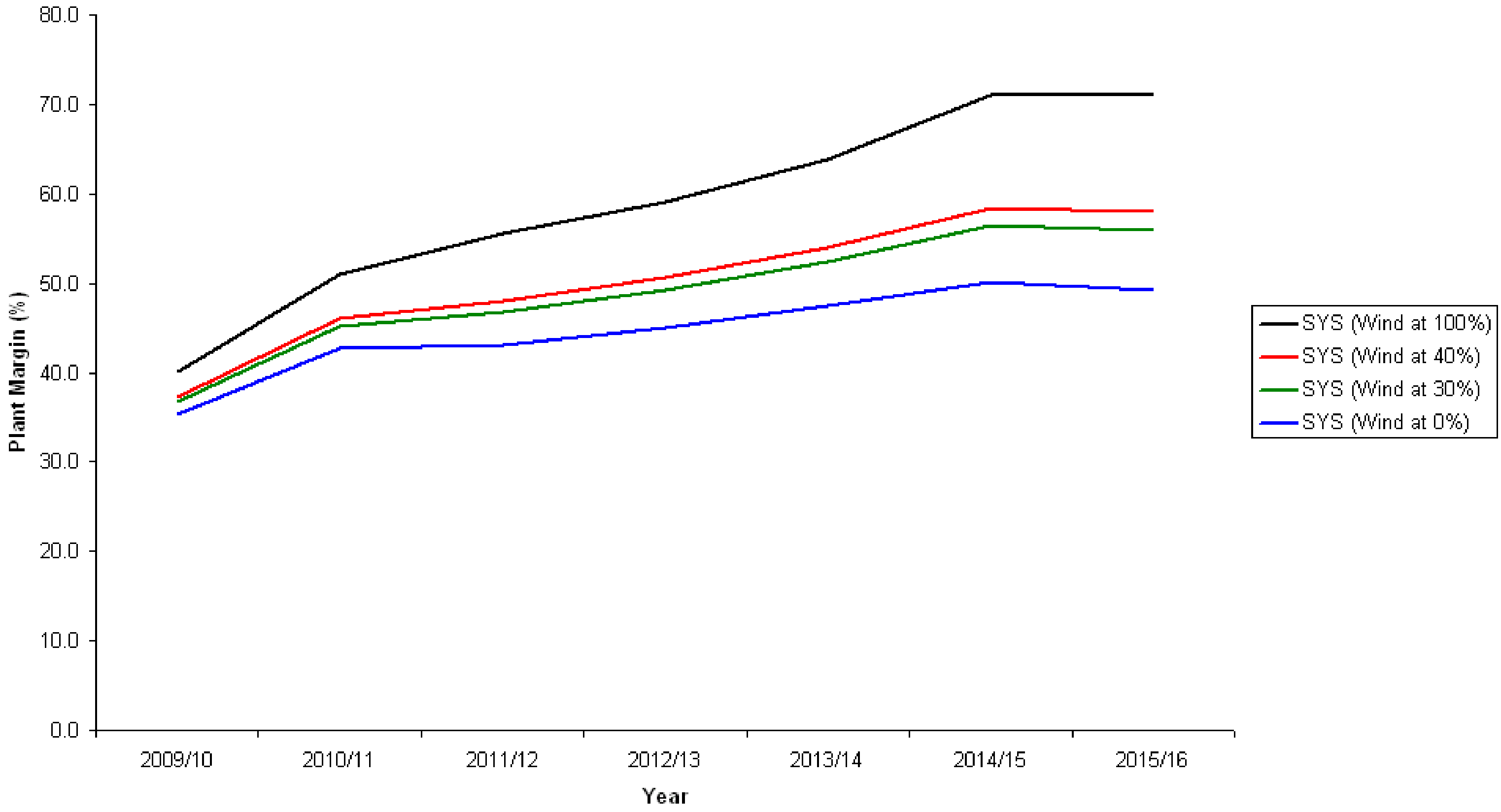


Figure 5.3 - Plant Margins for Various Wind Generation Availability Assumptions (relative to SYS Background)



Data download as CSV | Click to close window

Table 5.1 - Plant/Demand Balance for SYS Background (SYS)

Plant Type	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change (MW)
Biomass	45	97	97	546	546	347	546	501
CCGT	28428	32583	34763	36483	38693	38693	38693	10265
CHP	2326	2326	2326	2326	2326	2326	2326	0
Hydro	1069.7	1069.7	1069.7	1069.7	1118.2	1125.7	1125.7	56
IGCC with CCS	0	0	800	800	800	3325	3325	3325
Interconnector	1988	3188	3188	3188	3188	3188	3188	1200
Large Unit Coal	4413	4413	4413	4413	4413	4413	4413	0
Large Unit Coal + AGT	21467	21467	21467	21467	21467	21467	21467	0
Medium Unit Coal	1102	1102	1102	1102	1102	1102	1102	0
Medium Unit Coal + AGT	1131	1131	1131	1131	1131	1131	1131	0
Nuclear AGR	8244	8244	8244	8244	8244	8244	8244	0
Nuclear Magnox	1450.4	1450.4	0	0	0	0	0	-1450.4
Nuclear PWR	1200	1200	1200	1200	1200	1200	1200	0
OCGT	588.9	588.9	588.9	588.9	588.9	588.9	588.9	0
Offshore Wind	800	1505	3229	3523	4170	6052	6052	5252
Oil + AGT	3636	3636	3636	3636	3636	3636	3636	0
Onshore Wind	2095.7	3375.9	4418.1	5194.1	5997.9	7150.7	7891.6	5795.9
Pumped Storage	2744	2744	2744	2744	2744	2744	2744	0
Small Unit Coal	783	783	783	783	783	783	783	0
Woodchip	0	0	350	350	350	350	350	350
Total Capacity	83511.7	90903.9	95549.7	98788.7	102498	107866.3	108806.2	25294.5
GB Demand at ACS Peak (MW)	59594.5	60235.7	61426.4	62122.6	62574.5	63077.2	63533.4	3938.9
Plant Margin (%)	40.1	50.9	55.6	59	63.8	71	71.3	31.1

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Table 5.2 - Plant/Demand Balance for Consents (C) Background

Plant Type	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change (MW)
Biomass	45	45	45	45	45	45	45	0
CCGT	28428	30583	32763	34213	34683	34683	34683	6255
CHP	2326	2326	2326	2326	2326	2326	2326	0
Hydro	1069.7	1069.7	1069.7	1069.7	1118.2	1125.7	1125.7	56
Interconnector	1988	3188	3188	3188	3188	3188	3188	1200
Large Unit Coal	4413	4413	4413	4413	4413	4413	4413	0
Large Unit Coal + AGT	21467	21467	21467	21467	21467	21467	21467	0
Medium Unit Coal	1102	1102	1102	1102	1102	1102	1102	0
Medium Unit Coal + AGT	1131	1131	1131	1131	1131	1131	1131	0
Nuclear AGR	8244	8244	8244	8244	8244	8244	8244	0
Nuclear Magnox	1450.4	1450.4	0	0	0	0	0	-1450.4
Nuclear PWR	1200	1200	1200	1200	1200	1200	1200	0
OCGT	588.9	588.9	588.9	588.9	588.9	588.9	588.9	0
Offshore Wind	800	1505	1505	1505	1505	1505	1505	705
Oil + AGT	3636	3636	3636	3636	3636	3636	3636	0
Onshore Wind	2095.7	3235.9	3382.8	3469.8	3469.8	3501.8	3501.8	1406.1
Pumped Storage	2744	2744	2744	2744	2744	2744	2744	0
Small Unit Coal	783	783	783	783	783	783	783	0
Woodchip	0	0	350	350	350	350	350	350
Total Capacity	83511.7	88711.9	89938.4	91475.4	91993.9	92033.4	92033.4	8521.7
GB Demand at ACS Peak (MW)	59594.5	60235.7	61426.4	62122.6	62574.5	63077.2	63533.4	3938.9
Plant Margin (%)	40.1	47.3	46.4	47.2	47	45.9	44.9	4.7

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Table 5.3 - Plant/Demand Balance for Existing or Under Construction (E, UC) Background

Plant Type	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change (MW)
Biomass	45	45	45	45	45	45	45	0
CCGT	28428	30583	31013	31013	31013	31013	31013	2585
CHP	2326	2326	2326	2326	2326	2326	2326	0
Hydro	1069.7	1069.7	1069.7	1069.7	1118.2	1125.7	1125.7	56
Interconnector	1988	3188	3188	3188	3188	3188	3188	1200
Large Unit Coal	4413	4413	4413	4413	4413	4413	4413	0
Large Unit Coal + AGT	21467	21467	21467	21467	21467	21467	21467	0
Medium Unit Coal	1102	1102	1102	1102	1102	1102	1102	0
Medium Unit Coal + AGT	1131	1131	1131	1131	1131	1131	1131	0
Nuclear AGR	8244	8244	8244	8244	8244	8244	8244	0
Nuclear Magnox	1450.4	1450.4	0	0	0	0	0	-1450.4
Nuclear PWR	1200	1200	1200	1200	1200	1200	1200	0
OCGT	588.9	588.9	588.9	588.9	588.9	588.9	588.9	0
Offshore Wind	800	800	800	800	800	800	800	0
Oil + AGT	3636	3636	3636	3636	3636	3636	3636	0
Onshore Wind	2005.7	2562.7	2562.7	2562.7	2562.7	2562.7	2562.7	557
Pumped Storage	2744	2744	2744	2744	2744	2744	2744	0
Small Unit Coal	783	783	783	783	783	783	783	0
Total Capacity	83421.7	87333.7	86313.3	86313.3	86361.8	86369.3	86369.3	2947.6
GB Demand at ACS Peak (MW)	59594.5	60235.7	61426.4	62122.6	62574.5	63077.2	63533.4	3938.9
Plant Margin (%)	40	45	40.5	38.9	38	36.9	35.9	-4

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Table 5.4 - Plant Margins (%)

Demand Forecast	Generation Background	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Customer-Based	SYS	40.1	50.9	55.6	59	63.8	71	71.3
Customer-Based	C	40.1	47.3	46.4	47.2	47	45.9	44.9
Customer-Based	E/UC	40	45	40.5	38.9	38	36.9	35.9
NGET 'Base'	SYS	47.4	61.9	69.6	73.8	80.5	89.1	90
NGET 'Base'	C	47.4	58	59.7	60.9	62	61.4	60.7
NGET 'Base'	E/UC	47.2	55.5	53.2	51.8	52.1	51.4	50.9

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Table 5.5 - Plant Margins for Various Wind Generation Availability Assumptions (relative to SYS Background)

Generation Background	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
SYS (Wind at 100%)	40.1	50.9	55.6	59	63.8	71	71.3
SYS (Wind at 40%)	37.2	46.1	48.1	50.6	54.1	58.4	58.1
SYS (Wind at 30%)	36.7	45.2	46.8	49.2	52.4	56.4	55.9
SYS (Wind at 0%)	35.3	42.8	43.1	45	47.6	50.1	49.3

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Table 5.6 - GB Plant Margins: Historical Outturns

Year	Total Capacity - January Update (GW)	ACS Corrected Peak Demand excluding Station Demand (GW)	Plant Margin based on ACS Corrected Peak Demand (%)	Actual Peak Demand excluding Station Demand (GW)	Plant Margin based on Actual Peak Demand (%)
2005/06	75.1	61.6	21.9	59.6	25.9
2006/07	77	61.2	25.7	57.8	33.1
2007/08	76.9	60.8	26.4	60.1	27.9
2008/09	79.5	58.4	36.1	58.6	35.7

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GB Seven Year Statement 2009

Introduction to Chapter 6

This chapter describes the existing and planned GB transmission system in terms of the electrical parameters of its components, its electrical and geographical structure and its planned development over the period to 2015/16. The chapter identifies the generation and demand tariff zones, which are used in the Transmission Network Use of System (TNUoS) charging process. To complete the picture, the chapter also reports on the main system boundaries which are used to illustrate the overall capability of the transmission system to transmit power and on the associated study zones used in the various technical analyses contained in this Statement.

In view of the volume of transmission system data presented in this chapter, most of the figures and tables are presented in **Figures** and **Data** and only referenced in the text. As explained in the **Introduction** such figures and tables have accordingly been prefixed with the letter 'A' or 'B' as appropriate (e.g. **Figure A.1.2**).

The latter part of this chapter includes some basic introductory material relating to the GB transmission system to assist readers, unfamiliar with power systems, in gaining a better understanding of the material contained in the Statement.

The SYS Background

The existing and planned GB transmission system described in this chapter, together with the customer-based demand forecasts described in Chapter 2 and the existing and planned generation background described in Chapter 3, form the basis of the SYS background upon which most of the studies and analyses presented in this Statement are based.

These three elements of the SYS background (namely: demand; generation; and transmission) are internally consistent. For example, the transmission background of this chapter includes all transmission connection developments cited explicitly in the relevant Bilateral Connection Agreements as being necessary to permit the connection of the generation contained in the generation background of Chapter 3.

The "SYS background" is internally consistent. For example, the transmission background includes all transmission connection developments cited in the relevant connection agreement as being necessary to connect the generation contained in the generation background. The "SYS background" does not include any transmission development that may be needed to accommodate prospective projects of new generation or demand, which do not have an appropriate Bilateral Agreement in place on the Data Freeze Date of 31 December 2008.

As a point of interest, the proposed connection of a significant volume of new transmission contracted generation in the SHETL area, substantially made up of wind farms, is dependant on the completion of transmission reinforcements, including the proposed Beauly/Denny transmission reinforcement. The Beauly/Denny reinforcement is included as part of the SYS background for commissioning by 2013/14. However, elements of this reinforcement are currently the subject of a Public Inquiry and, consequently, the final commissioning date may vary, which would impact on the study results presented in **GB Transmission System Performance** and **GB Transmission System Capability**.

Scope

Accordingly, this chapter provides information on the existing transmission network and on those future transmission developments, which are considered ‘firm’ in that they are least likely to be varied or cancelled as the needs of the evolving system change. Such transmission developments include, but are not be restricted to, those schemes, which have been technically and financially sanctioned by the relevant Transmission Owner.

Other schemes, which may not yet be financially sanctioned by the relevant Transmission Owner, but which are however considered ‘firm’, are also be included. Such transmission reinforcement schemes are, nevertheless, associated with “Transmission Contracted” generation projects included in the generation background and may have an appropriate Transmission Owners Construction Agreement (TOCA) and Transmission Owners Reinforcement Instruction (TORI) in place. The meaning of the terms TORI and TOCA are explained in the Glossary and discussed in **Transmission System Access**.

In view of the uncertainty associated with future developments (particularly that relating to future transmission contracted generation), the timing of construction of infrastructure reinforcements is managed such that investments are made to well defined requirements. This means that in some cases construction is deferred to the last moment to avoid the risk of undertaking investments which may turn out to be unnecessary (e.g. where transmission contracted generation does not in the event proceed to completion), while at the same time ensuring that an efficient, co-ordinated and economic system, compliant with the Licence Standard is provided as required by the Transmission Licences.

Accordingly, the SYS background, upon which the bulk of this Statement is based, does not necessarily contain all the transmission reinforcement schemes that may in the event be required for compliance with the Licence Standard. This chapter focuses on the transmission network of the ‘SYS background’ which comprises the existing network together with those planned future transmission developments which are considered least likely to be varied to meet the changing needs of the system as it evolves.

Planned transmission developments may include:

• developments needed for 'transmission contracted' generation and demand cited in relevant bilateral agreements as being necessary precursors to the connection. These can include reinforcements to the infrastructure of the transmission system remote from the connection site as well as reinforcements local to the connection site; and

• infrastructure developments required to meet the general needs of the system as it evolves rather than the needs of any specific user (generation or demand).

The Existing and Planned Network

Network Parameters

The GB 400kV, 275kV and 132kV transmission system for the winter of 2009/10 (as at the data freeze date of 31 December 2008) is shown geographically in **Figure A.1.2**. **Table 6.2**lists the main planned developments to the transmission system in each year up to 2015/16.

Network parameter values for the existing and planned 400kV, 275kV and 132kV transmission system are included in Appendix B:

- Table B.1a , Table B.1b , Table B.1c

Substations are referred to in some tables and figures by a 5 or 6 character code. The first four letters of the code refer to the site name and are listed in **Table B.1a** (for SHETL), **Table B.1b** (for SPT) and **Table B.1c** (for NGET). In other parts of this Statement, a fifth and sixth character is added. In these cases, the fifth character refers to the voltage level as follows:
• 4 means 400kV
• 2 means 275kV
• 1 means 132kV
• 6 means 66kV
• 3 means 33kV
For example Feckenham 400kV has code FECK4.
For non-generator bus bars, the sixth character of the bus bar name is chosen to provide information about the bus bar. In general, a value of '0' represents a solid bus bar. Bus bar sections which are capable of being coupled but which are run separate due to fault level or load flow reasons, are given characters other than zero.
The three tables also show Demand and Generation Use of System Charging zones and the low voltage shunt susceptance at each node as supplied by users. The information contained in **Table B.2.1c** relates to the NGET 400/275kV transmission system. NGET own a number of bus bars at lower voltages, which are embedded within distribution systems. For the purposes of this Statement these assets are not considered to be part of the GB transmission system but, nevertheless, **Table B.2.1c**does list these lower voltage bus bars. For further information on this, users should contact National Grid as explained in **Further Information**.

- Table B.2.1a, Table B.2.1b, Table B.2.1c

These tables list the parameters of all circuits as at the winter of 2009/10, for each of the three transmission companies (SHETL, SPT and NGET respectively), including length, type (overhead line or underground cable), resistance, reactance, susceptance and post fault continuous seasonal ratings. Please note that circuit lengths are indicative only as they do not include detail such as 'cable entries' at substations.

For composite circuits, which include component lengths of both overhead line and cable, the total length of each component (i.e. overhead line and cable) is given.

The information contained in **Table B.2.1c** relates to the NGET 400/275kV transmission system. NGET own a number of circuits at lower voltages which are embedded within distribution systems. For the purposes of this Statement these assets are not considered to be part of the GB transmission system. Nevertheless, **Table B.2.1c** lists these lower voltage circuits. For further information users should contact National Grid as explained in **Further Information**.

The actual electrical connections between circuits at the substation are commonly referred to as the substation 'running arrangement'. Please note that, whilst **Table B.2.1a**, **Table B.2.1b** and **Table B.2.1c** assume particular running arrangements for the various substations on the system, these may be subsequently varied for instance to reduce fault levels.

• Table B2.2a, Table B2.2b and Table B2.2c
These tables list the planned changes to the circuit parameters for each of the three transmission companies over the period from 2010/11 to 2015/16. The year of the change is also given together with the new parameter values. Again, where appropriate, where a change involves a composite circuit, the total length of each component (i.e. overhead line and cable) is given.

- Table B.3.1a , Table B.3.1b and Table B.3.1c

These tables list the parameters of all grid supply transformers for the three transmission companies together with their nominal ratings (in MVA).

- Table B.4a , Table B.4b and Table B.4c

These tables list typical transformer, Static Var Compensator and quadrature booster parameters respectively for the three companies. For exact values at a particular site, users should contact the relevant transmission company as explained in **Further Information**.

- Table B.5.1a , Table B.5.1b , Table B.5.1c

These tables give information all reactive compensation plant owned by the three transmission companies, together with Mvar capabilities. The system location of this plant is indicated in **Figure A.2.4** , **Figure A.3.4** and **Figure A.4.4**.

- Table B5.2a , Table B5.2b and Table B5.2c

These tables list the planned changes to reactive compensation for each of the three transmission companies over the period from 2010/11 to 2015/16. The year of the change is also given together with the new parameter values.

- Table B.6a , Table B.6b and Table B.6c

These tables list indicative circuit breaker ratings for the three transmission companies.

Finally, to provide a more complete picture, **Table 6.5** lists planned developments on the transmission system that are beyond the scope of this GB SYS. The schemes in Table 6.5 are either planned for beyond 2015/16, or are associated with new customer connections which are due to connect beyond 2015/16.

Network Diagrams

The existing 2008/09 GB transmission system is shown schematically **Figure A.2.1** for SHETL, **Figure A.3.1** for SPT and **Figure A.4.1** for NGET. . Looking forward, the GB transmission system as projected for the 2015/16 peak, including planned main extensions, is shown schematically in **Figure A.2.3** for SHETL, **Figure A.3.3** for SPT and **Figure A.4.3** for NGET. As previously mentioned, the planned extensions include transmission connection developments cited explicitly in the relevant Bilateral Connection Agreements as being necessary to permit the connection of the generation contained in the generation background of Chapter 3. It is worth repeating, however, that the SYS background, and hence the figures, does not include any transmission development that may be needed to accommodate prospective projects of new generation or demand, which do not have an appropriate Bilateral Agreement in place on the Data Freeze Date of 31 December 2008.

The above schematic figures are complemented by the schematic power flow diagrams, which cover each winter peak from 2009/10 to 2015/16 inclusive and are presented in **GB Transmission System Performance**. The power flow diagrams also highlight planned developments in each year over the period. However, such planned developments are only shown in so far as they affect the figures. In addition, please note that the substation 'running arrangements' reflected in this series of figures are subject to variation (see **Table B.2.1a** , **Table B.2.1b** and **Table B.2.1c**). **Table 6.2** provides a more complete description of developments some of which may not be reflected in the power flow diagrams in **GB Transmission System Performance**.

As mentioned previously, the system location of reactive compensation plant as at 2009/10, is shown schematically in **Figure A.2.3** for SHETL, **Figure A.3.3** for SPT and **Figure A.4.4** for NGET. For details of additional reinforcement schemes, not forming part of the 'SYS background', which may be necessary for full compliance with the Transmission Licence security standards, please refer to **Table 8.2** and **Indicative Reinforcements for Licence Compliance**.

Use of System Tariff Zones

Transmission Network Use of System (TNUoS) charges reflect the cost of installing, operating and maintaining the GB transmission system (see **Market Overview**. The basis of TNUoS charging is the Investment Cost Related Pricing (ICRP) methodology introduced in 1993/94.

Generation TNUoS Tariff Zones

There are 20 generation TNUoS tariff zones defined in such a way as to meet the criteria for defining zones set out in the ICRP methodology. These criteria broadly require that: first, zones should contain nodes whose marginal costs fall within a specified narrow band; and second, nodes within zones should be both geographically and electrically proximate. The 20 generation TNUoS tariff zones are depicted geographically in **Figure A.1.3** against a backdrop of the 2009/10 GB transmission system.

Demand TNUoS Tariff Zones

There are 14 demand TNUoS tariff zones, which correspond to the original Regional Electricity Company (REC) franchise areas in England and Wales, and the geographical areas of the two Scottish electricity companies. These are again depicted geographically in **Figure A.1.4** against a backdrop of the 2009/10 GB transmission system.

General Interpretation

Both **Figure A.1.3** and **Figure A.1.4** only provide an approximate indication of the geographical area of the tariff zones. Formally, it is only the transmission substations that are allocated to zones and the figures should not therefore be used to establish the zone of any particular town or village. A demand customer's zone is effectively determined by the Grid Supply Point (GSP) Group to which the customer is deemed to be connected. In the case of a directly-connected power station, the generation tariff zone applicable relates to the geographical location of the transmission substation (connection site) to which the station is connected. In the case of an embedded power station, the generation tariff zone applicable relates to the transmission substation to which that station is deemed connected. This would depend on the operating arrangements of the lower voltage distribution networks under the control of the local distribution Network Operator.

The geographic picture provided by **Figure A.1.3** is complemented by **Figure A.2.2** for SHETL, **Figure A.3.2** for SPT and **Figure A.4.2** for NGET, which present the generation tariff zones against the 2009/10 schematic/electrical backgrounds of each Transmission Area.

Table E 1.1 1 lists the 2009/10 maximum demand for each GSP and was introduced in **Electricity Demand**. The final column in the table also gives DCLF (Direct Current Load flow) Node information. This has been included to increase the transparency, particularly with regard to the use of GB SYS data in the DCLF Transport model, which is used for calculating TNUoS tariffs. Whilst the information provided allows Users to identify the DCLF nodes at which LV demand is mapped, it is important to note that this additional information will not enable Users to replicate the demand data used in the DCLF model exactly. This is due to the treatment of Large embedded generation and station demand, which is not included in these figures.

SYS Boundaries and SYS Study Zones

SYS Boundaries

For the purpose of illustrating system performance, the need or otherwise for transmission reinforcement and for describing opportunities, it is useful to divide the system up and consider power transfers across certain critical boundaries. 17 such boundaries are used in this Statement (11 for England & Wales and 6 for Scotland).

The 17 boundaries are shown schematically/electrically in **Figure A.2.4** for SHETL, **Figure A.3.4** for SPT and **Figure A.4.4** for NGET against the backdrop of the 2014/15 system and are listed in **Table 6.3**. The 17 boundaries are also shown in **Figure A.1.6** against a geographic backdrop, which includes the 2009/10 system. These boundaries are used, amongst other things, to provide a clearer picture of the overall capability of the transmission system to transmit power **Transmission System Capability**.

SYS Study Zones

The areas of the system described by and/or encompassed by the 17 SYS boundaries are referred to as the SYS Study Zones. There are 17 such SYS Study Zones and these are listed in **Table 6.4** and shown in **Figure A.1.6** against a geographic backdrop, which also depicts the 2009/10 system.

Introduction to the GB Transmission System

System Overview

By the end of 2009/10 the power system in Great Britain will be made up of 161 Large power stations, the 400kV and 275kV transmission system (and 132kV transmission system in Scotland) and 14 distribution systems.

The location of Large power stations is shown against a backdrop of the 2009/10 transmission system in **Figure A.1.1**, The 2009/10 GB transmission system is again depicted in Figure A.1.2, with the 400kV system shown in blue, the 275kV system in red and the 132kV system in black.

The GB transmission system includes:

• Overhead Lines
Circuit kilometres of overhead lines which are normally energised and in service:

400kV 11,634km
275kV 5,766km
132kV & below 5,254km

Total 22,654km

• Underground Cables
Circuit kilometres of underground cable which are normally energised and in service:

400kV 195km
275kV 498km
132kV & below 216km
DC (Channel Link) 327km

Total 1,236km

• Substations
Transmission system facilities where voltage transformation or switching takes place:

400kV 163
275kV 127
132kV & below 395

Total 685

• Power transformers and Quadrature Boosters (QBs)
Power transformers and QBs which are normally energised and in service:
Note: 132kV was assumed to be LV in England & Wales, but not in Scotland.

400/275kV 110
400/132kV 10 (SPT only)
275/132kV 46 (SHETL & SPT only)
400/LV 243 (NGET only and includes 400/132kV units)
275/LV 441
132/LV 290
QBs 20

Total 1160

• Grid Supply Points
Points where electrical supplies are provided to Users:
Note: 132kV & 66kV were assumed to be Supply Voltages in England & Wales, but not in Scotland.

132kV 151
66kV 23
33kV and below 172

Total 346

The majority of Large power stations are directly connected to the GB transmission system. However, several Large power stations are embedded within the lower voltage distribution networks. Medium and Small power stations are currently all embedded within the distribution networks.

Table 6.1 summarises the capacity of Large power stations by fuel type and quantity as at the winter peak of 2009/10. The capacity of Auxiliary Gas Turbines associated with the Large power stations are included.

Currently there are two HVDC External Interconnections linking the GB transmission system with External Systems. These are:

• Connecting converter stations at Sellindge in Kent and Les Mandarins near Calais in France; and
• Connecting converter stations at Auchencrosh in the south of the SPT system and Islandmagee in Northern Ireland.

Grid Supply transformers connect the GB transmission system with the distribution systems at 'Grid Supply Points', where bulk supplies of electricity are delivered to the Distribution Companies and Non Embedded Customers. Electricity is then usually supplied to domestic, commercial and industrial customers through the distribution systems.

Until the 1930's electricity supply in Great Britain was the responsibility of a multiplicity of private and municipally owned utilities, each operating largely in isolation. The Electricity Supply Act (1926) recognised that this was a wasteful duplication of resources. In particular, each authority had to install enough generating plant to cover the breakdown and maintenance of its generation. Once installed, it was necessary to run more plant than the expected demand to allow for possible sudden plant failure.

By interconnecting separate utilities with the high voltage transmission system, it is possible to pool both generation and demand, not only providing a number of economic and other benefits, including:

• An interconnected transmission system providing a more efficient bulk transfer of power from generation to demand centres.

• The interconnected transmission system, by linking together all participants across the transmission system, makes it is possible to select the cheapest generation available.

• Transmission circuits tend to be far more reliable than individual generating units, and enhanced security of supply is achieved because the transmission system is better able to exploit the diversity between individual generation sources and demand.

• An interconnected transmission system enables surplus generation capacity in one area to be used to cover shortfalls elsewhere on the system, resulting in lower requirements for additional installed generation capacity, to provide sufficient generation security for the whole system.

• Without transmission interconnection, each separate system would need to carry its own frequency response to meet demand variations, but with interconnection the net response requirement only needs to match the highest of the individual system requirements to cover for the largest potential loss of power (generation) rather than the sum of them all.

Transmission System Capability

Three factors can limit the capability of the transmission system to transfer power across a system boundary

• Thermal capability is the maximum amount of power that can be transferred across a boundary on the system without exceeding the thermal rating of any one of the individual circuits; it depends to a large degree on the way in which the power transfer is shared between them

• Voltage capability, because it is sometimes necessary to restrict power transfers to a level lower than the firm thermal capability to ensure satisfactory voltage levels in the importing area.

• Stability limits, because the power transfer between two areas or between a major generating station and the system can also be limited by considerations of electro-mechanical stability. Two stability regimes are usually defined:

• Transient, after a severe disturbance, like a network fault.

• Steady state, which concerns the response to small disturbances such as the normal random load fluctuations.

Transmission System Losses

The flow of power across the transmission system causes power losses in the various elements of the system. Most of these power losses are a function of the square of the current flowing through the circuit or transformer windings (I2R) and cause unwanted but inevitable heating of transmission lines, cables and transformers. Since such losses are variable they are often referred to as the ‘variable’ power losses.

In addition there are unavoidable ‘fixed’ losses associated with overhead lines and transformers. The term ‘fixed’ losses, however, is something of a misnomer. Relative to the ‘variable’ losses they are reasonably static, but they can and do vary. ‘Fixed’ losses on overhead transmission lines take the form of corona losses that are a function of voltage levels and weather conditions. Corona loss is the loss of power to the air and insulation surrounding high-voltage equipment and is generally visible in the dark as a luminous glow surrounding high-voltage conductors.

‘Fixed’ losses in a transformer take the form of iron losses. Iron losses occur in the iron core of the transformer when subjected to an alternating magnetic field and as such vary with the frequency of the power flow producing the alternating magnetic field. Iron losses are further sub divided into hysteresis and eddy current losses. It may be noted that the ‘variable’ transformer heating losses mentioned above are sometimes referred to as ‘copper’ losses in recognition of the material used for transformer windings. Thus transformers have ‘variable’ copper losses and ‘fixed’ iron losses.

An estimated breakdown of transmission power losses at the time of ACS peak demand is given in **Power Losses**.

Impact of Generation Siting

Users can directly influence the need for major transmission reinforcements by their choice of where to site their new generating stations. For example, if a User sites a new station in an exporting area (i.e. where the amount of generation already exceeds the demand), the maximum power flow will increase and may exceed the firm transmission capacity of the existing system, thus precipitating the need for transmission reinforcement. The converse is, of course, also true.

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Table 6.1 - Summary of Power Stations 2009/10

Fuel Type	Number	Capacity(MW)
Nuclear		
Magnox	2	1450.4
AGR	7	8244
PWR	1	1200
Sub Total	10	10894.4
Coal (+ AGT)		
Small Unit	2	783
Medium Unit	2	2233
Large Unit	13	25880
Sub Total	17	28896
CCGT	36	25858
CHP	10	2326
Sub Total	46	28184
Oil (+ AGT)	3	3636
OCGT	6	588.9
Sub Total	9	4224.9
Hydro	35	1069.7
Pumped Storage	4	2744
Sub Total	39	3813.7
Onshore Wind	34	1513.4
Sub Total	34	1513.4
Biomass	1	45
Sub Total	1	45
TOTAL	156	77571.4

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Table 6.2 - Planned Developments on the GB Transmission System

Licensee	Year	Site	Works
SHETL	2009	Boat of Garten	Replace two existing transformers at Boat of Garten 132kV substation with two new 60MVA units
SHETL	2009	Strichen	Grid Transformer upgrade
SHETL	2009	Macduff	Grid Transformer upgrade
SHETL	2009	Inverness	Install an additional 90MVA transformer at Inverness GSP
SHETL	2009	Cassley	Grid Transformer upgrade
SHETL	2009	Fasnakyle	Grid Transformer upgrade
SHETL	2009	Invergarry	Grid Transformer upgrade
SHETL	2009	Persley	Grid transformer upgrade
SHETL	2009	Dundee	Replace Dundee City 132kV cables
SHETL	2009	Dunvegan	Connect Edinbane Wind, Skye, 42MW at 132kV.
SHETL	2009	Bridge of Dun	Connect Tullo Wind Farm, Laurencekirk, 14MW at 33kV.
SHETL	2009	Peterhead	Install 3rd 275/132kV SGT at Peterhead
SHETL	2009	Ceannacroc/Ft Augustus	Connect Millenium Wind additional capacity of 15MW, Ceannacroc, total capacity 65MW at 132kV
SHETL	2009	Gordonbush	Connect Gordonbush Wind, Caithness, 70MW at 275kV/33kV, by 22/2/08. Construct a renewable generation tee-in connection at Gordonbush on the 275kV line from Dounreay to Beauly.
SHETL	2009	Kingsburn	Connect Kingsburn wind farm, 20MW, Fintry, Stirling.
SHETL	2009	Lairg	Connect Lairg - Achany Wind Farm, 50MW at 33kV
SHETL	2009	Orrin	Connect Fairburn Wind (Orrin), 40MW at 132kV
SHETL	2009	Strath Brora	Connect Kilbraur Wind, Farm additional capacity of 19.5MW at 275kV, total capacity 67MW
SHETL	2009	Overhead Line work	Killin/St Fillans 132kV reconductor
SHETL	2009	Overhead Line work	Clachan/Inveraray 132kV reconductor

SHETL	2009	Overhead Line work	Shin/Cassley 132kV reconductor
SHETL	2010	Sloy Area	Construct Inverarnan substation near Sloy where the SP Transmission Dalmally to Windyhill 275kV circuits cross the SHETL Killin to Sloy 132 kV circuits. Substation to have two 240 MVA 275/132kV auto transformers.
SHETL	2010	Inverness Area	Construct Knocknagael substation south of Inverness, located at Foyers tee point on the existing Beauly-Blackhillock 275kV line. Substation to comprise two 240MVA 275/132kV auto transformers, with existing Inverness 132kV Substation to be fed via two 3km cable circuits.
SHETL	2010	Carraig Gheal	Establish a new single 90 MVA transformer 132 / 33 kV substation at Carraig Gheal and connect this to the Inveraray / Taynuilt 132 kV circuit ITE on the same tower as the Nant 132 kV connection to ITW, via a single circuit 132 kV line. These works are for the connection of a new windfarm at 33 kV.
SHETL	2010	Overhead Line works	Install 3rd 132kV OHL circuit between Peterhead and St Fergus
SHETL	2010	Luichart	Grid transformer upgrade
SHETL	2010	Mossford	Grid transformer upgrade
SHETL	2010	Fiddes	Grid transformer upgrade
SHETL	2010	Errochty / Burghmuir	Connect Griffin Windfarm, near Aberfeldy, 204MW at 132kV.
SHETL	2010	Nant	Connect Carraig Gheal wind farm, 60MW
SHETL	2010	Overhead Line work	Inveraray/Port Ann 132kV reconductor
SHETL	2010	Overhead Line work	Inveraray/Taynuilt 132kV reconductor
SHETL	2010	Carradale	Connect Beinn an Turic 2 Windfarm, 36MW.
SHETL	2011	Mybster	Upgrade the existing 2 x 30MVA and 1 x 60MVA transformers at Mybster 132/33kV substation to 2 x 120MVA transformers
SHETL	2011	Mybster	Connect Causeymire Wind additional capacity of 7MW, total capacity 55MW
SHETL	2011	Strathleven	Connect Ballindalloch Muir Wind Farm, Balfron, 20.8MW.
SHETL	2011	Alness	Upgrade the existing 2 x 60MVA transformers at Alness 132/33kV substation to 2 x 120MVA transformers
SHETL	2011	Ardmore	Grid transformer upgrade
SHETL	2011	Dunvegan	Grid transformer upgrade
SHETL	2011	Harris	Grid transformer upgrade

SHETL	2011	Kintore	Grid transformer upgrade
SHETL	2012	Dounreay	Extend 275 kV and 132 kV busbars, and install a second 275/132 kV auto-transformer rated at 240MVA at Dounreay substation. Upgrade the existing 150 MVA auto-transformer to 240MVA. Install 2 x 60MVAr shunt reactors, connected onto tertiary windings of the two auto-transformers.
SHETL	2012	Overhead Line Works	Beauly / Dounreay Phase 1, install 2nd 275kV circuit.
SHETL	2012	Beauly	Beauly / Shin 132kV (BSW/BSE) phase shifter installation
SHETL/SPT	2013	North Argyll	Establish a twin auto-transformer 275/33kV substation adjacent to SPT's Dalmally 275kV substation compound, and connect the new substation to SPT's 275kV busbars. Erect three 33 kV circuits over 6km between the new Dalmally 275/33kV substation and a 33 kV switching substation at Stacain. (SPT are responsible for the 275kV connection works at Dalmally).
SHETL/SPT	2013	Beauly-Denny Works	Replace the existing Beauly-Fort Augustus-Fasnakyle-Errochty-Braco-Bonnybridge 132kV double-circuit line with 400kV construction, one circuit to be operated at 400 kV and the other circuit at 275kV. Modify the existing substation arrangements at Beauly, Fasnakyle, Fort Augustus, Errochty and Braco to interface with the new line operating voltages. Construct Denny North 400/275/132kV substation.
SHETL	2013	Beauly	Install a new +150/-150MVAr SVC at Beauly 275kV substation. Install 2 x 90MVAr shunt reactors at Beauly 275kV substation. Install 2 x 45MVAr MSCs at Beauly 132kV substation.
SHETL	2013	Fort Augustus	Install 3 x 60MVAr shunt reactors at Fort Augustus substation, these connected onto the tertiary windings of three 240MVA auto-transformers installed as part of Beauly-Denny works
SHETL	2013	Shira	Connect Shira wind farm, 52MW, Sron Mor, Argyll
SHETL	2013	Stacain	Connect Stacain wind farm, Sron Mor, 42MW.
SHETL	2013	Western Isles	Construct HVDC Link connecting Western Isles to Beauly Substation
SHETL	2013	Stornoway	Connect Pairc (South Lochs) Wind, Lewis, 94MW.

SHETL	2013	Beauly / Dounreay	Connect Strathy North & South Wind, 226MW at 275kV.
SHETL	2013	Blackhillock	Connect Berry Burn Wind, near Nairn, 82.5MW at 275kV.
SHETL	2013	Boat of Garten	Connect Tomatin Windfarm, 30MW at 33kV.
SHETL	2013	Dunoon	Connect Black Craig 40MW wind farm.
SHETL	2013	Fort Augustus	Increase Glendoe Hydro capacity to 100MW total.
SHETL	2013	Kintore / Tealing	Connect Mid Hill Wind, Stonehaven, 75MW at 275/33kV
SHETL	2014	Aultmore	Connect Aultmore Windfarm, 60MW at 132kV.
SHETL	2014	Blackhillock / Kintore	Connect Clashindarroch Wind, Huntly, 113MW at 33kV.
SHETL	2014	Bridge of Dun	Connect Montreathmont Moor Wind, Angus, 40MW at 33kV.
SHETL	2014	Dunbeath	Connect Dunbeath Wind Farm, 55MW at 33kV.
SHETL	2014	Errochty / Bonnybridge	Connect Calliacher Wind, 62MW at 275/33kV.
SHETL	2014	Mybster	Connect Camster Windfarm, Caithness, 63MW at 33kV.
SHETL	2014	Shetland	HVDC Link for North Nesting, with necessary reactive power compensation
SHETL	2014	Overhead Line Works	Reconductor the Beauly-Blackhillock-Kintore 275 kV double-circuit line with larger capacity conductor .
SHETL	2014	Alness	Connect Novar 2 Windfarm, 32MW.
SHETL	2014	Caithness	Connect North Nesting Wind, Shetland (250MW) via an HVDC link.
SHETL	2014	Dunoon	Connect Black Craig 90MW Wind Farm, Dunoon.
SHETL	2014	Fasnakyle	Additional 6MW of hydro capacity.
SHETL	2014	Thurso	Connect Stroupster Wind Farm, near Wick, Caithness, 32MW.
SHETL	2014	Stornoway	Connect Eishken Estate, Isle of Lewis, 300MW of wind generation.
SHETL	2014	Thurso	Connect Bailllie and Bardnaheigh Wind, 66MW.
SHETL	2015	Angus	Connect Careston Wind Farm, 32MW.
SPT	2009	Busby	Complete refurbishment of 275kV Substation.
SPT	2009	Carsfad 11kV Switchgear Change	Replace 11kV switchgear.
SPT	2009	Crystal Rig 2	Connect Crystal Rig 2 Wind Farm (200MW) at 132V.

SPT	2009	Dunlaw Extension Wind Farm	Connect Dun Law Extension Wind Farm (29.75MW) at 33kV.
SPT	2009	Longpark Wind Farm	Connect Longpark Wind Farm (38MW) at 33kV.
SPT	2009	Smeaton - Galashiels	Refurbish 132kV single circuit from Dalkeith to Galashiels. Commission 240MVA 275/132kV at Smeaton and Smeaton to Galashiels 132kV circuit.
SPT	2009	Strathaven - Harker	Increase the thermal rating of the 400kV circuits on the Strathaven-Harker route, by increasing the maximum operating temperature to 90deg.C.
SPT	2009	Strathaven - Harker: Gretna	Uprate Gretna to 400kV operation, completing upgrade of Strathaven-Harker route to double circuit 400kV operation.
SPT	2009	Strathaven - Harker: Linnmill	Convert Linnmill GSP to 132/33kV.
SPT	2009	Toddleburn Wind Farm	Connect Toddleburn Wind Farm (36MW) at 33kV.
SPT	2009	Windyhill	Commission series reactor on Windyhill - Neilston 275kV circuit.
SPT	2010	Andershaw Wind Farm	Connect Andershaw Wind Farm (45MW) at 33kV.
SPT	2010	Arecleoch Wind Farm	Connect Arecleoch Wind Farm (150MW) at 33kV.
SPT	2010	Auchencorth Wind Farm	Connect Auchencorth Wind Farm (45MW) at 33kV.
SPT	2010	Barmoor Wind Farm	Connect Barmoor Wind Farm (30MW) at 33kV.
SPT	2010	Clyde Wind Farm	Connect Clyde Wind Farm (519MW) at 33kV.
SPT	2010	Clyde's Mill	Complete refurbishment of 275kV Substation.
SPT	2010	Crookston B 132kV Transformer Replacement	Replace 132/33kV transformers T1B.
SPT	2010	Drone Hill Wind Farm	Connect Drone Hill Wind Farm (37.8MW) at 33kV.
SPT	2010	Earlston 11kV Switchgear Change	Replace 11kV switchgear.
SPT	2010	Eccles – Stella West	Complete replacement of overhead line conductor on the Eccles - Stella West 400kV double circuit from Eccles to the NGET area.
SPT	2010	Glasgow City Centre reinforcement	Establish a new 132/33kV grid supply point in the west end of Glasgow.
SPT	2010	Inverarnan	Commission substation connecting the SPT Dalmally - Windyhill 275kV circuit to the SHETL Killin to Sloy 132kV circuits.
SPT	2010	Kilmarnock South - Stratahven	Refurbish XV Route Kilmarnock South - Stratahven Overhead Line

SPT	2010	Kincardine - SHETL Border	Refurbish XL Route Kincardine - SHETL Border Overhead Line
SPT	2010	Mark Hill 132kV Substation	Establish Mark Hill 132kV Substation
SPT	2010	Mark Hill 275kV Substation	Establish Mark Hill 275kV substation
SPT	2010	Mark Hill Wind Farm	Connect Mark Hill Wind Farm (99MW) at 33kV.
SPT	2010	Rothes BioPower	Connect Rothes Bio-Plant (52MW) at 33kV.
SPT	2010	Tormywheel Wind Farm	Connect Tormywheel Wind Farm (32.4MW) at 33kV.
SPT	2010	Whitehouse 275/33kV Transformer Replacement	Replace 275/33kV transformers T1 and T2.
SPT	2010	Wishaw - Smeaton	Refurbish XJ Route Wishaw-Smeaton Overhead Line
SPT	2011	Coylton - New Cumnock	Construct 275kV overhead line and commission New Cumnock 275/132kV substation. Reconfigure Coylton 275kV Substation.
SPT	2011	Coylton 132kV Switchgear	Complete refurbishment of 132kV Substation.
SPT	2011	Dersalloch Wind Farm	Connect Dersalloch Wind Farm (69MW) at 33kV.
SPT	2011	Devol Moor - Erskine	Commission new double circuit 132kV overhead line and remove redundant single circuit. Re-configure Erskine 132kV Substation.
SPT	2011	Devol Moor - Erskine: Braehead Park	Reconfigure substation to form a second Neilston/ Paisley 132kV circuit and a second Govan/ Haggs Road 132kV circuit.
SPT	2011	Devol Moor - Erskine: Erskine	Reconfigure Erskine substation to form two Devol Moor - Braehead Park circuits, each with a tee-off into Erskine.
SPT	2011	Earlshaugh Wind Farm	Connect Earlshaugh Wind Farm (108MW) at 132kV.
SPT	2011	Elvanfoot	Install a new (1st) 225MVAr MSC at Elvanfoot 400kV substation.
SPT	2011	Ewe Hill Wind Farm	Connect Ewe Hill Wind Farm (66MW) at 33kV.
SPT	2011	Fallago Wind Farm	Connect Fallago Wind Farm (144MW) at 400kV.
SPT	2011	Govan	Replace 132/33kV transformers T1 and T2.
SPT	2011	Gretna - Ewe Hill	Establish 132kV overhead line from Gretna 132kV substation to Ewe Hill 132kV substation.
SPT	2011	Harestanes Wind Farm	Connect Harestanes Wind Farm (140MW) at 132kV.

SPT	2011	Harrows Law Wind Farm	Connect Harrows Law Wind Farm (55MW) at 132kV.
SPT	2011	Kaimes - Whitehouse - Dewar Place	Complete replacement of Kaimes - Whitehouse - Dewar Place 275kV gas compression cable.
SPT	2011	Kilmarnock South - Meadowhead	Connect new Kilmarnock South - Meadowhead 132kV connection and new 240MVA 275/132kV auto-transformer at Kilmarnock South.
SPT	2011	Kyle Wind Farm	Connect Kyle Wind Farm (300MW) at 132kV.
SPT	2011	Longannet	Install three new (1st, 2nd and 3rd) 150MVAr MSCs at Longannet 275kV substation.
SPT	2011	Moffat 132kV substation	Establish Moffat 132kV Substation.
SPT	2011	Moffat 400kV substation	Establish Moffat 400kV Substation. Install a new (1st) 225MVAr MSC at Moffat 400kV substation.
SPT	2011	Newfield Wind Farm	Connect Newfield Wind Farm (60MW) at 33kV.
SPT	2011	Portobello	Replace 275/33kV transformer SGT2A with a 120MVA unit.
SPT	2011	Strathaven	Reconfigure Strathaven 400kV Substation. Disconnect Strathaven SGT3 400/275kV 1000MVA transformer from the Inverkip 400kV circuit and install SGT4 400/275kV 1000MVA.
SPT	2011	Tongland	Replace 11kV switchgear.
SPT	2011	Waterhead Moor Wind Farm	Connect Waterhead Moor Wind Farm (73MW) at 132kV.
SPT	2011	Windyhill	Install a new (1st) 150MVAr MSC at Windyhill 275kV substation.
SPT	2011	Wishaw - Ravenscraig	Relocate Ravenscriag SGT1 and SGT2 to Wishaw and reconfigure primary system connections.
SPT	2012	Afton Wind Farm	Connect Afton Wind Farm (77MW) at 33kV.
SPT	2012	Black Hill	Establish Black Hill 132kV 'Collector' Substation.
SPT	2012	Brockloch Rig Wind Farm (formerly Windy Standard II)	Connect Windy Standard II Wind Farm (60MW) at 33kV.
SPT	2012	Dalmally	Reconfigure Dalmally 275kV substation.
SPT	2012	Dewar Place	Replace 275/33kV transformers SGT1 and SGT2.
SPT	2012	Glasgow East End Reinforcement	Reinforce and reconfigure the 132kV connections presently supported from Dalmarnock 132kV Substation.

SPT	2012	Glenglass	Establish Glenglass 132kV 'Collector' Substation.
SPT	2012	Glenlee	Replace 11kV switchgear.
SPT	2012	Hearthstanes Wind Farm	Connect Hearthstaines B Wind Farm (81MW) at 132kV.
SPT	2012	Kilmarnock South - Coylton	Reconfigure the 132kV transmission system near Kilmarnock South to deliver a Kilmarnock South - Coylton 132kV circuit.
SPT	2012	Neilston Wind Farm	Connect Neilston Wind Farm (100MW) at 132kV.
SPT	2012	New Cumnock - Black Hill - Glenglass	Establish 132kV overhead line from New cumnock to Black Hill to Glenglass.
SPT	2012	Pencloe Wind Farm	Connect Pencloe Wind Farm (63MW) at 33kV.
SPT	2012	Tongland	Replace 90MVA 132kV quad-booster with a unit of higher rating.
SPT	2012	Ulzieside Wind Farm	Connect Ulzieside Wind Farm (69MW) at 33kV.
SPT	2012	Whiteside Hill Wind Farm	Connect Whiteside Hill Wind Farm (27MW) at 33kV.
SPT	2013	Beauly - Denny: Denny North	Construct Denny North 400/275kV substation and associated infrastructure to connect 400kV tower line from the SHETL area.
SPT	2013	Blackcraig Wind Farm	Connect Blackcraig Wind Farm (71MW) at 33kV.
SPT	2013	Carscreugh Wind Farm	Connect Carscreugh Wind Farm (21MW) at 33kV.
SPT	2013	Margree Wind Farm	Connect Margree Wind Farm (70MW) at 33kV.
SPT	2013	New Cumnock to Blackcraig / Margree	Establish 132kV overhead line from New Cumnock to Blackcraig / Margree.
SPT	2014	Inverkip - Cowal 132kV Connection	Establish two 132kV connections from Dunoon to Inverkip.
NGET	2008	Bicker Fenn	Establish a new GSP. Construct two tee-points in the Walpole-West Burton and Spalding North - Keadby 400kV circuits. Connect the new tee-points to Bicker Fenn 132kV substation with two new 400/132kV transformers.
NGET	2008	Bramley	Install two new (5th and 6th) 400/132kV, 240MVA SGT's.
NGET	2008	East Claydon	Install a new (2nd) 225MVAr MSCDN at East Claydon 400kV substation.
NGET	2008	Enderby	Install a new 4th SGT 400/132kV, 240MVA transformer by 31/10/08.

NGET	2008	Exeter	Install a new 400/132kV, 240MVA transformer (SGT7) by 31/10/08.
NGET	2008	Grain	At Grain, replace the 5 existing OHBR140 400kV circuit breakers associated with bus section switches and reactor connections, with new 63kA rated units. Modify the Britned works such that two new 400/33kV SGTs are installed at West Thurrock, instead of the two 1100MVA 400/275kV SGTs at the site, to facilitate the Britned connection.
NGET	2008	Grain	connect 100MW of LNG demand with a new 400/132kV 240MVA SGT5.
NGET	2008	Grendon	Install a new (4th) 225MVAr MSC at Grendon 400kV substation.
NGET	2008	Harker	Install a new (1st) 225MVAr MSC at Harker 400kV substation.
NGET	2008	Hurst	Install a new 132kV circuit breaker in place of existing SGT4 circuit breaker.
NGET	2008	Hutton	Connect two new 400/26.25-0-26.25kV traction transformers rated at 80/40/40MVA to supply Network Rail
NGET	2008	Immingham	Connect the new Immingham CHP 601MW module 2 at Humber Refinery 400kV substation, by 15/01/08.
NGET	2008	Indian Queens	Install a new (4th) 400/132kV, 240MVA SGT.
NGET	2008	Iron Acton	Install a 2nd new 240MVA (275/132kV) SGT6, a 45Mvar MSC, and two line breakers on the Melksham No. 2 circuit, by 31/08/08.
NGET	2008	Kearsley	Install SGT7, a new, 400/132kV transformer, teed off the Penwortham-Daines 400kV circuit.
NGET	2008	Langage	Construct a new 400kV double-busbar substation at Langage. Connect the Abham-Landulph 1 & 2 400kV circuits into the new substation. This forms the Abham-Langage 1 & 2 and Landulph-Langage 1 & 2 400kV circuits. Connect 905MW of CCGT capacity (Langage stage 1) to the new substation.
NGET	2008	Lister Drive	Install a fourth 240MVA, 275/132kV transformer at Lister Drive, by 31/05/08.

NGET	2008	Marchwood	Construct a new 400kV double-busbar substation at Marchwood and turn in the Fawley-Nursling 400kV circuit to form a Fawley-Marchwood and a Marchwood-Nursling 400kV circuit. Connect the new Marchwood 900MW CCGT generating station to the new Marchwood 400kV substation.
NGET	2008	St. Johns Wood	Re-connect the existing 275/132kV SGT2B and SGT4B at St Johns Wood 132kV substation. Refurbish existing 275kV assets at the St Johns Wood 275kV mesh substation.
NGET	2008	St. Johns Wood 66kV (Lodge Road)	Transfer the existing 275/66kV SGT4A into a new 66kV switchbay via a new 66kV cable.
NGET	2008	Sizewell South	Construct a new, 132kV double-busbar substation at Sizewell Wents. Connect the new substation to the existing Sizewell 400/132kV substation with four new 132kV underground cable circuits, of length 1.6km. Connect two of the new cables to the existing substation using tee connections into the 132kV cable circuits of two of the existing 400/132kV transformers. Connect the other two new cable circuits directly to the 132kV cable circuits of the other two existing 400/132kV transformers, thus diverting them from the existing 132kV substation.
NGET	2009	Bramford	Increase the ratings of SGT 2, 3 and 4 to 260MVA continuous with new coolers and cable backfill
NGET	2009	Bushbury	Replace SGT2 and SGT3 with standard 240MVA 275/132kV units
NGET	2009	Canterbury North	Connect 300MW of offhsore wind generation (Thanet) by 31/10/09
NGET	2009	Cleve Hill	Construct a new 400kV substation at Cleve Hill. Divert and turn in the Canterbury North-Kemsley no.2 circuit to form Canterbury North-Cleve Hill and Cleve Hill-Kemsley 400kV circuits.
NGET	2009	Drakelow	Extend the 400kV busbars at Drakelow 400kV substation, and install three new generator transformer bays. Divert the Drakelow-Cellarhead 400kV no. 2 circuit at Drakelow 400kV substation, to accommodate the new generator transformer bays.
NGET	2009	Frodsham	Install two new 80MVA 400/25kV two-phase transformers

NGET	2009	Grain	Construct a new four-bay GIS substation section at Grain. Loop the new GIS section into the existing series reactor circuit at Grain 400kV substation. Remove the Medway tunnel cable rating limitation on the Grain-Kemsley circuits by improved cooling. Connect 0MW of HVDC link capacity (Netherlands Interconnector Stage 1).
NGET	2009	Hackney	Install two new 400/132kV transformers (SGT3 and SGT4) at a new nine-bay 400kV double-busbar GIS substation at Hackney. Loop-in the new Hackney 400kV substation into the existing Tottenham-Hackney-West Ham circuit 2, uprating the Hackney-West Ham route to form a new Hackney-West Ham 400kV circuit 2, and install a new 400/275kV SGT (SGT7) to connect to the existing Hackney 275kV substation.
NGET	2009	Kingsnorth	install a new 400KV series reactor at kingsnorth between sections 1 and 2 of the substation
NGET	2009	Kirkby	Install a new 240MVA 275/132KV transformer at Kirkby
NGET	2009	Mannington	By 31/10/09, install a new additional 400/132kV 240MVA transformer at Mannington substation.
NGET	2009	Ocker Hill	Replace SGT1 & SGT2 with standard 240MVA 275/132kV units
NGET/SPT	2009	Overhead Line Works	Uprate the Harker-Gretna-Strathaven 275kV circuit to 400kV operation.
NGET/SPT	2009	Overhead Line Works	Re-conductor the L2 construction sections (approx. 26km) of the Canterbury North-Sellindge 400kV overhead line circuits with GAP conductor and replace the substation entry cables.
NGET	2009	Overhead Line Works	Uprate 6km of overhead line and 300m of cross-site cables on the Uskmouth-Whitson 275kV 1 & 2 circuits. Uprate the Iron Acton-Whitson 275kV 1 & 2 circuits, and uprate the Severn crossing.
NGET	2009	Overhead Line Works	Reconductor the Canterbury North-Kemsley 1 & 2 400kV circuits with GAP.
NGET	2009	St. Johns Wood 66kV (Lodge Road)	Complete the transfer of the existing 275/66kV SGT1A and SGT3A into new 66kV switchbays via new 66kV cables. Demolish the old 66kV substation bays.
NGET	2009	Sizewell	Connect Geater Gabbard Offshore Windfarm (500MW) by 31/10/08 at Sizewell.

NGET	2009	Staythorpe	Connect 425MW of new CCGT generation (Staythorpe Stage 1) at Staythorpe 400kV substation by 01/01/09.
NGET	2009	Staythorpe	Connect 1275MW of new CCGT generation (Staythorpe Stage 2) at Staythorpe 400kV substation by 31/10/09.
NGET	2009	Thurcroft	Install a 3rd SGT 275/66kV 180MVA at Thurcroft by 31/10/09
NGET	2009	Uskmouth	Construct a new, 9-bay, double-busbar, 275kV substation, including a bus coupler circuit breaker. Connect the Uskmouth-Whitson 275kV 1 & 2 circuits into the new substation. Connect Uskmouth SGT1 and SGT2A/2B supergrid transformers into the new substation. Install a new 132kV series reactor at Uskmouth 132kV substation. Install a new 132kV dual busbar section connection arrangement for SGT4. Connect the Cardiff East-Uskmouth-Whitson 275kV circuit into the new Uskmouth 275kV substation. Connect the Uskmouth SGT4A/4B supergrid transformer into the new Uskmouth 275kV substation.
NGET	2009	Uskmouth	Connect 425MW of new CCGT generation (Severn Power Stage 1) at Uskmouth 275kV by 31/10/09.
NGET	2009	West Boldon	Install a 3rd SGT 275/66kV at West Boldon by 31/10/09
NGET	2009	West Burton	Turn the Keadby-Spalding North 400kV circuit into West Burton 400kV substation to form separate Keadby-West Burton and West Burton-Spalding North 400kV circuits. Install a new section breaker in the West Burton 400kV reserve busbar. Install a new 1500MVA, 2% impedance series reactor plus two new circuit breakers at West Burton 400kV substation.
NGET	2009	West Burton	Connect the new West Burton B Stage 1 (435MW) CCGT at West Burton 400kV substation by 31/10/10.
NGET	2009	West Burton	Extend West Burton 400kV substation to provide one skeletal generator bay at each end. Install a new (2nd) 400kV reserve section breaker. Install two new main busbar section breakers, utilising HIS equipment in space currently occupied by disconnectors X228 and X324.
NGET	2010	Beddington	Add a second 400kV cable circuit from Rowdown to Beddington

NGET	2010	Blyth	At Blyth install two new 400/275kV transformers and by constructing a double tee-point connect the new transformers to a new double tee-point on the Stella West-Eccles 400kV double circuit using part of the existing Blyth-Stella West/Blyth-Fourstones 275kV double-circuit route. Uprate this part of the existing Blyth-Stella West/Blyth-Fourstones 275kV double-circuit route to 400kV operation and reconductor with 3x700mm2.
NGET	2010	Elstree	Connect a new 400/25kV 80MVA traction transformer at Elstree 400kV substation, teed into the Elsree-Sundon no. 2 circuit. Install 25kV cable disconnectors and circuit breakers on each of +25kV, -25kV and neutral connections brought out.
NGET	2010	Fourstones	Connect the Foustones-Blyth 275kV circuit to the Blyth-Stella west 275kV circuit to form a Fourstones-Stella West 275kV circuit. Disconnect the sections of the existing Blyth-Stella West and Blyth-Fourstones 275kV double-circuit route to the west of the Stella West-Eccles 400kV double-circuit route.
NGET	2010	Grain	At Grain connect 860MW of gas-fired generation for the re-powering of Unit 1 at Grain. The TEC increase of 860MW brings the total TEC of Grain power station to 2215MW. Complete the Stage 1 infrastructure works.
NGET	2010	Grain	At Grain 400kV substation, increase the capacity of the HVDC link capacity to the Netherlands to 800MW import/ 1390MW export.
NGET	2010	Grain	At Grain 400kV substation, increase the capacity of the HVDC link capacity to the Netherlands to 1320MW import/ 1390MW export by 31/10/10.
NGET	2010	Grendon	Install a new (5th) 400/132kV 240MVA SGT at Grendon
NGET	2010	Hackney	Loop-in the new Hackney 400kV substation into the existing Tottenham-Hackney-West Ham circuit 1, uprating the Hackney-West Ham route to form a new Hackney-West Ham 400kV circuit 1, and install a new 400/275kV SGT (SGT6) to connect to the existing Hackney 275kV substation. Install the 3rd 400/132kV SGT (SGT5)

NGET	2010	Heysham	Install a new 240MVA, 400/132kV transformer (SGT4) at Heysham, including HV and LV switchbays, and associated cabling, by 31/10/10.
NGET	2010	Heysham	Connect the new 140MW Heysham offshore windfarm at Heysham 132kV.
NGET	2010	North Hyde	Install a third 275/66kV SGT banked between the existing two SGTs by nomally open circuit breakers and connect by cable to existing 66kV bay, by 31/10/10.
NGET	2010	Norwich	Install a 5th 240MVA 400/132kV SGT and construct 6 new 132kV bays. Connect Sheringham Shoal (315MW) offshore windfarm
NGET	2010	Overhead Line Works	Uprate the Littlebrook-West Thurrock 275kV circuits to 400kV operation. Increase the rating of the cable section of the Grain-Tilbury 400kV circuit at Grain by modifying the backfill resistivity.
NGET	2010	Overhead Line Works	Reconductor the Walpole-Norwich Main 400kV double-circuit route with 3x700mm2 AAAC for 75C operation. Reconductor the Norwich Main-Bramford 400kV double-circuit route with 3x700mm2 AAAC for 75C operation.
NGET	2010	Overhead Line Works	Reconductor the Heysham-Quernmore tee and Heysham-Hambleton tee 400kV double-circuit overhead lines with 3x700mm2 AAAC conductor. Reconductor the Penwortham-Quernmore tee and Penwortham-Hambleton tee 400kV double-circuit overhead lines with 2x620mm2 GZTACSR GAP conductor.
NGET/SPT	2010	Overhead Line Works	Reconductor the Stella West-Eccles 400kV double-circuit route with 3x700mm2.
NGET	2010	Overhead Line Works	Hot-wire the Drax – Thornton double circuit to 75C operation
NGET	2010	Pembroke	Connect 800MW of new CCGT capacity (Pembroke 1 stage 1) at Pembroke 400kV substation, by 01/04/09.
NGET	2010	Pembroke	Connect 1200MW of new CCGT capacity (Pembroke 1 stage 2) at Pembroke 400kV substation, by 31/10/09.
NGET	2010	Rayleigh	Complete the transfer of the existing 132kV SGT1, 2 and 4 bays into the new EDF 132kV substation adjacent to Rayleigh Main 400kV. Demolish OHL connections and switchgear associated with existing Rayleigh Local 132kV site.

NGET	2010	South Manchester	Install an additional 240MVA 275/132kV SGT (SGT5) at South Manchester
NGET	2010	Stoke Bardolph	Establish a new Grid Supply Point at Stoke Bardolph, near Nottingham, by 31/10/10. Construct a new 400kV substation including two new 240MVA 400/132kV SGTs. Turn the High Marnham-Ratcliffe on Soar circuit into the new substation.
NGET	2010	Tilbury	Turn the Grain-Tilbury-Coryton 400kV circuit into a new 400kV, 7-bay double-busbar substation at Tilbury. Connect the new substation to one circuit of a new Tilbury-West Thurrock-Littlebrook 400kV double-circuit route, by re-energising the existing 11.77km L2 construction Tilbury-West Thurrock overhead line route and reconductor with 2x620mm2 GZTACSR GAP conductor.
NGET	2010	Underground Cable Works	At Kingsnorth and Grain, replace the 400m substation entry cables on the Kingsnorth-Grain and Grain-Tilbury-Coryton 400kV circuits with new, 3420MVA 400kV cables.
NGET	2010	Uskmouth	Connect 425MW of new CCGT generation (Severn Power Stage 2) at Uskmouth 275kV by 31/08/10.
NGET	2010	Walpole	Extend the busbars at Walpole 400kV substation, and connect a new generator bay.
NGET	2010	Walpole	Connect Lincs offshore windfarm (250MW) at Walpole 400kV substation by 09/07/08.
NGET	2010	West Burton	Connect the new West Burton B Stages 2 & 3 (870MW) CCGT at West Burton 400kV substation by 31/10/11.
NGET	2011	Brine Field	Reconductor the Lackenby-Norton 400kV ZZA circuit with GZTACSR conductor from the new Brine Field 400kV substation point of connection to Norton 400kV substation. Carry out replacement and reinforcement of tower infrastructure as found necessary from line surveys.
NGET	2011	Carrington	Construct a new Carrington GIS 400kV double busbar substation with 2 feeder bays, a bus coupler bay and two generator bays. Construct a new tower to modify the ZQ route to turn-in the Daines-Kearsley 400kV single circuit. Connect 430MW of Partington generation.

NGET	2011	Creyke Beck	Extend the 400KV substation at Creyke Beck by two bays to accept the new circuits from Hedon
NGET	2011	Deeside	Extend the main and reserve section 3/4 busbars at Deeside 400kV substation. Construct a skeleton generation bay on the new busbar section.
NGET	2011	Deeside	Connect 500MW of interconnector generation from Republic of Ireland.
NGET	2011	Drakelow	Connect a new 1320MW CCGT power station at Drakelow 400kV substation.
NGET	2011	Grain Stage 2	EON Limited Connection and re-powering of unit 4 at Grain (430MW)
NGET	2011	Grain Stage 2 Infrastructure Works	BritNed Development Limited Connection of the Netherlands Interconnector at Grain
NGET	2011	Harker	Install a new (2nd) 225MVAr MSC at Harker 400kV substation.
NGET	2011	Hedon	Construct a new 7 bay 275KV GIS substation adjacent to the existing Saltend North substation. Install two new 400/275KV 1100MVA inter-bus transformers at the new sub connecting into the new Creyke Beck circuits. Connect 300MW of offshore winfarm capacity from Humber Gateway.
NGET	2011	Kemsley	Install 2 new 2750MVA QBs at Kemsley on the Kemsley/Cleve Hill/Canterbury North route. Upgrade 3 existing circuit breakers at Kemsley 400kV to enable solid operation of the substation.
NGET	2011	Kemsley	Install works to enable the two new 400kV 2750MVA quadrature boosters (QBs) at Kemsley to be switched between the Grain-Kemsley and the Kemsley-Canterbury North/Cleve Hill 400kV circuits.
NGET	2011	Margam	Construct a new Margam 275kV 3-bay double busbar substation, including a bus coupler circuit breaker. Connect the existing Baglan Bay-Margam and Margam-Pyle 275kV circuits into the new Margam 275kV substation.
NGET	2011	Margam	Connect Prenergy Woodchip Power Station, 295MW.
NGET	2011	Oldbury	Planned closure of Oldbury Nuclear Magnox station (470MW).
NGET	2011	Overhead Line Works	Uprate the Stella West to Norton route to 400KV operation

NGET	2011	Overhead Line Works	Upgrade the Macclesfield-Stocksbridge circuit by hotwiring and reconductoring different sections to achieve a rating of 1710 MVA
NGET	2011	Overhead Line Works	Upgrade the Drax-Eggborough 2 circuit by reconductoring the L12 sections with 2x850 at 90C to achieve 2970MVA post fault rating.
NGET	2011	Overhead Line Works	Construct a new 28km 400KV double circuit line between Hedon and Creyke Beck. Construct using L8 2x570 at 75C. Includes 750m oc cable to ross under rail lines at Creyke Beck and enter the substation.
NGET	2011	Overhead Line Works	Reconductor the Carrington-Daines circuit with 2x620mm2 GZTACSR conductor
NGET	2011	Overhead Line Works	Hotwire the YYW route between Saltend North, Saltend South and Creyke Beck to 90C rating
NGET	2011	Overhead Line Works	Reconductor the Lackenby, Tod Point to Hartlepool 275kV circuit with 2x570mm2 AAAC conductor operating at 90C
NGET	2011	Penwortham	Install quadrature boosters at Penwortham 400kV substation, to be connected in series with the Penwortham-Daines and Penwortham-Padiham 400kV circuits.
NGET	2011	Rhigos	Construct a new 400kV 6-bay double busbar substation at Rhigos. Connect the Cilfynydd-Pembroke no. 2 circuit and the Pembroke-Walham circuit into the new substation.Connect 299MW of wind generation.
NGET	2011	Spennymore	Construct a new 400KV double busbar substation at Spennymore to replace the existing 275kV substation. Connect into the new Stella West to Norton 400KV circuits.
NGET	2011	Stella West	Construct a new 400KV 12 bay double busbar substation at Stella West comprising 4 feeder bays, 2 interbus transformer bays, 1 MSC bay, 2 bus couplers and 2 skeletal bays. Install a new 400KV 225MVAr MSCDN
NGET	2011	St Asaph	Construct a new 4-bay 400KV GIS double busbar substation at St Asaph. Connect into the Deeside to Pentir 400kV double circuit with a double tee arangement using 0.5km of single overhead line and single cable circuit. Connect 294MW of offshore windfarm.

NGET	2011	Swansea	Construct a new 400kV GIS substation at Swansea. Turn-in the Pembroke-Cilfynydd 1 & 3 circuits into the new substation. Remove SGT1A 400/275kV transformer and install a new 1100MVA 400/275kV SGT9 feeding the Baglan bay 275kV circuit. Install 3 new 240MVA 400/132kV SGTs feeding the WPD 132kV site. Remove SGT 1B and SGT 2 275/132kV transformers.
NGET	2011	Thorpe Marsh	Construct a new 400KV double busbar AIS substation at Thorpe Marsh with a generator bay for connection of Hatfield Power IGCC. Connected by turn-in of the Brinsworth leg of the Drax-Keadby-Brinsworth circuit. Connect Hatfield 800MW IGCC with CSS.
NGET	2011	Tilbury	Turn the Kingsnorth-Tilbury-Rayleigh 400kV circuit into the new 400kV, 7-bay double-busbar substation at Tilbury. Connect the second circuit of the new Tilbury-West Thurrock-Littlebrook 400kV double-circuit route.
NGET	2011	Walpole	Extend the busbars at Walpole 400kV substation, and connect a new generator bay. Equip the 2nd 400kV section breaker at Walpole.
NGET	2011	West Burton	Reconductor High Marnham – West Burton single circuit (approximately 15km) with Matthew (GAP) conductor (including cable duplication at West Burton)
NGET	2011	Wylfa	Planned closure of Wylfa Nuclear Magnox station (TEC = 980MW).
NGET	2012	Amlwch	Connect 270MW of CCGT generation (Amlwch) at Amlwch 400kV.
NGET	2012	Amlwch	Construct a new 4-bay, indoor, double-busbar, GIS 400kV substation at Amlwch.
NGET	2012	Bramford	Turn in the Pelham-Sizewell 400kV circuit at a new substation extension at Bramford to form Pelham-Bramford and Bramford-Sizewell 400kV circuits. Install a new 400/132kV 240MVA SGT at the new sub at Bramford.
NGET	2012	Brine Field	Construct a new 6 bay 400kV GIS substation at Brine Field comprising 2 feeder bays, 3 skeleton generator bays and 1 bus coupler bay, with space provision for an additional skeleton section bay. Turn in the ZZA Lackenby to Norton 400kV circuit at Tower ZZA228 to form Lackenby-Brine Field and Brine Field-Norton 400kV circuits.

NGET	2012	Brine Field	Connect Brine Field 1020MW CCGT by 31/10/11.
NGET	2012	Carrington	Connect stage 2 of Partington at Carrignton (430MW)
NGET	2012	Cleve Hill	Connect 630MW of offshore windfarm to the new 400KV substation at Cleve Hill
NGET	2012	Iver	Replace the 180MVA SGT3A with a new 240MVA rated SGT. Replace the 500MVA SGT5B with a 1100MVA rated SGT however the rating will remain limited by the connecting cable at 775MVA.
NGET	2012	Lackenby	Connect 299MW MGT Power at Lackenby by extending the GIS substation to provide a connection point
NGET	2012	Overhead Line Works	Construct a new 400kV double-circuit overhead line of length approximately 7.5km, from the existing Pentir-Wylfa 400kV double-circuit overhead line, to a point near Amlwch, using L2 towers and 2 x 700mm2 conductor. Connect the new line to the existing Pentir-Wylfa 400kV double-circuit overhead line using a double-tee arrangement, including a 300m section of underground cable. Connect the new line to the new Amlwch 400kV substation by constructing a new 400kV double-circuit underground cable of length approximately 1km.
NGET	2012	St Asaph	Connect stage 2 (294MW) of Gwynt Y Mor windfarm
NGET	2013	Baglan Bay	Extend the Baglan Bay 275KV substation by one bay to connect Abernedd stage 1 435MW
NGET	2013	Barking	Construct a new generation connection bay and bus coupler at Barking 400kV GIS susbstation and connect 470MW of new CCGT capacity.
NGET	2013	Bramford	Turn the Norwich-Sizewell 400kV circuit into Bramford 400kV substation to form Norwich-Bramford and Bramford-Sizewell 400kV circuits. Uprate the Bramford-Norwich cables entries. Install a new 400kV bus section circuit breaker at Bramford 400kV substation.
NGET	2013	Cable Works	Construct a new 15km tunnel between St Johns Wood and Hackney. Install a 400KV 2550mm XLPE cable between St Johns Wood and Hackeny in the new tunnel. Decommision the existing 275KV cables between St Johns Wood and Tottenham.

NGET	2013	Cable Works	Install an additional 275KV cable per phase on the Baglan Bay - Swansea and Baglan Bay - Margam circuits at the M4 motorway crossing
NGET	2013	Cable Works	Install a second cable per phase on the Ross-on-Wye cable sections of the Rhigos-Walham and Rasssau-Walham 400KV double circuit
NGET	2013	Overhead Line Works	Reconductor the 400KV Harker Hutton double circuit with GAP conductor
NGET	2013	Overhead Line Works	Reconductor the VE route from Swansea through to Pyle with 2x570AAAC at 90C
NGET	2013	St Asaph	Connect stage 3 (147MW) of Gwynt Y Mor windfarm
NGET	2013	Walpole	Connect Race Bank offshore windfarm (500MW) at Walpole 400kV substation.
NGET	2013	Walpole	Extend the 400kV busbars for the connection of two generator bays. Equip the reserve section breaker. Extend the 400kV busbars for three new section bays and one coupler bay. Contsruct three new 400kV section breaker bays and install the breakers. Construct one new 400kV coupler bay and install the breaker. Transfer the Norwich 1 & 2 circuits to the new bays (so that the existing Norwich 1 & 2 breakers can be used for a generation connection). Uprate the HV breakers of SGT1, SGT2 and SGT4. Rebuild Walpole 132kV substation.
NGET	2013	Walpole	Connect the new Sutton Bridge B (1305MW) CCGT at Walpole 400kV substation.
NGET	2013	West Ham	Reposition the West Ham QBs into the West Ham - Barking circuits
NGET	2014	Alverdiscott	Reconfigure the tee-point at Alverdiscott 400KV into a double busbar substation with both Indian Queens and Taunton circuits fully turned in. Connect Bristol Channel Offshore Wind Farm, 1512MW.
NGET	2014	Blyth	Construct a new 400KV 9 bay double busbar GIS substation at Blyth with one new 400/275kV interbus transformer.
NGET	2014	Blyth	Connect 1600MW of new coal fired capacity at Blyth
NGET	2014	Cleve Hill	Connect London Array stage 2 370MW at the new Cleve Hill 400kV substation
NGET	2014	Overhead Line Works	Reconductor the Hartlepool, Saltholme, Norton 275kV circuit with 2X5702mm AAAC conductor operating at 90C.

NGET	2014	Overhead Line Works	Reconductor the Staythorpe-Grendon circuit with GZTACSR conductor
NGET	2014	Rochdale	Install an additional 400/275kV transformer at Rochdale banked with the existing transformer and install a second cable core per phase on the Eggborough entry cables.
NGET	2014	Teesport	Construct a new 400KV 7 bay double bus GIS substation at Teesport. Turn-in the Lackenby to Tod Point OHL circuit to facilitate connection. Connect 925MW of CCGT/IGCC generation.
NGET	2014	Transmission Works	Construction of a new 400kV overhead line crossing over the River Severn and divert the existing Seabank – Whitson – Cilfynydd and Melksham – Imperial Park 400kV circuits on to this new crossing. Divert the existing Iron Acton – Whitson 275kV circuits via the newly vacated 400kV cable tunnel, re-using the existing 400kV cables at 275kV and remove the existing 275kV overhead line crossing with the rationalisation of surrounding circuits.
NGET	2014	Saltholme	Construct a new 400KV GIS substation at Saltholme with an interbus transformer to to connect the existing Hartlepool - Tod Point circuit.
NGET	2014	Tod Point	Replace Tod Point 275/66kV substation with a new GIS 400/66kV substation
NGET	2015	Cable Works	Construct a new 15km tunnel from St Johns Wood to Wimbledon. Install two circuits of 2550mm XLPE cable connecting St Johns Wood to Wimbledon.
NGET	2015	Mid Wales West	Construct a new 6 bay 400kV double busbar AIS substation to be designated Mid Wales West 400kV substation. The substation will comprise 2 feeder bays, a bus coupler bay, and 3 400/132kV SGT bays. The exact location of the substation has yet to be confirmed. Construction of new 4 bay 132kV double busbar AIS substation to be designated Mid Wales West 132kV substation. The substation will comprise 3 SGT bays, a bus coupler bay, and space to allow connection of the wind farm HV generator circuit. The exact location of the substation has yet to be confirmed. Construct a new 400kV double circuit OHL route from the existing Legacy-Shrewsbury-Ironbridge and Legacy-Ironbridge 400kV circuits to the new Mid Wales West 400kV substation. The connection of the new double circuit

			OHL route to the existing Legacy-Shrewsbury-Ironbridge and Legacy-Ironbridge 400kV circuits will be via a double tee arrangement. The location of the tee point has yet to be confirmed. Construct a new 400 kV cable sealing end compound to allow connection of the new 400kV circuit to the existing Legacy-Ironbridge 400kV circuit by establishing a cable duck under.
NGET	2015	Mid Wales West	Connect 191MW of new onshore wind capacity (Carnedd Wen) at Mid Wales West 400kV substation.
NGET	2015	Mid Wales West	Connect 110MW of new onshore wind capacity (Llanbrynmair) at Mid Wales West 400kV substation.
NGET	2015	Saltholme	Extend Saltholme 400kV substation and the Norton 400kV substation with an additional circuit and associated switchgear to facilitlate the reconnection of the Saltholme-Norton circuit 12.38km at 400kV. Install 3x45MVAr MSCDN at Norton 132kV substation.
NGET	2015	Transmission Works	Rationalise the existing 132kV circuit between Trawsfynydd and tower 4ZC70 for 400kV operation restrung with 2x700mm2 conductor. Build a new 3-bay single switch mesh substation at Penisarwaun to allow Tee connection of Trawsfynydd leg of the new Pentir-Trawsfynydd circuit.
NGET	2015	Wimbledon	Install two new 400/275KV transformers to conenct into the two new cables from St Johns Wood.

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Table 6.3 - SYS Boundaries

Boundary Number	Boundary Name	Licensee
B1	North West Export	SHETL
B2	North-South	SHETL
B3	Sloy Export	SHETL
B4	SHETL-SPT	SHETL/SPT
B5	North-South	SPT
B6	SPT-NGET	SPT/NGET
B7	Upper North-North	NGET
B8	North to Midlands	NGET
B9	Midlands to South	NGET
B10	South Coast	NGET
B11	North East & Yorkshire	NGET
B12	South & South West	NGET
B13	South West	NGET
B14	London	NGET
B15	Thames Estuary	NGET
B16	North East, Trent & Yorkshire	NGET
B17	West Midlands	NGET

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Table 6.4 - SYS Study Zones

Zone Nmber	Zone Name	Licensee
Z1	North West (SHETL)	SHETL
Z2	North (SHETL)	SHETL
Z3	Sloy (SHETL)	SHETL
Z4	South (SHETL)	SHETL
Z5	North (SPT)	SPT
Z6	South (SPT)	SPT
Z7	North & NE England	NGET
Z8	Yorkshire	NGET
Z9	NW England & N Wales	NGET
Z10	Trent	NGET
Z11	Midlands	NGET
Z12	Anglia & Bucks	NGET
Z13	S Wales & Central England	NGET
Z14	London	NGET
Z15	Thames Estuary	NGET
Z16	Central S Coast	NGET
Z17	South West England	NGET

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Table 6.5 - Additional Planned Developments on the GB Transmission System

Licensee	Site	Works
NGET	Bramford	Install two switchable series reactors on the Bramford-Pelham feeder circuits at Bramford 400kV substation. Construct a new 16 bay 400kV GIS substation at Bramford, with four Sizewell, two Norwich, one Pelham and one Braintree/Rayleigh Main feeder bays, four SGT bays, two bus section and two bus coupler bays. Connect the new substation via one Pelham, one Braintree/ Rayleigh Main and two Bramford circuits tee-ed connections into the existing Sizewell-Bramford 400kV circuits. Extend the Bramford double busbar 400kV AIS by one coupler bay, converting one existing couple into a section bay, rearranging the feeder circuits to form two Sizewell circuits, one Twinstead Tee/Pelham and one Braintree/Rayleigh Main feeder bay (Twinstead Tee is the point where the current Bramford to Braintree to Rayleigh route diverges from the current Bramford to Pelham route).
NGET	Bradwell	Construct a new five-bay 400kV double-busbar AIS substation at Bradwell, with two feeder circuits to Rayleigh Main, two skeletal generation bays and one coupler.
NGET	Overhead Line Works	Rebuild the Bradwell-Rayleigh Main route using a new design of tower, new foundations and strung with 2x570mm2 AAAC conductor operating at up to 90C.
NGET	Rayleigh	Extend the Rayleigh Main 400kV double busbar 400kV AIS section 2 bays to facilitate two new Bradwell 400kV feeder bays.
NGET	Overhead Line Works	Reconductor the Twinstead tee-Pelham overhead line route with 3x700mm2 AAAC conductor at 75C. Construct a new double circuit overhead line between the Bramford and the Twinstead Tee point strung with 3x700mm2 AAAC conductor at 75C (28km). At Twinstead Tee rearrange the overhead line circuit to form the Bramford-Twinstead Tee-Pelham double circuit and Bramford-Twinstead Tee-Braintree-Rayleigh Main double circuit. Reconductor the Sizewell-Bramford circuit 1 and 3 overhead line route with 3x700mm2 AAAC conductor.
NGET	Overhead Line Works	Reconductor the Rayleigh Main-Coryton South-Tilbury overhead line route with 2x620mm2 GZTACSR GAP conductor.

NGET	Sizewell North	Construct a new 400kV GIS substation at Sizewell North, with four Bramford feeder circuits, four series reactor circuits, four skeletal generation bays, two bus sections and two bus coupler bays. Connect the new substation via two tee-ed connections into the existing Sizewell-Bramford 400kV circuits. Install two new 400kV 3000MVA reactors proximate to the new Sizewell North 400kV GIS substation site.
NGET	Lydd	Construct a new 400kV substation at Lydd. Connect the new substation into the Sellindge-Dungeness-Ninfield 400kV route, forming the following 400kV circuits: Sellindge-Lydd 1 & 2, Lydd-Dungeness 1 & 2, and Lydd-Ninfield 1 & 2.
NGET	Rowdown	Install a new 10 bay 400kV GIS double busbar substation at Rowdown consisting of 6 feeder bays, two bus couplers and two bus sections. The work includes decommissioning of two disconnectors at the site.
NGET	Overhead Line and Underground Cable Works	Construct a new 400kV double circuit 2x700mm2 overhead line between the new Lydd substation and the new Rowdown substation (95km). The route includes 4km of cable tunnel. Reconductor 8km of overhead line between Littlebrook and the Longfield tee on the Littlebrook-Kemsley-Rowdown 400kV 1 & 2 circuits, with 2x500mm2 AAAC conductor operating at 75C. Reconductor the Beddington-Chessington 275kV 1 & 2 circuits with 2x570mm2 AAAC conductor operating at 75C. At Beddington, replace 200m of 1200 mm2 of XLPE cable with 2500mm2 XLPE cable on the Beddington-Chessington 275kV circuits, matching the overhead line rating.
NGET	Hinkley Point	Construct a new 18-bay, 400kV GIS double-busbar substation at Hinkley Point, consisting of eight feeder bays, two bus couplers, four bus sections, two skeletal generation bays and two skeletal station transformer bays. Construct two new 400kV cable interconnectors between the new 400kV GIS substation and the existing 400kV AIS substation (approximately 1km). Decommission two feeder bays at the existing 400kV AIS substation, to be used for the cable interconnector circuits to the new 400kV GIS substation. Extend the six existing 400kV and 275kV feeder circuits at Hinkley Point to run to the new 400kV GIS substation. Decommission the two Bridgwater feeder bays at Hinkley Point 275kV substation.
NGET	Bridgwater	Replace the existing 275kV busbars and switchgear with 400kV equipment. Replace the two existing 275/132kV SGTs with 400/132kV units.
NGET	Seabank	Extend the existing 400kV GIS substation at Seabank by a feeder bay at either end of the substation (for the new Hinkley Point-Seabank circuits).
NGET	Tockington	Construct a new 400kV two-switch mesh substation near Tockington, where the Seabank overhead line circuits turn in the Melksham-Whitson/Cilfynydd route.

NGET	Overhead Line Works	Break into the existing Hinkley Point-Melksham overhead line route near the M5 motorway. Hot-wire the Melksham leg of this route to 90C operation and tee it into the Hinkley Point-Bridgwater circuit by a 3.5km section of new overhead line. Uprate the Hinkley Point-Bridgwater 275kV route to 400kV operation, and reconductor from the tee-point to Hinkley Point with 2x500mm2 AAAC conductor at 90C operation. Construct a new double-circuit overhead line between the Hinkley Point leg of the broken Hinkley Point-Melksham route and Seabank 400kV substation (40km). Hot-wire both the overhead line circuits on the Tockington-Melksham route to 65C operation. Reconductor the Seabank leg of the Seabank-Melksham overhead line circuit with 2x850mm2 AAAC conductor to operate at a maximum of 75C.
NGET	Fawley	Install two 400kV quadrature boosters at Fawley on the Fawley-Botley Wood and Fawley-Lovedean circuits.
NGET	Overhead Line and Underground Cable Works	Reconductor both of the Langage-Abham-Exeter overhead line circuits with 2x500mmm2 AAAC conductor to operate at a maximum of 75C. Reconductor both of the Bramley-Melksham overhead line circuits with GAP conductor. Reconductor both of the Bramley-West Weybridge overhead line circuits with 2x500mmm2 AAAC conductor to operate at a maximum of 75C. Bank both of the existing 400kV cables in the Cowley-Minety circuit, and install new cables in the 400kV Cowley-Walham circuit.
NGET	Tilbury	Install 2 bus sections, one bus coupler, and two 400/275kV SGT bays at Tilbury 400kV GIS substation. Install two switchable series reactors on Rayleigh Main and Coryton South feeder circuits at Tilbury 400kV GIS substation. At Tilbury 400kV GIS substation, install a new bus coupler bay, two new reactor bays, two new 400/275kV SGT bays (removing current tee-ed connections), two new skeletal generation bays, and populate two skeletal section bays within that design. Install a new 3000MVA 400kV series reactor at Tilbury, by relocating SGT4 to an alternate bay location.
NGET	Baglan Bay	Connect 435MW of new CCGT capacity (Baglan Bay 2 Stage 2) at Baglan Bay substation.
NGET	Kings Lynn	Construct a new 400kV GIS substation at King's Lynn, consisting of two 400kV feeder circuits (Walpole and Norwich legs), three 400kV generator skeletal bays, and one bus coupler bay. Turn in the existing Walpole-Norwich 400kV overhead line into the new substation. Construct a new 2.5km double-circuit overhead line from the turn-in to the new substation.
NGET	Walpole	Connect 981MW of new CCGT capacity (Kings Lynn B) at Walpole substation.
NGET	Tilbury	Connect 469MW of additional coal-fired capacity (Tilbury Stage 2) at Tilbury substation.

NGET	Transmission Works	Install two 2000MVA switchable series reactors at West Thurrock on the new 400KV Littlebrook-Barking-Tilbury circuits. Reconductor 65km of 400kV Kemsley-Longfield Tee-Rowdown overhead line sections with a combination of 2x620mm2 GZTACSR GAP conductor on L2 and L8 constructed sections and 3x700mm2 AAAC on L6 constructed sections. On the Littlebrook-Hurst 275kV circuits, replace coolers on the existing 950MVA 400/275kV SGTs. Re-conductor the 5km of overhead line circuit elements with 2x570mm2 AAAC conductor and replace the 2.5km of cable element of these circuits near Hurst substation with a combination of direct buried and thrust-bored installed 2x2550mm2 XLPE cable (2.5km). Connect a new 15km St Johns Wood-Wimbledon 400kV cable tunnel route via Kensal Green. Extend St John's Wood and Wimbledon substations.
NGET	North Wales	Increase the thermal capability of the existing Pentir-Trawsfynydd 400kV circuit by doubling up the cable sections between Pentir and tower 4ZC157, between Trawsfynydd and tower 4ZC5, and the cable section across the Glaslyn estuary. Hotwire the Legacy sections of the Deeside-Trawsfynydd-Legacy 1 & 2 circuits for operation at 90C.
NGET	Overhead Line Works	Hotwire the Drakelow-Hams Hall 400kV circuits for operation at 90C.
NGET	Wylfa	Connect 1670MW of new EPR nuclear generation at Wylfa 400kV substation.
NGET	Damhead Creek	Construct a new 14 bay 400kV Damhead Creek GIS substation, consisting of a Tilbury feeder circuit, a Grain feeder circuit, a Northfleet East feeder circuit, 2 x 3000MVA rated interbus connections to a single interconnector between the existing Kingsnorth substation and the new Damhead Creek substation, 2 series reactor bays, 2 bus section bays, 2 bus coupler bays and 3 skeleton generator bays. Divert the Grain-Tilbury overhead line route into the new substation such that the above GIS substation is looped into the Grain-Tilbury circuit. Install two new skeletal generation bays for the Damhead Creek 2 power station generation connections at the above Damhead Creek 400kV substation. Divert the Northfleet East- Kingsnorth 400kV route into the new Damhead Creek 400kV substation described above. Install an interconnector between Kingsnorth 400kV substation and the new 400kV substation at Damhead Creek. Relocate the Kingsnorth series reactor 2 to the new 400kV substation at Damhead Creek.
NGET	Damhead Creek	Connect 493MW of new CCGT capacity (Damhead Creek Bay 2 Stage 1) at Damhead Creek substation.

NGET	Transmission Works	Install two 2750MVA quadrature boosters on the Kingsnorth-Tilbury and Damhead-Tilbury circuits. Install a 7 bay 400kV double busbar AIS substation at Warley. Install a 14 bay 400kV GIS double busbar substation at Waltham Cross. Install 2 feeder bays and 1 skeleton section at Elstree 400kV. Install 2 feeder bays and 1 interbus transformer bay at Tilbury 400kV. Upgrade one of the two 275kV Tilbury to Elstree circuits (ZB route) to 400kV and reconductor with 2x620mm2 GZTACSR “GAP” conductor, looping this route into the new Warley and Waltham Cross 400kV substations. Replace two out of the 3 x 275/132kV transformers at Warley with 400/132kV transformers.
NGET	Hinkley Point West	Construct a new 8-bay 400kV GIS double-busbar substation (Hinkley Point West) at Hinkley Point (adjacent to the proposed Hinkley Point C 400kV GIS substation), with two feeder bays, one bus coupler, one bus section, two interbus reactor bays and two skeletal generator bays. Install two new 3000MVA 400kV interbus reactors. Reconfigure the Hinkley Point C 400kV GIS substation, transferring both Seabank circuits to the new Hinkley Point West 400kV GIS substation and re-use two feeder bays for the cable/tower interconnector circuits to the EDF substation (through reactors).
NGET	Hinkley Point West	Connect 1600MW of new EPR nuclear generation at Hinkley Point West 400kV substation.
NGET	Oldbury-on-Severn	Construct a new six-bay, double-busbar 400kV substation at Oldbury-on-Severn, consisting of two feeder bays, one bus coupler, one skeletal generator bay and one skeletal station transformer bay. Construct new Tockington – Oldbury-on-Severn and Oldbury-on-Severn – Melksham 400kV circuits, by utilising the existing NGET 132kV route and a short section of line currently owned by WPD. Underground the following overhead lines, as the new 400kV route needs to cross these circuits: Iron Acton - Whitson 1 & 2, and Iron Acton - Oldbury-on-Severn 2 & 3.
NGET	Oldbury-on-Severn	Connect 1600MW of new EPR nuclear generation at Oldbury-on-Severn 400kV substation.
NGET	Overhead Line Works	Reconductor the existing overhead line section of the Hinkley Point-Melksham double circuit with GAP conductor (L2 towers), and install 2 x 850mm2 AAAC at 90C on the new build section of the overhead line route (L12 towers). Reconductor the existing overhead line section of the Hinkley Point-Seabank double circuit with GAP conductor (L2 towers), and install 2 x 850mm2 AAAC at 90C on the new build section of the overhead line route (L12 towers). Reconfigure the Melksham 400kV line entries by swapping one of the Hinkley Point-Melksham circuits with one of the Bramley-Melksham circuits. Construct a short section of new overhead line (approximately 800m) between the line entries of the above two circuits. Reconductor the existing overhead line section of the Bramley-Melksham double circuit with GAP conductor (L2 towers), and install 2 x 850mm2 AAAC at 90C on the new build section of the overhead line route

		(L12 towers).
NGET	Underground Cable Works	Double the cable circuits on the Cowley-Minety section of the Hinksey cables.
NGET	Wylfa	Establish a new 400kV double-busbar GIS substation at Wylfa, comprising a bus coupler bay, three feeder bays, 2 SGT bays, 2 section switches and a skeletal generator bay. Reroute the HV SGT 1 and SGT3 connections from the Wylfa AIS 400kV substation into the new Wylfa GIS 400kV substation.
NGET	Pentir	Extend the 400kV Main and Reserve busbars to allow installation of the feeder bay for the 4th Wylfa circuit. Install a new 400kV 2000MVA 2% series reactor. Install 2 feeder bays for the 3rd and 4th Pentir-Deeside 400kV circuits.
NGET	Deeside	Install 2 new feeder bays for the 3rd and 4th Pentir-Deeside 400kV circuits.
NGET	Legacy	Install 2 new feeder bays for the new Trawsfynydd-Legacy 400kV double circuit. Install 2 new feeder bays for the new Legacy-Cellarhead 400kV double circuit. Install a new 400kV bus coupler between Main and Reserve busbar 1.
NGET	Cellarhead	Install 2 new feeder bays for the new Cellarhead-Legacy 400kV double circuit. Install a new 400kV bus coupler in Main and Reserve bar 2.
NGET	Transmission Works	Establish the 4th circuit between Wylfa and Pentir, connecting to the new Wylfa 400kV GIS substation. Reroute the Trawsfynydd legs of the Deeside-Legacy-Trawsfynydd 400kV double circuit from the Treuddyn tee point into Legacy and reconductor the circuits with 2x620mm2 GAP conductor. Establish a new (approximately 80km) 400kV double circuit between Legacy and Cellarhead. Establish a new 400kV double circuit between Pentir and Deeside (approx 80km). Reconductor the Legacy-Ironbridge and the Legacy-Shrewsbury-Ironbridge 400kV circuits with 2x620mm2 GAP conductor. Reconductor the Cellarhead-Drakelow 400kV circuit with 2x620mm2 GAP conductor. Reconductor the Drakelow-Hams Hall 400kV circuit with 2x620mm2 GAP conductor. Hotwire the Pentir-Deeside circuit from the Gwynt-y-Môr tee point to Deeside for operation at 75C.
NGET	Transmission Works	Establish a new 400kV circuit from Pentir to Trawsfynydd. Increase the thermal capability of the existing Pentir-Trawsfynydd 400kV circuit by doubling up the cable sections of the circuit between Pentir and tower 4ZC157, between Trawsfynydd and tower 4ZC5 and the 6km cable section that crosses the Glaslyn Estuary. Establish a new 400kV circuit from Wylfa – Pentir. Connect the new 400kV circuit at Pentir into the bay currently occupied by the Deeside 1 circuit. Transpose the Deeside 1 circuit onto the Bus Coupler 1 circuit with the Bus Coupler being replanted. Install a circuit breaker in the reserve bus-section bay at Pentir 400kV substation.

NGET	Reactive Compensation	Install reactive compensation plant at following sites: 0-270MVAr SVC at Drakelow 400kV substation, 225MVAr MSCDN at Legacy 400kV substation, 225MVAr MSCDN at Trawsfynydd 400kV substation, 225MVAr MSCDN at Ironbridge 400kV substation, 225MVAr MSCDN at Cellarhead 400kV substation, 225MVAr MSCDN at Feckenham 400kV substation.
NGET	Wylfa	Extend the Main and Reserve busbars and install a section switch in Main and Reserve busbar 2. Install a skeletal generator bay. Install a new feeder bay at Wylfa GIS 400kV substation and 2 new SGT bays. Reroute the HV SGT 2 and SGT4 connections from the Wylfa AIS 400kV substation into the new GIS 400kV substation. Reroute the Wylfa-Pentir 1 and 2 circuits from the Wylfa AIS 400kV substation to the new Wylfa GIS 400kV substation.
NGET	Damhead Creek	Connect 493MW of new CCGT capacity (Damhead Creek Bay 2 Stage 2) at Damhead Creek substation.
NGET	Spalding North	Extend the Spalding North 400kV busbars for two new section bays, one new coupler bay, three new line bays (one existing line bay to have underpass), and three new generator bays. Construct two new 400kV bus section bays and install new breakers. Construct two new 400kV line bays and install new breakers. Construct a new 400kV coupler bay and install a new breaker. Construct a new 5.5km 400kV double circuit overhead line from the Spalding North substation and connected via a double-turn-in arrangement to the existing Walpole-Bicker Fen overhead line route, to form a Walpole-Spalding North double circuit and a Spalding North-Bicker Fen double circuit.
NGET	Spalding North	Connect 840MW of new CCGT generation (South Holland power station) at Spalding North 400kV substation.
NGET	Huntspill	Connect 950MW of new CCGT/OCGT generation (Huntspill) at Huntspill 400kV substation.
NGET	Overhead Line Works	Hot-wire the 68km L2 Walham-Feckenham overhead line circuit to 90C operation (currently 2x500mm2 AAAC conductor at 75C).
NGET	Overhead Line Works	Hot-wire the 36km L6 Cowley-East Claydon overhead line circuit to 65C operation (currently 4x400mm2 ACSR conductor at 50C).
NGET	Overhead Line Works	Reconductor the Hinkley Point-Melksham double-circuit overhead line with GAP-type conductor.

NGET	Transmission Works	Install a third 400/132kV transformer at Warley 400kV substation. Reconductor the Barking-Northfleet East (ZR route) with GAP conductor, including the Thames Crossings. Upgrade the 2nd 275kV Tilbury to Elstree circuit (ZB route) to 400kV and reconductor with GAP conductor, looping into Warley and Waltham cross 400kV substations. Upgrade the Waltham Cross to Tottenham (ZBC route) to 400kV and reconductor with GAP conductor. Upgrade the Tottenham-Hackney (VC route) to 400kV and reconductor with GAP conductor. Replace two 275/132kV transformers at Brimsdown (on ZBC route) with 2x400/132 transformers tee connected to the new Waltham Cross-Hackney overhead line circuits. Replace the 2 x 400/66kV transformers at Hackney with 2 x 400/66kV SGTs tee connected into the Waltham Cross-Hackney route.
NGET	Transmission Works	Reconductor the Staythorpe-Ratcliffe 400kV overhead line circuit with GAP conductor for 75°C operation. At Sundon 400kV substation, install two new 400kV 2000MVA series reactors in the Sundon-Wymondley and the Sundon-Pelham 400kV circuits. Upgrade the Waltham Cross-Tottenham (ZBC route) to 400kV and re-conductor with GAP. Similarly upgrade the Hackney-Tottenham YYJ route. Install two new 400kV quadrature boosters of 3000MVA continuous rating on the Burwell-Pelham 400kV circuits. Install new gantry towers at Pelham 400kV substation, reconductoring with two spans of 3x700mm2 AAAC and installing associated down leads.
NGET	Wylfa	Extend Main and Reserve busbar 3 and install a section switch in Main bar 3 and Reserve bar 3 at the new Wylfa GIS 400kV substation. Install a bus coupler to connect Main bar 4 and Reserve bar 4 at Wylfa GIS 400kV substation. Install a skeletal generator bay.
NGET	Huntspill	Construct a new 7-bay, 400kV, double-busbar AIS substation at Huntspill, with four feeder bays, one bus coupler bay and two skeletal generator bays. Turn both circuits of the existing Hinkley Point-Melksham 400kV double-circuit line into the new substation.
NGET	Overhead Line Works	Reconductor the Minety-Feckenham overhead line circuit with GAP-type conductor. Reconductor the Melksham-Minety double-circuit overhead line circuit with GAP-type conductor.
NGET	Overhead Line Works	Reconductor the existing overhead line section of the Hinkley Point-Seabank double-circuit with GAP-type conductor (L2 towers) and install 2x850mm2 AAAC at 90C on the new build section of the route (L12 towers).

NGET	Mucking Flats	Construct a six-bay in-line double busbar AIS substation directly adjacent and to the north of the Rayleigh Main-Tilbury 400kV ZJ route between towers ZJ033 and ZJ034 at the point of convergence with the Coryton-Rayleigh/ Tilbury 400kV ZJA route. This will consist of 3 skeletal generation bay spaces (i.e. busbar extension) to cater for each CCGT generator circuit to be populated, 2 bays to facilitate a loop in to the existing Rayleigh Main-Tilbury 400kV circuit, and 1 bay for a bus coupler breaker. Create a single-circuit temporary bypass on the Coryton South-Tilbury 400kV circuit between towers ZJ025 and ZJ027 to remove the need for a double circuit outage. Turn in the Rayleigh-Tilbury 400kV overhead line circuit to the new 400kV substation at Stanford Le Hope using 2x850mm² AAAC downleads on to gantries to match the rating of the conductor forming the Rayleigh-Tilbury route following reconductoring associated with the Bradwell connections. Construct one new “DJT” tension tower to facilitate the loop-in to Stanford le Hope (existing adjacent towers are suspension towers only).
NGET	Mucking Flats	Connect 840MW of new CCGT generation (Thames Haven power station) at Mucking Flats 400kV substation.
NGET	Transmission Works	Install two new 400kV quadrature boosters (QBs) on the Barking-West Ham circuits of 3000MVA continuous rating at Barking via extended Gas insulated Busbar connections, requiring extension of the existing Barking substation site, replacing the existing 2000MVA QB units at West Ham. Bypass the existing West Ham QBs and new 400kV cable to uprate connections into West Ham substation of which immediate connections will be made via a gas insulated busbar extension. Re-conductor both Barking-West Ham 400kV circuits (ZR route, 12km) with 2x620mm² Matthew GTZACSR (GAP) conductor at 170C. Reconductor the overhead line section of the Littlebrook-Hurst VN route (from Littlebrook to Crayford, some 5.42km) using 2x570mm² Sorbus AAAC conductor for 400kV operation. Construct a thrust-bored cable tunnel from Hurst to Crayford with equivalent rating to the Hurst-Eltham cable tunnel (1217/1190/1100MVA Winter/Spring & Autumn/Summer rating). Replace the 2.12km cable from Crayford to Hurst on the VN route with 2 x 400kV XLPE cable elements rated at 1770MVA. Install two new 400/275kV 1100MVA interbus SGTs at Hurst on the Littlebrook-Hurst circuits along with revised cable interfaces on mesh corners 4 and 2, in line with circuit transpositions proposed under the South London medium term strategy work. Install two new 400kV Quad Boosters of 3000MVA continuous rating on the new Lydd-Rowdown circuits. Install a new bus coupler at Rayleigh Main 400kV substation, and re-distribute the ZT circuits, such that that Bradwell-Rayleigh circuit 1 is re-distributed to the Rayleigh main busbar 1. Move the Rayleigh Main-Coryton South circuit southwards to allow space to extend Rayleigh Main. This work will be conducted at the same time as that associated with works at Rayleigh associated with the connection of a new Rayleigh-Bradwell 400kV double

		circuit.